Pearson BTEC Level 2 Certificate in Military Engineering (QCF)

Specification

BTEC Specialist qualification

First teaching October 2014

Edexcel, BTEC and LCCI qualifications

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All information in this specification is correct at time of publication.

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Purpose of this specification

The purpose of a specification as defined by Ofqual is to set out:

- the qualification's objective
- any other qualification that a learner must have completed before taking the qualification
- any prior knowledge, skills or understanding that the learner is required to have before taking the qualification
- units that a learner must have completed before the qualification will be awarded and any optional routes
- any other requirements that a learner must have satisfied before they will be assessed or before the qualification will be awarded
- the knowledge, skills and understanding that will be assessed as part of the qualification (giving a clear indication of their coverage and depth)
- the method of any assessment and any associated requirements relating to it
- the criteria against which the learner's level of attainment will be measured (such as assessment criteria)
- any specimen materials
- any specified levels of attainment.

1 Introducing BTEC Specialist qualifications

What are BTEC Specialist qualifications?

BTEC Specialist qualifications are qualifications from Entry to Level 3 on the Qualifications and Credit Framework (QCF). They are work-related qualifications available in a range of sectors. They give learners the knowledge, understanding and skills they need to prepare for employment. The qualifications also provide career development opportunities for those already in work. The qualifications may be offered as full-time or part-time courses in schools or colleges. Training centres and employers may also offer these qualifications.

Some BTEC Specialist qualifications are knowledge components in Apprenticeship Frameworks, i.e. Technical Certificates.

There are three sizes of BTEC Specialist qualification in the QCF:

- Award (1 to 12 credits)
- Certificate (13 to 36 credits)
- Diploma (37 credits and above).

Every unit and qualification in the QCF has a credit value.

The credit value of a unit specifies the number of credits that will be awarded to a learner who has achieved the learning outcomes of the unit.

The credit value of a unit is based on:

- one credit for every 10 hours of learning time
- learning time – defined as the time taken by learners at the level of the unit, on average, to complete the learning outcomes to the standard determined by the assessment criteria.

2 Qualification summary and key information

Qualification title	Pearson BTEC Level 2 Certificate in Military Engineering (QCF)
QCF Qualification Number (QN)	601/4141/4
Qualification framework	Qualifications and Credit Framework (QCF)
Regulation start date	30/07/2014
Operational start date	01/10/2014
Approved age ranges	16–18 19+
Credit value	33
Assessment	Centre-devised assessment (internal assessment)
Guided learning hours	270–300
Grading information	The qualification and units are at pass grade.
Entry requirements	No prior knowledge, understanding, skills or qualifications are required before learners register for this qualification. However, centres must follow our Access and Recruitment Policy (see *Section 10 Access and recruitment*).

QCF Qualification Number and qualification title

Centres will need to use the QCF Qualification Number (QN) when they seek public funding for their learners. Every unit in a qualification has a QCF unit reference number (URN).

The qualification title, unit titles and QN are given on each learner's final certificate. You should tell your learners this when your centre recruits them and registers them with us. There is more information about certification in our *UK Information Manual,* available on our website at: www.edexcel.com/iwantto/Pages/uk-information-manual

Qualification objective

The Pearson BTEC Level 2 Certificate in Military Engineering (QCF) is for learners who work in, or who want to work in, the armed forces in an engineering capacity. Learners will choose between two pathways – **Maintenance Technology** and **Fabrication and Welding**.

It gives learners the opportunity to:

- develop knowledge related to engineering in a military context
- achieve a nationally-recognised Level 2 qualification that incorporates skills which are transferable to a future civilian career
- develop their personal growth and engagement in learning.

Apprenticeships

Semta, the Sector Skills Council (SSC) for the engineering sector, approves the Pearson BTEC Level 2 Certificate in Military Engineering (QCF) as a knowledge component for the Intermediate Apprenticeship in Engineering Manufacture (Operator and Semi-skilled).

Relationship with previous qualifications

This is a new qualification and it does not replace any qualification previously offered by Pearson.

Progression opportunities through Pearson qualifications

Learners who achieve the Pearson BTEC Level 2 Certificate in Military Engineering (QCF) can, as they are promoted in the armed services, progress to higher level qualifications.

As the qualification is designed to incorporate elements relevant to engineering in a civilian context, learners who leave military service can use the skills and knowledge they have gained in the qualification in their civilian careers.

After leaving military service, learners can progress to qualifications such as Pearson BTEC Level 3 Nationals in Engineering and Pearson BTEC Level 4 and 5 Higher Nationals, which are available in a wide range of engineering subjects.

Industry support and recognition

This qualification is supported by Semta, the Sector Skills Council for the engineering sector.

Relationship with National Occupational Standards

This qualification relates to the National Occupational Standards in Engineering and Manufacture. The mapping document in *Annexe A* shows the links between the units in this qualification, the Pearson Edexcel Level 2 NVQ Diploma in Engineering Maintenance and Installation (QCF), and the Pearson Edexcel Level 2 NVQ Diploma in Performing Engineering Operations (QCF).

3 Qualification structure

Pearson BTEC Level 2 Certificate in Military Engineering (QCF)

The learner will need to meet the requirements outlined in the table below before Pearson can award the qualification.

Minimum number of credits that must be achieved	33
Number of mandatory credits that must be achieved	14
Number of core credits that must be achieved	7
Minimum number of optional credits that must be achieved	12

Unit	Unit reference number	**Mandatory units** Learners must complete both units from this group.	Level	Credit	Guided learning hours
1	K/506/6187	Working in Military Engineering	2	7	60
2	K/506/6190	Materials, Maths and Science for Military Engineering	2	7	60
		Core units Learners must complete **one** unit from this group according to the pathway chosen: **Maintenance Technology** (Unit 3) or **Fabrication and Welding** (Unit 4).			
3	T/506/6192	Principles of Maintenance Technology	2	7	60
4	A/506/6193	Principles of Fabrication and Welding Technology	2	7	60
		Optional units Learners must complete a minimum of 12 credits from this group.			
5	H/600/3387	Operation and Maintenance of Fluid Power Systems and Components	2	10	60
6	D/600/0388	Engineering Maintenance Procedures	2	5	30
7	F/600/0402	Operation and Maintenance of Electrical Systems and Components	2	10	60
8	F/506/6194	Using Bench Fitting Techniques	2	7	60
9	K/600/0412	Application of Welding Processes	2	10	60

4 Assessment

The table below gives a summary of the assessment methods used in the qualification.

Units	Assessment method
All units	Centre-devised assessment

Centre-devised assessment (internal assessment)

Each unit has specified learning outcomes and assessment criteria. To pass an internally assessed unit, learners must meet all of the unit's learning outcomes. Centres may find it helpful if learners index and reference their evidence to the relevant learning outcomes and assessment criteria.

Centres need to write assignment briefs for learners to show what evidence is required. Assignment briefs should indicate clearly which assessment criteria are being targeted.

Assignment briefs and evidence produced by learners must meet any additional requirements given in the *Information for tutors* section of each unit.

Unless otherwise indicated in *Information for tutors*, the centre can decide the form of assessment evidence (for example performance observation, presentations, projects, tests, extended writing) as long as the methods chosen allow learners to produce valid, sufficient and reliable evidence of meeting the assessment criteria.

Centres are encouraged to give learners realistic scenarios and to maximise the use of practical activities in delivery and assessment.

To avoid over-assessment, centres are encouraged to link delivery and assessment across units.

There is more guidance about internal assessment on our website. For details please see *Section 13 Further information and useful publications*.

5 Recognising prior learning and achievement

Recognition of Prior Learning

Recognition of Prior Learning (RPL) is a method of assessment (leading to the award of credit) that considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and so do not need to develop through a course of learning.

Pearson encourages centres to recognise learners' previous achievements and experiences in and outside the workplace, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning.

RPL enables recognition of achievement from a range of activities using any valid assessment methodology. If the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be sufficient, reliable and valid.

Further guidance is available in our policy document *Recognition of Prior Learning Policy and Process*, available on our website at: www.edexcel.com/policies

Credit transfer

Credit transfer describes the process of using a credit or credits awarded in the context of a different qualification or awarded by a different awarding organisation towards the achievement requirements of another qualification. All awarding organisations recognise the credits awarded by all other awarding organisations that operate within the QCF.

If learners achieve credits with other awarding organisations, they do not need to retake any assessment for the same units. The centre must keep evidence of credit achievement.

6 Centre resource requirements

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

General resource requirements

- Centres must have appropriate physical resources (for example IT, learning materials, teaching rooms) to support delivery and assessment.
- Staff involved in the assessment process must have relevant expertise and occupational experience.
- There must be systems in place that ensure continuing professional development (CPD) for staff delivering the qualification.
- Centres must have in place appropriate health and safety policies relating to the use of equipment by learners.
- Centres must deliver the qualification in accordance with current equality legislation. For further details on Pearson's commitment to the Equality Act 2010, please see *Section 10 Access and recruitment* and *Section 11 Access to qualifications for learners with disabilities or specific needs*. For full details of the Equality Act 2010, please go to www.legislation.gov.uk

Specific resource requirements

As well as the general resource requirements given above, there are specific resources that centres must provide. They are listed by unit below.

Unit		Resources required
1:	Working in Military Engineering	Access to a suitably equipped workshop, manufacturers' service manuals, data sheets, parts lists, diagrams and drawings
2:	Materials, Maths and Science for Military Engineering	Engineering materials and supplier catalogues
3:	Principles of Maintenance Technology	Access to a workshop environment, components, tools, service manuals, data sheets, parts lists, drawings, test schedules and personal protective equipment (PPE)
4:	Principles of Fabrication and Welding Technology	Access to a workshop environment, cutting tools, measuring equipment, welding equipment, consumables, materials and personal protective equipment (PPE)

Unit		Resources required
5:	Operation and Maintenance of Fluid Power Systems and Components	Fluid power system circuits and components, pneumatic and hydraulic system test rigs, fluid power circuit drawings and computer simulation software, appropriate test equipment, data books and specifications, current health and safety legislation and regulations
6:	Engineering Maintenance	Access to a workshop, relevant manufacturers' service manuals, date sheets, parts lists and diagrams and drawings
7:	Operation and Maintenance of Electrical Systems and Components	Access to an electrical engineering workshop, industry standard electrical circuits, equipment and systems and their associated components and consumables, appropriate fault-finding instruments, safety equipment and tools, manufacturers' data books and specifications, maintenance manuals, parts catalogues and/or databases, flow charts, electrical circuit and system diagrams
8:	Using Bench Fitting Techniques	Access to a workshop with bench fitting equipment, workpiece materials, components and drawings
9:	Application of Welding Processes	Access to appropriate welding equipment, consumables and materials, destructive and non-destructive test equipment

7 Centre recognition and approval centre recognition

Centres that have not previously offered Pearson qualifications need to apply for, and be granted, centre recognition as part of the process for approval to offer individual qualifications.

Existing centres will be given 'automatic approval' for a new qualification if they are already approved for a qualification that is being replaced by a new qualification and the conditions for automatic approval are met.

Guidance on seeking approval to deliver BTEC qualifications is given on our website.

Approvals agreement

All centres are required to enter into an approval agreement that is a formal commitment by the head or principal of a centre to meet all the requirements of the specification and any associated codes, conditions or regulations.

Pearson will act to protect the integrity of the awarding of qualifications. If centres do not comply with the agreement, this could result in the suspension of certification or withdrawal of approval.

8 Quality assurance of centres

Quality assurance is at the heart of vocational qualifications. The centre assesses BTEC qualifications. The centre will use quality assurance to make sure that their managers, internal verifiers and assessors are standardised and supported. Pearson use quality assurance to check that all centres are working to national standards. It gives us the opportunity to identify and provide support, if needed, to safeguard certification. It also allows us to recognise and support good practice.

For the qualifications in this specification, the Pearson quality assurance model will follow one of the processes listed below.

1 Delivery of the qualification as part of a BTEC Apprenticeship ('single click' registration):
   - an annual visit by a Standards Verifier to review centre-wide quality assurance systems and sampling of internal verification and assessor decisions.

2 Delivery of the qualification outside the Apprenticeship:
   - an annual visit to the centre by a Centre Quality Reviewer to review centre-wide quality assurance systems
   - Lead Internal Verifier accreditation – this involves online training and standardisation of Lead Internal Verifiers using our OSCA platform, accessed via Edexcel Online. Please note that not all qualifications will include Lead Internal Verifier accreditation. Where this is the case, each year we will allocate a Standards Verifier to conduct postal sampling of internal verification and assessor decisions for the Principal Subject Area.

For further details please see the *UK Vocational Quality Assurance Handbook* on our website.

9 Programme delivery

Centres are free to offer this qualification using any mode of delivery (for example full time, part time, evening only, distance learning) that meets their learners' needs. Whichever mode of delivery is used, centres must make sure that learners have access to the resources identified in the specification and to the subject specialists delivering the units.

Those planning the programme should aim to enhance the vocational nature of the qualification by:

- liaising with employers to make sure that a course is relevant to learners' specific needs
- accessing and using non-confidential data and documents from learners' workplaces
- developing up-to-date and relevant teaching materials that make use of scenarios that are relevant to the sector
- giving learners the opportunity to apply their learning in practical activities
- including sponsoring employers in the delivery of the programme and, where appropriate, in assessment
- making full use of the variety of experience of work and life that learners bring to the programme.

Where legislation is taught, centres must ensure that it is current and up to date.

10 Access and recruitment

Pearson's policy regarding access to our qualifications is that:

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

Centres are required to recruit learners to BTEC Specialist qualifications with integrity.

Applicants will need relevant information and advice about the qualification to make sure it meets their needs.

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

For learners with disabilities and specific needs, this review will need to take account of the support available to the learner during teaching and assessment of the qualification. The review must take account of the information and guidance in *Section 11 Access to qualifications for learners with disabilities or specific needs*.

11 Access to qualifications for learners with disabilities or specific needs

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

We are committed to making sure that:

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

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

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

Details on how to make adjustments for learners with protected characteristics are given in the document *Pearson Supplementary Guidance for Reasonable Adjustment and Special Consideration in Vocational Internally Assessed Units*.

Both documents are on our website at: www.edexcel.com/policies

12 Units

Units have the following sections.

Unit title

The unit title is on the QCF and this form of words will appear on the learner's Notification of Performance (NOP).

Unit reference number

Each unit is assigned a unit reference number that appears with the unit title on the Register of Regulated Qualifications.

QCF level

All units and qualifications within the QCF have a level assigned to them. There are nine levels of achievement, from Entry to Level 8. The QCF Level Descriptors inform the allocation of the level.

Credit value

When a learner achieves a unit, they gain the specified number of credits.

Guided learning hours

Guided learning hours are the times when a tutor, trainer or facilitator is present to give specific guidance towards the learning aim for a programme. This definition covers lectures, tutorials and supervised study in, for example, open learning centres and learning workshops. It also includes assessment by staff where learners are present. It does not include time spent by staff marking assignments or homework where the learner is not present.

Unit aim

This gives a summary of what the unit aims to do.

Essential resources

This section lists any specialist resources needed to deliver the unit. The centre will be asked to make sure that these resources are in place when it seeks approval from Pearson to offer the qualification.

Learning outcomes

The learning outcomes of a unit set out what a learner knows, understands or is able to do as the result of a process of learning.

Assessment criteria

Assessment criteria specify the standard required by the learner to achieve each learning outcome.

Unit amplification

This section clarifies what a learner needs to know to achieve a learning outcome.

Information for tutors

This section gives tutors information on delivery and assessment. It contains the following subsections.

- *Delivery* – explains the content's relationship to the learning outcomes and offers guidance on possible approaches to delivery.
- *Assessment* – gives information about the evidence that learners must produce, together with any additional guidance if appropriate. This section should be read in conjunction with the assessment criteria.
- *Suggested resources* – lists resource materials that can be used to support the teaching of the unit, for example books, journals and websites.

Unit 1: Working in Military Engineering

Unit reference number: K/506/6187
QCF level: 2
Credit value: 7
Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to develop an understanding of what is required to carry out engineering activities in a military environment. Many reference documents and basic engineering skills are consistent across the Army, Navy and Air Force. However, each Service is responsible for its own specialist equipment and the technical, policy and training documentation particular to each.

Engineering working practices in a military environment involve the service, repair, adjustment and modification of engineering plant, equipment and machinery that support military operations both within the UK and across the world, from a tri-service perspective. Engineering in these circumstances requires an element of innovation and robust invention in order to support military operations remotely and locally, all within the letter of the law and under strict guidelines.

This unit introduces learners to the features of engineering procedures that determine their reliability, safety and maintainability. Learners will develop an understanding of the requirements when working in military engineering, emphasising the importance of safety, quality, training, maintenance procedures and planning. Learners will look in detail at health and safety regulations and procedures for the military workplace and the methods of communication used. The unit also introduces learners to the use of technical drawings and specifications in engineering and how to interpret them.

Learners will be expected to understand the requirements for integrating civilian personnel into a military environment. Learners will need to be aware of the steps required and the processes in place to ensure that integration is a success.

Essential resources

Access to a military workshop environment that includes a wide range of equipment, systems, devices and components is required. Experiencing military maintenance activities is essential, together with relevant manufacturers' service manuals, data sheets, parts lists, diagrams and drawings. Relevant test instruments, tools and safety equipment will also be required as appropriate to the equipment, systems, devices and components used. Official support from a current engineering service tradesperson (instructor qualified) as a 'subject expert' is also needed.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know health and safety regulations for working in military engineering	1.1	Outline health and safety regulations applicable to military engineering operations	□ *Health and safety regulations*: The Ministry of Defence (MOD) *Health and Safety handbook – Joint Service Publication (JSP) 375* is applicable across all areas of MOD and the Armed Forces. □ Volume 1: introduction to health and safety management; staff health and safety responsibilities; guidance on the production of action plans; MOD's health and safety training strategy. □ Volume 2: specific health and safety duties carried out in the MOD, contained within a series of leaflets. □ Volume 3: permit-to-work procedures (for land-based activities only) covering high-hazard activities, e.g. high voltage switching (11000 volts with no-break/short break systems), replacement of X antenna protective panels (incorporating working at height/clearing of area), setting up of temporary electrical installations in built-up areas (risk assessment/permit to dig etc.), close confinement areas such as ships. □ Volume 4: information for conducting MOD SHE Audits.
		1.2	State the responsibilities of the MOD as an employer to ensure health and safety in the workplace	□ *Responsibilities of the MOD*: to provide a safe place of work, including safe access to and exit from it; a healthy working environment; equipment, machinery and systems of work that are safe and without risks to health; safe arrangements for the use (including processing), handling, storage, transportation and disposal of articles and substances; sufficient information, instruction, training and supervision to enable all employees to avoid hazards and to contribute positively to their own health and safety at work; and adequate welfare facilities.

Learning outcomes		Assessment criteria		Unit amplification
		1.3	Identify the policies and procedures used to ensure effective health and safety implementation in a military engineering workplace	□ *Military policies and procedures*: *JSP375 Volume 3* is mandatory on the defence estate and is aligned to the structure and principles of recognised safety management systems, e.g. HSG65 and BS OSHAS 18001, it also serves to ensure that the requirements of UK legislation are being met; *JSP375 – MOD Health and Safety Handbook* is sponsored by 2nd Permanent Under Secretary (PUS) as Process Owner for Safety (and Sustainable Development and Environmental Protection).
		1.4	Describe the essential health and safety requirements to protect service and civilian personnel and bystanders	□ *Essential health and safety requirements*: e.g. Secretary of State Policy and site Organisation and Arrangements statement up to date, and displayed throughout site; local site Safety Health Environment arrangements/procedures maintained up to date; systems for reporting of Accidents/Incidents/Near Misses, staff competent for role with clear Terms of Reference (OHS, RSO, RPS, etc.); sufficient numbers of first aid trained staff; site SHE Committee established, including trade union representation and meets regularly; the following as required in place and up to date: Site Hazard Register, Site Risk Assessments, risk assessments, Asbestos Management Plan (AMP), Radon Management Plan (where necessary), Legionella Management Plan, Fire Safety Management Plans (FSMP), Comprehensive Emergency Procedures, 4C's system, signage, protective barriers, PPE available.

Learning outcomes		Assessment criteria		Unit amplification
		1.5	State the types and classification of health and safety signs used in an engineering/manufacturing environment	□ *Health and safety signs*: as required by the Health and Safety (Safety Signs and Signals) Regulations 1996 (the Safety Signs Regulations), which implement European Council Directive 92/58/EEC on minimum requirements for the provision of safety signs at work; CHIP – Chemicals (Hazard Information and Packaging for Supply) Regulations. □ *Types and classification*: as set out in *JSP375 Volume 2 Leaflet 44 'Safety Signs'*: prohibition sign – black pictogram on a white background with red edging and diagonal line; warning sign – black pictogram on a yellow or amber background with black edging; mandatory sign – white pictogram on a blue background; safe condition sign – white pictogram on a green background; fire-fighting sign – white pictogram on a red background.
		1.6	Outline the roles and responsibilities within the chain of command of personnel with responsibility for health and safety	□ *Roles and responsibilities*: as set out in *JSP375 Volume 1.* □ Employer (see Unit amplification for 1.2). □ Line manager – identify hazards and assess risks involved with the activities under their control; eliminate hazards or implement control measures; supply staff with adequate information, instruction and training; ensure staff are adequately supervised; investigate and report any injury to a member of their staff or any person resulting from the activities under their control in accordance with MOD policy. □ All staff to take reasonable care for their health and safety, and the health and safety of other persons affected by their acts or omissions; cooperate with their employer to ensure MOD discharges its legal obligations (e.g. attending mandatory training, reporting accidents); report any hazards or shortfalls in MOD safety systems to their line manager.

Learning outcomes		Assessment criteria		Unit amplification
2	Know procedures to follow to ensure health and safety in the military engineering workplace	2.1	Outline safe working practices that should be followed in the workplace	□ *Safe working practices*: e.g. sufficient numbers of first aid trained personnel; health and safety induction training completed and refresher training available; use of personal protective equipment, correct lifting and handling techniques, maintaining a tidy work area, correct disposal of waste materials; permit to work; isolation; risk assessments complete (both site and task focused); reporting of injuries; identification of noise hazardous areas; health surveillance programme in progress.
		2.2	Describe the human, environmental and service conditions that lead to accidents in the workplace and ways of controlling them	□ *Human conditions*: e.g. lack of knowledge or skill, improper motivation, physical or mental stress, inadequate physical or psychological capability, failure to warn or signal, nullifying safety devices, operating without authority, combat situations. □ *Ways of control*: e.g. training programmes, robust control strategies (welfare support, supervisory activities, assigning responsibilities), develop skills, provide encouragement and clear instruction, physical and mental preparation for combat situations. □ *Environmental conditions*: e.g. hazardous atmospheric conditions, inadequate illumination or noise, congestive working environment, projection hazards, hazardous placement or storage, combat situations. □ *Ways of control*: e.g. risk recognition process, effective communication with all staff, appropriate signage, PPE as required, training in hot, Arctic or inclement environmental conditions. □ *Service conditions*: e.g. inadequate warning systems, inadequate design or maintenance, inadequate provision of correct equipment for maintenance, inadequate PPE, inadequate work and purchasing standards, normal wear and tear. □ *Ways of control*: e.g. redevelopment of control strategies (risk assessments, planning better provision of resources, set objectives and standards, redefine and implement improved systems, procedures and work instructions).

Learning outcomes		Assessment criteria		Unit amplification
		2.3	Define what is meant by a dangerous occurrence	□ *Dangerous occurrence*: as defined in Annex B of *JSP375 Volume 2 Leaflet 14.*
		2.4	Describe how to carry out a risk assessment	□ *Risk assessment*: as detailed in *JSP375 Volume 2 Leaflet 39* – 5 steps to risk assessment.
		2.5	Identify potential hazards that a risk assessment may reveal	□ *Potential hazards*: anything that may cause harm or has the potential to cause harm, e.g. manual handling, exposure to hazardous substances, noise, vibration, working at height, lifting operations, confined spaces, exposure to electricity, transport, exposed machinery, construction activities, radiation, excessive stress, pressure systems, exposure to blood-borne viruses, explosive atmospheres and devices, fatigue, excessive heat or cold, fire, lighting levels.
		2.6	Describe methods of fire prevention and control in accordance with health and safety policy in a military engineering workplace	□ *Fire prevention and control*: robust induction to ensure that individuals know the following in the workplace: fire alarm, evacuation routes, evacuation assembly point, location and how to operate fire extinguishers and fire alarms, the emergency telephone number for aircraft fire and emergencies (separate numbers), actions to be taken on discovering a fire, rules relating to the operation of fire doors, the location of the main isolation switches, the location and contents of the fire safety noticeboard (e.g. two-hat system, the fire safety management plan).
		2.7	Outline procedures used to make a hazardous area safe before starting work, in either a military or a civilian workplace	□ *Procedures to make a hazardous area safe*: e.g. emergency and disaster planning strategy; health surveillance and health monitoring programme; risk assessments completed (e.g. manual handling, COSHH, working at heights, confined spaces, lifting operations, electricity safety, office safety, control of noise); management of PPE, permit to work procedure, first aid at work; lone working process; safe use of pressure systems; DSEAR if applicable; safety signs in place; management of asbestos and asbestos-containing materials; barriers in place; control of vibration needed; 4C system in place that manages visiting workers and contractors; safety in excavation procedure.

Learning outcomes		Assessment criteria		Unit amplification
3	Know effective methods of communication for an engineering environment	3.1	Identify the communication systems used in military and civilian engineering workplaces	□ *Communication systems used in both military and civilian engineering workplaces*: e.g. email; telephone; engineering websites identifying upgrades/common faults on equipment used; group briefs on identifying task delegation and their priorities; visual management boards within the workshop of tasks, stages of repair/completion, target dates; verbal/visual line management/team leader direction on current engineering processes and procedures; satellite systems, radio systems; digital systems; written communication. □ *Communication systems used in military engineering workplaces only*: Defence Internal Briefs (DIBs) on the Defence Intranet (i.e. announcement of the Defence Equipment and Support Material Strategy); Internal Briefing Notes (IBNs) (i.e. formation of 906 expeditionary wing); Defence Instructions and Notices (DINs) (i.e. equipment tables, scales and schedule); joint service publications identifying and instructing personnel on common practices, information and guidelines expected on a wide range of equipment/services/COP/safety; air publications ensuring correct engineering practices carried out on particular equipment; Station Routine Orders detailing correct action required by personnel within station boundaries including engineering areas; Station Engineering Orders detailing specific engineering issues/action on specific equipment.
		3.2	Outline the roles and responsibilities within the chain of command in a military workshop	□ *Roles and responsibilities*: as set out in AP(D)100E-15 Management of General Engineering Workshops and Associated Equipment and the overall control defined by the relevant service, HQ or unit, e.g. Senior Engineering Officer (Level K) has overall responsibility for workshop equipment on their unit; responsibility is discharged through either the established Ground Support Equipment Controller, Officer Commanding user section, Aviation Workshops Manager, or authorised inventory holder and includes operation within the unit's Quality Management System (QMS).

Learning outcomes		Assessment criteria		Unit amplification
		3.3	Identify a range of sources of engineering information	□ *Sources of engineering information*: e.g. manufacturer's documentation/handbook; unit/local engineering orders; British Standards; Defence Standards; Quality Standards; trade training documentation; equipment air publications; army equipment support publications; engineering websites, International Standards; approved codes of practice; engineering policy documentation; work instructions and procedures; historical maintenance documentation; noticeboards; engineering leaflets/magazines; subject matter experts (SMEs) with experience in their field; RAF Engineering Policy.
		3.4	Identify appropriate sources of advice and guidance	□ *Sources of advice and guidance*: e.g. team leader, line manager, engineering support team for specialist SME support, equipment user community list for regional/national advice on engineering issues, military publications library.
		3.5	Describe the importance of maintaining good relationships with internal and external stakeholders	□ *Maintaining good relationships*: e.g. gives continuity of key supplier routes/provision; allows regular, structured and informal communication routes between the internal/external stakeholders, which in turn leads to an open and honest relationship; promotes clear expectations and understanding of the services needed/provided; if problem resolution processes are well defined and used, this ensures minor problems do not escalate and cause relationship issues, avoiding a 'blame culture'.

Learning outcomes		Assessment criteria		Unit amplification
4	Understand engineering drawings and specifications	4.1	Describe how technical drawings and specifications are used in engineering	□ *Technical drawings and specifications*: how technical drawings and technical specifications relate to each other; contents, e.g. standards of materials and workmanship required, details of the work required to achieve completion, details of factory tests required, type and number (i.e. pressure tests, tensile testing).
		4.2	Interpret the essential information found on technical drawings using current standards	□ *Essential information*: defines what a part looks like, how it is made and how it fits together with other parts. □ *Current standards*: as set out in the *Manual of Engineering Drawing*, including technical product specification and documentation to British and International Standards, abbreviations and symbols, drawing components, dimensioning, geometric tolerances, lettering, tolerances.
		4.3	Describe the purpose of standards in engineering	□ *Purpose*: to ensure that products, items or parts consistently meet the standards set, whether they are British or International Standards; to encourage manufacturers/designers/operators to adhere to a common method for that particular standard/specification.
		4.4	Describe how specifications and quality systems are used in engineering	□ *Specifications*: used in engineering to supplement and add stringency to specific needs and clarify ISO 9001 requirements in order to provide a standardised and consistent approach □ *Quality systems*: the Quality Management System (QMS) is standard throughout military organisations and includes all workshops that have military/civilian personnel responsible for carrying out engineering and logistic activities.
		4.5	Interpret standard conventions used on technical drawings	□ *Standard conventions used on technical drawings*: e.g. 1st/3rd angle projection, technical sketch, mechanical drafting, computer-aided drafting (CAD).

Learning outcomes		Assessment criteria		Unit amplification
5	Know about working in engineering	5.1	Describe policies that relate to rights and responsibilities in military employment	□ *Policies that relate to rights and responsibilities in military employment*: AP1 identifies military ethos, core values and standards emphasising respect, integrity, service, excellence; AP3376 details terms and conditions of service of trade personnel; employment, career and competency structures e.g. for airmen, including command management training courses; Queen's Regulations detailing many aspects including general service proficiency and qualifications for promotions; Human Resources Management System (HRMS) for MOD employees; organisational structure clearly identifying roles, rights and responsibilities.
		5.2	Describe how to work effectively in a military and civilian engineering workplace	□ *Work effectively*: e.g. adhering to policy statements; ensuring trade ability and competence is at the correct level in the workplace; a robust and functioning managing safety regime; clear vision of the end goal and the output required; ensuring good leadership and management of all staff; ensuring equipment, processes, procedures and work instructions are fully functional and fit for purpose; emphasis on good quality and safety systems.

Learning outcomes		Assessment criteria		Unit amplification
		5.3	Give reasons for possible conflict situations in a military and civilian engineering workplace, and ways to avoid them	□ *Conflict situations*: reasons, e.g. military standards of discipline, differences in the standards expected from both a military and civilian perspective (MAA Policy and CAA Policy), standards of the basic and trade training experienced by a military employee as opposed to a civilian (AP1 and AP3376). □ *Ways to avoid*: e.g. a consistent and high level of workplace standards and instructions from induction training to awareness of up-to-date changes in policy statements; strong leadership from encompassing both military and civilian needs.
		5.4	State the roles and responsibilities of team members in a military and civilian engineering workplace	□ *Roles*: e.g. in RAF – military roles include Officer Commanding the Flight, Senior Non-Commissioned Officer/Manager, Non-Commissioned Officer/Supervisor, Senior Aircraftsman/Producer; civilian roles include Leading Charge Hand, Charge Hand, Civilian Mechanic, Civilian Technician. □ *Responsibilities*: as outlined on the Terms of Reference issued to each team member, detailing particular role within the management chain and outlining responsibilities for that particular role.
		5.5	Describe how to work effectively in a team in a military and civilian engineering workplace	□ *Work effectively*: contributory factors, e.g. training, ethos, common goals, pride, innovation, inventiveness, commitment to quality, joint welfare provision, camaraderie, correct equipment provision, teamwork away days (high/low rope exercises).

Information for tutors

Delivery

Since most learners are unlikely to have had prior experience in this area of work, it is essential to have some formal introduction to the content. The unit can then be regarded as essentially investigative. Visits to military engineering workshops would allow learners to carry out a practical investigation and through open discussion clarify essential points within the unit amplification.

The approach will be best determined through a tutor analysis of each learner's needs and, in particular, through consideration of the range of types of military workshop they are working with or preparing their learners for. Whichever approach is taken, the learner's experience should be sufficiently varied to provide them with knowledge and understanding of military engineering processes, procedures and planning in most military settings.

This unit is largely theoretical, although learners should have the opportunity to examine a range of military engineering workshops, particularly with regard to health and safety procedures. The unit is best delivered through a programme of lectures followed by some form of practical investigations or activities.

The unit gives learners an opportunity to work individually or in groups when planning or discussing military engineering policy, processes, training and procedures.

The learning outcomes are ordered logically and it would be a reasonable approach to develop them sequentially throughout the unit. In this way, the learner will understand military engineering requirements and then be able to carry out activities that support their understanding.

Tutors should always ensure that each learner has the correct personal protective equipment and that systems are safe for inspection and operation. It is also important that learners work in a safe manner when visiting a military establishment.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Learning outcomes 1 and 2 could be covered through an assignment that requires learners to respond to pre-set questions. These questions may be based around a case-study style scenario or test questions that have each been set within a relevant military engineering context. In either case, it is most likely that controlled conditions will be required to ensure the authenticity of the responses. For assessment criterion 1.1, learners will need to outline all four volumes of JSP375. For 1.2, learners should state at least three of the MOD's responsibilities as an employer. For 2.1, they should outline at least four safe working practices. For 2.2, they should describe at least one type of human, one type of environmental and one type of service condition with ways of controlling each. For 2.6, at least five potential hazards should be identified. For 2.7, learners need to outline at least four procedures used to make a hazardous area safe.

Learning outcome 3 could be assessed using a practical assignment that requires learners to identify the resources required for effective communication within a

military engineering environment. The communicative piece should be simple and include processes for engineering support from 'source to output', for example 'engine change required on a Chinook helicopter that is grounded overseas in Afghanistan'. Tutor observation will be necessary during the activity to capture the process evidence of correct communications being used, whilst adhering to the safe use of correct procedures. The evidence collected by direct observation could be supported with evidence from professional discussion or from authenticated reflective accounts provided by the learner. For 3.1, learners should identify at least four communication systems common to military and civilian engineering workplaces, and at least four communication systems used in military workplaces only. For 3.3, at least five sources of engineering information need to be identified, and at least three sources of advice and guidance for 3.4.

Learning outcome 4 could be assessed using a practical assignment that requires learners to understand engineering drawings and specifications within a military engineering environment. The engineering drawings and specifications piece should be simple and include processes for engineering support from 'source to output', for example 'modification required to improve performance of MK12 Air Starting Trolley'. Tutor observation will be necessary during the activity to capture the process evidence of engineering drawings and specifications being used. The evidence collected by direct observation could be supported with evidence from professional discussion or from authenticated reflective accounts provided by the learner.

Learning outcome 5 could be assessed using a practical assignment that requires learners to show knowledge of how to work effectively in a military engineering environment. The working in engineering piece should be simple and include processes for engineering support from 'source to output', for example 'setting up a forward operating base in a remote location'. Tutor observation will be necessary during the activity to capture the process evidence of equipment being used, detailed requirements, facilities provision etc., whilst adhering to the safe use of correct procedures. The evidence collected by direct observation could be supported with evidence from professional discussion or from authenticated reflective accounts provided by the learner. For 5.1, learners need to describe at least three policies. For 5.3, at least two reasons for possible conflict situations are required, with ways to avoid each.

Learners will also need to produce a report that includes the identification of resources and all handover documentation and completed records.

An alternative approach to assessment could be for learners to build a portfolio of evidence for the unit as a whole as they carry out a range of investigations and operations in the workplace.

A further alternative method could be the use of an integrated assignment, which links this unit with other practical units in a programme of study. If this approach is adopted, the evidence for the specific learning outcomes and associated assessment criteria will need to be identified clearly.

Suggested resources

Publications

Some of the following publications are specific to the Royal Air Force. Equivalent publications for the other Services should be used as required.

Air Publication 1 Royal Air Force Ethos, Core Values and Standards

Air Publication 2 Continuous Improvement

Air Publication 100C-10 Quality Assurance Activity Manual

Air Publication 3376 Vol 1 Ground Trade Personnel and Non-Commissioned Aircrew T&C of Service

Air Publication 3376 Vol 2 Employment, Careers and Competency Structures for Airman of the RAF

Air Publication 7001 Leadership in the RAF

Air Publication (Digital) 100E-15 Military Aviation Workshop Support Management and Policy

Approved Code of Practice HSG65

Fire Safety Order No.2

Joint Air Publication 100E-10 Military Aviation GSE Management & Policy

Joint Service Publication 375 MOD Health and Safety Handbook

Joint Service Publication 912 Human Factors Integration for Defence Systems

Manual of Maintenance and Airworthiness Processes 001

Manual of Maintenance and Airworthiness Processes 002

Military Aviation Authority

OSHAS 18001

Queen's Regulations (RAF)

Legislation

British Standards

Civil Aviation Authority

COSHH Regulations

DSEAR Regulations

Health & Safety at Work Act 1974

Health & Safety Signs Regulations 1996

International Standards

ISO 9001:2008

RIDDOR

Websites

www.hse.gov.uk – Health and Safety Executive

www.raf.mod.uk – Royal Air Force

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Exploring a given engineering activity from different perspectives to identify the resources required
Reflective learners	Reviewing progress with the engineering activity in a military workshop, acting on outcomes
Self-managers	Working towards a successful engineering activity in a military workshop, showing initiative, commitment and perseverance Organising time and resources, prioritising actions when carrying out an engineering activity in a military workshop
Effective participators	Identifying improvements when planning and carrying out a engineering activity that would benefit themselves and others

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Reflective learners	Evaluating experiences during workshop activities to inform progress with engineering tasks
Team workers	Collaborating with others when working in groups to gather information on engineering tasks and planning

Functional Skills – Level 2

Skill	When learners are…
ICT – Finding and selecting information	
Select information from a variety of sources to meet requirements of a complex task	Selecting and using the sources of information required to carry out an engineering activity independently
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Speaking and listening to operators/supervisors when planning for and carrying out engineering activity within a military workshop
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Comparing, selecting, reading and understanding resource material when preparing for a given engineering activity
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Writing documents in support of all engineering activity and explaining effect of resulting outputs, whether serviceability states or long term reliability Writing documents to describe planned and unplanned maintenance procedures Writing reports to document the maintenance procedures carried out on an engineering activity in a military workshop

Unit 2: Materials, Maths and Science for Military Engineering

Unit reference number: K/506/6190
QCF level: 2
Credit value: 7
Guided learning hours: 60

Unit aim

Working in an engineering workshop requires knowledge and understanding of the materials found within the components and products being used. In this unit learners will have the opportunity to investigate the properties of these materials.

This unit gives learners knowledge and understanding of the technology applied to military engineering. This will involve considering materials that are commonly used in military engineering solutions, and finding out about and understanding the properties of certain materials and how these properties can be altered.

Workshop calculations using simple mathematics are important and learners will have the opportunity to practise and use these mathematical skills when applied to military engineering problems. These skills are also required for scientific applications in a military environment, such as circuit parameter calculations.

Learners will develop the skills needed to apply analytical methods to military engineering mathematical applications. This will involve calculating areas and volumes of various shapes and solids, and calculating angles and lengths of objects. Learners will use graphical information to find relationships between parameters.

As well as using analytical methods in mathematical applications, learners will use them to solve problems in military engineering scientific applications. This will include calculating work carried out by simple machines along with the power used and energy generated. In doing so, learners will be able to calculate efficiency in terms of mechanical and electrical power and energy.

Essential resources

For this unit learners must have access to a range of engineering materials and supplier catalogues.

Although not essential, access to scientific equipment suitable for determining mechanical properties, work carried out by simple machines, power and strength of materials would be useful, as would a range of simple machines and equipment used to determine circuit parameters and to carry out heat-treatment processes.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know about materials used in engineering	1.1	Identify the range of materials commonly used in military engineering	□ *Range of materials*: ferrous material, e.g. cast iron, low to high carbon steel, stainless steel; non-ferrous material, e.g. aluminium, brass, bronze, copper, lead; thermoplastics, e.g. PVC, nylon, PTFE, polythene, Perspex; thermosetting polymer, e.g. Bakelite, Formica, melamine; smart materials, e.g. piezoelectric materials, shape memory alloys, magneto-rheostatic fluids, electro-rheostatic fluids, Kevlar; composites, e.g. glass fibre, carbon fibre, aramid fibre; rubber.
		1.2	Describe the forms of supply of materials	□ *Forms of supply*: form, e.g. bar stock (flat, round, square, hexagonal), sheet materials, pipe/tube, wire, rolled steel sections, castings, forgings, mouldings, extrusions, powders and fluids; surface finish, e.g. bright drawn, cold drawn, plated, painted, plastic coated; size, e.g. diameter(s), thickness, gauge.
		1.3	Identify materials by physical methods	□ *Physical methods*: tactile methods, e.g. touch, weight, texture; visual, e.g. colour, appearance.

Learning outcomes		Assessment criteria		Unit amplification
2	Know about the properties of engineering materials	2.1	Describe the physical properties of materials	□ *Physical properties*: melting points of metals, density, colour, magnetism, conductivity, insulation; chemical and durability, e.g. resistance to corrosion, solvents, environmental degradation, wear.
		2.2	Define what is meant by mechanical properties of materials	□ *Definition of mechanical properties*: tensile strength, toughness, hardness, elasticity, ductility, malleability.
		2.3	Describe the mechanical properties of materials	□ *Mechanical properties*: tensile, compressive and shear strength; toughness, hardness, elasticity, ductility, malleability.
		2.4	Describe methods of modifying properties of materials	□ *Methods of modification*: heat treatment, e.g. annealing, hardening, normalising, tempering; surface treatments, e.g. case hardening, plating, coating; effects of cold working.

Learning outcomes		Assessment criteria		Unit amplification
3	Be able to use analytical methods in engineering mathematical applications	3.1	Apply appropriate degree of accuracy to express numbers	□ *Degree of accuracy*: decimal places, significant figures, fractions as a decimal quantity.
		3.2	Calculate the areas of basic shapes	□ *Basic shapes*: square, rectangle, triangle, circle.
		3.3	Calculate the areas of compound shapes	□ *Compound shapes*: L-shapes, parallelograms, other shapes, e.g. involving squares, rectangles, triangles, circles, semicircles, quadrants of a circle.
		3.4	Calculate the surface areas of regular shaped solids	□ *Regular solids*: cube, rectangular prism, cylinder (curved surface area only).
		3.5	Calculate the volumes of regular shaped solids	□ *Regular solids*: cube, rectangular prism, cylinder.
		3.6	Determine the value of angles in triangles	□ *Triangles*: right-angled, isosceles, equilateral.
		3.7	Use Sine, Cosine and Tangent rules and Pythagoras' Theorem to solve right-angled triangle problems	□ *Right-angled triangle*: base, adjacent, hypotenuse. □ *Problems*: e.g. distance between hole centres, diagonal distance across a section, slope or incline, length of strengthening web, slope of a linear graph.
		3.8	Use data found on a straight line graph to interpret a relationship	□ *Straight line graphs*: determining gradient; intercept; finding relationships, e.g. distance travelled, linear acceleration, work done; given data (including scales, axes, X coordinates, Y coordinates, using given data).

Learning outcomes		Assessment criteria		Unit amplification
4	Be able to use analytical methods in engineering science applications	4.1	Define work done by a simple machine	□ *Work done*: definition; solving problems by formulae, force x distance moved. □ *Simple machine*: e.g. inclined plane, pulley, lever.
		4.2	Calculate power used	□ *Types of power*: mechanical, electrical.
		4.3	Calculate energy used	□ *Types of energy*: mechanical, electrical.
		4.4	Calculate the efficiency of a machine	□ *Efficiency*: mechanical (power, energy), electrical (power, energy).
		4.5	Solve simple electrical circuit problems using Ohm's law	□ *Circuit problems*: series and parallel circuit networks; current and resistance data for calculations; definition of Ohm's Law.
		4.6	Calculate the strength of engineering materials, quoting the answer using appropriate multiple prefix symbols	□ *Strength of materials*: calculations, e.g. yield stress, tensile stress, percentage elongation; use of graphs, e.g. force/extension graph, stress/strain graph. □ *Multiple prefix symbols*: factor, e.g. 10^6, 10^3; name, e.g. mega, kilo; symbol, e.g. M, k.

Information for tutors

Delivery

This unit should be delivered using lectures, tutor demonstrations and practical engineering activities. Centres must ensure sufficient coverage of the learning outcomes and content.

Learning outcome 1 is best delivered by practical means, whereby learners have access to a range of engineering materials and are able to touch and feel the materials, comparing the physical forms with those found in supplier catalogues. Learning outcomes 2 and 3 are again best suited to a practical approach. Learners could carry out simple mechanical tests and simple heat treatment processes to develop their knowledge of mechanical properties and methods of modifying them. Finally, learning outcome 4 requires learners to develop and practise their skills in carrying out calculations for a range of scientific applications associated with engineering.

For learning outcome 1, learners must be made aware of, and have access to, a range of different engineering materials. Tutors should ensure that each learner has knowledge of ferrous, non-ferrous, thermoplastic and thermosetting polymers, SMART materials and composites. Referring regularly to suppliers' catalogues is good practice. Learners need to have tactile contact with these materials and being in a military engineering workshop environment would be advantageous. Each learner could develop a simple checklist, or a competition about identifying the most materials could be set up, increasing learner motivation.

Learning outcome 2 will again be addressed better if learners have access to a military engineering workshop environment, relevant equipment that can demonstrate mechanical properties and, if possible, equipment to demonstrate and investigate physical properties. This learning outcome could be delivered so that learners see for themselves how these properties are measured and modified through experience of testing and heat treatment processes.

Learning outcomes 3 and 4 require practise with calculations involving mathematical and scientific applications. Preferably learners should be given an opportunity to perform practical activities with electrical circuits to confirm calculations using Ohm's Law. Likewise, using test equipment to produce load extension graphs for materials would be beneficial in developing their knowledge of strength of materials.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Much of the assessment evidence for this unit could come from written activities, including a range of solutions to problems using skills of calculation, and could be based on outcomes from practical activities. Learning outcomes 1 and 2 are probably best assessed through a written assignment. Learning outcomes 3 and 4 are likely to be practical exercises, in the form of a range of calculations to be carried out. Learner work used as evidence for practical activities should be supported by witness testimony or observation records.

Two assignments could be used for the assessment of this unit. However, this would involve a large number of tasks within each assignment addressing the individual criteria, so it may be preferable to have one assignment for each learning outcome. In this case the first, relating to learning outcome 1, would cover assessment criteria 1.1, 1.2 and 1.3. This could be a written assignment with a practical element requiring learners to identify at least one material for each type of material, i.e. ferrous, non-ferrous, thermoplastic and thermosetting polymers, SMART materials and composites. This practical element should be extended by giving learners the opportunity to identify these materials by tactile and visual methods. A record of this will need to be made, for example by ensuring that each material has a label and that learners use this labelling to identify the different materials on a written record, along with details of the physical methods they used to help in this identification.

A second assignment, relating to learning outcome 2, would cover assessment criteria 2.1, 2.2, 2.3 and 2.4. A holistic written assignment giving learners the opportunity to describe the physical and mechanical properties of a range of materials would be most suitable. This range should be similar to that used for assessment criterion 1.1. Learners should also be given a task asking them to define the full range of mechanical properties: tensile strength, toughness, hardness, elasticity, ductility, malleability. Learners should have opportunities to describe both heat treatment and surface treatment methods of modifying properties for criterion 2.4.

Assessment criteria 3.1 to 3.8 could be addressed through a third assignment. This would be purely practical with a range of questions or tasks to address the assessment criteria. For 3.1, the range of tasks given must include opportunities to demonstrate the degree of accuracy using decimal places, significant figures and fractions as a decimal quantity. The task for 3.2 must include calculating areas for all four shapes listed in the unit amplification. The task for 3.3 must include L-shapes, parallelograms and one from other shapes listed in the unit amplification. When setting tasks for the areas and volumes of regular shaped solids, for 3.4 and 3.5 respectively, all three solids should be covered (cube, rectangular prism, cylinder), however only the curved surface area is required to be calculated for the cylinder for 3.4. When setting a task for determining the angles of triangles, care must be taken to ensure all three triangles are covered as ranged by the unit amplification for 3.6. For 3.7, at least two problems need to be given to enable Pythagoras' Theorem to be used. These problems should be of an engineering nature. Finally, for 3.8, a task should be given that involves the learner interpreting a straight line relationship. They will need to determine the gradient and intercept and be able to find at least one of the relationships such as distance travelled, linear acceleration or work done. Different graphs could be given to different learners to help authenticity. In many of the tasks for this learning outcome, different problems or data could be given to different learners to help authenticity.

The last assignment, addressing assessment criteria 4.1 to 4.6, should be similar to that for learning outcome 3 and be purely practical, with a range of questions or tasks to address the assessment criteria. For 4.1, the task should include the need to define work done but also to solve a problem using the appropriate formulae, force x distance moved. Tasks addressing 4.2 and 4.3 should give learners opportunities to calculate for both mechanical and electrical systems power and energy respectively. A further task is then required that asks learners to calculate efficiency of both mechanical and electrical machines in terms of power and energy to address 4.4. To address 4.5 a task needs to be developed that allows Ohm's Law to be used on both series and parallel circuits to find potential difference, current and resistance. Finally, 4.6 should be addressed using a task that gives learners the opportunity to calculate yield stress or tensile stress or percentage elongation and use an appropriate graph. The outcomes will need to be quoted using multiple prefix symbols. In doing so, at least two materials need to be considered.

Suggested resources

Books

Aldis B – *Mathematics for Technicians* (McGraw Hill, 2002) ISBN 9780074711576

Askeland D – *Science and Engineering of Materials* (Cengage Publishing, 2006) ISBN 9780495244424

Bird J – *Basic Engineering Mathematics* (Elsevier, 2005) ISBN 9780750665759

Bolton W - *Newnes Engineering Materials Pocket Book* (Newnes, an imprint of Butterworth-Heinemann Ltd; 3rd Revised edition, 2000) ISBN 9780750649742

Clarke S, Darbyshire A, Mantovani B, Weatherill B – *BTEC Level 2 First Engineering* (Heinemann, 2010) ISBN 9781846907234

Clarke S, Darbyshire A, Goulden S, Hallgarth C, Watkins N – *BTEC Level 2 First Engineering Student Book* (Pearson Education, 2012) ISBN 9781446902431

Sullivan M and Shackelford J – *Introduction to Materials Science for Engineers* (Prentice Hall, 2004) ISBN 9780131276192

Tooley M, Deacon M, O'Dwyer N – *Engineering Level 2 Higher Diploma Student Book* (Heinemann, 2008) ISBN 9780435756208

Tooley M – *BTEC First in Engineering* (Newnes, 2006) ISBN 9780750680608

Websites

www.bbc.co.uk/schools/ks3bitesize/maths

www.khanacademy.org/math

www.learnerstv.com/Free-Maths-video-lecture-courses.htm

www.onlinemathlearning.com

www.freestudy.co.uk

www.key2study.com

www.matweb.com – database of materials and properties

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Identifying information used on given engineering documentation Identifying the forms of supply available for a given engineering material Analysing and evaluating information, judging its relevance and value Exploring issues and problems relating to electrical and mechanical engineering science
Creative thinkers	Asking questions when reviewing the properties of engineering materials to extend their thinking

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Creative thinkers	Trying out alternatives or new solutions to mathematical problems Trying out alternatives or new solutions to electrical and mechanical engineering science problems
Reflective learners	Explaining the properties that are used to define the behaviour of common engineering materials Describing the properties of a given engineering material Reviewing progress when solving problems during the learner's activities and acting on the outcomes to make corrections to understanding/solutions
Team workers	Participating in small groups to carry out exercises in material identification and forms of supply Collaborating with others when working on investigative group work to achieve a valid solution
Self-managers	Preparing for and carrying out set assignments Organising time and resources, prioritising actions Organising time and resources to carry out practical work relating to electrical and mechanical engineering science experiments and investigations
Effective participators	Discussing issues relating to the properties and applications of engineering materials

Functional Skills – Level 2

Skill	When learners are…
ICT – Finding and selecting information	
Select information from a variety of sources to meet requirements of a complex task	Identifying forms of supply available for engineering materials
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Speaking with and listening to peers and supervisors to establish an understanding of mathematical concepts and issues in engineering
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Selecting, reading and using appropriate mathematical data sources to solve engineering problems
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Taking notes and solving engineering mathematical problems to communicate accurate solutions effectively
Mathematics	
Representing – selecting the mathematics and information to model a situation	Recognising the relevant parameters and formulae to be applied to given situations involving areas, volumes, right-angled triangles and scientific applications
Analysing – processing and using mathematics	Using mathematical skills in given situations involving areas, volumes, right-angled triangles and scientific applications
Interpreting – interpreting and communicating the results of the analysis	Checking the results of solutions to given situations involving areas, volumes, right-angled triangles and scientific applications to evaluate their effectiveness and reality at each stage of the calculation

Unit 3: Principles of Maintenance Technology

Unit reference number: T/506/6192
QCF level: 2
Credit value: 7
Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to explore the basic principles of engineering maintenance in order to develop an understanding of how to perform maintenance activities safely in engineering environments.

Learners will investigate the importance of following specified procedures and complying with generic health and safety requirements and policies specific to the military workplace.

Learners will understand how planned maintenance can minimise or eliminate downtime due to failure, and will explore a range of fault finding techniques. They will understand the importance of planning so that the correct tools, equipment and documentation are available for a maintenance procedure. Learners will look at a range of activities associated with maintenance procedures, including the use of access equipment, safe lifting and moving of heavy items, how to replace life-determined components and apply lubricants, and how to dismantle and reassemble engineering systems and devices. They will also learn about the need to restore work areas to a tidy condition, correctly dispose of waste materials and fill out relevant documentation on completion of the procedure.

Essential resources

For this unit centres need to provide access to a workshop environment so that engineering maintenance procedures can be demonstrated. A range of equipment is required; this should include components, tools, service manuals, data sheets, parts lists, drawings, test schedules and personal protective equipment (PPE).

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know how to prepare for maintenance activities using safe and effective working practices	1.1	Describe safe working practices and health and safety requirements when carrying out maintenance procedures	□ *Own and others' responsibilities*: e.g. Health and Safety at Work Act and related legislation, Personal Protective Equipment at Work Regulations, Manual Handling Operations Regulations, Control of Substances Hazardous to Health Regulations, the Ministry of Defence (MOD) Health and Safety Handbook – Joint Service Publication (JSP) 375 – applicable across all areas of MOD and the Armed Forces, workplace policies and procedures, equipment isolation/lock-off, permit-to-work, workplace preparation and clean down, sign off procedure. □ *Emergency procedures*: workshop incidents, appropriate qualified persons to manage incidents, actions to take, incident reporting.
		1.2	Identify the hazards associated with maintenance procedures	□ *Hazards*: high-pressure fluids, flammable materials, high voltage electricity, heavy equipment, lubricants, cleaning fluids, damaged/badly maintained tools, not following specified maintenance procedures.
		1.3	Identify data used for reference purposes when planning and carrying out a maintenance procedure	□ *Data*: e.g. manufacturers' service manuals, servicing schedules and logs, fault reports, assembly drawings, system diagrams, technical specifications, component databases.
		1.4	Describe types of planned and unplanned maintenance procedures	□ *Procedures:* planned maintenance, e.g. scheduled routine servicing, preventative, condition monitoring, performance testing, front line; unplanned maintenance, e.g. breakdown, run to failure.

Learning outcomes		Assessment criteria		Unit amplification
		1.5	Describe the factors to be considered when planning a maintenance procedure	□ *Factors*: timescales, minimisation of downtime, economics of repair or replace components, tools and equipment, availability of maintenance personnel, availability of spare parts, location of equipment requiring maintenance, on-site services, e.g. electricity, water, compressed air, disposal of waste materials; consumables, e.g. solvents, cleaning materials, lubricants, welding electrodes, drill bits, nuts, bolts, screws, locking wire.
		1.6	Describe the procedure for reinstating a work area following spillage of a hazardous fluid	□ *Procedures*: approved working practices when using absorbent substances, detergents and solvents; disposal of waste materials; sign-off documentation.
		1.7	Outline fault finding techniques and associated reference materials	□ *Techniques*: visual checks, e.g. leakage, damage, missing parts, overheating, wear/deterioration, malfunction; sensory checks, e.g. sound, smell, touch; mechanical checks, e.g. operation of moving parts, correct working clearances, belt/chain tension, bearing loading, torque loading of fastenings, hydraulic system pressures; electrical checks, e.g. continuity, voltage, current, resistance; techniques, e.g. six point, half split, input/output, component substitution. □ *Reference materials*: repair manuals, flowcharts, checklists, drawings, maintenance records, performance data, equipment self-diagnostic reporting.

Learning outcomes		Assessment criteria		Unit amplification
2	Know how to select working methods, tools and equipment	2.1	Describe how to use access equipment so that a maintenance procedure can be carried out under safe conditions	□ *Equipment*: e.g. stepladders, ladders, platforms, scaffolding, cherry-pickers, scissor lifts, screw jacks, hydraulic jacks, mobile hoists, four-post hoists, ramps, heavy lift airbags, under-car trolley, axle stands. □ *Safe conditions*: equipment operating instructions, e.g. height restrictions, tying in/on, guard rails, centre of gravity position, slip and fall prevention, correct footing, inter-locks.
		2.2	Describe safe techniques for lifting heavy loads	□ *Techniques*: suspension, e.g. chains, ropes, wire slings, pulley blocks, winches; attachment, e.g. hooks, shackles, eye bolts; damage prevention, e.g. padding, wooden blocks; loading parameters, e.g. safe working load, centre of gravity; equipment, e.g. overhead gantry cranes, mobile cranes, derricks, tripods, forklifts, heavy lift airbags, ratchet lever hoists.
		2.3	Outline how to move heavy equipment across a flat surface	□ *Movement using*: rollers, pull-lifts, crowbar, roller pinch bar; load moving skates, e.g. fixed wheel, steerable, caterpillar.
		2.4	Describe correct selection and use of tools when carrying out a maintenance procedure	□ *Hand tools*: e.g. torque wrench, impact driver, circlip pliers, soft faced mallet, hammer, drifts, hub puller, bearing extractor, screw drivers, hex keys, feeler gauges, spanners, socket sets, soldering iron, de-soldering tool, pliers, crimping tools, wire cutters, wire strippers, taps, dies, easy-outs, drills, spring compressors. □ *Power tools*: e.g. drill, screwdriver, angle grinder, nut driver.
		2.5	Describe how to perform conformity checks using measuring equipment	□ *Measurements*: e.g. positional, alignment, clearance, backlash/slack, surface condition, torque settings, pressure, flow rate, voltage, current. □ *Equipment*: e.g. rules, tapes, squares, feeler gauges, micrometer, Vernier calipers, Vernier height gauge, dial test indicator, spirit level, belt tension gauge, laser devices, electrical multi-meter, pressure gauge, optical devices.

Learning outcomes		Assessment criteria		Unit amplification
		2.6	Describe the replacement of life-determined components	□ *Life-determined components*: e.g. batteries, electric motor brushes, filters, lubricating oil, hydraulic oil, bearings, braking components, clutches, seals and gaskets, high tensile bolts and washers, locking devices, structural components. □ *Replacement*: replace in accordance with manufacturer's/operator specified procedures.
		2.7	Describe methods and purpose for applying lubricants	□ *Methods*: e.g. brush, spray, splash, pressure feed, grease gun and nipple. □ *Purpose*: reduced friction, reduced wear between sliding parts, smoother running, heat dissipation, increased life of components, reduced surface degradation.

Learning outcomes		Assessment criteria		Unit amplification
3	Know how to use dismantling and assembly techniques for components or systems	3.1	Describe how to dismantle an engineering system or device	□ *Dismantle*: prepare e.g. sequence of operations, isolate and lock off, release pressure/force/electrical charge, identification marking and storage of components; removal of locking devices, e.g. wire locks, tab washers, clips, split pins; removal of retaining devices, e.g. nuts, bolts, studs, screws, pins, dowels, keys, circlips, rivets; extracting components, e.g. bearings, shafts, gears, couplings, springs, seals, gaskets, valves, motors, electrical/electronic components, fluid power components.
		3.2	Describe how to re-assemble an engineering system or device	□ *Re-assemble*: source replacement components, e.g. single components, sub-assemblies, seals, gaskets, locking devices, nuts, bolts, washers; lay out components and consumables, select correct assembly tools, select adjusting components, e.g. shims, packing; assemble components and mating parts, correctly tighten fastenings, e.g. tightening sequence, torque loading; correctly fit securing/locking devices; inspect/test, e.g. alignment, dimensional accuracy, correct belt/chain tension, device/system operating to specification.
		3.3	Describe how to use correct procedures to restore a work area to a ready condition	□ *Restore work area*: correct storage of tools, equipment and personal protective equipment, removal and storage of unused consumables, storage and disposal of waste materials, clean down, sign-off documentation. □ *Ready condition*: clean, tidy, ready for next job.
		3.4	Outline the information that should be included in reports produced on completion of maintenance activities	□ *Information included in report*: type of maintenance undertaken, repairs carried out, replaced components/assembles and consumables, time taken, serviceability of device or system; advisory information for next scheduled service, e.g. components that are beginning to show signs of wear or degradation, components that have been replaced on a temporary basis, life-determined components that are almost time expired.

Information for tutors

Delivery

All learning outcomes should be delivered through lectures, tutor demonstrations, practical activities or learner investigation. It is important to ensure that there is sufficient coverage of the learning outcomes and unit content. Relevance and interest may be added to delivery by showing learners exemplars of maintenance work being carried out on military equipment. There is no requirement for learners to perform assessed practical activities because the unit focus is on the theoretical aspects of maintenance. Learners have the opportunity to demonstrate their application and practical skills in other units within the qualification.

As learners may not have any prior knowledge of maintenance principles it is suggested that, before starting on delivery of the learning outcomes, they are given an overview presentation about why effective maintenance is important. This could include concepts about cost and inconvenience if equipment breaks down, prevention better than cure, repair or replace, etc.

All the unit content is applicable to any type of engineering context but because the unit is within a military engineering programme it is important to keep this in mind during delivery. Learners should be aware that maintenance activities take place in the field as well as in fully equipped workshops.

Learning outcome 1 starts by investigating safe working practices and health and safety requirements. As there is a large amount of information in the public domain, learners should be guided to focus their attentions on safety requirements specific to maintenance activities.

The learning outcomes follow a logical order and it would be a reasonable approach to develop them sequentially throughout the unit. In this way, the learner will understand maintenance procedures and be able to apply this knowledge to future practical situations.

The unit gives learners opportunities to work individually or in groups when carrying out research activities.

Tutors should always ensure that each learner uses the correct personal protective equipment if they are exposed to practical activities. It is important that learners take responsibility for their own safety and that of others when being shown maintenance procedures.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

There are close links between this unit and the following units in this qualification:

Unit 5: Operation and Maintenance of Fluid Power Systems and Components

Unit 6: Engineering Maintenance Procedures

Unit 7: Operation and Maintenance of Electrical Systems and Components.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Evidence of learner achievement of the assessment criteria could be collected from three assignments.

The focus of the unit is on the principles of engineering maintenance and learners should be aware from the start that assessment evidence needs to be in the form of written descriptions, presented as a portfolio. Images and diagrams can be used to support descriptive writing and it is acceptable for them to be clipped from approved sources, provided these sources are referenced. An example of unacceptable evidence is text cut and pasted from the internet.

Learning outcome 1, incorporating assessment criteria 1.1–1.7, could be covered through an assignment requiring learners to respond to pre-set questions, which could be based around a case study style scenario or could be test questions that have been set within a relevant engineering maintenance context. In either case, it is most likely that controlled conditions will be required to ensure the authenticity of the responses.

Assessment of learning outcomes 2 and 3 will be similar to that for learning outcome 1.

For assessment criteria 3.1 and 3.2, learners should be given an engineering system or device applicable to Level 2, i.e. not over complex. This could be a sub-system of something much larger, for example the wheel, bearing and brake assembly of a vehicle.

This unit links to other practical units in the programme of study and there is the opportunity, where the centre considers it appropriate, to set assignment tasks that cross over units. If this approach is adopted, it is important that portfolios include clear pointers to where evidence that addresses specific unit content and assessment criteria can be found.

Suggested resources

Books

Health and Safety Executive – *Essentials of Health and Safety at Work* (HSE, 2006) ISBN 9780717661794

Health and Safety Executive – *Health and Safety in Engineering Workshops* (HSE, 2004) ISBN 9780717617173

Kibbe R – *Mechanical Systems for Industrial Maintenance* (Prentice Hall, 2001) ISBN 9780130164902

Mobley K – *Maintenance Fundamentals*, 2nd Edition (Butterworth-Heinemann, 2004) ISBN 9780750677981

Sinclair I and Lewis G – *Electronic and Electrical Servicing* (Newnes, 2002) ISBN 9780717661794

Website

www.hse.gov.uk – Health and Safety Executive

Other

Manufacturers' specifications, as appropriate

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Investigating how to carry out maintenance procedures in a military engineering environment safely
Reflective learners	Reviewing progress and deciding what written evidence to put into their portfolio of evidence
Self-managers	Demonstrating initiative, commitment, perseverance and time management when investigating the principles of maintenance technology

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Team workers	Collaborating with others, if working in groups to gather information about safe working and maintenance procedures

Functional Skills – Level 2

Skill	When learners are…
ICT – Finding and selecting information	
Use appropriate search techniques to locate and select relevant information	Selecting and using sources of information when preparing a portfolio of evidence for assessment
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Listening to and speaking with tutors when investigating the principles of engineering maintenance
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Selecting, reading and using appropriate sources of information when preparing portfolio evidence
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Describing how to work safely in an engineering maintenance environment, describing how to select working methods, tools and equipment, and describing how to dismantle and assemble engineered products

Unit 4: Principles of Fabrication and Welding Technology

Unit reference number: A/506/6193
QCF level: 2
Credit value: 7
Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to explore the basic principles of fabrication and welding so that they have an understanding of how to select, prepare and weld metals to produce joints that can be inspected and tested for defects.

Welding is a fusion technique for producing permanent joints in metal, a method that involves heat and melting. Learners will investigate the use of electric arc, electrical resistance and gas combustion to produce the necessary heat at the weld position. Learners will understand that components joined by fusion cannot be separated back into their original configurations; they will investigate how to edge prepare and align materials correctly before the weld is made. Heat distortion and the strategies for controlling it are investigated.

Learners will consider the use of filler material and shielding gases in the production of welds that are structurally sound, free from defects and have the correct profile and surface finish. Identification of weld defects using non-destructive and workshop test methods is a topic covered in the unit.

Welded joint configurations are defined by welding standards; learners will gain a basic understanding of them and the symbols that are used on engineering drawings to represent them. Learners will look at the metals commonly used in welding and how to identify them. They will use basic mathematical skills to calculate bending and rolling allowances for materials that are shaped into curves before welding.

Learners can be given the opportunity to perform welding techniques but this is not mandatory to achieving a pass for the unit.

Essential resources

For this unit, centres need to provide access to a workshop environment so that fabrication and welding processes can be demonstrated. A range of equipment is required; this should include cutting tools, measuring equipment, welding equipment, consumables, materials and personal protective equipment (PPE).

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know the basic principles of welding metallic materials	1.1	Describe the effects of electricity on the welding process	□ *Effects*: e.g. supply voltage, current (amperage), direct current, alternating current, direction of current, positively/negatively charged anode, arc blow.
		1.2	Identify electrode coverings	□ *Electrode coverings*: e.g. rutile, basic, nickel alloy, cellulosic, calcium fluoride, iron powder.
		1.3	Describe the impact of different electrode coverings on the welding process	□ *Impact*: e.g. pool size, weld penetration, atmospheric contamination, weld surface profile/contour, ease of producing the weld, final appearance.
		1.4	Identify shielding gases and gas mixtures	□ *Shielding gases*: inert gas, active gas; gases, e.g. argon, helium, carbon dioxide, nitrogen, oxygen, mixtures.
		1.5	Describe the impact of different shielding gases and gas mixtures on the welding process	□ *Impact on the process*: welding process, e.g. metal inert gas (MIG), metal active gas (MAG), tungsten inert gas (TIG); effect of the gas, e.g. weld speed, weld surface finish, weld bead profile, porosity, penetration, mechanical properties of the weld.
		1.6	Describe the impact of welding flame conditions on the welding process	□ *Flame conditions*: oxyacetylene welding; flame zones, e.g. inner cone, outer cone, temperatures, colour; flame type, e.g. neutral, reducing, oxidising.
2	Know how to apply welding terminology and symbols	2.1	Describe the features of welded joints	□ *Features*: fillet profile, e.g. convex, concave, mitre; weld width, fusion zone (penetration), heat affected zone, surface finish.
		2.2	Describe the types of welded joints conforming to current standards	□ *Types of joint*: butt, tee, corner, lap, edge, weld symbols (BS EN22553). □ *Types of weld*: fillet, groove, tack, spot.
		2.3	Describe how to select joint preparation for type of weld	□ *Edge preparation*: e.g. flat, square butt (open), square butt (closed), bevel, chamfer, groove, vee butt.

Learning outcomes		Assessment criteria		Unit amplification
3	Understand the effects of welding	3.1	Describe the effects of different heat sources for welding	□ *Heat distribution*: weld metal, parent metal, structure as a whole.
		3.2	Describe heat distribution produced by welding processes	□ *Distortion*: e.g. shrinkage, expansion, uneven expansion and contraction, bowing, dishing, twisting, buckling. □ *Distortion control*: setting up, e.g. tack welds, back-to-back positioning, stiffeners, clamps, jigs, fixtures; welding, e.g. deposit weld metal as quickly as possible, backstep weld for long runs, balance welds around neutral axis, uniform heat distribution.
		3.3	Describe distortion caused by welding and ways of controlling it	□ *Weld defects*: lack of fusion, incomplete penetration, excessive penetration, cracks, porosity, slag inclusions, incorrect weld shape and size, burn through. □ *Causes*: incorrectly set welding parameters, e.g. flame condition, current flow, shielding gas flow, electrode, weld speed; operator error.
		3.4	Outline weld defects and what causes them	□ *Methods*: e.g. visual, dye penetrant, magnetic particle, x-ray, electromagnetic, ultrasonic; basic principles of operation; advantages and disadvantages of each method.
		3.5	Describe non-destructive test (NDT) methods that are used to identify weld defects	□ *Techniques*: visual tests, e.g. inspect by eye, macro-etch; mechanical tests e.g. bend (root/face), nick break (fracture), impact; weld gauges, e.g. fillet, leg length, undercut, hi-lo gauges.
		3.6	Describe workshop techniques for testing welds	□ *Heat distribution*: weld metal, parent metal, structure as a whole.

Learning outcomes		Assessment criteria		Unit amplification
4	Know how to identify common metals used in fabrication	4.1	Describe metals used in fabrications	□ *Metals*: low carbon steel, austenitic stainless steel, galvanised steel, aluminium, aluminium alloy.
		4.2	Identify forms of supply for metals used in fabrications	□ *Forms of supply*: plate, thin sheet; bar, e.g. circular, square, rectangular; structural sections, e.g. angle, tee, 'I'; hollow sections, e.g. circular, square, rectangular.
		4.3	Select, against criteria, materials for given applications	□ *Criteria*: mechanical properties, e.g. strength, malleability, ductility, hardness; physical properties, e.g. corrosion resistance, density; other, e.g. weldability, cost, surface appearance.
5	Know how to determine forming allowances for common metals used in fabrication	5.1	Determine, using given data, the bending and rolling allowances for fabricated forms	□ *Bending*: configuration, e.g. right angle, 45 degree, 'U'. □ *Calculations:* spring-back and bend allowance for tube and plate, rolling allowance for sheet material.

Information for tutors

Delivery

All learning outcomes should be delivered through lectures, tutor demonstrations, practical activities or learner investigation. It is important to ensure that there is sufficient coverage of the learning outcomes and unit content. Relevance and interest may be added to delivery by showing learners examples of fabrication and welding being carried out on military equipment. There is no requirement for learners to perform assessed practical activities because the unit focus is on the theoretical aspects of delivery. Learners have the opportunity to demonstrate their practical skills in *Unit 9: Application of Welding Processes*.

As learners may not have any prior knowledge of fabrication and welding, it is suggested that, before starting on delivery of the learning outcomes, they are given an overview presentation about how fabrication and welding sit alongside other manufacturing processes.

All the unit content is applicable to any type of engineering context, but because the unit is in a military engineering programme it is important to keep this in mind during delivery. Learners should be aware that welding activities take place on a mobile basis in the field as well as in fully equipped workshops.

Learning outcome 1 starts by investigating the basic principles of welding and formal delivery will benefit from being supported by practical demonstration and video presentation. Care should be taken to ensure that presentations are pitched at the correct level, i.e. Level 2. It is not the intention that learners be expert welders on completion of this unit and the welding application unit.

The learning outcomes follow a logical order and it would be a reasonable approach to develop them sequentially throughout the unit. In this way, the learner will understand the basic principles of welding and be able to apply this knowledge to future practical situations.

The unit gives learners opportunities to work individually or in groups when carrying out research activities.

Tutors should always ensure that each learner has the correct personal protective equipment and that equipment is in a serviceable form when being demonstrated. It is also important that learners take responsibility for their own safety and that of others when being shown fabrication and welding procedures.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

There are close links between this unit and the following unit in this qualification:

Unit 9: Application of Welding Processes.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Evidence of learner achievement of the assessment criteria could be collected from four assignments.

The focus of the unit is on the principles of fabrication and welding technology and learners should be aware from the start that assessment evidence should be in the form of written description, presented as a portfolio. Images and diagrams can be used to support descriptive writing and it is acceptable for them to be clipped from approved sources, provided these sources are referenced. An example of unacceptable evidence is text cut and pasted from the internet.

Learning outcome 1, incorporating assessment criteria 1.1–1.6 could be covered through an assignment that requires the learner to respond to pre-set questions. These could be based around a case study style scenario or could be test questions that have been set within a relevant engineering context. In either case, it is most likely that controlled conditions will be required to ensure the authenticity of the responses.

Assessment of learning outcomes 2, 3, 4 and 5 will be similar to that of learning outcome 1.

This unit link to *Unit 9: Application of Welding Processes* and there is the opportunity, where the centre considers it appropriate, to set assignment tasks that cross over units. For example, for this unit weld testing is addressed by assessment criteria 3.5 and 3.6, which would link to 4.1 in Unit 9. If this approach is adopted, it is important that portfolios include clear pointers to where evidence that addresses specific unit content and assessment criteria can be found.

Suggested resources

Books

Jeffus L – *Welding Principles and Applications* (Delmar Learning, 2007) ISBN 9781418052751

Kenyon W – *Basic Welding and Fabrication* (Longman, 1987) 9780582005365

Timings R – *Fabrication and Welding Engineering* (Newnes, 2008) ISBN 9780750666916

Websites

www.millerwelds.com/resources/video_library – short video clips of welding procedures

www.twi.co.uk – The Welding Institute

www.youtube.com – step-by-step welding videos

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Investigating the principles of fabrication and welding technology in a military engineering environment
Reflective learners	Reviewing progress and deciding what written evidence to put into their portfolio of evidence
Self-managers	Demonstrating initiative, commitment, perseverance and time management when investigating the principles of fabrication and welding technology

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Team workers	Collaborating with others if working in small groups to gather information about fabrication and welding technology

Functional Skills – Level 2

Skill	When learners are…
ICT – Finding and selecting information	
Use appropriate search techniques to locate and select relevant information	Selecting and using sources of information when preparing a portfolio of evidence for assessment
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Listening to and speaking with tutors when investigating the principles of fabrication and welding technology
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Selecting, reading and using appropriate sources of information when preparing portfolio evidence
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Describing the basic principles and terminology of welding, describing the thermal effects of welding, describing weld defects, describing types, selection and application of materials for fabricating products
Mathematics	
Representing – selecting the mathematics and information to model a situation	Calculating bending and rolling allowances from information supplied

Unit 5: Operation and Maintenance of Fluid Power Systems and Components

Unit reference number: H/600/3387
QCF level: 2
Credit value: 10
Guided learning hours: 60

Unit aim

This unit provides learners with a knowledge and understanding of fluid power systems, circuits, and components. Learners will also develop the skills needed to safely carry out maintenance activities on a range of pneumatic and hydraulic systems used in industry.

In every engineering workshop, processes and service operations need maintaining. The maintenance engineer is a key member of staff in ensuring the process or service continues to operate safely. This unit is about those aspects of fluid power systems and components that a maintenance engineer is likely to be involved with.

Learners will gain an understanding of fluid power diagrams, symbols, systems and their components. They will also develop an understanding of the operation of components such as pumps, reservoirs, air service units, control valves, actuators, sensors, regulators, compressors, pipes and hoses.

Learners will develop the skills needed to locate faults and carry out scheduled and corrective maintenance activities on pneumatic and hydraulic systems and components in accordance with approved procedures. In carrying out these activities learners will need to use a range of tools and fault-finding and diagnostic techniques. Learners will be able to identify and locate faults at unit, component and system level. They will then remove, replace and/or repair the faulty component and carry out tests to ensure that the system performs to specification.

Learners will gain an understanding of the procedures that must be followed before handing over maintained and/or installed equipment and confirming that the equipment is now ready to run in a safe and operable condition. They will be expected to demonstrate safe working practices when carrying out fault location and maintenance activities and the necessary safeguards to protect their own safety and that of others in the workplace.

Essential resources

In order to gain the relevant practical skills required for this unit it is essential that learners have access to:

- fluid power system circuits and components
- pneumatic and hydraulic system test rigs
- fluid power circuit drawings and computer simulation software
- appropriate test equipment
- data books and specifications
- current health and safety legislation and regulations and related publications.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know the health and safety regulations and precautions that need to be observed when working with fluid power systems	1.1	Identify the relevant health and safety regulations that need to be followed when working with fluid power systems	□ *Health and safety regulations*: e.g. Health and Safety at Work Act 1974, Control of Substances Hazardous to Health (COSHH), Management of Health and Safety Regulations, Pressure Systems and Transportable Gas Containers Regulations 1989 (SI 1989 No 2169), The Pressure Vessels Directive.
		1.2	Describe the safe practices that need to be followed when assembling, testing and maintaining a fluid power system	□ *Safe practices*: practices to be followed when assembling, testing and maintaining pneumatic equipment and systems, e.g. use of personal protective equipment, correct lifting and handling techniques, releasing pressure from systems, maintaining a tidy work area, correct disposal of waste materials, permit to work, isolation, risk assessment, reporting of injuries.
2	Be able to read and interpret fluid power symbols and diagrams	2.1	Identify the symbols used to represent seven given fluid power system components	□ *Symbols*: pneumatic and hydraulic symbols for common components, devices and equipment, e.g. pumps, cylinders, compressors, filters, receivers, spools, regulators, actuators, accumulators, valves, bearings, sensors, filters.
		2.2	Interpret a fluid power circuit diagram and explain the function of the circuit components shown	□ *Diagrams*: e.g. circuit diagrams, block diagrams, system layout diagrams, displacement step diagrams, related documentation (component and equipment data sheets, functional charts, operating instructions).

Learning outcomes		Assessment criteria		Unit amplification
3	Know the construction, operation and practical application of fluid power system components and equipment	3.1	Describe the construction and operation of six fluid power system components	□ *Components*: e.g. pumps, directional, flow, pressure and non-return valves, linear and rotary actuators, hydraulic and pneumatic motors, hoses/pipework, fittings, seals, air service units.
		3.2	Describe the construction, operation and application of a type of fluid power equipment	□ *Equipment*: construction; operation; application; types, e.g. pneumatic, hydraulic, vacuum.
4	Be able to carry out testing, fault diagnosis and maintenance activities on fluid power equipment and systems	4.1	Use two instruments to carry out testing and maintenance routines on a given fluid power system	□ *Testing*: regulations and codes of practice relating to the testing of pneumatic and hydraulic equipment and systems; test equipment, e.g. pressure indicators, flow indicators, measuring devices, self-diagnostic equipment; procedures and techniques for carrying out tests. □ *Instruments*: e.g. measuring devices, pressure indicators, flow indicators, self-diagnostic equipment. □ *Maintenance routines*: regular maintenance activities on fluid power components, devices and systems, e.g. inspection and functional testing, removing and replacing units/components, setting, aligning and adjusting replaced components, removing air lines and hoses, leak detection, replacing seals, filters, gaskets, carrying out adjustments as necessary; recording of condition; recommended frequencies for maintenance; the use of maintenance manuals and documentation; the need to record maintenance and final test; handover procedures.

Learning outcomes		Assessment criteria		Unit amplification
		4.2	Use two fault diagnosis techniques and two diagnostic aids to identify a fluid power system problem and report the findings	□ *Faults*: terminology used, e.g. 'symptom', 'fault', 'cause'; typical faults in pneumatic and hydraulic components and equipment; symptoms of non-complex faults and their causes. □ *Fault diagnosis techniques*: e.g. visual examination, unit substitution, input to output, inspection and sampling, six point (collect the evidence, analyse evidence, locate fault, determine and remove cause, rectify fault, check system), fault/repair reporting; emergent sequence. □ *Diagnostic aids*: e.g. functional charts, diagrams, flow charts, trouble-shooting charts, component data sheets, operation and maintenance manuals, software-based records and data. □ *Problem*: e.g. intermittent, partial failure/out-of-specification output, complete breakdowns. □ *Report findings*: e.g. scheduled maintenance report, corrective maintenance report, other company-specific reports, job cards, maintenance log.

Information for tutors

Delivery

This unit should be delivered using lectures, tutor demonstrations and practical engineering activities. During the delivery of the unit, centres must ensure sufficient coverage of the learning outcomes and content. Learning outcomes 2 and 3 are best suited to a practical approach, although learners will at first need a broad overview of different pneumatic and hydraulic diagrams, systems and components to enable correct selection and application of maintenance, diagnostic and testing techniques. A good knowledge and understanding of the circuits and components prior to diagnosing faults or maintaining systems is essential.

Learners must be made aware of, and have access to, relevant UK health and safety legislation and know the importance of the use of appropriate risk assessment. Tutors should ensure that each learner has the correct PPE and that the system is safe for operation. It is also important that learners work in a safe manner when using equipment or working on fluid power systems.

The unit should be delivered by focusing on developing learners' diagnostic and practical skills together with an understanding of pneumatic systems maintenance, construction and operation.

The delivery approach will be determined through an analysis of learners' needs and, in particular, through consideration of the range of industries that the centres are working with or preparing their learners for. However, it is expected that learners' experience should be sufficiently varied to provide them with the underpinning knowledge and skills needed to apply fault-finding techniques and repair and maintain pneumatic systems in most industrial settings. It would not be appropriate for this unit to be taught without any practical application, as the use of theory lessons and simulation exercises does not have the same value that real practical experience in a working environment can bring.

The learning outcomes are ordered logically and it would be reasonable to develop them sequentially throughout the unit. In this way, the learner will be able to apply health and safety precautions and knowledge of circuit diagrams and components before attempting to locate faults and maintain systems. For example, a short introduction to a component (or a range of components), the function of the component within the larger system, the tools necessary to carry out the maintenance task and their limits with any safety considerations – followed by practise.

Centres are encouraged to find innovative ways of bringing the unit to life for the learner and giving it true relevance. This will generally be achieved through the use of practical 'hands-on' experiences for the learner, which can be achieved in a learning environment or through actual work place experience. The learners could be provided with access to workshops and the necessary tools, materials and equipment to carry out practical exercises on fault finding, repair and maintenance of fluid power systems. Learners can also be given a range of system and component faults on which to practice their skills.

Each task should be designed so that it requires the learners to prepare the work environment, prepare for the activity and then complete the work activity. The opportunity to work with individuals during the delivery of this practical work can be used to good effect to underpin learning. In particular, it can be used to reinforce working practices/skills, help them to deal with problems affecting the engineering processes being experienced or to support them when they need to work with others more effectively in order to achieve the task.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Much of the assessment evidence for this unit could come from practical activities. These can be carried out solely for the purpose of this unit but, equally, could be the activities associated with other units or from work-based evidence.

Learning outcomes 1, 2 and 3 are probably best assessed through the use of written assignments. Learning outcome 4 is likely to be combination of both written assignments and practical exercises, supported by tutor observation reports and learners' portfolio work logs and other documentation.

Four assignments could be used for the assessment of this unit. The first, relating to learning outcome 1, would cover 1.1 and 1.2. This could be a written assignment that asks for a description of the relevant health and safety regulations and safe working practices that need to be followed when working with fluid power systems. Evidence could be in the form of a written report, or alternatively an information leaflet or poster.

A second written assignment could be used to cover 2.1 and 2.2, based on a given list of components and a fluid power circuit containing a minimum of six different components. Learners would first need to identify the symbols used to represent seven different fluid power components. They would then need to identify and describe the function of six fluid power components from the diagram.

The third assignment will require learners to provide a description of the construction and operation of fluid power components and a type of equipment (pneumatic, hydraulic or vacuum).

The fourth assignment should be based on practical testing and fault diagnosis on a fluid power system. Assessment evidence is therefore likely to be in the form of witness statements and annotated photographs along with the learner's report/log of the work carried out.

Suggested resources

Books

Health and Safety Executive – *Essentials of Health and Safety at Work* (Health and Safety Executive, 2006) ISBN 9780717661794

Timings R L – *Basic Manufacturing* (Newnes, 2004) ISBN 9780750659901

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Analysing and evaluating information relating to health and safety regulations, judging its relevance to working with fluid power systems
Self-managers	Anticipating, taking and managing risks when carrying out fault location, testing, and maintenance activities on pneumatic equipment and systems in a safe and approved manner Working towards an engineering maintenance activity showing initiative, commitment and perseverance Organising time, resource and prioritising actions to prepare for and carry out an engineering maintenance activity
Team workers	Collaborating with others when identifying faults and maintaining pneumatic systems

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Reflective learners	Reviewing progress during practical activities and acting on the outcomes
Creative thinkers	Questioning their own and others' ideas during group work activities on the assessment when identifying faults and maintaining pneumatic systems
Effective participators	Identifying improvements that benefit others as well as themselves when identifying faults and maintaining pneumatic systems Discussing issues of concern with respect to the relevant health and safety precautions/legislation relevant to fault diagnosis and maintenance of pneumatic systems Seeking resolution with colleagues/tutor where needed

Functional Skills – Level 2

Skill	When learners are…
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	Using software-based systems for circuit simulation construction and fault diagnosis
Manage information storage to enable efficient retrieval	Using software-based data systems when diagnosing faults
ICT – Develop, present and communicate information	
Present information in ways that are fit for purpose and audience	Using software-based systems when handing over and commissioning system
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	Speaking and listening to colleagues and others when carrying out fault location, testing, and maintenance activities on pneumatic equipment and systems
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	Reading current safety legislation to select the information required enabling the learners to complete tasks safely Reading information to enable learners to prepare for and carry out fault diagnosis, location, testing, and maintenance activities on pneumatic equipment and systems in a safe and approved manner
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	Explaining the importance of applying safe working practices when carrying out maintenance on a fluid power system Writing a report analysing the system for ease of maintenance, comparing and contrasting the diagnostic techniques used to locate faults and identifying how a work activity can be improved.

Unit 6: Engineering Maintenance Procedures

Unit reference number: D/600/0388
QCF level: 2
Credit value: 5
Guided learning hours: 30

Unit aim

This unit gives learners the opportunity to explore the purpose, procedures and resources required to carry out maintenance activities on non-complex engineering systems.

Engineering maintenance involves the service, repair and adjustment of engineering plant, equipment and machinery in order to ensure that it continues to perform its intended function. In recent years, maintenance needs have changed due to advances in manufacturing systems and increasing sophistication of industrial equipment and computer technology. It is therefore vital for modern manufacturing organisations to have effective maintenance planning and procedures in place to guarantee the reliable and safe operation of plant and equipment.

This unit introduces learners to the features of engineering systems that determine their reliability, safety and maintainability. The unit gives learners an understanding of the fundamentals of engineering system maintenance procedures and planning.

Learners will understand the causes and effects of equipment failure and know how planned maintenance can minimise or eliminate downtime due to failure. Learners will develop knowledge and understanding of engineering maintenance methods and procedures, and develop the skills needed to plan and carry out maintenance activities on engineering systems.

Learners will be expected to carry out maintenance procedures and planning activities on a non-complex engineering system and complete the necessary documentation before handing over and confirming that the system is now ready to run in a safe and operable condition.

Essential resources

Learners need access to a workshop environment and a wide range of equipment, systems, devices and components required to carry out engineering maintenance activities, together with relevant manufacturers' service manuals, data sheets, parts lists, diagrams and drawings. Relevant test instruments, tools and safety equipment will also be required as appropriate to the equipment, systems, devices and components used.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know about engineering maintenance purposes, procedures and resources	1.1	Describe four different causes of engineering equipment failure	□ *Causes of equipment failure*: e.g. age, wear, vibration, corrosion, fouling, environment, lack of maintenance.
		1.2	Describe the effect of each of the four failures	□ *Effects*: e.g. importance of downtime, increased cost, equipment/component life.
		1.3	Describe a planned type of maintenance procedure	□ *Planned maintenance*: e.g. routine maintenance, preventative maintenance, condition monitoring, front-line maintenance and when/where they are used, servicing.
		1.4	Describe an unplanned type of maintenance procedure	□ *Unplanned maintenance*: e.g. breakdown, front-line maintenance and when/where they are used, repair, equipment failure, run to failure.
		1.5	Describe the resources needed for engineering maintenance operations	□ *Resources of maintenance operations*: human (roles and responsibilities), e.g. managers, maintenance personnel, operators; tools, materials and equipment – for specific maintenance functions, e.g. basic test instruments, hand tools, replacement parts, cleaning and lubricating materials.

Learning outcomes		Assessment criteria		Unit amplification
2	Be able to plan and carry out a maintenance activity on a non-complex engineering system	2.1	Identify the resources required for a given maintenance activity	□ *Maintenance activity*: maintenance undertaken for specific parts of an engineering system, e.g. pump, valve, compressor, heating, lighting, fluid power, manufacturing or test equipment. □ *Identification of resources*: availability of maintenance and production staff; appropriate documentation, e.g. permit to work, maintenance check lists, production schedules, machine/process records, handover documents, equipment manuals; fault-finding aids; appropriate spares/materials/consumables; appropriate test equipment and tools.
		2.2	Use maintenance documentation to plan a given maintenance activity on an engineering system	□ *Maintenance planning*: frequency of maintenance; reasons for selecting different frequency rates for specific maintenance, e.g. on shift/daily/weekly/monthly/yearly routines; identification of planned repairs/replacements; health and safety issues; environmental issues; estimation of costs.
		2.3	Use documentation to carry out a maintenance activity	□ *Maintenance documentation*: information, e.g. manufacturers' manuals, drawings, charts and diagrams, planning sheets, instructions, schedules; recording, e.g. maintenance logs, other records; handover documents; fault-finding aids.

Information for tutors

Delivery

Since most learners are unlikely to have had prior experience in this area of work, it is essential to have some formal introduction to the content. The unit can then be regarded as essentially investigative; the use of non-complex rigs would allow learners to carry out a practical investigation.

The approach will be determined best through an analysis of each learner's needs and, in particular, through consideration of the range of industries that centres are working with or preparing their learners for. Whichever approach is taken, the learner's experience should be sufficiently varied to provide them with knowledge and understanding of engineering system maintenance procedures and planning in most industrial settings.

This unit is a mix of theoretical and practical aspects and learners should have the opportunity to examine a range of mechanical, electrical and manufacturing systems. The unit is best delivered through a programme of lectures followed by some form of practical investigations or activities.

The unit provides an opportunity for learners to work individually or in groups when planning engineering system maintenance procedures.

The learning outcomes are ordered logically and it would be a reasonable approach to develop them sequentially throughout the unit. In this way, the learner will understand maintenance methods and procedures and then be able to carry out a maintenance planning activity.

Tutors should always ensure that each learner has the correct personal protective equipment and that systems are safe for inspection and operation. It is also important that learners work in a safe manner when using equipment or working on systems.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Learning outcome 1 and the associated criteria (1.1–1.5) could be covered through an assignment that requires the learner to respond to preset questions. These questions may be based around a case study style scenario or test questions that have each been set within a relevant engineering context. In either case, it is most likely that controlled condition will be required to ensure the authenticity of the responses.

Learning outcome 2 and its associated criteria (2.1–2.3) could be assessed using a practical assignment that requires the learners to identify the resources required for a given maintenance activity and use maintenance documentation to plan for and carry out a given maintenance activity on an engineering system. The engineering system should be a non-complex system, for example pumps, valves, compressors, heating, lighting, fluid power and manufacturing or test equipment. Tutor observation will be necessary during the activity to capture the process evidence of maintenance documentation use and the safe use of correct procedures. The learners will also be required to produce a report that includes the identification of resources and all handover documentation and completed records.

An alternative approach to assessment could be to require the learners to build a portfolio of evidence for the unit as a whole as they carry out a range of investigations and operations in the workplace.

A further alternative method could be the use of an integrative assignment, which links this unit with other practical units in a programme of study. If this approach is adopted, the evidence for the specific learning outcomes and associated assessment criteria will need to be clearly identified.

Suggested resources

Books

Kibbe R – *Mechanical Systems for Industrial Maintenance* (Prentice Hall, 2001) ISBN 9780130164902

Mobley K – *Maintenance Fundamentals*, 2nd Edition (Butterworth-Heinemann, 2004) ISBN 9780750677981

Other

Engineering data handbooks and manufacturers' specifications

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Exploring a given maintenance activity from different perspectives to identify the resources required
Reflective learners	Reviewing progress with the maintenance activity on an engineering system, acting on outcomes
Self-managers	Working towards a successful maintenance activity on an engineering system Showing initiative, commitment and perseverance Organising time and resources, prioritising actions when carrying out a maintenance activity on an engineering system
Effective participators	Identifying improvements when planning and carrying out a maintenance activity that would benefit themselves and others

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Reflective learners	Evaluating experiences during workshop activities to inform future progress with maintenance tasks
Team workers	Collaborating with others when working in groups to gather information on engineering maintenance and maintenance planning

Functional Skills – Level 2

Skill	When learners are…
ICT – Finding and selecting information	
Select information from a variety of sources to meet requirements of a complex task	Selecting and using the sources of information required to carry out a maintenance activity independently
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Speaking and listening to operators/supervisors when planning for and carrying out maintenance activities on engineering systems
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Comparing, selecting, reading and understanding resource material when preparing for a given maintenance activity
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Writing documents to describe causes of engineering equipment failure and explaining effect of failure Writing documents to describe planned and unplanned maintenance procedures Writing reports to document the maintenance procedures carried out on an engineering system

Unit 7: Operation and Maintenance of Electrical Systems and Components

Unit reference number: F/600/0402
QCF level: 2
Credit value: 10
Guided learning hours: 60

Unit aim

This unit will develop learners' knowledge of the function, operation and maintenance of a variety of electronic systems and system components.

Electrical engineering equipment, systems, processes and service operations, all need to be maintained to ensure continued serviceability and fitness for purpose. This unit has been designed to ensure that learners have the knowledge and skills necessary to undertake such maintenance in a safe and efficient manner.

Learners will gain knowledge of the safety precautions required for personal protection, the protection of others and the safe handling of the equipment and systems they will find in an electrical engineering environment.

Learners will be introduced to the function and operation of a variety of electrical systems and system components and will be expected to carry out maintenance on them. In particular, learners will carry out activities that develop their skills and knowledge in fault-finding, routine maintenance, dismantling and assembly of a variety of electrical systems.

Learners will be expected to obtain all necessary information, documentation, tools and equipment, prior to carrying out any given maintenance activity. They will also need to demonstrate that they can select, follow and correctly interpret maintenance procedures, safe working practices, and health and safety requirements when carrying out routine maintenance activities.

Essential resources

Learners will require access to an electrical engineering workshop and relevant tools and equipment. In particular learners should have access to:

- a wide range of industry standard electrical circuits, equipment and systems and their associated components and consumables
- appropriate fault-finding instruments, safety equipment and tools
- manufacturers' data books and specifications
- maintenance manuals, parts catalogues and/or databases, flow charts, electrical circuit and system diagrams
- British/International Standards, health and safety publications and local workshop safety documentation and procedures.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know the workplace hazards and health and safety requirements associated with electrical maintenance operations	1.1	Describe the workplace hazards and health and safety requirements relevant to a given electrical maintenance activity	□ *Workplace hazards*: e.g. flammable substances, pressurised systems, hot surfaces, electrical equipment, electrostatic hazards, unfenced machinery, toxic substances and fumes, falling objects, liquid spillage, untidy work area, badly maintained tools and equipment. □ *Health and safety requirements*: personal safety, e.g. appropriate dress, protective clothing, appropriate or protective headgear, protective gloves and footwear, eye protection, face masks and respirators, electrical testing safety; personal health, e.g. appropriate use of barrier creams, personal cleanliness, consumption of food, prompt attention to injuries; procedures, e.g. treatment for electric shock, response to alarms, use of safety equipment, reporting of accidents, reporting of hazardous items of plant or equipment; safe working practices, e.g. permit to work, use of danger tags, warning notices, safety barriers, cones and tapes, isolation of equipment, proof marking, recording of maintenance operations.
2	Know the operation of electrical systems and circuits	2.1	Describe with the aid of block diagrams, the operation of a given electrical system	□ *Electrical systems*: block diagram representation; equipment, e.g. switchgear and distribution panels, electrical plant, wiring enclosures, portable appliances, motors and starters, luminaries, control systems, small fans, pumps, compressors, alarm and safety systems.
		2.2	Describe with the aid of diagrams the operation of a given electrical circuit	□ *Electrical circuits*: wiring diagram representation; circuit, e.g. single phase power, single phase lighting, three phase power, direct current power.

Learning outcomes		Assessment criteria		Unit amplification
3	Understand the selection, function and operation of electrical system components	31.	Use manufacturers' databases or parts catalogues to select four electrical system components	□ *System components*: electrical supply, e.g. cables and connectors, batteries, transformers, rectifiers, contactors; circuit components, e.g. capacitors, circuit boards, switches, solenoids, thermistors, thermocouples; devices, e.g. overload protection device, inverter and servo controllers, relays, sensors, encoders, resolvers, locking and retaining devices, lighting fixtures; use of maker's catalogue or database for selecting replacements.
		3.2	Explain the function and operation of six electrical system components	□ Function and operation of six electrical system components as described above.

Learning outcomes		Assessment criteria		Unit amplification
4	Be able to fault-find and carry out routine maintenance activities on electrical components and systems	4.1	Use four fault-finding aids/techniques to identify the problem in an electrical system and report findings	□ *Faults, aids, techniques and documentation*: faults, e.g. intermittent operation, partial failure/out-of-specification output, complete breakdowns; aids, e.g. functional charts, diagrams, trouble-shooting charts, instruments (such as multimeter, insulation resistance tester, light meter, portable appliance tester, earth loop impedance tester), component data sheets, software-based records and data; techniques, e.g. six point (collect the evidence, analyse evidence, locate fault, determine and remove cause, rectify fault, check system), half split, input/output, unit substitution, emergent sequence, visual examination, unit substitution; documentation, e.g. operation and maintenance manuals, fault/repair reports, final test handover procedures.
		4.2	Use the appropriate aids and tools to dismantle and reassemble an electrical system, replace any identified faulty components and check the system for serviceability	□ *Dismantling and assembly*: aids, e.g. use of manufacturers' service manuals, parts lists and drawings, approved working procedures, spare parts catalogues, maintenance manuals; systems/equipment, e.g. switchgear/distribution panels, electrical plant, wiring enclosures, portable appliances, motors and starters, luminaries, control systems, fans, pumps, compressors, alarm and safety systems. □ *Component/equipment removal and replacement*: components, e.g. damaged wires and cables, electrical units/components, termination and connection, soldering and de-soldering; use of appropriate tools, equipment and documentation, e.g. solder, soldering irons, crimping pliers, hand tools, replacement parts, approved working procedures and spare parts catalogues.
		4.3	Carry out routine maintenance activities on an electrical component or system, using the correct documentation, and record actions	□ *Routine maintenance activities and documentation*: inspection, checks and tests, e.g. as wear, chafing, fouling, security of attachment, missing or loose fittings, adjustments, replacements; reports and documentation, e.g. BS, ISO and/or BSEN standards, scheduled maintenance report, corrective maintenance report, other company-specific report, job cards, maintenance log, recording of condition, use of maintenance manuals and parts catalogues.

Information for tutors

Delivery

This unit can be delivered as a stand-alone package or integrated with other units in the qualification such as those outlined below.

This unit is essentially practical and learners should have the opportunity to dismantle, examine and reassemble a range of electrical components, equipment and systems. Ideally the learning outcomes should be achieved through investigation and participation in practical activities. Thus the unit is best delivered through a programme of lectures, demonstrations and practical work.

The approach used will be determined through an analysis of learners' needs and through consideration of the range of industries that the centre is working with or preparing their learners for. Whichever approach is taken should provide learners with the underpinning knowledge and skills required to repair, replace and generally maintain electrical components, equipment and systems in most industrial settings.

Learners must be made aware of, and have access to, relevant UK health and safety legislation and know the importance of the use of risk assessment appropriate to the maintenance techniques they are using. Tutors should always ensure that each learner has the correct personal protective equipment and that the system is safe for operation. It is also important that learners work in a safe manner when using equipment or working on electrical circuits and systems.

The unit provides an opportunity for learners to work in teams or groups when diagnosing component or system faults. The delivery of this unit should focus on learners developing diagnostic and practical skills together with an understanding of electrical components, equipment and systems maintenance.

The four learning outcomes are ordered logically and it would be reasonable to deliver them sequentially throughout the unit.

All the learning outcomes can be delivered using a practical approach rather than spending too much time in theory lessons. For example, a short introduction to a component (or range of components), the function of the component within the larger equipment or system, the tools necessary to carry out the maintenance task together with any safety considerations, followed by practise. Learners need a broad overview of the different electrical components and systems to enable correct selection and application of maintenance, fault-finding and testing techniques.

Learning outcome 4 has a high reliance on understanding developed from the other three learning outcomes. As such, teaching and learning needs also to focus on the development of this knowledge in order that it may be applied to learning outcome 4. The use of demonstrations to introduce fault-finding, dismantling and assembly techniques, would be a beneficial method of delivery for the learner, prior to them carrying out their practise practical activities and assessments.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Evidence of achieving the learning outcomes may be collected from well-planned investigative assignments or reports of practical workshop activities. It may be accumulated by learners building a portfolio from their investigations, maintenance activities in the workplace or by a tutor-led series of assignments, realistic maintenance exercises and tests.

Evidence of achievement for learning outcome 1 could come from a written assignment, requiring learners to describe the hazards and safe working practices related to an electrical maintenance activity.

Learning outcomes 2 and 3 are linked, so might best be assessed using one combined assessment instrument. A written assignment (completed in a workshop environment) could be used, where learners provide evidence for 2.1 by sketching a block diagram of a required system, showing the interconnection of its major components. Then for 2.2, learners use a given simple circuit diagram and again describe its operation. A parts catalogue or access to a suitable database would be needed in order that learners can select four electrical system components (3.1). In order to satisfy 3.2 learners will need to describe the function and operation of six electrical system components/devices. These should be selected by tutors based on the specialist needs of the learner.

Learning outcome 4 is best assessed through one or more investigative practical-based activities carried out in an electrical workshop environment or at the learner's workplace. A multi-stage practical/theoretical assignment could be set to cover the related criteria (4.1 and 4.2), where learners are first required to identify the problem/fault on a given electrical system using four fault-finding aids/techniques and report their findings. Evidence is likely to come from the learner's report and the results of observation at the time the activity takes place. For 4.2, learners need to dismantle the system, replace the component/ part identified as causing the problem, reassemble the system and carry out a simple test/check to ascertain serviceability. Assessment evidence can be obtained from the results of tutor observations and by determining whether or not the learner returns the system to a serviceable condition.

Learners are required to undertake and successfully complete a routine maintenance activity in order to meet 4.3. The learner's ability to use the correct documentation and accurately record their actions, as well as perform the practical aspects of the given maintenance, should be taken into account when tutor observation evidence, is obtained. This final assignment should be focused on the learner's particular field of electrical maintenance and the routine maintenance activities applicable to their electrical systems, circuits or equipment.

The learner's knowledge of and compliance with all related safety issues, also needs to be assessed during the time that all the above practical assignment activities are being carried out.

Suggested resources

Books

Adams J – Electrical Safety: A Guide to the Causes and Prevention of Electrical Hazards (Institution of Electrical Engineers, 1994) ISBN 9780852968062

Gates E – Introduction to Electronics (Delmar, 2006) ISBN 9781401889005

Health and Safety Executive – Essentials of Health and Safety at Work (HSE, 2006) ISBN 9780717661794

Sinclair I and Lewis G – Electronic and Electrical Servicing (Newnes, 2002) ISBN 9780717661794

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Analysing and evaluating information in manufacturers' databases, evaluating its relevance and value Identifying questions to answer and problems to resolve when using a variety of fault-finding techniques to identify the problem
Self-managers	Organising time and resources when dismantling, inspecting and reassembling an electrical system

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Independent enquirers	Using the appropriate instruments, aids and tools to dismantle, inspect and reassemble, an electrical equipment or system Replacing identified faulty components/devices and testing the system for serviceability, following safety and servicing procedures
Creative thinkers	Analysing a given electrical equipment or system for ease of maintenance
Effective participators	Carrying out a risk assessment investigation of an electrical work area and reporting their findings

Functional Skills – Level 2

Skill	When learners are…
ICT – Using ICT	
Manage information storage to enable efficient retrieval	Using manufacturers' databases and/or parts catalogues to identify and select electrical components/devices
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Describing the workplace hazards and health and safety requirements relevant to given electrical maintenance activities
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Researching and investigating the function and operation of electrical systems and components
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Describing the workplace hazards and health and safety requirements relevant to given electrical maintenance activities

Unit 8: Using Bench Fitting Techniques

Unit reference number: F/506/6194
QCF level: 2
Credit value: 7
Guided learning hours: 60

Unit aim

This unit gives learners knowledge and understanding of bench fitting techniques, especially when applied to a maintenance activity. Learners will also develop the skills needed to carry out bench fitting techniques safely in order to produce components.

Maintenance activities are required in every engineering workshop. Those undertaking maintenance activities are likely to need skills in making replacement parts for parts that may no longer be available. This unit gives learners the opportunity to experience this scenario.

Learners will gain understanding of relevant health and safety considerations, along with hazards associated with bench fitting activities. They will develop skills in extracting information from engineering drawings to enable successful bench fitting activities. Learners will develop skills in checking portable machines and equipment, such as angle grinders, for safe condition and operation. They will learn the importance of, and demonstrate, restoring a work area and disposing of waste materials in a recognised manner.

Essential resources

For this unit, learners need access to a workshop fully equipped with a range of bench fitting equipment, including that used for measurement and marking out. A range of workpiece materials, components and drawings will be required to enable learners to gain the range of experience and coverage expected. Access to portable machines and equipment such as angle grinders is required.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know how to prepare for bench fitting activities	1.1	Explain how to use safe working practices and procedures for maintenance activities	□ *Safe working practices*: wearing appropriate protective clothing and equipment, e.g. overalls, safety footwear, eye protection, hearing protection, use of barrier cream. □ *Procedures*: maintaining a clean and tidy work area; preparing the work area; leaving the work area in a safe and clean condition; risk assessments. □ *Maintenance activities:* maintenance undertaken for specific parts of an engineering system, e.g. pump, valve, compressor, heating, fluid power, manufacturing or test equipment.
		1.2	Describe the hazards associated with bench fitting activities	□ *Hazards*: e.g. handling of coolants and cutting oils/compounds, misuse of tools, use of damaged or badly maintained tools, storage of measuring and marking out equipment.
		1.3	Use information from engineering drawings to carry out a given bench fitting activity	□ *Information*: dimensional; geometrical; materials; limits. □ *Engineering drawings*: working drawings, e.g. component, general assembly/sub-assembly, fabrication, welding, repair/modification; graphical representations, e.g. sketches, flowcharts, physical layout diagrams, illustrations from manufacturers' manuals.

Learning outcomes		Assessment criteria		Unit amplification
2	Be able to apply bench fitting techniques to produce component parts	2.1	Select tools and equipment to undertake a given bench fitting activity	□ *Tools and equipment*: tools, e.g. engineer's rule, scriber, centre punch, dividers, odd-leg callipers, engineer's square, scribing block, Vernier protractor, Vernier height gauge, dial test indicators, slip gauges; work-holding devices, e.g. surface tables/plates, angle plates, v-blocks and clamps; marking out mediums, e.g. lacquer, whitewash, engineer's blue; cutting and shaping tools and equipment, e.g. drills, taps and dies, reamers, powered hand tools, hand grinding machine, angle grinder, forming and bending equipment; calibration of measuring and marking out equipment.
		2.2	Use safe working practices and procedures during maintenance activities	□ *Safe working practices*: wearing appropriate protective clothing and equipment, e.g. overalls, safety footwear, eye protection, hearing protection, use of barrier cream. □ *Procedures*: maintaining a clean and tidy work area; preparing the work area; leaving the work area in a safe and clean condition; risk assessments. □ *Maintenance activities:* maintenance undertaken for specific parts of an engineering system, e.g. pump, valve, compressor, heating, fluid power, manufacturing or test equipment.
		2.3	Check that portable machines and equipment are safe to operate	□ *Portable machines and equipment*: machines, e.g. off-hand grinding machines, angle grinder; equipment, e.g. emergency stop, use of guards, interlocking devices; safe operating procedures, e.g. moving parts, removal of swarf, setting, checking gap between rest and wheel, wheel imperfections, position of guards, wheel selection, changing the wheel.

Learning outcomes		Assessment criteria		Unit amplification
		2.4	Make and assemble component parts using safe working practices	□ *Make and assemble component parts*: setting of work datums; use charts to obtain drill diameters for clearance and tapping hole; assemble component parts in the correct sequence and without damage. □ *Safe working practices*: personal protection and hygiene procedures, e.g. overalls, eye protection, barrier creams; appropriate behaviour in the working environment; maintaining a tidy and safe work area; appraisal of health and safety risks to self and others, e.g. risk assessments.
		2.5	Check a given component for accuracy and quality	□ *Given component*: relative to maintenance requirement, e.g. gasket, flange, bearing, location pins, location keys, end plate, guard, cover, handle. □ *Accuracy and quality*: inspection techniques; quality control charts; compliance records.
		2.6	Restore the work area using the correct procedures for the disposal of waste	□ *Restore work area*: leaving the work area in a safe condition; cleaning of equipment; storage of measuring and marking out equipment. □ *Disposal of waste*: legal requirements for the disposal of waste and the implications of failure to comply; materials, e.g. metallic materials, plastics, textiles, paper and card; procedures, e.g. segregate, label, dispose.

Information for tutors

Delivery

This unit should be delivered using lectures, tutor demonstrations and practical engineering activities. Centres must ensure sufficient coverage of the learning outcomes and content. Learning outcome 2 is best suited to a practical approach, although learners will at first need to be given a broad overview of different maintenance activities associated with bench fitting practices. A good knowledge and understanding of the health and safety requirements prior to doing any practical work is essential.

Learners must be made aware of, and have access to, relevant UK health and safety legislation and know the importance of the use of appropriate risk assessment. Tutors should ensure that each learner has the correct PPE and that any activity they work on is safe for operation. Referring to the HSE website regularly is good practice.

From a teaching point of view it is best to address both learning outcomes together.

Learning outcomes 1 and 2 require access to an engineering workshop environment with relevant tools and equipment, along with a suitable maintenance activity to undertake. During delivery, learners could undertake a range of simple bench fitting and marking out tasks to enable them to practise their skills and to provide an opportunity for support and guidance to be given. Each task should require learners to think about what they are going to do, including the selection of tools and equipment and health and safety considerations when planning and completing the work activity. The opportunity to work with other individuals during the delivery of this practical work can be used to good effect to underpin learning. In particular, working with others can be used to reinforce planning, marking out practices and skills, to help learners deal with problems experienced and to support them in achieving the task.

Continually practising bench fitting skills will ensure learners are well equipped to take on the assessment tasks.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Much of the assessment evidence for this unit could come from practical activities. These can be carried out solely for the purpose of this unit but, equally, could be derived from activities associated with other units or from work-based evidence.

Learning outcome 1 is best assessed through a written assignment. Learning outcome 2 is likely to be assessed through practical exercises, supported by tutor observation reports, annotated photographs and the learner's portfolio work logs and other documentation.

Two assignments could be used for the assessment of this unit. The first, relating to learning outcome 1, would cover assessment criteria 1.1, 1.2 and 1.3. This could be a written assignment requiring an explanation of how the relevant health and safety practices and safe working procedures are used when a specific maintenance activity is carried out. Evidence could be in the form of a written report or, alternatively, an information leaflet or poster.

A second assignment, relating to learning outcome 2, would cover assessment criteria 2.1, 2.2, 2.3, 2.4, 2.5 and 2.6. A holistic practical assignment would be most suitable, involving a task that gives learners the opportunity to select fitting tools and to use holding devices, marking out mediums and cutting and shaping tools and equipment. Learners should also have the opportunity to calibrate measuring and marking out equipment. Another task should ensure learners carry out a maintenance activity for 2.2; produce and assemble parts for 2.4; and check a component for accuracy using appropriate inspection techniques and recording documentation for 2.5. The maintenance activity given should include an opportunity to check portable machines and equipment for 2.3, and also have a requirement to dispose of waste materials for 2.6. Most of this evidence can be captured in tutor observation reports, annotated photographs and the learner's portfolio work logs and other documentation.

Suggested resources

Books

Clarke S, Darbyshire A, Mantovani B, Weatherill B – *BTEC Level 2 First Engineering* (Heinemann, 2010) ISBN 9781846907234

Health and Safety Executive – *Essentials of Health and Safety at Work* (Health and Safety Executive, 2006) ISBN 9780717661794

Timings R L – *Basic Manufacturing* (Newnes, 2004) ISBN 9780750659901

Tooley M – *BTEC First in Engineering* (Newnes, 2006) ISBN 0750680601

Tooley M, Deacon M, O'Dwyer N – *Engineering Level 2 Higher Diploma Student Book* (Heinemann, 2008) ISBN 9780435756208

Website

www.youtube.com – demonstrations of bench fitting activities

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Identifying questions to answer and problems to resolve when selecting suitable measuring and marking out methods and equipment for marking out activities
Self-managers	Organising time and resources, prioritising actions when producing and assembling component parts
Effective participators	Identifying improvements to working practice and good housekeeping

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Independent enquirers	Resolving problems by recommending corrective action for unsafe or defective equipment
Reflective learners	Collaborating with others when carrying out marking out activities
Team workers	Reviewing progress and monitoring performance when carrying out checks to ensure that the marked out components meet the requirements of the drawing Evaluating their own experience and learning when justifying the work-holding equipment and measurement techniques used in marking out applications

Functional Skills – Level 2

Skill	When learners are…
English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Discussing safe working and good housekeeping practices
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Reading information and drawings for component marking out applications
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Describing the hazards associated with bench fitting activities
Mathematics	
Representing – selecting the mathematics and information to model a situation	Measuring marking out and carrying out checks for accuracy
Analysing – processing and using mathematics	Measuring marking out and carrying out checks for accuracy
Interpreting – interpreting and communicating the results of the analysis	Measuring marking out and carrying out checks for accuracy

Unit 9: Application of Welding Processes

Unit reference number: K/600/0412
QCF level: 2
Credit value: 10
Guided learning hours: 60

Unit aim

This unit aims to give learners the knowledge and skills they need to safely carry out a range of welding techniques and to test welded joints for defects and irregularities.

Welding is frequently used in manufacturing engineering to ensure that permanent, high-quality joints are made between metal parts or components. This unit gives learners with little or no previous welding experience the opportunity to gain knowledge and understanding of the processes used throughout industry. This applies to a diverse number of engineering industries including those involving sheet metal, structural steel fabrication and motor vehicle bodies.

Learners will develop knowledge of the importance starting with the preparation of their work area, ensuring that health and safety legislation and safe working practices are understood and adhered to at all times. Learners will select appropriate welding equipment and check that it is in a safe and usable condition before welding. This is particularly important as learners will be working with electric currents or combustible gas mixtures.

Learners will be expected to interpret written, graphical and verbal instructions while carrying out practical tasks. They will become competent in using a fusion welding process through tutor-led demonstrations and supervised practice.

Continuous assessment should be carried out to ensure that learners' skill levels are improved to meet the required standard. To measure their competence, learners will test their welded joints with reference to European quality standards, ensuring that they are able to produce acceptable welds as well as recognise them. This will be reinforced with the use of destructive and non-destructive tests.

Essential resources

Centres delivering this unit will need access to appropriate welding equipment, consumables and materials as outlined in the Unit amplification. Centres must also have access to appropriate destructive and non-destructive test equipment.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know about health and safety legislation and safe working practices when welding	1.1	Outline the health and safety legislation and safe working practices used in a welding environment	□ *Legislation*: aspects relevant to welding, e.g. Health and Safety at Work Act, Fire Precautions Act, Control of Substances Hazardous to Health (COSHH), Provision and Use of Work Equipment Regulations (PUWER), Health and Safety (First Aid) Regulations, Manual Handling Operations Regulations. □ *Safe working practices*: fire prevention; accident prevention and reporting; risk assessment; fuses; circuit breakers; earthing of equipment; manual handling, e.g. materials, safe handling of gas cylinders; checking conditions, e.g. gas leaks, voltage and amperage, leads; personal protective equipment (PPE); ventilation and extraction; closing down equipment safely; storing equipment; safe disposal of waste materials; emergency procedures, e.g. within the learning environment, workplace; common hazards associated with welding, e.g. fumes, burns, radiation, electric shock.

Learning outcomes		Assessment criteria		Unit amplification
2	Be able to prepare for work in a welding environment	2.1	Select the tools, equipment and information needed when materials are to be joined by welding	□ *Tools and equipment*: equipment availability, e.g. cables, hoses, torches/electrode holders, gas pressure regulators, flow meters; assembling welding equipment, e.g. cables, weld return clamps, electrode holders, gas supplies, safety devices; setting and adjusting welding conditions, e.g. gas pressures/flow rates, voltage, amperage; connecting the weld return lead. □ *Information sources*: safety instructions; job instructions; engineering drawings; quality control documentation, e.g. weld procedure specification, record/reporting sheet.
		2.2	Prepare a list of consumables that are needed for a welding process	□ Welding: processes, e.g. oxyacetylene, manual metal arc (MMA), metal inert gas (MIG), metal active gas (MAG), cored wire, tungsten inert gas (TIG), plasma-arc. □ *Consumables*: storage of consumables; consumables appropriate for welding processes, e.g.: □ for MMA: e.g. rutile, basic, nickel alloy, cellulosic, stainless steel, other electrodes □ for MIG, MAG and cored wire: e.g. two wire types from different groups, two different shielding gases where applicable □ for TIG, plasma-arc: e.g. one size of electrode, two types of filler wire from different material groups □ for gas welding: oxygen; acetylene; filler wire, e.g. two different sizes, two different material groups.

Learning outcomes		Assessment criteria		Unit amplification
3	Be able to produce joints to welding standards	3.1	Produce two joints safely and to a required quality standard using different welding positions	□ *Safety*: fire prevention; accident prevention and reporting; risk assessment; manual handling; checking conditions, e.g. gas leaks, voltage and amperage, leads; personal protective equipment (PPE); ventilation and extraction; closing down equipment safely. □ *Welding positions*: to British Standard (BS) EN 287, e.g. flat (PA), horizontal vertical (PB), horizontal (PC), vertical upwards (PF), vertical downwards (PG); welding technique, e.g. torch and filler angles for various positions.
		3.2	Produce two joints safely and to a required quality standard using different types of joint	□ *Safety*: fire prevention; accident prevention and reporting; risk assessment; manual handling; checking conditions, e.g. gas leaks, voltage and amperage, leads; personal protective equipment (PPE); ventilation and extraction; closing down equipment safely. □ *Joints*: producing joints using welding processes, e.g.: □ for MMA, MIG, MAG and cored wire: a fillet and a butt weld □ for TIG, plasma-arc and gas welding: a butt weld and either a fillet weld or an autogenous weld (without filler wire). □ *Material*: types, e.g. carbon steel, stainless steel, aluminium; forms, e.g. plate, section, pipe/tube, sheet metal less than 3mm thick. □ *Quality standard*: minimum weld quality equivalent to the level given in the relevant European/International Standard, e.g. BS EN ISO 5817 and BS EN ISO 10042; meeting the required dimensional accuracy within the specification.

Learning outcomes		Assessment criteria		Unit amplification
4	Be able to perform destructive and non-destructive tests on welded joints	4.1	Perform two destructive and two non-destructive tests and record the test outcomes	□ *Weld testing*: safety when using test equipment and chemicals; visual inspection for defects and irregularities; non-destructive, e.g. visual, dye penetrant, fluorescent particle, magnetic particle; destructive, e.g. macroscopic examination, nick break (fracture) tests, bend tests; non-thermal specimen removal processes, e.g. hand saws, power saws, abrasive discs; specimen preparation processes, e.g. removing slag, spatter and surface irregularities, cleaning, degreasing, polishing, making saw cuts in welds to be fracture tested; typical defects; consequences of defects; recording and reporting of weld defects.

Information for tutors

Delivery

This unit should be delivered using tutor-led demonstrations followed by practical tasks, during which learners can gain experience of working with appropriate tools and equipment. Underpinning knowledge could be delivered using practical demonstrations supported by classroom based sessions focusing on specific theoretical aspects of the processes used.

Tutors must ensure that learners understand the hazards and safe working practices associated with welding equipment before they are allowed to use the process. Learners should be introduced to the process using a series of graded, formative tasks to enable them to demonstrate their competence before attempting the summative tasks.

Learners should be encouraged to evaluate their performance through formative tasks using a combination of tutor and self/peer assessment. Learners should be provided with appropriate feedback, both formative and summative, to further encourage their development. The early introduction of weld testing in the workshop will encourage discussion and self-assessment, enabling learners to improve weld quality by making adjustments to process parameters.

The learning outcomes are ordered to enable learners to develop an understanding of the fundamental stages involved in the production of welded joints, irrespective of the process used. Job instructions should be written in a logical format, that will lead learners to consider all aspects of the task from safety, selection of tools, equipment and materials, process set-up and operation, through to production and testing of the welded joint.

Summative tasks will assess learners' competence in the use of the welding process and technique and their ability to control process parameters to produce welds that meet a specified quality standard.

Work-based learners should be encouraged to relate to the processes and techniques used at their place of work and also the wider perspective of welding processes used in industry. Centres should relate tasks to the needs of local industries to prepare learners not currently employed with the appropriate skills and knowledge necessary to enter employment.

Note that the use of 'e.g.' in the Unit amplification is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Achievement of the assessment criteria will require evidence of the production of welded joints in a workshop environment and responses to questions, either oral, written or a combination of both. Observations carried out during practical sessions should evidence the learners understanding of health and safety legislation and safe working practices; however a written description would produce best evidence against this criterion (1.1). In the event of a breach of health and safety or approved safe working practices, the assessment should be terminated.

Assessment criteria 2.1 and 2.2 must be completed satisfactorily before proceeding with criteria 3.1 and 3.2. It is expected that observation will capture learners' performance when using these welding processes. On completion of the welded joints, it is recommended that learners carry out the mandatory visual inspection of the weld during 3.1 and 3.2. The outcome from these welding processes should compare with the quality standard required. The requirement for 4.1 can be achieved during or after the practical activities and could be listed as a separate task.

In order to document evidence of practical tasks, centres may wish to consider the use of a logbook or portfolio to record the processes and techniques used. The inclusion of photographic evidence, drawings and a written description of each stage of the task would enable learners to demonstrate their competence with regard to the tools and equipment. Health and safety legislation and working practices relative to the task should be included in each description, as well as references to the safe operation of specific tools and equipment.

Suggested resources

Books

Jeffus L – *Welding Principles and Applications* (Delmar Learning, 2007)
ISBN 9781418052751

Timings R – *Fabrication and Welding Engineering* (Newnes, 2008)
ISBN 9780750666916

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the assessment criteria of this unit.

Skill	When learners are…
Independent enquirers	Analysing the welds that they have completed to visually examine the quality of welds and identify weld irregularities
Self-managers	Planning and organising their time and resources when selecting the correct tools, equipment and consumables and carrying out welding techniques

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are…
Creative thinkers	Continuously exploring the effects of changing welding parameters and techniques Generating ideas as to the cause of weld defects either by visual examination or destructive or non-destructive testing
Reflective learners	Analysing the outcomes of changing welding parameters and techniques Visually examining their weld samples for defects and irregularities and understanding their causes

Functional Skills – Level 2

English	
Speaking, listening and communication – make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	Speaking and listening to peers and those supervising when reviewing the quality of welds produced, and the results of testing
Reading – select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	Selecting, reading and using appropriate sources of information during welding tasks, e.g. job instructions, safety instructions, quality specifications
Writing – write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	Describing health and safety legislation and common hazards associated with welding Planning and justifying the tools and equipment required for welding, and listing consumables Writing a report to show the results of destructive or non-destructive tests

13 Further information and useful publications

To get in touch with us visit our 'Contact us' pages:

- Edexcel: **www.edexcel.com/contactus**
- BTEC: **www.edexcel.com/btec**
- Pearson Work Based Learning and Colleges: **www.edexcel.com/about-wbl**
- books, software and online resources for UK schools and colleges: **www.pearsonschoolsandfecolleges.co.uk**

Key publications:

- *Adjustments for candidates with disabilities and learning difficulties – Access and Arrangements and Reasonable Adjustments, General and Vocational qualifications* (Joint Council for Qualifications (JCQ))
- *Equality Policy* (Pearson)
- *Recognition of Prior Learning Policy and Process* (Pearson)
- *UK Information Manual* (Pearson)
- *UK Quality Vocational Assurance Handbook* (Pearson).

All of these publications are available on our website.

Publications on the quality assurance of BTEC qualifications are available on our website at www.edexcel.com/btec/delivering-BTEC/quality/Pages

Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please go to www.edexcel.com/resources/publications/Pages

Additional resources

If you need further learning and teaching materials to support planning and delivery for your learners, there is a wide range of BTEC resources available.

Any publisher can seek endorsement for their resources, and, if they are successful, we will list their BTEC resources on our website at: www.edexcel.com/resources/publications/Pages

14 Professional development and training

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- Ask the Expert: submit your question online to our Ask the Expert online service www.edexcel.com/aboutus/contact-us/ask-expert/Pages and we will make sure your query is handled by a subject specialist.

Annexe A

Mapping with NVQ/competence-based qualifications

The grid below maps the knowledge covered in the Pearson BTEC Level 2 Certificate in Military Engineering (QCF) against the underpinning knowledge of the Pearson Edexcel Level 2 NVQ Diploma in Engineering Maintenance and Installation (QCF) and the Pearson Edexcel Level 2 NVQ Diploma in Performing Engineering Operations (QCF). Centres can use this mapping when planning holistic delivery and assessment activities.

KEY

\# indicates partial coverage of knowledge in the NVQ/competence-based qualification unit

A blank space indicates no coverage of the knowledge

NVQ/competence-based units \ BTEC Specialist units		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
Pearson Edexcel Level 2 NVQ Diploma in Engineering Maintenance and Installation (QCF)										
1	Complying with Statutory Regulations and Organisational Safety Requirements			#						
2	Using and Interpreting Engineering Data and Documentation	#								
4	Handing Over and Confirming Completion of Maintenance or Installation Activities					#	#	#		
9	Carrying Out Fault Location on Electrical Equipment and Circuits							#		
10	Carrying Out Maintenance Activities on Electrical Equipment							#		
11	Carrying Out Modifications or Rewiring Electrical Circuits							#		
12	Carrying Out Scheduled Maintenance Tasks on Electrical Equipment							#		

NVQ/competence-based units		BTEC Specialist units: Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
16	Carrying Out Fault Location on Fluid Power Equipment and Circuits					#				
17	Carrying Out Maintenance Activities on Fluid Power Equipment					#				
18	Carrying Out Scheduled Maintenance Tasks on Fluid Power Equipment					#				
Pearson Edexcel Level 2 NVQ Diploma in Performing Engineering Operations (QCF)										
3	Using and Communicating Technical Information	#								
5	Producing Components Using Hand Fitting Techniques								#	
19	Maintaining Mechanical Devices and Systems						#			
21	Maintaining Fluid Power Equipment					#	#			
27	Preparing and Using Manual Metal Arc Welding Equipment				#					#
28	Preparing and Using Manual TIG or Plasma-Arc Welding Equipment				#					#
29	Preparing and Using Manual MIG, MAG and Other Continuous Wire Welding Equipment				#					#
30	Preparing and Using Gas Welding Equipment				#					#
37	Maintaining Electrical Equipment/Systems						#	#		
38	Maintaining Electronic Equipment/Systems						#			

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September 2014

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