

Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (CNC Machining) (1712-31)

November 2022 Version 2.0



Qualification at a glance

Subject area	Mechanical Manufacturing Engineering
City & Guilds number	1712-31
Age group approved	16+
Entry requirements	None
Assessment	Portfolio of evidence
Automatic approval	Available
Support materials	Centre handbook
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering – CNC Machining	439	1060	1712-31	601/0081/3

Version and date	Change detail	Section
1.1 February 2018	Added TQT and GLH details Deleted QCF	Qualification at a Glance, Structure Throughout
1.2 October 2018	Changed from a seven to a nine	Unit 201 Assessment criteria 2.3
2.0 November 2022	Adjusted document to only fit extended diploma requirements, as the original diploma has expired Adjusted TQT & GLH Added PEO Requirements Links updated throughout	Structure GLH & TQT Throughout



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1 Introduction

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

Area	Description
Who is the qualification for?	It is for candidates who work or want to work as mechanical manufacturing engineers – CNC machining 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.
Is the qualification part of a framework or initiative?	It serves as a competence qualification, in the Engineering Apprenticeship framework.
What opportunities for progression are there?	It allows candidates to progress into employment or to the following City & Guilds qualifications: <ul style="list-style-type: none">• City & Guilds Level 4 engineering qualifications• Foundation degree or other higher education qualifications

Structure

To achieve the **Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering (CNC Machining)**, Learners must also achieve the minimum requirements from the Performing Engineering Operations (PEO) units, which can be found on the “1712 L2 Unit pack” document on the mechanical manufacturing engineering (1712) page (cityandguilds.com):

- A minimum of **27 credits** and **3 units** from PEO pathway A (704-761, 765-773), or:
- A minimum of **51 credits** must be achieved from PEO pathway B: this must be achieved from:
 - **11 credits** and **1 unit** from group B1 (704, 731,761)
 - **16 credits** and **2 units** from group B2 (762-764) and
 - **24 credits** and **2 units** from group B3 (765-768)
- If PEO pathway A is undertaken learners **must** note the following barred units
 - Only one unit from 704, 732 and 761 may be included in the learner’s choice of three units
 - If unit 765 is selected units 705, 706, 708, 711, 712, 715, 716, 717 cannot be included in the learner’s choice of three units
 - If unit 766 is selected units 710, 722, 723, 725, 726, 727, 728, 729, 730, 734 cannot be included in the learner’s choice of three units.
 - If unit 767 is selected units 733, 735, 736, 740 cannot be included in the learners choice of three units.
 - If unit 768 is selected units 719, 721, 737, 738, 739, 740, 758, 759 cannot be included in the learner’s choice of three units.

Learners must also achieve **15** credits from the mandatory units and a minimum of **111** credits from **1** of the optional groups available

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Mandatory			
A/601/5013	Unit 201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	Unit 202	Using and Interpreting engineering data and documentation	5
K/601/5055	Unit 303	Working efficiently and effectively in engineering	5
Optional Group A			

L/600/5523	Unit 330	Loading and proving CNC machine tool programs	24
M/600/5529	Unit 331	Carrying out CNC machine tool programming	84
Optional Group B			
H/600/5561	Unit 332	Setting CNC turning machines for production	70
F/600/5566	Unit 333	Machining components using CNC turning machines	63
Optional Group C			
R/600/5572	Unit 334	Setting CNC milling machines for production	70
K/600/5576	Unit 335	Machining components using CNC milling machines	63
Optional Group D			
J/600/5584	Unit 336	Setting CNC grinding machines for production	70
R/600/5622	Unit 337	Machining components using CNC grinding machines	63
Optional Group E			
K/600/5643	Unit 338	Setting CNC punching machines for production	70
T/600/5662	Unit 339	Machining components using CNC punching machines	63
Optional Group F			
R/600/5670	Unit 340	Setting CNC laser profiling machines for production	70

H/600/5916	Unit 341	Machining components using CNC laser profiling machines	63
Optional Group G			
M/600/5921	Unit 342	Setting CNC electro-discharge machines for production	70
F/600/5924	Unit 343	Machining components using CNC electro-discharge machines	63
Optional Group H			
R/600/5927	Unit 344	Setting CNC vertical boring machines for production	70
Y/600/5928	Unit 345	Machining components using CNC vertical boring machines	63
Optional Group I			
K/600/5951	Unit 346	Setting CNC horizontal boring machines for production	70
K/600/5965	Unit 347	Machining components using CNC horizontal boring machines	63
Optional Group J			
L/600/5974	Unit 348	Setting CNC gear cutting machines for production	70
D/600/5980	Unit 349	Machining components using CNC gear cutting machines	63
Optional Group K			
L/600/5991	Unit 350	Setting CNC machining centres for production	78
D/600/5994	Unit 351	Machining components using CNC machining centres	63

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering - CNC Machining	439	1060



2 Centre requirements

Approval

Centres currently offering the City & Guilds Level 3 NVQ in Mechanical Manufacturing Engineering (1682) will be automatically approved to run this new qualification.

To offer this qualification new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual - Supporting Customer Excellence for further information.

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

Resource requirements

Centre staffing

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

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

Centre staff may undertake more than one role, e.g. tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors and internal verifier

Assessor Requirements to Demonstrate Effective Assessment Practice

Assessment must be carried out by competent Assessors that as a minimum must hold the Level 3 Award in Assessing Competence in the Work Environment. Current and operational assessors that hold units D32 and/or D33 or A1 and/or A2 as appropriate 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 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 Awarding Organisation's assessment recording documentation used for the 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 Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this 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 Level 3 Award in Assessing Competence in the Work Environment.

External quality assurance (**External Verification**) must be carried out by competent External Verifiers that as a minimum must hold the Level 4 Award in the External Quality Assurance of Assessment Processes and Practices. Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this 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 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 NVQ units against which the assessments and verification are to be carried out, the appropriate Regulatory Body's systems and procedures and the relevant Awarding Organisation's documentation.

Continuing Professional Development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Candidate entry requirements

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

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 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 take the same form as in the workplace.

Age restrictions

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

Legal restrictions apply to candidates under the age of 18 working unsupervised with children. Centres and candidates should be fully aware of minimum age requirements in their home nation and any implications for completing assessments.



3 Delivering the qualification

Initial assessment and induction

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

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

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

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.

Recording documents

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

City & Guilds endorses several ePortfolio systems. Further details are available at: www.cityandguilds.com/eportfolios.

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

Recording forms are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre.

Amendable (MS Word) versions of the forms are available on the City & Guilds website.



4 Assessment

Assessment of the qualification

Candidates must have a completed portfolio of evidence for each unit chosen.

Evidence requirements

Carrying Out Assessments

The NVQ units were specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the learner's 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
- 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 (qualifications consultant) 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 (the Sector Skills Council) expect 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.

Recognition of Prior Learning (RPL)

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



5 Units

Availability of units

The following units can also be obtained from The Register of Regulated Qualifications: **The Register of Regulated Qualifications: Home page (ofqual.gov.uk)**

Structure of units

These units each have the following:

- City & Guilds unit number
- Title
- Unit Accreditation Number (UAN)
- Level
- Credit value
- Recommended Guided Learning Hours (GLH)
- Relationship to NOS, other qualifications and frameworks
- Endorsement by a sector or other appropriate body
- Unit aim(s)
- Learning outcomes which are comprised of a number of assessment criteria.

Unit 201

Complying with statutory regulations and organisational safety requirements

UAN:	A/601/5013
Level:	2
Credit value:	5
GLH:	35
Relationship to NOS:	This unit has been derived from Semta national occupational standard: Complying with statutory regulations and organisational safety requirements (Suite 2).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
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 outcome
The learner will: 1. comply with statutory regulations and organisational safety requirements
Assessment criteria
The learner can: 1.1 comply with their duties and obligations as defined in the Health and Safety at Work Act 1.2 demonstrate their understanding of their duties and obligations to health and safety by: <ul style="list-style-type: none">• 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:<ul style="list-style-type: none">- 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 1.3 present themselves in the workplace suitably prepared for the activities to be undertaken

1.4	follow organisational accident and emergency procedures
1.5	comply with emergency requirements, to include: <ul style="list-style-type: none"> • 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
1.6	recognise and control hazards in the workplace
1.7	identify the hazards and risks that are associated with the following: <ul style="list-style-type: none"> • 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
1.8	use correct manual lifting and carrying techniques
1.9	demonstrate one of the following methods of manual lifting and carrying: <ul style="list-style-type: none"> • lifting alone • with assistance of others • with mechanical assistance
1.10	apply safe working practices and procedures to include: <ul style="list-style-type: none"> • 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.

Learning outcome	
The learner will:	
2.	know how to comply with statutory regulations and organisational safety requirements
Assessment criteria	
The learner can:	
2.1	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)
2.2	describe the specific regulations and safe working practices and procedures that apply to their work activities
2.3	describe the warning signs for the nine main groups of hazardous

- substances defined by Classification, Packaging and Labelling of Dangerous Substances Regulations
- 2.4 explain how to locate relevant health and safety information for their tasks, and the sources of expert assistance when help is needed
 - 2.5 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)
 - 2.6 describe their responsibilities for identifying and dealing with hazards and reducing risks in the workplace
 - 2.7 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)
 - 2.8 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)
 - 2.9 describe the first aid facilities that exist within their work area and within the organisation in general; the procedures to be followed in the case of accidents involving injury
 - 2.10 explain what constitute dangerous occurrences and hazardous malfunctions, and why these must be reported even if no-one is injured
 - 2.11 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
 - 2.12 describe the organisational policy with regard to fire fighting procedures; the common causes of fire and what they can do to help prevent them
 - 2.13 describe the protective clothing and equipment that is available for their areas of activity
 - 2.14 explain how to safely lift and carry loads, and the manual and mechanical aids available
 - 2.15 explain how to prepare and maintain safe working areas; the standards and procedures to ensure good housekeeping
 - 2.16 describe the importance of safe storage of tools, equipment, materials and products
 - 2.17 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

UAN:	Y/601/5102
Level:	2
Credit value:	5
GLH:	25
Relationship to NOS:	This unit has been derived from Semta national occupational standard: Using and interpreting engineering data and documentation (Suite 2).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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.</p>

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 outcome
The learner will: 1. use and interpret engineering data and documentation
Assessment criteria
The learner can: 1.1 use the approved source to obtain the required data and documentation 1.2 use the data and documentation and carry out all of the following: <ul style="list-style-type: none">• 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 1.3 correctly identify, interpret and extract the required information 1.4 extract information that includes three of the following: <ul style="list-style-type: none">• materials or components required• dimensions• tolerances• build quality• installation requirements• customer requirements• time scales• 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
- 1.5 use the information obtained to ensure that work output meets the specification
- 1.6 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
- 1.7 use information extracted from related documentation, to include two from the following:
- instructions (such as job instructions, drawing instructions, manufacturers instructions)

	<ul style="list-style-type: none"> • 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
1.8	deal promptly and effectively with any problems within their control and report those which cannot be solved
1.9	report any inaccuracies or discrepancies in documentation and specifications.

Learning outcome	
The learner will:	
2. know how to use and interpret engineering data and documentation	
Assessment criteria	
The learner can:	
2.1	explain what information sources are used for the data and documentation that they use in their work activities
2.2	explain how documents are obtained, and how to check that they are current and valid
2.3	explain the basic principles of confidentiality (including what information should be available and to whom)
2.4	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)
2.5	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)
2.6	describe the importance of differentiating fact from opinion when reviewing data and documentation
2.7	describe the importance of analysing all available data and documentation before decisions are made
2.8	describe the different ways of storing and organising data and documentation to ensure easy access
2.9	describe the procedures for reporting discrepancies in the data or documentation, and for reporting lost or damaged documents
2.10	describe the importance of keeping all data and documentation up

to date during the work activity, and the implications of this not being done

- 2.11 explain the care and control procedures for the documents, and how damage or graffiti on documents can lead to scrapped work
- 2.12 explain the importance of returning documents to the designated location on completion of the work activities
- 2.13 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)
- 2.14 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)
- 2.15 explain the imperial and metric systems of measurement; tolerancing and fixed reference points
- 2.16 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)
- 2.17 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.

Unit 303

Working efficiently and effectively in engineering

UAN:	K/601/5055
Level:	3
Credit value:	5
GLH:	25
Relationship to NOS:	This unit has been derived from Semta national occupational standard: Working efficiently and effectively in engineering (Suite 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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 that any tools, equipment, materials and other resources required are available and in a safe and usable condition.</p> <p>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.</p> <p>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</p>

colleagues and line management. The learner will also be expected to review objectives and targets for their personal development and make recommendations 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 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 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 contribute to improvements, 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.

Learning outcome
The learner will: 1. work efficiently and effectively in engineering
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 prepare the work area to carry out the engineering activity 1.3 prepare to carry out the engineering activity, taking into consideration all of the following, as applicable to the work to be undertaken: <ul style="list-style-type: none">• the work area is free from hazards and is 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
- 1.4 check that there are sufficient supplies of materials and/or consumables and that they meet work requirements
- 1.5 ensure that completed products or resources are stored in the appropriate location on completion of the activities
- 1.6 complete work activities, to include all of the following:
- completing all necessary documentation accurately and legibly
 - returning tools and equipment
 - returning drawings and work instructions
 - identifying, where appropriate, any unusable tools, equipment or components
 - arranging for disposal of waste materials
- 1.7 tidy up the work area on completion of the engineering activity
- 1.8 deal promptly and effectively with problems within their control and report those that cannot be resolved
- 1.9 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
- 1.10 contribute to and communicate opportunities for improvement to working practices and procedures
- 1.11 make recommendations for improving to two of the following:
- working practices
 - working methods
 - quality
 - safety
 - tools and equipment
 - supplier relationships
 - internal communication
 - customer service
 - training and development
 - teamwork
 - other
- 1.12 maintain effective working relationships with colleagues to include

two of the following:

- colleagues within own working group
- colleagues outside normal working group
- line management
- external contacts

1.13 review personal training and development as appropriate to the job role

1.14 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.

Learning outcome

The learner will:

2. know how to work efficiently and effectively in engineering

Assessment criteria

The learner can:

- 2.1 describe the safe working practices and procedures to be followed whilst preparing and tidying up their work area
- 2.2 describe the correct use of any equipment used to protect the health and safety of themselves and their colleagues
- 2.3 describe the procedure for ensuring that all documentation relating to the work being carried out is available and current, prior to starting the activity
- 2.4 describe the action that should be taken if documentation received is incomplete and/or incorrect
- 2.5 describe the procedure for ensuring that all tools and equipment are available prior to undertaking the activity
- 2.6 describe the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity
- 2.7 describe the action that should be taken if tools and equipment are not in full working order
- 2.8 describe the checks to be carried out to ensure that all materials required are correct and complete, prior to undertaking the activity
- 2.9 describe the action that should be taken if materials do not meet the requirements of the activity
- 2.10 explain whom to inform when the work activity has been completed
- 2.11 describe the information and/or documentation required to confirm that the activity has been completed
- 2.12 explain what materials, equipment and tools can be reused
- 2.13 explain how any waste materials and/or products are transferred, stored and disposed of
- 2.14 explain where tools and equipment should be stored and located
- 2.15 describe the importance of making recommendations for improving working practices

- 2.16 describe the procedure and format for making suggestions for improvements
- 2.17 describe the benefits to organisations if improvements can be identified
- 2.18 describe the importance of maintaining effective working relationships within the workplace
- 2.19 describe the procedures to deal with and report any problems that can affect working relationships
- 2.20 describe the difficulties that can occur in working relationships
- 2.21 describe the regulations that affect how they should be treated at work (such as Equal Opportunities Act, Race and Sex Discrimination, Working Time Directive)
- 2.22 describe the benefits of continuous personal development
- 2.23 describe the training opportunities that are available in the workplace
- 2.24 describe the importance of reviewing their training and development
- 2.25 explain with whom to discuss training and development issues
- 2.26 describe the extent of their own responsibility and to whom they should report if they have any problems that they cannot resolve.

Unit 330

Loading and proving CNC machine tool programs

UAN:	L/600/5523
Level:	3
Credit value:	24
GLH:	91
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 30: Loading and Proving CNC Machine Tool Programs (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to load and prove machine tool programs on Computer Numerical Control (CNC) machine tools, in accordance with approved procedures. The learner will be required to obtain the correct component program, which may be on punched or magnetic tape, disk or downloaded from a remote computer. The learner will need to check the program for currency and load it correctly into the machine controller, checking for fault/error messages and dealing with these as appropriate to their level of responsibility. The learner will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. The learner must ensure that any edited programs are saved safely and correctly.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for obtaining, loading and proving the programs, and to report any problems with these activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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.</p>

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying the machine tool programming procedures used. The learner will understand the CNC machine tools used in the process, and their application, and will know about the programming, editing and proving process, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring the machine controller is set up to produce the components to the required specification.

The learner will understand the safety precautions required when working on 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 outcome
The learner will: 1. load and prove CNC machine tool programs
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 ensure that they apply all of the following during the programming activities: <ul style="list-style-type: none"> • 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 • follow safe practice/approved programming procedures at all times • obtain the required operating program and check it for currency and validity • prepare the machine controller to accept the operating program • load the program into the controller safely and correctly • ensure that program media is stored safely and correctly, away from contaminants or electromagnetic sources • leave the work area and machine in a safe and appropriate condition on completion of the activities 1.3 use the correct control program and ensure it is correctly loaded into the machine controller 1.4 load and prove programs for one of the following types of CNC

machine tool:

- two axis machine
- three axis machine
- multiple axis machines (5 or more)
- machining centres

- 1.5 follow the correct procedures for calling up the program and dealing with any error messages or faults
- 1.6 obtain and load programs stored on one of the following mediums:
 - punched tape
 - disk
 - magnetic tape
 - remote computer system
- 1.7 confirm program integrity
- 1.8 adjust the equipment and program operating parameters to optimise the outcomes to be achieved
- 1.9 load and correctly set up all associated equipment
- 1.10 operate a CNC machine controller using six of the following, as applicable to the machine type:
 - single block run
 - graphic displays
 - full dry run
 - search facilities
 - program save/store facilities
 - edit facilities
 - program override controls (speed, feed, tool data)
 - data input facilities
- 1.11 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.12 confirm that the machine and program operates safely and correctly by checking all of the following, as applicable to the machine type:
 - datums for each machine axis are set in relation to all equipment and tooling used
 - tool offsets are correctly entered into the machine controller
 - tool change positions are safe and clear of the workpiece and machine equipment
 - the correct tools are selected at the appropriate points in the program
 - tool cutter paths are executed safely and correctly
 - all operations are carried out to the program co-ordinates
 - any alterations to programs are communicated fully to the appropriate personnel
- 1.13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome
The learner will: 2. know how to load and prove CNC machine tool programs
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when loading and proving CNC machine tool operating programs 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.4 explain how to handle and store program tapes and disks safely and correctly, away from contaminants and electromagnetic sources 2.5 describe the computing coding language used in CNC programs 2.6 describe the function keys and operating system of the machine computer control system being operated 2.7 explain how to load, execute, edit and exit programs correctly 2.8 explain how to set machine datums for each of the machine axis being used 2.9 explain how to deal with error messages and faults on the program or computer controlled equipment 2.10 explain how to place the machine into the correct operating mode and access the program edit facility, in order to enter tooling data such as tool datums, positions, lengths, offsets and radius compensation 2.11 describe the use of tool posts, magazines and carousels, and how to identify the tools in relationship to the operating program 2.12 explain how to conduct trial runs, using single block run, dry run and feed and speed override controls 2.13 describe the things that they need to check before allowing the machine to operate in full program run mode 2.14 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 2.15 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.16 describe the factors which will affect the feeds and speeds that can be used, and why they may need to be adjusted from the program setting (condition of material, workholding method, tooling used, tolerance and finish to be achieved) 2.17 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids 2.18 describe the typical problems that can occur with the loading and editing of the operating program, and what to do if they occur 2.19 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 331

Carrying out CNC machine tool programming

UAN:	M/600/5529
Level:	3
Credit value:	84
GLH:	231
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 31: Carrying Out CNC Machine Tool Programming (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to produce, load and prove machine tool programs on Computer Numerical Control (CNC) machine tools, in accordance with approved procedures. The learner will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program on magnetic tape, disc or by downloading it into the machine controller from the computer. The learner will need to check the program using single block run and program edit facilities. The learner will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. The learner must ensure that any edited programs are saved safely and correctly.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for producing, loading and proving the programs, and to report any problems with these activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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.</p>

The learner's knowledge will provide a good understanding of their work, and will provide an informed approach to applying the machine tool programming procedures used. The learner will understand the CNC machine tools used in the process, and their application, and will know about the programming, editing and proving process, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring the machine controller is set up to produce the components to the required specification.

The learner will understand the safety precautions required when working on 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 outcome
The learner will: 1. carry out CNC machine tool programming
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the programming activities: <ul style="list-style-type: none"> • 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 the appropriate reference manuals and programming codes to suit the machine controller • follow safe practice/approved programming procedures at all times • prepare the machine controller ready to accept the operating program • input/load the prepared program into the controller safely and correctly • store programs safely and correctly in the appropriate format and away from contaminants or electromagnetic sources • leave the work area and machine in a safe and appropriate condition on completion of the activities 1.3 use the correct control program and ensure it is correctly loaded into the machine controller 1.4 prepare, load and prove programs for one of the following types of

CNC machine tool:

- two axis machine
 - three axis machine
 - multiple axis machines (5 or more)
 - machining centres
- 1.5 follow the correct procedures for calling up the program and dealing with any error messages or faults
- 1.6 produce CNC programs using one of the following methods:
- written
 - entered directly into the machine controller
 - using computer software
- 1.7 develop part programs which contain all of the following, as applicable to the machine type:
- all necessary positional information
 - appropriate letter address codes
 - preparatory commands and machine management/auxiliary functions
 - repetitive programs (sub-routines, canned cycles, labels)
 - absolute or incremental systems of measurement
 - tool/cutter change positions
 - tool information (lengths, offsets, radius compensation, wire size)
- 1.8 confirm program integrity
- 1.9 prove the part program using six of the following:
- single block run
 - graphic displays
 - full dry run
 - search facilities
 - program save/store facilities
 - edit facilities
 - program override controls (speed, feed, tool data)
 - data input facilities
- 1.10 adjust the equipment and program operating parameters to optimise the outcomes to be achieved
- 1.11 load and correctly set up all associated equipment
- 1.12 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.13 confirm that the machine and program operates safely and correctly, by checking all of the following:
- all operations are carried out to the program co-ordinates
 - tool change positions are safe and clear of the workpiece and machine equipment
 - the correct tools are selected at the appropriate points in the program
 - tool cutter paths are executed safely and correctly
 - auxiliary functions operate at the correct point in the program (cutter start/stop, coolant flow)
 - programs have been saved in the appropriate format

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

Learning outcome

The learner will:

2. know how to carry out CNC machine tool programming

Assessment criteria

The learner can:

- 2.1 describe the specific safety precautions to be taken when loading and proving CNC machine tool operating programs
- 2.2 explain how to start and stop the machine in normal and emergency situations
- 2.3 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.4 describe the computer coding language used in CNC programs with regard to machine axes, positional information, machine management and auxiliary functions
- 2.5 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
- 2.6 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, and system of tolerancing
- 2.7 explain how to interpret CNC drawings, and the use of workpiece zero/reference points
- 2.8 describe the systems of measurement used on CNC drawings, including absolute and incremental
- 2.9 describe the use of repetitive programs and canned cycles, to reduce program size and input time
- 2.10 explain how to prepare part programs, using operational sequences and machining techniques which avoid unnecessary tool/cutter movements or tool changes
- 2.11 describe the function keys and operating system of the machine computer control system being operated
- 2.12 explain how to set machine datums for each of the machine axes being used
- 2.13 explain how to set the machine controller in the program and editing mode, and enter or download the prepared program
- 2.14 explain how to deal with error messages and faults on the program or equipment
- 2.15 explain how to access the program edit facility, in order to enter tooling data such as tool datums, positions, lengths, offsets and radius compensation
- 2.16 describe the use of tool posts, magazines and carousels, and how to identify the tools in relationship to the operating program
- 2.17 explain how to conduct trial runs, using single block run, dry run and feed and speed override controls
- 2.18 describe the factors which will affect the feeds and speeds that can be used, and why they may need to be adjusted from the program setting (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)

- 2.19 describe the things that they need to check before allowing the machine to operate in full program run mode
- 2.20 explain how to save the completed programs in the appropriate format, and the need to store program tapes and disks safely and correctly, away from contaminants and electromagnetic sources
- 2.21 describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
- 2.22 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 332

Setting CNC turning machines for production

UAN:	H/600/5561
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 32: Setting CNC Turning Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) machines or CNC machining centres, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine spindle. The learner will also be required to select the appropriate cutting tools, mount and secure them to the appropriate tool holding devices, and place the cutting tools in the relevant positions within the tool posts, turrets, slides or tool change magazine/carousel, where this is applicable.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes.</p> <p>The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during</p>

production, will also form part of their role.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC turning machine used, and its application, and will know about the workholding devices, tooling, machine operating programmes and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults, and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC turning machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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• follow safe practice/approved setting up procedures at all

- times
 - confirm that the correct operating program has been loaded
 - check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data, as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 determine what has to be done and how the machine will be set to achieve this
- 1.5 prepare one of the following CNC turning machines in readiness for production:
- CNC lathe
 - CNC machining centre
- 1.6 prepare the tooling for operation, by carrying out all the following activities, as applicable to the machine type:
- positioning tools in the correct position in the tool posts, turrets, magazine or carousel
 - checking tools have a specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (tool lengths, tool offsets, radius compensation)
 - pre-setting tooling using setting jigs/fixtures
 - setting tool datum
 - saving changes to the program
- 1.7 mount and set the required workholding devices, workpiece and cutting tools
- 1.8 position and secure workpieces using two of the following workholding methods and devices:
- chucks with hard jaws
 - chucks with soft jaws
 - fixtures
 - drive centres
 - collet chucks
 - faceplates
 - magnetic/pneumatic devices
 - other workholding devices
- 1.9 select and mount the appropriate tool holding device and eight of the following types of cutting tool:
- roughing tool
 - finishing tool
 - parting-off tool
 - screw-thread tool
 - profiling tools
 - form tools
 - centre drills

- twist/core drills
 - boring tools
 - reamers
 - maxi-tipped drills
- 1.10 set the machine tool operating parameters to achieve the component specification
- 1.11 set up the machine to produce components combining several different operations, covering ten from:
- 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
- 1.12 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.13 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm
 - reamed and bored holes within H8
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
- 1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome

The learner will:

2. know how to set CNC turning machines for production

Assessment criteria

The learner can:

- 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC lathes
- 2.2 explain how to start and stop the machine in normal and emergency situations
- 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutting tools and workholding devices
- 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.5 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
- 2.6 explain how to handle and store cutting tools and verified tapes and programs, safely and correctly
- 2.7 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
- 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.9 describe the range of workholding methods and devices that are used on CNC lathes
- 2.10 explain why it is important to set the workholding device in relationship to the machine datum's and reference points
- 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used
- 2.12 describe the range of cutting tools that are used on CNC lathes, and typical applications
- 2.13 explain how to check that the cutting tools are in a safe and serviceable condition
- 2.14 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
- 2.15 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
- 2.16 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures
- 2.17 describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
- 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data, such as tool datums, positions, lengths, offsets and radius compensation

- 2.19 explain how to conduct trial runs using single block run, dry run and feed and speed override controls
- 2.20 describe the things that they need to check before allowing the machine to operate in full program run mode
- 2.21 explain how the various types of materials used will affect the feeds and speeds that can be used
- 2.22 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
- 2.23 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 333

Machining components using CNC turning machines

UAN:	F/600/5566
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 33: Machining Components using CNC Turning Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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 take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including turned plain diameters, eccentric diameters, internal/external threads, stepped diameters, flat faces and shoulders, chamfers and radii, special forms and profiles, tapered diameters and faces, internal and external profiles, grooves/undercuts, steps, drilled holes, reamed and tapped holes, and plain and tapered bored holes. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line</p>

with their permitted authority. 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 activities undertaken, and to report any problems with the equipment, tooling, program, materials or 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, 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 enable them to adopt an informed approach to applying CNC turning procedures. The learner will have an understanding of the CNC turning process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC turning machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point
 - ensure that machine guards are in place and correctly adjusted
 - ensure that components are correctly positioned and held securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the machine spindle before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC turning machines:
- CNC lathe
 - CNC machining centre
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce components combining several different operations, and covering ten 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 features
 - external screw threads
 - internal screw threads
 - chamfers and radii
 - bored holes
 - grooves
- 1.7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved

- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the relevant quality and accuracy standards, as applicable to the operations performed:
 - dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm
 - reamed and bored holes within H 8
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
- 1.11 carry out the necessary checks during production, for accuracy of five of the following:
 - diameters
 - hole size/fit
 - angle/taper
 - surface finish
 - lengths/depths
 - thread profile and fit
 - concentricity
 - slot/recess width
- 1.12 shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome
The learner will: 2. know how to machine components using CNC turning machines
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when working with CNC turning machines and equipment 2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly 2.3 explain how to start and stop the machine in both normal and emergency situations 2.4 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 2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.6 describe the application of a range of CNC turning machines (such as CNC lathes and CNC machining centres) 2.7 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 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and

- system of tolerancing
- 2.9 explain how to use the visual display and understand the various messages displayed
 - 2.10 describe the function of error messages and what to do when an error message is displayed
 - 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
 - 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
 - 2.13 explain how to operate the machine using single block run, full program run and feed/speed override controls
 - 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
 - 2.15 explain how to set and secure the workpiece to the machine spindle/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
 - 2.16 describe the various types of cutting tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel
 - 2.17 describe the safe and correct handling and storage of tooling
 - 2.18 explain how to check that the indexable tooling is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
 - 2.19 describe the problems that can occur with turning activities, and how these can be overcome
 - 2.20 describe the application of cutting fluids with regard to different materials being machined
 - 2.21 describe the quality control procedures used, inspection checks that need to be carried out, and the equipment that is used
 - 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
 - 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 334

Setting CNC milling machines for production

UAN:	R/600/5572
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 34: Setting CNC Milling Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) three axis or five axis machines or CNC machining centres, in accordance with approved procedures. This involves selecting the appropriate workholding devices, and mounting and positioning them to the machine table in the designated or appropriate position, as required by the machine-operating program. The learner will also be required to select the appropriate milling cutters to use, and to mount and secure them to the appropriate tool holding devices. The learner will be expected to place the tools in the relevant positions within the tool change magazine or carousel, where this is applicable.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving the component program, checking for errors/faults, editing and saving program changes. The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related</p>

problems during production, will also form part of their role.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC milling machine used, and its application, and will know about the workholding devices, tooling, materials, machine operating program and setting-up procedures, in adequate depth to provide a sound basis for setting-up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC milling machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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

- follow safe practice/approved setting up procedures at all times
 - confirm that the correct operating program has been loaded
 - check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data, as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm
 - reamed and bored holes within H8
 - flat and square 0.001" per inch or 0.025mm per 25mm
 - angles within +/- 0.5 degree
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following CNC milling machines in readiness for production:
- CNC three axis milling machine
 - CNC five axis milling machine
 - CNC machining centre
- 1.7 prepare tooling for operation by carrying out all the following activities, as applicable to the machine type:
- positioning tools in the correct position in the tool magazine or carousel
 - checking tools have specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (tool lengths, tool offsets, radius compensation)
 - presetting tooling using setting jigs/fixtures
 - setting tool datum
 - saving changes to program
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using two of the following workholding methods and devices:
- machine vices
 - fixtures
 - chucks
 - pneumatic or magnetic table
 - direct clamping to machine table
 - ancillary indexing devices
 - angle plate

<p>1.10 select and mount four of the following types of milling cutters to the appropriate tool holding device:</p> <ul style="list-style-type: none"> • face mills • end mills • twist/core drills • boring tools • reamers • slot drills • special profile cutters <p>1.11 set the machine tool operating parameters to achieve the component specification</p> <p>1.12 set up the machine to produce components, combining different operations, covering eight from:</p> <ul style="list-style-type: none"> • flat faces • steps/shoulders • enclosed slots/recesses • internal profiles • holes on pitch circles • parallel faces • angular faces • open ended slots • external profiles • holes linearly pitched • circular/curved profiles • special forms (such as concave, convex) • faces that are square to each other <p>1.13 machine components made from one of the following types of material:</p> <ul style="list-style-type: none"> • ferrous • non-ferrous • stainless • non-metallic <p>1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>

Learning outcome
The learner will: 2. know how to set CNC milling machines for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC milling machines 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutters and workholding

- devices
- 2.4 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, lifting and handling workholding devices, hot and airborne metal particles), and how to minimise them and reduce any risk
 - 2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
 - 2.6 explain how to handle and store milling cutters safely and correctly
 - 2.7 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
 - 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
 - 2.9 explain how to read and interpret CNC drawings and extract the relevant information
 - 2.10 describe the range of workholding methods and devices that are used on CNC milling machines
 - 2.11 explain why it is important to set the workholding device in relation to the machine axis and reference points
 - 2.12 describe the methods of setting the workholding devices, and the tools and equipment that can be used
 - 2.13 describe the range of cutting tools that are used on CNC milling machines, and typical applications
 - 2.14 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
 - 2.15 explain how to check that the cutting tools are in a safe and serviceable condition
 - 2.16 describe the various tool holding devices that are used, and the methods of mounting and securing the cutting tools to the tool holders
 - 2.17 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs
 - 2.18 describe the use of tool magazines and carousels, and how to position and identify the tools in relation to the operating program
 - 2.19 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool lengths, tool offsets, radius compensation)
 - 2.20 explain how to conduct trial runs using single block run, dry run, and feed and speed override controls
 - 2.21 describe the things that they need to check before allowing the machine to operate in full program run mode
 - 2.22 explain how the various types of materials used will affect the feeds and speeds that can be used
 - 2.23 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
 - 2.24 describe the typical problems that can occur with the setting up of

the tooling and workholding devices, and what to do if they occur
2.25 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 335

Machining components using CNC milling machines

UAN:	K/600/5576
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 35: Machining Components using CNC Milling Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to operate Computer Numerical Control (CNC) three axis or five axis machines or CNC machining centres, in accordance with approved procedures. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including such things as flat faces, angled faces, internal and external profiles, slots, steps, holes which are linearly or circularly pitched, and special profiles such as convex or concave. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p>

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 machine, tooling, materials or 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, 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 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, tooling, materials and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC milling machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point• ensure that machine guards are in place and correctly adjusted• ensure that components are correctly positioned and held

- securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the machine spindle before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC milling machines:
- three axis milling machine
 - multi-axis milling machine
 - machining centre
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce machined components, which combine different operations and cover eight of the following:
- flat faces
 - steps/shoulders
 - enclosed slots/recesses
 - internal profiles
 - holes on pitch 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
- 1.7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all the relevant quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm

<ul style="list-style-type: none"> • reamed and bored holes within H8 • flatness and squareness 0.001” per inch or 0.025mm per 25mm • angles within +/- 0.5 degree <p>1.11 carry out the necessary checks during production, for accuracy of five of the following:</p> <ul style="list-style-type: none"> • dimensions • squareness • hole size/fit • surface finish • angles • flatness • slots • recesses <p>1.12 shut down the equipment to a safe condition on conclusion of the activities.</p>
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Learning outcome
The learner will: 2. know how to machine components using CNC milling machines
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when working with CNC milling machines and equipment 2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly 2.3 explain how to start and stop the machine in both normal and emergency situations 2.4 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, lifting and handling workholding devices, hot and airborne metal particles), and how to minimise them and reduce any risks 2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.6 describe the application of a range of CNC milling machines, such as three axis, five axis and machining centres 2.7 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 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.9 explain how to interpret the visual display and understand the various messages displayed 2.10 describe the function of error messages, and what to do when an error message is displayed 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program

- 2.12 describe the operation of the various hand and automatic modes of machine control (such as handwheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine using single block run, full program run, and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine table/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.16 describe the various types of milling cutters used, and how they are located and secured to the machine spindle, tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the milling cutters are in a serviceable condition, and the effects that worn cutters will have on the finished work
- 2.19 describe the problems that can occur with the milling activities, and how these can be overcome
- 2.20 describe the application of cutting fluids with regard to different materials being machined
- 2.21 describe the quality control procedures used, inspection checks that need to be carried out, and the equipment that is used
- 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 336

Setting CNC grinding machines for production

UAN:	J/600/5584
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 36: Setting CNC Grinding Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerically Control (CNC) grinding machines, such as CNC universal grinding machines, CNC gear grinding machines, CNC ring grinding machines, and CNC grinding machining centre, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine table or spindle in the designated or appropriate position, as required by the machine operating program. The learner will also be expected to select the appropriate grinding wheels, and to balance, dress, mount and secure them to the appropriate machine spindles and/or tool change magazine/carousel, where this is applicable.</p> <p>The learner will need to ensure that all grinding wheels have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine controller. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, grinding wheels, programs or setting up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC grinding machine used, and its application, and will know about the workholding devices, grinding wheels, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC grinding machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"> • 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 • follow safe practice/approved setting up procedures at all times

- confirm that the correct operating program has been loaded
 - check that the grinding wheels are in a safe and usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - flat and square 0.0005" per inch or 0.005mm per 25mm
 - angles within +/- 0.5 degree
 - surface finish 32µin or 0.8µm
 - ground bores/holes within H8
 - screw threads BS medium fit
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following NC/CNC grinding machines in readiness for production:
- CNC universal grinder
 - CNC gear grinder
 - CNC grinding machining centre
 - CNC thread grinder
 - CNC ring grinder
- 1.7 prepare the tooling by carrying out all of the following activities, as applicable to the machine type:
- pre-setting grinding wheels/spindles using balancing units and setting jigs/fixtures
 - setting tool datum
 - positioning grinding wheels/spindles in the correct position in the machine spindle, magazine or carousel
 - checking wheels/spindles have a specific tool number in relation to the operating program
 - entering all relevant tooling data to the operating program (wheel/spindle position offsets)
 - saving changes to programme
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using four of the following workholding methods and devices:
- chucks
 - collets
 - clamps
 - machine vices

- faceplates
 - vee-blocks
 - centers
 - fixtures
 - angle plates
 - mandrels/arbours
 - power chucks/blocks
 - other workholding arrangements
- 1.10 select/mount grinding wheels and dress six of the following types of feature on the grinding wheel:
- rough grinding
 - male radius
 - finish grinding
 - angles
 - for thread grinding
 - component form profile
 - for gear grinding
 - female radius
- 1.11 set the machine tool operating parameters to achieve the component specification
- 1.12 set up to produce ground components, which combine different operations and cover six of the following:
- 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
- 1.13 machine one different type of material from:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome
The learner will: 2. know how to set CNC grinding machines for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC grinding machines 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 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 risks 2.4 describe the Grinding Wheel Regulations covering the use and operation of grinding wheels and equipment 2.5 describe the importance of ensuring that the machine is isolated from the power supply before mounting grinding wheels and workholding devices 2.6 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.7 explain how to handle and store grinding wheels, spindles, verified tapes and programs, safely and correctly 2.8 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 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.10 describe the range of workholding methods and devices that are used on CNC grinding machines 2.11 explain why it is important to set the workholding device in relation to the machine datum's and reference points 2.12 describe the methods of setting the workholding devices, and the tools and equipment that can be used 2.13 describe the range of grinding wheels that are used on CNC lathes, and typical applications 2.14 explain how to check that the grinding wheels are in a safe and serviceable condition 2.15 describe the use of silicon carbide, aluminium oxide and diamond wheels, and the material conditions determining their use 2.16 explain how to select the correct grade and type of grinding wheel for the materials being machined 2.17 describe the various grinding tool holding devices that are used, and the methods of correctly mounting and securing the grinding wheels to the machine spindle and tool holders 2.18 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures 2.19 describe the use of magazines and carousels, and how to position and identify the tools in relation to the operating program 2.20 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling

- data (such as tool datums, positions, lengths and offsets)
- 2.21 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
 - 2.22 describe the things that they need to check before allowing the machine to operate in full program run mode
 - 2.23 explain how the various materials will affect the feeds and speeds that can be used
 - 2.24 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
 - 2.25 describe the typical problems that can occur when setting-up of grinding wheels and workholding devices, and what to do if they occur
 - 2.26 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 337

Machining components using CNC grinding machines

UAN:	R/600/5622
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 37: Machining Components using CNC Grinding Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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 take charge of the prepared machine and check that it is ready for the grinding operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including ground plain diameters, eccentric diameters, external threads, stepped diameters, flat faces and shoulders, chamfers and radii, special forms and profiles, tapered diameters and faces, internal and external profiles, grooves/undercuts, gear teeth, bearing tracks, parallel and tapered bores and curvic couplings. The learner will be required to continuously monitor the machining operations, making any necessary</p>

adjustments to machine parameters, in line with their permitted authority. 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 activities undertaken, and to report any problems with the equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 enable them to adopt an informed approach to applying CNC grinding procedures. The learner will have an understanding of the CNC grinding process, and its application, and will know about the machine, grinding wheels, materials, consumables and grinding activities, in adequate depth to provide a sound background to machine operation and 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 outcome
The learner will: 1. machine components using CNC grinding machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point
 - ensure that machine guards are in place and correctly adjusted
 - ensure that components are correctly positioned and held securely without distortion
 - check and maintain grinding wheels correctly dressed, and in a safe and usable condition
 - ensure that the workpiece is clear of the machine spindle before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC grinding machines:
- CNC universal grinder
 - CNC gear grinder
 - CNC grinding machining centre
 - CNC thread grinder
 - CNC ring grinder
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce ground components, which combine different operations and cover six of the following:
- 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
- 1.7 machine one different type of material from:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment

	faults that are within their control and report those that cannot be solved
1.9	monitor the computer process and ensure that the production output is to the required specification
1.10	produce component within all of the following quality and accuracy standards, as applicable to the operations performed: <ul style="list-style-type: none"> • dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7 • flatness and squareness 0.0005" per inch or 0.012mm per 25mm • angles within +/- 0.5 degree • surface finish 32µin or 0.8µm • ground bores/holes within H8 • screw threads BS medium fit
1.11	carry out the necessary checks for accuracy during production of four of the following: <ul style="list-style-type: none"> • dimensions • parallelism • squareness • profile • concentricity • thread form • surface texture • angle/taper • ovality/lobbing • hole size
1.12	shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome	
The learner will:	
2.	know how to machine components using CNC grinding machines
Assessment criteria	
The learner can:	
2.1	describe the specific safety precautions to be taken when working with CNC grinding machines and equipment
2.2	describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
2.3	explain how to start and stop the machine in both normal and emergency situations
2.4	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 risks
2.5	describe the Grinding Wheel Regulations covering the use and operation of grinding wheels and equipment
2.6	describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy

- 2.7 describe the application of a range of CNC grinding machines
- 2.8 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
- 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.10 explain how to use the visual display and understand the various messages displayed
- 2.11 describe the function of error messages, and what to do when an error message is displayed
- 2.12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.13 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.14 explain how to operate the machine using single block run, full program run and feed/speed override controls
- 2.15 explain how to make adjustments to the program operating parameters to take account of wheel wear
- 2.16 explain how to set and secure the workpiece to the machine table/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.17 describe the various types of grinding wheels used, and how they are located and secured to the machine spindle, tool holders and tool magazine or carousel
- 2.18 describe the safe and correct handling and storage of grinding wheels
- 2.19 explain how to check that the grinding wheel is in a serviceable condition, and the effects that worn/burnished tooling will have on the workpiece surface finish and tolerances
- 2.20 describe the problems that can occur with grinding activities, and how these can be overcome
- 2.21 describe the application of cutting fluids with regard to different materials being machined
- 2.22 describe the quality control procedures used, inspection checks that need to be carried out, and the equipment that is used
- 2.23 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 338

Setting CNC punching machines for production

UAN:	K/600/5643
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 38: Setting CNC Punching Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) punching machines, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine spindle. The learner will also be required to select the appropriate cutting tools, mount and secure them to the appropriate tool holding devices, and place the cutting tools in the relevant positions within the tool posts, turrets, slides or tool change magazine/carousel, where this is applicable.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes.</p> <p>The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC punching machine used, and its application, and will know about the workholding devices, tooling, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC punching machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"> • 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 • follow safe practice/approved setting up procedures at all times

- confirm that the correct operating program has been loaded
 - check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - components to be free from deformity, burrs and sharp edges
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following CNC punching machines in readiness for production:
- CNC punching machine
 - CNC fabrication machining centre (for punching operations)
- 1.7 prepare the tooling by carrying out all of the following activities, as applicable to the machine type:
- pre-setting tooling using setting jigs/fixtures
 - setting tool datums
 - positioning tools in the correct position in the tool posts, turrets, magazine or carousel
 - checking tools have a specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (tool lengths, tool offsets, radius compensation)
 - saving changes to program
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using two of the following workholding methods and devices:
- direct clamping to machine table
 - magnetic chucks
 - pneumatic chucks
 - jigs and fixtures
 - other workholding devices
- 1.10 select and mount, in the appropriate holding device, two of the following types of punching/forming tool:
- hole punching tools
 - nibbling tools
 - forming tools
- 1.11 set the machine tool operating parameters to achieve the component specification
- 1.12 set up the machine to produce components, combining several different operations, and cover four from:

<ul style="list-style-type: none"> • holes linearly pitched • holes radially pitched • square/rectangular profiles • curved profiles • swages • louvres • other applications <p>1.13 machine one of the following types of material:</p> <ul style="list-style-type: none"> • ferrous • non-ferrous • stainless • special alloys <p>1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>
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Learning outcome
The learner will: 2. know how to set CNC punching machines for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC punching machines 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting punching tools and workholding devices 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.5 describe the hazards associated with working on CNC punching machines (such as moving machinery, automatic machine operation, handling punching tools, lifting and handling workholding devices, handling sheet materials), and how to minimise them and reduce any risks 2.6 explain how to handle and store punching tools and verified tapes and programs, safely and correctly 2.7 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 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.9 describe the range of workholding methods and devices that are used on CNC punching machines 2.10 explain why it is important to set the workholding device/workpiece in relationship to the machine datum's and reference points 2.11 describe the methods of setting the workholding

- devices/workpieces, and the tools and equipment that can be used
- 2.12 describe the range of punching tools that are used on CNC punching machines, and typical applications
 - 2.13 explain how to check that the punching tools are in a safe and serviceable condition
 - 2.14 describe the use of high-speed steel and tungsten carbide tooling, and the factors which will determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
 - 2.15 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the punching tools to the tool holders
 - 2.16 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures
 - 2.17 describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relation to the operating program
 - 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datum's, positions, lengths, offsets and radius compensation)
 - 2.19 explain how to conduct trial runs using single block run, dry run and feed/speed override controls
 - 2.20 describe the things that they need to check before allowing the machine to operate in full program run mode
 - 2.21 explain how the various types of materials will affect the feeds and speeds that can be used
 - 2.22 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
 - 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 339

Machining components using CNC punching machines

UAN:	T/600/5662
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 39: Machining Components using CNC Punching Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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 take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required materials and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including holes linearly pitched, holes radially pitched, internal square/rectangular profiles, curved/circular profiles, swages, louvres, special forms and profiles. The learner will be required to continuously monitor the punching operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p>

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 equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 enable them to adopt an informed approach to applying CNC punching procedures. The learner will have an understanding of the CNC punching process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC punching machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the punching activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point• ensure that machine guards are in place and correctly adjusted• ensure that materials/components are correctly positioned

- and held securely without distortion
 - check and maintain punching tools in a safe and usable condition
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC punching machines:
- CNC punching machine
 - CNC fabrication machining centre (for punching operations)
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce components which combine several different operations and cover five of the following:
- holes linearly pitched
 - holes radially pitched
 - internal curved profiles
 - internal square profiles
 - louvres
 - swages
 - other applications
- 1.7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - special alloys
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - components to be free from deformity, burrs and sharp edges
- 1.11 carry out the necessary checks during production, for accuracy of four 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 louvers and swages

1.12 shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome

The learner will:

2. know how to machine components using CNC punching machines

Assessment criteria

The learner can:

- 2.1 describe the specific safety precautions to be taken when working with CNC punching machines and equipment
- 2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 2.3 describe the hazards associated with working on CNC punching machines (such as moving machinery, automatic machine operation, handling punching tools, lifting and handling workholding devices, handling sheet materials), and how to minimise them and reduce any risks
- 2.4 explain how to start and stop the machine in both normal and emergency situations
- 2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.6 describe the application of the CNC machine, and the range of operations it can perform
- 2.7 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
- 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.9 explain how to interpret the visual display and understand the various messages displayed
- 2.10 describe the function of error messages, and what to do when an error message is displayed
- 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine using single block run, full program run and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters, to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.16 describe the various types of punching tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the punches are in a serviceable condition, and the effects that worn tooling will have on the

workpiece and tolerances

- 2.19 describe the problems that can occur with punching activities, and how these can be overcome
- 2.20 describe the quality control procedures used, inspection checks that need to be carried out, and the equipment that is used
- 2.21 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.22 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 340

Setting CNC laser profiling machines for production

UAN:	R/600/5670
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 40: Setting CNC Laser Profiling Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to set up CNC laser profiling machines and associated equipment, in accordance with approved procedures. The learner will be required to select the appropriate workholding devices, and to mount and secure them to the machine table in the correct relation to the operating program and machine parameters.</p> <p>The learner will need to set up the machine conditions and adjust/edit program parameters, controlling the setting of the optical system, laser characteristics, laser alignment, electrical parameters, and the laser cutting speed. This will involve loading and proving component programmes, checking for errors/faults, editing and saving program changes. The learner must produce trial components, and prove the machine is working correctly and producing the components to the required specification, before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p> <p>The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any</p>

problems with the equipment or setting activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting up procedures used. The learner will understand the CNC laser profiling machine used, and its application, and will know about the workholding devices, machine operating programmes and setting-up procedures, in adequate depth to provide a sound basis for setting-up the equipment, correcting faults and ensuring the work output is produced to the required specification.

The learner will understand the safety precautions required when working on the machine and its associated 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 outcome
The learner will: 1. set CNC laser profiling machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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• follow safe practice/approved setting up procedures at all times• confirm that the correct operating program has been loaded• ensure that the laser lens is in a clean and usable condition ensure that the material/workpiece is correctly positioned and secured without distortion• update the program data as applicable• ensure that correctly adjusted machine guards are in place

- leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
 - dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - angles within +/- 0.5 degree
 - surface texture within 63µin or 1.6µm
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 mount and set the required workholding devices, workpiece and cutting tools
- 1.7 position and secure materials/workpiece using three of the following workholding devices:
 - machine vices
 - chucks
 - fixtures
 - direct clamping to machine table
 - Indexing tables/devices
 - Other
- 1.8 set the machine tool operating parameters to achieve the component specification
- 1.9 set up, in accordance with work instructions and specifications, all of the following:
 - optical system
 - laser positioning
 - profiling parameters
 - saving changes to programme
 - laser alignment
 - cutting speed
- 1.10 set up the equipment to produce machined components which cover six of the following features:
 - square/rectangular profiles
 - angular profiles
 - curved profiles
 - circles
 - ellipses
 - holes linearly positioned
 - holes radially positioned
 - slots and apertures
 - other features
- 1.11 machine one of the following types of material:
 - ferrous
 - non-ferrous
 - stainless
 - non-metallic

- 1.12 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome

The learner will:

- 2. know how to set CNC laser profiling machines for production

Assessment criteria

The learner can:

- 2.1 describe the safe working practices and procedures to be observed when setting and operating CNC laser profiling machines (care when working with high power laser beams machine guards; ventilation and fume extraction; machine safety devices)
- 2.2 explain how to start and stop the machine in normal and emergency situations, and how to close the machine down on completion of activities
- 2.3 describe the importance of ensuring that the machine is isolated from the power supply before working with machinery; and of taking particular care when working with high-power laser beams
- 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.5 describe the hazards associated with setting laser machines (such as dangers from high power laser beams; live electrical components; moving parts of machinery), and how to minimise them and reduce any risks
- 2.6 describe the basic principles of laser profiling (such as using a laser beam to cut metals; forming component profile; process principles; nature of the laser beam; methods of generating a laser beam; guiding and optical focussing laser optics; parameters; how variation in the parameters influences the component feature, quality and output; terminology used in laser machining)
- 2.7 describe the key components and features of the equipment (such as types of laser beam generator, beam characteristics, power ranges; beam guiding and focusing arrangements; power sources; materials and thickness capabilities; facilities for manipulating the components for machining; and safety features)
- 2.8 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
- 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.10 describe the range of workholding methods and devices used on laser profiling machines
- 2.11 describe the methods of setting up the components in relation to the machine's datum's and operating parameters (such as to achieve correct laser alignment; manipulation of work holding equipment to present the component correctly relative to the laser).
- 2.12 describe the setting up the laser equipment to achieve the component specification (such as electrical and optical conditions;

focal distance; cutting speed)

- 2.13 explain how to place the machine in the correct operating mode, and how to access the program edit facility in order to make minor adjustments for production
- 2.14 explain how to conduct trial runs, using single block run, speed override controls, and checking that the machine functions to the required specification
- 2.15 explain how the various materials will affect the operating conditions used, and the cutting speed that can be applied
- 2.16 describe the problems that can occur with laser cutting activities, and how these can be overcome (such as causes of distortion and methods of control, cutting characteristics of parent materials; sources of component defects and methods of prevention)
- 2.17 describe the organisational quality systems (such as standards to be achieved; production records to be kept)
- 2.18 describe the extent of their responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 341

Machining components using CNC laser profiling machines

UAN:	H/600/5916
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 41: Machining Components using CNC Laser Profiling Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out cutting and profiling operations using CNC laser profiling machines, in accordance with approved procedures. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required materials and consumables are present, and that the machine has been approved for the production. 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.</p> <p>The components produced will have a number of different features, including square and rectangular profiles, angular profiles, curved profiles, circles, holes linearly positioned, holes radially positioned, slots and grooves. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.</p>

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 equipment, program or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to applying CNC laser profiling procedures. The learner will understand the CNC profiling process, and its 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 laser profiling machine and its associated 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 outcome
The learner will: 1. machine components using CNC laser profiling machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the laser profiling activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point• ensure that all safety equipment and guards are in place and functioning correctly• ensure that materials/components are correctly positioned and held securely without distortion• check that the laser lens is clean and in a suitable condition

- use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 follow the defined procedures for starting and running the operating system
- 1.5 produce laser machined components which cover six of the following features:
- square/rectangular profiles
 - angular profiles
 - curved profiles
 - circles
 - ellipses
 - holes linearly positioned
 - holes radially positioned
 - slots and apertures
 - other features
- 1.6 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.7 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.8 monitor the computer process and ensure that the production output is to the required specification
- 1.9 produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - angles within +/- 0.5 degree
 - surface texture within 63µin or 1.6µm
- 1.10 carry out the necessary checks during production for accuracy of four of the following:
- dimensions
 - position of features
 - holes positioned linearly
 - holes positioned radially
 - angles
 - profiles
 - flatness / freedom from distortion
- 1.11 shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome
The learner will: 2. know how to machine components using CNC laser profiling machines
Assessment criteria
The learner can: 2.1 describe the safe working practices and procedures to be observed when setting and operating CNC laser profiling machines (care when working with high power laser beams; machine guards; ventilation and fume extraction; machine safety devices) 2.2 explain how to start and stop the machine in normal and emergency situations, and how to close the machine down on completion of activities 2.3 describe the importance of ensuring that the machine is isolated from the power supply before working with machinery; and the care needed, particularly when working with high power laser beams 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.5 describe the hazards associated with laser profiling machines (such as dangers from the high power laser beam; live electrical components; moving parts of machinery), and how to minimise them and reduce any risks 2.6 describe the principles and operation of lasers; laser machines; terminology used 2.7 describe the key components and features of the equipment (such as types of laser beam generators, laser characteristics, power ranges; beam guiding and focussing arrangements; power sources; materials and thickness capabilities; and safety features) 2.8 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 2.9 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.10 explain how to interpret the visual display and understand the various messages displayed 2.11 describe the function of error messages, and what to do when an error message is displayed 2.12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program 2.13 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons) 2.14 explain how to operate the machine using single block run, full program run and speed override controls 2.15 explain how to make adjustments to machine operating programs to take account of out-of-specification components 2.16 explain how to set and secure the workpiece to the work holding device; the effects of clamping the workpiece; and how material removal can cause distortion in the finished component 2.17 explain how to extract the information required from the drawings

and component specifications

- 2.18 describe the care of equipment and operating programs, including safe storage of material away from electromagnetic forces
- 2.19 explain how to monitor the machine during the cutting process; recognition of problems and action to be taken
- 2.20 describe the problems that can occur during the laser cutting activities, and how to prevent them
- 2.21 describe the organisational quality systems (such as standards to be achieved; production records to be kept)
- 2.22 describe the extent of their responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 342

Setting CNC electro-discharge machines for production

UAN:	M/600/5921
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 42: Setting CNC Electro-Discharge Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) electrical discharge machines, such as spark erosion and wire erosion machines, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices, and to mount and secure them to the machine table in the designated or appropriate position, as required by the machine-operating program. The learner will also be expected to select the appropriate electrode cartridge holders or wires, and to mount and secure these to the appropriate machine head/slide and/or tool change holder mechanism, where this is applicable.</p>

The learner will need to ensure that all electrode cartridges/holders and/or wires have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions are entered into the operating program of the machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.

The learner's responsibilities will require

them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling programs or setting-up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC electrical discharge machine used, and its application, and will know about the workholding devices, tooling, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting-up the equipment, correcting faults and ensuring the work output is produced to the required specification.

The learner will understand the safety precautions required when working with the CNC electro-discharge 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 outcome
The learner will: 1. set CNC electro-discharge machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"> • 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 • follow safe practice/approved setting up procedures at all times • confirm that the correct operating program has been loaded • check that the electrode or wire is of the correct type and in a

- usable condition
 - check that the dielectric fluid is at an appropriate level
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place and safety devices are working
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - flatness and squareness 0.001" per inch or 0.025mm per 25mm
 - components to be free from false starts and sharp edges
 - surface finish 32µin/0.8µm, 18VDI
 - machined holes within H8
 - angles within +/- 0.5 degree
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following electro-discharge machines for operation:
- CNC wire erosion machine
 - CNC spark erosion machine
 - CNC electrical discharge machining centre
- 1.7 prepare the tooling by carrying out all the following activities, as applicable to the machine type:
- pre-setting electrodes in tooling cartridges/holders manually or by using setting jigs/fixtures
 - loading and threading wire through wire feed mechanism and wire guides
 - positioning electrode cartridges/holders in correct position on machine head or magazine/docking station
 - checking electrode cartridges/holders/wire have a specific tool number or technology setting in relation to the operating program
 - entering all wire data to the operating program (such as wire type and size, material thickness, number of skims)
 - entering all relevant tooling data to the operating program (such as cartridge/holder position, offsets)
 - setting tool/wire datum point
 - saving changes to program
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using three of the following workholding methods and devices:
- clamping direct to machine table

<ul style="list-style-type: none"> • pneumatic or magnetic table • machine vice (such as plain, swivel, universal) • angle plate • vee block and clamps • fixtures • chucks (such as 3 jaw, 4 jaw) • ancillary indexing device
<p>1.10 select, load and set in the appropriate tool holding device, one of the following electrode types:</p> <ul style="list-style-type: none"> • plain electrodes • profile electrodes • hollow electrodes • wires
<p>1.11 set the machine tool operating parameters to achieve the component specification</p>
<p>1.12 set up to produce machined components, which combine different operations and cover ten of the following:</p> <ul style="list-style-type: none"> • 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 pitch circles • linear holes (rows, angles) • special profiles (such as concave, convex) • parallel and tapered steps/slots/shoulders • circular/curved profiles (internal and external) • other special forms or activities
<p>1.13 machine components from one of the following types of material:</p> <ul style="list-style-type: none"> • ferrous • non-ferrous
<p>1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p>
<p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>

Learning outcome
The learner will:
2. know how to set CNC electro-discharge machines for production
Assessment criteria
The learner can:
2.1 describe the specific safety precautions to be taken when setting

- up workholding devices and tooling on CNC electrical discharge machinery
- 2.2 explain how to start and stop the machine in normal and emergency situations
 - 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting electrodes, cartridges/holders and workholding devices
 - 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
 - 2.5 describe the hazards associated with CNC electro-discharge operations (such as moving parts of machinery, electrical components, handling dielectrics, fumes), and how to minimise them and reduce any risks
 - 2.6 explain how to handle and store electrodes or wire, electrode cartridges/holders, verified tapes and programs, safely and correctly
 - 2.7 explain how to extract and use information from engineering drawings or other data supplied and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
 - 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
 - 2.9 describe the range of work holding methods and devices that are used on CNC electrical discharge machines
 - 2.10 explain why it is important to set the workholding device in relation to the machine datums and reference points
 - 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used
 - 2.12 describe the range of eroded features that are produced on CNC electrical discharge machines
 - 2.13 explain how to check that the electrodes or wires are in a good and serviceable condition
 - 2.14 describe the different types of electrodes/wire, and the material conditions determining their use
 - 2.15 explain how to select the correct grade and type of electrode/wire for the materials and profiles being machined
 - 2.16 describe the various electrode tool holding devices that are used, and the methods of correctly loading, securing and setting the electrodes/wire in the electrode cartridge/holder/feed mechanism and the machine head/wire guides
 - 2.17 describe the use of tooling magazines or technology settings, and how to position and identify the tools in relation to the operating program
 - 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility, in order to enter tooling data (such as tool datum's, positions, height, lengths and offsets, and number of skims)
 - 2.19 explain how to conduct trial runs using single block run, dry run and feed/speed override controls
 - 2.20 describe the typical faults that occur when electrical discharge machining and die sinking
 - 2.21 describe the things that they need to check before allowing the

machine to operate in full program run mode

- 2.22 explain how the various types of materials will affect the feeds and voltage that can be used
- 2.23 describe the application of dielectric fluids with regard to a range of different materials
- 2.24 describe the typical problems that can occur when setting-up electrodes/wires in cartridges/holders/feed mechanisms and with using workholding devices, and what to do if problems occur
- 2.25 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 343

Machining components using CNC electro-discharge machines

UAN:	F/600/5924
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 43: Machining Components using CNC Electro-Discharge Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to operate Computer Numerical Control (CNC) electrical discharge machines, such as spark erosion, tape erosion and wire erosion machines, in accordance with approved procedures. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including such things as flat, tapered and angled faces, internal and external profiles, parallel and tapered slots and steps, parallel and tapered holes, which are linearly or circularly pitched, and special profiles such as convex or concave. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important issue</p>

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 activities undertaken, and to report any problems with the equipment, tooling, program, materials or 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, 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 enable them to adopt an informed approach to applying CNC electrical discharge procedures. The learner will have an understanding of the CNC electrical discharge machining process, and its application, and will know about the equipment, tooling, materials and consumables, in adequate depth to provide a sound background to the machine operation and for carrying out the activities to the required specification.

The learner will understand the safety precautions required when working with the CNC electro-discharge 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 outcome
The learner will: 1. machine components using CNC electro-discharge machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the electro-discharge machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point

- ensure that machine guards are in place and correctly adjusted
 - ensure that materials/components are correctly positioned and held securely without distortion
 - check that the electrode or wire is in place and is in usable condition
 - ensure that the dielectric fluid is at an appropriate level
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC electrical discharge machines:
- CNC wire erosion machine
 - CNC spark erosion machine
 - CNC electrical discharge machining centre
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce machined components which combine different operations, and cover ten of the following:
- flat faces
 - angular faces
 - tapered faces
 - parallel faces
 - faces square to each other
 - external profiles
 - internal profiles
 - enclosed slots/recesses
 - open ended slots/recesses
 - tapered holes
 - holes on pitch circles
 - linear holes (rows, angles)
 - special profiles (such as concave, convex)
 - other special forms or activities
 - parallel and tapered steps/slots/shoulders
 - circular/curved profiles (internal or external)
 - engraving
 - threads
- 1.7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved

- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - flatness and squareness 0.001" per inch or 0.025mm per 25mm
 - components to be free from false starts and sharp edges
 - surface finish 32µin/0.8µm, 18VDI
 - machined holes within H8
 - angles within +/- 0.5 degree
- 1.11 carry out the necessary checks during production for accuracy of five of the following:
- dimensions
 - position
 - parallelism
 - angle/taper
 - squareness
 - surface texture
 - profile
- 1.12 shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome

The learner will:

2. know how to machine components using CNC electro-discharge machines

Assessment criteria

The learner can:

- 2.1 describe the specific safety precautions to be taken when working with CNC electrical discharge machines and equipment
- 2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 2.3 explain how to start and stop the machine in both normal and emergency situations
- 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.5 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
- 2.6 describe the application of a range of CNC electrical discharge machines such as spark erosion and wire erosion machines
- 2.7 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
- 2.8 explain how to interpret first and third angle drawings, imperial and

- metric systems of measurement, workpiece reference points and system of tolerancing
- 2.9 explain how to interpret the visual display and understand the various messages displayed
 - 2.10 describe the function of error messages, and what to do when an error message is displayed
 - 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
 - 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
 - 2.13 explain how to operate the machine, using single block run, full program run and feed/speed override controls
 - 2.14 explain how to make adjustments to the program operating parameters to take account of electrode wear
 - 2.15 explain how to set and secure the workpiece to the machine table/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
 - 2.16 describe the various types of electrodes/wire used, and how they are located and secured to the machine head, tool cartridge and tool magazine
 - 2.17 describe the safe and correct handling and storage of tooling
 - 2.18 explain how to check that the electrode/wire is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
 - 2.19 describe the procedures for dressing and reshaping electrodes, and the equipment to be used
 - 2.20 describe the problems that can occur with electrical discharge activities, and how these can be overcome
 - 2.21 describe the application of dielectric and ionised fluids with regard to different materials being machined
 - 2.22 describe the quality control procedures used, inspection checks to be carried out, and the equipment that is used
 - 2.23 explain where to obtain component drawings, eroding data, specifications and/or job instructions required for the components being machined
 - 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 344

Setting CNC vertical boring machines for production

UAN:	R/600/5927
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 44: Setting CNC Vertical Boring Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) vertical boring machines, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices to be used, and to mount and position them to the machine in the correct location for the type of operation being carried out. The learner will also be required to select the appropriate boring tools and cutters, check them for defects, and mount and secure them to the relevant tool holding devices and machine spindle.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC vertical boring machine used, and its application, and will know about the workholding devices, tooling, machine operating programmes and setting-up procedures, in adequate depth to provide a sound basis for setting-up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC vertical boring machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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• follow safe practice/approved setting up procedures at all times• confirm that the correct operating program has been loaded

- check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm
 - reamed and bored holes within H8
 - flatness and squareness 0.001" per inch or 0.025mm per 25mm
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following CNC boring machines in readiness for production:
- CNC vertical boring machine
 - CNC boring centre
- 1.7 prepare the tooling for operation by carrying out all of the following activities, as applicable to the machine type:
- positioning tools in the correct position in the tool posts, turrets, magazine or carousel
 - checking tools have a specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)
 - pre-setting tooling using setting jigs/fixtures
 - setting tool datum's
 - saving changes to programme
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using four of the following workholding methods and devices:
- clamping direct to machine table
 - machine vice (such as plain, swivel, universal)
 - three jaw chucks, hard jaws
 - pneumatic or magnetic table
 - indexing/rotating device
 - vee block and clamps
 - three jaw chucks, soft jaws
 - angle plate
 - other workholding devices

- four jaw chucks
 - fixtures
- 1.10 select and mount, in the appropriate tool holding device, eight of the following types of cutting tool:
- boring bars
 - turning tools
 - chamfering tools
 - recessing tools
 - profiling
 - form tools
 - centre drills
 - twist/core drills
 - boring tools
 - reamers
 - grinding wheels
 - milling cutters
- 1.11 set the machine tool operating parameters to achieve the component specification
- 1.12 set up the machine to produce components, combining several different operations, and cover ten of the following:
- plain internal/external diameters
 - stepped diameters
 - tapered diameters
 - special forms (such as concave, convex)
 - angular faces
 - internal/external undercuts
 - internal and external profiles
 - drilled holes
 - reamed holes
 - tapped holes
 - eccentric diameters
 - screw threads
 - internal bores
 - chamfers and radii
 - bored holes
 - flat faces
- 1.13 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome
The learner will: 2. know how to set CNC vertical boring machines for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC vertical boring machines 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutting tools and workholding devices 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.5 describe the hazards associated with working on CNC vertical boring machines (such as use of 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 2.6 explain how to handle and store cutting tools and verified tapes and programs, safely and correctly 2.7 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 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.9 describe the range of workholding methods and devices that are used on CNC vertical boring machines 2.10 explain why it is important to set the workholding device in relation to the machine datums and reference points 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used 2.12 describe the range of cutting tools that are used on CNC vertical boring machines, and typical applications 2.13 explain how to check that the cutting tools are in a safe and serviceable condition 2.14 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications) 2.15 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders 2.16 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures 2.17 describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relation to the operating program

- 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
- 2.19 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
- 2.20 describe the things that they need to check before allowing the machine to operate in full program run mode
- 2.21 explain how the various types of materials will affect the feeds and speeds that can be used
- 2.22 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
- 2.23 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 345

Machining components using CNC vertical boring machines

UAN:	Y/600/5928
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 45: Machining Components using CNC Vertical Boring Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out vertical boring operations, in accordance with approved procedures, using Computer Numerical Control (CNC) Machines. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including plain internal/external diameters, eccentric diameters, stepped diameters, chamfers and radii, special forms and profiles, tapered diameters, flat and angular faces, internal and external profiles, grooves/undercuts, drilled holes, and reamed and tapped holes. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important issue, and their production records must show consistent and</p>

satisfactory performance.

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 equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work with minimum 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 enable them to adopt an informed approach to applying CNC vertical boring procedures. The learner will have an understanding of the CNC vertical boring process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC vertical boring machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point

- ensure that machine guards are in place and correctly adjusted
 - ensure that materials/components are correctly positioned and held securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC boring machines:
- CNC vertical boring machine
 - CNC boring centre
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce machined components which combine several different operations, and cover ten of the following:
- plain internal/external diameters
 - stepped diameters
 - tapered diameters
 - special forms (such as concave, convex)
 - angular faces
 - internal/external undercuts
 - internal and external profiles
 - drilled holes
 - reamed holes
 - tapped holes
 - eccentric diameters
 - screw threads
 - internal bores
 - chamfers and radii
 - bored holes
 - flat faces
- 1.7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the relevant quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade

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<ul style="list-style-type: none"> • surface finish 63µin or 1.6µm • reamed and bored holes within H8 • flatness and squareness 0.001” per inch or 0.025mm per 25mm • angles within +/- 0.5 degree • screw threads BS medium fit
<p>1.11 carry out the necessary checks during production, for accuracy of five of the following:</p> <ul style="list-style-type: none"> • external diameters • internal diameters • lengths/depths • reamed hole size/fit • taper/angles • thread fit • slot/recess width • surface finish • flatness of faces • squareness of faces
<p>1.12 shut down the equipment to a safe condition on conclusion of the activities.</p>

Learning outcome
<p>The learner will:</p> <p>2. know how to machine components using CNC vertical boring machines</p>
Assessment criteria
<p>The learner can:</p> <p>2.1 describe the specific safety precautions to be taken when working with CNC vertical boring machines and equipment</p> <p>2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly</p> <p>2.3 explain how to start and stop the machine in both normal and emergency situations</p> <p>2.4 describe the hazards associated with working on CNC vertical boring machines (such as use of 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</p> <p>2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy</p> <p>2.6 describe the application of a range of CNC vertical boring machines</p> <p>2.7 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</p> <p>2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing</p>

- 2.9 explain how to interpret the visual display and understand the various messages displayed
- 2.10 describe the function of error messages, and what to do when an error message is displayed
- 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine, using single block run, full program run and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine spindle/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.16 describe the various types of cutting tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the indexable tooling is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
- 2.19 describe the problems that can occur with vertical boring activities, and how these can be overcome
- 2.20 describe the application of cutting fluids with regard to different materials being machined
- 2.21 describe the quality control procedures used, inspection checks to be carried out, and the equipment that is used
- 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 346

Setting CNC horizontal boring machines for production

UAN:	K/600/5951
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 46: Setting CNC Horizontal Boring Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) horizontal boring machines, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices to be used, and to mount and position them to the machine in the correct location for the type of operation being carried out. The learner will also be required to select the appropriate boring tools and cutters, check them for defects, and mount and secure them to the relevant tool holding devices and machine spindle.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting-up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC horizontal boring machine used, and its application, and will know about the workholding devices, tooling, machine operating programmes and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring that the work output is produced 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 outcome
The learner will: 1. set CNC horizontal boring machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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• follow safe practice/approved setting up procedures at all times• confirm that the correct operating program has been loaded

- check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - surface finish 63µin or 1.6µm
 - reamed and bored holes within H8
 - flatness and squareness 0.001" per inch or 0.025mm per 25mm
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following CNC boring machines in readiness for production:
- CNC horizontal boring machine
 - CNC boring centre
- 1.7 prepare the tooling for operation by carrying out all of the following activities, as applicable to the machine type:
- positioning tools in the correct position in the tool posts, turrets, magazine or carousel
 - checking tools have a specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)
 - setting tool datum's
 - pre-setting tooling using setting jigs/fixtures
 - saving changes to programme
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using four of the following workholding methods and devices:
- clamping direct to machine table
 - machine vice (plain, swivel, universal)
 - three jaw chucks, hard jaws
 - pneumatic or magnetic table
 - indexing/rotating device
 - vee block and clamps
 - three jaw chucks, soft jaws
 - other work holding devices
 - four jaw chucks

<ul style="list-style-type: none"> • fixtures • angle plate <p>1.10 select and mount, in the appropriate tool holding device, eight of the following types of cutting tool:</p> <ul style="list-style-type: none"> • boring tools • turning tools • chamfering tools • recessing tools • facing tools • twist/core drills • taps • reamers • milling cutters • forming tools <p>1.11 set the machine tool operating parameters to achieve the component specification</p> <p>1.12 set up the machine to produce components, combining several different operations, and cover eight from:</p> <ul style="list-style-type: none"> • bored holes through the workpiece • bored holes to a depth • external diameters • flat faces • internal and external profiles • square and parallel faces • angular faces • slots • indexed or rotated forms • grooves/undercuts • drilled holes • reamed holes • tapped holes <p>1.13 machine one of the following types of material:</p> <ul style="list-style-type: none"> • ferrous • non-ferrous • stainless • non-metallic <p>1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations</p> <p>1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.</p>

Learning outcome
The learner will:
2. know how to set CNC horizontal boring machines for production
Assessment criteria
The learner can:
2.1 describe the specific safety precautions to be taken when setting

- up workholding devices and tooling on CNC horizontal boring machines
- 2.2 explain how to start and stop the machine in normal and emergency situations
 - 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutting tools and workholding devices
 - 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
 - 2.5 describe the hazards associated with working on CNC horizontal boring machines (such as use of 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
 - 2.6 explain how to handle and store cutting tools and verified tapes and programs, safely and correctly
 - 2.7 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
 - 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
 - 2.9 describe the range of workholding methods and devices that are used on CNC horizontal boring machines
 - 2.10 explain why it is important to set the workholding device in relationship to the machine datums and reference points
 - 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used
 - 2.12 describe the range of cutting tools that are used on CNC horizontal boring machines, and typical applications
 - 2.13 explain how to check that the cutting tools are in a safe and serviceable condition
 - 2.14 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
 - 2.15 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
 - 2.16 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures
 - 2.17 describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
 - 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
 - 2.19 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
 - 2.20 describe the things that they need to check before allowing the machine to operate in full program run mode

- 2.21 explain how the various types of materials will affect the feeds and speeds that can be used
- 2.22 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
- 2.23 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 347

Machining components using CNC horizontal boring machines

UAN:	K/600/5965
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 47: Machining Components using CNC Horizontal Boring Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out horizontal boring operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machines. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including bored holes to a depth and through the workpiece, tapered holes, external diameters, flat faces, square and parallel faces, angular faces, slots, indexed or rotated forms, internal and external profiles, grooves/undercuts, and drilled, reamed and tapped holes to depth and through the workpiece. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting</p>

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 activities undertaken, and to report any problems with the equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work with minimum 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 enable them to adopt an informed approach to applying CNC horizontal boring procedures. The learner will have an understanding of the CNC horizontal boring process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC horizontal boring machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point
 - ensure that machine guards are in place and correctly adjusted
 - ensure that materials/components are correctly positioned and held securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC boring machines:
- CNC horizontal boring machine
 - CNC boring centre
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce components which combine several different operations and cover eight of the following:
- bored holes through the workpiece
 - bored holes to a depth
 - tapered holes
 - external diameters
 - flat faces
 - square and parallel faces
 - angular faces
 - slots
 - indexed or rotated forms
 - grooves/undercuts
 - drilled holes
 - reamed holes
 - tapped holes
 - internal and external profiles
- 1.7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the relevant quality and accuracy standards, as applicable to the operations performed:

<ul style="list-style-type: none"> • dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7 • surface finish 63µin or 1.6µm • reamed and bored holes within H8 • flatness and squareness 0.001” per inch or 0.025mm per 25mm <p>1.11 carry out the necessary checks during production, for accuracy of six of the following:</p> <ul style="list-style-type: none"> • external diameters • internal diameters • lengths/depths • reamed hole size/fit • taper/angles • thread fit • slot/recess width • surface finish • flatness of faces • squareness of faces <p>1.12 shut down the equipment to a safe condition on conclusion of the activities.</p>
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<p>Learning outcome</p> <p>The learner will:</p> <p>2. know how to machine components using CNC horizontal boring machines</p>
<p>Assessment criteria</p> <p>The learner can:</p> <p>2.1 describe the specific safety precautions to be taken when working with CNC horizontal boring machines and equipment</p> <p>2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly</p> <p>2.3 explain how to start and stop the machine in both normal and emergency situations</p> <p>2.4 describe the hazards associated with working on CNC horizontal boring machines (such as use of 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</p> <p>2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy</p> <p>2.6 describe the application of a range of CNC horizontal boring machines</p> <p>2.7 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</p> <p>2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing</p>

- 2.9 explain how to interpret the visual display and understand the various messages displayed
- 2.10 describe the function of error messages, and what to do when an error message is displayed
- 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine, using single block run, full program run, and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine spindle/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.16 describe the various types of cutting tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the indexable tooling is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
- 2.19 describe the problems that can occur with horizontal boring activities, and how these can be overcome
- 2.20 describe the application of cutting fluids with regard to different materials being machined
- 2.21 describe the quality control procedures used, inspection checks to be carried out, and the equipment that is used
- 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 348

Setting CNC gear cutting machines for production

UAN:	L/600/5974
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 48: Setting CNC Gear Cutting Machines for Production (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) gear cutting machines, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices to be used, and to mount and position them to the machine in the correct location for the type of operation being carried out. The learner will also be required to select the appropriate tools and cutters, check them for defects, and mount and secure them to the relevant tool holding devices and machine spindle.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programmes, checking for errors/faults, editing and saving program changes.</p> <p>The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC gear cutting machine used, and its application, and will know about the workholding devices, tooling, machine operating programmes and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC gear cutting machines for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none">• 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• follow safe practice/approved setting up procedures at all times• confirm that the correct operating program has been loaded

- check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as 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
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare one of the following CNC gear cutting machines in readiness for production:
- CNC gear cutting machine
 - CNC gear hobbing machine
 - CNC gear shaving machine
- 1.7 prepare the tooling by carrying out all of the following activities, as applicable to the machine type:
- positioning tools in the correct position in the turrets, magazine or carousel
 - checking tools have a specific tool number in relation to the operating program
 - entering all relevant tool data to the operating program (such as tool lengths, tool offsets)
 - setting tool datum's
 - pre-setting tooling using setting jigs/fixtures
 - saving changes to program
- 1.8 mount and set the required workholding devices, workpiece and cutting tools
- 1.9 position and secure workpieces using four of the following workholding methods and devices:
- arbors
 - mandrels
 - chucks
 - pots
 - collets
 - fixtures
 - centres
 - clamps
 - face plates

- 1.10 select and mount, in the appropriate tool holding device, three of the following types of cutting tool:
- hobs
 - shaving tools
 - bevel gear cutting tools
 - rack cutting tools
 - spline/serration cutting tools
 - other cutting tools
- 1.11 set the machine tool operating parameters to achieve the component specification
- 1.12 set up the machine to produce components combining several different operations, and cover four from:
- external spur gears
 - internal spur gears
 - external helical gears
 - internal helical gears
 - straight splines
 - involute splines
 - serrations
 - bevel gears
 - racks
- 1.13 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.14 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome
The learner will: 2. know how to set CNC gear cutting machines for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC gear cutting machines 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutting tools and workholding devices 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.5 describe the hazards associated with working on CNC gear cutting machines (such as use of 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
- 2.6 explain how to handle and store cutting tools and verified tapes and programs, safely and correctly
 - 2.7 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
 - 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
 - 2.9 describe the range of workholding methods and devices that are used on CNC gear cutting machines
 - 2.10 explain why it is important to set the workholding device in relationship to the machine datums and reference points
 - 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used
 - 2.12 describe the range of cutting tools used on CNC gear cutting machines, and typical applications
 - 2.13 describe the different types of gears and their application
 - 2.14 explain how to check that the cutting tools are in a safe and serviceable condition
 - 2.15 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
 - 2.16 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
 - 2.17 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures
 - 2.18 describe the use of magazines and carousels, and how to position and identify the tools in relation to the operating program
 - 2.19 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
 - 2.20 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
 - 2.21 describe the things that they need to check before allowing the machine to operate in full program run mode
 - 2.22 explain how the various types of materials will affect the feeds and speeds that can be used
 - 2.23 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
 - 2.24 describe the typical problems that can occur with the setting-up of the tooling and workholding devices, and what to do if they occur.
 - 2.25 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 349

Machining components using CNC gear cutting machines

UAN:	D/600/5980
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 49: Machining Components using CNC Gear Cutting Machines (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>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 take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present and that the machine has been approved for production. 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.</p>

The components produced will have a number of different features, including internal and external spur gears, helical gears, involute splines, straight splines, serrations, racks and bevel gears. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. 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 gear cutting activities undertaken, and to report any problems with the equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 enable them to adopt an informed approach to applying CNC gear cutting procedures. The learner will have an understanding of the CNC gear cutting process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC gear cutting machines
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point• ensure that machine guards are in place and correctly adjusted• ensure that materials/components are correctly positioned

- and held securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 operate one of the following CNC gear cutting machines:
- CNC gear cutting machine
 - CNC gear hobbing machine
 - CNC gear shaving machine
- 1.5 follow the defined procedures for starting and running the operating system
- 1.6 produce machined components which combine several different operations and cover four of the following:
- external spur gears
 - internal spur gears
 - external helical gears
 - internal helical gears
 - straight splines
 - involute splines
 - serrations
 - bevel gears
 - racks
- 1.7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 1.9 monitor the computer process and ensure that the production output is to the required specification
- 1.10 produce components within all of the relevant quality and accuracy standards, as 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
- 1.11 carry out the necessary checks during production, for accuracy of five of the following:

- gear blanks
- lead and helix angle
- gear tooth thickness
- involute form
- composite error rolling test
- surface texture

1.12 shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome

The learner will:

2. know how to machine components using CNC gear cutting machines

Assessment criteria

The learner can:

- 2.1 describe the specific safety precautions to be taken when working with CNC gear cutting machines and equipment
- 2.2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 2.3 explain how to start and stop the machine in both normal and emergency situations
- 2.4 describe the hazards associated with working on CNC gear cutting machines (such as use of 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
- 2.5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 2.6 describe the application of a range of CNC gear cutting machines
- 2.7 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
- 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.9 explain how to interpret the visual display and understand the various messages displayed
- 2.10 describe the function of error messages, and what to do when an error message is displayed
- 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine, using single block run, full program run and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine spindle/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the

finished workpiece

- 2.16 describe the various types of cutting tools used, and how they are located and secured to the machine tool posts, turrets, slides and tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the indexable tooling is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
- 2.19 describe the problems that can occur with gear cutting activities, and how these can be overcome
- 2.20 describe the application of cutting fluids with regard to different materials being machined
- 2.21 describe the quality control procedures used, inspection checks that need to be carried out, and the equipment that is used
- 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.23 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 350

Setting CNC machining centres for production

UAN:	L/600/5991
Level:	3
Credit value:	70
GLH:	140
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 50: Setting CNC Machining Centres for Production (Level 3)
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to prepare and set up Computer Numerical Control (CNC) machining centres, in accordance with approved procedures. The learner will be expected to select the appropriate workholding devices to be used, and to mount and position them to the machine in the correct location for the type of operation being carried out. The learner will also be required to select the appropriate tools and cutters, check them for defects, and mount and secure them to the relevant tool holding devices and machine spindle.</p> <p>The learner will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions are entered into the operating program and machine. This will involve loading and proving component programs, checking for errors/faults, editing and saving program changes. The learner must produce trial components and prove the machine is working satisfactorily before declaring the machine ready for production. Making adjustments to settings to achieve specification, and solving machine-related problems during production, will also form part of their role.</p>

The learner's responsibilities will require them to comply with organisational policy and procedures for the machine setting activities undertaken, and to report any problems with the equipment, tooling, programs or setting up activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work 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 provide a good understanding of their work, and will provide an informed approach to the setting-up procedures used. The learner will understand the CNC machining centre used, and its application, and will know about the workholding devices, tooling, machine operating programs and setting-up procedures, in adequate depth to provide a sound basis for setting up the equipment, correcting faults and ensuring the work output is produced 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 outcome
The learner will: 1. set CNC machining centres for production
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the setting-up activities: <ul style="list-style-type: none"> • 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 • follow safe practice/approved setting up procedures at all times • confirm that the correct operating program has been loaded

- check that the tooling is in a usable condition
 - ensure that the workpiece is correctly positioned and secured without distortion
 - update the program tool data as applicable
 - ensure that correctly adjusted machine guards are in place
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 follow the correct specifications for the component to be produced
- 1.4 set the machine to produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - components to be free from false tool cuts, burrs and sharp edges
 - flatness and squareness 0.001" per inch or 0.025mm per 25mm
 - reamed/bored holes within H8
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
 - surface finish 63 μm or 1.6 μm
- 1.5 determine what has to be done and how the machine will be set to achieve this
- 1.6 prepare the tooling for operation by carrying out all of the following activities, as applicable to the machine type:
- positioning tools in the correct position in the turrets, magazine or carousel
 - checking tools have a specific tool number in relationship to the operating program
 - entering all relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)
 - setting tool datums
 - pre-setting tooling using setting jigs/fixtures
 - saving changes to program
- 1.7 mount and set the required workholding devices, workpiece and cutting tools
- 1.8 position and secure workpieces using four of the following workholding methods and devices:
- clamping direct to machine table
 - vee blocks and clamps
 - machine vice
 - chucks with hard jaws
 - chucks with soft jaws
 - collet chucks
 - jigs and fixtures
 - angle plate
 - indexing/rotating device
 - magnetic or pneumatic tables
 - other work holding devices

- 1.9 select and mount in the appropriate tool holding device, eight of the following types of cutting tool:
- turning tools
 - boring tools
 - facing
 - thread cutting tools
 - twist/core drills
 - reamers
 - recessing/undercutting tools
 - face mills
 - slotting cutters
 - slitting saws
 - end mills
 - slot drills
 - grinding wheels
 - taps
- 1.10 set the machine tool operating parameters to achieve the component specification
- 1.11 set up the machine to produce components combining several different operations and cover ten from:
- external diameters
 - tapered diameters
 - shoulders and steps
 - bored holes
 - square and parallel faces
 - angular faces
 - indexed or rotated forms
 - internal and external profiles
 - grooves/undercuts
 - drilled holes
 - flat faces
 - reamed holes
 - tapped holes
 - slots
 - tapered holes
- 1.12 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.13 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- 1.14 deal promptly and effectively with problems within their control and report those that cannot be solved.

Learning outcome
The learner will: 2. know how to set CNC machining centres for production
Assessment criteria
The learner can: 2.1 describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC machining centres 2.2 explain how to start and stop the machine in normal and emergency situations 2.3 describe the importance of ensuring that the machine is isolated from the power supply before mounting cutting tools and workholding devices 2.4 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy 2.5 describe the hazards associated with working on CNC machining centres (such as use of 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 2.6 explain how to handle and store cutting tools and verified tapes and programs safely and correctly 2.7 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 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing 2.9 describe the range of workholding methods and devices that are used on CNC machining centres 2.10 explain why it is important to set the workholding device in relation to the machine datum's and reference points 2.11 describe the methods of setting the workholding devices, and the tools and equipment that can be used 2.12 describe the range of cutting tools used on CNC machining centres, and typical applications 2.13 explain how to check that the cutting tools are in a safe and serviceable condition 2.14 describe the use of tungsten carbide, ceramic and diamond indexable tips, and the factors which will determine their selection and use (such as condition of material supplied, hardness of the material, cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications) 2.15 describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders 2.16 describe the advantages of using pre-set tooling, and how to set the tooling using setting jigs/fixtures 2.17 describe the use of magazines and carousels, and how to position and identify the tools in relation to the operating program 2.18 explain how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling

data (such as tool datums, positions, lengths, offsets and radius compensation)

- 2.19 explain how to conduct trial runs, using single block run, dry run and feed/speed override controls
- 2.20 describe the things that they need to check before allowing the machine to operate in full program run mode
- 2.21 explain how the various types of materials will affect the feeds and speeds that can be used
- 2.22 describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
- 2.23 describe the typical problems that can occur with the setting up of the tooling and workholding devices, and what to do if they occur
- 2.24 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 351

Machining components using CNC machining centres

UAN:	D/600/5994
Level:	3
Credit value:	63
GLH:	126
Relationship to NOS:	This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 51: Machining Components using CNC Machining Centres (Level 3).
Endorsement by a sector or other appropriate body:	This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.
Aim:	<p>This unit covers the skills and knowledge needed to prove the competences required to carry out operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machining centres. The learner will take charge of the prepared machine and check that it is ready for the machining operations to be performed. This will involve checking that all the required components and consumables are present, and that the machine has been approved for production. 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.</p> <p>The components produced will have a number of different features, including bored holes to a depth and through the workpiece, tapered holes, external diameters, flat faces, square and parallel faces, angular faces, slots, indexed or rotated forms, internal and external profiles, grooves/undercuts, and drilled, reamed and tapped holes to depth and through the workpiece. The learner will be required to continuously monitor the machining operations, making any necessary adjustments to machine parameters, in line with their permitted authority. Meeting production targets will be an important</p>

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 activities undertaken, and to report any problems with the equipment, tooling, program, materials or activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to with minimum 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 enable them to adopt an informed approach to applying CNC machining centre procedures. The learner will have an understanding of the CNC machining centre process, and its application, and will know about the machine, tooling, materials, machining activities and consumables, in adequate depth to provide a sound background to the machine operation and 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 outcome
The learner will: 1. machine components using CNC machining centres
Assessment criteria
The learner can: 1.1 work safely at all times, complying with health and safety and other relevant regulations and guidelines 1.2 carry out all of the following during the machining activities: <ul style="list-style-type: none">• 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 the operating program is at the correct start point
 - ensure that machine guards are in place and correctly adjusted
 - ensure that materials/components are correctly positioned and held securely without distortion
 - check and maintain cutting tools in a safe and usable condition
 - ensure that the workpiece is clear of the tooling before starting the machine
 - use safe working practices and start up procedures at all times
 - adjust machine settings, as required, to maintain the required accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 1.3 confirm that the equipment is set up and ready for operation
- 1.4 follow the defined procedures for starting and running the operating system
- 1.5 produce components which combine several different operations and cover ten 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
- 1.6 machine one of the following types of material:
- ferrous
 - non-ferrous
 - stainless
 - non-metallic
- 1.7 produce components within all of the following quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - components to be free from false tool cuts, burrs and sharp edges

	<ul style="list-style-type: none"> • flatness and squareness 0.001” per inch or 0.025mm per 25mm • reamed/bored holes within H8 • angles within +/- 0.5 degree • screw threads BS medium fit • surface finish 63µin or 1.6µm
1.8	deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
1.9	monitor the computer process and ensure that the production output is to the required specification
1.10	carry out the necessary checks during production, for accuracy of five of the following: <ul style="list-style-type: none"> • 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
1.11	shut down the equipment to a safe condition on conclusion of the activities.

Learning outcome	
The learner will:	
2. know how to machine components using CNC machining centres	
Assessment criteria	
The learner can:	
2.1	describe the specific safety precautions to be taken when working with CNC machining centre and equipment
2.2	describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
2.3	explain how to start and stop the machine in both normal and emergency situations
2.4	describe the hazards associated with working on CNC machining centres (such as use of 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
2.5	describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
2.6	describe the application of a range of CNC machining centres
2.7	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

- 2.8 explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 2.9 explain how to interpret the visual display and understand the various messages displayed
- 2.10 describe the function of error messages, and what to do when an error message is displayed
- 2.11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 2.12 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 2.13 explain how to operate the machine, using single block run, full program run and feed/speed override controls
- 2.14 explain how to make adjustments to the program operating parameters to take account of tool wear
- 2.15 explain how to set and secure the workpiece to the machine spindle/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece
- 2.16 describe the various types of cutting tools used, and how they are located and secured to the machine tool-posts, turrets, slides and tool magazine or carousel
- 2.17 describe the safe and correct handling and storage of tooling
- 2.18 explain how to check that the indexable tooling is in a serviceable condition, and the effects that worn tooling will have on the workpiece surface finish and tolerances
- 2.19 describe the problems that can occur with horizontal boring activities, and how these can be overcome
- 2.20 describe the application of cutting fluids with regard to different materials being machined
- 2.21 describe the quality control procedures used, inspection checks to be carried out, and the equipment that is used
- 2.22 explain where to obtain component drawings, specifications and/or job instructions required for the components being machined
- 2.23 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

Mapping is provided as guidance and suggests areas of commonality between the qualifications. It does not imply that candidates completing units in one qualification have automatically covered all of the content of another.

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

This qualification has connections to the:

- Level 3 NVQ in Mechanical Manufacturing Engineering (1682)

Literacy, language, numeracy and ICT skills development

This qualification can develop skills that can be used in the following qualifications:

- Functional Skills (England) – see **Functional Skills | City & Guilds (cityandguilds.com)**
- Essential Skills (Northern Ireland) – see **Essential Skills (Northern Ireland) qualifications and training courses | City & Guilds (cityandguilds.com)**
- Essential Skills Wales – see **Skills for Wales - Wales | City & Guilds (cityandguilds.com)**



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
- **Events:** dates and information on the latest Centre events
- **Online assessment:** how to register for e-assessments.

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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 F: +44 (0)20 7294 2413

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

City & Guilds Group

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

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WW-03-1712