Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence) (1271-02)

Version 2 (March 2019)

Qualification Handbook

Qualification at a glance

Subject area	Mechanical
City & Guilds number	1271
Age group approved	16-19, 19+
Entry requirements	None
Assessment types	Portfolio
Approvals	Automatic approval
Support materials	Qualification handbook
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds qualification number	Ofqual accreditation number
1271-02 Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)	418	820	1271-02	603/1704/8

Version and date	Change detail	Section
Version 2 March 2019	TQT information updated	Total Qualification Time
	References to Machinist (Advanced Manufacturing Engineering) Trailblazer Group replaced	Throughout

Contents

1 Introduction

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

Area	Description
Who is the qualification for?	This qualification is aimed at learners aged 16 and above who would like to gain the skills required during their initial training to become a Machinist (Advanced Manufacturing Engineering) as part of an apprenticeship.
What does the qualification cover?	Learners will develop skills needed to carry out different activities related to advanced manufacturing engineering. Learners will develop transferable skills valued by employers such as working efficiently and effectively and contribute to improving business performance. Critically they will learn to carry out tasks to meet regulatory and legal requirements.
What opportunities for progression are there?	Upon completion of the qualification learners will have developed skills required of the Foundation phase of the Machinist (Advanced Manufacturing Engineering) pathway, enabling them to progress further with their training.
Who did we develop the qualification with?	This qualification has been developed in collaboration with the Engineering Technician standard Trailblazer Group.
Is it part of an apprenticeship framework or initiative?	Yes. This qualification has been developed to be included within the Foundation phase of the Engineering Technician standard apprenticeship.

Structure

Level 2 Diploma in Advanced Manufacturing Engineering (1271-02)

Learners are required to complete the following:

- 4 mandatory units (201-204)
- plus 6 optional units from (205-245).

Barred Combinations

- 235 with 206, 207, 209, 210, 211, 236, 237, 238
- 215 with 216 and 217; 216 with 215 and 217
- 218 with 219
- 236 with 235, 237, 238

City & Guilds unit number	Unit title	GLH
Mandatory		
201	Complying with statutory regulations and organisational safety requirements	35
202	Working efficiently and effectively in an engineering environment	25
203	Using and communicating technical information	25
204	Conducting business improvement techniques	41
Optional		
205	Producing components using hand fitting techniques	**64**
206	Preparing and using lathes for turning operations	68
207	Preparing and using milling machines	68
208	Preparing and using grinding machines	68
209	Preparing and using CNC turning machines	64
210	Preparing and using CNC milling machines	64
211	Preparing and using machining centres	64
212	Preparing and using CNC fabrication equipment	64
213	Preparing and using CNC machine tool programs	64
214	Producing components by rapid prototyping techniques	61
215	Producing CAD models (drawings) using a CAD system	61
216	Producing mechanical engineering drawings using a CAD systems	61
217	Producing electrical or electronic engineering drawings using a CAD system	61
218	Producing mechanical assemblies	61

219	Producing tool and die assemblies	68
220	Maintaining mechanical devices and equipment	64
221	Forming and assembling pipework systems	64
222	Producing sheet metal components and assemblies	64
223	Maintaining electrical equipment/systems	68
224	Maintaining electronic equipment and circuits	61
225	Wiring and testing electrical equipment and circuits	64
226	Wiring and testing programmable controller based systems	68
227	Assembling and testing electronic circuits	64
228	Forming and assembling electrical cable enclosure and support systems	65
229	Assembling, wiring and testing electrical panels/components mounted in enclosures	64
230	Maintaining and testing process instrumentation and control devices	68
231	Preparing and using industrial robots	64
232	Preparing and using electro-discharge machines	64
233	Maintaining fluid power equipment	64
234	Assembling and testing fluid power systems	64
235	General turning, milling and welding applications	55
236	General welding applications	55
237	Preparing and using semi-automatic MIG, MAG and flux cored arc welding equipment	68
238	Preparing and using manual TIG or plasma-arc welding equipment	68
239	Carrying out heat treatment of engineering materials	41
240	Wiring and testing vehicle electrical equipment and circuits	68
241	Maintaining vehicle electrical equipment/systems	68
242	Diagnosing and rectifying faults on vehicle systems	68
243	Stripping and rebuilding vehicle engines	64
244	Using computer software packages to assist with engineering activities	37
245	Producing engineering project plans	37

Total Qualification Time

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

TQT is comprised of the following two elements:

1) The number of hours which an awarding organisation has assigned to a qualification for Guided Learning, and
2) An estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by - but, unlike Guided Learning, not under the Immediate Guidance or Supervision of - a lecturer, supervisor, tutor or other, appropriate provider of education or training.

Title and level	GLH	TQT
1271-02 Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)	418	820

2 Centre requirements

Approval

Centres that are currently approved to offer the relevant predecessor qualifications (1712-20, 1712-21) will receive automatic approval for this qualification. If your centre is not eligible for automatic approval you will require full qualification approval.

New centres will need to gain centre approval. Existing centres who wish to offer this qualification must go through City & Guilds' full Qualification Approval Process. Please refer to the City & Guilds website for further information on the approval process: www.cityandguilds.com.

Resource requirements

Resources

The qualification should be delivered in the workshops and classrooms of a centre with full facilities for machining activities. The machinery, tools, equipment and resources used must be representative of industry standards and there must be sufficient equipment/resources available for each learner to demonstrate their competence individually.

Centre staffing

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

- be occupationally competent or technically knowledgeable in the 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, eg tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors

Assessment must be carried out by competent assessors. Ass a minimum, they must hold the Level 3 Award in Assessing Competence in the Work Environment or equivalent such as D32/33, A1/2. 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 assessment in sheltered and workplace environments to the most up to date standards.

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 unit assessment criteria. This will be demonstrated by either holding a relevant technical qualification or by proven industrial experience of the technical areas they are assessing/ The assessor's competence must, at least, be at the same level as that required of the unit being assessed.

Internal Quality Assurers

Internal quality assurance must be carried out by competent Internal Quality Assurers (IQAs). As a minimum, they must hold the Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices or equivalent such as V2 or D35. They must also hold, or at least be familiar with the Level 3 Award in Assessing Competence in the Work Environment or equivalents such as D32/33, A1/2.

IQAs will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out quality assurance of assessment processes to the most up to date standards. They will also be expected to be conversant with the terminology of the unit against which assessments and quality assurance are carried out.

Continuing Professional Development

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.

Learner entry requirements

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

Age restrictions

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

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 qualifications
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

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

Support materials

The following resources are available for these qualifications:

Description	How to access
Qualification Handbook	www.cityandguilds.com

Recording documents

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

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

City & Guilds has developed a set of *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 methods

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

Assessment environment

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 compete
- aspects of working relationships and communications for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence.

Simulations/replications will require prior approval from the centre's City & Guilds External Quality Assurer 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(s) takes the same form as the workplace.

Evidence requirements

Carrying out assessments

The units were specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the learners choice of "bulleted items" listed in the unit assessment criteria. Where the assessment criteria gives a choice of bulleted items (for example 'any three from five'), assessors should note that learners do not need to provide evidence of the other items to complete the unit (in this example, two) items, particularly where these additional items may relate to other activities or methods that are not part of the learners normal workplace activity or area of expertise.

Minimum performance of 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 maybe 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 Quality Assurer 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. 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.

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 testimonies

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.

5 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- Title
- Level
- Guided learning hours (GLH)
- Learning outcomes
- Topics and the related scope of content.

Centres must deliver the full breadth of the range. For the practical assessments for this qualification, centres should ensure that there are sufficient resources to complete the task. They are required to use all the equipment or commodities in the range, unless otherwise specified.

Unit 201 Complying with statutory regulations and organisational safety requirements

Unit level:	Level 2
GLH:	35
Unit aim:	This unit identifies the knowledge, skills and understanding required in order that the learner can demonstrate that they are competent in being able to deal with statutory regulations and organisational safety requirements, in accordance with approved procedures.
Relationship to NOS:	EUCL2F-001

Learning outcome

The learner will:

1 Comply with statutory regulations and organisational safety requirements

Assessment criteria

The learner can:

1.1 Apply duties and responsibilities required under the Health and Safety at Work Act and other current legislation
1.2 Identify, within the organisation, sources of information and guidance on health and safety issues
1.3 Identify the warning signs and labels of the main groups of hazardous or dangerous substances
1.4 Comply with regulations
1.5 Present themselves in the workplace suitably prepared for the activities to be undertaken
1.6 Identify the appropriate qualified first aiders and the location of first aid facilities
1.7 Identify the procedures to be followed in the event of injury to themselves or others
1.8 Follow organisational procedures in the event of fire, accident, emergencies and the evacuation of premises
1.9 Identify the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment
1.10 Recognise and control hazards and risks in the workplace
1.11 Use correct manual lifting and carrying techniques
1.12 Demonstrate methods of manual lifting and carrying
1.13 Maintain a tidy workplace, with exits and gangways free from obstruction
1.14 Use equipment safely and only for the purpose intended
1.15 Observe organisational safety rules, signs and hazard warnings

1.16 Take measures to protect others from any harm resulting from the work that they are carrying out

1.17 Observe personal protection and hygiene procedures.

Range

(AC1.2) **Health and safety issues:**

- Eye protection
- Personal Protective Equipment (PPE)
- Risk assessments.

(AC1.4) **Regulations:**

- Statutory
- Specific to their work.

(AC1.10) **Hazards and risks:**

- In the working environment
- With the equipment used
- Materials and substances used
- Working practices that do not follow laid-down procedures.

(AC1.12) **Methods of manual lifting and carrying:**

- Lifting alone

Plus one from the following:

- With assistance of others
- With mechanical assistance.

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

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 main groups of hazardous substances

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

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 and their responsibilities for minimising them

2.8 Describe the processes and procedures that are used to identify and rate the level of risk

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

2.10 Explain what constitute dangerous occurrences and hazardous malfunctions, and why these must be reported even if no-one was 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 personal protective equipment (PPE) and protective clothing that is available for their areas of activity

2.14 Explain the need to observe personal protection and hygiene procedures

2.15 Describe how to act responsibly within the working environment

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

2.17 Explain how to prepare and maintain safe working areas and the standards and procedures to ensure good housekeeping

2.18 Describe the importance of safe storage of tools, equipment, materials and products

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

Unit 202 Working efficiently and effectively in an engineering environment

Unit level:	Level 2
GLH:	25
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to work efficiently and effectively in an engineering environment.
Relationship to NOS:	EUCL2F-002.

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 Apply checks and practices to all engineering activities
1.3 Prepare to carry out engineering activities
1.4 Produce work plans for engineering activities
1.5 Deal with problems affecting the engineering activity
1.6 Create and maintain effective working relationships and behaviours
1.7 Contribute to developing own engineering competence
1.8 Clean, tidy up and restore the work area on completion of the engineering activities.

Range

(AC1.2) **Checks and practices:**

- Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
- Wear the appropriate personal protective equipment for the work area and specific activity being carried out
- Use all tools and equipment safely and correctly, and only for their intended purpose including adherence to the Control of Vibration at Work Regulations (Hand and Arm)
- Ensure that the work area is maintained and left in a safe and tidy condition.

(AC1.3) **Prepare:**

- Ensure the work area is free from hazards and suitably prepared for the activities to be undertaken
- Ensure any required safety procedures are implemented

- Ensure any necessary personal protection equipment is obtained and is in a usable condition
- Ensure tools and equipment required are obtained and checked that they are in a safe and useable condition
- Ensure all necessary drawings, specifications and associated documentation is obtained
- Ensure job instructions are obtained and understood
- Ensure the correct and sufficient materials or components are obtained
- Ensure storage arrangements for work are appropriate
- Ensure appropriate authorisation to carry out the work is obtained.

(AC1.4) **Work plans:**

- Documentation required
- Materials required
- Equipment required
- Workholding methods and equipment
- Tools required
- Measuring/test equipment needed
- Operating sequence to be followed
- Timescale required to complete activities.

(AC1.5) **Problems:**

To include four of the following:

- Materials
- Job specification
- Timescales
- Tools and equipment
- Quality
- Safety
- Drawings
- People
- Work activities or procedures.

(AC1.6) **Working relationships and behaviours:**

- Maintain a consistently good record of punctuality and attendance in accordance with company policy
- Dress suitably for the activities to be undertaken
- Follow both verbal and written instructions provided, seeking additional information, clarification or assistance where necessary in a courteous and polite manner
- Take advice from others in a positive way
- Make a positive contribution to any discussions
- Be flexible in their approach to work, responding positively to any agreed amendments or changes
- Communicate with others using clear, accurate and appropriate language
- Demonstrate an open and honest approach, showing respect for the views, rights and property of others including the values of diversity and equality
- Demonstrate a willingness to help others when working towards a common team objective
- Work to targets and deadlines.

(AC1.7) **Developing own engineering competence:**

- Describe the levels of skill, knowledge and understanding needed for competence in the areas of work expected of them
- Describe their development objectives/program, and how these were identified
- Provide information on their expectations and progress towards their identified objectives
- Use feedback and advice to improve their personal performance.

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 environment

2.2 Explain the importance of applying the appropriate behaviours in the workplace and the implications if these are not adhered to

2.3 Describe how to present themselves in the workplace suitably dressed for the activities to be undertaken

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

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

2.6 Explain the benefits of team working and understanding of team objectives

2.7 Describe the roles of individual team members and the strengths they bring to the team

2.8 Explain the importance of clear communication both oral and written, using appropriate language and format

2.9 Explain the need to change communication styles to meet the needs of the target audience

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

2.11 Explain the importance of seeking additional support and guidance when required

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

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

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

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

2.16 Explain the importance of respecting others, including an awareness of diversity and inclusion

2.17 Describe the personal protective equipment (PPE) to be worn for the engineering activities undertaken

2.18 Describe the correct use of any equipment used to protect the health and safety of themself and their colleagues

2.19 Describe planning and preparation needed to carry out the engineering activity

2.20 Describe the procedure for ensuring that all documentation, tools, equipment and materials relating to the work being carried out is available, prior to starting the activity

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

2.22 Describe how to deal effectively with problems that could arise

2.23 Describe their role in helping to develop their own skills and knowledge

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

2.25 Explain the importance of reviewing their training and development with trainers and supervisors, of comparing the skills, setting objectives to overcome any shortfall or address any development needs

2.26 Describe their responsibilities for providing evidence of their performance and progress

2.27 Explain the importance of maintaining effective working relationships within the workplace

2.28 Explain the importance of informing others of their activities which may have impact on their work

2.29 Describe how to deal with disagreements with others in ways which will help to resolve difficulties and maintain long term relationships

2.30 Describe the regulations that affect how individuals should be treated at work

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

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

2.33 Explain the need to dispose of waste materials and consumables in a safe and environmentally friendly way

2.34 Describe where tools and equipment should be stored and located and the importance of returning all tools and documentation to their designation on completion of work activities

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

2.36 Explain the importance of leaving the work are in a safe condition on completion of activities.

Range

(AC2.2) **Implications:**

- To the business
- To the employee.

(AC2.30) **Regulations:**

- Equal Opportunities and Equal Pay
- Race Relations and Sex Discrimination
- Working Time Directive
- Disabled Persons Acts.

Unit 203 Using and communicating technical information

Unit level:	Level 2
GLH:	25
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to communicate in the workplace.
Relationship to NOS:	EUCLF2-003

Learning outcome

The learner will:

1 Use and communicate technical information

Assessment criteria

The learner can:

1.1 Use approved sources to obtain the required data, documentation or specifications
1.2 Use information extracted from engineering documentation
1.3 Use information extracted from related documentation
1.4 Extract information to establish work requirements
1.5 Record and communicate the technical information
1.6 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve.

Range

(AC1.1) **Use approved sources:**

- 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
- Make valid decisions based on the evaluation of the engineering information
- Return all documentation to the approved location on completion of the work
- Complete all necessary production documentation.

(AC1.2) **Engineering documentation:**

Use four of the following:

- Detailed component drawings

- General assembly drawings
- Repair drawings
- Fluid power drawings
- Wiring/circuit diagrams
- Installation drawings
- Approved sketches
- Illustrations
- Visual display screens
- Modification drawings
- Sub-assembly drawings
- Schematic diagrams
- Fabrication drawings
- Pattern drawings
- Welding drawings
- Casting drawings
- Operational diagrams
- Physical layouts
- Manufacturers' manuals/drawings
- Photographic representations
- Contractual specifications.

(AC1.3) **Related documentation:**

Use four of the following:

- Job instructions
- Drawing instructions
- Test schedules
- Manufacturers' instructions
- Welding procedure specifications
- Material specifications
- Reference tables/charts
- National, international and organisational standards
- Planning documentation
- Quality control documents
- Operation sheets
- Process specifications
- Welding procedure specifications
- Performance parameters.

(AC1.4) **Information:**

Extract eight of the following:

- Materials or components required
- Dimensions
- Tolerances
- Build quality
- Installation requirements
- Connections to be made
- Surface texture requirements
- Location/orientation of parts
- Process or treatments required

- Assembly sequence
- Inspection requirements
- Part numbers for replacement parts
- Surface finish required
- Weld type and size
- Operations required
- Shape or profiles
- Test points to be used
- Circuit characteristics
- Maintenance requirements.

(AC1.5) **Technical information:**

Use three of the following methods:

- Produce fully detailed sketches of work/circuits completed or required
- Prepare work planning documentation
- Record data from testing activities
- Produce technical reports on activities they have completed
- Complete material and tool requisition documentation
- Produce a list of replacement parts required for a maintenance activity
- Complete training records or portfolio references.

Learning outcome

The learner will:

2 Know how to use and communicate technical information

Assessment criteria

The learner can:

2.1 Describe the information sources used for the data and documentation that they use in their work activities

2.2 Explain why technical information is presented in different forms

2.3 Explain how and where to obtain the various documents that they will be using and how to check that they are current and valid

2.4 Describe the types of engineering drawings used, and how they interrelate

2.5 Describe the meaning of the different symbols and abbreviations found on the documents that they use

2.6 Explain how to use other sources of information to support the data

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

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

2.9 Describe the typical ways of communicating technical information), and the amount of detail that should be included

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

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

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

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

2.14 Explain to whom they should report in the event of problems that they cannot resolve.

Unit 204 Conducting business improvement activities

Unit level:	Level 2
GLH:	41
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to contribute to effective business improvement.
Relationship to NOS:	EUCL2F-004

Learning outcome

The learner will:

1 Conduct business improvement activities

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

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

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

1.5 Apply the principle and processes of visual management to an operation or process using a variety of visual management techniques

1.6 Identify appropriate parts of the operation or process that will have visual control

1.7 Identify key performance indicators that will be displayed in the work area

1.8 Calculate performance indicators

1.9 Identify improvements within the operation or process

1.10 Contribute to improvements in existing standard operating procedures

1.11 Create or update visual controls that promote business improvement

1.12 Record and present the records from business improvement activities to the appropriate people

1.13 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve.

Range

(AC1.8) **Performance indicators:**

Calculate the following:

- Not right first time
- Delivery schedule achievement

Plus one of the following:

- Parts per operator hour (PPOH)
- Overall equipment effectiveness (OEE)
- Value added per person (VAPP)
- Stock turns
- Cost breakdown in term of labour, material and overhead
- Floor space utilization (FSU).

(AC1.9) **Improvements within the operation or process:**

Improvements for three of the following:

- Reduced product cost
- Improved quality
- Improved safety
- Improvements to working practices
- Improvement in delivery performance
- Reduction in waste and/or energy usage
- Reduction in lead times
- Resource utilisation
- Improvement in customer satisfaction.

(AC1.10) **Improvements in existing standard operating procedures:**

Improvements for three of the following:

- Customer service
- Health and safety practices
- Product quality
- Cleaning of equipment/work area
- Process procedures
- Maintenance of equipment
- Manufacturing operations
- Staff development.

(AC1.11) **Visual controls:**

Use visual controls to promote improvement in six of the following:

- Producing shadow boards to standardise the storage and location of area equipment
- Colour coding of equipment
- Safety
- Performance measures
- Parts control system
- Zero defects
- Process control boards
- Skills matrices
- Process concerns or corrective actions
- Workplace organisation
- Work in progress locations and quantities (WIP)
- Problem resolution (such as Kaizen boards)
- Standard operating procedures
- Autonomous maintenance worksheets.

(AC1.12) **Present:**

- Verbal report using visual aids

Plus one of the following:

- Written or typed report
- Computer based presentation
- Specific company documentation.

Learning outcome

The learner will:

2 Know how to conduct business improvement activities

Assessment criteria

The learner can:

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

2.2 Describe how to conduct a systematic Plan, Do, Check, Act (PDCA) approach to problem-solving and business improvement

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

2.4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the employee and the business if these are not adhered to

2.5 Describe what is meant by business improvement and how continuous improvement activities can benefit a company

2.6 Outline the application of the measures of competitiveness

2.7 Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements

2.8 Describe different types of waste and how to eliminate them from a process or operation

2.9 Describe the steps in a 5S/5C audit and a `red tag' exercise

2.10 Explain how to score and audit the 5S/5C exercise

2.11 Explain the importance of arranging and labelling the equipment

2.12 Describe how to use 'root cause' problem solving analysis using the 5 whys/how technique

2.13 Describe methods of evaluating improvement ideas in order to select those that are to be pursued

2.14 Describe how improvements to the process could be achieved by engaging the knowledge and experience of the people working on the process

2.15 Explain the importance of creating Standard Operating Procedures (SOPs) and of relating work activities to them

2.16 Describe the methods that can be used to communicate information using visual control systems

2.17 Describe how information can be displayed differently depending on various work applications.

Range

(AC2.6) **Measures of competitiveness:**

- Delivered right first time
- Delivery schedule achievement
- People productivity
- Stock turns
- Overall equipment effectiveness
- Value added per person
- Floor space utilisation.

(AC2.8) **Types of waste:**

- Over-production
- Inventory
- Transport
- Over-processing
- Waiting time
- Operator motion
- Bad quality
- Failure to exploit human potential.

Unit 205 Producing components using hand fitting techniques

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to effectively plan and prepare, use appropriate tools and equipment and a range of techniques to produce components with different types of features.
Relationship to NOS:	EUCL2F-005

Learning outcome

The learner will:

1 Produce components using hand fitting techniques

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations when carrying out fitting activities
1.3 Follow job instructions, assembly drawings and procedures
1.4 Ensure that all tools and equipment, power tool cables, extension leads or air supply hoses are in a safe, useable and serviceable condition
1.5 Check that all measuring equipment is within calibration date
1.6 Ensure that the components used are free from foreign objects, dirt or other contamination
1.7 Return all tools and equipment to the correct location on completion of the fitting activities
1.8 Plan the fitting activities
1.9 Mark out a range of material forms
1.10 Use marking out equipment
1.11 Mark out features on workpieces
1.12 Cut and shape the materials to the required specification, using appropriate tools and techniques
1.13 Use hand fitting activities
1.14 Produce component features which combine different operations
1.15 Use measuring equipment during the hand fitting and checking
1.16 Carry out checks for accuracy
1.17 Produce components to standard

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

1.19 Leave the work area in a safe and tidy condition on completion of the fitting activities.

Range

(AC1.9) **Material forms:**

To include two of the following:

- Square/rectangular
- Circular/cylindrical
- Sections
- Irregular shapes.

(AC1.10) **Marking out equipment:**

- Rules
- Scribers
- Dividers/trammels
- Centre punches
- Squares
- Vernier instruments

Plus one of the following:

- Protractor
- Templates.

(AC1.11) **Features:**

- Datum/centre lines
- Circles
- Linear hole positions
- Square/rectangular
- Radial profiles
- Angles/angular profiles
- Radial hole positions.

(AC1.12) **Materials:**

- Ferrous
- Non ferrous
- Non metallic.

(AC1.13) **Hand fitting activities:**

- Filing
- Hand sawing
- Power sawing
- Offhand grinding.

(AC1.14) **Features:**

- Flat datum faces
- Drilled through holes
- Internal threads
- Faces which are square to each other
- Reamed holes
- External threads
- Curved profiles

- Faces that are parallel to each other
- Chamfers and radii
- Faces angled to each other
- Counterbore, countersink, or spot face
- Holes drilled to a depth
- Sliding or mating parts.

(AC1.15) **Measuring equipment:**

- External micrometers
- Surface finish equipment
- Vernier callipers

Plus six more of the following:

- Rules
- Feeler gauges
- Squares
- Bore/hole gauges
- Callipers
- Slip gauges
- Protractors
- Radius/profile gauges
- Depth micrometers
- Thread gauges
- Depth Verniers
- Dial test indicators (DTI)
- Coordinate measuring machine (CMM).

(AC1.16) **Checks for accuracy:**

- Linear dimensions
- Hole position
- Flatness
- Hole size/fit
- Squareness
- Depths
- Angles
- Thread size and fit
- Profiles
- Surface finish.

(AC1.17) **Standard:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.25mm or +/- 0.010”
- There must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”
- Flatness and squareness 0.05mm per 25mm or 0.002 per inch
- Angles within +/- 1 degree
- Screw threads to BS medium fit
- Reamed and bored holes within H8
- Surface finish 63 µin or 1.6 µm.

Learning outcome

The learner will:

2 Know how to produce components using hand fitting techniques

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements and safe working practices and procedures required for the hand fitting activities undertaken

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

2.3 Describe the hazards associated with the hand fitting activities and how they can be minimised

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

2.5 Explain how to use and extract information from engineering drawings and related specifications, in relation to work undertaken

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

2.7 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety

2.8 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

2.9 Describe the methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used

2.10 Describe the use of marking out conventions when marking out the workpiece

2.11 Describe the ways of laying out the marking out shapes or patterns to maximise use of materials

2.12 Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements

2.13 Explain how to set and adjust tools

2.14 Describe the importance of using tools only for the purpose intended; the care that is required when using the equipment and tools; the proper way of storing tools and equipment between operations

2.15 Describe the cutting and shaping methods to be used, and the sequence in which the operations are to be carried out

2.16 Describe the various types of file that are available, and the cut of files for different applications

2.17 Describe the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits

2.18 Explain how to prepare the components for the filing operations

2.19 Describe the use of vice jaw plates to protect the workpiece from damage

2.20 Explain how to file flat, square and curved surfaces, and how to achieve a smooth surface finish

2.21 Explain how to select saw blades for different materials, and how to set the saw blades for different operations

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

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

2.24 Explain how to prepare drilling machines for operations

2.25 Explain how to mount the workpiece; techniques of positioning drills to marking out, use of centre drills and taking trial cuts and checking accuracy, and how to correct holes which are off centre

2.26 Explain how to produce a sliding or mating fit using filing

2.27 Describe the problems that can occur with the hand fitting activities, and how these can be overcome

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

2.29 Describe the importance of leaving the work area in a safe and clean condition on completion of the fitting activities.

Unit 205 Producing components using hand fitting techniques

Supporting Information

Evidence requirements

In order to prove their ability to combine different fitting operations, at least one of the components produced must be of a significant nature, and must have a minimum of five of the features listed in 1.14.

Unit guidance

2.5 To include symbols and conventions to appropriate BS or ISO standards.

2.10 To include datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes which are linearly positioned, boxed and on pitch circles.

Unit 206 Preparing and using lathes for turning operations

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to carry out turning operations on machines such as centre lathes, capstan or turret lathes, automatic or other specific turning machines.
Relationship to NOS:	EUCL2F-013

Learning outcome

The learner will:

1 Prepare and use lathes for turning operations

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and are correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure cutting tools are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the machining activities
1.8 Obtain and prepare the appropriate materials, tools and equipment
1.9 Mount, secure and machine components using workholding devices
1.10 Mount and use machining tools
1.11 Set and adjust the machine tool speeds and feeds to achieve the component specification
1.12 Use the machine tool controls safely and correctly, in line with operational procedures
1.13 Produce machined component features which combine different operations
1.14 Machine components made from different types of material
1.15 Carry out the checks for accuracy
1.16 Use measuring equipment during the machining and checking activities
1.17 Produce components to standard
1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

1.19 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.9) **Workholding devices:**

- Three-jaw chucks with hard jaws
- Three-jaw chucks with soft jaws
- Four-jaw chucks
- Collet chucks

Plus two from the following:

- Drive plate and centres
- Magnetic or pneumatic devices
- Fixtures
- Fixed steadies or travelling steadies
- Faceplates
- Special purpose workholding devices.

(AC1.10) **Machining tools:**

Use eight of the following machining tools:

- Turning
- Knurling
- Recessing/grooving
- Twist/core drills
- Thread forming tools
- Facing
- Parting off
- Chamfering
- Reamers
- Dies
- Boring
- Forming
- Centre drills
- Taps.

(AC1.13) **Features:**

- Flat faces
- Stepped diameters
- Drilled holes
- Chamfers
- Parallel diameters
- Tapered diameters
- Reamed holes
- Grooves/undercuts
- Bored holes

Plus four of the following:

- Internal threads
- External threads
- Eccentric diameters
- Knurls or special finishes

- Parting off
- Profile forms.

(AC1.14) **Materials:**

- Ferrous
- Non ferrous
- Metallic.

(AC1.15) **Checks for accuracy:**

- External diameters
- Bore/ hole size/fit
- Surface finish
- Parallelism
- Angle/taper
- Linear dimensions
- Grooves/undercuts

Plus two of the following:

- Internal diameters
- Concentricity
- Eccentricity
- Ovality
- Thread fit.

(AC1.16) **Measuring equipment:**

- External micrometers
- Dial test indicators (DTI)
- Vernier/digital/dial callipers
- Surface finish equipment

Plus six of the following:

- Rules
- Bore/hole gauges
- Internal micrometers
- Thread gauges
- Depth micrometers
- Plug gauges
- Depth Verniers
- Radius/profile gauges
- Slip gauges
- Protractors
- Coordinate measuring machine (CMM).

(AC1.17) **Standard:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.15mm or +/- 0.006”
- There must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
- Surface finish 63 µin or 1.6µm
- Reamed holes within H8
- Screw threads BS medium fit
- Angles within +/- 0.5 degree.

Learning outcome

The learner will:

2 Know how to prepare and use lathes for turning operations

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using lathes

2.2 Describe the hazards associated with the turning operations and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the turning activities

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

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

2.6 Describe how to plan and prepare to carry out the machining operations

2.7 Describe how to use and extract information from engineering drawings and related specifications in relation to work undertaken

2.8 Describe the main features of the lathe and the accessories that can be used

2.9 Explain how to position and secure workholding devices to the machine spindle, and the checks to be made

2.10 Describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components

2.11 Describe the various turning operations that can be performed, and the shapes and types of tooling that can be used

2.12 Explain how to mount and secure the cutting tools in the tool holding devices

2.13 Explain how to check that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly

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

2.15 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy

2.16 Describe the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken

2.17 Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used

2.18 Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used

2.19 Describe how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring internal and external dimensions; measuring geometric features; how to check surface finish

2.20 Describe the problems that can occur with the turning activities and how these can be overcome

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

2.22 Describe the importance of leaving the work area and machine in a safe condition on completion of the turning activities.

Unit 206 Preparing and using lathes for turning operations

Supporting Information

Evidence requirements

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of six of the features listed in 1.14.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards, first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing.

Unit 207 Preparing and using milling machines

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to carry out milling operations on horizontal, vertical or universal milling machines.
Relationship to NOS:	EUCL2F-014

Learning outcome

The learner will:

1 Prepare and use milling machines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure cutting tools are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the machining activities
1.8 Obtain and prepare the appropriate materials, tools and equipment
1.9 Mount, secure and machine components using workholding devices
1.10 Mount and use milling cutters/tools
1.11 Set and adjust the machine tool speeds and feeds to achieve the component specification
1.12 Use the machine tool controls safely and correctly, in line with operational procedures
1.13 Produce machined component features that combine different operations
1.14 Machine components made from different types of material
1.15 Carry out checks for accuracy
1.16 Use measuring equipment during the machining and checking activities
1.17 Produce components to standard
1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.19 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.9) **Workholding devices:**

- Fixed vice
- Direct clamping to machine table

Plus two of the following:

- Magnetic or pneumatic devices
- Swivel or universal vice
- Angle plates
- Chucks
- Fixtures
- Vee block and clamps
- Indexing device
- Other employer specific.

(AC1.10) **Milling cutters/tools:**

Use six of the following:

- Face mills
- Slot cutters
- Twist/core drills
- Slab/cylindrical cutters
- Slitting saws
- Reamers
- End mills
- Vee cutters
- Boring bars
- Slot drills
- Taps
- Side and face cutters
- Other form cutters.

(AC1.13) **Features:**

- Flat faces
- Parallel faces
- Open ended slots
- Square faces
- Steps/shoulders
- Enclosed slots
- Drilled holes

Plus two of the following:

- Angular faces
- Reamed holes
- Bored holes
- Indexed or rotated forms
- Recesses
- Tee slots
- Profile forms.

(AC1.14) **Material:**

- Ferrous

- Non ferrous
- Non metallic.

(AC1.15) **Checks for accuracy:**

- Linear dimensions
- Surface finish
- Depths
- Slots
- Flatness
- Angles
- Squareness
- Hole size/fit.

(AC1.16) **Measuring equipment:**

- Rules
- Squares
- External micrometers
- Dial test indicators (DTI)
- Vernier/digital/dial callipers
- Surface finish equipment

Plus three of the following:

- Feeler gauges
- Bore/hole gauges
- Internal micrometers
- Slip gauges
- Depth micrometers
- Radius/profile gauges
- Depth Verniers
- Protractors
- Coordinate measuring machine (CMM).

(AC1.17) **Standard:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.15mm or +/- 0.006”
- There must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
- Flatness and squareness within 0.125mm per 25mm or 0.005” per inch
- Reamed holes within H8
- Surface finish 63 µin or 1.6µm
- Angles within +/- 1 degree.

Learning outcome

The learner will:

2 Know how to prepare and use milling machines

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using milling machines

2.2 Describe the hazards associated with the milling operations and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the milling activities

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

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

2.6 Describe the planning and preparing to carry out the machining operations

2.7 Explain how to use and extract information from engineering drawings and related specifications in relation to work undertaken

2.8 Describe the main features of the milling machine, and the accessories that can be used

2.9 Explain how to position and secure workholding devices to the machine table, and the checks to be made

2.10 Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

2.11 Describe the various milling operations that can be performed, and the types of cutters that are used

2.12 Explain how to mount and secure the cutting tools in the tool holding devices and to the machine spindle

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

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

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

2.16 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy

2.17 Describe the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken

2.18 Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used

2.19 Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used

2.20 Explain how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions; measuring geometric features; how to check surface finish

2.21 Describe the problems that can occur with the milling activities and how these can be overcome

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

2.23 Describe the importance of leaving the work area and machine in a safe condition on completion of the milling activities.

Unit 207 Preparing and using milling machines

Supporting Information

Evidence requirements

In order to prove their ability to combine different milling features, at least one of the components produced must be of a significant nature, and must have a minimum of five of the features listed in 1.13.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards, first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing.

Unit 208 Preparing and using grinding machines

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to carry out grinding operations.
Relationship to NOS:	EUCL2F-033

Learning outcome

The learner will:

1 Prepare and use grinding machines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure grinding wheels are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the grinding activities
1.8 Obtain and prepare the appropriate materials, tools and equipment
1.9 Grind components from different types of material
1.10 Mount, secure and machine components using different types of workholding devices
1.11 Prepare grinding wheels
1.12 Produce ground component features from combined operations
1.13 Set and adjust the machine tool speeds and feeds to achieve the component specification
1.14 Use the machine tool controls safely and correctly in line with operational procedures
1.15 Carry out the checks for accuracy
1.16 Use measuring equipment
1.17 Produce components to meet quality standards
1.18 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve
1.19 Shut down the equipment to a safe condition on completion of the grinding activities.

Range

(AC1.9) **Types of material:**

Use two of the following:

- Ferrous
- Non ferrous
- Non metallic.

(AC1.10) **Workholding devices:**

Use two of the following:

- Magnetic chuck or blocks
- Angle plates
- Chucks
- Fixed vice
- Vee block and clamps
- Centres
- Swivel or universal vice
- Fixtures
- Mandrels.

(AC1.11) **Prepare:**

- Dressing and 'trueing up' grinding wheels

Plus one of the following

- Wheel forming
- Relieving the wheel sides.

(AC1.12) **Features:**

Produce five of the following:

- Flat faces
- Parallel diameters
- Parallel faces
- Stepped diameters
- Faces square to each other
- Tapered diameters
- Vertical faces
- Counterbores
- Angular faces
- Tapered bores
- Steps and shoulders
- Parallel bores
- Slots
- Profile forms.

(AC1.15) **Checks for accuracy:**

- Dimensions
- Parallelism
- Surface texture

Plus two of the following:

- Flatness
- Profile
- Concentricity

- Squareness
- Angle/taper
- Ovality/lobbing.

(AC1.16) **Measuring equipment:**

- External micrometers
- Vernier/digital/dial callipers
- Dial test indicators (DTI)
- Surface finish equipment

Plus two of the following:

- Squares
- Feeler gauges
- Internal micrometers
- Bore/hole gauges
- Depth micrometers
- Slip gauges
- Depth Verniers
- Radius/profile gauges
- Comparators (external or internal)
- Protractors
- Coordinate measuring machine (CMM).

(AC1.17) **Quality standards:**

- Components to be free from false grinding cuts, wheel marks, burrs and sharp edges
- General dimensional tolerance +/- 0.125mm or +/- 0.005"
- There must be one or more specific dimensional tolerances within +/- 0.025mm or +/- 0.001"
- Flatness and squareness within 0.025mm per 25mm or 0.001" per inch
- Surface texture 8 µin or 0.2µm
- Angles/tapers within +/- 30 minutes.

Learning outcome

The learner will:

2 Know how to prepare and use grinding machines

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using grinding machines

2.2 Describe the hazards associated with the grinding operations and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the grinding activities

2.4 Describe the safety mechanisms on the machine, and the procedure for checking that they function correctly

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

2.6 Explain how to plan and prepare to carry out the grinding operations

2.7 Explain how to use and extract information from engineering drawings and related specifications in relation to work undertaken

2.8 Describe the main features of the grinding machine, and the accessories that can be used

2.9 Describe the range of workholding methods and devices that are used on grinding machines

2.10 Explain how to position and secure workholding devices and the workpiece to the machine table, and the checks to be made

2.11 Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

2.12 Describe the various grinding operations that can be performed, and the types of grinding wheels that are used

2.13 Explain how to check that the grinding wheels are in a safe and serviceable condition

2.14 Describe the importance of 'trueing up' and dressing wheels to prevent glazing and burning of the workpiece, and methods of forming the wheels to the required profile

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

2.16 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on wheel life, surface finish and dimensional accuracy

2.17 Describe the factors that affect the selection of grinding feeds and speeds, and the depth of cut that can be taken

2.18 Describe the application of cutting fluids with regard to a range of different materials, and why some materials do not require cutting fluids to be used

2.19 Explain how to recognise grinding faults, and how to identify when grinding wheels need dressing

2.20 Describe the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used

2.21 Explain how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions; measuring geometric features; how to check surface finish

2.22 Describe the problems that can occur with the grinding activities and how these can be overcome

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

2.24 Describe the importance of leaving the work area and machine in a safe condition on completion of the grinding activities.

Unit 208 Preparing and using grinding machines

Supporting Information

Evidence requirements

In order to prove their ability to combine different grinding operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of three features from 1.12.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards in relation to work undertaken and first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing.

Unit 209 Preparing and using CNC turning machines

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use CNC turning machines.
Relationship to NOS:	EUCL2F-034

Learning outcome

The learner will:

1 Prepare and use CNC turning machines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure cutting tools are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the CNC machining activities
1.8 Position and secure workpieces using different workholding methods and devices
1.9 Select and mount the tool holding device and cutting tools
1.10 Prepare the tooling for operation
1.11 Produce machined component features from combined operations
1.12 Check the safe and correct operation of the machine and program
1.13 Machine components made from different types of material
1.14 Carry out checks for accuracy using different types of measuring equipment
1.15 Produce components to meet quality standards
1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.17 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.8) **Workholding methods and devices:**

Use three of the following:

- Chucks with hard jaws
- Chucks with soft jaws
- Fixtures
- Drive centres
- Collet chucks
- Faceplates
- Magnetic/pneumatic devices
- Other workholding devices.

(AC1.9) **Cutting tools:**

Use six of the following:

- Roughing tool
- Screw-thread tool
- Centre drills
- Reamers
- Finishing tool
- Profiling tools
- Twist/core drills
- Maxi-tipped drills
- Parting-off tool
- Form tools
- Boring tools
- Carbide insert drills.

(AC1.10) **Prepare:**

- Position tools in the correct location in the tool posts, turrets, magazine or carousel
- Check the tool numbers in relation to the CNC program
- Enter relevant tool data into the CNC program or control system, as appropriate
- Pre-set tooling using setting jigs/fixtures
- Set tool datum
- Save changes to the program.

(AC1.11) **Features:**

- Parallel diameters
- Stepped diameters
- Flat faces
- Drilled holes
- Chamfers and radii
- Screw threads using formed tooling (internal or external)

Plus four of the following:

- Tapered diameters
- Parting-off
- External profiles
- Undercuts
- Reamed holes
- Eccentric diameters
- Bored holes
- Internal profiles
- Tapped holes.

(AC1.12) **Check:**

- Datums for each machine axis are set in relation to all equipment and tooling used
- The machining carried out meets the drawing specification
- 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 offsets are correctly entered
- Tool cutter paths are executed safely and correctly
- Auxiliary/miscellaneous functions operate at the correct point in the program (cutter start/stop, coolant flow)
- Programs have been saved in the appropriate format.

(AC1.13) **Types of material:**

- Ferrous
- Non ferrous
- Non metallic.

(AC1.14) **Checks for accuracy:**

- External diameters
- Parallelism/cylindricity
- Linear dimensions
- Surface finish
- Concentricity/coaxiality
- Thread fit

Plus four of the following:

- Internal diameters
- Bore/hole size/fit
- Angle/taper
- Grooves/undercuts
- Eccentricity
- Ovality.

(AC1.14) **Measuring equipment:**

- External micrometers
- Vernier/digital/dial callipers
- Dial test indicators (DTI)
- Surface finish equipment

Plus six of the following:

- Rules
- Bore/hole gauges
- Internal micrometers
- Thread gauges
- Depth micrometers
- Plug gauges
- Depth Verniers
- Radius/profile gauges
- Slip gauges
- Protractors
- Coordinate measuring machine (CMM).

(AC1.15) **Quality standards:**

- Components to be free from false tool cuts, burrs and sharp edges

- General dimensional tolerance +/- 0.15mm or +/- 0.006”
- There must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
- Surface finish 63 µin or 1.6µm
- Reamed holes within H8
- Screw threads BS medium fit
- Angles/tapers within +/- 0.5 degree.

Learning outcome

The learner will:

2 Know how to prepare and use CNC turning machines

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC lathes

2.2 Describe the hazards associated with the using CNC lathes and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the CNC turning activities

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

2.5 Describe the correct operation of the various hand and automatic modes of machine control

2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.7 Explain how to use and extract information from engineering drawings or data and related specifications in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

2.9 Describe the computer coding language used in CNC programs, with regard to machine axes, positional information, machine management and auxiliary/miscellaneous functions

2.10 Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program

2.11 Explain how to deal with error messages and faults on the program or equipment

2.12 Describe the range of workholding methods and devices that are used on CNC lathes

2.13 Explain why it is important to set the workholding device in relationship to the machine datums and reference points

2.14 Describe the methods of setting the workholding devices, and the tools and equipment that can be used

2.15 Describe the range of cutting tools that are used on CNC lathes, and typical applications

2.16 Explain how to check that the cutting tools are in a safe and serviceable condition

2.17 Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use

2.18 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders

2.19 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

2.20 Describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

2.21 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

2.22 Explain how to conduct trial runs using single block run, dry run, and feed and speed override controls

2.23 Describe the items that they need to check before allowing the machine to operate in full program run mode

2.24 Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting

2.25 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

2.26 Explain how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

2.27 Describe the typical problems that can occur with the CNC turning activities, and what to do if they occur

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

2.29 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities.

Unit 209 Preparing and using CNC turning machines

Supporting Information

Evidence requirements

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of five of the features listed in 1.11.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards.

Unit 210 Preparing and using CNC milling machines

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use CNC milling machines.
Relationship to NOS:	EUCL2F-035

Learning outcome

The learner will:

1 Prepare and use CNC milling machines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure cutting tools are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the CNC machining activities
1.8 Load/input the program to the machine controller and check the program for errors using the approved procedures
1.9 Position and secure workpieces using different workholding methods and devices
1.10 Select and mount milling cutters to the appropriate tool holding device
1.11 Prepare the tooling for operation
1.12 Produce machined components features that combine different operations
1.13 Check that the machine and program operates safely and correctly
1.14 Machine components using different types of material
1.15 Carry out the checks for accuracy
1.16 Use different types of measuring equipment during the machining and checking activities
1.17 Produce components to quality standards
1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.19 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.9) **Workholding methods and devices:**

- Machine vices
- Direct clamping to machine table
- Chucks

Plus two of the following:

- Pneumatic or magnetic table
- Fixtures
- Ancillary indexing devices
- Angle plate
- Other workholding devices.

(AC1.10) **Milling cutters:**

- Face mills
- Slot drills
- Twist/core drills

Plus one of the following:

- Special profile cutters
- Boring tools
- Reamers
- End mills.

(AC1.11) **Prepare:**

- Secure tools to the machine spindle or positioning tools in the correct position in the tool magazine/carousel
- Check that tools have specific tool number in relation to the operating program
- Enter all relevant tool data to the operating program
- Pre-set tooling using setting jigs/fixtures
- Set tool datum
- Save changes to the program.

(AC1.12) **Features:**

- Flat faces
- Open ended slots
- Drilled holes linearly pitched
- Steps/shoulders
- Enclosed slots/recesses
- Parallel faces
- Square faces
- Drilled holes on pitched circles

Plus three of the following:

- External profiles
- Tapped holes
- Circular/curved profiles
- Bored holes
- Angular faces
- Special forms
- Internal profiles
- Reamed holes.

(AC1.13) **Check:**

- Datums for each machine axis are set in relation to all equipment and tooling used
- 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 offsets are correctly entered into the machine controller
- Tool cutter paths are executed safely and correctly
- Auxiliary functions operate at the correct point in the program
- Programs have been saved in the appropriate format.

(AC1.14) **Types of material:**

- Ferrous
- Non ferrous
- Non metallic.

(AC1.15) **Checks for accuracy:**

- Linear dimensions
- Slots
- Flatness
- Surface finish
- Squareness
- Parallelism
- Concentricity

Plus two of the following:

- Hole size/fit
- Angles
- Recesses
- Thread fit.

(AC1.16) **Measuring equipment:**

- External micrometers
- Vernier/digital/dial callipers
- Dial test indicators (DTI)
- Surface finish equipment
- Slip gauges
- Vernier protractors

Plus four of the following:

- Rules
- Bore/hole gauges
- Internal micrometers
- Thread gauges
- Depth micrometers
- Plug gauges
- Depth Verniers
- Radius/profile gauges
- Coordinate measuring machine (CMM).

(AC1.17) **Quality standards:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.15mm or +/- 0.006”

- There must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
- Surface finish 63 µin or 1.6µm
- Reamed holes within H8
- Screw threads BS medium fit
- Angles/tapers within +/- 0.5 degree
- Flatness and squareness 0.001” per inch or 0.025mm per 25mm.

Learning outcome

The learner will:

2 Know how to prepare and use CNC milling machines

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC milling machines

2.2 Describe the hazards associated with the using CNC milling machines and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the CNC milling activities

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

2.5 Describe the correct operation of the various hand and automatic modes of machine control

2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.7 Explain how to use and extract information from engineering drawings or data and related specifications in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

2.9 Describe the computer coding language used in CNC programs

2.10 Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program

2.11 Explain how to deal with error messages and faults on the program or equipment

2.12 Describe the range of workholding methods and devices that are used on CNC milling machines

2.13 Explain why it is important to set the workholding device in relationship to the machine axis and reference points

2.14 Describe the methods of setting the workholding devices, and the tools and equipment that can be used

2.15 Describe the range of milling cutters/cutting tools that are used on CNC milling machines, and their typical applications

2.16 Explain how to check that the cutting tools are in a safe and serviceable condition

2.17 Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors which will determine their selection and use

2.18 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders and machine spindle

2.19 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

2.20 Describe the use of tool magazines and carousels, and how to position and identify the tools in relationship to the operating program

2.21 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

2.22 Explain how to conduct trial runs

2.23 Describe the items that they need to check before allowing the machine to operate in full program run mode

2.24 Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting

2.25 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

2.26 Explain how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

2.27 Describe the typical problems that can occur with the CNC milling activities, and what to do if they occur

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

2.29 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities.

Range

(AC2.22)
- Single block run
- Dry run
- Feed and speed override controls.

Unit 210 Preparing and using CNC milling machines

Supporting Information

Evidence requirements

In order to prove their ability to combine different milling operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of five of the features listed in 1.12.

Unit 211 Preparing and using CNC machining centres

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use machining centres.
Relationship to NOS:	EUCL2F-036

Learning outcome

The learner will:

1 Prepare and use CNC machining centres

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure machine guards are in place and correctly adjusted
1.4 Ensure components are held securely without damage or distortion
1.5 Ensure cutting tools are maintained in a suitable and safe condition
1.6 Ensure the work area is maintained and left in a safe and tidy condition
1.7 Plan the CNC machining activities
1.8 Load/input the program to the machine controller, and check the program for errors using the approved procedures
1.9 Position and secure workpieces, using different types of workholding methods and devices
1.10 Select and mount the appropriate tool holding device and cutting tools
1.11 Prepare tooling for operation
1.12 Produce machined component features from combining different operations
1.13 Check that the machine and program operates safely and correctly
1.14 Machine components made from different types of material
1.15 Carry out checks for accuracy
1.16 Use measuring equipment during the machining and checking activities
1.17 Produce components to meet quality standards
1.18 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.19 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.9) **Workholding methods and devices:**

Use three of the following:

- Clamping direct to machine table
- Collet chucks
- Indexing/rotating device
- Machine vice
- Jigs and fixtures
- Magnetic or pneumatic devices
- Chucks with hard jaws
- Faceplates
- Angle plate
- Chucks with soft jaws
- Other workholding devices.

(AC1.10) **Cutting tools:**

Use eight of the following:

- Turning tools
- Thread cutting tools
- Face mills
- Slot drills
- Boring tools
- Centre drills
- Slotting cutters
- Grinding wheels
- Twist/core drills
- Facing tools
- Slitting saws
- Taps
- Profiling tools
- Reamers
- End mills
- Dies
- Parting-off tool
- Recessing/undercutting tools.

(AC1.11) **Prepare:**

- Position tools in the correct position in the tool posts, turrets, magazine or carousel
- Check that tools have a specific tool number in relation to the operating program
- Enter relevant tool data to the operating program
- Pre-set tooling by using setting jigs/fixtures
- Set tool datum
- Save changes to the program.

(AC1.12) **Features:**

Produce twelve of the following:

- Parallel diameters
- Internal screw threads
- Drilled holes linearly pitched
- Parting-off
- Drilled holes on pitched circles
- Stepped diameters
- Tapered diameters
- Chamfers and radii
- Indexed or rotated forms
- Eccentric diameters
- Tapered holes
- Internal profiles
- Drilled holes
- Flat faces
- External profiles
- Reamed holes
- Square faces
- Open ended slots
- Bored holes
- Parallel faces
- Enclosed slots/recesses
- Tapped holes
- Angular faces
- Grooves/undercuts
- External screw threads
- Shoulders and steps
- Special forms.

(AC1.13) **Check:**

- Datums for each machine axis are set in relation to all equipment and tooling used
- 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 offsets are correctly entered into the machine controller
- 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.

(AC1.14) **Types of material:**

- Ferrous
- Non ferrous
- Non metallic.

(AC1.15) **Checks for accuracy:**

- External diameters
- Slots
- Internal diameters
- Concentricity
- Linear dimensions
- Eccentricity
- Bore/hole size/fit
- Flatness
- Surface finish
- Parallelism
- Angle/taper
- Squareness
- Thread fit
- Grooves/undercuts
- Ovality.

(AC1.16) **Measuring equipment:**

- External micrometers
- Dial test indicators (DTI)
- Vernier/digital/dial callipers
- Surface finish equipment

Plus six of the following:

- Rules
- Thread gauges
- Internal micrometers
- Plug gauges
- Depth micrometers
- Radius/profile gauges
- Depth Verniers
- Protractors
- Slip gauges
- Bore/hole gauges
- Coordinate measuring machine (CMM).

(AC1.17) **Quality standards:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.15mm or +/- 0.006”
- There must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
- Surface finish 63 µin or 1.6µm
- Reamed holes within H8
- Screw threads BS medium fit
- Angles/tapers within +/- 0.5 degree
- Flatness and squareness 0.001” per inch or 0.025mm per 25mm.

Learning outcome

The learner will:

2 Know how to prepare and use CNC machining centres

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using CNC machining centres

2.2 Describe the hazards associated with the using CNC machining centres and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be worn for the CNC machining activities

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

2.5 Describe the correct operation of the various hand and automatic modes of machine control

2.6 Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.7 Explain how to use and extract information from engineering drawings or data and related specifications in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

2.9 Describe the computer coding language used in CNC programs

2.10 Describe how to set the machine controller in the program and editing mode, and how to enter or download the prepared program

2.11 Describe how to deal with error messages and faults on the program or equipment

2.12 Describe the range of workholding methods and devices that are used on CNC machining centres

2.13 Explain why it is important to set the workholding device in relationship to the machine datum/axis and reference points

2.14 Describe the methods of setting the workholding devices, and the tools and equipment that can be used

2.15 Describe the range of cutting tools that are used on CNC machining centres, and their typical applications

2.16 Explain how to check that the cutting tools are in a safe and serviceable condition

2.17 Describe the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use

2.18 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders

2.19 Describe the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

2.20 Describe the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

2.21 Describe how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data

2.22 Explain how to conduct trial runs

2.23 Describe the items that they need to check before allowing the machine to operate in full program run mode

2.24 Describe the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting

2.25 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

2.26 Explain how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

2.27 Describe the typical problems that can occur with the CNC machining activities, and what to do if they occur

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

2.29 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities.

Range

(AC2.9) **Computer coding language:**

- Machine axes
- Positional information
- Machine management
- Auxiliary functions.

(AC2.22) **Trial runs:**

- Single block run
- Dry run
- Feed and speed override controls.

Unit 211 Preparing and using CNC machining centres

Supporting Information

Evidence requirements

In order to prove their ability to combine different features, at least one of the machined components produced must be of a significant nature, and must have a minimum of six of the features listed in 1.12.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards.

Unit 212 Preparing and using CNC fabrication equipment

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use CNC fabrication equipment.
Relationship to NOS:	EUCL2F-044

Learning outcome

The learner will:

1 Prepare and use CNC fabrication equipment

Assessment criteria

The learner can:

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

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

1.3 Ensure that machine guards are in place and are correctly adjusted

1.4 Ensure that components are held securely without damage or distortion

1.5 Ensure that tooling is maintained in a suitable/safe condition

1.6 Make sure that the work area is maintained and left in a safe and tidy condition

1.7 Plan CNC fabrication activities

1.8 Position and secure workpieces on CNC fabrication machines using different workholding methods and devices

1.9 Select and mount cutting/forming tools in the appropriate holding device

1.10 Prepare tooling

1.11 Set up the machine to produce component features by combining several different operations

1.12 Check the machine and program operate safely and correctly

1.13 Carry out checks for accuracy

1.14 Produce components from different types of material that meet quality standards

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

1.16 Shut down the equipment to a safe condition on completion of the machining activities.

Range

(AC1.8) **CNC fabrication machines:**

Use one of the following:

- Shearing machine
- Bending machine
- Laster cutting machine
- Punching machine
- Plasma cutting machine
- Gas cutting machine
- Water cutting machine
- Forming machine.

(AC1.8) **Workholding methods:**

Use two of the following:

- Jigs and fixtures
- Pneumatic/magnetic devices
- Clamps and stops
- Other workholding devices.

(AC1.9) **Cutting/forming tools:**

Select and mount one of the following:

- Shearing blades
- Forming tools
- Bending tools
- Hole punching tools
- Nibbling tools
- Cutting heads/nozzles.

(AC1.10) **Prepare:**

- Pre-set tooling
- Use setting jigs/fixtures
- Set tool datums
- Mount tools in the correct position in the tool-posts, turrets, magazine or carousel
- Check that tools have a specific tool number in relationship to the operating program
- Enter all relevant tool data into the operating program
- Save changes to the program.

(AC1.11) **Features:**

Produce four of the following:

- Straight cuts
- Holes radially pitched
- Multi-bend platework
- Square/rectangular profiles
- Louvres
- Curved plates
- Curved profiles
- Swages
- Bends of various angles
- Internal profiles
- Bends at 90°

- Holes linearly pitched
- Other specific operations.

(AC1.12) **Check:**

- 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 offsets are correctly entered into the machine controller
- Tool cutter paths are executed safely and correctly
- Auxiliary functions operate at the correct point in the program
- Programs have been saved in the appropriate format.

(AC1.13) **Checks for accuracy:**

Carry out three of the following:

- Linear dimensions
- Flatness/freedom from excessive distortion
- Position of features
- Accuracy of louvres and swages
- Accuracy of profiles.

(AC1.14) **Types of material:**

Use one of the following:

- Ferrous
- Non ferrous
- Stainless
- Special alloys
- Other specific materials.

(AC1.14) **Quality standards:**

- Dimensional accuracy is within specification tolerance
- Components are free from deformity, burrs and sharp edges
- Profiles conform to specification/template requirements.

Learning outcome

The learner will:

2 Know how to prepare and use CNC fabrication equipment

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when setting up workholding devices and tooling on CNC fabrication machines

2.2 Describe how to start and stop the machine, in normal and emergency situations

2.3 Explain the importance of ensuring that the machine is isolated from the power supply before mounting the cutting and forming tools and workholding devices

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

2.5 Describe the hazards associated with working on CNC fabrication equipment and how they can be minimised

2.6 Describe how to handle and store cutting and forming tools, and programs, safely and correctly

2.7 Describe how to use and extract information from engineering drawings or data and related specifications in relation to work undertaken

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

2.9 Describe how to carry out currency/issue checks of the specifications they are working with

2.10 Describe the range of workholding methods and devices that are used on CNC fabrication machines

2.11 Explain why it is important to set the workholding device/workpiece in relationship to the machine datums and reference points

2.12 Describe the methods of setting the workholding devices/workpieces, and the tools and equipment that can be used

2.13 Describe the range of cutting and forming tools that are used on the CNC fabrication machine

2.14 Describe how to check that the cutting and forming tools are in a safe and serviceable condition

2.15 Describe the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting and forming tools to the tool holders

2.16 Explain the advantages of using pre-set tooling, and how to set the tooling by 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 Describe how to set and secure the workpiece to the machine/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece

2.19 Describe how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data

2.20 Describe how to interpret the visual display and the various messages displayed

2.21 Explain the function of error messages, and what to do when an error message is displayed

2.22 Describe how to find the correct restart point in the program when the machine has been stopped before completion of the program

2.23 Describe the operation of the various hand and automatic modes of machine control

2.24 Describe how to operate the machine using single-block run, full programme parameters run and feed/speed override controls

2.25 Describe how to make adjustments to the operating program

2.26 Describe how to conduct trial runs using single block run, dry run, and feed and speed override controls

2.27 Identify the items that they need to check before allowing the machine to operate in full program run mode

2.28 Describe how the various types of materials used will affect the feeds/speeds that can be used

2.29 Explain typical problems that can occur with the setting up and operating of the machine and workholding devices, and what to do if they occur

2.30 Describe how to save the completed or edited programs in the appropriate format, and the need to store programs and storage devices safely and correctly, away from contaminants and possible corruption

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

2.32 Explain the importance of leaving the work area and machine in a safe condition on completion of the activities.

Unit 212 Preparing and using CNC fabrication equipment

Supporting Information

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards.

Unit 213 Preparing and proving CNC machine tool programs

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare basic computer numerical control (CNC) programs.
Relationship to NOS:	EUCL2F-021

Learning outcome

The learner will:

1 Prepare and prove CNC machine tool programs

Assessment criteria

The learner can:

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

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

1.3 Ensure the correct component drawings are obtained and checked for currency and validity

1.4 Ensure the appropriate reference manuals and programming codes are used to suit the machine controller

1.5 Ensure the machine controller is prepared ready to accept the operating program

1.6 Ensure the prepared program is input/loaded into the controller safely and correctly

1.7 Ensure programs are stored safely and correctly in the appropriate format

1.8 Ensure program media is stored safely and correctly, away from contaminants and corruption

1.9 Plan the programming activities

1.10 Prepare and prove programs for CNC machine tools

1.11 Produce CNC programs to produce component features using different types of material

1.12 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes

1.13 Specify positional information and machine axes that are consistent with the requirements of each stage/operation

1.14 Prove the part program

1.15 Confirm that the program operates safely and correctly

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

1.17 Shut down the equipment to a safe condition on completion of the programming activities.

Range

(AC1.10) **Machine tools:**

Produce programs for one of the following:

- Two axis machine
- Three axis machine
- Multiple axis machines (4 or more)
- Machining centres.

(AC1.11) **CNC programs:**

- Entered directly into the machine controller or
- Using computer software

Containing:

- All necessary positional information
- Appropriate codes
- Machine management commands (preparatory/auxiliary functions)
- Repetitions within programs
- Absolute or incremental co-ordinates
- Tool/cutter change positions
- Tool information.

(AC1.11) **Component features:**

To include eight of the following:

- Parallel diameters
- Angular faces
- Enclosed slots/recesses
- Stepped diameters
- Internal profiles
- Open ended slots
- Tapered diameters
- External profiles
- Eccentric diameters
- Flat faces
- Reamed holes
- External screw threads
- Internal undercuts
- Tapped holes
- Internal screw threads
- External undercuts
- Drilled holes
- Chamfers and radii
- Steps/shoulders
- Holes on pitched circles
- Bored holes
- Parallel faces
- Holes linearly pitched
- Special forms

- Faces that are square to each other
- Parting-off.

(AC1.11) **Types of material:**

Use two of the following:

- Low carbon/mild steel
- Cast iron
- Plastic/nylon/composite
- High carbon steel
- Brass/brass alloys
- Aluminium/aluminium alloys
- Other specific material.

(AC1.14) **Prove:**

Using six of the following:

- Single block mode
- Graphic displays/modelling/simulation
- Data input facilities
- Full dry run (in air)
- Search facilities
- Edit facilities
- Program override controls (spindle speed, feed rate, tool data)
- Program save/store facilities.

(AC1.15) **Confirm:**

- Datums for each machine axis are set in relation to all equipment and tooling used
- 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 offsets are correctly entered into the machine controller
- 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.

Learning outcome

The learner will:

2 Know how to prepare and prove CNC machine tool programs

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when developing and proving CNC machine tool programs

2.2 Describe the hazards associated with using CNC machine tools and how they can be minimised

2.3 Describe the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area clean and tidy

2.4 Describe the safety mechanisms on the machine and the procedure for checking that they function correctly

2.5 Describe the correct operation of the various hand and automatic modes of machine control

2.6 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

2.7 Explain how to use and extract information from engineering drawings or data and related specifications in relation to work undertaken

2.8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

2.9 Describe the computer coding language used in CNC programs with regard to machine axes, positional information, machine management and auxiliary functions

2.10 Explain how to prepare part programs using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes

2.11 Describe the use of features that enable reductions in program size and input times

2.12 Describe the function keys and operating system of the machine computer control system being operated

2.13 Explain how to set machine datums for each of the machine axes being used

2.14 Explain how to set the machine control system in the programming and editing mode, download (input) and upload (output) modes

2.15 Explain how to deal with error messages and faults on the program or equipment

2.16 Explain how to access the program edit facility, in order to enter tooling data

2.17 Describe the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program

2.18 Explain how to conduct trial runs using single block run, dry run and feed and spindle speed override controls

2.19 Describe the factors that may affect the feeds and spindle speeds being used, and why they may need to be adjusted from the programmed values

2.20 Describe the checks to be made before allowing the CNC machine to operate in full program run mode

2.21 Explain how to save the completed programs in the appropriate format, and the need to store programs and storage devices safely and correctly, away from contaminants and possible corruption

2.22 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

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

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

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

2.26 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities.

Unit 213 Preparing and proving CNC machine tool programs

Supporting Information

Evidence requirements

In order to prove their ability to produce programs that combine different features, at least one of the programs produced must be of a significant nature, and must cover a minimum of five of the features listed in 1.11.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards.

Unit 214 Producing components by rapid prototyping techniques

Unit level:	Level 2
GLH:	61
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to produce components by rapid prototyping techniques.
Relationship to NOS:	EUCL2F-024

Learning outcome

The learner will:

1 Produce components by rapid prototyping techniques

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Load/input the program file to the machine controller
1.3 Check the program for errors using the approved procedures
1.4 Check that all machine safety mechanisms are in place
1.5 Check that the equipment is set correctly for the required operations
1.6 Check that all the equipment is in a safe and usable working condition
1.7 Obtain sufficient quantities of all required materials
1.8 Check material use by dates
1.9 Obtain all the necessary data, documentation and specifications for the components to be produced
1.10 Download the correct build files to produce the components
1.11 Check that data files are suitable for the application
1.12 Load materials
1.13 Set equipment operating parameters
1.14 Produce components which comply with quality and accuracy requirements
1.15 Unload components
1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.17 Shut down the equipment to a safe condition on completion of the rapid prototyping activities.

Range

(AC1.14) **Produce components:**

Made from one of the following materials:

- Photo-polymer resin
- Wax
- Laminated paper
- Plastics
- Metal
- Polyurethane.

(AC1.14) **Quality and accuracy requirements:**

- Correctly formed
- Checked against model specification
- Free from manufacturing defects
- Satisfactory visual appearance/finish.

(AC1.15) **Unload components:**

To include all of the following:

- Removing the part from remaining raw material
- Removing the part from supports
- Pre-cleaning
- Infiltrate
- Packing to avoid damage
- Storing
- Complete all relevant documentation.

Learning outcome

The learner will:

2 Understand how to produce components by rapid prototyping techniques

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be observed when setting and operating rapid prototyping equipment

2.2 Describe 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 hazards associated with operating rapid prototyping machines and how they can be minimised

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

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

2.6 Explain the importance of ensuring that the machine is isolated from the power supply before working with the equipment

2.7 Describe the basic principles of rapid prototyping relevant to the machine being used

2.8 Describe the benefits and limitations of the different types of rapid prototyping equipment

2.9 Describe how to differentiate between different rapid prototyping processes

2.10 Describe the advantages and disadvantages of different rapid prototyping processes

2.11 Describe the finishing techniques that are required, and how they are applied to the different rapid prototyping processes

2.12 Describe how to use and extract information from engineering drawings and related specifications in relation to work undertaken

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

2.14 Describe how to import appropriate files from a data system into the rapid prototyping software

2.15 Describe how to set up the rapid prototyping equipment to achieve the component specification

2.16 Describe how to place the machine in the correct operating mode

2.17 Describe how to use the program edit facility to make minor adjustments for production

2.18 Describe how different materials used will affect the operating conditions that can be applied relevant to the machine being used

2.19 Describe the reasons why certain materials are suitable for producing components by the rapid prototyping process

2.20 Explain the importance of knowing when components can be unloaded from the machine in relation to the different rapid prototyping processes

2.21 Explain the importance of handling and storing materials correctly and linking to the correct documentation

2.22 Describe how problems and defects occur in components produced by rapid prototyping processes

2.23 Describe preventative actions needed to avoid defects

2.24 Describe when to act on own initiative and when to seek help and advice from others

2.25 Describe the importance of leaving the machine in a safe condition on completion of the rapid prototyping activities.

Unit 215 Producing CAD models (drawings) using a CAD system

Unit level:	Level 2
GLH:	61
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to set up and operate a computer aided drawing (CAD) system to produce detailed three-dimensional models for engineering activities.
Relationship to NOS:	UCL2F-030

Learning outcome

The learner will:

1 Produce CAD models (drawings) using a CAD system

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Check that all the equipment is correctly connected and in a safe, PAT tested and usable working condition
1.3 Power up the equipment and activate the appropriate modelling software
1.4 Set up the modelling environment and select a suitable template/folder
1.5 Set up and check that all peripheral devices are connected and correctly operating
1.6 Set the drawing datum at a convenient point
1.7 Create a modelling template to the required standards, which includes all necessary detail
1.8 Plan the modelling activities
1.9 Use appropriate sources to obtain the required information for the model to be created
1.10 Apply factors to the model being produced
1.11 Ensure that the data and information they have is complete and accurate
1.12 Review the data and information to identify the model requirements
1.13 Access and use the correct modelling software
1.14 Use appropriate techniques to create models that are sufficiently and clearly detailed
1.15 Use modelling tools
1.16 Use CAD operations to highlight design areas in the modelling environment
1.17 Produce models using the part feature menu
1.18 Modify parts in the assembly environment
1.19 Export a model to a manufacturing system

1.20 Use codes and other references that follow the required conventions

1.21 Save and store models in appropriate locations

1.22 Produce models that comply with requirements

1.23 Produce hard copies of the finished models, with sufficient detail to allow production

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

1.25 Shut down the CAD system to a safe condition on completion of the modelling activities.

Range

(AC1.9) **Sources:**

- Use five of the following:
- Model brief/request
- Specifications
- Change order/modification request
- Regulations
- Manuals
- Sample component
- Calculations
- Previous models/designs
- Sketches
- Notes from meetings/discussions
- Standards reference documents
- Other available data.

(AC1.10) **Factors**:

Take into account five of the following:

- Function
- Cost
- Physical space
- Quality
- Lifetime of the product
- Operating environment
- Manufacturing method
- Tolerances
- Interfaces
- Clearance
- Safety
- Ergonomics
- Materials
- Aesthetics.

(AC1.15) **Modelling tools:**

Use one of the following:

- Surface modelling
- Solid modelling
- Wire frame modelling.

(AC1.21) **Save and store:**

- Ensure that their model has been checked and that it complies to their company QA procedure
- Check that the model is correctly titled, referenced and annotated

- Save the model to an appropriate storage medium
- Create a separate backup copy, and place it in safe storage
- Register and store the models in the appropriate company information system
- Record and store any changes to the models in the appropriate company information system.

(AC1.22) **Requirements:**

Comply with at least one of the following:

- Organisational guidelines
- Statutory regulations and codes of practice
- CAD software standards
- BS and ISO standards
- Other international standard.

Learning outcome

The learner will:

2 Know how to produce CAD models (drawings) using a CAD system

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when working with computer systems

2.2 Describe the importance of good housekeeping arrangements

2.3 Describe the relevant sources and methods for obtaining any required technical information relevant to the model being produced

2.4 Describe the identification of the correct 3D drawing software package from the menu or windows environment and the various techniques that are available to access and use the CAD software

2.5 Describe the correct start-up and shutdown procedures to be used for the computer systems

2.6 Explain how to access the specific computer modelling software to be used, and the use of the help file to aid efficient operation of the relevant drawing system

2.7 Explain how to deal with system problems

2.8 Describe the documentation required for particular applications

2.9 Describe the types of drawings that may be produced by the modelling software

2.10 Explain how to set up the viewing screen to show multiple views of the component to help with drawing creation

2.11 Describe the national, international and organisational standards and conventions that are used for the models/drawings

2.12 Describe the application and use of modelling tools

2.13 Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

2.14 Describe the applications of different 3D modelling programs

2.15 Explain how to produce models with sufficient information to allow them to be successfully exported to the manufacturing system used

2.16 Describe the need for document control

2.17 Explain why it is necessary to be able to recall previous issues of modified models

2.18 Describe the need to create backup copies, and to file them in a separate and safe location also filing and storing hard copies for use in production

2.19 Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

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

2.21 Describe the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities.

Range

(AC2.1) **Safety precautions:**

- Safety guidance relating to the use of visual display unit (VDU) equipment and work station environment
- Repetitive strain injury (RSI)
- The dangers of trailing leads and cables
- How to spot faulty or dangerous electrical leads, plugs and connections.

(AC2.1) **Views:**

- Isometric front and side elevations

Unit 215 Producing CAD models (drawings) using a CAD system

Supporting Information

Evidence requirements

In order to prove their ability to combine different 3D modelling features, at least one of the models/drawings produced must be of a significant nature. It must involve a minimum of five of the operations from the part feature menu (1,17) and must include a minimum of seven modification features in 1.18.

Unit 216 Producing mechanical engineering drawings using a CAD system

Unit level:	Level 2
GLH:	61
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to set up and operate a computer aided drawing (CAD) system to produce detailed drawings for mechanical engineering activities.
Relationship to NOS:	EUCL2F-038

Learning outcome

The learner will:

1 Produce mechanical engineering drawings using a CAD system

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Check that all the equipment is correctly connected and in a safe and usable working condition
1.3 Power up the equipment and activate the appropriate drawing software
1.4 Set up the drawing system to be able to produce the drawing to the appropriate scale
1.5 Set up and check that all peripheral devices are connected and correctly operating
1.6 Set up drawing parameters to company procedures or to suit the drawing produced
1.7 Create a drawing template to the required standards
1.8 Plan the drawing activities
1.9 Use appropriate sources to obtain the required information for the drawing to be created
1.10 Apply appropriate design features to drawings being produced
1.11 Prepare for producing the engineering drawing
1.12 Produce different types of drawing with different methods of projection
1.13 Produce mechanical drawings with different types of features
1.14 Save the drawings in the appropriate medium
1.15 Produce drawings that meet quality requirements
1.16 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.17 Shut down the CAD system to a safe condition on completion of the drawing activities.

Range

(AC1.6) **Parameters:**

- Layers
- Line types
- Colour
- Text styles.

(AC1.9) **Sources:**

Use five of the following:

- Drawing brief
- Specifications
- Drawing change or modification request
- Regulations
- Manuals
- Sample component
- Calculations
- Existing drawings/designs
- Sketches
- Notes from meetings/discussions
- Standards reference documents
- Other available data.

(AC1.10) **Design features:**

Apply five of the following:

- Function
- Materials
- Clearance
- Operating environment
- Quality
- Cost
- Aesthetics
- Interfaces
- Manufacturing method
- Life of the product
- Physical space
- Ergonomics
- Tolerances
- Safety.

(AC1.11) **Prepare:**

- Ensure that the data and information they have is complete and accurate
- Review the data and information to identify the drawing requirements
- Recognise and deal with problems

(AC1.12) **Methods of projection:**

Use two of the following:

- First angle orthographic
- Isometric/oblique
- Third angle orthographic.

(AC1.12) **Types of drawing:**

Produce two of the following:

- Detail drawings
- General arrangement drawings
- Sub-assembly drawings
- Installation drawings.

(AC1.13) **Features:**

Include ten of the following:

- Straight lines
- Symbols and abbreviations
- Dimensions
- Hidden detail
- Curved/contour lines
- Sectional detail
- Angled lines
- Circles or ellipses
- Parts lists
- Text
- Geometrical tolerancing
- Insertion of standard components
- Other specific detail.

(AC1.14) **Save:**

- Ensure that their drawing has been checked and approved by their supervisor
- Check that the drawing is correctly titled and referenced
- Save the drawing to an appropriate storage medium
- Create a separate backup copy and place it in safe storage
- Produce a hard copy printout of the drawing for file purposes
- Register and store the drawings in the appropriate company information system
- Record and store any changes to the drawings in the company information system.

(AC1.15) **Quality requirements:**

- BS and ISO standards

Plus one of the following:

- Organisational guidelines
- Statutory regulations and codes of practice
- Other international standard.

Learning outcome

The learner will:

2 Know how to produce mechanical engineering drawings using a CAD system

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when working with computer systems

2.2 Describe good housekeeping arrangements

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

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

2.5 Describe the relevant sources and methods for obtaining any required technical information relevant to the drawing being produced

2.6 Describe the basic principles of engineering manufacturing operations, assembly and installation methods, and limitations of the equipment/processes that are used to produce the drawn item and how these can influence the way they present the drawing

2.7 Describe the functionality of the component being drawn, and its interrelationship with other components and assemblies

2.8 Describe the correct start-up and shutdown procedures to be used for the computer systems

2.9 Identify the correct drawing software package from the menu or operating environment and describe the various techniques that are available to access and use the CAD software

2.10 Describe the use of software manuals and related documents to aid efficient operation of the relevant drawing system

2.11 Explain how to deal with system problems

2.12 Describe the types of drawings that may be produced by the software

2.13 Describe how to set up the viewing screen to show multiple views of the drawing to help with drawing creation

2.14 Describe the national, international and organisational standards and conventions that are used for the drawings

2.15 Explain how to set up the drawing template parameters

2.16 Describe the application and use of drawing tools

2.17 Describe how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

2.18 Explain the need for document control

2.19 Describe how to save and store drawings

2.20 Explain the need to create backup copies, and to file them in a separate and safe location

2.21 Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

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

2.23 Describe the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities.

Unit 216 Producing mechanical engineering drawings using a CAD system

Supporting Information

Evidence requirements

In order to prove their ability to combine different drawing features, at least one of the drawings produced must be of a significant nature, and must have a minimum of seven of the features listed in 1.13.

Unit 217 Producing electrical or electronic engineering drawings using a CAD system

Unit level:	Level 2
GLH:	61
Unit aim:	The purpose of this unit is for learners to develop the understanding and skills needed to produce electrical or electronic drawings using a CAD system.
Relationship to NOS:	EUCL2F-031

Learning outcome

The learner will:

1 Produce electrical or electronic engineering drawings using a CAD system

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Check that all the equipment is correctly connected and in a safe and usable working condition
1.3 Power up the equipment and activate the appropriate drawing software
1.4 Set up the drawing system to be able to produce the drawing to the appropriate scale
1.5 Set up and check that all peripheral devices are connected and correctly operating
1.6 Set up drawing parameters to company procedures or to suit the drawing produced
1.7 Create a drawing template to the required standards
1.8 Plan the drawing activities
1.9 Use appropriate sources to obtain the required information for the drawing to be created
1.10 Apply appropriate design features to drawings being produced
1.11 Prepare for producing the engineering drawing
1.12 Produce different types of drawing with different types of features
1.13 Save the drawings in the appropriate medium
1.14 Produce drawings that meet quality requirements
1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.16 Shut down the CAD system to a safe condition on completion of the drawing activities.

Range

(AC1.6) **Parameters:**

- Layers
- line types
- Colour
- Text styles.

(AC1.9) **Sources :**

Use three of the following:

- Drawing brief/request
- Specifications
- Drawing change or modification request
- Electrical regulations
- Manuals
- Previous drawings/designs
- Calculations
- Standards
- Sketches
- Standard reference documents
- Notes from meetings/discussions
- Other available data.

(AC1.10) **Design features:**

Apply four of the following:

- Function
- Operating voltages
- Ergonomics
- Operating environment
- Cost
- Lifetime of the product
- Tolerances
- Interfaces
- Aesthetics
- Physical space/dimensions of circuit
- Power supplies
- Safety
- Component orientation
- Connectors/test point access
- Types of components available/to be used
- Method of installation
- Position of circuit elements/components
- Type of cables
- Connections between components
- Uses an appropriate type of circuit
- Uses appropriate technology of circuit design
- Meets signal integrity parameters
- Meets specified operating conditions
- Any assembly/manufacturing schedule constraints.

(AC1.11) **Prepare:**

- Ensure that data and information are complete and accurate
- Review the data and information to identify the drawing requirements

- Recognise and deal with problems.

(AC1.12) **Types of drawings:**

Produce three of the following:

- Circuit diagrams
- General assembly drawings
- Installation/commissioning
- Wiring diagrams
- Panel assembly
- Manufacture of cable looms
- Block diagrams
- Cable and routing
- Fault diagnostics
- Schematics
- Circuit board assembly
- System drawings
- Circuit board layout
- Modifications to equipment/systems.

(AC1.12) **Types of features:**

Include ten of the following:

- Straight lines
- Curved/contour lines
- Dimensions
- Circles or ellipses
- Angled lines
- Hidden detail
- Text
- Parts lists
- Insertion of standard electrical or electronic components
- Test points
- Type and size of cables
- Colour/component coding
- Connection/termination details
- Parts lists
- Electrical/electronic symbols and abbreviations
- Fault diagnosis
- Other specific electrical or electronic detail.

(AC1.13) **Save:**

- Ensure that their drawing has been checked and approved by the appropriate person(s)
- Check that the drawing is correctly titled and referenced
- Save the drawing to an appropriate storage medium
- Create a separate backup copy, and place it in safe storage
- Produce a hard copy printout
- Register and store the drawings in the appropriate company information system.

(AC1.14) **Quality requirements:**

- BS and ISO standards and procedures

Plus one of the following:

- Organisational guidelines
- Statutory regulations and codes of practice
- International standards.

Learning outcome

The learner will:

2 Understand how to produce electrical or electronic engineering drawings using a CAD system

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when working with computer systems
2.2 Describe good housekeeping arrangements
2.3 Describe the relevant sources and methods for obtaining any required technical information relevant to the drawing being produced
2.4 Describe the functionality of the circuit being drawn, and its interrelationship with other circuits and assemblies
2.5 Describe the use of software manuals and related documents to aid efficient operation of the relevant drawing system
2.6 Describe how to deal with system problems
2.7 Describe different types of electrical or electronic drawings that may be produced by the software
2.8 Describe the national, international and organisational standards and conventions that are used for the drawings
2.9 Describe how to set up the drawing template parameters
2.10 Describe the application and use of drawing tools
2.11 Describe how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
2.12 Describe the factors to be taken into account when producing electrical drawings
2.13 Describe the purpose of electrical or electronic equipment and circuits being worked on, and the function of the individual components within the circuits
2.14 Explain the selection of the various components and cables being used
2.15 Describe the use of specific regulations and standard reference tables when selecting components and cables
2.16 Explain how power cables might affect/corrupt signal transmission, and the need to consider this in siting and routing cables
2.17 Describe the basic calculations that may be required to be carried out to verify the acceptability of components and circuits (such as Ohm's Law)
2.18 Explain the need to create backup copies, and to file them in a separate and safe location
2.19 Explain when to act on their own initiative and when to seek help and advice from others
2.20 Describe the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities.

Unit 218 Producing mechanical assemblies

Unit level:	Level 2
GLH:	61
Unit aim:	The aim of this unit is to develop in the learner the understanding and skills needed produce mechanical assemblies.
Relationship to NOS:	EUCL2F-012

Learning outcome

The learner will:

1 Produce mechanical assemblies

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions, assembly drawings and procedures

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

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

1.6 Use lifting and slinging equipment in accordance with health and safety guidelines and procedures

1.7 Ensure that the components used are free from foreign objects, dirt or other contamination

1.8 Return all tools and equipment to the correct locations on completion of the assembly activities

1.9 Plan the assembly activities

1.10 Obtain and prepare the appropriate components, tools and equipment

1.11 Produce mechanical assemblies using different methods and techniques

1.12 Assemble products from different types of component

1.13 Use assembly aids and equipment

1.14 Secure the components using different categories of fastening devices

1.15 Carry out the quality checks using appropriate equipment

1.16 Produce mechanical assemblies which comply with requirements

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

1.18 Leave the work area in a safe and tidy condition on completion of the assembly activities.

Range

(AC1.11) **Methods and techniques:**

Use eight of the following:

- Assembling of components by expansion/contraction
- Applying sealants/adhesives
- Fitting
- Electrical bonding of components
- Securing by using mechanical fasteners/threaded devices
- Assembling of products by pressure
- Setting and adjusting
- Applying bolt locking methods
- Aligning components
- Drilling
- Shimming and packing
- Riveting
- Pinning
- Reaming
- Blue-bedding of components
- Torque setting
- Balancing components.

(AC1.12) **Components:**

Use twelve of the following:

- Assembly structure (framework, support, casings, panels)
- Pre-machined components
- Shafts
- Levers/linkages
- Springs
- Fabricated components
- Chains
- Keys
- Belts
- Bearings
- Couplings
- Pulleys
- Gaskets
- Seals
- Sprockets
- Gears
- Pipework/ hoses
- Bushes
- Cams and followers
- Other specific components.

(AC1.13) **Assembly aids and equipment:**

Use two of the following:

- Workholding devices
- Shims and packing

- Lifting and moving equipment
- Rollers or wedges
- Specialised assembly tools/equipment
- Supporting equipment
- Jigs and fixtures.

(AC1.14) **Categories of fastening devices:**

- Threaded fasteners
- Locking and retaining devices

Plus two of the following:

- Pins
- Spring clips
- Rivets.

(AC1.15) **Quality checks:**

Carry out checks on eight of the following:

- Positional accuracy
- Alignment
- Freedom of movement
- Function
- Component security
- Bearing/shaft end float
- Completeness
- Operating/working clearances
- Dimensions
- Freedom from damage or foreign objects
- Orientation
- Torque settings.

(AC1.16) **Requirements:**

- All components are correctly assembled and aligned in accordance with the specification
- Moving parts are correctly adjusted and have appropriate clearances
- Assemblies meet required geometric tolerances
- All fastenings have appropriate washers and are tightened to the required torque
- Where appropriate, bolt locking methods are applied.

Learning outcome

The learner will:

2 Know how to produce mechanical assemblies

Assessment criteria

The learner can:

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

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

2.3 Describe the hazards associated with the assembly activities and how they can be minimised

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

2.5 Explain how to use and extract information from engineering drawings and related specifications in relation to work undertaken

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

2.7 Explain how to prepare the components in readiness for the assembly activities

2.8 Describe the general principles of produced mechanical assemblies

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

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

2.11 Describe the various mechanical fastening devices that are used

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

2.13 Describe the application of sealants within the assembly activities, and the precautions that must be taken when working with them

2.14 Describe how to conduct any necessary checks to ensure the accuracy, position, security, function and completeness of the assembly

2.15 Explain how to detect assembly defects, and what to do to rectify them

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

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

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

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

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

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

2.22 Explain how to leave the work area in a safe and clean condition on completion of the assembly activities.

Range

(AC2.8) **General principles:**

- Purpose and function of the components and materials used
- Component identification systems such as codes and component orientation indicators.

Unit 218 Producing mechanical assemblies

Supporting Information

Evidence requirements

In order to prove their ability to combine different assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of six of the components listed in 1.12.

Unit guidance

2.5 To include symbols and conventions to appropriate BS or ISO standards.

Unit 219 Producing tool and die assemblies

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to produce tool and die assemblies.
Relationship to NOS:	EUCL2F-045

Learning outcome

The learner will:

1 Produce tool and die assemblies

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions, assembly drawings and procedures

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

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

1.6 Use lifting and slinging equipment in accordance with health and safety guidelines and procedures

1.7 Ensure that the components used are free from foreign objects, dirt or other contamination

1.8 Return all tools and equipment to the correct locations on completion of the assembly activities

1.9 Plan assembly activities

1.10 Obtain and prepare components, tools and equipment

1.11 Carry out tool assembly activities using different types of tool and die

1.12 Produce assemblies using different methods and techniques

1.13 Assemble tools to meet required specification

1.14 Assemble dies to meet required specification

1.15 Use aids and equipment

1.16 Carry out quality checks

1.17 Produce assemblies that comply with quality standards

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

1.19 Leave the work area in a safe and tidy condition on completion of the assembly activities.

Range

(AC1.11) **Types of tool:**

Use two of the following:

- Single stage tools
- Combination/composite tools
- Two-plate tools
- Unscrewing tools
- Three-plate tools
- Split tools
- Prototype tools
- Assembly tools
- Multi-stage tools
- Compound tools
- Form tools
- Draw tools
- Progression tools
- Transfer tools.

(AC1.11) **Types of die:**

Use two of the following:

- Draw die
- Trim
- Flange
- Combination
- Pierce
- Re-strike
- Pressure (high or low)
- Transfer
- Pultrusion
- Stamping
- Progression
- Extrusion.

(AC1.12) **Methods and techniques:**

Use seven of the following:

- Assembling of components by expansion/contraction
- Aligning components
- Applying sealants/adhesives
- Fitting
- Electrical bonding of components
- Securing by using mechanical fasteners/threaded devices
- Assembling of products by pressure
- Torque setting
- Setting working clearances
- Drilling
- Remaining
- Applying bolt locking methods
- Matched components

- Shimming and packing
- Riveting
- Blue-bedding of components
- Soldering/brazing
- Fusion (non-critical joints).

(AC1.13) **Assemble tools:**

Use nine of the following:

- Bolsters
- Top plate
- Pierce punches
- Scrap chutes
- Retaining pins
- Wear plates
- Locators
- Supports
- Air cylinders
- Springs (gas/coil/rubber)
- Stripper plates
- Clamps
- Guide bushes
- Guides (bushes/pillars/pins)
- Bearings
- Ejectors
- Assembling of components by expansion/contraction
- Aligning components
- Fitting
- Torque setting
- Securing by using mechanical fasteners/threaded devices
- Assembling of products by pressure
- Setting working clearances
- Drilling
- Reaming
- Matched components
- Applying bolt locking methods
- Shimming and packing
- Blue-bedding of components

Plus four of the following sub-assembles to meet required specification if assembling injection mould tool assemblies:

- Ejector system
- Cooling system
- Venting system
- Gate system
- Runner system
- Core inserting system
- Heater systems
- Guides and slides
- Pneumatic/hydraulic cylinders

- Injection system
- Sliding cores
- Safety equipment
- Unscrewing systems.

(AC1.14) **Assemble dies:**

Use seven of the following:

- Upper or lower die shoes
- Keeper plates
- Panel bucks
- Location pins and bushes
- Gas springs
- Air pins
- Guide plates
- Compression springs
- Hold-off cones
- Feed plates
- Pierce steels
- Profiled plates/blocks
- Positive returns.

(AC1.15) **Aids and equipment:**

Use two of the following:

- Workholding devices
- Lifting and moving equipment
- Specialised assembly tools/equipment
- Jigs and fixtures
- Shims and packing
- Supporting equipment
- Jacks
- Rollers or wedges.

(AC1.16) **Quality checks:**

Check eight of the following:

- Positional accuracy
- Freedom of movement
- Component/mould tool security
- Completeness
- Dimensions
- Orientation
- Alignment
- Function
- Profile/form
- Bearing end float
- Operating/working clearances
- Leak test
- Freedom from damage or foreign bodies.

(AC1.17) **Quality standards:**

Comply with one of the following:

- BS, ISO, BSEN standards and procedures

- Company standards and procedures
- Customer standards and requirements
- Specific system requirements.

Learning outcome

The learner will:

2 Know how to produce tool and die assemblies

Assessment criteria

The learner can:

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

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

2.3 Describe the hazards associated with the assembly activities and how they can be minimised

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

2.5 Describe how to use and extract information from engineering drawings and related specifications in relation to work undertaken

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

2.7 Describe how to prepare the components in readiness for the assembly activities

2.8 Describe the general operating principles of tool and die assembly(s) and the purpose and function of the components and materials used

2.9 Describe the preparations to be undertaken on the components prior to fitting them into the assembly

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

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

2.12 Describe the various mechanical fastening devices that are used

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

2.14 Describe the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them

2.15 Explain how to conduct any necessary checks to ensure accuracy, position, security, function, and completeness of the assembly

2.16 Explain how to detect assembly defects, and what to do to rectify them

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

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

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

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

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

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

2.23 Explain the importance of leaving the work area in a safe and clean condition on completion of the assembly activities.

Unit 219 Producing tool and die assemblies

Supporting Information

Evidence requirements

In order to prove their ability to combine different assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of seven of the methods and techniques listed in 1.12.

Unit guidance

2.5 To include symbols and conventions to appropriate BS or ISO standards.

Unit 220 Maintaining mechanical devices and assemblies

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to maintain mechanical devices and equipment.
Relationship to NOS:	EUCL2F-006

Learning outcome

The learner will:

1 Maintain mechanical devices and equipment

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of equipment where appropriate

1.4 Follow job instructions, maintenance drawings and procedures

1.5 Check that the tools and test instruments are within calibration date, and are in a safe and usable condition

1.6 Ensure that the system is kept free from foreign objects, dirt or other contamination

1.7 Return all tools and equipment to the correct location on completion of the maintenance activities

1.8 Carry out maintenance activities on mechanical equipment

1.9 Plan the maintenance activities

1.10 Obtain all the information they need for the safe removal and replacement of the equipment components

1.11 Obtain and prepare the appropriate tools and equipment

1.12 Use maintenance diagnostic techniques, tools and aids

1.13 Carry out maintenance activities

1.14 Remove and refit mechanical components

1.15 Carry out maintenance checks on the maintained equipment

1.16 Maintain mechanical equipment in compliance with requirements

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

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities.

Range

(AC1.8) **Mechanical equipment:**

Carry out activities on four of the following:

- Gearboxes
- Machine tools
- Engines
- Pumps
- Compressors
- Processing plant
- Transfer equipment
- Workholding devices
- Process control valves
- Mechanical structures
- Lifting and handling equipment
- Company-specific equipment.

(AC1.12) **Diagnostic techniques, tools and aids:**

Use six of the following:

- Fault finding techniques
- Diagnostic aids
- Information gathered from fault reports
- Visual checks
- Alignment checks
- Movement checks
- Force/pressure checks
- Overheating checks
- Sensory input
- Information from monitoring equipment or gauges
- Operating
- Test instrumentation measurement
- Measuring instruments.

(AC1.13) **Maintenance activities:**

- Dismantling equipment to unit/sub-assembly level
- Setting, aligning and adjusting replaced components
- Dismantling units to component level
- Proof marking/labelling of components
- Tightening fastenings to the required torque
- Checking components for serviceability
- Making 'off-load' checks before starting up
- Replacing all 'lifed' items
- Replenishing oils and greases
- Replacing damaged/defective components.

(AC1.14) **Mechanical components:**

Remove and refit twelve of the following:

- Shafts
- Bearing
- Seals
- Slides
- Couplings
- Fitting keys
- Rollers
- Gears
- Springs
- Housings
- Clutches
- Diaphragms
- Actuating mechanisms
- Valves and seals
- Cams and followers
- Structural components
- Pistons
- Chains and sprockets
- Locking and retaining devices
- Brakes
- Pulleys and belts
- Splines
- Levers and links
- Other specific components.

(AC1.15) **Maintenance checks:**

Carry out seven of the following checks:

- Freedom from damage and foreign parts
- Correct operation of moving parts
- Alignment
- Correct working clearance of parts
- Backlash in gears
- Belt/chain tension
- Bearing loading
- Torque loading of fasteners
- Completeness
- Operational performance
- Functionality test the system.

(AC1.16) **Compliance requirements:**

Comply with two of the following:

- Organisational guidelines and codes of practice
- Equipment manufacturers' operation range
- BS and/or ISO standards.

Learning outcome

The learner will:

2 Know how to maintain mechanical devices and equipment

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the mechanical maintenance activities undertaken

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

2.3 Describe the hazards associated with carrying out mechanical maintenance activities and how to minimise them

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

2.5 Explain how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process

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

2.7 Describe the operating principles of mechanical assemblies maintained

2.8 Describe the various maintenance diagnostic techniques and aids that can be used

2.9 Describe the various fault location techniques that can be used, and how they are applied

2.10 Describe how to evaluate sensory information

2.11 Describe the sequence to be adopted for the dismantling/reassembly of various types of assemblies

2.12 Describe the methods and techniques used to dismantle/assemble mechanical equipment

2.13 Describe the methods of checking that components are fit for purpose, and how to identify defects and wear characteristics

2.14 Describe the identification, application, fitting and removal of different types of bearings

2.15 Describe the methods and techniques of fitting keys and splines

2.16 Describe the identification, application, fitting and removal of different types of gears

2.17 Explain how to correctly tension belts and chains

2.18 Describe the identification and application of different types of locking device

2.19 Describe the methods of checking that removed components are fit for purpose, and the need to replace 'lifed' items

2.20 Describe the uses of measuring equipment

2.21 Explain how to check that tools and equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose

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

2.23 Describe the importance of making 'off-load' checks before running the equipment under power

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

2.25 Explain how to use lifting and handling equipment in the maintenance activity

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

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

2.28 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the maintenance activities.

Range

(AC2.7) **Operating principles:**

- How the equipment functions
- Its operating sequence
- The working purpose of individual units/components
- Component identification systems and orientation indicators
- How components interact within the equipment.

Unit 220 Maintaining mechanical devices and assemblies

Supporting Information

Evidence requirements

In order to prove their ability to combine different maintenance operations, at least one of the maintenance activities must be of a significant nature, and must cover at least seven of the activities plus the removal and replacement/refitting of a minimum of five of the mechanical components listed in 1.14.

Unit 221 Forming and assembling pipework systems

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to form and assemble pipework systems.
Relationship to NOS:	EUCL2F-020

Learning outcome

The learner will:

1 Form and assemble pipework systems

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Follow job instructions, assembly drawings and procedures
1.4 Check that the bending and forming equipment is in a safe and usable condition
1.5 Return all tools and equipment to the correct location on completion of the pipe fitting activities
1.6 Plan the pipe fitting activities
1.7 Produce pipework assemblies using different types of pipe
1.8 Mark out pipework using different methods
1.9 Cut and prepare the pipes for forming and assembly using different tools and equipment
1.10 Produce pipework bends/forms using different methods
1.11 Produce pipework assemblies which combine a range of different fittings
1.12 Assemble pipework using different methods and techniques
1.13 Carry out tests on the assembled pipework
1.14 Produce pipework assemblies that comply with requirements
1.15 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.16 Leave the work area in a safe and tidy condition on completion of the assembly activities.

Range

(AC1.7) **Types of pipe:**

Use two of the following:

- Carbon steel
- Copper
- Aluminium
- Stainless steel
- Brass
- Plastic.

(AC1.8) **Marking out methods:**

- Direct marking using tapes and markers

Plus one of the following:

- Set-outs of pipework using templates
- Producing set wires
- Set-outs of pipework onto floor.

(AC1.9) **Cut and prepare:**

- Cutting pipes to length with appropriate allowance for fittings
- Removing all external and internal burrs
- Cleaning pipe ends for soldering or cementing
- Cutting threads on pipe ends to the appropriate length
- Checking that prepared pipes are the correct length.

(AC1.9) **Tools and equipment:**

- Saws (hand or power)

Plus two of the following:

- Pipe/tube cutter
- De-burring reamers
- Abrasive cloth
- Wire pipe cleaners.

(AC1.10) **Bends and forms:**

- Angular bends
- Offsets

Plus one of the following:

- Bridge sets
- Radii
- Internal swaged ends
- Expansion loops
- External swaged ends.

(AC1.10) **Methods:**

- Hand operated pipe bender

Plus one of the following:

- Bending springs
- Pipe expander
- Swaging kit
- Hydraulic pipe bending equipment
- Heating methods

- Fillers.

(AC1.11) **Fittings:**

- Straight couplings
- Elbows
- Tee pieces

Plus three of the following:

- Flanges
- Reduction pieces
- Drain/bleeding devices
- Unions
- Valves
- Blanking caps
- Screwed fittings.

(AC1.12) **Assembly methods and techniques:**

- Securing pipework supports to structures
- Connecting pipe-to-equipment
- Fitting pipework supports
- Using gaskets, seals/sealing tapes or jointing compounds
- Connecting pipe-to-pipe
- Alignment/levelling equipment.

(AC1.13) **Tests:**

Use one of the following:

- Hydraulic pressure test
- Gas/air leakage test
- Water leakage test.

(AC1.14) **Requirements:**

- Pipes are bent to the appropriate shape/form and position
- All pipe bends are free from buckling or deformation
- Appropriate fittings are used, and are secure and leak free
- Soldered and cemented fittings are free from excessive residues
- The completed assembly meets the specific system requirements.

Learning outcome

The learner will:

2 Know how to form and assemble pipework systems

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the pipe fitting activities undertaken

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

2.3 Describe the hazards associated with the pipe fitting activities and how they can be minimised

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

2.5 Explain how to use and extract information from engineering drawings and related specifications in relation to work undertaken

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

2.7 Describe the principles and methods of marking out pipework, and the type of equipment used

2.8 Describe how to prepare the pipes in readiness for the marking out activities

2.9 Explain how to determine the overall length of the pipework required, taking into account allowances for pipe fittings and screwed connections

2.10 Describe the tools and equipment used in cutting and preparing the pipes

2.11 Describe the characteristics of the various materials that are to be used with regard to the bending operations, and why some materials may require the addition of heat/hot air to aid the bending process

2.12 Describe the methods used to hand bend and form the pipe

2.13 Describe how to produce the various bends required

2.14 Describe the reasons for incorporating expansion loops in a system, and where they should be positioned

2.15 Explain how to prepare pipework and fittings for the assembly operation

2.16 Describe the range of pipe fittings that can be used, and how to identify them

2.17 Describe the different types of fittings available

2.18 Describe how to produce screw threads on the pipe ends, and the tools and equipment that can be used

2.19 Describe the methods used to seal screwed joints

2.20 Describe the use of flanges to connect pipes; use of gaskets; and torque loading of flange bolts

2.21 Describe the methods used to prepare pipe ends and fittings for soldering or brazing, and why it is necessary to ensure that these preparations are carried out

2.22 Describe the various types of soldered connectors available

2.23 Describe the methods used to solder the joints, and how to recognise when the fitting is correctly soldered

2.24 Explain the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint

2.25 Describe the methods used to prepare pipe ends and fittings when using adhesives, and why it is necessary to ensure that these preparations are carried out

2.26 Describe the methods used to cement the joints, and how to recognise when the fitting is correctly secured

2.27 Describe the various adhesives and sealing compounds that are used on non-metallic pipework

2.28 Explain the precautions to be taken when using the adhesives, cements and sealing compounds

2.29 Describe the use of compression fittings; how the pipes are sealed; and the effects of over tightening the fittings

2.30 Describe the use of push-fit connectors, and their advantages and disadvantages

2.31 Explain how to identify the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation

2.32 Describe the supporting methods that are used when assembling pipework, and the type of fittings that are used

2.33 Describe the methods of testing pipework systems for leaks

2.34 Describe the extent of their own responsibility and whom they should report to if they have problems that they cannot resolve

2.35 Describe the importance of leaving the work area in a safe and clean condition on completion of the pipework assembly activities.

Unit 221 Forming and assembling pipework systems

Supporting Information

Evidence requirements

In order to prove their ability to combine different pipe assembly operations, at least one of the pipe assemblies produced must be of a significant nature, and must have a minimum of five of the fittings listed in 1.11.

Unit guidance

2.5 To include symbols and conventions to appropriate BS or ISO standards.

2.12 To include the use of bending springs, hand bending machines, fillers, heating methods.

Unit 222 Producing sheet metal components and assemblies

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to produce sheet metal components and assemblies.
Relationship to NOS:	EUCL2F-022

Learning outcome

The learner will:

1 Produce sheet metal components and assemblies

Assessment criteria

The learner can:

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

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

1.3 Ensure that all power tool cables, extension leads or air supply hoses are in a tested and serviceable condition

1.4 Return all tools and equipment to the correct location on completion of the sheet metalworking activities

1.5 Check that all measuring equipment is within calibration date

1.6 Plan the sheet metalworking activities

1.7 Use different types of materials

1.8 Obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition

1.9 Use marking out methods and techniques

1.10 Use marking out equipment

1.11 Mark out materials with features

1.12 Cut and finish material to the marked out shape using different hand and machine tools

1.13 Carry out forming operations which produce shaped components using different types of forming equipment/techniques

1.14 Assemble sheet metal components

1.15 Measure and check that all dimensional and geometrical aspects of the component are to the specification

1.16 Produce sheet metal components which meet standards

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

1.18 Leave the work area in a safe and tidy condition on completion of the fitting activities.

Range

(AC1.7) **Types of material:**

Use sheet metal (up to and including 3 mm) in two different materials from the following:

- Hot rolled mild steel
- Cold rolled mild steel
- Coated mild steel (such as primed, tinned and galvanised)
- Copper
- Brass
- Lead
- Stainless steel
- Titanium
- Aluminium.

(AC1.9) **Marking out methods:**

- Direct marking using instruments

Plus one of the following:

- Use of templates
- Tracing/transfer methods.

(AC1.10) **Marking out equipment:**

- Scriber
- Rule or tape
- Square
- Dividers or trammels
- Punch
- Straight edge
- Protractor
- Chalk, blueing or paint.

(AC1.11) **Features:**

- Datum and centre lines
- Curved profiles
- Square/rectangular profiles
- Cutting and bending detail (including allowances)
- Angles
- Hole centring and outlining.

(AC1.12) **Hand tools:**

- Tin snips
- Bench shears

Plus two of the following:

- Hacksaw
- Files
- Hand power tools
- Pneumatic tools
- Trepanning

- Thermal devices
- Other specific tools.

(AC1.12) **Machine tools:**

- Guillotine

Plus two of the following:

- Pillar drill
- Punch/cropping machine
- Trepanning machine
- Bench saw
- Nibbling machine
- Band saw.

(AC1.12) **Shapes:**

- Square or rectangular profiles
- Angled profiles
- External curved profiles

Plus two of the following:

- Notches
- Internal curved contours
- Round holes
- Square holes.

(AC1.13) **Forming techniques/equipment:**

- Bending machine (hand or powered)
- Rolling machine (hand or powered)

Plus two of the following:

- Hammers/panel beating equipment
- Wheeling machine
- Stakes and formers
- Swaging machine
- Presses
- Shrinking techniques
- Jenny/wiring machine
- Stretching techniques.

(AC1.13) **Shaped components:**

- Bends/upstands
- Folds/safe edges
- Tray/box sections
- Cylindrical sections

Plus one of the following:

- Wired edges
- Cowlings and rounded covers
- Swages
- Square to round trunking
- Curved panels
- Lobster-back trunking
- Ribbed components
- Concertina ducting or trunking.

(AC1.14) **Assemble:**

Use two of the following methods:

- Temporary tack welding
- Adhesive bonding
- Soldering or brazing
- Flanged and mechanically fastened (such as bolts, screws)
- Resistance spot welding
- Self securing joints (such as knocked up, paned down, swaged, joggled)
- Riveting (such as hollow or solid).

(AC1.16) **Standards:**

- All dimensions are within +/- 2.0mm or +/- 0.079”
- Finished components meet the required shape/geometry (square, straight, angles free from twists)
- Completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
- All components are correctly assembled and have secure and firm joints.

Learning outcome

The learner will:

2 Know how to produce sheet metal components and assemblies

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the sheet metalworking activities undertaken

2.2 Describe the personal protective clothing and equipment (PPE) to be worn when carrying out the sheet metal activities and the importance of keeping the work area safe and tidy

2.3 Describe the correct methods of moving or lifting sheet materials

2.4 Describe the safe working practices and procedures to be observed when using manual and power operated tools

2.5 Describe the hazards associated with carrying out sheet metalworking and how they can be minimised

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

2.7 Explain how to use and extract information from engineering drawings and related specifications 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 prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety

2.10 Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

2.11 Describe the use of marking out conventions when marking out the workpiece

2.12 Describe the ways of laying out the marking-out shapes or patterns to maximise use of materials

2.13 Describe the tools and techniques available for cutting and shaping sheet metal

2.14 Describe the use and care of tools and equipment

2.15 Describe the hand tools used in sheet metal forming and typical operations that they are used for

2.16 Describe the various machine tool forming equipment that can be used to produce a range of shapes

2.17 Describe the methods of stretching and shrinking materials, and the tools, equipment and techniques used for this

2.18 Explain how to set up the various machines to produce the required forms

2.19 Describe the ways of limiting distortion, marking, creases and flats in curved sections

2.20 Describe the characteristics of the various materials used with regard to the bending and forming process

2.21 Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming

2.22 Explain the importance of using tools or equipment only for the purpose intended; the care that is required when using the tools or equipment; the proper way of preserving tools or equipment between operations

2.23 Describe the various methods of securing the assembled components, and the range of mechanical fastening devices that are used, resistance and tack welding methods and techniques, adhesive bonding of components and self secured joints

2.24 Describe the preparations to be carried out on the components prior to assembling them

2.25 Explain how to set up and align the various components, and the tools and equipment that are used for this

2.26 Describe the methods of temporarily holding the joints together to aid the assembly activities

2.27 Describe the inspection techniques that can be applied to check that shape, straightness and dimensional accuracy are to specification and within acceptable limits

2.28 Describe the problems that can occur with the sheet metalworking activities and how these can be overcome

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

2.30 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the sheet metal activities.

Unit 222 Producing sheet metal components and assemblies

Supporting Information

Evidence requirements

In order to prove their ability to combine different sheet metal cutting and forming operations, at least one of the jobs produced must be of a significant nature, and must contain a minimum of three cut shapes and three formed shapes.

Unit guidance

2.7 To include symbols and conventions to appropriate BS or ISO standards.

2.11 To include datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles.

2.14 To include checks that must be made to ensure that the tools are fit for purpose - such as sharp, undamaged, plugs and cables secure and free from damage, PAT tested, machine guards or safety devices operating correctly.

Unit 223 Maintaining electrical equipment/systems

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to maintain electrical equipment/systems.
Relationship to NOS:	EUCL2F-009

Learning outcome

The learner will:

1 Maintain electrical equipment/systems

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of equipment

1.4 Follow job instructions, maintenance drawings and procedures

1.5 Check that the tools and test instruments are within calibration date and are in a safe, PAT tested and usable condition

1.6 Ensure that the system is kept free from foreign objects, dirt or other contamination

1.7 Return all tools and equipment to the correct location on completion of the maintenance activities

1.8 Carry out maintenance activities on different types of electrical equipment

1.9 Plan the maintenance activities

1.10 Obtain all the information needed for the safe removal and replacement of the equipment/system components

1.11 Obtain and prepare the appropriate tools and equipment

1.12 Use maintenance diagnostic techniques

1.13 Carry out maintenance/repair activities on electrical systems

1.14 Replace/refit electrical components

1.15 Carry out checks and tests on the maintained equipment

1.16 Maintain electrical equipment, in accordance with quality and accuracy standards

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

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities.

Range

(AC1.8) **Types of electrical equipment:**

Carry out maintenance activities on four of the following:

- Motors and starters
- Transformers
- Wiring enclosures
- Heaters
- Pumps
- Portable appliances
- Luminaires
- Fans/blowers
- Generators
- Switchgear
- Distribution panels
- Other specific electrical equipment.

(AC1.12) **Maintenance diagnostic techniques:**

- Fault finding techniques
- Test instrumentation measurement

Plus three of the following:

- Diagnostic aids
- Information gathered from fault reports
- Visual checks
- Movement checks
- Monitoring equipment or gauges.

(AC1.13) **Electrical systems:**

Carry out activities on three of the following:

- Lighting circuits
- Air conditioning control circuits
- Power circuits
- Refrigeration control circuits
- Motor start and control circuits
- Heating/boiler control circuits
- Power generation and control circuits
- Instrumentation and control circuits
- Emergency lighting systems
- Alarm systems
- Communication systems
- Electro-pneumatic or electro-hydraulic control circuits
- Computer systems
- Other control circuits
- Other specific electrical circuits.

(AC1.13) **Maintenance activities:**

- Removing excessive dirt and grime
- Making mechanical/screwed/clamped connections
- Dismantling/disconnecting equipment to the required level
- Soldering and de-soldering

- Crimping (such as tags and pins)
- Disconnecting and reconnecting wires and cables
- Replacing damaged/defective components
- Stripping cable insulation/protection
- Removing and replacing damaged wires and cables
- Attaching suitable cable identification markers
- Setting and adjusting replaced components
- Removing electrical units/components
- Making de-energised checks before reconnecting power supply
- Removing/replacing cable end fittings
- Checking components for serviceability.

(AC1.14) **Electrical components:**

Replace/refit six of the following:

- Cables and connectors
- Capacitors
- Batteries
- Locking and retaining devices
- Circuit boards
- Transformers
- Overload protection devices
- Luminaires
- Solenoids
- Inverter and servo controllers
- Switches or sensors
- Thermistors or thermocouples
- Relay components
- Contactors
- Encoders or resolvers
- Rectifiers
- Other specific components.

(AC1.15) **Checks and tests:**

- Visual checks
- Movement checks
- Testing that the equipment operates to the circuit specification
- Check/test load current

Plus five of the following:

- Carrying out fault finding techniques
- Protective conductor impedance
- Power rating
- Insulation resistance values
- Polarity
- Frequency values
- Continuity
- Resistance
- Inductance
- Voltage levels
- Capacitance

- RCD disconnection time
- Specialised tests.

(AC1.16) **Quality and accuracy standards:**

Complying with two of the following:

- BS 7671/IET wiring regulations
- Other BS and/or ISO standards
- Company standards and procedures
- Equipment manufacturer's requirement.

Learning outcome

The learner will:

2 Know how to maintain electrical equipment/systems

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the electrical maintenance activities undertaken

2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to electrical maintenance activities

2.3 Describe the hazards associated with carrying out electrical maintenance activities and how to minimise them

2.4 Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock

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

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

2.7 Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities

2.8 Describe the principles of how the equipment functions, and the working purpose of individual units/components

2.9 Describe the various maintenance diagnostic techniques and aids that can be used

2.10 Describe the various fault location techniques that can be used, and how they are applied

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

2.12 Describe the care, handling and application of electrical measuring instruments

2.13 Describe the different types of cabling used in the maintenance activities, and their methods of termination

2.14 Describe the techniques used to dismantle/assemble electrical equipment

2.15 Describe the methods of removing and replacing cables and wires in wiring enclosures without causing damage to existing cables

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

2.17 Describe earthing systems and their applications

2.18 Explain why electrical bonding/earthing is critical and why it must be both mechanically and electrically secure

2.19 Describe the methods of attaching identification markers/labels to removed components or cables, to assist with re-assembly

2.20 Describe the tools and equipment used in the maintenance activities

2.21 Describe the methods of checking that components are fit for purpose, and the need to replace 'lifed' items

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

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

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

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

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

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

2.28 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities.

Unit 223 Maintaining electrical equipment/systems

Supporting Information

Evidence requirements

In order to prove their ability to combine different electrical maintenance operations, at least one of the electrical maintenance activities carried out must be of a significant nature, and must cover a minimum of eight of the activities listed in 1.13.

Unit guidance

2.2 To include electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured.

2.4 To include methods of safely removing the victim from the power source, isolating the power source, and how to obtain first aid assistance.

Unit 224 Maintaining electronic equipment and circuits

Unit level:	Level 2
GLH:	61
Unit aim:	The purpose of this unit is for learners to develop the understanding and skills needed to maintain electronic equipment/systems.
Relationship to NOS:	EUCL2F-017

Learning outcome

The learner will:

1 Maintain electronic equipment and circuits

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of equipment

1.4 Follow job instructions, maintenance drawings and procedures

1.5 Take electrostatic discharge (ESD) precautions when handling sensitive components and circuit boards

1.6 Check that the tools and test instruments are within calibration date and are in a safe, PAT tested and usable condition

1.7 Ensure that the system is kept free from foreign objects, dirt or other contamination

1.8 Return all tools and equipment to the correct location on completion of the maintenance activities

1.9 Carry out maintenance/repair activities on different types of electronic equipment

1.10 Plan the maintenance activities

1.11 Obtain all the information they need for the safe removal and replacement of the equipment/system components

1.12 Obtain and prepare the appropriate tools and equipment

1.13 Apply appropriate maintenance diagnostic techniques and procedures

1.14 Carry out maintenance techniques and procedures on electronic systems

1.15 Replace/refit a range of electronic components

1.16 Use the correct joining/connecting techniques to deal with different types of connection

1.17 Use different types of test equipment

1.18 Carry out checks and tests on the maintained equipment

1.19 Maintain electronic equipment, in accordance with quality and accuracy

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

1.21 Leave the work area in a safe and tidy condition.

Range

(AC1.9) **Electronic equipment:**

Carry out activities on three of the following:

- Power supplies
- Motor control systems
- Sensor/actuator circuit
- Digital circuit
- Signal processing circuit
- Alarms and protection circuits
- ADC and DAC hyrid circuits.

(AC1.13) **Maintenance diagnostics:**

Use four of the following:

- Fault finding techniques
- Diagnostics aids
- Information from the person who reported the fault
- Visual checks
- Movement checks
- Monitoring equipment or gauges
- Test instrumentation measurement.

(AC1.14) **Maintenance techniques and procedures:**

- Removing excess dirt and grime
- Dismantling/disconnecting equipment to the required level
- Disconnecting and reconnecting wires and cables
- Checking the condition/deterioration of components
- Soldering and de-soldering
- Repairing circuit board tracks
- Removing and replacing electronic circuit boards
- Removing and replacing electronic components
- Making adjustments to components and/or connections
- Re-assembling of units and sub-assemblies.

(AC1.15) **Electronic components:**

To include twelve of the following:

- Cables and connectors
- Rectifiers
- Surface mount packages
- Printed circuit boards
- Encoders and resolvers
- Integrated circuits
- Fixed resistors
- Potentiometers

- Thyristors
- Transistors
- Regulators
- Decoders
- Light dependent resistor (LDR)
- Thermistors
- Diodes
- Zener diodes
- Opto-electonics/optical fibre components
- Light emitting diodes (LEDs)
- Analogue or digital integrated circuits
- Fixed capactitors
- Electrolytic capacitors
- Variable capacitors
- Sensors
- Switches
- Edge connectors
- Heat sinks
- Wiring pins/tags/wire links
- Mini transformers
- Protection devices
- Inverters or servo controllers
- Relays
- Inductors.

(AC1.16) **Types of connection:**

Deal with three of the following:

- Push-fit connectors
- Crimpled connections
- Soldering or de-soldering
- Zero insertion force (zif) connectors
- Clip assemblies
- Adhesive joints/assemblies
- Threaded connections
- Edge connectors.

(AC1.17) **Test equipment:**

Use five of the following:

- Multimeter
- Signal generator
- Oscilloscope
- Signal tracer
- Logic probe/clip
- Stabilised power supplies
- Logic analyser
- Measuring bridges
- Pulse sequencing analyser
- Software diagnostic programs
- Counter-timers

- Data communications test set
- Signature analysers
- Bus exerciser/analyser
- Protocol analyser.

(AC1.18) **Checks and tests:**

- Visual checks
- Movement checks

Plus three of the following:

- Logic states
- Pulse width/rise time
- Inductance
- Dc voltage/current levels
- Open/short circuit
- Frequency modulation/demodulation
- Ac voltage/current levels
- Resistance
- Amplification
- Clock/timer switching
- Capacitance
- Signal noise/interference levels
- Oscillations
- Wave form analysis
- Attenuation.

(AC1.19) **Quality and accuracy standards:**

In accordance with one of the following:

- Organisational guidelines and codes of practice
- Equipment manufacturer's operation range
- BS and ISO standards.

Learning outcome

The learner will:

2 Understand how to maintain electronic equipment and circuits

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the electronic maintenance activities undertaken

2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the electronic repair activities

2.3 Describe the hazards associated with maintaining electronic equipment, and with the tools and equipment that are used and how these can be minimised

2.4 Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock

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

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

2.7 Describe how to extract information from job instructions, drawings and

2.8 Describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD) hazards

2.9 Describe the general principles of how the electronic circuit built functions, and the working purpose of individual units/components and how they interact

2.10 Describe different maintenance diagnostic techniques and aids that can be used

2.11 Describe the care, handling and application of electronic measuring instruments/fault diagnostic equipment

2.12 Describe how to check that equipment is within current calibration approval dates and PAT tested

2.13 Describe how to check that the test equipment is suitable for the tests they are to carry out and can cover the range and values they are to measure

2.14 Identify correct test points in the circuit

2.15 Describe how to position test instruments into circuits without damaging circuit components

2.16 Describe how to set instrument zero readings

2.17 Describe how to obtain instrument readings and compare them with expected results

2.18 Describe the application of Ohm's Law and relevant calculations

2.19 Describe the use of calculations and regulations, when selecting wires and cables and when carrying out tests on electronic circuits

2.20 Describe how to make adjustments to circuit components

2.21 Describe how to make decisions on circuit performance and faulty components

2.22 Describe how to remove and replace faulty components

2.23 Describe how to check that the replacement components meet the required specification/operating conditions

2.24 Describe methods of removing and replacing the faulty components from the equipment without causing damage to other components, wiring, circuit boards or the surrounding structure

2.25 Describe the application of tools and equipment used in the repair activities and how to check that they are in a safe and usable condition

2.26 Describe the sequence for reconnecting the equipment

2.27 Describe checks to be made prior to restoring power

2.28 Explain the importance of making de-energised checks before proving the equipment with the electrical supply on

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

2.30 Describe the documentation and/or reports to be completed following the maintenance activity

2.31 Explain the importance of ensuring that reports are completed accurately and legibly

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

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

2.34 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities.

Unit 224 Maintaining electronic equipment and circuits

Supporting Information

Evidence requirements

In order to prove their ability to combine different electronic maintenance operations, at least one of the electronic maintenance activities carried out must be of a significant nature, and must cover a minimum of **five** of the activities listed in 1.14 **plus** the removal and replacement/refitting of **seven** of the components identified in 1.15.

Unit 225 Wiring and testing electrical equipment and circuits

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the skills and knowledge needs to apply electrical wiring and testing procedures and techniques safely.
Relationship to NOS:	EUCL2F-010

Learning outcome

The learner will:

1 Wire and test electrical equipment and circuits

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of services during the wiring and testing activities

1.4 Follow job instructions, circuit drawings and test procedures

1.5 Check that tools and test instruments are within calibration date, and are in a safe, PAT tested and usable condition

1.6 Ensure that the system is kept free from foreign objects, dirt or other contamination

1.7 Apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards

1.8 Return all tools and equipment to the correct location on completion of the wiring and testing activities

1.9 Wire circuits using different types of cables

1.10 Connect electrical modules/components to produce circuits

1.11 Apply wiring methods and techniques

1.12 Carry out cable termination activities

1.13 Wire up electrical systems

1.14 Use test instruments during the wiring and testing activities

1.15 Carry out checks and adjustments, appropriate to the equipment and circuits being wired

1.16 Produce electrical circuits in accordance with standards.

Range

(AC1.9) **Types of cables:**

- Single core
- Multicore
- PVC twin and earth
- Armoured

Plus two of the following:

- Flexible
- Data/communication
- Ribbon cables
- Fibre-optics
- Screened
- Coaxial
- Wiring loom/harness.

(AC1.10) **Electrical modules/components:**

- Isolators
- Protective devices (must include fuses such as HBC and HRC and circuit breakers)
- Contactors
- Motor starters
- Motors
- Transformers
- Residual current device (RCD)

Plus eight of the following:

- Overloads
- Blowers
- Cable connectors
- Switches
- Lamp holders
- Sockets
- Panel lamps
- Luminaires
- Sensors
- Ballast chokes
- Actuators
- Solenoids
- Consumer units
- Junction boxes
- Relays
- Terminal blocks
- Alarm devices
- Instruments
- Electronic modules/units
- Control devices
- Pumps
- Panels or sub-assemblies
- Heaters

- Other electrical components.

(AC1.11) **Wiring methods and techniques:**

- Position and secure equipment and components
- Level and align components
- Determine and calculate current rating and lengths of cables required
- Secure by using mechanical fixings
- Lay-in cables without twisting or plaiting
- Feed cables into conduit without twisting or plaiting
- Leave sufficient slack for termination and movement.

(AC1.12) **Cable termination activities:**

Carry out eight of the following:

- Stripping cable sheaths without damage to conductor insulation
- Terminating mineral insulated cables
- Removing cable insulation
- Sealing/protecting cable connections
- Connecting accessories
- Attaching suitable cable identification
- Making mechanical/screwed/clamped connections
- Crimping
- Soldering and de-soldering
- Securing wires and cables
- Terminating armoured cables
- Heat shrinking (devices and boots)
- Earthing and bonding
- Cable glands and grips.

(AC1.13) **Electrical systems:**

Three of the following:

- Lighting circuits
- Air conditioning control circuits
- Power circuits
- Refrigeration control circuits
- Motor start and control
- Heating/boiler control circuits
- Power generation and control circuits
- Instrumentation and control circuits
- Emergency lighting systems
- Alarm systems
- Communication systems
- Electro-pneumatic or electro-hydraulic control circuits
- Computer systems
- Other control circuits
- Other specific electrical circuits.

(AC1.15) **Checks and adjustments:**

- Visual checks
- Movement checks
- Testing that the equipment operates to the circuit specification

- Check/test load current

Plus six more checks/tests from the following:

- Carrying out fault finding techniques
- Protective conductor impedance
- Power rating
- Insulation resistance values
- Polarity
- Frequency values
- Continuity
- Resistance
- Inductance
- Voltage levels
- Capacitance
- RCD disconnection time
- Specialised tests.

(AC1.16) **Standards:**

In accordance with two of the following:

- BS 7671/IET wiring regulations
- other BS and/or ISO standards
- company standards and procedures.

Learning outcome

The learner will:

2 Understand how to wire and test electrical equipment and circuits

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that need to be observed when wiring and testing electrical equipment

2.2 Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, and how they can be minimised

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

2.4 Identify what constitutes a hazardous voltage

2.5 Describe how to recognise victims of electric shock

2.6 Describe how to reduce the risks of a phase to earth shock

2.7 Describe how to interpret information

2.8 Describe the general principles of operation of the equipment/circuits produced

2.9 Describe the purpose of the individual modules/components used in equipment/circuits produced and how they interact

2.10 Describe different types of cabling and their application

2.11 Describe the applications of a range of electrical components

2.12 Describe the applications of circuit protection equipment

2.13 Describe different earthing systems and their applications

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

2.15 Describe how to check that components meet the required specification/operating conditions

2.16 Describe methods of mounting and securing electrical equipment/components to various surfaces

2.17 Describe the importance of checking that the positions selected for mounting the components do not interfere with or damage existing services

2.18 Describe methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited

2.19 Explain why airflow is an important factor to consider when installing cables and wires

2.20 Describe how to calculate airflow

2.21 Describe the techniques used to terminate electrical equipment

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

2.23 Describe methods of attaching markers/labels to components or cables to assist with identification

2.24 Describe the tools and equipment used in the wiring and testing activities

2.25 Explain why equipment is checked so that it is electrically safe

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

2.27 Explain the importance of conducting inspections and checks before connecting to the supply

2.28 Describe the care, handling and application of electrical test and measuring instruments

2.29 Explain the importance of applying approved test procedures

2.30 Describe the safe working practices and procedures required when carrying out the various tests

2.31 Explain the need to use suitably fused test probes and clips

2.32 Describe how to identify suitable test points within the circuit

2.33 Describe how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment

2.34 Describe how to set test instrument's zero readings

2.35 Describe how to obtain instrument readings and comparing them with circuit parameters

2.36 Describe the fault-finding techniques to be used if the equipment fails to operate correctly

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

2.38 Describe the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities.

Range

(AC2.1) **Safety practices and procedures:**

Specific legislation, regulations or codes of practice for the activities, equipment or materials.

(AC2.7) **Information:**

- circuit diagrams
- wiring diagrams

- other relevant specifications
- BS and ISO schematics
- wiring regulations, symbols and terminology.

(AC2.24) **Tools and equipment:**

- cable stripping tools
- crimping tools
- soldering irons and torches
- gland connecting tools.

Unit 225 Wiring and testing electrical equipment and circuits

Supporting Information

Evidence requirements

In order to prove their ability to combine different electrical assembly and wiring activities, at least one of the electrical assemblies produced must be of a significant nature, and must contain a minimum of **five** of the components listed in 1.10 **plus five** of the activities listed in 1.12.

Unit 226 Wiring and testing programmable controller based systems

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to wire and test programmable controller based systems.
Relationship to NOS:	EUCL2F-011

Learning outcome

The learner will:

1 Wire and test programmable controller based systems

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation

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

1.3 Ensure the safe isolation of services during the wiring activities

1.4 Follow job instructions, wiring drawings and test procedures at all times

1.5 Obtain the correct tools and equipment for the wiring and testing operations

1.6 Check that the tools and test instruments are within calibration date and are in a safe and usable condition

1.7 Ensure that the programmable controller system is kept free from foreign objects, dirt or other contamination

1.8 Return all tools and equipment to the correct location on completion of the installation activities

1.9 Plan the programmable controller wiring and testing activities

1.10 Use appropriate sources to obtain the required circuit diagrams, wiring, programming and test information

1.11 Position and secure the programmable controller components and peripheral devices safely and correctly, to meet specification requirements

1.12 Connect and terminate the cables to the appropriate connections on the components

1.13 Apply wiring and connection methods and techniques

1.14 Develop programmable controller programs, using the appropriate techniques and programming language

1.15 Prove and edit the programmable logic controller program

1.16 Use appropriate test methods and equipment to check and prove the program integrity

1.17 Carry out post programming activities

1.18 Use diagnostic techniques, tools and aids

1.19 Wire and test programmable controllers in accordance with standards

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

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

Range

(AC1.12) **Components:**

Connect and test one of the following:

- Rack mounted controller units
- Modular controller units

Plus eight from the following:

- Sensors
- Actuators
- Printers panels and sub assemblies
- Switches
- Valves
- Electrical wires and cable connections
- Safety interlocks
- Signal transmission components/cables
- Motor starters
- Overload protection devices
- Barcode scanners
- PC peripheral devices
- Analogue to digital modules
- PID (proportional, integral, derivative) controller
- Other devices.

(AC1.14) **Programmable controller programs:**

Develop programs which use one of the following:

- Ladder and logic diagrams
- Function block diagrams
- Statement/instruction lists
- State logic
- Structured text
- Sequential function charts
- Other specific programming language.

(AC1.15) **Prove and edit:**

- Edit facilities
- Program full run

Plus five of the following:

- Single block/sub routine run
- Program save/store facilities
- Data input facilities

- Search facilities
- Program override controls
- Graphic displays
- Taking test measurements
- Using monitoring mode
- Using process simulation techniques (forcing contacts on/off)
- Counter and timer settings.

(AC1.16) **Test equipment:**

Use three of the following:

- Multimeter
- Voltmeter/indicator
- Programming devices
- Network testing equipment
- Other specific test equipment.

(AC1.18) **Diagnostic techniques, tools and aids:**

- Visual checks
- Movement checks
- Fault finding techniques
- Diagnostic aids
- Test instrumentation measurement
- Controller error warning lights/displays.

(AC1.19) **Standards:**

In accordance with two of the following:

- Equipment manufacturer's specification/operation range
- BS7671/IET wiring regulations
- Other BS and/or ISO standards
- Company standards and procedures**.**

Learning outcome

The learner will:

2 Understand how to wire and test programmable controller based systems

Assessment criteria

The learner can:

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

2.2 Describe the hazards associated with wiring and testing programmable controller equipment, and with the tools and equipment used and how they can be minimised

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

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

2.5 Explain the implications if the computer being used does become infected with a virus and who to contact if it does occur

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

2.7 Describe how to reduce the risks of a line to earth shock

2.8 Describe how to interpret of circuit and wiring diagrams, and specifications used for the wiring and testing activities

2.9 Describe the general principles of operation of the programmable controller equipment/circuits being connected and tested, and the purpose of the individual modules/components used

2.10 Describe the techniques used to connect programmable controller equipment

2.11 Identify the current required to operate the input/output devices if the controller is sinking or sourcing

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

2.13 Describe how to conduct any necessary checks to ensure the accuracy and quality of the wiring

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

2.15 Describe the programming languages commonly used with programmable controller based systems

2.16 Describe the common programmable controller numbering systems

2.17 Describe the different programming codes used to identify inputs, outputs, process management and auxiliary functions

2.18 Describe the information and data required in order to produce a complete and accurate programmable controller program

2.19 Describe how to translate the operating criteria into logic programming format

2.20 Describe the factors to be taken into account when producing programs and the safety considerations and the product/environment being controlled by the process

2.21 Describe the methods and procedures used to check that the completed program will control the required parameters safely, accurately and efficiently

2.22 Describe how to identify system errors

2.23 Describe how to search a program within the programmable controller for specific elements and rectify the causes of the errors

2.24 Describe how to save the completed programs

2.25 Explain the need to store the program safely and correctly, away from contaminants and possible corruption

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

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

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

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

2.30 Describe he importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities

Unit 226 Wiring and testing programmable controller based systems

Supporting Information

Evidence requirements

In order to prove their ability to combine different wiring and testing operations, at least one of the PLC systems worked on must be of a significant nature, and must cover a minimum of **five** of the items listed in 1.12.

Unit 227 Assembling and testing electronic circuits

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to assemble and test electronic circuits.
Relationship to NOS:	EUCL2F-016

Learning outcome

The learner will:

1 Assemble and test electronic circuits

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions, assembly drawings and test procedures at all times

1.4 Ensure that the components are free from damage, dirt or other contamination

1.5 Prepare the electronic components for the assembly operations

1.6 Use safe and approved techniques to mount the electronic components on the circuit boards

1.7 Check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition

1.8 Apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards

1.9 Follow clean work area protocols

1.10 Return all tools and equipment to the correct location on completion of the assembly activities

1.11 Plan the electronic assembly

1.12 Use appropriate sources to obtain the required specifications, circuit diagrams, component assembly and test information

1.13 Use the appropriate methods and techniques to assemble the components in their correct positions

1.14 Secure the components, using the specified connectors, securing devices and soldering techniques

1.15 Wire and terminate cables to the appropriate connections on the circuit boards

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

1.17 Carry out checks, adjustments and fault rectification

1.18 Produce electronic circuits in accordance with requirements

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

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

Range

(AC1.13) **Assemble circuits:**

Assemble one of the following circuit types:

- Single-sided circuit
- Thick film circuit
- Thin film circuit
- Flexible circuit
- Double-sided circuit
- Hybrid circuit.

(AC1.13) **Assembly techniques:**

Use two of the following:

- Manual soldering techniques
- Surface mount techniques
- Mechanical fixing methods.

(AC1.13) **Assembly tools:**

Use four of the following tools:

- Heat shunts/tweezers
- Component forming devices
- Mechanical fasteners
- Snipe or long nosed pliers
- Wire strippers
- Anti-static packaging, mats and straps
- Sleeving pliers
- Side or end cutters
- Specialised assembly tools/equipment.

(AC1.13) **Types of component:**

Assemble circuits including fifteen of the following:

- Fixed resistors
- Variable resistors
- Potentiometers
- Encoders or resolvers
- Transistors
- Inverters or servo controller**s**
- Thyristors
- Edge connectors
- Thermistors
- Light dependant resistors (LDR)
- Analogue or digital integrated circuits
- Wiring pins/tags/wire links

- Fixing spacers
- Fixed capacitors
- Variable capacitors
- Insulators
- Surface mount packages
- Rectifiers
- Small heat sinks
- Electrolytic capacitors
- Switches
- Cables
- Diodes
- Zener diodes
- Light emitting diodes (LEDs)
- Mini transformers
- Decoders
- Protection devices
- Cable connectors
- Regulators
- Relays
- Inductors
- Other specific electronic components.

(AC1.13) **Assemble electronic components:**

Assemble components to produce five of the following:

- Audio amplifiers
- Filters
- Regulated power supplies
- Signal converters
- Microprocessor based applications
- Logic function controls
- Signal generators
- Comparators
- Display circuits
- Counter/timers
- Power amplifiers
- ADC and DAC hybrid circuits
- Oscillators
- Motor control
- Sensor/actuator circuit
- Digital circuit
- Signal processing circuit
- Alarms and protection circuits
- Other specific circuits**.**

(AC1.16) **Test equipment:**

Use five of the following:

- Multimeter
- Signal generator
- Oscilloscope

- Signal tracer
- Logic probe/clip
- Stabilised power supplies
- Logic analyser
- Measuring bridges
- Pulse sequencing analyser
- Software diagnostic programs
- Counter/timers
- Data communications test set
- Signature analysers
- Bus exerciser/analyser
- Protocol analyser.

(AC1.17) **Checks, adjustments and fault rectification:**

To include six of the following:

- Logic states
- Pulse width/rise time
- Inductance
- Dc voltage/current levels
- Open/short circuit
- Frequency modulation/demodulation
- Ac voltage/current levels
- Resistance
- Amplification
- Clock/timer switching
- Capacitance
- Signal noise/interference levels
- Oscillations
- Waveform analysis
- Attenuation.

(AC1.18) **Requirements:**

In accordance with one of the following:

- BS or ISO standards and procedures
- Customer standards and requirements
- Company standards and procedures
- oOher international standards.

Learning outcome

The learner will:

2 Understand how to assemble and test electronic circuits

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that need to be observed when assembling and testing electronic circuits

2.2 Describe the hazards associated with assembling and testing electronic circuits and how they can be minimised

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

2.4 Describe the precautions to be taken to prevent electrostatic discharge (ESD) damage to electronic circuits and components

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

2.6 Describe how to reduce the risks of a line to earth shock

2.7 Describe how to use and extract information from circuit diagrams, block and schematic diagrams, equipment manuals, data sheets, test procedures and instructions

2.8 Describe the different types of circuit boards

2.9 Describe how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies

2.10 Describe how to check that components meet the required specification/operating conditions

2.11 Describe the general principles of operation of the electronic circuits they have assembled, and the purpose of the individual modules/components within the circuits and how they interact

2.12 Describe the application and use of circuit protection equipment

2.13 Describe the preparation requirements for components to be used in the assembly

2.14 Describe the methods of mounting and securing electronic components to various surfaces

2.15 Describe methods of attaching markers/labels to components or cables to assist with identification

2.16 Describe the use of calculations, and regulations, when selecting wires and cables and when carrying out tests on electronic circuits

2.17 Explain the importance of making visual checks of the completed assembly

2.18 Describe the tools and equipment used in the electronic assembly activities

2.19 Explain the importance of ensuring that all tools are in a safe and serviceable condition, are used correctly and are returned to their correct location on completion of the assembly activities

2.20 Describe the care, handling and application of electronic test and measuring instruments

2.21 Describe how to check that equipment is within current calibration approval dates and PAT tested

2.22 Describe how to check that the test equipment is safe amd suitable for the tests they are to carry out and can cover the range and values they are to measure

2.23 Identify the correct test points in the circuit

2.24 Describe how to position test instruments into circuits without damaging circuit components

2.25 Describe how to set instrument zero readings

2.26 Describe how to obtain instrument readings and compare them with expected results

2.27 Describe how to make adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components

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

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

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

2.31 Describe the importance of leaving the work area in a safe and clean condition on completion of the electronic assembly and testing activities.

Unit 227 Assembling and testing electronic circuits

Supporting Information

Evidence requirements

In order to prove their ability to combine different electronic assembly and testing activities, at least one of the electronic assemblies produced must be of a significant nature, and must contain a minimum of **ten** of the components listed in 1.13 'Types of Components'.

Unit 228 Forming and assembling electrical cable enclosure and support systems

Unit level:	Level 2
GLH:	65
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to form and assemble electrical cable enclosures and support systems.
Relationship to NOS:	EUCL2F-040

Learning outcome

The learner will:

1 Form and assemble electrical cable enclosure and support systems

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions and assembly/installation drawings at all times

1.4 Ensure that the electrical cable enclosure system is kept free from foreign objects, dirt or other contamination

1.5 Return all tools and equipment to the correct location on completion of the installation activities

1.6 Plan the assembly and installation of the cable enclosure system

1.7 Obtain the correct tools and equipment for the cutting, forming and assembly operations, and check that they are in a safe and usable condition

1.8 Cut and form the cable enclosure components to the required size and shape, using appropriate tools and techniques

1.9 Assemble the cable enclosure/support system, using the appropriate connectors

1.10 Construct cable enclosures/support system components

1.11 Apply installation methods and techniques

1.12 Mount and secure the cable enclosure components safely and correctly to meet the specification requirements

1.13 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly is secure and meets the required specification

1.14 Produce cable enclosure/support systems in accordance with standards.

Range

(AC1.8) **Types of electrical cable enclosures/support systems:**

Form and assemble two of the following:

- Metal conduit system
- Non-metallic conduit system
- Metal trunking system
- Non-metallic trunking system
- Traywork system.

(AC1.9) **Cable enclosure/support systems:**

- Bends/elbows (solid or inspection type)
- Horizontal runs
- Boxes
- Vertical drops

Plus three of the following:

- Straight connectors/couplings
- Conversion units and adaptors
- Tee pieces
- Cross over units
- Reducers
- Off sets.

(AC1.10) **Construct:**

- Selecting the correct type and size of conduit, trunking or traywork
- Cutting the materials to the correct lengths
- Removing all burrs and sharp edges
- Producing external threads on conduit
- Producing or fabricating bends, up to and including 90°
- Producing or fabricating bends over 90°
- Making tee/multiple junctions in trunking/traywork
- Producing or fabricating offsets
- Producing or fabricating bridge/saddle sets.

(AC1.11) **Installation methods and techniques:**

- Marking out the location of the trunking, traywork or conduit
- Positioning and securing the trunking, traywork or conduit using mechanical fixings
- Drilling and preparing holes for the trunking, traywork or conduit
- Levelling and alignment of the wiring enclosures and components.

(AC1.13) **Checks:**

- For level and alignment
- That all connections are secure
- That sufficient supports are used and that they are correctly spaced
- That correct outlets are used.

(AC1.14) **Standards:**

To meet one of the following:

- BS 7671/IET wiring regulations
- Other BS and/or ISO standards
- Company standards and procedures.

Learning outcome

The learner will:

2 Understand how to form and assemble electrical cable enclosure and support systems

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when forming and assembling cable enclosure/support systems

2.2 Describe the hazards associated with forming and assembling cable enclosure/support systems, and with the tools and equipment used and how they can be minimised

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

2.4 Describe how to interpret information sources used for the installation

2.5 Describe the various types of electrical cable enclosure and support systems used, and their typical applications

2.6 Describe the factors to be taken into account when choosing metallic or non-metallic systems, and the effects of ambient temperatures within conduit and trunking systems

2.7 Describe marking out lengths to be cut, taking into account any allowances

2.8 Describe methods of holding workpieces without damaging them

2.9 Describe the tools and equipment used in the cutting, bending and forming operations

2.10 Describe methods of producing bends and sets in conduit materials

2.11 Describe methods of bending plastic conduit

2.12 Describe how to produce fabricated bends in trunking and traywork section material

2.13 Describe the methods of forming screw threads on ends of conduit, and of using appropriate tools to remove all sharp edges and burrs

2.14 Describe the various fittings used to assemble conduit, trunking and traywork systems

2.15 Describe the importance and use of inspection fittings

2.16 Describe the problems to look for when checking finished components/installations

2.17 Describe how to join the system components

2.18 Describe how to check alignment of components

2.19 Describe the methods of supporting and securing the components

2.20 Describe the types and application of masonry fixing devices used in installation work

2.21 Explain the need to ensure that components are clear of services drilling walls

2.22 Describe the problems that can occur with the installation operations, and how these can be overcome

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

2.24 Describe the importance of leaving the work area in a safe and clean condition on completion of the assembly/installation activities.

Range

(AC2.4) **Information sources:**

- BS and ISO schematics
- Circuit and wiring diagrams

- Specifications
- Wiring regulations
- Symbols and terminology.

(AC2.14) **Fittings:**

- Screwed fittings
- Cemented fittings
- Straight connectors
- Bends
- Tees
- Inspection fittings
- Light
- Power and control outlet boxes.

Unit 228 Forming and assembling electrical cable enclosure and support systems

Supporting Information

Evidence requirements

In order to prove their ability to combine different cable enclosure forming and assembly operations, at least one of the cable enclosure and support systems produced must be of a significant nature, and must contain a minimum of **four** of the features listed in 1.09.

Unit 229 Assembling, wiring and testing electrical panels/components mounted in enclosures

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding g and skills needed to assemble, wire and test electrical panels/components mounted in enclosures.
Relationship to NOS:	EUCL2F-039

Learning outcome

The learner will:

1 Assemble, wire and test electrical panels/components mounted in enclosures

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions, assembly drawings and test procedures at all times

1.4 Ensure that the components are free from damage, foreign objects, dirt or other contamination

1.5 Check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition

1.6 Prepare the electrical components and enclosures for the assembly operations

1.7 Use safe and approved techniques to mount the electrical components in the enclosures

1.8 Apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards

1.9 Return all tools and equipment to the correct location on completion of the assembly activities

1.10 Plan the electrical assembly, wiring and testing activities

1.11 Use appropriate sources to obtain the required specifications, circuit diagrams, components, assembly and test

1.12 Obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition

1.13 Mount electrical components on panels or into enclosures

1.14 Wire electrical components on panels or in enclosures using different cable/wire types and methods and techniques

1.15 Secure the components, using the specified connectors and securing devices

1.16 Use appropriate quality checks to check that the completed assembly is safe and meets all aspects of the specification

1.17 Assemble components in accordance with standards

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

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

Range

(AC1.13) **Electrical components:**

To include twelve of the following:

- Enclosure partitions
- Bases for plug-in devices
- Soft starters
- Components mounting plates
- Switches (push button, toggle)
- Variable speed drives
- Component marking
- Capacitors
- Limit switches
- Trunking
- Resistors
- Sensors
- Conduit
- Rectifiers
- Programmable controllers
- Contactors
- Timers
- Plugs/sockets
- Overload and other relays
- Power supplies
- Grommets/grommet strip
- Transformers/chokes
- Circuit boards
- Lighting fixtures
- Circuit breakers/fuses
- Thermistors/thermocouples
- Batteries
- Panel meters (voltage, current)
- Indicators (lamps, LEDs)
- Connector rails
- Terminal blocks/junction boxes
- Thermostats
- Solenoids
- Safety interlocks
- Busbars

- Isolators
- Other specific components.

(AC1.13) **Activities to be carried out during mounting:**

To include eight of the following:

- Setting working clearance
- Aligning components
- Applying sealants/adhesives
- Drilling
- Torque setting fasteners
- Clamping
- Filing
- Earthing and bonding
- Crimping
- Riveting
- Securing using mechanical fasteners/threaded devices
- Component marking
- Sawing/cutting
- Making screw connections
- Forming
- Punching
- Measuring.

(AC1.14) **Cable/wire types:**

Use two of the following:

- Single core cable
- Mineral insulated cable
- Twisted pair/ribbon cable
- Multicore cable
- Screened cable
- Braided copper
- Laminated copper
- Fibre-optic
- Data/communication cable
- Other specialist cable.

(AC1.14) **Methods and techniques:**

To include ten of the following:

- Cable forming/bending
- Making screwed connections
- Cable supporting/tying
- Soldering
- Cable/wire clamping
- Cable routeing
- Cable protection
- Connecting pre-formed looms
- Cable/wire crimping
- Wire marking/colour coding
- Insulation stripping.

(AC1.16) **Quality checks:**

- Positional accuracy of all components
- Correct termination of all wires to components
- Correct orientation
- Completeness
- Correct alignment
- Ensuring enclosure is free of debris
- Component security
- Security of all terminations
- Ensuring freedom from damage
- Continuity of cable/wiring connections
- Polarity
- Protective conductor resistance values
- Earth continuity
- Insulation resistance.

(AC1.17) **Standards:**

Assemble components in accordance with at least one of the following:

- BS7671/IET wiring regulations
- Other BS or ISO standards and procedures
- Company standards and procedures.

Learning outcome

The learner will:

2 Understand how to assemble, wire and test electrical panels/components in enclosures

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when assembling, wiring and testing electrical components mounted in enclosures

2.2 Describe the hazards associated with assembling, wiring and testing electrical panels and how they can be minimised

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

2.4 Describe the precautions to be taken to prevent electrostatic discharge (ESD) damage to circuits and sensitive components

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

2.6 Describe how to reduce the risks of a line to earth shock

2.7 Describe how to obtain and interpret information needed for the electrical component mounting, wiring and testing activities

2.8 Describe the basic principle of operation of the equipment/circuits being assembled and wired, and the purpose of individual components within the circuit

2.9 Describe the assembly methods and techniques to be used when wiring electrical panels or components mounted in enclosures

2.10 Describe the type of components and sub-assemblies that are used in the assembly activities

2.11 Describe preparations to be undertaken on the components and enclosure, prior to the mounting activities

2.12 Describe how the components are to be aligned and positioned prior to securing, and the tools and equipment that are used

2.13 Describe how to identify any orientation requirements, values or polarity for the components used in the electrical wiring activities

2.14 Describe methods of attaching identification markers/labels during electrical assembly activities

2.15 Describe the different types of cabling, and their application

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

2.17 Describe the use of BS7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on electrical circuits

2.18 Describe how to conduct any necessary checks to ensure the accuracy and quality of the assembly produced

2.19 Describe how to check that tools and equipment are free from damage or defects, are in a safe, tested, calibrated and usable condition, and are configured correctly for the intended purpose

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

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

2.22 Describe the importance of leaving the work area in a safe and clean condition on completion of the electrical assembly and wiring activities.

Range

(AC2.7) **Information:**

- Drawings
- Circuit and physical layouts
- Charts
- Specifications
- Graphical electrical symbols
- BS and ISO wiring regulations
- Other documents.

Unit 229 Assembling, wiring and testing electrical panels/components mounted in enclosures

Supporting Information

Evidence requirements

In order to prove their ability to combine different electrical panel assembly and wiring operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **eight** of the components listed in 1.13 'electrical components' **plus six** of the activities listed in 1.14 'methods and techniques'.

Unit 230 Maintaining and testing process instrumentation and control devices

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to maintain and test process instrumentation control devices.
Relationship to NOS:	EUCL2F-023

Learning outcome

The learner will:

1 Maintain and test process instrumentation and control devices

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of instruments

1.4 Follow job instructions, maintenance drawings and procedures

1.5 Check that the tools and test instruments are within calibration date and are in a safe and usable condition

1.6 Ensure that the equipment/system is kept free from foreign objects, dirt or other contamination

1.7 Return all tools and equipment to the correct location on completion of the maintenance activities

1.8 Carry out maintenance activities on instrumentation and control systems

1.9 Plan the maintenance activities

1.10 Obtain all the information needed for the safe removal and replacement of the instruments and/or sensors

1.11 Obtain and prepare the appropriate tools and equipment

1.12 Use maintenance diagnostic techniques, tools and aids

1.13 Carry out instrumentation maintenance activities

1.14 Set up and test sensing elements and/or stand alone instruments

1.15 Use instrumentation test and calibration equipment

1.16 Maintain instrumentation and control systems

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

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities.

Range

(AC1.8) **Instrumentation and control systems:**

Carry out maintenance activities on two of the following types opf system:

- Pressure
- Speed measurement
- Fluid level
- Noise
- Fluid flow
- Vibration monitoring
- Temperature measurement
- Nucleonic and radiation measurement
- Fire detection
- Telemetry
- Gas detection
- Weight measurement
- Emergency shutdown
- Alarm
- Environmental
- Other specific system.

(AC1.12) **Maintenance diagnostic techniques, tools and aids:**

Use four of the following:

- Fault finding techniques
- Diagnostic aids
- Information gathered from the person who reported the fault
- Visual checks
- Movement checks
- Monitoring equipment or gauges
- Test instrumentation measurement.

(AC1.13) **Instrumentation maintenance activities:**

- Removing excessive dirt and grime
- Replacing all 'lifed' items
- Taking electrostatic discharge (ESD) precautions
- Replacing instruments/devices in the system
- Setting, aligning and adjusting components
- Disconnecting supply/signal connections
- Tightening fastenings to the required torque
- Removing instruments from the system
- Re-connecting instrumentation pipework and power supply
- Dismantling equipment to the required level
- Labelling/marking of components
- Checking signal transmission is satisfactory

- Checking components for serviceability
- Replacing or repairing damaged/defective components
- Functionally testing the maintained equipment.

(AC1.14) **Sensing elements and stand alone instruments:**

Set up and test three of the following:

- Pressure
- Temperature
- Flow
- Level
- Other instruments/sensing elements.

(AC1.15) **Instrumentation test and calibration equipment:**

Use four of the following:

- Signal sources
- Pressure sources
- Logic probes
- Standard test gauges
- Comparators
- Temperature baths
- Analogue or digital meters
- Manometers
- Workshop potentiometers
- Digital pressure indicators
- Current injection devices
- Dead weight testers
- Calibrated flow meters
- Calibrated weights
- Insulation testers
- Special-purpose test equipment.

(AC1.16) **Maintain:**

Maintain in accordance with at least one of the following:

- Organisational guidelines and codes of practice
- Equipment manufacturer's operation range
- BS and ISO standards.

Learning outcome

The learner will:

2 Know how to maintain and test process instrumentation and control devices

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the instrumentation maintenance activities undertaken

2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the system and instruments being worked on, and how to check that any stored energy in pipework and instruments has been released

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

2.4 Describe the hazards associated with carrying out instrumentation and control maintenance activities and how to minimise them

2.5 Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock

2.6 Describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD)

2.7 Explain how to obtain and interpret information from job instructions and other documents needed for the maintenance activities

2.8 Describe the basic principles of operation of the instrumentation being maintained

2.9 Explain how to identify the various instrument sensors

2.10 Describe the various maintenance diagnostic techniques and aids that can be used

2.11 Describe the various fault location techniques that can be used, and how they are applied

2.12 Explain how to select and use a range of fault diagnostic equipment to investigate the problem

2.13 Describe the care, handling and application of instrumentation and control measuring instruments

2.14 Describe the reasons for making sure that control systems are isolated or put into manual control, and that appropriate trip locks or keys are inserted, before removing any sensors or instruments from the system, and the consequences of failing to do this

2.15 Describe the techniques used to dismantle/remove the equipment

2.16 Describe the methods of attaching identification marks/labels to removed components or cables, to assist with reassembly

2.17 Describe the methods of checking that components are fit for purpose, and the need to replace batteries, boards and other failed items

2.18 Describe the correct way of re-fitting instruments to avoid faulty readings

2.19 Explain how to carry out visual checks of the instruments

2.20 Describe the need to carry out tests and calibration checks on the various sensing elements and stand alone instruments, and the use of standard calibration charts and tables

2.21 Describe the types and application of standard test equipment

2.22 Explain how to check that tools and equipment are free from damage or defects and are in a safe, calibrated, PAT tested and usable condition

2.23 Describe the approved methods of carrying out the tests on each type of instrument/sensor; setting instrument zero readings; obtaining instrument readings and comparing them with the circuit parameters; making adjustments to instrument/circuit components

2.24 Describe the generation of maintenance documentation and/or reports following the maintenance activity

2.25 Describe the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome

2.26 Describe the organisational procedure to be adopted for the safe disposal of waste of all types of materials

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

2.28 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities.

Range

(AC2.8) **Instrumentation:**

- Pressure
- Temperature
- Level
- Flow.

(AC2.9) **Identify:**

- Their markings
- Calibration information
- Component values
- Operating parameters and
- Working range.

Unit 230 Maintaining and testing process instrumentation and control devices

Supporting Information

Evidence requirements

In order to prove their ability to combine different process instrumentation and control maintenance operations, at least one of the instrumentation maintenance activities carried out must be of a significant nature, and must cover a minimum of **eight** of the maintenance activities listed in 1.13.

Unit 231 Preparing and using industrial robots

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use industrial robots.
Relationship to NOS:	EUCL2F-018

Learning outcome

The learner will:

1 Prepare and use industrial robots

Assessment criteria

The learner can:

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

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

1.3 Check that all the equipment is correctly connected, and is in a safe and usable working condition

1.4 Activate the programming software

1.5 Set up the computer system to produce the program

1.6 Ensure that the correct process input/output and control data to produce the program is obtained and checked for currency and validity

1.7 Store completed program media safely and correctly, away from contaminants or possible corruption

1.8 Plan the programming activities

1.9 Prepare and use industrial robots

1.10 Prepare, load and prove programs

1.11 Produce robot programs for engineering applications

1.12 Select and set up robot end effectors for the engineering application

1.13 Develop programs for different activities

1.14 Determine an operational sequence that avoids wasted robot arm movements and tool/accessory changes

1.15 Prove the robot program

1.16 Mount and set the required workholding devices and robot tooling

1.17 Run the operating program, and check and adjust the operating parameters to achieve the output specification

1.18 Carry out operations for engineering applications

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

1.20 Shut down the equipment to a safe condition on completion of the robotic activities.

Range

(AC1.9) **Industrial robots:**

Use one of the following:

- Cartesian (gantry)
- SCARA
- Articulated
- Parallel
- Other specific type.

(AC1.10) **Programs:**

Use one of the following:

- Positional commands (x, y, z)
- Teach pendant
- Off-line programming
- Other specific method.

(AC1.11) **Engineering applications:**

Produce programs for one of the following:

- Welding
- Surface coating
- Gluing/sealing
- Machine loading/unloading
- Assembly
- Logistics movement/control
- Packaging
- Stud welding
- Other specific activity.

(AC1.12) **Robot end effectors:**

Select and set up one of the following:

- Welding guns
- Spot welders
- Spray guns
- Grippers
- Drills
- Vacuum devices
- Other specific tooling.

(AC1.13) **Program activities:**

Programs must contain the following activities:

- Safe start and stop positions
- All necessary positional information
- Type of motion
- Preparatory commands and process management/auxiliary functions
- Repetitive programs (sub-routines, canned cycles, labels)
- Speed/acceleration parameters

- Sensor information
- Part programs downloaded from a computer
- Use of workframes.

(AC1.15) **Prove the program:**

Use four of the following:

- Single block run
- Full dry run
- Search facilities
- Edit facilities
- Program override controls
- Data input facilities
- All modes.

(AC1.18) **Operations:**

Carry out the following for the engineering application selected in 1.11:

- Check that all safety mechanisms are in place and that the equipment is set correctly for the required operations
- Position work in relation to the robot parameters
- Run the operating program in accordance with operating procedures
- Check that all operations are carried out safely and correctly
- Edit programs using the correct procedure
- Examine the completed work visually and/or using suitable test/measuring instruments, gauges or checking fixtures, as appropriate to the operations performed
- Determine if the completed setup completes the operations to the required specification, including repeatability and accuracy.

Learning outcome

The learner will:

2 Know how to prepare and use industrial robots

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when developing and proving industrial robot operating programs

2.2 Describe the hazards associated with using industrial robots and how they can be minimised

2.3 Describe the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area clean and tidy

2.4 Describe the safety mechanisms on the robot and operating envelope and the procedure for checking that they function correctly

2.5 Describe how to stop the robot in both normal and emergency situations, and the procedure for restarting after an emergency

2.6 Describe the correct operation of all available modes

2.7 Describe how to drive the robot in each type of coordinate frame

2.8 Explain how to drive the robot at different speeds, including jog mode

2.9 Describe the main robot types that are available, and explain the importance of understanding that a different robot may use a completely different syntax for similar functions

2.10 Describe the information and data required in order to produce complete and accurate robot programs

2.11 Explain how to extract and interpret general and technical data and information from different sources in order to produce the robot program

2.12 Describe the factors to be taken into account when producing robot programs

2.13 Describe how to produce effective and efficient programs to avoid unnecessary operations

2.14 Describe the methods and procedures used to check that the completed program will perform safely, accurately and efficiently

2.15 Explain the importance of storing programs safely and correctly, away from contaminants and possible corruption

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

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

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

2.19 Describe the problems that can occur with the downloading and running of the robot program, and how these can be overcome

2.20 Describe the various workholding devices that are used for robot applications, and the methods of positioning and setting them in relation to the robot's operating parameters

2.21 Describe the various tools and end effector equipment that are used for the particular robot operations

2.22 Explain why tools must be positioned correctly in relationship to the robot's reference points and tool centre points

2.23 Describe the importance of checking that tool change positions are clear of the workpiece and can be safely and quickly achieved

2.24 Describe the need to ensure that all guards are in place and that the interlock systems are in correct working order

2.25 Describe how to run the robot operating program and check that all operations are carried out safely and correctly

2.26 Describe how to check that the finished operations meet the work specification

2.27 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

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

2.29 Describe the importance of leaving the work area and machine in a safe condition on completion of the activities.

Range

(AC2.12) **Factors:**

- The type of robot
- Its control capabilities
- Safety
- The product/environment being controlled.

Unit 231 Preparing and using industrial robots

Supporting Information

Evidence requirements

In order to prove their ability to combine different processes and operations, at least one of the activities carried out must be of a significant nature, and must cover a minimum of four of the activities (1.13) plus five of the operations listed in 1.18.

Unit 232 Preparing and using electro-discharge machines

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use electro-discharge machines.
Relationship to NOS:	EUCL2F-041

Learning outcome

The learner will:

1 Prepare and using electro-discharge machines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines

1.2 Obtain and use the appropriate documentation

1.3 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work

1.4 Ensure that the appropriate fluids are at the appropriate levels

1.5 Plan the activities

1.6 Operate an electro-discharge machines

1.7 Position and secure workpieces to machine table without distortion

1.8 Select and mount electrodes for roughing and finishing

1.9 Machine components from different types of material

1.10 Set up the machine tool operating parameters in accordance with instructions and specifications

1.11 Rough and machine component features

1.12 Use appropriate gauges or instruments to carry out the necessary checks for accuracy during production

1.13 Produce components that comply with quality standards

1.14 Deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved

1.15 Shut down the equipment to a safe condition on conclusion of the activities

1.16 Leave the work area and machine in a safe and appropriate condition on completion of the activities.

Range

(AC1.6) **Electro-discharge machine:**

Operate one of the following:

- Spark erosion machine (manual or CNC)
- Wire erosion machine (manual or CNC).

(AC1.7) **Secure:**

Use two of the following:

- Clamping direct to machine table
- Angle plate
- Chucks
- Pneumatic or magnetic table
- Ancillary indexing device
- Vee block and clamps
- Machine vice
- Fixtures.

(AC1.8) **Electrodes:**

Use one of the following types:

- Plain
- Hollow
- Profile
- Wire.

(AC1.9) **Types of material:**

Use one of the following types:

- Ferrous
- Non ferrous.

(AC1.10) **Operating parameters:**

- Electrical conditions
- Alignment of electrodes
- Wire tension feeds and speeds
- Correct threading of wire through wire guides and feed mechanisms
- Wire speeds
- Fluid flow rates
- Filtration equipment
- Ventilation and fume extraction
- Safety mechanisms/devices.

(AC1.11) **Features:**

Produce four of the following:

- Flat faces
- Concave forms
- Profile forms
- Square/rectangular forms
- Square faces
- Convex forms
- Cavities
- Angular faces
- Parallel faces

- Holes
- Radii/arcs
- Engraving
- Threads
- Slots
- Other special forms or features.

(AC1.12) **Checks for accuracy:**

Check for accuracy of three of the following:

- Dimensions
- Parallelism
- Squareness
- Profile
- Position
- Surface texture
- Angle/taper.

(AC1.13) **Quality standards:**

- Dimensional tolerance equivalent to BS EN 20286 or BS Grade 9
- Components to be free from false starts, and sharp edges
- Angles within +/- 0.5 degree
- Surface finish 32 µin; 0.8 µm; 18VDI.

Learning outcome

The learner will:

2 Know how to prepare and use electro-discharge machines

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions / working practices to be taken when setting up and operating workholding devices and electrodes or wires on electro-discharge machines

2.2 Describe the hazards associated with setting and operating electro-discharge machines and how to minimise them and reduce any risks

2.3 Describe the operation of the machine controls in both hand and power modes, and how to stop the machine in an emergency

2.4 Explain the importance of ensuring that the machine is isolated from the power supply before mounting electrodes, wires and workholding devices

2.5 Explain the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy

2.6 Describe how to handle and store electrodes and wires safely and correctly

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

2.8 Describe how to extract and use information from engineering drawings or data and related specifications in relation to work undertaken

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

2.10 Describe how to use imperial and metric systems of measurement

2.11 Define terminology used in electro-discharge machining in relation to the activities undertaken

2.12 Explain the effects of clamping the work piece in a chuck/work holding device, and how this can cause distortion in the finished components

2.13 Describe the type of fluids that are used; filtration requirements; and precautions to be taken when handling and using them

2.14 Describe the various erosion operations that are used to produce the required forms, and the types of electrodes or wires used

2.15 Explain the importance of checking the position and alignment of the workpiece before commencing the erosion operations, and the tools and equipment that are used

2.16 Explain factors which affect the selection of electrode or wire feeds and speeds

2.17 Describe the application of roughing and finishing cuts, and the effect on electrode life, surface finish and dimensional accuracy

2.18 Explain how to recognise erosion faults and identify when electrodes need changing

2.19 Describe the quality control procedures used, inspection checks to be carried out, and the equipment to be used

2.20 Describe problems that can occur with setting up the electrodes or wires, workholding devices, and machine operating parameters, and what to do if problems occur

2.21 Explain the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 232 Preparing and using electro-discharge machines

Supporting Information

Unit guidance

2.8 To include symbols and conventions to appropriate BS, ISO or BSEN standards.

Unit 233 Maintaining fluid power equipment

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to maintain fluid power equipment.
Relationship to NOS:	EUCL2F-008

Learning outcome

The learner will:

1 Maintain fluid power equipment

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of equipment

1.4 Follow job instructions, maintenance drawings and procedures

1.5 Check that tools and test instruments to be used are within calibration and are in a safe and usable condition

1.6 Ensure that the system is kept free from foreign objects, dirt or other contamination

1.7 Return all tools and equipment to the correct location on completion of the maintenance activities

1.8 Plan the maintenance activities

1.9 Obtain all the information, tools and test equipment needed they need for the safe isolation, removal and replacement of the system components and ensure they are prepared for use

1.10 Use maintenance diagnostic techniques, tools and aids

1.11 Use fluid power test instruments

1.12 Carry out all maintenance activities on different types of fluid power equipment

1.13 Remove and replace fluid power components

1.14 Carry out checks to ensure the accuracy and quality of the tests carried out

1.15 Carry out tests on the maintained equipment

1.16 Maintain fluid power equipment in compliance with requirements

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

1.18 Leave the work area in a safe and tidy condition on completion of the maintenance activities.

Range

(AC1.10) **Diagnostic techniques, tools and aid:**

- Fault finding techniques
- Diagnostic aids
- Information gathered from fault reports
- Inspecting
- Sensory input
- Monitoring equipment or gauges
- Operating the equipment
- Test instrumentation measurement.

(AC1.11) **Test instruments:**

Use two of the following:

- Measuring devices
- Flow indicators
- Self-diagnostic equipment
- Pressure indicators
- Test rigs.

(AC1.12) **Maintenance activities:**

- Chocking/supporting cylinders/rams/components
- Draining and removing fluids
- Releasing stored energy
- Disconnecting/removing hoses and pipes
- Removing and replacing units/components
- Proof marking/labelling of removed components
- Checking components for serviceability
- Replacing damaged/defective components
- Replacing all 'lifed' items
- Tightening fastenings to the required torque
- Setting, aligning and adjusting replaced components
- Prime, bleed and recharge the system
- Making de-energised checks before re-pressurising the system.

(AC1.12) **Types of fluid power equipment:**

Carry out activities on two types of fluid power equipment:

- Pneumatic
- Hydraulic
- Vacuum.

(AC1.13) **Fluid power components:**

- Cylinders
- Pipework/hoses
- Valves
- Actuators

Plus eight of the following:

- Reservoirs/storage devices
- Pumps
- Switches
- Accumulators

- Sensors
- Motors
- Pressure intensifiers
- Gaskets and seals
- Lubricators
- Compressors
- Pistons
- Filters
- Receivers
- Spools
- Regulators
- Gauges/indicators
- Timers
- Coolers
- Other specific components.

(AC1.14) **Checks:**

- The test equipment is correctly calibrated
- The test equipment used is appropriate for the tests being carried out
- Test procedures used are as recommended in the appropriate specifications
- Test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings
- Test equipment is operated within its specification range.

(AC1.15) **Tests:**

- Leak test
- Operational performance

Plus two of the following:

- Pressure line pressure tests
- Speed
- Return line pressure test
- Sequence
- Flow
- Fluid contamination test.

(AC1.16) **Requirements:**

Comply with two of the following:

- Organisational guidelines and codes of practice
- Specific system requirements
- Equipment manufacturers' operation range
- BS and/or ISO standards.

Learning outcome

The learner will:

2 Know how to maintain fluid power equipment

Assessment criteria

The learner can:

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

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

2.3 Describe the hazards associated with carrying out maintenance activities on fluid power equipment and how these can be minimised

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

2.5 Explain how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, history/maintenance reports, symbols used in fluid power, and other documents needed in the maintenance activities

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

2.7 Describe the basic principles of how the fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

2.8 Describe the different types of pipework, fittings and manifolds, and their application

2.9 Identify different types of valve and describe their application

2.10 Identify different types of sensors and actuators and describe their application

2.11 Identify different types of cylinder and describe their application

2.12 Identify different types of pump and describe their application

2.13 Identify different types compressors and describe their application

2.14 Describe the application and fitting of static and dynamic seals

2.15 Describe the techniques used to dismantle/assemble fluid power equipment

2.16 Describe the methods of checking that components are fit for purpose

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

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

2.19 Explain the selection of fluids for the system

2.20 Identify contaminants and describe the problems they can create, and the effects and likely symptoms of contamination in the system

2.21 Describe the various maintenance diagnostic techniques and aids that can be used

2.22 Describe the various fault location techniques that can be used, and how they are applied

2.23 Describe how to evaluate sensory information

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

2.25 Describe the care, handling and application of mechanical measuring/test equipment

2.26 Describe the types of test equipment to be used, and their selection for particular tests

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

2.28 Describe the techniques, methods and procedures to be used during the tests

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

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

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

2.32 Describe how to check that tools and test equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose

2.33 Describe the problems associated with maintaining fluid power equipment, and how they can be overcome

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

2.35 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities.

Unit 233 Maintaining fluid power equipment

Supporting Information

Evidence requirements

In order to prove their ability to combine different maintenance operations, at least one of the fluid power maintenance activities must be of a significant nature, and must involve the removal and replacement/refitting of a minimum of five of the components listed in 1.13.

Unit 234 Assembling and testing fluid power systems

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to assemble and test fluid power systems.
Relationship to NOS:	EUCL2F-007

Learning outcome

The learner will:

1 Assemble and test fluid power systems

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Ensure the safe isolation of equipment
1.4 Follow job instructions, assembly drawings and procedures
1.5 Check that assembly tools and test instruments to be used are within calibration date and are in a safe and usable condition
1.6 Ensure that the fluid power system is kept free from foreign objects, dirt or other contamination
1.7 Return all tools and equipment to the correct location on completion of the assembly activities
1.8 Produce a drawing/sketch of a fluid power circuit using the correct symbols
1.9 Plan the assembly activities
1.10 Obtain all the information they need for the safe assembly of the fluid power system
1.11 Obtain and prepare the appropriate components, assembly tools and test equipment
1.12 Produce fluid power assemblies that contain different components
1.13 Assemble different types of fluid power systems
1.14 Apply fluid power assembly methods and techniques
1.15 Carry out quality checks using appropriate equipment
1.16 Carry out tests and adjustments on assembled systems
1.17 Carry out all checks to ensure the accuracy and quality of tests on assembled systems
1.18 Produce fluid power assemblies which meet standards

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

1.20 Leave the work area in a safe and tidy condition on completion of the assembly activities.

Range

(AC1.12) **Fluid power assembly components:**

- Hoses
- Valves
- Cylinders/actuators

Plus eight of the following:

- Rigid pipework
- Pumps
- Lubricators
- Switches
- Compressors
- Pressure intensifiers
- Sensors
- Cables and wires
- Accumulators
- Regulators
- Receivers
- Gaskets and seals
- Reservoirs/storage devices
- Gauges/indicators
- Filters
- Motors
- Coolers
- Timers (electrical, pneumatic and mechanical)
- Other specific components.

(AC1.13) **Types of fluid power system:**

Assemble two of the following types:

- Pneumatic
- Hydraulic
- Vacuum.

(AC1.14) **Fluid power assembly methods and techniques:**

- Checking components for serviceability
- Applying screw fastener locking devices
- Positioning equipment/components
- Tightening fastenings to the required torque
- Aligning pipework and connections
- Applying hose/cable clips and fasteners
- Dressing and securing pipes and hoses
- Making de-energised checks before filling and/or pressurising the system
- Setting, aligning and adjusting system components
- Securing by using mechanical fixings.

(AC1.15) **Quality checks:**

- The system is complete, as per specification
- Connections to components are tightened to the required torque
- Dimensions are within specification requirements
- Components are correctly positioned
- Pipework is free from ripple and creases
- Components are correctly aligned
- Electrical connections are correctly made
- Direction and flow indicators on components are correct
- Components are securely held in place.

(AC1.16) **Test and adjustments:**

- Leak test
- Operational performance

Plus two of the following:

- Pressure line pressure tests
- Speed
- Return line pressure test
- Sequence
- Flow
- Contamination.

(AC1.17) **Checks:**

- The test equipment is correctly calibrated
- The test equipment used is appropriate for the tests being carried out
- Test procedures used are as recommended in the appropriate specifications
- Test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings
- Test equipment is operated within its specification range.

(AC1.18) **Standards:**

- All components are correctly assembled and aligned, in accordance with the specification
- Moving parts are correctly adjusted and have appropriate clearances
- The system functions in line with the specification requirements
- The system is leak free.

Learning outcome

The learner will:

2 Know how to assemble and test fluid power systems

Assessment criteria

The learner can:

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

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

2.3 Describe the hazards associated with carrying out assembly activities on fluid power equipment and how these can be minimised

2.4 Explain how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, symbols used in fluid power, and other documents needed in the assembly activities

2.5 Explain how to use and extract information from engineering drawings and related specifications, including symbols and conventions to appropriate BS or ISO standards in relation to work undertaken

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

2.7 Describe the basic principles of how the fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

2.8 Describe the different types of pipework, fittings and manifolds, and their application

2.9 Identify different types of valve and describe their application

2.10 Identify different types of sensors and actuators and describe their application

2.11 Identify different types of cylinder and describe their application

2.12 Identify different types of pump and describe their application

2.13 Identify different types compressors and describe their application

2.14 Describe the application and fitting of static and dynamic seals

2.15 Describe the techniques used to assemble/install fluid power equipment

2.16 Describe the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections

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

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

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

2.20 Explain how to make safety checks of the system before carrying out tests, to ensure that all pipes and components are secure and that moving parts are chocked or parked

2.21 Explain how to connect suitably calibrated test equipment into the circuit, and how to connect the circuit to a suitable pressure source containing appropriate ancillary equipment

2.22 Explain how to carry out the tests

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

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

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

2.26 Explain how to check that tools and test equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose

2.27 Describe the problems associated with the fluid power assembly and testing activity, and how they can be overcome

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

2.29 Describe the importance of leaving the work area in a safe and clean condition on completion of the assembly activities.

Unit 234 Assembling and testing fluid power systems

Supporting Information

Evidence requirements

In order to prove their ability to combine different fluid power assembly operations, at least one of the fluid power assemblies produced must be of a significant nature, and must contain a minimum of six of the components listed in 1.12.

Unit 235 General turning, milling and welding applications

Unit level:	Level 2
GLH:	55
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to apply turning, milling and welding applications.
Relationship to NOS:	EUCL2F-019

Learning outcome

The learner will:

1 Apply turning, milling and welding applications

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines when turning, milling and welding

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

1.3 Ensure that all hand tools and equipment used are in a safe and serviceable condition and electrically safe condition

1.4 Ensure that all machine tools are correctly guarded at all times

1.5 Check that all measuring equipment is within calibration date

1.6 Return all tools and equipment to the correct location on completion of the fabrication activities

1.7 Plan turning, milling and welding activities

1.8 Obtain and prepare the appropriate materials, tools, equipment and consumables for turning, milling and welding

1.9 Grind lathe tools and drills to meet the required component specification

1.10 Mount and set the required turning and milling workholding devices, workpiece and cutting tools

1.11 Set and adjust the turning and milling machine tool speeds and feeds to achieve the component specification

1.12 Use the turning and milling machine tool controls safely and correctly, in line with operational procedures

1.13 Carry out turning operations

1.14 Carry out milling operations

1.15 Carry out checks for accuracy of machining operations

1.16 Use measurement equipment for machining operations
1.17 Produce machined components to standard
1.18 Prepare and support the joint, using the appropriate methods
1.19 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
1.20 Produce welded joints in good access situations
1.21 Carry out checks of the welded joint against specification
1.22 Carry out testing of the welds
1.23 Produce welded joints to meet requirements
1.24 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
1.25 Shut down the equipment to a safe condition on completion of the machining and welding activities

Range

(AC1.10) **Workholding:**

Use four of the following:

- Three-jaw chuck
- Collet chuck
- Four-jaw chuck
- Machine vice
- Clamping direct to milling machine table
- Indexing device
- Other work holding/supporting methods.

(AC1.13) **Turning operations:**

- Facing off
- Producing chamfers
- Producing tapered diameters
- Producing parallel diameters
- Centre drilling and drilling a hole
- Producing stepped diameters
- Reaming or boring a hole
- Producing and/or maintaining internal and external threads
- Producing grooves/undercuts
- Producing radii
- Parting off
- Knurling.

(AC1.14) **Milling operations:**

- Producing flat and square faces
- Producing an enclosed slot
- Producing parallel faces
- Producing an open ended slot
- Producing angular faces
- Centre drilling and drilling a hole
- Reaming a hole
- Producing a tapped hole.

(AC1.15) **Checks for accuracy:**

- Linear dimensions
- Internal/external diameters
- Hole size and position
- Thread size and fit
- Squareness
- Angles
- Parallelism
- Surface finish.

(AC1.16) **Measurement equipment:**

- External micrometers
- Vernier/digital/dial calliper
- Protractors
- Dial test indicators (DTI)
- Squares.

Plus four of the following:

- Rules
- Bore/hole gauges
- Slip gauges
- Radius/profile gauges
- Depth micrometers
- Thread gauges
- Depth Verniers
- Feeler gauges
- Surface finish equipment
- Coordinate measuring machine (CMM).

(AC1.17) **Standards:**

- Components to be free from false tool cuts, burrs and sharp edges
- General dimensional tolerance +/- 0.25mm or +/- 0.010"
- There must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004"
- Flatness and squareness 0.05mm per 25mm or 0.002" per inch
- Angles within +/- 0.5 degree
- Screw threads to BS Medium fit
- Reamed holes within H8
- Surface finish 63µin; 1.6 µm.

(AC1.20) **Welded joints:**

Produce two of the following welded joints of at least 150mm long, with at least one stop and start included:

- Fillet lap joints
- Corner joints
- Tee fillet joints
- Butt joints.

(AC1.20) **Good access situations:**

Weld joints in two of the following BS EN ISO 6947 positions:

- Flat (PA)
- Vertical upwards (PF)

- Horizontal vertical (PB)
- Vertical downwards (PG)
- Horizontal (PC).

(AC1.21) **Checks:**

- Dimensional accuracy
- Size and profile of weld
- Alignment/squareness.

(AC1.22) **Tests:**

Use one of the following tests:

- Dye or fluorescent penetrant
- Nick break test
- Bend tests.

(AC1.23) **Requirements:**

Reference to BS 4872 Part 1 Weld test requirements as applicable to the weld being produced:

- Welds meet the required dimensional accuracy
- Fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
- The weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
- The welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- Joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- Tack welds are blended in to form part of the finished weld, without excessive hump
- The weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- The weld surface and adjacent parent metal is substantially free from arcing or chipping marks.

Learning outcome

The learner will:

2 Understand how to apply turning, milling and welding operations

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the turning, milling and welding activities undertaken

2.2 Describe the hazards associated with the activities and how they can be minimised

2.3 Describe how to extract and use information from engineering drawings and related specifications, including symbols and conventions to appropriate BS or ISO standards, in relation to work undertaken

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

2.5 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the machining and welding activities

2.6 Describe methods of holding the workpiece for the turning and milling activities

2.7 Describe the various turning operations that can be performed

2.8 Describe the various milling operations that can be performed

2.9 Describe how to mount and secure the cutting tools in the tool holding devices

2.10 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy

2.11 Describe factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken

2.12 Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used

2.13 Describe how to check the workpiece and the measuring equipment that is used

2.14 Describe the need to check that the measuring equipment is within current calibration dates, and

2.15 Describe how instruments are correctly zeroed

2.16 Describe how to check surface finish

2.17 Describe how to measure geometric features and internal and external diameters

2.18 Describe problems that can occur with the turning and milling activities and how these can be overcome

2.19 Describe the correct handling and storage of gas cylinders

2.20 Describe the general principles of the type of welding process being undertaken

2.21 Describe power sources requirements

2.22 Describe the major parts of the welding equipment

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

2.24 Describe the types of welded joints to be produced

2.25 Define terminology used for the appropriate welding positions

2.26 Describe how to prepare the materials in readiness for the welding activity

2.27 Describe how to set up and restrain the joint, and the tools and techniques to be used

2.28 Describe the appropriate tack welding size and spacing

2.29 Describe checks to be made prior to welding

2.30 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions

2.31 Describe problems that can occur with the welding activities and how these can be overcome

2.32 Describe how to safely prepare the welds for examination

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

2.34 Describe the various procedures for both visual examination and testing of the welds

2.35 Describe how to identify and check for weld defects

2.36 Explain when to act on your own initiative and when to seek help and advice from others.

Unit 235 General turning, milling and welding applications

Supporting Information

Evidence requirements

Turning

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **nine** of the features listed in 1.13.

Milling

In order to prove their ability to combine different milling features, at least one of the components produced must be of a significant nature, and must have a minimum of **eight** of the features listed in paragraph 5 in 1.14.

Welding

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

Unit 236 General welding applications

Unit level:	Level 2
GLH:	55
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed for general welding applications.
Relationship to NOS:	EUCL2F-043

Learning outcome

The learner will:

1 Carry out welding activities

Assessment criteria

The learner can:

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

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

1.3 Check the condition of, and correctly connect, welding leads, earthing arrangements, electrode holder, welding gun / torch, hoses, shielding gas, and wire feed mechanisms

1.4 Set and adjust the welding conditions/parameters, in accordance with the welding procedure specification

1.5 Prepare the work area for the welding activities

1.6 Prepare the materials and joint in readiness for welding

1.7 Ensure that the work area is maintained and left in a safe and tidy condition

1.8 Plan welding activities

1.9 Tack weld joints at appropriate intervals

1.10 Produce welded joints from different types and forms of materials in good access situations using a welding process

1.11 Identify weld defects

1.12 Check the quality of the weld is to specification

1.13 Produce welds to meet quality standards

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

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

1.16 Leave the work area in a safe and tidy condition on completion of the manufacturing activities.

Range

(AC1.10) **Welding process:**

Use one of the following:

- Manual metal-arc (MMA)
- MIG/MAG/Flux Cored Arc
- TIG/Plasma Arc.

(AC1.10) **Welded joints:**

Produce two of the following joints of at least 150mm long with a minimum of one stop and start:

- Fillet lap joints
- Tee fillet joints
- Butt

Plus the following:

- Corner joint.

(AC1.10) **Types of material:**

Use one of the following:

- Carbon steel
- Stainless steel.

(AC1.10) **Forms of material:**

Use one of the following:

- Sheet (less than 3mm)
- Pipe/tube
- Plate
- Other forms
- Section.

(AC1.10) **Good access situations:**

Weld joints in three of the following BS-EN-ISO-6947 positions:

- Flat (PA)
- Vertical upwards (PF)
- Horizontal vertical (PB)
- Vertical downwards (PG)
- Horizontal (PC).

(AC1.11) **Weld defects:**

- Lack of continuity of the weld
- Uneven and irregular ripple formation
- Incorrect weld size or profile
- Undercutting
- Overlap
- Lack of fusion
- Porosity
- Lack of penetration

Plus one of the following:

- Surface cracks
- Internal cracks
- Inclusions.

(AC1.13) **Quality standards:**

BS4872 Part 1 Weld test requirements:

- Welds are adequately fused and have a uniform profile, free from excessive undulations, with regular and even ripple formation
- The weld surface is free from cracks and substantially free from porosity, shrinkage cavities and trapped slag
- Joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- Tack welds are blended in to form part of the finished weld, without excessive hump.

Learning outcome

The learner will:

2 Know how to carry out welding activities

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements, and safe working practices and procedures required for the welding activities undertaken

2.2 Describe the personal protective clothing and equipment (PPE) to be worn when carrying out the welding and the importance of keeping the work area safe and tidy

2.3 Describe the hazards associated with welding activities and how they can be minimised

2.4 Describe the correct handling and storage of gas cylinders

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

2.6 Describe how to extract and use information from engineering drawings and related specifications in relation to work undertaken

2.7 Describe the manual welding process

2.8 Describe the types of welded joints to be produced

2.9 Describe the types, selection and application of filler wires and welding electrodes

2.10 Explain the reasons for using shielding gases, the types and application of the various gases and the importance of ensuring correct gas pressures and flow rates

2.11 Define the terminology used for the appropriate welding positions

2.12 Describe how to prepare the materials in readiness for the welding activity by ensuring that they are free from excessive surface contamination

2.13 Explain why the edges to be welded need to be correctly prepared

2.14 Describe how to set up and restrain the joint, and the tools and techniques to be used

2.15 Describe checks to be made prior to welding

2.16 Describe tack welding size and spacing

2.17 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions

2.18 Describe methods/modes of metal transfer and their uses

2.19 Explain how to control distortion

2.20 Explain problems that can occur with the welding activities and how these can be overcome

2.21 Describe how to close down the welding equipment safely and correctly

2.22 Describe the safe working practices and procedures to be adopted when preparing the welds for examination

2.23 Describe how to prepare the welds for examination

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

2.25 Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions

2.26 Describe the various procedures for carrying out destructive tests on the welds

2.27 Describe methods of removing a specimen of weld from a suitable position in the joint using a non-thermal process

2.28 Describe how to examine the welds after the tests and how to check for such defects as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

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

2.30 Explain the importance of leaving the work area and equipment in a safe condition on completion of the welding activities.

Unit 236 General welding applications

Supporting Information

Unit guidance

2.6 To include symbols and conventions to appropriate BS or ISO standards.

Unit 237 Preparing and using semi-automatic MIG, MAG and flux cored arc welding equipment

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use semi-automatic MIG, MAG and flux cored arc welding equipment.
Relationship to NOS:	EUCL2F-015

Learning outcome

The learner will:

1 Prepare and use semi-automatic MIG, MAG and flux cored arc welding equipment

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 Plan the welding activities
1.4 Obtain and prepare the appropriate welding equipment and welding consumables
1.5 Check the condition of welding equipment and welding consumables
1.6 Correctly connect welding equipment and welding consumables
1.7 Set and adjust the welding conditions/parameters, in accordance with the welding procedure specification
1.8 Prepare the work area for the welding activities
1.9 Prepare the materials and joint in readiness for welding
1.10 Prepare and support the joint, using the appropriate methods
1.11 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
1.12 Produce welded joints in good access situation
1.13 Use appropriate methods and equipment to check the quality
1.14 Ensure that all dimensional and geometrical aspects of the weld are to the specification requirements
1.15 Carry out tests on welds
1.16 Identify weld defects
1.17 Make sure the work area is maintained and left in a safe and tidy condition

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

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

Range

(AC1.6) **Consumables:**

- Solid wire
- Cored wire

Plus one of the following types of shielding gases:

- Inert
- Active.

(AC1.12) **Welded joints:**

Produce three of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included:

- Fillet lap joints
- Corner joints
- Tee fillet joints
- Butt joints.

(AC1.12) **Good access situations:**

Weld joints in two of the following BS EN ISO 6947:2011 positions:

- Flat (PA)
- Vertical upwards (PF)
- Horizontal vertical (PB)
- Vertical downwards (PG)
- Horizontal (PC).

(AC1.14) **Specification requirements:**

- Dimensional accuracy
- Size and profile of weld
- Number of runs
- Alignment/squareness.

(AC1.14) **Requirements:**

Reference to BS 4872 Part 1:1982 Weld test requirements as applicable to the weld being produced:

- Welds meet the required dimensional accuracy
- Fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
- The weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
- The welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- Joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- Tack welds are blended in to form part of the finished weld, without excessive hump
- Corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint

- The weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- The weld surface and adjacent parent metal is substantially free from arcing or chipping marks.

(AC1.15) **Non-destructive tests:**

Using one of the following non-destructive tests:

- Dye penetrant
- Fluorescant penetrant
- Magnetic particle.

(AC1.15) **Destructive tests:**

Using one of the following destructive tests:

- Macroscopic examination
- Nick break test
- Bend tests.

(AC1.16) **Weld defects:**

- Lack of continuity of the weld
- Uneven and irregular ripple formation
- Incorrect weld size or profile.

Plus four of the following:

- Undercutting
- Internal cracks
- Overlap
- Surface cracks
- Inclusions
- Lack of fusion
- Porosity
- Lack of penetration.

Learning outcome

The learner will:

2 Understand how to prepare and use semi-automatic MIG, MAG and flux cored arc welding equipment

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using MIG, MAG or flux cored wire arc welding equipment

2.2 Describe the hazards associated with MIG, MAG or flux cored-wire arc welding and how they can be minimised

2.3 Describe the personal protective equipment to be worn for the welding activities

2.4 Describe the correct handling and storage of gas cylinders

2.5 Describe how to use and extract information from engineering drawings and related specifications including symbols and conventions to appropriate BS or ISO standards, in relation to work undertaken

2.6 Describe the semi-automatic MIG, MAG or flux cored wire arc welding processes

2.7 Describe types, selection and application of electrode wires
2.8 Describe reasons for using shielding gases, and the types and application of the various gases
2.9 Describe gas pressures and flow rates in relation to the type of material being welded
2.10 Describe the types of welded joints to be produced
2.11 Define terminology used for the appropriate welding positions
2.12 Describe how to prepare the materials in readiness for the welding activity
2.13 Describe how to set up and restrain the joint, and the tools and techniques to be used
2.14 Describe tack welding size and spacing in relation to material thickness
2.15 Describe checks to be made prior to welding
2.16 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions
2.17 Describe methods/modes of metal transfer and their uses
2.18 Describe how to close down the welding equipment safely and correctly
2.19 Describe problems that can occur with the welding activities how to control distortion
2.20 Describe the safe working practices and procedures to be adopted when preparing the welds for examination
2.21 Describe how to prepare the welds for examination
2.22 Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
2.23 Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions
2.24 Describe the various procedures for carrying out destructive tests on the welds
2.25 Describe methods of removing a specimen of weld from a suitable position in the joint
2.26 Describe how to examine the welds after the tests and to check for defects
2.27 Explain when to act on your own initiative and when to seek help and advice from others
2.28 Describe the importance of leaving the work area and equipment in a safe condition on completion of the welding activities.

Unit 238 Preparing and using manual TIG or plasma arc welding equipment

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to prepare and use manual TIG or plasma arc welding equipment.
Relationship to NOS:	EUCL2F-042

Learning outcome

The learner will:

1 Prepare and use manual TIG or plasma arc welding equipment

Assessment criteria

The learner can:

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

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

1.3 Plan the welding activities

1.4 Obtain and prepare the appropriate welding equipment and welding consumables

1.5 Check the condition of welding equipment and welding consumables

1.6 Connect welding equipment and welding consumables

1.7 Set and adjust the welding conditions/parameters, in accordance with the welding procedure specification

1.8 Prepare the work area for the welding activities

1.9 Prepare the materials and joint in readiness for welding

1.10 Prepare and support the joint, using the appropriate methods

1.11 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding

1.12 Produce welded joints in good access situations to meet requirements

1.13 Check welded joints conform to specification

1.14 Carry out tests on welds

1.15 Identify weld defects

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

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

Range

(AC1.12) **Welded joints:**

Produce three of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included:

- Fillet lap joints
- Corner joints
- Tee fillet joints
- Butt joints.

Using one of the following methods:

- With wire filler
- Without wire filler (autogenously).

(AC1.12) **Good access situations:**

Weld joints in good access situations, in two of the following BS EN ISO 6947:2011 positions:

- Plat (PA)
- Vertical upwards (PF)
- Horizontal vertical (PB)
- Vertical downwards (PG)
- Horizontal (PC).

(AC1.13) **Requirements:**

Produce welded joints which meet all of the following (with reference to BS 4872:1982 Part 1 Weld test requirements):

- Welds meet the required dimensional accuracy
- Fillet welds are equal in leg length and slightly convex in profile (where applicable), with the size of the fillet equivalent to the thickness of the material welded
- The weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
- The welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- Weld finishes are built up to the full section of the weld
- Joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
- Tack welds are blended in to form part of the finished weld, without excessive hump
- Corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3mm for at least 75% of the joint
- The weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
- The weld surface and adjacent parent metal is substantially free from arcing or chipping marks.

(AC1.13) **Specification:**

- Dimensional accuracy
- Size and profile of weld
- Number of runs
- Alignment/squareness.

(AC1.14) **Destructive tests:**

Use one of the following tests:

- Macroscopic examination
- Nick break tests
- Bend tests.

(AC1.14) **Non-destructive tests:**

Use one of the following tests:

- Dye penetrant
- Fluorescent penetrant
- Magnetic particle.

(AC1.15) **Weld defects:**

- Lack of continuity of the weld
- Uneven and irregular ripple formation
- Incorrect weld size or profile

Plus four of the following:

- Undercutting
- Internal cracks
- Overlap
- Surface cracks
- Inclusions
- Lack of fusion
- Porosity
- Lack of penetration.

Learning outcome

The learner will:

2 Understand how to prepare and use manual TIG or plasma arc welding equipment

Assessment criteria

The learner can:

2.1 Describe the safe working practices and procedures to be followed when preparing and using TIG or plasma-arc welding equipment

2.2 Describe the hazards associated with TIG and plasma-arc welding and how they can be minimised

2.3 Describe the personal protective equipment to be worn for the welding activities

2.4 Describe the correct handling and storage of gas cylinders

2.5 Describe how to use and extract information from engineering drawings and related specifications, including symbols and conventions to appropriate BS or ISO standards in relation to work undertaken

2.6 Describe the manual TIG or plasma-arc welding process

2.7 Describe types, selection and application of filler wires and welding electrodes

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

2.9 Describe gas pressures and flow rates in relationship to the type of material being welded

2.10 Describe the types of welded joints to be produced

2.11 Define terminology used for the appropriate welding positions

2.12 Describe how to prepare the materials in readiness for the welding activity
2.13 Describe how to set up and restrain the joint, and the tools and techniques to be used
2.14 Describe tack welding size and spacing
2.15 Describe checks to be made prior to welding
2.16 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions
2.17 Describe how to control distortion
2.18 Describe problems that can occur with the welding activities
2.19 Describe how to close down the welding equipment safely and correctly
2.20 Describe the safe working practices and procedures to be adopted when preparing the welds for examination
2.21 Describe how to prepare the welds for examination
2.22 Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
2.23 Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions
2.24 Describe the various procedures for carrying out destructive tests on the welds
2.25 Describe methods of removing a specimen of weld from a suitable position in the joint using a non-thermal process
2.26 Describe how to examine the welds after the tests and how to check for defects
2.27 Explain when to act on their own initiative and when to seek help and advice from others

Unit 239 Carrying out heat treatment of engineering materials

Unit level:	Level 2
GLH:	41
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to carry out heat treatment of engineering materials.
Relationship to NOS:	EUCL2F-037

Learning outcome

The learner will:

1 Carry out heat treatment of engineering materials

Assessment criteria

The learner can:

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

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

1.3 Follow job instructions and heat treatment process specifications and procedures

1.4 Ensure that the equipment is correctly prepared for the heat treatment operations being performed

1.5 Store all tools and equipment on completion of the heat treatment activities

1.6 Dispose of waste and excess materials, in line with agreed organisational procedures

1.7 Carry out heat treatment processes

1.8 Apply heat treatments to different types of material

1.9 Prepare the components for the heat treatment activities

1.10 Plan the heat treatment activities

1.11 Use different methods of heating components

1.12 Use different methods of quenching/cooling the materials

1.13 Carry out the heat treatment activities

1.14 Carry out checks and tests on the heat treated components

1.15 Ensure heat treatment processes comply with requirements

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

1.17 Shut down the heat treatment equipment to a safe condition on completion of the activities

1.18 Leave the work area in a safe condition on completion of the heat treatment activities.

Range

(AC1.7) **Heat treatment processes:**

Carry out three of the following processes:

- Flame hardening
- Carburising
- Annealing
- Case hardening
- Tempering
- Normalising/stress relieving.

(AC1.8) **Types of material:**

Use two of the following:

- Low carbon steel
- High carbon steel
- Silver/tool steel
- Chilled cast iron
- Welded fabrications
- Copper
- Other materials.

(AC1.9) **Prepare:**

Carry out two of the following:

- Removing scale
- Degreasing/cleaning
- Masking
- Polishing area to be tempered
- Pre-heating.

(AC1.11) **Methods of heating the components:**

Use two of the following:

- Furnace
- Blacksmith's forge
- Gas torches
- Salt/chemical baths.

(AC1.12) **Methods of quenching/cooling:**

Use two of the following:

- Fresh water
- Salt water
- Oil
- Air
- Sand
- Leave in the furnace to cool.

(AC1.13) **Heat treatment activities:**

- Light up the furnace/forge or torch, using approved procedures
- Set the equipment to maintain the correct conditions
- Check that the components are correctly prepared for the required heat treatment activities
- Check that there is sufficient cooling medium
- Load the components safely into the heat source/solution

- Ensure that components are left for the required induction period
- Remove the components from the heat source/solution safely and correctly
- Quench/cool the components, using the appropriate medium and technique.

(AC1.14) **Checks and tests:**

Use two of the following:

- Visual checks for cracks or distortion
- NDT tests
- Simple physical checks to confirm that hardening or annealing has been achieved
- Specific hardness tests.

(AC1.15) **Requirements:**

- The final heat treated material is in line with the specification or job requirements
- The heat treated material is free from defects
- The heat treatment process meets customer/company requirements.

Learning outcome

The learner will:

2 Know how to carry out heat treatment of engineering materials

Assessment criteria

The learner can:

2.1 Describe the specific health and safety precautions which must be taken when carrying out heat treatment processes

2.2 Describe the hazards associated with carrying out heat treatment processes and how they can be minimised

2.3 Describe the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition

2.4 Explain the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

2.5 Explain the importance of following job instructions and defined heat treatment procedures

2.6 Describe how to obtain the required information on heat treatment temperatures, tempering colours, soak times and quenching/cooling methods to be used

2.7 Describe the various types of material that can be flame hardened, case hardened, tempered, normalised and annealed

2.8 Describe the material preparation methods and techniques to be undertaken prior to applying the heat treatments

2.9 Describe the specific heat treatment process to be carried out, and the types of application for which they are best suited

2.10 Describe the basic principles of operation of the specific heat treatment process being carried out

2.11 Describe how to prepare the equipment for the heat treatment activities

2.12 Explain the visual checks to be made on the components prior to carrying out the surface treatment activities

2.13 Explain the need to make certain that all components and jigs are completely free of water or other solvents prior to immersing them in a hot solution, and the potential consequences of failing to check this

2.14 Describe the methods used to hold/secure components in a heat treatment solution

2.15 Describe the importance of monitoring the equipment settings and process solutions during the heat treatment process

2.16 Explain how to heat the components to the correct temperature for the process being carried out and why these must be adhered too

2.17 Describe the quenching and cooling methods to be used

2.18 Describe the need to maintain quenching oil at a temperature below its flash point

2.19 Explain how to check the finished work after heat treatment

2.20 Describe the problems that can occur with the heat treatment operations, and how these can be overcome

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

2.22 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the heat treatment activities.

Unit 240 Wiring and testing vehicle electrical equipment and circuits

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to wire and test vehicle electrical equipment/systems.
Relationship to NOS:	EUCL2F-025

Learning outcome

The learner will:

1 Wire and test vehicle electrical equipment and circuits

Assessment criteria

The learner can:

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

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

1.3 Ensure the safe isolation of services during the wiring and testing activities

1.4 Follow job instructions, circuit drawings and test procedures

1.5 Plan the wiring and testing activities

1.6 Use appropriate sources to obtain the required specifications, circuit diagrams and test information

1.7 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition

1.8 Check that tools and test instruments to be used are within calibration date, and are in a safe and usable condition

1.9 Ensure that the electrical system is kept free from foreign objects, dirt or other contamination

1.10 Apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards

1.11 Wire circuits using different types of cable

1.12 Connect electrical modules/components to produce circuits

1.13 Apply wiring methods and techniques to electrical systems

1.14 Carry out cable termination activities

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

1.16 Carry out checks and adjustments, appropriate to the equipment and circuits being wired

1.17 Produce electrical circuits that meet standards

1.18 Return all tools and equipment to the correct location on completion of the wiring and testing activities

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

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

Range

(AC1.11) **Types of cable:**

Use six of the following:

- Single core
- Multicore
- PVC twin and earth
- Armoured
- Flexible
- Data/communication
- Ribbon
- Fibre-optics
- Screened
- Coaxial
- Wiring loom/harness.

(AC1.11) **Electrical modules/components:**

Connect eighteen of the following:

- Isolators
- Fuses
- Starter motors
- Transformers
- Circuit breakers
- Overloads
- Cable connectors
- Switches
- Lamp holders
- Sockets
- Panel lamps
- Lighting
- Sensors
- Actuators
- Solenoids
- Relays terminal blocks
- Alarm devices
- Instruments
- Electronic modules/units
- Control device
- Pumps
- Heaters

- Other electrical components.

(AC1.13) **Wiring methods and techniques:**

- Positioning and securing of equipment and components
- Levelling and alignment of components
- Determining and calculating current rating and lengths of cables required
- Securing by using mechanical fixings
- Laying in cables without twisting or plaiting
- Feeding cables into conduit without twisting or plaiting
- Leaving sufficient slack for termination and movement.

(AC1.13) **Electrical systems:**

Wire up six of the following:

- Vehicle lighting circuits
- Vehicle air conditioning control circuits
- Vehicle heating or ventilating
- Power generation and control circuits
- Vehicle starting and ignition systems
- Instrumentation and control systems
- Communication systems
- Electro-pneumatic or electro-hydraulic control circuits
- Computer systems
- Other vehicle control circuits
- Other specific electrical circuits.

(AC1.14) **Cable termination activities:**

Carry out nine of the following:

- Stripping cable sheaths without damage to conductor insulation
- Terminating cables
- Removing cable insulation
- Sealing/protecting cable connections
- Connecting accessories
- Attaching suitable cable identification
- Making mechanical/screwed/clamped connections
- Soldering and de-soldering
- Crimping
- Securing wires and cables
- Terminating armoured cables
- Heat shrinking
- Earthing and bonding.

(AC1.15) **Test equipment:**

- Multimeter
- Other specific test/proving equipment.

(AC1.16) **Checks:**

- Visual
- Movement
- Equipment operates to specification
- Fault finding techniques

Plus six of the following checks/tests:

- Power rating

- Load current
- Insulation resistance values
- Polarity
- Frequency values
- Continuity
- Resistance
- Inductance
- Voltage levels
- Capacitance
- Specialised tests.

(AC1.17) **Standards:**

- BS and/or ISO standards
- Company standards and procedures.

Learning outcome

The learner will:

2 Understand how to wire and test vehicle electrical equipment and circuits

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that need to be observed when wiring and testing electrical equipment

2.2 Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used and how they can be minimised

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

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

2.5 Describe how to reduce the risks of a line to earth shock

2.6 Describe the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications, including BS and ISO schematics, wiring regulations, symbols and terminology

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

2.8 Describe the different types of cabling and their application

2.9 Describe the application and use of circuit protection equipment the application and use of a range of electrical components

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

2.11 Describe how to check that components meet the required specification/operating conditions

2.12 Describe methods of mounting and securing electrical equipment/components to various surfaces

2.13 Describe how to check that the positions selected for mounting the components do not interfere with or damage existing vehicle systems

2.14 Describe methods of laying in or drawing cables into conduit and the need to ensure the cables are not twisted or plaited

2.15 Describe the techniques used to terminate electrical equipment

2.16 Describe the use of wiring regulations when selecting wires and cables and when carrying out tests on systems

2.17 Describe methods of attaching markers/labels to components or cables to assist with identification

2.18 Describe the tools and equipment used in the wiring and testing activities

2.19 Explain why equipment is checked so that it is electrically safe and the implications if this is not undertaken

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

2.21 Explain the importance of conducting inspections and checks before connecting to the supply

2.22 Describe the care, handling and application of electrical test and measuring instruments

2.23 Describe how to apply approved test procedures and the safe working practices and procedures required

2.24 Describe how to identify suitable test points within the circuit, and the need to use suitably fused test probes and clips

2.25 Describe how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment

2.26 Describe how to set the instrument's zero readings

2.27 Describe how to obtain instrument readings and compare them with circuit parameters

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

2.29 Describe the fault-finding techniques to be used if the equipment fails to operate correctly

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

2.31 Describe the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities.

Unit 240 Wiring and testing vehicle electrical equipment and circuits

Supporting Information

Evidence requirements

In order to prove their ability to combine different electrical assembly and wiring activities, at least one of the electrical assemblies produced must be of a significant nature, and must contain a minimum of **five** of the components listed in 1.12 plus **five** of the activities listed in 1.14.

Unit 241 Maintaining vehicle electrical equipment/systems

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to maintain vehicle electrical equipment/systems.
Relationship to NOS:	EUCL2F-026

Learning outcome

The learner will:

1 Maintain vehicle electrical equipment/systems

Assessment criteria

The learner can:

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

1.2 Plan the maintenance activities, in conjunction with others involved, so as to minimise disruption to the vehicle preparation

1.3 Obtain all the information they need for the vehicle electrical maintenance activities to be carried out

1.4 Adhere to risk assessment, COSHH and other relevant safety standards

1.5 Ensure the safe isolation of equipment

1.6 Ensure that safe working arrangements have been provided for the maintenance area

1.7 Carry out maintenance activities on vehicle sub-systems

1.8 Replace and/or repair vehicle electrical components

1.9 Maintain vehicles to required standards

1.10 Report any instances where the maintenance activities cannot be fully met, or where there are identified defects outside the planned schedule

1.11 Use the evidence they have gained to during maintenance activities to improve future reliability and performance of the vehicle

1.12 Complete the relevant maintenance records accurately, and pass them on to the appropriate person

1.13 Re-connect and return the equipment to service on completion of activities

1.14 Dispose of waste items in a safe and environmentally acceptable manner, and leave the work area in a safe and tidy condition

Range

(AC1.7) **Vehicles:**

Carry out maintenance of electrical equipment on two of the following types of vehicle:

- Front wheel drive
- Rear wheel drive
- Four wheel drive
- Hybrid
- Other specific approved vehicle.

(AC1.7) **Vehicle sub-systems:**

Carry out maintenance activities on six of the following:

- Charging systems
- Lighting systems
- Data acquisition systems
- Instrumentation, indication and warning systems
- Direct current power supply system
- Electrical control system
- Auxiliary motorsport vehicle power supply system
- Safety and emergency system
- Air conditioning
- ABS braking system.

(AC1.7) **Maintenance activities:**

- Isolating the equipment
- Disconnecting and reconnecting wires and looms
- Attaching suitable cable identification markers
- Removing electrical units/components
- Checking components for serviceability
- Replacing damaged/defective components
- Removing and replacing damaged wires and looms
- Setting and adjusting replaced components
- Making 'continuity' checks before powering up
- Functionally testing the maintained equipment
- Examining wiring looms for chafing, dislodging, correct routeing, protection in hazardous areas.

(AC1.8) **Vehicle electrical components:**

Replace and/or repair fourteen of the following:

- Looms and connectors
- Capacitors
- Batteries
- Locking and retaining devices
- Circuit boards
- Solenoids
- Overload protection devices
- Lighting components
- Thermistors or thermocouples
- Pickup sensors
- Electrical switches or sensors

- Starter motors
- Relay components
- Manual switches
- Transmitter beacons
- Potentiometers
- Other specific vehicle related components

(AC1.9) **Standards:**

In compliance with three of the following:

- BS or ISO standards and procedures
- Vehicle manufacturer's specification
- Company standards and procedures
- Specific system requirements.

(AC1.12) **Records:**

Complete three of the following:

- Job cards
- Computer records
- Company specific documentation
- Formal risk assessment
- Vehicle maintenance logs or reports.

Learning outcome

The learner will:

2 Understand how to maintain vehicle electrical equipment/systems

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that they need to observe when carrying out electrical maintenance activities on vehicles

2.2 Describe the hazards associated with removing and replacing vehicle electrical components, and with the tools and equipment used and how they can be minimised

2.3 Describe the protective equipment that needs to be used for both personal protection and protection of the vehicle

2.4 Describe the importance of good housekeeping within the working area

2.5 Describe how to use and extract information from vehicle documentation

2.6 Describe the importance of ensuring that the correct and up-to-date documentation is used

2.7 Describe the basic principles of how the vehicle electrical equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

2.8 Describe the different types of cabling and their application as used on vehicles

2.9 Describe the care, handling and application of electrical measuring instruments

2.10 Describe the techniques used to dismantle/assemble electrical equipment

2.11 Describe the various types of electrical connectors that are used,

2.12 Describe methods of unlocking, orientation indicators and locating and locking in of the connections

2.13 Describe methods of removing and replacing cables, wires and looms without causing damage to existing cabling or other vehicle components

2.14 Describe the use of BS/ISO wiring and other regulations when selecting wires and cables, and when carrying out tests on systems

2.15 Describe methods of attaching identification markers/labels to removed components or cables to assist with re-assembly

2.16 Describe the tools and equipment used in the maintenance activities

2.17 Describe methods of checking that components are fit for purpose, and the need to replace `lifed' items

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

2.19 Describe how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are set up correctly for the intended purpose

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

2.21 Describe the equipment operating and control procedures to be applied during the maintenance activity

2.22 Describe how to use appropriate lifting and handling equipment techniques in the maintenance activity

2.23 Describe the problems that can occur during the maintenance activity, and how they can be overcome

2.24 Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation

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

2.26 Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the maintenance activities.

Range

(AC2.1) **Safety practices and procedures:**

- Lifting and handling techniques
- Safe working practices with regard to removing components from vehicles
- Procedures which satisfy current regulations.

Unit 242 Diagnosing and rectifying faults on vehicle systems

Unit level:	Level 2
GLH:	68
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to diagnose and rectify faults on vehicle systems.
Relationship to NOS:	EUCL2F-027

Learning outcome

The learner will:

1 Diagnose and rectify faults on vehicle systems

Assessment criteria

The learner can:

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

1.2 Obtain and use all the relevant information on the symptoms and problems associated with the vehicle

1.3 Carry out fault diagnostic activities resulting in breakdown on different types of vehicle

1.4 Assist in the collection of evidence regarding faults

1.5 Assist in carrying out fault diagnostic techniques

1.6 Rectify faults in vehicle systems using different rectification activities

1.7 Carry out monitoring procedures to help diagnose and check that the faults have been rectified

1.8 Ensure that any stored energy or substances are released safely and correctly

1.9 Report any instances where the removal and replacement activities cannot be fully met, or where there are identified defects outside the planned activities

1.10 Complete the relevant documentation, in accordance with organisational requirements

1.11 Clean the work area and dispose of waste materials and defective components, in accordance with safe working practices and approved procedures.

Range

(AC1.3) **Fault diagnostic activities:**

- Carry out all preparatory work
- Check for obvious signs of damage
- Check for excessive wear or play

- Check for leaks on seals, gaskets, bushes, controls and pipe fittings
- Check the condition and security of suspension and drive components
- Check the condition of tyres
- Check for metallic particles in lubricants.

(AC1.3) **Types of vehicle:**

Assist in diagnosing faults on two of the following types of vehicle:

- Front wheel drive
- Rear wheel drive
- Four wheel drive
- Hybrid
- Other specific approved vehicle.

(AC1.3) **Faults that have resulted in two of the following breakdown categories**:

- Intermittent problem
- Partial failure
- Complete breakdown.

(AC1.4) **Collection of evidence:**

Collect evidence from six of the following sources:

- System diagrams
- Maintenance/history records
- Vehicle/equipment manuals
- Discussion with user/team member
- Data logging
- Monitoring equipment
- Test instruments
- Fault analysis charts
- Equipment self-diagnostics
- Troubleshooting guides.

(AC1.5) **Fault diagnostic techniques:**

Assist in carrying out six of the following:

- Function testing
- Half-split
- Unit substitution
- Input/output
- Sensory input
- Taking measurements and readings.

(AC1.6) **Rectify faults:**

- Engine
- Steering
- Transmission
- Fuel
- Chassis
- Lubrication
- Wheel braking
- Cooling
- Suspension
- Electrical.

(AC1.6) **Rectification activities:**

To include seven of the following:

- Removing and replacing electrical connections
- Removing and replacing mechanical fasteners
- Removing and replacing hoses and pipes
- Replacing faulty and or worn components with new or reconditioned components
- Adjusting components
- Realignment of components
- Repairing components
- Refitting loose/dislodged components
- Making temporary repairs to an acceptable standard.

(AC1.7) **Monitoring procedures:**

- Pressure testing
- Electrical checks
- Noise intensity
- Exhaust analysis
- Thermal checks
- Movement checks
- Vibration analysis
- Functional testing
- Visual examination to the required standard.

(AC1.10) **Documentation:**

- Body sheets
- Computer records
- Vehicle log/report
- Corrective action report.

Learning outcome

The learner will:

2 Understand how to diagnose and rectify faults on vehicle systems

Assessment criteria

The learner can:

2.1 Describe the health and safety requirements of the area in which the fault diagnostic activities are carried out and the responsibility these requirements place on them

2.2 Describe the specific safety precautions to be taken when carrying out fault diagnosis on vehicles

2.3 Describe the importance of wearing protective clothing and other appropriate safety equipment during the fault diagnosis and rectification activities

2.4 Describe the hazards associated with diagnosing and rectifying vehicle faults, and with the tools and equipment used and how they can be minimised

2.5 Describe how to extract and use information from the relevant areas to assist in the diagnosis and rectification of the fault on the vehicles

2.6 Describe the techniques used to diagnose the faults

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

2.8 Describe how to evaluate the likely risk of running the vehicle with the known fault, and the effects that the fault could have on health and safety, and on the overall vehicle performance

2.9 Describe how to remove components from vehicle systems without damage to the components or surrounding structure

2.10 Describe how to use a range of hand tools to remove a range of components

2.11 Describe how to use release agents to help free joined parts where seizure or crash damage may have occurred

2.12 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement

2.13 Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used

2.14 Explain the importance of being methodical and laying the removed components out in a logical sequence

2.15 Describe methods that can be used to keep component parts together in the order they were removed

2.16 Describe methods of inspecting removed components, and the awareness of what to look for with regard to damage and wear

2.17 Describe how to rectify the faults

2.18 Describe how to select and carry out visual, aural, functional and measurement tests to ensure the correct operation of the component or system

2.19 Describe the expected outcomes of the tests being conducted

2.20 Explain how to deal with problems

2.21 Explain the importance of working to the critical timescales

2.22 Explain when to act on their own initiative and when to seek help and advice from others relevant to the industry

2.23 Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the activities.

Unit 243 Stripping and rebuilding vehicle engines

Unit level:	Level 2
GLH:	64
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to strip and rebuild vehicle engines.
Relationship to NOS:	EUCL2F-029

Learning outcome

The learner will:

1 Strip and rebuild vehicle engines

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Obtain all the information they need for the engine stripping and re-building activities to be carried out
1.3 Prepare for stripping and rebuilding
1.4 Carry out stripping and rebuilding activities
1.5 Remove and refit engine components
1.6 Take suitable precautions to prevent damage to components and surrounding systems
1.7 Report any instances where the engine stripping and re-building activities cannot be fully met, or where there are identified defects outside the planned activities
1.8 Carry out inspection and testing techniques
1.9 Carry out tasks in compliance with standards
1.10 Complete the relevant documentation, in accordance with organisational requirements
1.11 Label and store in an appropriate location components that require repair or overhaul
1.12 Dispose of waste materials and scrap components, in accordance with safe working practices and approved procedures.

Range

(AC1.2) **Information:**

- System diagrams
- Engine build book
- Engineering drawings
- Lifting records
- Engineer's records

- Engine re-build sheets.

(AC1.3) **Prepare:**

- Remove engine from its transportation container, and remove dirt, and oil from engine externals
- Visual check for damage and wear to engine externals
- Mount the engine on the correct mounting stand
- Obtain any tooling including any specialist tooling obtain suitable storage bins for the removed components drain all coolants and lubricants from the engine.

(AC1.4) **Stripping and rebuilding activities:**

Carry out fourteen of the following:

- Removing covers and cowlings
- Disconnecting and removing hoses and pipes
- Separation of components by means of removing mechanical fasteners
- Inspecting components for damage and wear, and identifying all components and fasteners that require replacement
- Arranging and storing components in a manner that makes re-assembly as straightforward as possible
- Labelling components that require repair or overhaul
- Storing in the correct location components that require repair or overhaul
- Replacing damaged/defective and `lifed' components
- Reassembly of components, using mechanical fastening devices
- Checking of bearing clearances
- Lapping in valves and valve seats
- Torque setting cylinder-head bolts, in the correct sequence
- Replacement of sealing devices
- Positioning, aligning, setting, and adjusting replaced components
- Tightening fastenings to the required torque, and applying bolt locking methods

(AC1.5) **Engine components:**

Engine components from four of the following areas:

- Engine ancillary components
- Clutch
- Cam timing
- Electrical
- System components.

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

- Cylinder head
- Engine block
- Lubrication system
- Fuel system.

(AC1.8) **Inspection and testing:**

Carry out three of the following:

- Ferrous metal crack detection
- Sensory testing
- Non-ferrous crack detection
- Connecting and setting engine to dynamometer installation
- Mechanical measurements

Plus three of the following:

- Compression testing
- Ignition timing
- Lead down cylinder leakage testing
- Electrical charging tests
- Other specific tests.

(AC1.9) **Standards:**

Strip and rebuild engine equipment and components in compliance with two of the following:

- BS or ISO standards
- Vehicle manufacturer's specification
- Customer standards and requirements
- Company standards and procedures
- Specific engine system requirements.

(AC1.10) **Documentation:**

Complete one of the following:

- Engineer's/team's records
- Engine re-build sheet
- Formal risk assessment.

Learning outcome

The learner will:

2 Understand how to strip and rebuild vehicle engines

Assessment criteria

The learner can:

2.1 Describe the specific safety practices and procedures that need to be observed when stripping and rebuilding engines and when using lubricants and fluids

2.2 Describe the hazards associated with stripping and re-building engine components, and with the tools and equipment used and how they can be minimised

2.3 Describe the protective equipment that need to be used for both personal protection and protection of the engine

2.4 Explain the importance of good housekeeping within the working area

2.5 Describe preparations to be carried out on the engine

2.6 Describe how to use and extract information from engine building documentation

2.7 Explain the importance of ensuring the correct and up-to-date documentation is used and produced

2.8 Describe the techniques used to remove components from engines without damage to the components or surrounding systems

2.9 Describe how to use a range of hand tools remove a range of components

2.10 Describe how to use release agents to help free joined parts where seizure or damage may have occurred

2.11 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement

2.12 Describe the various types of electrical connectors that are used,

2.13 Describe methods of unlocking, orientation indicators and locating and locking-in of connections

2.14 Describe methods of lifting, handling and supporting the components/equipment during the stripping and re-building activities

2.15 Describe methods of checking the components for damage or wear

2.16 Describe the need to use new components where checks during stripping revealed such needs

2.17 Describe methods used to fit together new or prototype components where a degree of initial fitting may be needed

2.18 Describe how to seal and secure components

2.19 Describe how to check for correctness of fit and accuracy at critical stages during the rebuild and on completion of the assembly

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

2.21 Explain why securing devices need to be tightened to the correct torque and locked

2.22 Describe the tools and equipment used in the engine stripping and re-building activities

2.23 Describe calibration/care and control procedures used for tools and equipment

2.24 Describe the need to control and account for all tools and equipment used

2.25 Describe how to deal with problems stripping and re-building activities

2.26 Describe the recording documentation to be completed for the activities undertaken

2.27 Explain the importance of marking and identifying specific pieces of work in relation to the documentation

2.28 Describe the procedure for the safe disposal of waste materials, scrap components, contaminated oil and fuel

2.29 Describe inspection and testing techniques such as sensory and smoke testing when to act on their own initiative and when to seek help and advice from others

2.30 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the stripping and rebuilding activities.

Range

(AC2.1) **Safety practices and procedures:**

- Lifting and handling techniques
- Safe working practices with regard to dismantling vehicles
- Procedures which satisfy current regulations.

(AC2.15) **Methods of checking:**

- Visual methods
- Measurements
- Crack detection techniques.

Unit 244 Using computer software packages to assist with engineering activities

Unit level:	Level 2
GLH:	37
Unit aim:	The aim of this unit is to develop in learners the understanding and skills needed to use computer software packages to assist with engineering activities.
Relationship to NOS:	EUCL2F-029

Learning outcome

The learner will:

1 Use computer software packages to assist with engineering activities

Assessment criteria

The learner can:

1.1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
1.2 Check that all the equipment is correctly connected and in a safe and usable working condition
1.3 Check that all peripheral devices are operating correctly
1.4 Create and maintain folders and files, in accordance with organisational procedures
1.5 Use appropriate sources to obtain the required information for the activities to be undertaken
1.6 Use word-processing software to produce documentation
1.7 Use database software for applications
1.8 Use spreadsheet software for applications
1.9 Use graphics software for applications
1.10 Use electronic communication methods
1.11 Carry out activities whilst using software
1.12 Save and store files in appropriate locations
1.13 Comply with requirements whilst using software packages.

Range

(AC1.6) **Documentation:**

To include three of the following:

- Standard letter
- Work timetable

- Memorandum
- Layouts/.templates
- Facsimile
- Macros
- Curriculum vitae
- Project report
- Instruction manual
- Other specific application

(AC1.7) **Database applications:**

To include two of the following:

- Personnel details list
- Plant maintenance information
- Address list
- Fault diagnosis information
- Customer/sales details
- Stock control
- Other specific application.

(AC1.8) **Spreadsheet applications:**

To include two of the following:

- Budgeting
- Wages
- Cost analysis
- Project costing
- Other specific application.

(AC1.9) **Graphics applications:**

To include two of the following:

- Preparing visual aids for a presentation
- Producing logbook entries
- Producing advertising material
- Producing technical information
- Other specific application.

(AC1.10) **Electronic communication methods:**

Use two of the following:

- Company email system
- Mobile text messaging
- Internet email
- Web camera chat/conferencing.

(AC1.11) **Activities:**

- Ensure that they have all the required information/data for the activities to be carried out
- Open or create a suitable word processing file/format document which will display the information effectively
- Create a suitable spreadsheet/worksheet which contains a suitable number of cells and rows of the required width
- Enter formulae at the relevant point within the worksheet
- Use graphs which are representative of the information to be shown
- Create a suitable database with appropriate alpha/numeric fields and search facilities

- Use a font style and size of text in keeping with organisational codes and specific job requirements
- Enter alpha and numeric data/text accurately into the correct location
- Select and use appropriate text features
- Import and export information to and from other files or software packages
- Correct routine errors or mistakes in operation
- Edit documents, using appropriate techniques for the package being used.

(AC1.12) **Save and store files:**

- Create a group of folders or directories in which related files can be stored
- Check that the file/document is correctly titled and referenced
- Determine the size of the file/document, and check for sufficient space on the storage device for saving it
- Save the file/document to an appropriate storage medium
- Create a separate backup copy and place it in safe storage
- Produce a hard copy printout of the file/document.

(AC1.13) **Compliance :**

Comply with at least one of the following:

- Organisational guidelines
- Statutory regulations and codes of practice
- BS and ISO standards.

Learning outcome

The learner will:

2 Understand how to use computer software packages to assist with engineering activities

Assessment criteria

The learner can:

2.1 Describe the specific safety precautions to be taken when working with computer systems

2.2 Explain the importance of good housekeeping arrangements

2.3 Describe the correct start-up and shutdown procedures to be used for the computer systems

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

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

2.6 Describe techniques that are available to access and use the software

2.7 Describe how to use of software manuals or help facilities and related documents to aid efficient operation of the relevant software system

2.8 Describe how to deal with system problems

2.9 Describe the various software packages that are used within an engineering environment

2.10 Describe the use of personal access codes, and logging on/off procedures that are required

2.11 Describe the various standard document formats that are used

2.12 Describe how to create and set up a spreadsheet/worksheet, and how to determine and set out the required number of cells, rows, cell width

2.13 Describe how to create a database record, and how to determine and set out the required alpha/numeric fields of the correct size and type

2.14 Describe how to enter alpha/numeric and formulaic data, using keyboards, mouse and menu/tool bar facilities

2.15 Describe how to use highlighting/enhancement features and techniques

2.16 Describe how to edit documents using sort, search and edit facilities, spelling and grammar checks

2.17 Describe how to create tables, charts and graphs

2.18 Describe how to import and export files to and from other locations and other software packages

2.19 Describe how to save and store files/documents

2.20 Describe the need to create backup copies, and to file them in a separate and safe location away from contamination and possible corruption

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

2.22 Describe the importance of leaving the work area and equipment in a safe condition on completion of the activities

Unit 245 Producing engineering project plans

Unit level:	Level 2
GLH:	37
Unit aim:	The aim of this unit is for learners to develop the understanding and skills needed to produce engineering project plans.
Relationship to NOS:	EUCL2F-032

Learning outcome

The learner will:

1 Produce engineering project plans

Assessment criteria

The learner can:

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

1.2 Determine the scope, aims and objectives of the project and the processes required to achieve it

1.3 Collect all the information needed to prepare the project plan

1.4 Determine the resources required and their availability

1.5 Identify the specific operations to be carried out, and determine their sequence

1.6 Produce detailed work instructions of the specific processes required

1.7 Produce a Gantt Chart showing estimates of the timeframe for the project

1.8 Estimate project costs

1.9 Identify health and safety issues, and safe working practices and procedures that must be followed

1.10 Prepare a detailed project plan which accurately reflects the project aims and objectives in appropriate formats

1.11 Present project plan to the appropriate people for approval

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

Range

(AC1.4) **Resources required:**

To include five of the following:

- People required who have the necessary skills and knowledge
- The raw materials required
- Mechanical fasteners required

- Bought-in standard components required
- Equipment required
- Measuring or test equipment required
- Consumable materials required
- Any outside support services required
- Special/specific safety equipment required.

(AC1.6) **Work instructions:**

- Details of the drawing/specification to be used
- Specific materials required for this part of the process/operation
- The specific tools and equipment required for each operation being carried out
- The specific operations to be carried out
- The specific sequence in which the operations must be carried out
- The specific time to produce/complete the operations
- Quality control checks that need to be implemented.

(AC1.7) **Timeframe:**

- Start time of the project
- Outcomes to be achieved at milestones
- Completion date of project.

(AC1.8) **Costs:**

- Material costs (raw, consumable, bought-in)
- Labour costs (based on estimated working time and a fixed manufacturing cost figure)
- Overhead costs.

(AC1.10) **Project plan:**

- The aims and objectives of the engineering project being undertaken
- Description of the activities to be carried out
- The sequence in which the activities will take place
- The documentation to be used
- Tooling requirements
- Resources required
- The timescales to be met
- Any special requirements that must be met
- Outcomes in terms of quality, cost and delivery
- People involved, and their responsibilities
- How the project will be proved and evaluated
- Any relevant regulations, standards and guidelines (health and safety requirements, BS and ISO standards and procedures, company policies and procedures).

(AC1.11) **Present:**

- Verbally

Plus one of the following:

- Written (word-processed)
- Specific company documentation
- Digital media.

Learning outcome

The learner will:

2 Understand how to produce engineering project plans

Assessment criteria

The learner can:

2.1 Describe how to access information on health and safety regulations and guidelines relating to the engineering activities to be used and project plans being produced

2.2 Describe the implications of not taking account of legislation, regulations, standards and guidelines when producing the engineering project plans

2.3 Describe how to obtain information on the engineering requirements, and the type of information that is available

2.4 Describe how to access and use the appropriate information and documentation systems

2.5 Describe the types of data that should be included in the engineering project plans

2.6 Describe how to extract information from engineering drawings and related specifications, including symbols and conventions to appropriate BS or ISO standards in relation to work being planned

2.7 Describe the materials, formats, codes and conventions that are used in preparing the engineering project plans

2.8 Describe the main project planning methods and techniques in use, and what problems could occur with them

2.9 Describe the factors to be taken into account when preparing the project plans, especially those covering working conditions and safety

2.10 Describe the main types of resource involved with the various types of engineering activity (

2.11 Describe the obvious and hidden costs of resources/activities

2.12 Describe the normal timescales for carrying out specific engineering activities, and how and why they vary

2.13 Describe how to arrive at an estimate of timescales for the project, and the need to set milestones for achievement

2.14 Describe how to estimate the likely costs of the project

2.15 Describe the products/assets involved in the activity being planned, and how to determine their availability

2.16 Describe the development of the engineering project plans including master documents and working instructions, along with their purpose, content and status

2.17 Describe how to write project plans that specify quality, cost and delivery requirements including allocation of responsibilities and milestone targets

2.18 Describe how to prepare the plans including the structure, style, clarity and compliance with relevant standards

2.19 Describe the process used in the organisation to validate the engineering plans produced

2.20 Describe the procedures for changing the plans, and why control procedures are used

2.21 Describe the procedures and process for project plan approval, and why these procedures and processes are used

2.22 Explain the importance of maintaining records

2.23 Describe what needs to be recorded and where records are kept

2.24 Explain why contingency plans need to be drawn up

2.25 Describe the different ways of presenting information to different people

2.26 Explain the importance of providing the right information at the right time

2.27 Describe typical of problems that can occur during the implementation of the plan, and how these problems can be rectified

2.28 Explain when to act on their own initiative and when to seek help and advice from others.

Appendix 1 Relationships to other qualifications

Links to other qualifications

This qualification is part of a suite that contributes to the delivery and assessment of the on-programme element of the Machinist pathway in the Engineering Technician Standard apprenticeship. The qualifications in the suite are:

- 1272-02 Level 2 Diploma in Machining (Foundation Knowledge)
- 1272-03 Level 3 Diploma in Machining (Development Knowledge)
- 1271-02 Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)
- 1271-03 Level 3 Diploma in Advanced Manufacturing Engineering (Development Competence) Machining

Literacy, language, numeracy and ICT skills development

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

- Functional Skills (England) – see www.cityandguilds.com/functionalskills
- Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni
- Essential Skills Wales – see www.cityandguilds.com/esw

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:

- 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 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.

Centre Guide – Delivering International Qualifications 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.

Specifically, the document includes sections on:

- The centre and qualification approval process and forms

- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Appendix 3 Useful contacts

UK learners General qualification information	**E: learnersupport@cityandguilds.com**
International learners General qualification information	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	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	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	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	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	F: +44 (0)20 7294 2413

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