

Level 2 Diploma in Maritime Defence (Foundation Knowledge) (4715-02)

Version 1.1 (January 2018)

Qualification Handbook

Qualification at a glance

Subject area	Mechanical
City & Guilds number	4715
Age group approved	16+
Entry requirements	None
Assessment types	Multiple Choice and Short Answer, Centre Devised
Approvals	See page 8 for details
Support materials	Assessment pack
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds qualification number	Ofqual accreditation number
Level 2 Diploma in Maritime Defence Pass (Foundation Knowledge)	350	380	4715-02	603/2425/9

Version and date	Change detail	Section
v1 September 2017	Original documentation	
V1.1 January 2018	Updates to unit 202, 205, 207 and 218 in LOs and range	Units

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1 Introduction

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

Area	Description
Who is the qualification for?	<p>It is aimed at anyone over the age of 16 who has an interest in working and progressing in the Maritime Engineering sector.</p> <p>It is designed to be the base to train and qualify the next generation of Maritime Defence Engineers to meet an identified gap in the market and minimise the potential loss of skills and knowledge over the next 5-10 years.</p>
What does the qualification cover?	This qualification allows learners to learn, develop and practise the skills required for employment and/or career progression in the Maintenance and Engineering sector in general.
What opportunities for progression are there?	Upon completion of this qualification learners will have developed most of the basic skills and knowledge required during their foundation phase of the Apprenticeship and will enable them to progress into further training. Learners can progress to the Level 3 Diploma in Maritime Defence (Development Knowledge).
Who did we develop the qualification with?	<p>This qualification has been developed in collaboration with the Engineering Technician Employer Group which included the following organisations:</p> <p>BAE Systems, Airbus Group, The Institution of Engineering and Technology, British Airways, Rolls-Royce plc, Royal Aeronautical Society, Royal Air Force Cosford, Royal Navy, Institution of Mechanical Engineers, Siemens plc, Jaguar Land Rover, BMW, Toyota Motor Manufacturing (UK) Ltd and Babcock International Ltd.</p> <p>As well as SEMTA and EAL.</p>
Is it part of an apprenticeship framework or initiative?	<p>Yes. This qualification forms part of the mandatory foundation phase for the on-programme section of the new Engineering Technician Standard.</p> <p>The qualification can also be used for full time students who would like to gain the basic knowledge and skills that will enable them to progress into further training to become a Marine Engineer</p>

Structure

Learners must achieve 3 mandatory units (201-203) plus 3 optional units from (204-218)

Centres should use the following certification units to claim for the achieved grade

901 Pass

902 Merit

903 Distinction.

Please see the Grading section for the grading process.

City & Guilds unit number	Unit title	GLH
Mandatory		
201	Working in a marine engineering environment	60
202	General engineering principles	60
203	General engineering mathematics and science principles	60
Optional		
204	Principles of welding and fabrication	60
205	Principles of pipework fabrication	60
206	Principles of electrical maintenance	60
207	Principles of mechanical maintenance	60
208	Business improvement techniques	50
209	Principles of electronic and electrical technology	60
210	General machining applications (turning and milling)	60
211	Assembling and maintaining fluid power systems	60
212	Constructing, testing and fault finding electronic circuits	60
213	Electrical inspection and testing	60
214	Thermal cutting techniques	60
215	Sheet metalwork techniques	60
216	Plate metalwork techniques	60
217	Principles of mechanical assembly and fitting	60
218	Principles of Computer Aided Design (CAD)	60

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
Level 2 Diploma in Maritime Defence Pass (Foundation Knowledge)	350	380

2 Centre requirements

Approval

If your centre is approved to offer the following qualifications:

Level 2 Diploma in Engineering (2850-60, 61, 62)

Level 3 Diploma in Engineering (2850-70, 71, 72)

then you will have automatic approval for the new Level 2 Diploma in Maritime Defence (Foundation Knowledge).

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

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

Internal quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications.

Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance.

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

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

In order to carry out the quality assurance role, Internal Quality Assurers must have appropriate teaching and vocational knowledge and expertise. Assessor/Verifier (A/V) units are valued as qualifications for the centre, but they are not currently a requirement for this qualification.

Staff must:

- be familiar with the occupation and technical content covered within the qualification
- be familiar with the Engineering Technician (UK spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK Spec and the evidence requirements to meet the Engineering Technician (UK Spec) criteria.

Resource requirements

Centre staffing

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

- be occupationally competent or technically knowledgeable in the 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.

Additionally, those involved in internal quality assurance must:

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

Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but cannot internally verify their own assessments. They must:

- be technically knowledgeable in the area(s) for which they are delivering training/assessing, with appropriate qualifications
- be familiar with the Engineering Technician (UK Spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK Spec and the evidence requirements to meet the Engineering Technician (UK Spec) criteria.

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.

Individual employers will set the criteria, but most candidates will have four GCSEs at grade C (or equivalent) or above on entry (including English, Maths & Science). Employers who recruit learners without English, Maths and Science at Grade C or above, must ensure that the learner achieves this requirement, or an equivalent Level 2, prior to completion of the Apprenticeship.

This qualification is a mandatory component of the on-programme foundation phase of the Engineering Technician Apprenticeship Standard for the following occupational pathways:

Maritime Electrical Fitter
Maritime Mechanical Fitter
Maritime Fabricator
Maritime Pipeworker

The Standard and Assessment plan has been designed by Employers. Centres should make themselves familiar with the Standard, Assessment Plan and Employer Occupational Brief requirements, details of which can be found at:

<https://www.gov.uk/government/collections/apprenticeship-standards>

Age restrictions

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

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
- 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
Assessment pack	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

Summary of assessment methods

Candidates must:

- have completed the relevant assessment for each Mandatory unit
- have completed the relevant assessment for each optional unit chosen

Available assessments/assignments

City & Guilds has written the following assessments to use with this qualification:

- evolve tests for the unit 201, 203
- assignments for units 202, 204-209, 217-218

City & Guilds has written guidance for centres to write their own assessments/assignments for units 210-216

Assessment Types

Unit	Title	Assessment method	Grading	Where to obtain assessment materials
201	Working in a marine engineering environment	online multiple choice examination via evolve	PMDX	www.cityandguilds.com
202	General engineering principles	Assignment - SAQ externally set and internally marked	PMDX	www.cityandguilds.com
203	General engineering mathematics and science principles	online multiple choice examination via evolve	PMDX	www.cityandguilds.com
204	Principles of welding and fabrication	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
205	Principles of pipework fabrication	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
206	Principles of electrical maintenance	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
207	Principles of mechanical maintenance	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
208	Business improvement techniques	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
209	Principles of electrical and electronic technology	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
210	General machining applications (turning and milling)	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com

Unit	Title	Assessment method	Grading	Where to obtain assessment materials
211	Assembling and maintaining fluid power systems	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
212	Constructing, testing and fault finding electronic circuits	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
213	Electrical inspection and testing	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
214	Thermal cutting techniques	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
215	Sheet metalwork techniques	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
216	Plate metalwork techniques	Centre Devised Internally set and marked assessments	P/X	www.cityandguilds.com
217	Principles of mechanical assembly and fitting	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com
218	Principles of Computer Aided Design (CAD)	Assignment - SAQ externally set and internally marked	P/X	www.cityandguilds.com

Assessment requirements

Assessment strategy

Access to assessment

Mandatory unit 201 and 203 are assessed by a multiple-choice online test, which are graded Pass/Merit/Distinction. This is marked by City & Guilds.

Mandatory unit 202 is assessed by short-answer question assessments, set by City & Guilds, internally marked by centres and externally verified. These assessments are graded Pass, Merit and Distinction.

Optional units 204-209 and 217-218 are assessed by short-answer questions assessments, set by City & Guilds, internally marked by centres and externally verified. These assessments are graded Pass/Fail only.

Optional units 210-216 are assessed by centre devised assessment and internally marked by centres and externally verified. These assessments are to be graded Pass/Fail only.

Test Specifications

The way the knowledge is covered by each externally marked test is laid out in the tables below:

Assessment title: Working in a marine engineering environment

Assessment type: Online Multiple Choice

Assessment conditions: Invigilated examination conditions

Grading: X/P/M/D

	Duration: 70 minutes		
	Learning Outcome	Number of marks	%
Unit 201	Understand the health and safety regulations and requirements in mechanical engineering	17	34.0
	Understand the health and safety regulations and requirements in electrical engineering	14	28.0
	Understand how to communicate effectively	9	18
	Understand how to work in an engineering environment	10	20
Total		50	100

Assessment title: General engineering mathematics and science principles

Assessment type: online multiple choice

Assessment conditions: Invigilated examination conditions

Grading: X/P/M/D

	Duration: 75 minutes		
	Learning Outcome	Number of marks	%
Unit 203	Understand fundamental numeracy applied to engineering	25	50
	Understand fundamental science applied to engineering	25	50
Total		50	100

5 Grading

Grading of individual assessments

Some individual assessments will be graded Pass/Merit/Distinction.

For a unit to be achieved, candidates must achieve a minimum Pass in the assessment, as per the marking scheme provided.

A Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in the depth and breadth of the learner's knowledge, as well as in the type of cognitive operations they demonstrate.

Grading of the qualification

Individual assessments will be graded Pass/Merit/Distinction where indicated

The grade boundaries for Pass, Merit and Distinction for each assessment have been set through a judgemental process using technical experts, aimed at defining what the grades for each assessment should mean in practice. The following descriptors are based on that process.

For the units to be achieved, candidates must achieve a minimum of Pass in the assessments. The descriptors given here simply provide a baseline against which Merit and Distinction grades can be understood and should **not** be used for grading/markings the assessments.

Pass

The candidate has a solid understanding of the unit key concepts. Some understanding may be simplistic, narrow or shallow. Individual topics are dealt with separately but understanding is clear. Recall of the unit content is generally accurate, without serious misapprehensions or gaps. Recall may be slow or show signs of difficulty/uncertainty and minor misapprehensions may occur.

Indicators:

- explanations may be a little incoherent or incomplete but the meaning is on the whole accurate
- the use of illustrations/examples are mostly relevant to the explanation
- relationships between concepts are missing
- reasoning shows comprehension of the main facts
- analyses or evaluations are simplistic but relevant
- sources, when used, are limited but relevant
- main facts are stated accurately
- definitions and descriptions are accurate, but somewhat limited
- diagrams, when used, are mostly correctly annotated, with some minor errors eg spelling.

Merit

The candidate has a sound understanding of the breadth/depth of the relevant concepts. Topics are dealt with in relation to each other and communicated clearly. The breadth and depth of the unit content are recalled in an accurate and complete manner. Recall is confident.

Indicators:

- explanations are coherent, complete and accurate
- use of illustrations/examples which accurately and clearly add to/support the explanation
- relationships are made between concepts
- reasoning is plausible and conventional
- analyses and evaluations are methodical and plausible
- information is drawn from a range of appropriate sources and used appropriately
- facts are accurate and cover the breadth and depth of the unit
- definitions and descriptions are clear
- technical language is accurate

Distinction

The candidate has a well-developed understanding of the relevant concepts. Relationships between topics are highly developed and may be set in context; interactions between topics are clearly expressed. There is evidence of understanding of some facts/knowledge which go beyond the requirements of the unit. Recall is automatic and can be brought together making useful connections.

Indicators

- explanations are well thought out, thorough and well-argued/justified
- well-chosen illustrations/ examples, which accurately and precisely clarify explanations
- relationships are brought together to show an understanding of the bigger picture
- reasoning is justified, well-argued and may be creative
- analyses and evaluations are thorough, well-developed
- sourced information is critically evaluated, showing awareness of its importance or relevance
- evidence of interest beyond the scope of the unit
- descriptions and definitions are detailed
- use of knowledge is consistently high and second nature.

Grading of qualification

The Employer Group has taken the decision to grade this qualification Pass/Merit/Distinction, through the aggregation of the individual assessment graded Pass/Merit/Distinction.

Grading can be of use both as a motivational tool within the learning environment and also to learners presenting evidence of their knowledge to prospective employers.

All assessments must be achieved at a minimum of Pass for the qualification to be awarded. All assessments graded Pass/Merit/Distinction contribute equally to the overall qualification grade.

Learners **must** achieve a Pass in assessments graded pass/fail only; however, they do **not** contribute to the overall qualification grade.

Centres will need to calculate the qualification grade as follows:

- Centre will mark and grade each externally marked graded assessment using the model answer mark scheme provided by City & Guilds and available on www.cityandguilds.com
- The grade achieved by a learner will need to be converted into points as follows:

Individual assessment grade	Grade points
Pass	1
Merit	2
Distinction	3

- Grade points for each assessment need to be added together and the overall qualification grade determined using the following conversion table:

Total grade points	Overall qualification grade
3 - 4	Pass
5 - 7	Merit
8 - 9	Distinction

- Overall qualification grades must be entered using **one** of the following overall grading modules on the Walled Garden:

901 Pass
902 Merit
903 Distinction

Example

Learner A has achieved the following:

Assessment	Grade achieved	Grade points
Mandatory		
201	Merit	2
202	Pass	1
203	Pass	1
Optional		
xxx	Pass	No grade points, as Pass/Fail only
yyy	Pass	No grade points, as Pass/Fail only
zzz	Pass	No grade points, as Pass/Fail only
Total grade points		4
Overall qualification grade		Pass

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience, or qualifications which have already been achieved, to contribute to a new qualification.

RPL is **not** allowed for this qualification.

<http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/quality-assurance-documents>

6 Units

Availability of units

Some of the units can be found in a separate document.

Structure of the units

These units each have the following:

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

Centres must deliver the full breadth of the range. Specialist equipment or commodities may not be available to all centres, so centres should ensure that their delivery covers their use. This may be covered by a practical demonstration (e.g. video). For the practical assessments for this qualification, centres should ensure that there are sufficient resources to complete the task but are not required to use all the equipment or commodities in the range.

Unit level:	Level 2
GLH:	60

Learning outcome

The learner will:

- 1 Understand the health and safety regulations and requirements in mechanical engineering

Assessment criteria

The learner can:

- 1.1 describe current health and safety regulations
- 1.2 describe the function of health and safety documentation
- 1.3 describe manual handling/lifting techniques
- 1.4 describe types of hazards in a marine environment
- 1.5 describe confined spaces and precautions
- 1.6 describe compartments that are not confined spaces but have specific entry regulations/precautions
- 1.7 describe the range and use of Personal Protection Equipment (PPE)
- 1.8 describe the welding/burning sentry (safety number) duties
- 1.9 describe lagging procedures
- 1.10 describe the procedure necessary to TAG-OUT a circuit, system and pump
- 1.11 describe Shiphaz and Radhaz hazards
- 1.12 describe emergency procedures including methods of fire prevention and control of fires

Range

(AC1.1) **health and safety regulations:**

- Health and Safety at Work Act
- Health and Safety Regulations
- Control of Substances Hazardous to Health
- Lifting Operations and Lifting Equipment Regulations
- Reporting of Injuries
- Diseases and Dangerous Occurrences Regulations
- Personal Protective Equipment at Work Regulations
- Confined Space Regulations
- Lagging Regulations

- (AC1.2) **health and safety documentation:**
- (Control of Substances Hazardous to Health (COSHH) data log
 - hazard data sheets and Contents of Assessment Form
- hazard data sheets**
- MOD (Ministry of Defence) regulations
 - COSHH Log holders and instructions on how to complete risk assessment form.
- (AC1.3) **manual handling/lifting techniques**
- Safe personal procedures and examples
- (AC1.4) **hazards:** within machinery spaces and other compartments
- (AC1.5) **confined spaces**
- ventilation
 - testing
 - entry signs
 - communication
 - personnel and hygiene
 - equipment
 - Personal Protective Equipment (PPE) required
- (AC1.6) **specific entry regulations/precautions:** compartments that meet this regulation.
- (AC1.7) **personal protection equipment:**
- Safety boots
 - gloves
 - goggles
 - overalls
 - ear defenders
 - face masks
 - barrier cream
- (AC1.8) **welding/burning sentry:**
- Equipment required for duties
 - checks to be conducted before, during and after welding/burning operation.
- (AC1.9) **lagging procedures**
- Pre inspection of work to be carried out
 - signs
 - warning broadcasts
 - Personal Protective Equipment (PPE) required
 - equipment and materials
 - ventilation
 - debris bagging /disposal
 - testing on completion
 - Personnel and hygiene

(AC1.10) **TAG-OUT:**

- from obtaining permission to recording
- isolation and restoration of system/equipment

(AC1.11) **Shiphaz and Radhaz hazards**

- working aloft
- underwater
- radio/radar emissions
- engine & diesel generator emissions
- wires/ rigging
- weather conditions
- unexpected noise and discharges from funnels
- incorrect clothing

(AC1.12) **fire prevention and control:** conditions required for combustion and extinction

- causes of fire
- fire prevention
- fire procedures
- fire drills
- firefighting equipment
- different types of fire extinguishers
- automatic systems, e.g. sprinklers

Learning outcome

The learner will:

- 2 Understand the health and safety regulations and requirements in electrical engineering

Assessment criteria

The learner can:

- 2.1 describe possible major causes of electrical accidents
- 2.2 describe first aid procedures including first aid action in event of electrical shock
- 2.3 describe the causes of electric shock
- 2.4 describe how to minimise risk of electric shock
- 2.5 describe the dangers of electrical current
- 2.6 define the formula for body resistance
- 2.7 describe hazardous electrical components
- 2.8 describe precautions for working on live electrical equipment
- 2.9 describe the procedure for working on dead electrical equipment
- 2.10 describe types of hand change over switches and operating procedure
- 2.11 describe charging batteries procedures
- 2.12 define statutory navigation lights and describe their configuration
- 2.13 describe the neutralising agents used in regards to battery charging

Range

- (AC2.1) **major causes of electrical accidents:**
- personal Hazards
 - physical Hazards
- (AC2.2) **first aid action:** Procedure and action to be taken In the event of accidents and electrical shock.
- (AC2.3) **electric shock**
- equipment failure (indirect contact)
 - human failure (direct contact)
 - combination of equipment failure and human error
- (AC2.4) **minimise risk**
- know the hazard
 - know the precaution
 - learn first aid procedures
 - maintain safety discipline
 - develop the habit of noticing potential dangers.
- (AC2.5) **dangers of electrical current:** Including physical injury.
- (AC2.7) **hazardous electrical components:**
- tantalum capacitors
 - selenium rectifiers
 - radioactive valves
 - penetone TPC
 - microwave ovens
- (AC2.8) **live electrical equipment:** Procedure and precautions to be observed working on live equipment.
- (AC2.9) **dead electrical equipment:** Procedure for testing and making safe whilst working.
- (AC2.10) **hand change over switches:** types and operation procedures.
- (AC2.11) **charging batteries:** Procedures, safety precautions and Personal Protective Equipment (PPE) required.
- (AC2.13) **neutralising agents:**
- sulphuric acid - caustic soda
 - alkaline - boric acid.

Learning outcome

The learner will:

- 3 Understand how to communicate effectively

Assessment criteria

The learner can:

- 3.1 describe procedures regarding employment rights and responsibilities
- 3.2 describe the communication systems used in the workplace
- 3.3 describe the roles and responsibilities of various departments and personnel within an engineering organisation
- 3.4 outline how to use a range of sources of engineering information
- 3.5 know where to seek advice and guidance
- 3.6 describe the correct approach to use when seeking advice and guidance

Range

(AC3.1) **employment rights and responsibilities:** Procedures for requesting/recording time off work for illness, medical/dental reasons, holidays, family reasons.

(AC3.2) **communication systems:**

- verbal
- written
- drawings
- electronic
- signs.

(AC3.3) **roles/departments**

- Marine Engineering (ME)
- Weapons Engineering (WE)
- Executive (EXEC)
- LOGISTICS.

(AC3.3) **personnel**

- Marine Engineering Officer (MEO)
- Weapons Engineering Officer (WEO)
- Deputy Marine Engineering Officer (DMEO)
- Deputy Weapons Engineering Officer (DWEO)
- Divisional Officer (DO)
- Training Coordinator
- Section Head
- Leading Hands.

(AC3.4) **sources of engineering information:**

- BS EN standards, instruction manuals (BR – Book of Reference)
- technical handbooks
- tables
- charts
- graphs
- data sheets
- textbooks
- reference materials
- computer based
- internet
- intranet.

(AC3.5,
3.6) **advice and guidance:**

- mentor
- trainer
- supervisor.

(AC3.5,
3.6) **correct approach:**

- politeness
- timeliness
- attentiveness

Learning outcome

The learner will:

- 4 Understand how to work in an engineering working environment

Assessment criteria

The learner can:

- 4.1 describe the approach to work ethics expected within engineering workplace
- 4.2 outline the conduct expected when acting as a guide
- 4.3 describe how to effectively request advice from colleagues, trainers or supervisors
- 4.4 describe how to deal with conflict situations
- 4.5 describe how to avoid conflict situations
- 4.6 outline how to function effectively within a team/section

Range

(AC4.1) **approach:**

- timekeeping and absenteeism
- observation of rules
- regulations and procedures
- conduct within the workplace
- relationships with colleagues
- supervisors and managers
- respect for company property
- observing safety policies and regulations.

(AC4.2) **conduct expected:**

- smart
- polite
- observe health and safety
- know tour route
- timings
- relevant information to tour.

(AC4.3) **request advice:**

- stating the problem clearly and succinctly
- listening to the response attentively
- seeking clarification on points not fully understood.

(AC4.4) **deal with conflict situations:**

- calmness
- patience
- clarity of understanding of situation
- good listener
- seek advice.

(AC4.5) **avoid conflict situations:**

- enquiring politely
- timeliness when seeking advice or assistance
- avoiding conflict and knowing when to by withdraw from the situation
- listening carefully, following reasonable requests from supervisors
- offering help when colleagues are in need of assistance

(AC4.6) **team/section:**

- roles and responsibilities of team leaders
- team members; difficulties or situations arise due to differences of opinion
- unpopular team leader decisions,
- working within time constraints
- team member aspirations and/or ambitions
- individual skill levels
- personal development
- team member personalities; participation in group discussions and decision making suggesting solutions to problems
- how to give and receive constructive criticism, when to be assertive, when to concede to individual or group pressure.

Unit level:	Level 2
GLH:	60

Learning outcome

The learner will:

- 1 Know how to select engineering materials

Assessment criteria

The learner can:

- 1.1 describe different classifications of materials used within engineering applications
 - 1.2 describe the range of materials commonly used within engineering applications
 - 1.3 describe the factors that make materials suitable for different engineering applications
 - 1.4 identify different forms of supply of engineering materials
-

Range

(AC1.1) **classifications:**

- metallic (pure metals and alloys, ferrous and non-ferrous)
- non-metallic materials (polymers, ceramics, natural materials, composites, smart materials)

(AC1.2) **materials, to include:**

- low carbon/mild steel
- high carbon steel
- stainless steel
- cast iron
- aluminium/aluminium alloys
- brass/brass alloys
- polymers (thermoplastics, thermosetting plastics)
- ceramics
- composites

(AC1.3) **factors, to include:**

- properties
 - surface finish
 - cost
 - quantity
 - processing requirements
 - mode of delivery
-

(AC1.4) **form of supply, to include:**

- sheet
 - plate
 - bar
 - wire
 - section
 - extrusions
 - castings
 - wrought
 - forgings
 - pipe and tube
 - pressings
 - other specific forms of supply
-

Learning outcome

The learner will:

- 2 Understand the properties of materials and the effects of heat treatment

Assessment criteria

The learner can:

- 2.1 define the physical and mechanical properties of materials
 - 2.2 describe different effects heat can have on the properties of metal
 - 2.3 explain why different properties make materials suitable for different engineering applications
-

Range

(AC2.1) **properties:**

- **Mechanical properties**
 - strength (tensile, compressive)
 - yield strength/elastic limit
 - Ultimate Tensile Strength (UTS)
 - elongation
 - ductility
 - elasticity
 - malleability
 - toughness
 - hardness/wear resistance
 - fatigue strength
 - shear strength

 - **physical properties**
 - density
 - thermal and electrical conductivity
 - corrosion resistance
-

- (AC2.2) **heat treatment processes:**
- quenching and tempering
 - annealing
 - normalising

- (AC2.3) **properties:**
- mechanical
 - physical
 - weight
 - cost
-

Learning outcome

The learner will:

- 3 Understand forms of communication used within engineering

Assessment criteria

The learner can:

- 3.1 State different forms of communication and their typical use
- 3.2 describe basic drawing conventions/layouts
- 3.3 describe different types of lines, detailing, and dimensioning
- 3.4 outline how computer based tools are used within engineering
-

Range

(AC3.1) **forms of communication, to include:**

- verbal
- written
- electronic
- graphical

(AC3.2) **conventions/layouts**

- isometric
- oblique
- first and third angle projection
- other types of drawing (detail, assembly, circuit and wiring, block diagrams)

(AC3.3) **types:**

- presentation
 - line types
 - abbreviations
 - hatching
 - symbols
 - sections
-

(AC3.4) **uses of IT/ICT:**

- Computer Aided Design (CAD)
 - Computer Aided Manufacture (CAM)
 - Computer Numerical Control (CNC)
 - simulation packages
 - rapid prototyping/3D printing
-

Learning outcome

The learner will:

- 4 Know the basic tools and techniques used in engineering

Assessment criteria

The learner can:

- 4.1 identify different work and tool holding methods and their functions within engineering
- 4.2 identify types of manufacturing processes and tools used in engineering and their functions
- 4.3 state the meaning of the nomenclature used to describe basic screw thread forms
- 4.4 outline the basic methods of joining components
-

Range

(AC4.1) **work and tool holding methods:**

- vices
- clamps
- jigs
- fixtures
- collets
- chucks
- angle plates
- mandrels

(AC4.2) **manufacturing processes:**

- wasting (cutting , drilling, turning, milling)
- forming (bending, pressing)
- shaping (casting)
- joining (brazing, welding, adhesives and mechanical fixing, soldering)

(AC4.2) **tool types:**

- hand tools for wasting and forming including portable power tools
- turning tools, e.g. used for facing off, thread cutting, taper turning, drilling, boring
- milling/routing tools, e.g. used for slot drilling, end milling, face milling, use of a rotary table

(AC4.4) **basic methods of joining components:**

- thermal
 - adhesive
 - mechanical fixings
-

Learning outcome

The learner will:

5 Know measurement and marking out techniques

Assessment criteria

The learner can:

- 5.1 describe the sources of information used in engineering to support marking out activities
 - 5.2 describe different types of measuring and marking out equipment and their uses
 - 5.3 describe surface preparation methods and the importance of surface preparation before marking out
 - 5.4 describe different measuring and marking out techniques
 - 5.5 describe methods of supporting work pieces whilst measuring or marking out
 - 5.6 describe the errors that can occur when measuring and marking out
-

Range

(AC5.1) **sources:**

- engineering drawings
- circuit diagrams
- work instructions
- data sheets
- reference charts

(AC5.2) **types:**

- engineering rules
- scribes and scribing blocks
- engineering and tri squares
- depth gauges
- Vernier callipers
- protractors
- micrometers
- plug gauges
- thread gauges

(AC5.3) **methods:**

- degreasing
- bluing
- deburring

(AC5.4) **techniques:**

- templates
- datums
- hole centres
- centre lines
- angular and radial profiles

(AC5.5) **aids to marking out:**

- marking out tables and plates
- angle plates
- vee blocks
- jack screws

- clamps
- vices

(AC5.6) **errors:**

- observation errors
 - recording errors
 - unit errors
 - calibration errors
-

Learning outcome

The learner will:

6 Understand the types of Computer Numerical Control (CNC) machines and their uses

Assessment criteria

The learner can:

6.1 explain the advantages and disadvantages of CNC machine compared to manual machines

6.2 describe the main features and uses of different types of CNC machine

Range

(AC6.2) **CNC machine types:**

- lathe
- milling machine
- router
- machining centre

Unit level:	Level 2
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GLH:	60
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Learning outcome

The learner will:

- 1 Understand fundamental numeracy applied to engineering

Assessment criteria

The learner can:

- 1.1 identify the metric and imperial systems and the preferred standard form
 - 1.2 identify the techniques used for calculating approximation
 - 1.3 add, subtract, multiply and divide: whole numbers, fractions and decimals
 - 1.4 convert fractions to decimals and decimals to fractions
 - 1.5 calculate average, mean, median and mode
 - 1.6 calculate ratio, proportion and percentages
 - 1.7 calculate area, surface area, mass, volume, capacity
 - 1.8 calculate probability
 - 1.9 calculate the square and square root of a number
 - 1.10 transpose simple formulae
 - 1.11 construct simple graphs
 - 1.12 calculate angles and lengths for triangles using trigonometric functions
-

Range

(AC1.3) **perform calculations using addition, subtraction, multiplication and division, using:**

- whole numbers
- fractions
- decimals

(AC1.4) **to convert fractions to decimals and decimals to fractions:**

- to two decimal places

(AC1.10) **transpose simple formulae:**

- e.g. using $V=IR$ and $A=\pi r^2$
-

(AC1.11) **construct simple graphs:**

- determine values for given angles
-

Learning outcome

The learner will:

- 2 Understand fundamental science applied to engineering

Assessment criteria

The learner can:

- 2.1 recognise common SI units
 - 2.2 state the types of forces used in engineering
 - 2.3 identify the modes of heat transfer
 - 2.4 identify how and why materials are selected with low frictional values
 - 2.5 identify structures and states of matter
 - 2.6 identify lines of the lines of flux within magnetic fields
 - 2.7 list the causes of friction
 - 2.8 recognise the main principles of the basic theory of electricity
 - 2.9 recognise the relationship between conductors, current, magnetic fields and relative movement
 - 2.10 calculate moments and levers
 - 2.11 calculate heat input and change in length
 - 2.12 calculate resistors in series and parallel circuits
 - 2.13 perform simple calculations using the basics of electricity
-

Range

(AC2.1) **common SI units:**

- length
- area
- volume
- time
- heat
- temperature
- mass
- force

(AC2.3) **modes of heat transfer:**

- conduction
- convection
- radiation

(AC2.5) **structures and states of matter**

- atoms
 - molecules
-

- elements
- mixtures
- compounds

(AC2.8) **basic theory**

- electron flow
- structure of an atom
- charged particles
- coulomb
- ampere

(AC2.13) **basics of electricity:**

- simple circuits
- $w = \text{volts} \times \text{amps}$
- current
- voltage
- resistance
- ohms law

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand different welding and fixing techniques

Assessment criteria

The learner can:

- 1.1 describe different types of welding and fixing techniques
 - 1.2 describe the principles and applications of non-fusion joining processes
 - 1.3 describe the principles and applications of the fusion welding processes
 - 1.4 outline health and safety procedures when carrying out welding operations
-

Range

(AC1.1) **welding and fixing techniques:**

- temporary fixings (tack welding)
- soldering
- brazing
- spot welding

(AC1.2) **non-fusion joining processes:**

- riveting
- adhesive bonding (e.g. composite bonding films, epoxy resins)
- mechanical fastenings (bolts, screws)
- self-securing joints (knock up, panel down, swaged, joggled)

(AC1.3) **fusion welding processes**

- arc welding (MMA)
- oxyacetylene
- spot welding
- MIG/ MAG and FCAW
- TIG
- Plasma arc

- (AC1.4)
- hazards (arc light, fume, heat, electric shock)
 - control measures (screening, fume extraction, PPE, safe working procedures)
-

Learning outcome

The learner will:

- 2 Know the terminology and symbols used within welding

Assessment criteria

The learner can:

- 2.1 describe the features of different types of weld joints
 - 2.2 identify the characteristics of a weld including symbols used on engineering drawings
-

Range

(AC2.1) **types of weld joints**

- butt welds
- fillet welds/tee welds
- corner welds
- lap weld
- edge weld
- tack welds
- multi-run welds

(AC2.1) **welding positions**

- Flat (PA)
- Vertical upwards (PF)
- Horizontal vertical (PB)
- Vertical downwards (PG)
- Horizontal (PC)

(AC2.1) **characteristics of a weld**

- weld bead
- penetration
- throat (actual, effective)
- leg length
- root
- toe
- reinforcement
- Heat Affected Zone (HAZ)
- symbols used on engineering drawings in line with current conventions

Learning outcome

The learner will:

- 3 Understand the potential faults that can arise due to welding

Assessment criteria

The learner can:

- 3.1 describe types of distortion that can occur when welding and their causes
- 3.2 describe different types of weld defect which can occur when welding and their causes
- 3.3 describe methods used to identify weld distortion and defects

Range

(AC3.1) **types of distortion**

- longitudinal shrinkage
- transverse shrinkage
- angular distortion
- bowing and dishing
- buckling
- twisting

(AC3.2) **types of defect**

- 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
- surface cracks
- internal cracks
- inclusions

(AC3.3) **methods**

- testing (e.g. destructive, non-destructive)
- checking (e.g. dimensional, visual), quality standards

Learning outcome

The learner will:

- 4 Know common materials used in fabrication

Assessment criteria

The learner can:

- 4.1 describe the different materials and their forms that can be used in fabrication
4.2 outline possible fabrication applications for different types of materials
-

Range

(AC4.1) **materials**

- ferrous (low-carbon, medium-carbon, high-carbon and stainless steels)
- non-ferrous (aluminium/aluminium alloys, brass, copper, titanium/titanium alloys, zinc/zinc alloys)

(AC4.2) **different types of materials**

- metallic and polymers
 - composites
-

Learning outcome

The learner will:

- 5 Know the different types and application of tools used in fabrication

Assessment criteria

The learner can:

- 5.1 identify the use of hand tools within fabrication applications and their function
5.2 identify and machine tools used within fabrication and their functions
-

Range

(AC5.1) **hand tools**

- hammers
 - mallets
 - files, chisels
 - clamps and grips
 - spanners
 - cutting tools
 - screwdrivers
 - pliers
 - saws
 - formers
 - wire brushes
-

(AC5.2) **machinery**

- milling machines
- drills
- saws
- grinding machines
- guillotines
- shears
- punches

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Know how to prepare equipment, tools and materials for cutting pipework

Assessment criteria

The learner can:

- 1.1 outline how to prepare equipment and tools for a cutting operation
 - 1.2 describe how to prepare materials for a cutting operation
 - 1.3 describe how to safely carry out cutting processes
-

Range

(AC1.1) **equipment and tools**

- drills (bench, pillar, portable)
- rotary pipe cutters (hand-held, machine)
- bandsaw
- oxy-fuel gas cutting equipment
- grinders (portable angle grinders/sanders, internal grinding)

(AC1.2) **prepare**

- interpret the drawings
- methods of marking out including use of datums

(AC1.3) **cutting processes**

- drills (bench, pillar, portable)
- rotary pipe cutters (hand-held, machine)
- bandsaw
- oxy-fuel gas cutting equipment
- grinders (portable angle grinders/sanders, internal grinding)

Learning outcome

The learner will:

- 2 Understand how to prepare and use equipment, tools and materials to safely form and fabricate pipework

Assessment criteria

The learner can:

- 2.1 describe the processes used for forming pipework
- 2.2 describe the methods used to assemble pipework

Range

(AC2.1) processes

- hot bending (principles, including control of pipe deformation by sand packing)
- cold bending (hand and machine methods including wire templates and control of pipe deformation)

(AC2.2) assemble

- branches and trunnions (equal, unequal)
- fittings (elbows, tees, reducers, flanges, unions, couplings, weldolets, elbowlets, lateralets, end caps)
- work holding and alignment (pipe vice, pipe clamps, vee blocks, wedges)

Learning outcome

The learner will:

- 3 Know how to produce and test fabricated pipework assemblies using joining techniques

Assessment criteria

The learner can:

- 3.1 describe the joining techniques to safely produce fabrications
- 3.2 describe how to test fabricated pipework safely

Range

(AC3.1) joining techniques

- mechanical fixings: bolts and nuts including, use of washers, gasket and seals including jointing compounds
- compression joints including push-fit fitting connection
- adhesive bonded connections
- soldered
- brazed
- welded (manual metal arc, TIG, MIG/MAG)

health and safety considerations

(AC3.2) **test pipework**

- hydrostatic, pneumatic and vacuum (principles, operation, safety considerations)

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand how to prepare for electrical maintenance activities using safe and effective working practices

Assessment criteria

The learner can:

- 1.1 describe safe working practices and health and safety requirements
- 1.2 describe the hazards associated with electrical maintenance activities
- 1.3 describe sources of information used during electrical maintenance activities
- 1.4 describe types of electrical maintenance activities
- 1.5 describe the factors to be considered when planning an electrical maintenance activity
- 1.6 describe the procedures for cleaning work areas following a spillage or leakage
- 1.7 describe maintenance diagnostic and fault location techniques and aids used

Range

(AC1.1) **safe working practices**

- Health and safety law
- wearing appropriate protective clothing and equipment, signs (mandatory, warning, prohibited, emergency)
- maintaining a clean and tidy work area, use of barriers and/or tapes, post warning signs
- informing personnel of maintenance activities
- system isolation procedures for power and pressure sources, permit-to work procedures
- preparing the work area
- leaving the work area in a safe and clean condition

(AC1.2) **hazards**

- handling of oils and grease
- misuse of tools
- use of damaged or badly maintained tools
- not following laid-down maintenance procedures

(AC1.3) **information sources:**

- drawings, charts, tables
- manufacturers' instructions
- service manuals
- drawings (orthographic, isometric, exploded views)
- technical specifications
- circuit and wiring diagrams
- layout diagrams
- previous inspection reports

(AC1.4) **maintenance activities:**

- routine servicing schedules, planned
- preventive maintenance
- repair or replacement following breakdowns
- monitoring and performance tests

(AC1.5) **planning**

- tools and equipment requirements
- materials and replacement parts
- importance of minimising downtime to avoid production loss
- site conditions
- component location
- provision of services (electricity, water, drainage)

(AC1.6) **cleaning work areas**

- approved waste disposal methods
- absorbent substances
- use of detergents and solvents

(AC1.7) **diagnostic and fault location techniques:**

- evaluation using sensory information
- diagnostic techniques
- fault location techniques

aids:

- manuals
- flow charts
- troubleshooting guides
- maintenance records
- barcodes
- catalogue numbers

Additional Guidance:

- Diagnostic and fault location techniques: evaluation using sensory information (sight, sound, smell, touch), diagnostic techniques (fault reports, visual checks, measurement, movement and termination checks, testing), fault location techniques (half-split, input-to-output, function testing, unit substitution, equipment self-diagnostics)

Learning outcome

The learner will:

- 2 Know how to select working methods, tools and equipment

Assessment criteria

The learner can:

- 2.1 describe how to set-up access equipment for safe working
- 2.2 describe safe lifting techniques
- 2.3 state how to move heavy equipment across a flat surface
- 2.4 describe types of tools and equipment and how they are used
- 2.5 describe how to perform measurement and alignment using equipment
- 2.6 describe how to replace life determined items
- 2.7 describe the methods of applying lubricants and reasons for applying them

Range

(AC2.1) access equipment:

- ladders
- scaffolding
- platforms
- mobile hoists

(AC2.2) lifting techniques:

- chains
- rope and wire slings
- hooks
- Shackles
- eye bolts
- methods of sling attachment to prevent damage to sling / machinery (protective padding, wooden blocks) estimation of approximate weight
- use of manufacturers data, centre of gravity of load
- angle of splay between two leg sling chains not to exceed 120°
- never exceed the safe working load [SWL]
- inspection records for lifting equipment are current
- lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks)

(AC2.3) heavy equipment:

- rollers and skates
- crowbars
- pull-lifts
- lubricated plates

(AC2.4) **tools and equipment**

- torque/impact wrenches, pipe wrenches, pipe cutting and threading, spanners and socket sets, drifts and wedges, extractors, feeler gauges, screw drivers, pliers, wire cutter/strippers
- rules/tapes, micrometers, vernier instruments, ammeters, voltmeters,
- ohmmeters, insulation resistance tester, multi-meters, straight edges, squares, feeler gauges, plumb line, spirit level, piano wire, optical instruments, lasers, checks for accuracy
- high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets
- Bearings, slideway materials, belt and chain drives (including drive pulleys and sprockets, braking media, filters, springs, shock absorbing components, mechanical seals)
- friction between moving parts, wear, generation of heat, force required to overcome friction, methods of reduction (oils [mineral, synthetic, animal and vegetable] greases, copper compound, graphite), application (total loss, re-circulatory, splash, grease guns and nipples), reasons for oil deterioration (excessive heat, oxidation, contamination, breakdown of structure, poor storage conditions)

(AC2.5) **perform**

- test using calibrated equipment and the importance of calibration

equipment: use of and checks for accuracy

- rules/tapes, ammeters, voltmeters, ohmmeters/continuity testers, insulation resistance testers, multi-meters, straight edges, squares, chalk line, spirit level, lasers

Learning outcome

The learner will:

- 3 Understand how to use dismantling/assembly techniques for components/systems

Assessment criteria

The learner can:

- 3.1 describe how to dismantle an electrical engineering device or system
- 3.2 describe how to re-assemble an electrical engineering device or system
- 3.3 describe how to restore the work area using the correct procedures for the disposal of waste
- 3.4 state what would be covered in a report completed following an electrical maintenance activity

Range

(AC3.1) **electrical systems**

- Lighting, power, control, LV, ELV

dismantle

- procedure for isolation and locking off a device/system
- sequence of operations used to dismantle a device/system
- correct storage procedures for removed parts diodes/transistors, fuses, printed circuit boards, seals, gaskets, rivets;
- removal and refitting of: seals, gaskets, packings, grommets

(AC3.2) **re-assemble**

- laying out components parts in logical sequence to aid re-assembly
- fitting of mating parts
- type and use of mechanical/electrical securing devices
- tighten fastenings correctly

(AC3.3) **restore the work area:**

- leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

(AC3.4) **report:**

including:

- identification of equipment
- type of maintenance undertaken
- repairs carried out
- details of replaced parts and consumables
- time taken
- any outstanding maintenance issues.
- parts beginning to show signs of wear or deterioration that were not replaced, but would need attention when next maintained
- any improved or unusual operating conditions as a result of maintenance
- the process of cancellation of work permits and removal of tag outs

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand how to prepare for mechanical maintenance activities using safe and effective working practices

Assessment criteria

The learner can:

- 1.1 describe safe working practices and health and safety requirements
- 1.2 describe the hazards associated with mechanical maintenance activities
- 1.3 describe sources of information used during mechanical maintenance activities
- 1.4 describe types of mechanical maintenance activities
- 1.5 describe the factors to be considered when planning a mechanical maintenance activity
- 1.6 explain the procedures for cleaning work areas following a spillage or leakage
- 1.7 describe maintenance diagnostic and fault location techniques

Range

(AC1.1) **safe working practices**

- Health and safety law
- PPE
- Signage (mandatory warning prohibited and emergency)
- procedures for informing personnel of maintenance activities
- system isolation procedures for power and pressure sources
- permit-to work procedures

(AC1.2) **hazards**

- handling of oils and grease
- use of damaged or badly maintained tools
- not following laid-down maintenance procedures
- risk of entanglement
- electrical risks

(AC1.3) **information sources**

- drawings (orthographic, isometric, exploded views)
- charts
- tables
- manufacturers' instructions
- service manuals
- technical specifications
- signs (mandatory, warning, prohibited, emergency)

(AC1.4) **maintenance activities**

- routine servicing schedules
- planned / preventive maintenance
- repair /replacement following breakdowns
- monitoring and performance tests

(AC1.5) **planning**

- tools and equipment requirements
- materials and replacement parts
- importance of minimising downtime to avoid production loss
- site conditions
- component location
- provision of services (electricity, water, drainage)

(AC1.6) **cleaning work areas**

- Know the required waste disposal methods
- absorbent substances
- use of detergents and solvents

(AC1.7) **diagnostic and fault location techniques:**

evaluation using sensory information

- sight
- sound
- smell
- touch

diagnostic techniques

- fault reports
- visual checks
- measurement
- movement and alignment checks
- testing

fault location techniques

- half-split
- input-to-output
- function testing
- unit substitution
- equipment self-diagnostics

Learning outcome

The learner will:

- 2 Know how to select working methods, tools and equipment

Assessment criteria

The learner can:

- 2.1 describe how to set-up access equipment for safe working
- 2.2 state how to move heavy equipment across a flat surface
- 2.3 describe types of tools and equipment and how they are used
- 2.4 describe how to perform measurement and alignment using equipment
- 2.5 describe how to replace life determined items
- 2.6 describe the methods of applying lubricants and the reasons for applying them

Range

(AC2.1) **access equipment**

- ladders
- scaffolding
- platforms
- mobile hoists

(AC2.2) **heavy equipment**

- rollers and skates
- crowbars
- pull-lifts
- lubricated plates

(AC2.3) **tools and equipment**

- torque/impact wrenches
- pipe wrenches
- pipe cutting and threading
- spanners and socket sets
- drifts and wedges
- extractors
- feeler gauges
- screwdrivers
- pliers
- wire cutter/strippers

(AC2.4) **perform:** measure using calibrated equipment and the importance of calibration

(AC2.4) **equipment**

- engineering rules
- micrometers
- Vernier instruments
- ammeters
- voltmeters
- ohmmeters
- insulation resistance tester
- multi-meters
- straight edges
- squares
- feeler gauges
- plumb line
- spirit level
- piano wire
- optical instruments
- lasers

(AC2.4) checks for accuracy

(AC2.5) **life determined**

- high tensile bolts and washers
- nylon insert nuts
- locking devices
- split pins
- seals and gaskets

(AC2.6) **lubricants:**

Types of lubricant

- oils (mineral, synthetic, animal and vegetable)
- greases
- copper compound
- graphite

Application methods

- total loss oiling system
- re-circulatory
- splash
- grease guns
- nipples

Reasons

- friction between moving parts
- wear
- generation of heat

Learning outcome

The learner will:

- 3 Understand how to use dismantling/assembly techniques for device or systems

Assessment criteria

The learner can:

- 3.1 describe how to dismantle a mechanical engineering device or system
- 3.2 describe how to re-assemble a mechanical engineering device or system
- 3.3 state what would be covered in a report completed following a mechanical maintenance activity

Range

(AC3.1, **mechanical systems**

- AC3.2)
- bearings
 - slideway materials
 - belt and chain drives

(AC3.1) **dismantle:**

procedure for dismantling

- isolation and locking off a device/system,
- sequence of operations used
- proof marking
- correct storage procedures for removed parts
- release of pressure/force

(AC3.2) **re-assemble:**

Procedure for re-assembly

- laying out components parts in logical sequence to aid re-assembly
- tensioning (belts, chains)
- components that may need to be replaced (high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets)
- fitting of mating parts (filing, scraping locating, cleaning)
- need for the use of shims or packing
- type and use of mechanical locking devices
- tighten fastenings correctly (correct torque applied, correct tightening sequence)

(AC3.3) **report**

- identification of equipment
- type of maintenance undertaken
- repairs carried out
- details of replaced parts and consumables
- time taken
- any outstanding maintenance issues
- any improved or unusual operating conditions as a result of maintenance.

Unit level: Level 2

GLH: 50

Learning outcome

The learner will:

- 1 Understand what is meant by continuous improvement

Assessment criteria

The learner can:

- 1.1 explain the meaning of continuous improvement
 - 1.2 outline the benefits of applying continuous improvement techniques
 - 1.3 define each stage of the Plan – Do – Check – Act (PDCA) improvement cycle
 - 1.4 define the different categories of waste
-

Range

(AC1.2)

benefits

- reduced cost, e.g. production
- improved quality, e.g. reduced defects
- improved safety, e.g. safe to use
- improved working practices, e.g. reduced operator motion
- improved delivery, e.g. reduced transportation time, reduced lead time
- reduction of waste, e.g. over processing, excess inventory
- resource utilisation, e.g. reduced waiting time
- improved customer satisfaction, e.g. meeting customer requirements

(AC1.4) **categories of waste, to include:**

- transport
- inventory
- motion
- waiting
- over production
- over processing
- defects
- skills/unrecognised people potential

(AC1.4) **categories of work:**

- value added
 - non-value added
 - waste
-

Learning outcome

The learner will:

- 2 Understand what is meant by workplace organisation

Assessment criteria

The learner can:

- 2.1 explain the meaning of workplace organisation
- 2.2 outline the benefits of having an organised working environment
- 2.3 describe the effect an unorganised work environment may have
- 2.4 explain the importance of Standard Operating Procedures (SOPs) within workplace organisation

Range

(AC2.3) **unorganised work environment effects:**

- poor quality
- increased costs
- reduced efficiency
- poor delivery times
- poor morale/teamwork
- poor health and safety

Learning outcome

The learner will:

- 3 Understand what is meant by visual management

Assessment criteria

The learner can:

- 3.1 explain the meaning of visual management
- 3.2 describe the benefits of applying good visual management
- 3.3 describe different types of visual management

Range

(AC3.1, **good visual management benefits**

- AC3.2)
- accurate and relevant
 - eye-catching
 - simple
 - greater ownership

(AC3.3) **types of visual management**

- shadow boards
 - PDCA worksheets
 - colour coding
 - floor footprints
 - storyboards
 - gauges
 - photographs/pictures
 - labelling
 - lights
 - schedule boards
 - Kanban (pull systems)
 - graphs
 - management boards
 - other area-specific types of visual management
-

Learning outcome

The learner will:

4 Understand problem solving techniques

Assessment criteria

The learner can:

- 4.1 explain what is meant by a problem within a work environment
 - 4.2 describe the benefits of solving work related problems
 - 4.3 outline different techniques used for identifying and analysing problems
 - 4.4 explain the importance of applying the appropriate corrective action and eliminating the root cause of a problem
-

Range

(AC4.3) **techniques**

- tally charts
 - flow charts
 - histogram/Pareto chart
 - benchmarking
 - process mapping
 - correlation diagram
 - run diagram
 - statistical process control
 - control charts
 - Gantt charts
 - root cause paths
 - value stream maps
 - Ishikawa diagrams (cause and effect, fishbone)
 - brainstorming
 - mind mapping
 - 5 why analysis
-

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand the basic units used in electrotechnology

Assessment criteria

The learner can:

- 1.1 describe the theories used in electrotechnology
- 1.2 state the basic units used in electrotechnology
- 1.3 carry out electrical calculations

Range

(AC1.1) **theories**

- voltage
- current
- resistance
- power
- series and parallel circuits

(AC1.2) **basic units:**

S.I. Units and derived units including multiples and sub-multiples for length, area and volume, force, energy, power, pressure & stress, electrical potential, charge & flux, magnetic flux, flux density, electrical resistance, capacitance, inductance, frequency, temperature, current

(AC1.3) **electrical calculations**

- Ohms Law
- resistivity
- resistors in series and parallel
- current, voltage and resistance in parallel circuits
- power including power ratings for common components and equipment
- electrical energy transferred (power x time)

Learning outcome

The learner will:

- 2 Understand the application of electrotechnology

Assessment criteria

The learner can:

- 2.1 describe the characteristics and functions of electrical components
 - 2.2 describe the application of electrical components
-

Range

(AC2.1) **electrical components**

- magnets
- solenoids
- relays
- resistors
- capacitors (polarised, paper, polyethylene, air, mica)
- AC and DC motors / generators.
- Transformers (basic construction of single phase transformers, core types, core, shell and toroidal, laminations and ferrite cores, double wound and auto-transformers)
- diodes, Zener diodes, LEDs, bi-polar transistors.
- Light Dependent Resistors (LDRs)
- thermistors
- commercially available sockets and plugs (phono, din, edge, 'D' co-axial).

(AC2.2) **application**

- AC and DC power generation.
- motors, motor drive control DC or AC
- bridge rectifier circuits
- basic lighting, lighting control, LED drive circuitry
- light detection systems using an LDR
- temperature control (environmental control)
- basic transistor circuits (switching, amplifier)
- voltage transformation systems
- security systems alarms

Learning outcome

The learner will:

- 3 Know how to identify the characteristics of an electrical circuit

Assessment criteria

The learner can:

- 3.1 determine the current and voltage distribution in series and parallel circuits
- 3.2 describe the magnetic fields for bar magnets in various configurations
- 3.3 describe sine waves as displayed on oscilloscopes
- 3.4 determine the input and output voltage of double wound transformers

Range

(AC3.2) **magnetic fields:**

magnetic fields for single bar magnets, N-N, S-S and N-S combinations.

(AC3.3) **sine wave:**

Sketch a sine wave and indicate peak, average and root mean square values.

Unit 210

General machining applications (turning and milling)

Unit level:	Level 2
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GLH:	60
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Learning outcome

The learner will:

- 1 Understand the equipment and procedures used in machining operations

Assessment criteria

The learner can:

- 1.1 state their duties under the relevant legislation
 - 1.2 describe how to operate machines safely relating to the setting and use of machines
 - 1.3 identify the main parts of machines and its controls
 - 1.4 describe the range of operations that can be undertaken on the machines
 - 1.5 describe how to plan the sequence of operations for machining specific components
-

Range

(AC1.1) **relevant legislation:**

- use of machinery and equipment
- risk assessment
- personal protective equipment
- hazardous substances
- environmental considerations such as safe/correct disposal of waste and recycling

(AC1.2) **specific safety precautions:**

- following safe working practices and procedures
 - emergency stops
 - machine guarding
 - mounting workholding equipment, tools and work pieces
 - PPE
-

(AC1.3, **machine controls, component parts:**

AC1.4, controls:

- AC1.5)
- speed and feed selectors
 - start and stop systems

machine parts:

- carriage
- bed
- slides
- arbor
- rotating parts including spindles
- feed shafts and lead screws
- guards and motor
- toolposts

(AC1.6) **range of operations:**

lathe:

- plain
- stepped and tapered diameters
- faces
- shoulders
- internal and external threads
- drilled, bored and reamed holes
- chamfers
- radii
- grooves
- undercuts and parting off
- knurling.

mill:

- flat
- parallel and square faces
- open ended and enclosed slots
- steps
- shoulders and angular faces
- indexed or rotated forms
- recesses/keyways
- tee slot
- dovetail and woodruff

profile forms:

- vee
- concave
- convex
- gear forms
- serrations
- special form

(AC1.7) **Operations for machining:**

- cutting tools and cutting fluids

- calculating speeds and feeds
-

Learning outcome

The learner will:

- 2 Understand how to use workholding equipment correctly

Assessment criteria

The learner can:

- 2.1 explain the different types of workholding available and their use
 - 2.2 outline the appropriate applications of work holding devices
 - 2.3 describe methods of protecting finished surfaces from marking or damage
 - 2.4 describe how to mount, secure and align appropriate work holding devices
 - 2.5 describe how to mount work in work holding devices
-

Range

(AC2.1) **workholding devices:**

lathe:

- 3 jaw chuck
- 4 jaw chuck
- face plate

milling:

- machine vice
- angle plates
- vee block and clamps
- clamping directly to a machine table

general considerations :

- methods of protecting finished surfaces from marking or damage including soft jaws

Learning outcome

The learner will:

- 3 Understand the types and applications of cutting tools

Assessment criteria

The learner can:

- 3.1 identify types of cutting tools and describe their applications
- 3.2 outline how to use the correct cutting tools to manufacture a component to a given specification

Range

(AC3.1) **cutting tool and applications:**

milling:

- end face
- side face
- slot drills
- form cutters

turning:

- facing
- straight nosed rougher
- round nose planer
- knife or side cutters
- parting off external screw cutting
- knurling
- centre drill
- countersink
- boring bar
- reamer

(AC3.2) **uses:**

- use of manufacturer's data sheets to determine cutting speeds and feed rates.
- types of lubrication and reasons for their use
- influence of workpiece material, cutting speed and feed rates and lubrication on the quality of the machine part.

Learning outcome

The learner will:

- 4 Understand the quality/standards and requirements associated with machining operations

Assessment criteria

The learner can:

- 4.1 explain the role of standards
- 4.2 state the meaning of the term 'tolerance' and explain the importance of tolerances
- 4.3 calculate tolerances
- 4.4 outline the appropriate applications of measuring equipment

Range

(AC4.1) **standards:**

The learner needs to be able to explain the reasons for having standards and list the following standard bodies.

- British Standards (BS)
- European Standards (EN)
- International Standards (ISO)

(AC4.4) **measuring equipment:**

- micrometers
- Vernier calliper
- engineering rules
- hole gauges
- thread gauges
- protractors
- radius/profile gauges
- Dial Test Indicators (DTI)
- surface finish equipment (such as comparison plates, machines)
- Coordinate Measuring Machine (CMM)

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 know the function and purpose of common fluid power system components

Assessment criteria

The learner can:

- 1.1 state the purpose of the fluid power systems
 - 1.2 state the function of typical fluid power systems components
-

Range

(AC1.2) **components:**

- valves
- cylinders/actuators
- pumps
- lubricators
- switches
- bearings
- compressors
- pressure intensifiers
- sensors
- accumulators
- regulators
- receivers
- gaskets and seals
- reservoirs/storage devices
- gauges/indicators
- filters
- motors
- coolers
- timers

(AC1.3) **system:** types of fluid power system (pneumatic and hydraulic)

Learning outcome

The learner will:

- 2 Know how to prepare for routine maintenance activities and dismantle devices and equipment

Assessment criteria

The learner can:

- 2.1 describe the hazards associated with fluid systems maintenance activities
- 2.2 outline how to produce a plan for an assembly/maintenance activity for a fluid power circuit
- 2.3 describe how to extract information from sources

Range

(AC2.1) hazards

- handling of oils and grease (toxicity, harmful effects to skin and body)
- misuses of tools
- use of damaged or badly maintained tools
- not following laid-down maintenance procedures
- stored energy/force
- handling of compressed air (harmful effects to skin and body)

(AC2.2) plan

- description of task
- location(s)
- date and times (commencement, completion, handover)
- parts and consumables to be used
- test data requirements
- checks to be made
- permits to work required
- tools and equipment requirements
- isolation/barrier requirements
- sequence of operations for dismantle/re-assemble components
- provision for spillages

(AC2.3) information sources

- charts (seals and gaskets, lubrication and screw threads, etc)
- internet
- catalogues

Learning outcome

The learner will:

- 3 Know how to apply testing/fault finding techniques

Assessment criteria

The learner can:

- 3.1 describe how to assess fluid power system for common faults
- 3.2 describe how to carry out fluid power testing
- 3.3 describe how to identify and rectify leaks/faults
- 3.4 outline how to complete relevant test/maintenance records/documentation

Range

(AC3.1) **common faults**

- ensure all pipes/components are secure
- moving parts are chocked or parked
- evaluation using sensory information

(AC3.1) **test instruments and diagnostic techniques**

- diagnostic techniques
- fault location techniques
- diagnostic aids
- test instruments
- contamination testing
- operational testing

(AC3.2) **fluid power testing**

- connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem
- importance of correct calibration of test equipment
- handling/application of measuring/test equipment
- static tests
- dynamic test

(AC3.3) **leaks/faults**

hydraulic:

- know the reasons for effect of air in the system and the need for bleeding
- effect of leaks
- the reason for applying test pressures in incremental stages
- check for: no open ends, valves in test position/status, moving parts in test position/status, pipe/components fitted to specification, clamps/brackets position and fitted correctly, bleed vents accessible

pneumatic:

- know the reasons for applying test pressures in incremental stages
- re-run of tests to confirm that system performs to specification
- know how to check for:
 - all connections have been completed
 - all components are secure
 - leaks including the use of leak detection fluids
 - moving parts are 'parked'.

(AC3.4) **test/maintenance records/documentation**

- description of work undertaken
- location(s)
- date and times (commencement, completion, handover)
- parts and consumables used
- test data
- movement of parts
- noise and vibration levels
- temperature
- adjustment required
- permit to work reference

Learning outcome

The learner will:

- 4 Understand how to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

Assessment criteria

The learner can:

- 4.1 state the safe working practices and procedures used during maintenance activities
- 4.2 identify the tools and equipment used to undertake maintenance operations
- 4.3 explain how to safely dismantle, clean and inspect faulty components in fluid power systems
- 4.4 explain how to re-assemble fluid power systems
- 4.5 outline how to prepare a report following maintenance activities

Range

(AC4.1) **safe working practices**

- wearing appropriate protective clothing and equipment
- use of barriers and/or tapes
- warning signs
- methods of informing personnel of maintenance activities
- system isolation procedures for power and pressure sources
- permit to work procedures

(AC4.2) **tools and equipment**

- spanners (open-ended, socket sets, ring)
- torque wrenches
- screwdrivers
- allen keys
- fastening devices for hydraulic equipment (nuts, bolts, studs, screws, locking devices)

(AC4.3) **dismantle**

- release of pressure
- proof marking

(AC4.4) **clean**

- dust (blow, vacuum)
- dirt (brushing, vacuum)
- grease (degreasing agents, solvents, steam)

(AC4.4) **inspect**

- methods of checking that components are fit for purpose, free from damage, distortion and leaks (pipes and hose connections, cylinders and valves, corrosion)

(AC4.4) **re-assemble**

- hand bending methods
- types of fittings (screwed, flanged, push in)
- leak free joints (gaskets, jointing and sealing compounds, seals)
- methods of securing components and pipe (clamps, brackets)

(AC4.5) **report**

- importance of completing a maintenance documentation following the maintenance activities
- reporting defect (tools, equipment, components)

Unit 212

Constructing, testing and fault finding electronic circuits

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Know how to prepare for building and testing of electronic circuits

Assessment criteria

The learner can:

- 1.1 define units of measurement and their multiples and sub-multiples for electrical quantities and components
 - 1.2 describe the relationship between Voltage current and resistance in simple dc circuits (Ohms Law)
 - 1.3 identify components and their circuit symbols
 - 1.4 describe the component functions
 - 1.5 state typical applications for power supplies
 - 1.6 explain the function of a heat sink
 - 1.7 outline how to select and use information from common sources used in the electronics industry
 - 1.8 identify potential hazards and safety measures that could be applied
-

Range

(AC1.1) **units of measurement**

- ampere
- volt
- ohm
- Watt
- Farad

scales

- pico
 - nano
 - micro
 - milli
 - Kilo
 - Mega
 - Giga
-

- Tera

(AC1.3) **electronic components**

AC1.4) Input device:

- switches
- LDR
- thermistors

process:

- integrated circuits

drivers:

- Transistor
- Darlington
- MOSFET

passive:

- resistors (fixed and variable)
- capacitors (polarised and non-polarised)
- inductors
- diodes

transformers

fuses

outputs:

- lamp
- LED
- buzzer
- loud speaker
- relay
- motors

(AC1.5) **power supplies**

- mains
- batteries (rechargeable, non-rechargeable)

(AC1.7) **common sources**

- circuit diagrams
- block diagrams
- layout diagrams
- wiring diagrams
- equipment reference manuals
- data sheets

(AC1.8) **potential hazards**

- using hand tools
- soldering equipment
- high voltages

(AC1.8) **safety measures**

- isolation transformers
- RCD protection
- rubber matting
- anti-static wrist / ankle straps / clothing
- solder fume extraction

Learning outcome

The learner will:

- 2 Understand how to test, fault find and repair electronic equipment

Assessment criteria

The learner can:

- 2.1 describe preparatory activities necessary prior to testing electronic equipment
 - 2.2 describe the test methods
 - 2.3 describe typical faults in electrical equipment and how they can be identified
 - 2.4 describe common factors that determine the method of repair
-

Range

(AC2.1) **preparatory activities**

- safety checks
- test instrument calibration check
- setting up of test instruments
- removal of equipment covers / casings, mains supply isolation
- cleaning of modules/components

(AC2.2) **test methods**

- use of measuring instruments (multimeter, continuity tester, oscilloscope,)
- visual inspection

(AC2.4) **typical faults:** the Learner should be able to identify the terminology: symptom-fault-cause in relation to this assessment criteria.

faults:

- damaged/faulty components
- damaged wiring/cables
- breaks in printed circuit board tracks
- shorting
- test probes
- instrument sensors
- risk of arcing
- risk of shorting
- risk of circuit loading

fault diagnosis techniques

(AC2.5) **common factors**

- time versus cost of module/unit
 - serviceability of module/unit
 - availability of individual components
 - possibility of damage to other components / modules
-

Learning outcome

The learner will:

- 3 Know how to construct new electronic equipment

Assessment criteria

The learner can:

- 3.1 describe how to use the correct assembly methods for circuit boards

Range

(AC3.1) **assembly methods**

- through hole construction
- surface mount
- non-permanent methods
- wired

considerations

- avoiding static damage
- effective soldering practices
- de-soldering
- component removal methods
- wiring
- positioning of components
- component orientation
- component mounting
- avoidance of component damage
- routing and grouping of wiring
- marking of flying leads / connectors
- cable ties and clamps

Unit level:

Level 2

GLH:

60

Learning outcome

The learner will:

- 1 Understand safe electrical isolation procedures

Assessment criteria

The learner can:

- 1.1 outline the dangers of electricity and high voltages
 - 1.2 explain the need to safely isolate circuits, and the safe isolation procedure
 - 1.3 explain how to identify unsafe/safe electrical situations
 - 1.4 describe how to perform the safe isolation procedure
-

Learning outcome

The learner will:

- 2 Understand how to inspect and test a circuit

Assessment criteria

The learner can:

- 2.1 describe preparatory activities necessary prior to testing electronic equipment
 - 2.2 describe the test methods and their applications
 - 2.3 describe typical faults in electrical equipment and how they can be identified
-

Range

(AC2.1) preparatory activities

- safety checks
 - test instrument calibration check
 - setting up of test instruments
 - removal of equipment covers / casings
 - mains supply isolation, cleaning of modules/components
-

(AC2.2) **test methods**

- use of measuring instruments:
 - Multimeter
 - continuity tester
 - oscilloscope
 - insulation tester
- visual inspection

(AC2.3) **typical faults:** the Learner should be able to identify the terminology: symptom-fault-cause in relation to this assessment criteria.

faults

- damaged/faulty components
- damaged wiring/cables
- breaks in printed circuit board tracks
- shorting
- test probes
- instrument sensors
- risk of arcing
- risk of shorting
- risk of circuit loading

fault diagnosis techniques

Learning outcome

The learner will:

- 3 Know the main requirements of standards and guidance

Assessment criteria

The learner can:

- 3.1 state the requirements of BS7671 and how they apply in marine engineering applications
- 3.2 list the requirements of GS38 HSE guidance
- 3.3 state the markers/labels to components or cables to assist with identification
-

Range

(AC3.3) **identification**

- colour coding conductors
- using coded tabs

Unit level:

Level 2

GLH:

60

Learning outcome

The learner will:

- 1 Understand the principles of thermal cutting

Assessment criteria

The learner can:

- 1.1 describe the safe working practices whilst performing thermal cutting activities
 - 1.2 describe the principles of thermal cutting processes
-

Range

(AC1.1) safe working practices

- type of PPE worn
- requirements for local and portable extraction
- storage, handling and movement of compressed gases
- risks associated with oxygen and oxygen enrichment including dangers of oil
- risks associated with high power laser light
- electrical risks including high voltages
- handling of hot materials

(AC1.2) thermal cutting

Oxy-fuel

- principles
- equipment
- compressed gas requirements

Plasma arc

- principles
- equipment
- compressed air/gas requirements

Laser beam

- principles
 - equipment
-

Learning outcome

The learner will:

- 2 Understand the equipment and consumables used in thermal gas cutting

Assessment criteria

The learner can:

- 2.1 describe the function and operational requirements of the equipment used
 - 2.2 describe the requirements when working with compressed gases
-

Range

(AC2.1) **Equipment**

oxy-fuel cutting

- thread types for oxygen and fuel gases (including exceptions)
- torches
- hoses
- hose check valves
- flashback arrestors
- regulators
- Types of cutting nozzles including condition and maintenance of nozzles

plasma arc cutting

laser beam cutting

(AC2.2) **gas safety requirements**

- gas identification
 - colour codes
 - particular gas characteristics
-

Learning outcome

The learner will:

- 3 Understand setting up, using and shutting down equipment for thermal cutting

Assessment criteria

The learner can:

- 3.1 describe the setting up of thermal cutting equipment
 - 3.2 describe the use of up thermal cutting equipment
 - 3.3 describe the shutting down of thermal cutting equipment
-

Range

(AC3.1) **setting up**

oxy-fuel cutting

- selecting the nozzle size and cutting pressure
- assembly of equipment including leak testing where appropriate

plasma cutting

- voltage return to earth

holding methods used for the work piece

(AC3.2) **use of**

- cut straight lines, curves and holes
- cutting parameters including speed of travel and where appropriate, angle of torch and stand-off distance
- preheat requirements
- features of a good cut
- common cutting defects and causes
- the effects of oil paint grease scale and dirt
- for oxy fuel cutting the characteristics of correct flame settings and the neutral condition
- flame cleaning
- profile cutting
- piercing
- cutting aids such as cutting guides trammels and templates

(AC3.3) **shutting down:** for oxy fuel cutting, the procedure for extinguishing the flame.

Learning outcome

The learner will:

- 4 Understand the application of thermal cutting

Assessment criteria

The learner can:

- 4.1 describe the factors to be considered when selecting thermal cutting as a process
- 4.2 describe the applications of thermal cutting

Range

(AC4.1) **factors**

- material thickness
- material types
- quantity of cuts required
- accessibility
- availability of equipment

(AC4.2) **applications**

- manufacture of products from plate and sheet
- weld repair/removal
- level of automation used with the different processes

Unit 214 **Thermal cutting techniques**

Supporting Information

Unit guidance

Wherever possible learners should be encouraged to discuss how thermal/plasma cutting is used in their own workplaces for different applications.

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand work organisation and management

Assessment criteria

The learner can:

- 1.1 describe how to handle sheet and section materials safely
 - 1.2 describe how to prepare materials to be marked out, cut, shaped and assembled to account for the material dimensions and properties
-

Range

(AC1.1) **handle sheet and section materials safely and with regard to the local environment:**

- correct handling lifting and storage of materials
- de-burr / make safe sheet materials and sections
- principles
- equipment

(AC1.2) **prepare materials to be marked out, cut, shaped and assembled to account for the material dimensions and properties:**

- accurately transfer measurements and profiles to sheet metal and sections
 - accurately use manual and digital measuring and marking equipment
 - arrange shapes and forms to make the most economic use of available material (nesting) and reduce scrap material
 - the common characteristics such as malleability, ductility and tenacity of a range of sheet metal to include:
 - low carbon steels
 - aluminium and aluminium alloys
 - tin/brass/copper
 - galvanised and anodised sheet
 - stainless steel
-

Learning outcome

The learner will:

- 2 Understand pattern development

Assessment criteria

The learner can:

- 2.1 outline how to identify sheet metal forms from drawings in first, third angle and orthographic projection
- 2.2 describe how to apply the methods and principles of manual pattern development for parallel line, radial line and triangulated developments
- 2.3 describe how to transfer drawing information and dimension to sheet metal and sections

Range

(AC2.1) **sheet metal forms**

- identify sheet metal components and forms requiring pattern development including;
 - parallel line
 - radial line
 - triangulated
- right cylinders and cylinder frustums and intersections
- right cones and frustums and intersections
- right triangulated components

(AC2.2) **manual pattern development**

- apply standard and machine manufacturers bend and bend reduction allowances to patterns based on material type and thickness
- apply bend relief and notches to pattern corners and joints

(AC2.3) **drawing**

- manual methods using marking out equipment
- pattern materials such as paper card or metal
- projection methods using digital media

Learning outcome

The learner will:

- 3 Understand cutting and forming

Assessment criteria

The learner can:

- 3.1 list the thermal cutting methods and state the advantages and disadvantages
- 3.2 state the benefits of using CNC cutting and forming machines
- 3.3 outline how to calculate allowances for cutting, notching, bending, rolling and forming in a range of materials and sections up to 3mm in thickness
- 3.4 describe how to select, adjust and safely use a range of hand and power operated cutting machines to cut materials
- 3.5 describe how to select, adjust and safely use a range of hand and power operated forming machines to shape materials

Range

(AC3.1) **thermal cutting methods**

- oxy-fuel gas
- plasma
- laser

(AC3.2) **benefits**

- the advantages of producing components on CNC cutting equipment
- the processes available from:
 - guillotines
 - saws
 - thermal (oxy-fuel, plasma, laser)
 - water jet
 - forming and shaping machines (press, panel bending, roll forming)
- the limitations of the use of CNC equipment

(AC3.3) **calculate allowances**

- the use of mean line bending calculations for bending and rolling operations
- the causes of springback, methods to overcome it
- describe the notching procedure as required for the production of corner joints and the intersection between self-secured joints
- calculate the allowance for metal thickness to avoid “pinching” when forming materials
- describe nesting operations and explain why there are required

(AC3.4) **hand and power operated cutting machines**

- guillotines
- vibratory shears
- nibbling machines
- drilling machines
- mechanical saw
- punch and die
- grinding tools
- hacksaw and band saw
- hand shears
- punches
- calculate and set blade clearance on shearing machines
- state the relationship between cutting speeds and feeds on sawing machines and drills:
- describe the effect of rake angle on cutting
- identify from published data the correct feeds and shields
- state how to set punches and dies

(AC3.5) **select, adjust and safely use a range of hand and power operated forming machines to shape materials:**

- justify the selection of forming process for sheet metal products from range of equipment to include as many as possible from:
 - folding machines
 - rolling machines
 - edge, section rolling and forming machines
- describe how to use swaging and flanging machines
- describe the use of forming and ball swages

Learning outcome

The learner will:

- 4 Understand assembly processes

Assessment criteria

The learner can:

- 4.1 state the joining methods and the equipment needed to safely make joints in a range of materials up to 3mm in thickness
- 4.2 state the effects of joining on materials and components

Range

(AC4.1) **joining methods and the equipment needed**

- describe how to assemble products using solid and hollow rivets
- calculate the allowance for rivet size, diameter and spacing
- tools (set and snap, pulling up hollow rivets)
- mechanical fasteners (nuts, bolts, and screws)
- produce flanged and swaged joints on flat and curved surfaces
- state the safe set up and use of Arc welding processes for tack welding
- state the safe set up and use of resistance spot welding, soft and hard soldering
- state the safe use of fluxes for soldering operations

(AC4.2) **state the effects of joining on materials and components:**

- methods that will allow joined components to be aligned and free from twist and buckle
- methods of temporary assembly to ensure correct alignment of components
- methods that can be used to protect the surface finish of sheet metal components during the assembly process

Learning outcome

The learner will:

- 5 Understand finishing

Assessment criteria

The learner can:

- 5.1 state the range and characteristics of each type of surface finish
- 5.2 describe how to select and use hand tools and equipment to finish components and products safely
- 5.3 outline how to inspect finished components and products to drawings, standards and instructions

Range

(AC5.1) **range and characteristics**

- the range of finishing processes available
- the characteristics of each type of finish
- the range of tools and equipment required to operate finishing processes
- the preparation for the range of surface finishes available including:
 - powder coating
 - anodising, painting
 - polishing
 - plating
 - galvanising

(AC5.2) **finish components and products**

The learner should cover:

- planishing hammers
- bench tools and stakes
- burnishing and abrasive media
- polishing and cleaning materials
- describe how to use of power tools and equipment to finish sheet metal items including surface texturing equipment
- describe how to finish welds to achieve suitable finished profiles
- describe how to polish sheet metal and sections to achieve a saleable finish

(AC5.5) **inspect**

use measuring equipment to inspect fabrications including:

- engineering rules
- micrometres
- Vernier callipers, height gauges and protractors
- digital devices including CMM
- feeler and radius gauges

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand the types and applications of non-thermal cutting equipment

Assessment criteria

The learner can:

- 1.1 describe the principles of chip and non-chip-forming cutting
 - 1.2 state the factors that ensure efficient metal cutting
 - 1.3 list the different methods of cutting
-

Range

(AC1.1) **cutting**

- thermal cutting – oxy fuel, plasma and laser
- chip forming cutting methods
- shear; shear force of machine must overcome the shear strength of the material.
- the three stages of cutting (deformation, work hardening and fracture).

(AC1.2) **factors**

- machine capacity
- maximum thickness
- length of cut
- blade set up (rake and clearance angles)
- clearance between punch and die
- cutting tool material and condition

(AC1.3) **different methods**

- saws (band and circular)
 - guillotines
 - bench shears
 - universal steel worker
 - punches
 - nibbling machines (using punches and blades)
 - the advantages and disadvantages of the different machine types
-

Learning outcome

The learner will:

- 2 Understand the methods used for forming metal plate

Assessment criteria

The learner can:

- 2.1 describe the safe set-up procedures of bending, rolling and pressing machines
 - 2.2 describe the operational principles of forming machinery
 - 2.3 describe the difference between bending, rolling, and pressing machines
 - 2.4 describe the function and operation of forming equipment
 - 2.5 describe the forming processes used in hot and cold forming of plate work and structural steel section
-

Range

(AC2.1) to include:

- press brakes
- presses
- powered roll

the selection of appropriate machines for purpose:

- material type
- material thickness/length
- size of plate/component interpretation of machine's details from manufactures information
- the advantages and disadvantages of the different machines

- (AC2.2)
- mechanical press
 - hydraulic press

(AC2.3) **differences**

The differences between:

- manual
- mechanical
- and hydraulic operation

- (AC2.5)
- pyramid
 - pinch
 - ring rolling
 - four roll set ups
 - fixed and moving dies
 - the forming of simple shapes
 - the understanding and avoiding of cracking during bending
 - correct tooling
 - set-up
 - pressure
 - pre-heat
-

Learning outcome

The learner will:

- 3 Understand the methods used when assembling metal plate fabrications

Assessment criteria

The learner can:

- 3.1 describe the joining methods used in assembling thick plate fabrications
3.2 outline how to prepare for a fabricated assembly
3.3 describe mechanical assembly techniques used in assembling thick plate fabrications
3.4 describe tack welding techniques used in assembling thick plate fabrications
-

Range

(AC3.1) **joining methods**

- mechanical
 - mechanical fastening devices and applications
 - sequential tightening
 - assembly sequence
 - prefabrication/sub assembly/trial erection
 - (distortion avoidance)
 - temporary fastening (tack bolts)
- tack welding techniques:
 - checking assembly aids, to include:
 - clamps
 - cleats
 - wedged
 - clamping dogs and bolts
 - bridge pieces
 - strong backs

(AC3.2) **prepare**

- selection of process appropriate for purpose, taking into account material type and thickness
- the assembly methods used in plate fabrication
- requirements for marking out
- checking components prior to assembly:
 - condition and accuracy
 - position of holes/weld preparations
 - orientation and fit up of parts

Learning outcome

The learner will:

- 4 Understand the welding techniques used for assembling metal plate fabrications

Assessment criteria

The learner can:

- 4.1 describe the set-up and safe use of arc welding equipment
4.2 describe the safe working practices observed when using an arc welding processes
4.3 describe the welding of plain carbon steels, low alloy steels and stainless steels
-

Range

(AC4.1) **set-up and safe use**

- welding process TIG, MIG/MAG, MMA
- equipment used for arc welding processes

(AC4.2) **safe working practices to include:**

- hazards associated with welding plant and equipment
- PPE
- types of radiation emitted from the arc
- fume and extraction

(AC4.3) **welding**

- selection of an appropriate consumable or electrode as appropriate
- use of a shielding gas as appropriate
- back purging where appropriate
- joint preparation
- joint cleanliness
- pre-welding alignment and accuracy checks
- methods of distortion control
- application of pre-heat
- post-weld cleaning
- recognition of welding defects

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Understand the processes that support the mechanical assembly and fitting of engineering components

Assessment criteria

The learner can:

- 1.1 describe the uses of engineering drawings and specifications in mechanical assembly and fitting
 - 1.2 describe the processes that support the mechanical assembly and fitting of engineering components
-

Range

(AC1.1) **uses**

- visual perspective
- technical details
- accurately illustrates engineering components

(AC1.2) **supportive processes, to include:**

- support documentation
 - standards documentation
 - specifications
-

Learning outcome

The learner will:

- 2 Understand assembling and fitting components safely to engineering equipment

Assessment criteria

The learner can:

- 2.1 describe how to safely connect/fit given components to engineering equipment
 - 2.2 describe how to safely use tools and relevant assembly methods and techniques to carry out different assembly tasks safely
-

2.3 describe how to use relevant standards and instructions to check the compliance of an assembly for quality and accuracy

Range

(AC2.1) **components**

electrical/electronic components:

- components, to include: conduit, trunking, tray type table enclosures, plugs and sockets, sensors, motors, transformers, relays, solenoids, switches, electronic modular units, instrumentation units
- techniques, to include: routing cables and wires, mounting/securing components, cable fixings and fasteners, terminating and joining cables/wires using screwed/clamped/soldered/crimped connections
- use of cable protection devices, to include:
 - sleeving
 - grommets

hydraulic power components

- components, to include: motors, pumps, compressors, intensifiers, filters, lubricators, separation units, reservoirs, accumulators, sensors, meters, gauges, indicators
- pipework and connection devices, to include: manifolds, couplings, laying pipework/cabling/wires
- control components, to include: valves, actuators, cylinders, regulators

(AC2.2) The learner should cover the following:

- fitting, to include: filing, scraping, lapping, polishing, blue bedding of components, shimming, packing, use of expansion/contraction methods
- securing, to include: fasteners, threaded devices, bolt locking methods, riveting, soldering, brazing, sealants, adhesives
- use of tools, to include: drilling, soldering irons, reaming, press tools, hacksaws, files, spanners, screwdrivers, wrenches, sockets, crimping tools, torque wrench, alignment tools
- use of assembly aids and equipment, to include: work-holding devices, jigs, fixtures, supports, lifting and moving equipment, rollers, wedges
- working within specified timeframes, to include: estimation time to complete task, working to set times
- maintaining safe working environment, to include: appropriate and approved assembly techniques used at all times, work area housekeeping, risk assessments
- assembly tasks (sub-assemblies or assemblies), to include: panel, support framework, casings, hydraulic power, simple electrical circuit, component kits

- ### (AC2.3)
- quality checks, to include: setting working clearance, torque settings, alignment, balancing
 - national standards, to include: British Standards (BS), International Organisation for Standardisation (ISO)
 - design standards, to include: customer standards and requirements, company standards and procedures

- specified instructions, to include: specific system requirements, operational manuals, manufacturers' instructions

Learning outcome

The learner will:

- 3 Understand the safe use of tools, equipment and measuring instruments to carry out quality checks on assembled engineering equipment

Assessment criteria

The learner can:

- 3.1 describe how hand and power tools, equipment and measuring instruments are fit for purpose
- 3.2 describe how to safely use tools, equipment and measuring instruments to carry out quality checks on different types of assembled engineering equipment
- 3.3 describe how to safely carry out quality checks on given engineering equipment and their components

Range

- (AC3.1)
- appropriateness to assembly task
 - health and safety considerations
 - relevant regulations and guidance
 - permitted operating range
- (AC3.2)
- hand tools, e.g. hacksaws, files, spanners, screwdrivers, wrenches, sockets, crimping tools
 - power tools, e.g. drills, soldering irons, air tools
 - equipment: Personal Protective Equipment (PPE); other, e.g. for lifting and moving, jigs, fixtures, supports, wire looms
 - measuring instruments, e.g. rule, tape measure, micrometers, gauges, dial test indicators, multimeters, pressure meters
- (AC3.3)
- quality checks, e.g. completeness, alignment, size, positional accuracy, component security, damage or foreign objects
 - engineering equipment that has a range of components e.g.:
 - electrical/electronic – correct inputs/outputs, electrical continuity
 - hydraulic power – function, leak and pressure testing, electrical continuity, pipework free from ripples or creases
 - sub-assemblies – function, freedom of movement, orientation, operating/working clearances, bearing end float

Unit level: Level 2

GLH: 60

Learning outcome

The learner will:

- 1 Know the risks to health and safety associated with the use of computer equipment and associated peripheral devices

Assessment criteria

The learner can:

- 1.1 describe the hazards and possible risks associated with the use of Visual Display Unit (VDU) equipment and peripheral devices
- 1.2 describe the requirements of a suitable working environment relating to the safe use of computer equipment
- 1.3 outline the requirements of the current Health and Safety (Display Screen Equipment) Regulations

Range

(AC1.1) **hazard**

- electrical hazard
- repetitive work
- screen glare
- excessive VDU use

(AC1.2, **requirements**

- AC1.3)
- working position
 - lighting
 - environment

Learning outcome

The learner will:

- 2 Understand how to configure the CAD system to suit drawing requirements

Assessment criteria

The learner can:

- 2.1 outline drawing parameters that can be set by the user during system configuration
- 2.2 explain the benefits and limitations of the use of CAD software in comparison to conventional drawing methods

Range

(AC2.1) **drawing parameters**

- drawing templates
- sheet sizes
- drawing lines and limits
- scales
- line types
- text and dimension styles
- screen display
- drawing origin and datum
- drawing layers
- peripheral devices input and output procedures
- customised menus
- units
- toolbars

(AC2.2) **benefits and limitations**

- productivity and speed of drawing creation
- accuracy of drawing components
- uniformity of production
- modification/editing
- storage space required
- standardised parts, symbols etc.
- working practices
- electronic data exchange and transfer
- finite element analysis
- set-up cost
- data storage
- training

Learning outcome

The learner will:

- 3 Understand the requirement to comply with national and international drawing standards

Assessment criteria

The learner can:

- 3.1 outline the national and international standards and conventions that relate to engineering drawing practice
- 3.2 outline features of a CAD drawing that need to comply with national and international standards
- 3.3 describe the use of standard symbols and representations used within CAD drawings

Range

(AC3.1) **national and international standards and conventions**

- drawing sheet sizes and layouts
- projection – first and third angle
- types of line
- lettering and numbering
- dimensioning
- symbols
- section cross hatching
- units
- abbreviations
- representation of common features

(AC3.3) **standard symbols**

- weld symbols
- electrical/electronic symbols
- fluid power symbols
- mechanical symbols

(AC3.3) **standard representations**

- sketches
- schematic diagrams
- flow charts
- physical layout diagrams
- illustrations from manufacturers' manuals

Learning outcome

The learner will:

- 4 Understand how to use CAD software for the production of 2D industry standard engineering drawings

Assessment criteria

The learner can:

- 4.1 describe the requirements of drawing datum selection
- 4.2 describe the different co-ordinate input methods and their uses
- 4.3 outline types of geometry that can be drawn
- 4.4 describe the use of drawing aids that are commonly used
- 4.5 describe methods of adding dimensions and text to drawn geometry to create a working drawing
- 4.6 outline the benefits of using drawing templates
- 4.7 describe the types of device available to produce hard copy of the completed drawing
- 4.8 outline the importance of saving partial or completed drawings at appropriate intervals

Range

(AC4.1) **requirements**

- reference point
- ease of use
- compatibility

(AC4.2) **co-ordinate input methods**

- absolute
- relative/incremental
- polar

(AC4.3) **geometry**

- lines
- circles
- arcs
- ellipses

(AC4.4) **drawing aids**

- coordinate grids and snaps
- object snaps
- viewing features, e.g. zoom, previous, pan

(AC4.5) **dimensions**

- linear dimensions
- radial dimensions
- angular dimensions
- leaders dimensions

- text dimensions
 - tolerances dimensions
-

Learning outcome

The learner will:

- 5 Understand how to use layers, copy, modify and manipulate drawn entities to maintain drawing efficiency

Assessment criteria

The learner can:

- 5.1 describe how to set-up different layers and typical uses
 - 5.2 describe the attributes of entities that can be edited or modified
 - 5.3 outline drawing commands by which entities can be modified/manipulated to aid drawing efficiency
-

Range

(AC5.1) **layers**

- layer definition
- layer management

(AC5.2) **attributes**

- size
- position
- orientation

(AC5.3) **drawing commands**

- scaling
 - mirroring
 - rotating
 - trimming
 - moving/translating
 - corner filleting/chamfering
 - exploding
 - copying
 - arrays/patterns
 - extending
 - stretching
 - erasing
-

Appendix 1 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 2 Useful contacts

UK learners General qualification information	E: learnersupport@cityandguilds.com
International learners General qualification information	E: intcg@cityandguilds.com
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	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	E: singlesubjects@cityandguilds.com
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	E: intops@cityandguilds.com
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e- assessment, Navigation, User/menu option, Problems	E: walledgarden@cityandguilds.com
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	E: business@cityandguilds.com
Publications Logbooks, Centre documents, Forms, Free literature	

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