ENERGY & ENVIRONMENT AWARDS

Skills for a greener world

Qualification Specification

EEA Level 3 Diploma for Engineering Maintenance Technician

November 2025 / V 1.0

Contents

Updates to this Specification

Since the first publication of the Level 3 Diploma for Engineering Maintenance Technician qualification specification, the following updates have been made.

1 Qualification Overview

At a Glance Qualification Summary

Qualification titles	EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical) (610/6635/7) EEA Level 3 Diploma for Engineering Maintenance Technician (Mechanical) (610/6636/9) EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation and Control) (610/6637/0) EEA Level 3 Diploma for Engineering Maintenance Technician (Mechanical/Electrical) (610/6642/4) EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical/Instrumentation and Control) (610/6643/6) EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation and Control/Mechanical) (610/6644/8)
Guided Learning Hours (GLH)	EEA Level 3 Diploma for Engineering Maintenance Technician - Electrical: **891 GLH** - Mechanical: **826 GLH** - Instrumentation and Control: **904 GLH** - Mechanical/Electrical: **1318 GLH** - Electrical/Instrumentation and Control: **1396 GLH** - Instrumentation and Control/Mechanical: **1331 GLH**
Total Qualification Time (TQT)	EEA Level 3 Diploma for Engineering Maintenance Technician - Electrical: **1286 TQT** - Mechanical: **1206 TQT** - Instrumentation and Control: **1312 TQT**

	- Mechanical/Electrical: **1867 TQT** - Electrical/Instrumentation and Control: **1973 TQT** - Instrumentation and Control/Mechanical: **1893 TQT**
RQF Level	3
Pathways	Learners can choose to work towards a single or dual discipline qualification and in order to achieve this they will need to complete the required units for each discipline.
Qualification credit value	EEA Level 3 Diploma for Engineering Maintenance Technician - Electrical: **129** - Mechanical: **121** - Instrumentation and Control: **131** - Mechanical/Electrical: **187** - Electrical/Instrumentation and Control: **197** - Instrumentation and Control/Mechanical: **189**
Entry requirements	Learners should be aged 16 or above
Assessment requirements	Each qualification is assessed by Portfolio of Evidence. There is an assessment strategy which underpins the qualification and some unit-specific evidence requirements.
Progression opportunities	Learners can progress to further engineering maintenance qualifications or other sector specific qualifications. These qualifications cover the knowledge and skills from the Level 3 Engineering Maintenance Technician (single or dual discipline) apprenticeship standard, learners may decide to progress onto an apprenticeship.
Regulatory Body / Status	These qualifications are regulated by Ofqual, the independent qualifications regulator for England.

Energy & Environment Awards

Energy & Environment Awards is an Ofqual recognised Awarding Organisation, offering End-point Assessments and Qualifications within the energy and utilities skills footprint. This qualification supports Energy & Environment Awards' commitment to promoting skills for a greener world through delivering a safe, skilled and sustainable workforce with energy and utilities industries.

Introduction

Energy & Environment Awards has secured recognition from Ofqual, the independent qualifications regulator for England, to offer the:-

- EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical)
- EEA Level 3 Diploma for Engineering Maintenance Technician (Mechanical)
- EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation and Control)
- EEA Level 3 Diploma for Engineering Maintenance Technician (Mechanical/Electrical)
- EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical/Instrumentation and Control)
- EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation and Control/Mechanical)

These qualifications have been developed through consultation with key external stakeholders, including Employers, Training Providers and technical experts.

This Qualification Specification provides guidance for approved Centres on how to consistently apply the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** along with content and relevant additional information to support the delivery of these qualifications.

Aims and Objectives of the Qualification

The purpose of the Level 3 Diploma for Engineering Maintenance Technician qualifications is to develop learners technical skills and knowledge in all aspects of engineering maintenance. The qualifications cover either a single or dual discipline in electrical engineering maintenance; mechanical engineering maintenance; or instrumentation and control engineering maintenance, learners will choose the

qualification which best meets the requirements of their sector, role and areas of responsibility.

These qualifications are suitable for individuals who are employed as an Engineering Maintenance Technician and are aged 16 or above. These qualifications contain the underpinning knowledge and skills that are required to deem a learner competent to be an Engineering Maintenance Technician. These qualifications have been designed and developed in accordance with legislative and industry requirements for the Engineering industry.

The qualification structures and units of achievement have been designed through consultation with employers, training providers and technical experts.

The units have also been written to align with the Level 3 Engineering Maintenance Technician (Single / Dual Discipline) apprenticeship and cover the knowledge and skills requirements of these standards.

These qualifications can either be offered as stand-alone qualifications or they can be used to support the on-programme delivery of the Level 3 Engineering Maintenance Technician (Single / Dual Discipline) apprenticeship.

2 Assessment

Assessment Strategy

Energy & Environment Awards have issued, and own, the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** which provides crucial information on the expected delivery, administration and quality assurance of the assessment for these qualifications.

Energy & Environment Awards have broken down the key elements of the assessment strategy in the sections which follow to make it easier for Energy & Environment Awards Centres to understand and follow. However, Centres are also required to familiarise themselves with the full content of the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** in order to comply with Energy & Environment Awards requirements, particularly in relation to the Portfolio of Evidence and the role of the Assessor and Internal Quality Assurer (herein referred to as IQA).

The information which follows should therefore be read in conjunction with the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician***.

Assessors

Centres must comply with both the qualification and sector experience requirements for Assessors, as outlined in the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician***, as part of the qualification-specific Centre approval requirements. Assessors are responsible for making and recording assessment decisions in the Portfolio of Evidence.

Further information, advice and guidance relating to the Energy & Environment Awards expectations on Assessors and the Portfolio of Evidence can be found in the sections which follow.

Overview of Assessment Methods

These qualifications are assessed wholly by Portfolio of Evidence, underpinned by the ***Energy & Environment Awards Assessment Strategy - Engineering Maintenance Technician.***

Assessment Method: Portfolio of Evidence

Assessment Preparation

Assessors will need to prepare fully for supporting learners in their collation of evidence for the Portfolio of Evidence. It is our expectation that the Centre's Assessor will ensure the learner's Portfolio of Evidence meets the requirements of the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** and any unit-specific evidence requirements / guidance. In order to sufficiently prepare for the assessment, Centres, and specifically Assessors, will need to:-

1. Liaise with the learner's employer to provide clear expectations on their role within the assessment process, including any requirement to contribute to assessment evidence and/or to sign off pieces of evidence.
2. Fully understand the unit-specific assessment / evidence requirements and/or guidance, including any range statements included within the unit content.
3. Fully understand the requirements of the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician.***
4. Familiarise themselves with the information and documentation contained within the ***Energy & Environment Awards Engineering Maintenance Technician Learner Assessment Guidance Pack.***
5. Ensure each learner has a copy of the ***Energy & Environment Awards Engineering Maintenance Technician Assessment Guidance Pack*** for the qualification and understands how to use the documentation appropriately.
6. Seek approval from Energy & Environment Awards for the use of realistic work environments (RWE) and simulation as supporting evidence, where allowed within the individual unit.

Assessment

These qualifications are assessed wholly by a Portfolio of Evidence, which is a collection of pieces of evidence generated by the learner, which demonstrate a learner's competence and underpinning knowledge for each unit they are registered on. The ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** outlines the Energy & Environment Awards requirements for ensuring the Portfolio of Evidence constitutes a valid measurement of the learner's skills and underpinning knowledge for the unit and/or qualification being assessed, including providing details of acceptable types of evidence that can be incorporated

into the learner's Portfolio of Evidence. In addition to this, unit-specific evidence requirements and/or guidance are also stipulated in the individual unit.

With evidence generation it is important to note that the learner's workplace should, where possible, be used as the assessment location and that naturally occurring workplace evidence is the primary source for determining competence. There may be exceptions to this, for example, where an environment similar to the learner's own workplace (for example another site) is allowed to be used to demonstrate competence where it is not possible within the learner's own workplace, as recognised in the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** as a realistic work environment (RWE). Similarly, some units allow the use of simulation where it is not possible to complete the work activity in a real work situation, for example a gas emergency. Individual units stipulate whether RWE and/or simulation is allowed and approved Centres wishing to deliver an assessment in an RWE or through simulation must have been approved by Energy & Environment Awards as having the specific, appropriate resources and site environment to use RWE or simulation according to the requirements of each unit.

Types of Evidence

The ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** outlines some examples of suitable types of evidence for use within the learner's Portfolio. It is important to note that this list is not exhaustive but does provide a starting point for learners and Assessors to identify suitable pieces of evidence. With any piece of evidence it is important to include the following:-
Details of the work activity undertaken by the learner or their role within the task where it has been completed as part of a group activity.

- Learner declaration to confirm that the evidence generated is the learner's own work with details of where a third party or additional source may have been used to support the evidence generated. The ***Energy & Environment Awards Engineering Maintenance Technician Evidence Declaration Form*** within the ***Engineering Maintenance Technician Learner Assessment Guidance Pack*** can be used for this purpose.
- Training provider and Employer declaration to confirm that the evidence provided is an accurate reflection of the learner's knowledge, understanding and/or competence and that it is the learner's own work (***Energy & Environment Awards Engineering Maintenance Technician Evidence Declaration Form*** within the ***Energy & Environment Awards Engineering Maintenance Technician Learner Assessment Guidance Pack***).

- Cross-reference mapping to indicate which learning outcomes and assessment criteria have been achieved through each piece of evidence (***Energy & Environment Awards Evidence Matrices*** within the ***Energy & Environment Awards Engineering Maintenance Technician Learner Assessment Guidance Pack***).

As referenced above Energy & Environment Awards has provided documentation in the ***Energy & Environment Awards Engineering Maintenance Technician Learner Assessment Guidance Pack*** for these qualifications. Although Centres may use their own documentation or electronic Portfolio systems if they prefer, provided that the content is in line with, and equivalent to, our requirements.

Assessment Decisions

The Assessor will review each piece of evidence in full, ensuring it meets the requirements of the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** and the individual unit requirements including learning outcomes and assessment criteria. The Assessor will determine which pieces of evidence best demonstrate the learner's knowledge, understanding and skills for each unit and cross reference these pieces of evidence to the relevant assessment criteria that they address on the unit-specific evidence matrix.

Energy & Environment Awards has provided an evidence matrix for each unit within these qualifications in the Energy ***& Environment Awards Engineering Maintenance Technician Learner Assessment Guidance Pack.*** Although Centres may use their own documentation or electronic portfolio systems for this purpose if they prefer.

In order to assess a learner as "competent" in the required skills and underpinning knowledge and understanding, Energy & Environment Awards would typically expect a learner to produce three pieces of evidence; one of which should be generated on a work site (unless this is not appropriate to the work activity being assessed and the unit allows for simulation or realistic working environment). Where possible, evidence should be collected from a range of sites and/or from different sources, this enables the learner to demonstrate that they have consistently applied the relevant skills and/or knowledge and understanding to their work activities. However, Energy & Environment Awards recognises that there may be occasions when fewer pieces of evidence or even one piece of evidence, can also fully meet these requirements. Similarly, a single piece of evidence may cover, or partially cover, the assessment criteria within more than one unit.

When a learner is deemed to be competent in an individual unit the Assessor needs

to ensure the Energy & Environment Awards evidence matrix (or Centre-specific form) for the relevant unit is completed in full and is signed by the learner, the Assessor and the Employer. There is also space for the Centre's IQA to sign in line with the Centre's IQA sampling policy. The Centre will record the assessment decision as "Achieved" on QuartzWeb. QuartzWeb is the Energy & Environment Awards web based learner management system for Approved Centres.

All learners must be registered with Energy & Environment Awards through QuartzWeb in order for learners' achievement to be recognised and certificated.

Internal Quality Assurance

The Centre's IQA will sample learners' assessment decisions and documentation and observe assessment discussions between the Assessor and the learner according to the Centre's IQA sampling approach, which will have been approved by Energy & Environment Awards as meeting the quality assurance requirements for these qualifications.

IQAs will keep records of the assessments which are sampled in line with their IQA policy and process. These reports provide essential evidence for the Energy & Environment Awards External Quality Assurer (herein referred to as EQA) for determining whether the qualification is being assessed in line with the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician***, Energy & Environment Awards Centre approval requirements and the Centre's own quality assurance policies and procedures.

IQAs are also required to ensure consistency across the Centre's Assessors through monitoring assessment decisions, holding regular standardisation meetings and ensuring the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician*** is fully understood and being implemented appropriately. IQAs are also involved in the escalation and/or investigation of any issues or queries or potential malpractice relating to the assessment, grading decisions and the Assessor's occupational competence.

Further details about the role and responsibilities of the Centre's IQA are found in the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician.***

External Quality Assurance

Energy & Environment Awards externally quality assures the Level 3 Diploma for Engineering Maintenance Technician qualifications through appointing each Centre an EQA, who is responsible for checking and monitoring the assessment and quality assurance practices within the Centre to ensure assessments are conducted and quality assured in a robust, consistent manner, in line with the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician***. The EQA does this through:-

- Approving Centres according to the Energy & Environment Awards qualification-specific Centre approval criteria and carrying out a visit as part of this approval, where required.
- Approving and monitoring where an assessment can be carried out in either a realistic work environment (RWE) or through simulation.
- Determining the sampling approach for each Centre, according to their risk, volume of learners and history as an approved Centre.
- Planning and conducting EQA visits to Centres, at least once a year. The frequency of these visits will again be determined on a risk-based approach and the volume of learners. An EQA may also visit a Centre more frequently where assessments are being conducted in a live work-based site situation rather than at a Centre in a simulated environment. EQA visits will enable the EQA to observe live assessments, sample learner's evidence and assessment decisions and to review internal quality assurance documentation and practices to ensure the Centre is delivering a robust internal quality assurance of the assessment decisions which Assessors make.
- Writing a report on their findings for both the Centre and Energy & Environment Awards which details the EQAs findings, including any areas where remedial action is required and an action plan to be agreed with the Centre.
- Providing advice and support to Centres in relation to meeting the requirements of the ***Energy & Environment Awards Assessment Strategy for Engineering Maintenance Technician***.

3 Qualification Information

Unit Achievements

As you will see from the qualification structure in the section that follows that all of the units in Group A are mandatory units which are common to all of the Engineering Maintenance Technician qualifications. All of the units in Group B are mandatory units for Electrical Maintenance Technician pathway. All of the units in Group C are mandatory units for Instrumentation and Control Maintenance Technician pathway. All of the units in Group D are mandatory units for Mechanical Maintenance Technician pathway.

Once the learner has achieved these units with Energy & Environment Awards they do not need to complete them again if they decide to move onto a further Level 3 Diploma in Engineering Maintenance Technician qualification with Energy & Environment Awards, instead they can be exempt from having to achieve the unit a second time. Please see below for an example.

Mateo is a learner who has achieved the EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation & Control) and they have recently changed jobs and would now like to complete EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical). From looking at the qualification structure they can see that they have achieved all of the units in Group A.

In order to complete the Energy & Environment Awards Level 3 Diploma for Engineering Maintenance Technician (Electrical) they will need to complete all the units in Group B.

Recognition of Prior Learning

Energy & Environment Awards has a comprehensive Recognition of Prior Learning (RPL) and Recognition of Prior Achievement (RPA) Policy, which all approved Centres have access to and is available at: https://energyenvironmentawards.co.uk/policies-and-fees/. This policy sets out our approach to the Recognition of Prior Learning (RPL) and Recognition of Prior Achievement (RPA), providing guidance on what constitutes acceptable evidence and the circumstances when RPL or RPA would, and would not be acceptable, in order to for us to meet our Regulatory requirements.

Recognition of Prior Learning applies to the acceptance of evidence that the learner has completed learning which may exempt them from certain elements of training but it will not exempt them from the assessment(s). This may, for example, apply to experienced workers who do not require as much training as new entrants to the role / sector.

Learners are also able to be registered on, and achieve, individual units where appropriate instead of completing the full qualification.

Pre-requisites

There are no pre-requisites for entry to this qualification.

Qualification Structures

EEA Level 3 Diploma for Engineering Maintenance Technician

In order to achieve the **EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical)** qualification, learners must complete all mandatory units in Group A and all the mandatory units in Group B.

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In order to achieve the **EEA Level 3 Diploma for Engineering Maintenance Technician (Instrumentation and Control)** qualification, learners must complete all mandatory units in Group A and all the mandatory units in Group C.

…….

In order to achieve the **EEA Diploma for Engineering Maintenance Technician (Mechanical)** qualification, learners must complete all mandatory units in Group A and the mandatory unit in Group D.

…….

order to achieve the **EEA Level 3 Diploma for Engineering Maintenance Technician (Mechanical / Electrical)** qualification, learners must complete all mandatory units in Group A and all the mandatory units in Group B and Group D.

…….

In order to achieve the **EEA Level 3 Diploma for Engineering Maintenance Technician (Electrical / Instrumentation and Control)** qualification, learners must complete all mandatory units in Group A and all the mandatory units in Group B and Group C.

…….

In order to achieve the **EEA Diploma for Engineering Maintenance Technician (Instrumentation and Control / Mechanical)** qualification, learners must complete all mandatory units in Group A and the mandatory unit in Group C and Group D.

Group A: Mandatory units for all learners	
EEA Unit Ref:	**Unit Title:**
1686	Principles of engineering maintenance, regulations and standards
1687	Working within health and safety requirements in engineering maintenance to ensure compliance
1688	Working effectively as part of a team to undertake engineering maintenance
1689	Working with engineering information, materials, new technology and technical drawings required for maintenance

1690	Working with mathematical principles and formulae required for engineering maintenance
1691	Undertake planning, organising and engineering maintenance tasks
1692	Complying with business operations and quality systems within engineering maintenance

Group B: Mandatory units for Electrical Maintenance Technician pathway:	
EEA Unit Ref:	**Unit Title:**
1693	Principles and regulations of electrical engineering systems
1695	Working with technology, equipment and systems required for electrical engineering maintenance
1696	Undertake maintenance, inspection, calibration and testing activities for electrical systems
1697	Undertake safe isolation and deisolation of electrical systems whilst conducting maintenance activities
1698	Diagnose electrical system faults and implement problem solving techniques

Group C: Mandatory units for Instrumentation and Control Maintenance Technician pathway:	
EEA Unit Ref:	**Unit Title:**
1699	Principles and regulations of instrumentation and control engineering systems
1700	Undertake maintenance, inspection, calibration and testing activities for Instrumentation and Control Systems
1701	Undertake safe isolation and deisolation of Instrumentation and Control systems whilst conducting maintenance activities
1702	Working with technology, equipment and systems required for instrumentation and control engineering maintenance
1703	Diagnose instrumentation and control system faults and implement problem solving techniques

Group D: Mandatory units for Mechanical Maintenance Technician pathway:	
EEA Unit Ref:	**Unit Title:**
1704	Principles of mechanical engineering systems
1705	Undertake maintenance, inspection, calibration and testing activities for mechanical Systems
1706	Undertake safe isolation and deisolation of mechanical systems whilst conducting maintenance activities
1707	Working with technology, equipment and systems required for mechanical engineering maintenance
1708	Diagnose mechanical system faults and implement problem solving techniques

Core Mandatory Units

Unit Ref:	1686
Ofqual Unit Ref:	A/651/8288
Unit Title:	Principles of engineering maintenance, regulations and standards
Level:	3
Credit value:	7
GLH:	48
TQT:	74
Unit aim(s):	This unit allows learners to develop skills and knowledge in the principles of the engineering maintenance sector including roles and responsibilities of a maintenance technician, environmental regulation, standards and operational procedures.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Level 3 Engineering Maintenance Technician Apprenticeship standard: K1, K2, K3, K7, K13, K14, K15, K20, S11, S12, S14

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand sectors in which engineering maintenance takes place and the roles and responsibilities of a maintenance technician	1.1 Explain the sectors where engineering maintenance roles are required and how the sector and future trends can impact on the maintenance activities
	1.2 Summarise the different maintenance disciplines and functional areas
	1.3 Compare how the different maintenance disciplines work together
	1.4 Discuss the roles and responsibilities of a maintenance technician
	1.5 Explain the escalation procedures relevant to the role of a maintenance technician
2. Know and understand engineering standards and maintenance strategies	2.1 Explain engineering standards and how these can impact on the role of the maintenance technician
	2.2 Evaluate the different maintenance strategies which are relevant to the role of maintenance technician and when these need to apply
3. Know and understand environmental regulations and sustainability requirements relevant to the engineering maintenance sector	3.1 Describe environmental regulations and standards which are relevant to a maintenance technician
	3.2 Summarise the UK's net zero commitment
	3.3 Discuss the principles of sustainability and how these apply to the maintenance technician role
	3.4 Explain recycling and waste management requirements

4. Be able to implement engineering maintenance standards and operational procedures	4.1 Implement organisational procedures to ensure efficient workplace operations
	4.2 Apply engineering maintenance standards and adapt where required
	4.3 Escalate issues and report concerns which are outside the limits of a maintenance technician
5. Be able to apply environmental regulations and sustainability requirements within the workplace	5.1 Apply sustainability principles and comply with environmental regulations within the workplace
	5.2 Implement organisational waste management procedures

Range Statements:

Learning outcome 1
Learners must be aware of the following maintenance disciplines and how they have an impact on and integrate with the functional areas, key points:

- **Preventative maintenance practices** - Routine servicing and inspections to include the replacement of parts, filters and lubricants to increase the working life of the equipment and reduce the instances of failures.
- **Reactive maintenance practices** - Repairing systems after breakdown by replacing broken items such as belts, switches, sensors, bearings, etc. To restore the system back to operational condition.
- **Predictive maintenance practices** - The use of condition monitoring techniques such as infrared thermography, vibration monitoring and ultrasound to detect potential failures before they occur.

Other relevant areas may also include:

- **Reliability Centred Maintenance (RCM) practices** - Improving system reliability; Reducing unnecessary maintenance activity and costs; prioritising operational critical equipment; the use of several different maintenance strategies; enhancing safety and compliance
- **Total Productive Maintenance (TPM) practices** - The use of LEAN maintenance strategies such as streamlining maintenance workflows and the use of condition-based maintenance; Root Cause Analysis (RCA); Improved Workforce training; Holistic approach to maintenance with the integration of operational and maintenance staff.

Learners should know the working relationships between the maintenance function, operations, reliability engineering and spares and parts provision.

Learners must be aware of their individual roles and responsibilities that ensure the plant and equipment remain in an optimal operational condition, minimise downtime and improve efficiency.

These roles and responsibilities may include:

- Performing schedules servicing and inspection
- Carrying out lubrication, cleaning and minor adjustments of plant and equipment
- Use of specialist tools and equipment to conduct maintenance activities which may also include the use of condition monitoring equipment.
- Working in a safe and competent manner.
- Following any Safe Systems of Work (SSoW), Standard Operating Procedures (SOPs), Permits to Work as required by their workplace and industry.

Report and record any findings from their maintenance activities and knowing who to report to should they come across a problem outside of their scope of responsibility.

Learning outcome 2 and 4
Learners should be aware of, and apply, Engineering standards to ensure quality, safety and efficiency in their role.

British Standards Institution (BSI) including but not limited to:

- BS EN 17666:2022 – Maintenance engineering — Requirements
- BS EN 15628:2025 – Maintenance — Qualification of maintenance personnel
- BS EN 17007:2017 – Maintenance process and associated indicators
- BS 14200:2023 – Maintenance of machinery — Specification

International Organisation for Standardisation (ISO) Standards including but not limited to:

- ISO 9001 - Quality Management Systems
- ISO 45001 - Occupational Health and Safety Management Systems
- ISO 14001 - Environmental Management Systems

Learners must be aware of the procedure used to report and escalate issues outside of their limits of responsibility to the relevant parties using the relevant methods. Concerns such as:

- Health and Safety concerns
- Safeguarding
- Maintenance issues
- Welfare concerns

Learning outcome 3 and 5
Regulations and Standards:

- Environmental Management Systems (EMS) - standard ISO 14001
- Environmental Protection Act 1990
- Hazardous Waste Regulations 2005.

Learners must be aware of the UK Government's pledge to reduce Green House Gas (GHG) emissions to net zero by 2050 and the policies and strategies used to achieve this. These Key Points may include:

- Phasing out coal by 2024
- Expanding renewable energy
- Ban on petrol and diesel cars by 2035
- Investing in public transport
- Supporting carbon capture
- Replacing old heating technologies with low carbon heating technologies

Learners must know and apply how their job role directly affects the environment. Key points to understand are:

- **Environmental Awareness:**
  - environmental legislation and regulations relevant to their maintenance activities.
  - strategies for identifying and mitigating environmental risks associated maintenance activities
- **Sustainable Practices:**
  - implement energy-efficient practices and use sustainable materials in their work
  - promote and practice the principles of reduce, reuse, and recycle in all work activities
- **Waste Management:**
  - managing and disposing of waste materials in accordance with environmental regulations
  - segregate waste for recycling and ensure hazardous materials are handled safely
  - company's waste management and recycling policy and follow the laid down practice when managing and disposing of waste including the segregation of waste for recycling and ensure
  - hazardous materials are handled safely.

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1687
Ofqual unit Ref:	M/651/8293
Unit Title:	Working within health and safety requirements in engineering maintenance to ensure compliance
Level:	3
Credit value:	8
GLH:	50
TQT:	78
Unit aim(s):	This unit enables learners to develop knowledge and skills of the health and safety requirements in the engineering maintenance sector, including managing risk and ensuring compliance.
Assessment requirements:	Portfolio of Evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K8, K9, K10, K11, K12, K16, S7, S8, S9, S10

Learning Outcome: The learner will:		Assessment Criteria: The learner can:
1.	Know and understand health and safety regulations and working practices that apply to an engineering workplace	1.1 Describe health and safety regulations and working practices that apply to the role of a maintenance technician
		1.2 Explain the roles and responsibilities of the employer and the employee under health and safety regulations
		1.3 Describe sources of information and resources on health and safety relevant to the maintenance technician role
2.	Know and understand the hazards and risks in the engineering workplace and how to mitigate these	2.1 Explain the hazards and risks associated in an engineering workplace
		2.2 Explain the responsibilities of a maintenance technician to deal with hazards and manage risks
		2.3 Describe the processes and procedures that are used to identify risks
		2.4 Identify action that is required to remove hazards and to mitigate against risks
3.	Know and understand the requirement for personal protective equipment to be used in an engineering workplace	3.1 Describe personal protective equipment which a maintenance technician is required to use
		3.2 Explain how personal protective equipment is to be maintained
4.	Know and understand security procedures for an engineering workplace	4.1 Describe security procedures which are relevant to the role of a maintenance technician
		4.2 Explain requirements for asset security
5.	Know and understand emergency and incident response procedures	5.1 Describe the emergency response procedures relevant to the role of a maintenance technician
		5.2 Evaluate the reporting requirements for accidents and incidents
6.	Be able to manage health and safety risks in an	6.1 Carry out a risk assessment within the workplace

	engineering workplace and apply measures to control these	6.2 Implement measures to control and mitigate risks which have been identified within the workplace
7.	Be able to apply health and safety procedures in an engineering workplace to ensure compliance with regulations and standards	7.1 Apply health, safety and environmental procedures which are relevant to the maintenance technician role
		7.2 Demonstrate compliance with health and safety regulations and standards
8.	Be able to implement security procedures in an engineering workplace	8.1 Implement security procedures within an engineering workplace
		8.2 Use correct documentation for security procedures
		8.3 Escalate security concerns to relevant colleagues and organisations
9.	Be able to carry out emergency response procedures in an engineering workplace	9.1 Carry out emergency response procedures
		9.2 Escalate concerns with emergency response procedures to the correct colleagues

Range Statements:

Learning outcome 1 and 7

Regulations and working practices:

- Health and Safety at Work etc Act 1974
- Workplace (Health, Safety and Welfare) Regulations 1992
- ATEX - safety requirements for workplaces and equipment used in explosive atmospheres
- Control of Asbestos Regulations 2012
- Control of Major Accident Hazards (COMAH) Regulations 2015
- Control of Substances Hazardous to Health (COSHH) Regulations 2002
- Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002
- Display Screen Equipment Regulations (DSE)
- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)
- Management of Health and Safety at Work Regulations1999
- Manual Handling Operations Regulations 1992
- Personal Protective Equipment (PPE) at Work Regulations 2022
- Provision and Use of Work Equipment Regulations (PUWER) 1998
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 2013

- Working at Height Regulations 2005
- Working in Confined Spaces Regulations 1997

Learning outcome 2 and 6

Learners should be aware of, and understand, the hazards associated with their maintenance activities and working environment this should also include following and conducting risk assessments as required. Key points to note are:

- Types of hazards
- Physical
- Chemical
- Mechanical and Electrical
- Ergonomic
- Psychosocial

Risk Assessments:

- **Identification of Hazards:** Recognise potential hazards associated with engineering maintenance tasks
- **Risk Evaluation:** Assess the likelihood and severity of risks to determine appropriate control measures
- **Control Measures:** Implement measures to mitigate identified risks, ensuring the safety of all personnel and the environment
- **Documentation:** Accurately document risk assessments, including identified hazards, risk levels, and control measures

Learners should be aware of and understand the key elements of a Safe Systems of Work (SSoW) associated with their maintenance activities and working environment. These may include:

- Hazard identification
- Risk assessment
- Procedure development
- Control measures
- Training and Competency
- Communication
- Monitoring and supervision
- Review and continuous improvement
- Emergency procedures
- Types of SSoW
- Standard Operating Procedures (SOPs)
- Permit to Work Systems
- Safe Work Method Statements (SWMS)

- Risk Control Plans

Learning outcome 3

Personal Protective Equipment (PPE) relevant to their job role and tasks may include:

- Safety boots
- Gloves
- Hard hat
- Goggles
- Respirator
- Role specific safety equipment

Learning outcome 4 and 8

Company guidelines and procedures in relation to the security of the company's assets in accordance with their roles and responsibilities. These may include measures such as:

- Mechanical locks
- Access control
- Maintenance and inspection
- document classification
- securing assets.

They should be able to follow the relevant security procedures for their job role and working environment. These may include:

- Security passes
- Site access
- Document security
- Facility and asset security
- Reporting procedures

Learning outcome 5

Emergency procedures:

- Evacuation procedures
- fire safety
- first aid
- natural disasters
- Chemical spills
- release of radioactivity
- location of emergency exits, first aid kits, fire extinguishers and muster points

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1688
Ofqual Unit Ref:	J/651/8290
Unit Title:	Working effectively as part of a team to undertake engineering maintenance
Level:	3
Credit value:	7
GLH:	48
TQT:	71
Unit aim(s):	This unit allows learners to develop the knowledge and skills to work effectively as part of a team, including communication techniques, equity and diversity principles and continuous improvement techniques.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K25, K26, K27, K28, K29, K30, K31, S18, S19, S21, S22, S23, S24, S25, S26

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the principles of effective team working	1.1 Explain the principles of team working that apply to the role of a maintenance technician
	1.2 Evaluate the importance of teamworking as a maintenance technician
	1.3 Explain the principals of collaboration between different trades or stakeholders that apply to the role of maintenance technician
2. Know and understand the principles of equity, diversity and inclusion in the workplace	2.1 Describe the principles of equity, diversity and inclusion
	2.2 Explain how the principles of equity, diversity and inclusion are applied in the workplace
3. Know and understand communication methods and techniques relevant to engineering maintenance	3.1 Explain the written communication techniques which apply to the role of the maintenance technician
	3.2 Explain the non-written communication methods and techniques and how these can be used by the technician
	3.3 Describe engineering maintenance terminology which is suitable for the maintenance technician role
4. Know and understand the requirements for documenting information within engineering maintenance	4.1 Describe the types of documentation which a maintenance technician will need complete and review
	4.2 Explain why records and documentation should be kept and maintained
	4.3 Evaluate the different types of digital and information technology that is available to support the maintenance technician
	4.4 Explain operational procedures and regulation requirements for storing information safely

5. Know and understand the principles of continuous improvement and how these apply to the role of a maintenance technician	5.1 Describe continuous improvement systems and techniques that apply to the role of the maintenance technician
	5.2 Explain the importance of continuous improvement for a maintenance technician and their organisation
6. Be able to work and communicate effectively in a team	6.1 Apply team working principles in order to establish and maintain productive working relationships
	6.2 Communicate effectively with others to ensure information is transferred clearly and correctly
7. Be able to produce documentation, record information and report inaccuracies with information within an engineering workplace	7.1 Be able to produce documentation, record information and report inaccuracies with information within an engineering workplace
	7.2 Use digital and information technology relevant to the role of the maintenance technician
	7.3 Follow operational procedures and regulation requirements to ensure that information is captured and stored safely and securely
	7.4 Identify and record issues with drawings and highlight these to relevant colleagues
	7.5 Apply continuous improvement techniques to identify improvement suggestions
8. Be able to undertake continuous professional development	8.1 Carry out and record planned and unplanned learning and development activities
	8.2 Undertake a review of personal development needs and identify opportunities for further development

Range Statements:

Learning outcome 1

Effective team working principles:

- Clear goals
- Open communication
- Trust
- Defined roles
- Collaborative and supportive environment
- Continuous improvement

Learning outcome 2

Principles of equity, diversity and inclusion in the workplace:

- **Equity** – Provide support and resources to individuals to access opportunities, whilst recognising that different people will have different needs
- **Diversity** – to have a workforce with a wide range of backgrounds and skills including differences in gender, age, race, disability, religion, sexual orientation and cultural background
- **Inclusion** – to create a workplace environment where every employee feels they belong and are respected and able to contribute their opinions

Learning outcome 3 and 6

Methods of communicating:

- Verbal, non-verbal, written and visual
- Regular team meetings/briefings
- Documentation – records and logs
- Standard protocols – handover notes, work orders, incident reports
- Technology - Computerised Maintenance Management Systems (CMMS), Live chat, mobile apps and cloud platforms

Techniques:

- Active listening
- Providing information clearly avoiding complex technical information
- Awareness of non-verbal communication including body language
- Empathy
- Asking questions and providing feedback
- Adapting communication depending on audience – colleagues, customer, stakeholders

Learning outcome 4 and 7

Documentation may include, but not limited to:

- Work orders / Job reports
- Maintenance logs
- Inspection reports
- Permits to work / safe systems of work forms
- Handover reports
- Fault finding reports / root cause analysis documents
- Stock control reports
- Compliance
- Standard operating procedures
- Manufacture instructions
- Risk assessments
- Maintenance schedules
- Technical drawings and schematics

Types of digital and information technology may include but not limited to:

- **Software and platforms:**
  - Computerised maintenance management systems (CMMS)
  - Inventory software
  - Data analytics
  - Enterprise asset management
- **Hardware and physical technologies:**
  - Internet of Things (IoT) Sensors
  - Wearable technology
  - Robotics automation
  - Mobile devices
- **Advanced and emerging technologies:**
  - Virtual Reality (VR) and Augmented Reality (AR)
  - Digital twin technology
  - 3D Printing

Regulations for storing information:

- Data Protection Act 2018
- UK General Data Protection Regulation (GDPR)

Operational procedures for safe storage of information:

- **Technical measures** – network security, anti-virus software, data and storage back up, access controls
- **Physical measures** – secure paper records, alarms, CCTV, visitor access
- **Administrative measures** – policies and procedures, staff training

Learning outcome 5

Continuous improvement systems and techniques:

- Total productive maintenance (TPM)
- Kaizen
- Lean maintenance
- PDCA Cycle (Plan-Do-Check-Act)
- Six Sigma for Maintenance

Learning outcome 8

Continuous professional development includes but not limited to:

- Formal training
- Mentoring
- Qualifications
- Webinars
- Keeping up to date with legislative changes
- Learning new skills through colleagues
- Implementing new procedures

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1689
Ofqual unit ref:	K/651/8291
Unit Title:	Working with engineering information, materials, new technology and technical drawings required for maintenance
Level:	3
Credit value:	10
GLH:	63
TQT:	101
Unit aim(s):	This unit allows for learners to develop their skills and knowledge of engineering information, materials, technical drawings and new technology required for engineering maintenance technicians.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K18, K19, K21, K32, S1

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand sources of engineering information to support maintenance activities	1.1 Describe the types of engineering information sources for engineering maintenance
	1.2 Explain the importance of using accurate information in engineering maintenance tasks
	1.3 Research technical information to inform maintenance tasks
	1.4 Analyse engineering data from technical documents
	1.5 Evaluate the reliability and suitability of information for specific maintenance scenarios
2. Know and understand how to interpret engineering sketches, drawings, and graphical information	2.1 Explain standard conventions used in engineering drawings
	2.2 Interpret engineering drawings to extract relevant information
	2.3 Recognise different types of engineering drawings and their purposes in a maintenance context
3. Know and understand the principles, technologies, and benefits of Industry 4.0 in engineering maintenance environments	3.1 Explain Industry 4.0 and its relevance to modern engineering and maintenance practices
	3.2 Describe how systems are integrated in an Industry 4.0 environment
	3.3 Summarise key technologies used in Industry 4.0
	3.4 Describe the impact of Industry 4.0 in maintenance operations
	3.5 Explain the potential considerations and challenges when implementing Industry 4.0 technologies in existing maintenance operations

4. Know and understand the properties of engineering materials and how they affect suitability and performance in maintenance applications	4.1 Identify common engineering materials used in maintenance tasks
	4.2 Describe the properties of key engineering materials
	4.3 Evaluate how material properties influence the selection and use of materials in different engineering environments
	4.4 Explain the impact of operating conditions on material performance and degradation
	4.5 Recognise the importance of sourcing and using materials that comply with industry standards and specifications
5. Be able to review and use technical information to carry out maintenance activities accurately and safely	5.1 Select appropriate technical documents for maintenance tasks
	5.2 Interpret and extract relevant data from technical information sources to inform maintenance actions
	5.3 Verify that the technical information being used is current, accurate, and authorised
	5.4 Apply information from technical documents to complete maintenance tasks in line with specified requirements
	5.5 Produce technical sketches to communicate component features or maintenance requirements using appropriate conventions
	5.6 Record completed work in line with the technical documentation and organisational procedures
	5.7 Report discrepancies or issues in technical information during the maintenance process

Range Statements:

Learning outcome 1 and 5

Sources of information may include:

- Drawings (hardcopy and electronic)
- Computer Aided Design (CAD) 2D drawings (laptops, tablets)
- Computer Aided Design (CAD) 3D models
- Work instructions
- Method statements
- Standard work procedures
- Manufactures' Technical Documentation - manufacturer's manual
- Safety data sheets
- Design Specifications
- Test results, test data, graphs, units
- Plant Configurations
- Zeus Tables
- Engineering Institutions such as IMechE and IET
- The Engineering Council
- Technological advancements for accessing 3D experiences such as Augmented Reality (AR)
- Rapid prototypes
- technical manuals
- digital databases

Engineering representations, sketches, drawings and graphical information may include:

- Technical Drawings
- Schematics
- Isometric
- Assembly
- Flowcharts
- Graphs and Charts
- Sketches
- Graphical information conventions: Standardisation (BS and ISO), Line types and styles, Dimensioning and tolerances, Symbols and annotation, Scales, Colour coding, projection methods
- Extract information from engineering drawings such as dimensions, tolerances, and material specifications

Learning outcome 3

Industry 4.0 can be defined as the integration of intelligent digital technologies into manufacturing and industrial processes. It encompasses a set of technologies that include:

- industrial IoT networks
- Interconnectivity
- Data-driven decision making
- Automation and Robotics
- Artificial Intelligence (AI)
- Cloud Computing
- Additive Manufacturing (3D printing)
- Augmented Reality (AR) and Virtual Reality (VR)
- Cybersecurity
- Cyber-physical systems

Key points:

- **Benefits:** Increased Productivity, Cost savings, Enhanced quality, Sustainability, improved decision making, Customisation and flexibility
- **System integration in an Industry 4.0 environment** - how physical systems are integrated with internet connectivity, cloud computing, and data analytics
- **Key technologies used in Industry 4.0** - sensors, Internet of Things (IoT), cyber-physical systems, and cloud platforms
- **Impact of Industry 4.0 in maintenance operations** - benefits, increased automation, reduced downtime, and improved decision-making

Learning outcome 4

Key points:

- **Mechanical Properties:** Strength, Hardness, Ductility, Toughness, Elasticity
- **Thermal Properties:** Thermal conductivity, Thermal Expansion, Melting Point
- **Electrical Properties:** Conductivity, Resistivity, Dielectric Strength
- **Chemical Properties:** Corrosion resistance, Reactivity, Oxidation resistance
- **Physical Properties:** Density, Specific Gravity, Transparency
- **Environmental Properties:** UV resistance, Recyclability
- **Manufacturing Properties:** Machinability, Weldability, Malleability
- **Common engineering materials:** metals, polymers, ceramics, and composites.
- **Properties of engineering materials:** strength, hardness, ductility, toughness, corrosion resistance, thermal conductivity, and wear resistance.
- **Operating conditions:** temperature, load, environment
- Incorrect material selection can lead to premature failure, safety risks, or increased maintenance needs.
- knowledge of material properties supports effective inspection, repair, and replacement decisions.

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1690
Ofqual unit ref:	L/651/8292
Unit Title:	Working with mathematical principles and formulae required for engineering maintenance
Level:	3
Credit value:	7
GLH:	42
TQT:	67
Unit aim(s):	This unit allows learners to develop their skills and knowledge in mathematical principles and formulae required for engineering maintenance technicians.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K17, S13

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand mathematical calculations and methods required for engineering maintenance	1.1 Explain algebraic methods used in engineering maintenance
	1.2 Describe how algebraic methods are required to solve engineering-related problems
	1.3 Describe trigonometric methods and standard formulae required for engineering maintenance
	1.4 Evaluate the different statistical techniques required to present and interpret engineering data
	1.5 Explain the purpose of basic calculus techniques required for engineering maintenance
2. Be able to apply mathematical principles and formulae to complete engineering maintenance tasks	2.1 Select appropriate mathematical methods and formulae based on the requirements of the maintenance task
	2.2 Apply algebraic methods to solve engineering-related problems
	2.3 Use trigonometric methods and standard formulae to calculate areas and volumes of components
	2.4 Interpret and present data using statistical techniques
	2.5 Apply basic calculus techniques to interpret rates of change in maintenance systems
	2.6 Verify the accuracy of calculated results against task specifications or expected outcomes
	2.7 Demonstrate use of calculated values to inform decisions or adjustments during maintenance procedures
	2.8 Record and present mathematical information following organisational procedure

Range Statements:

Learning outcome 1 and 2

Mathematics calculations and methods:

- Algebraic Linear equations
- Trigonometric methods
- Standard formulae to determine areas and volumes
- Statistical methods to display data (mean, mode, median).
- Elementary calculus techniques: coefficient, gradient of a curve, rate of change.

Learners should be able to:

- Perform accurate calculations involving measurements, tolerances, forces, areas, volumes, or rates of change, as required.
- Use algebraic, trigonometric, statistical, or calculus-based methods to support problem-solving in maintenance activities.
- Record and present mathematical information clearly, using correct units and notation

The requirements will vary depending on the learners specialism but examples are:

- Solve linear and quadratic equations relevant to maintenance engineering contexts.
- Simplify and manipulate algebraic expressions including factorisation and expansion.
- Rearrange formulae to change the subject, demonstrating accuracy and logical progression.
- Apply trigonometric ratios (sine, cosine, tangent) to calculate unknown lengths or angles in right-angled triangles.
- Use standard geometrical and trigonometric formulae to determine the area of 2D shapes.
- Calculate the volume of regular and compound 3D objects using appropriate mathematical formulae.
- Calculate and interpret measures of central tendency: mean, median, and mode.
- Present engineering-related data in tabular and graphical formats.
- Interpret trends and patterns in data to inform maintenance decisions.
- Determine the gradient of a curve at a point using first principles or standard differentiation rules.
- Interpret the rate of change in relation to maintenance scenarios (e.g., wear rate, temperature variation).
- Use differentiation to find maxima and minima in simple applied contexts relevant to maintenance tasks.
- Calculate and interpret measures of central tendency: mean, median, and mode.
- Present engineering-related data in tabular and graphical formats.
- Interpret trends and patterns in data to inform maintenance decisions.
- Determine the gradient of a curve at a point using first principles or standard differentiation rules.

- Interpret the rate of change in relation to maintenance scenarios (e.g., wear rate, temperature variation).
- Use differentiation to find maxima and minima in simple applied contexts relevant to maintenance tasks.

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1691
Ofqual unit Ref:	D/651/8289
Unit Title:	Undertake planning, organising and engineering maintenance tasks
Level:	3
Credit value:	13
GLH:	81
TQT:	125
Unit aim(s):	This unit allows learners to develop knowledge and skills in planning, organising and engineering maintenance tasks including prioritisation and time management techniques
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K5, S2, S3, S4, S5, S6, S16, S17

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand planning, prioritisation, organisation, and time management techniques in engineering maintenance tasks	1.1 Explain the principles of effective planning, prioritisation, organisation, and time management in a maintenance context
	1.2 Discuss common challenges faced in maintenance scheduling and how they can be mitigated
	1.3 Describe how to plan and prioritise maintenance tasks
	1.4 Describe techniques for organising resources during maintenance activities to ensure efficiency and minimise downtime
	1.5 Outline time management tools and strategies that can be used to optimise the completion of maintenance tasks
2. Be able to apply planning, prioritising, organising, and time management techniques to prepare and manage maintenance tasks	2.1 Identify the objectives and requirements of a maintenance task
	2.2 Plan and prioritise maintenance tasks required
	2.3 Organise resources to optimise task execution and minimise downtime
	2.4 Use appropriate time management tools and techniques to structure and monitor work progress.
	2.5 Adapt plans in response to unexpected issues or changing priorities
	2.6 Record and report the planned task sequence to relevant stakeholders in accordance with organisational procedures

3. Be able to identify and organise the resources required to complete maintenance tasks	3.1 Identify task requirements to determine and select the necessary resources required
	3.2 Review the availability, condition, and suitability of resources before starting the task.
	3.3 Organise resources to support efficient workflow and minimise downtime during task execution.
	3.4 Follow organisational procedures for using and returning resources
4. Be able to respond and adapt to work demands	4.1 Identify changes in the working environment that affect planned tasks
	4.2 Assess the impact of unplanned events on task priorities and maintenance schedules.
	4.3 Re-prioritise workloads based on operational urgency, safety, and resource availability.
	4.4 Adapt working methods to suit new or changing conditions
	4.5 Communicate changes in work priorities or approaches to relevant personnel.
	4.6 Demonstrate flexibility in managing time and resources
	4.7 Record and justify details of changes made to task plans or procedures
5. Be able to identify correct equipment for maintenance and verify plant configuration against defined specifications	5.1 Identify equipment to be worked on using relevant documentation
	5.2 Carry out physical checks of equipment
	5.3 Use and interpret plant configuration information from authorised sources
	5.4 5.4 Compare current plant or equipment configuration to defined specifications and documentation
	5.5 Report deviations or inconsistencies between actual configuration and documented information

	5.6 Follow organisational procedures when discrepancies in configuration are detected
6. Be able to prepare the work area to undertake maintenance tasks	6.1 Carry out risk assessments of the work area where maintenance tasks are due to commence
	6.2 Implement safety measures in accordance with site procedures
	6.3 Monitor the environmental controls to ensure that they are appropriate for the maintenance task
	6.4 Report issues with the work area that could affect the safety or success of the maintenance task
7. Be able to follow control procedures for maintenance tools and equipment	7.1 Select and use tools and equipment for specific maintenance tasks in accordance with operational and site guidelines
	7.2 Store tools and equipment in designated areas
	7.3 Follow procedures for cleaning, calibrating, and maintaining tools and equipment
	7.4 Record the use, maintenance, and condition of tools and equipment in accordance with organisational procedures
	7.5 Report damage, loss, or malfunctions of tools and equipment following correct reporting procedures
8. Be able to reinstate the work area after completing maintenance tasks	8.1 Carry out disposal of waste materials in accordance with environmental and safety guidelines
	8.2 Follow organisational procedures to organise and clean the work area appropriately
	8.3 Carry out a risk assessment of the work area to identify any remaining hazards or safety concerns, addressing them appropriately
	8.4 Follow organisational procedures to record the completion of the reinstatement of the work area

Range Statements:

Learning Outcome 1 and 2

They should know and apply planning, prioritisation, organisation and time management techniques associated with their maintenance activities such as:

- Type of maintenance required
- Priority
- Scheduling - Block, Shift based, downtime
- Work specifications
    - Work orders
    - Resources (Personnel, parts, consumables)
    - Documentation including planning systems
    - Tools and equipment
    - Lean maintenance techniques
    - Performance measurement

Key points

- Challenges in maintenance scheduling can be mitigated through effective planning; contingency planning and flexibility when unexpected issues arise during maintenance work.
- How to plan and prioritise maintenance tasks – setting clear goals, deadlines, and milestones in maintenance planning; prioritise based on factors such as urgency, impact on operations, and safety considerations.
- Time management tools - Gantt charts, task lists, time-blocking
- Review job schedules and maintenance logs
- Task Breakdown
- Identify required tools, parts, and safety equipment
- Check technical documentation and maintenance procedures.
- Coordinate with team members or supervisors to clarify task responsibilities.
- Use maintenance software or job cards to plan the sequence and timing of tasks.

Learning Outcome 3

Key points

- Resources - tools, equipment, consumables, and documentation.
- Select appropriate resources based on job specifications, operational procedures, and safety requirements.
- Ensure that consumables are used correctly, accounted for, and replenished as required.
- Follow organisational procedures for issuing, tracking, and returning resources.

- Report any shortages, defects, or resource-related issues to the appropriate personnel in a timely manner.

Learning outcome 4

Respond and adapt to the work demands in relation to their specific industry and job role. Examples of this may include:

- Adapting their working method due to the change in weather conditions, working conditions, for instance working at height or in a confined space, changes with the perceived level of risk within the environment.
- Changes in priority due to operational constraints, requirements or breakdowns.
- changes in work environment such as breakdowns, delays, or safety issues
- always maintain compliance with safety and quality standards.

Learning outcome 5

Identify correct equipment for maintenance and verify against defined specifications using:

- Engineering Drawings and Schematics
- Computerised Maintenance Management System (CMMS)
- Asset Tags and Identification Numbers
- Standard Operating Procedures (SOPs)
- Plant Configuration Management Systems
- Control Room or SCADA System Feedback
- Communication with Supervisors or Engineers
- Work Order Documentation
- Physical checks should include - Verify the identity through such as serial numbers, labels, or system tags.)

Learning outcome 6 and 8

Prepare work area maintenance and reinstate work area after completing maintenance tasks. Key points may include:

- Documentation
- Tools and Equipment including PPE
- Components
- Consumables
- Risk Assessments - Inspect the work area to ensure it is clean, safe, and free from obstructions or hazards. COSHH, PPE
- Access
- Isolations
- LOTO
- Safety measures - signage, barriers, and lockout/tagout if required. Position tools, equipment, and resources in a way that ensures efficient workflow and safe access.
- Environmental controls - ventilation, lighting, spill containment

- Disposal and storage of waste

Learning outcome 7

Selection of tools and equipment - in line with safety, proper use to prevent damage, ensure longevity, and maintain safety standards.

Storage of tools and equipment - ensuring they are organised, secure, and in good condition for future use

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1692
Ofqual Unit ref:	Y/651/8287
Unit Title:	Complying with business operations and quality systems within engineering maintenance
Level:	3
Credit value:	11
GLH:	67
TQT:	109
Unit aim(s):	This unit allows learners to develop knowledge and skills in business operations and quality systems including quality management and continuous improvement systems, standard operating systems required and Foreign Material Exclusion (FME) principles and practices.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K4, K6, K22, K23, K24, S15

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the key business operation considerations required for engineering maintenance	1.1 Describe the impact quality standards has on engineering maintenance
	1.2 Analyse the role of cost management in maintenance activities
	1.3 Discuss the importance of ethical practices in maintenance operations
	1.4 Explain the relationship between business operations and continuous improvement
2. Know and understand equipment life cycle considerations and their impact on maintenance planning and decision-making	2.1 Explain the stages of equipment life cycle
	2.2 Explain how life cycle considerations influence maintenance strategies and scheduling
	2.3 Describe the cost implications associated with different life cycle stages
	2.4 Explain how data on equipment performance and reliability informs life cycle decisions
	2.5 Discuss environmental and sustainability considerations throughout the equipment life cycle
	2.6 Recognise how life cycle planning supports business goals
3. Understand and apply quality management and continuous improvement systems used in engineering environments	3.1 Describe the key principles of quality management systems and their relevance to maintenance activities
	3.2 Explain the function and benefits of maintenance systems in engineering operations
	3.3 Explain continuous improvement principles used in engineering maintenance
	3.4 Describe the purpose of calibration and control of measuring equipment

	3.5 Explain how quality and maintenance systems interact to support continuous improvement and operational reliability
4. Know and understand Standard Operating Procedures (SOPs) in engineering maintenance	4.1 Describe Standard Operating Procedures (SOP) and their role in engineering and maintenance environments
	4.2 Summarise why Standard Operating Procedures (SOPs) should be followed
	4.3 Identify the potential risks and consequences of not adhering to Standard Operating Procedures (SOPs) in engineering operations
	4.4 Describe how Standard Operating Procedures (SOPs) contribute to compliance
	4.5 Recognise the importance of sourcing and using materials that comply with industry standards and specifications
5. Know and understand the principles and practices of Foreign Material Exclusion (FME) in maintenance operations	5.1 Explain Foreign Material Exclusion (FME) and its purpose in engineering and maintenance environments
	5.2 Describe common sources of foreign material and how they can affect equipment
	5.3 Identify where Foreign Material Exclusion (FME) is critical
	5.4 Explain methods used to prevent, detect, and control foreign material contamination during maintenance activities
	5.5 Describe the responsibilities of maintenance personnel in maintaining Foreign Material Exclusion (FME) standards and reporting incidents
6. Be able to apply foreign material exclusion (FME) procedures during maintenance activities	6.1 Select and use appropriate Foreign Material Exclusion (FME) tools and methods according to organisational procedures
	6.2 Apply Foreign Material Exclusion (FME) protocols during maintenance tasks

6.3 Record Foreign Material Exclusion (FME) related checks in accordance with site or task-specific requirements
6.4 Report any Foreign Material Exclusion (FME) breaches or risks

Range Statements:

Learning outcome 1
Learners should be aware of and understand the planning, management and delivery of their maintenance activities. Taking into consideration things such as:

Costs:
- Fixed (Rent, insurance, equipment depreciation, insurance)
- Variable (wages, fuel, consumables, tools, sub-contractors)
- there should be a balance between cost-effectiveness and quality

Service delivery:
- Quality
- Time of requirement
- Customer satisfaction
- Compliance (Safety and regulatory)
- Timely delivery of maintenance services contributes to operational efficiency and business success

Ethical:
- Pricing
- Environmental responsibility
- Welfare
- Legal and regulatory
- Commercial in confidence
- Fair treatment of employees and suppliers

Continuous improvement:
- customer feedback
- performance metrics
- strategic objectives
- Identify the impact of poor quality, high costs, missed deadlines, and unethical practices on business reputation and profitability.

Learning outcome 2

Stages of equipment lifecycle:
- Planning and acquisition
- Installation and commissioning
- Operation and maintenance
- Upgrades and modifications

- Decommissioning and disposal
- Review and evaluation

Key considerations:

- The role of maintenance in extending equipment life and maintaining performance over time.
- Planned preventive maintenance, condition monitoring
- cost implications of different lifecycle stages - capital expenditure and operational costs.
- Lifecycle decisions such as repair, replacement, or upgrade.
- Environment and sustainability considerations including energy use, materials, and end-of-life disposal.
- Lifecycle planning supports business goals such as efficiency, compliance, and return on investment.

Learning Outcome 3
Quality, maintenance and continuous improvement systems:

- ISO 9001:2015 – The international standard for Quality Management Systems
- Planned Preventive Maintenance (PPM) Systems (covered within types of maintenance)
- Total Productive Maintenance (TPM) (covered within types of maintenance)
- Lean, Kaizen and Six Sigma Principles - explain how they contribute to improved maintenance efficiency and reduced waste
- Health, Safety, Environment, and Quality (HSEQ) Systems
- Calibration and Control of Measuring Equipment - maintaining product quality and process accuracy

Learning outcome 4
Standard operating procedures (SOP) key points:

- Detailed written instructions, structured, task specific, consistent
- Necessary steps, safe, consistent and efficient
- Importance: Ensure safety, reduce risk, Consistency, Efficiency, Measure, Quality Control, Reporting, Accountability, Continuous Improvement, Lessons learned
- Standard operating procedures should be followed to ensure safety, quality, and consistency of maintenance tasks.
- They contribute to compliance with industry standards, regulations, and continuous improvement practices.

Learning outcome 5 and 6
Foreign Material Exclusion (FME) key points:

- Protocols to prevent introduction of foreign objects and debris: Maintain cleanliness and control of tools, parts, and materials in designated FME zones
- foreign material can affect equipment performance, safety, and reliability
- FME components, systems, or environments is critical in turbines, reactors, or clean rooms.
- FME zones control
- Material and tool controls
- Preparation and clearing up
- System checks and documentation

- Report any breaches or risks promptly and take appropriate corrective actions
- Precision, Safety, Quality

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Electrical Units

Unit Ref:	1693
Ofqual unit ref:	T/651/8295
Unit Title:	Principles and regulations of electrical engineering systems
Level:	3
Credit value:	12
GLH:	96
TQT:	119
Unit aim(s):	This unit allows learners to develop their knowledge and understanding of the regulations and principles relevant for electrical engineering maintenance technicians.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K33, K35, K36

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the regulations which are applicable to working with electrical systems	1.1 Summarise the regulations which apply to working with electrical equipment and systems
	1.2 Explain the importance of compliance and consequences of non-compliance with the regulations
	1.3 Describe how to comply with the regulations, noting organisational procedures/processes
	1.4 Explain practical application of the regulations
2. Know and understand the operating principles of electrical devices and equipment	2.1 Describe the operating principles of electrical devices and equipment
	2.2 Explain the selection of electrical devices and equipment
	2.3 Describe the potential consequences of incorrect selection of devices and equipment
	2.4 Explain monitoring and protection equipment including their uses
3. Know and understand electrical engineering principles, terminology and calculations	3.1 Explain electrical engineering principles and theories
	3.2 Describe the application of the principles and theories in a practical environment
	3.3 Explain the terminology within the context of a practical workplace environment
	3.4 Identify calculations, units used when working with electrical systems

Range Statements:

Learning outcome 1

Regulations applicable to working with electrical systems:

- Electricity and Work Regulations 1989 and BS 7671 Requirements of Electrical Installations (IET wiring regulations). Including:
  - knowing the ID numbers and the current versions
  - Should be able to explain what is included
- HSE GS38 Electrical test equipment for use on low voltage electrical systems (guidance document)
- Electrical Equipment (Safety) Regulations 2016 and applicable regulations for safe operation of equipment such as Provision and Use of Work Equipment Regulations (PUWER) 1998
- Waste Electrical and Electronic Equipment Regulations (WEEE) 2013
- Applicable regulations (to workplace) and Approved Codes of Practice's as listed on the Health Safety Executive (HSE) website, categories are:
  - Electrical and power
  - Electrical appliances
  - Electromagnetic compatibility
  - Flammable atmospheres
  - Machinery.

Learning outcome 2

They should have a good understanding of how various electrical equipment and electrical systems and devices work, including:

- Systems; Single phase, three phase
- Equipment; motors, generators, transformers
- Motor configurations STAR and DELTA
- Monitoring devices; voltmeters, ammeters, temperature sensors, vibration sensors, power quality analysers, energy monitoring equipment.
- Protection devices; fuses, circuit breakers, miniature circuit breakers (MCB's), overload relays, residual current devices (RCD's), surge protection devices

Learning outcome 3

Should have a good understanding of the following:

- Electrical properties of materials
- Circuit terminology including; circuit, node, branch, loop, mesh, voltage, current, resistance, capacitance, power, series, parallel, resistors, capacitors, power sources, conductors, insulators
- Other electrical terminology including; inductance, impedance, earth loop impedance, frequency, duty cycle, service factor, overload, wave form, power factor, real power, apparent power, electrical bonding, earth bonding, fault current, design current, electromagnetic compatibility (EMC), electromotive force (EMF)
- Wiring regulation terminology including; conductor CSA (cross sectional area), current carrying capacity, single core, multi-core, voltage drop
- Law & theories; Ohms Law, Watts Law, Kirchoff's Current Law, Kirchoff's Voltage Law, Faradays Law of Electromagnetic Induction, Lenz's Law, Transformer theory.
- AC and DC theory (Alternating and Direct Current)
- Power calculations in circuits; DC power calculations, AC power calculations and utilising Power Factor (PF).
- Power calculations of motors, generators
- Efficiency of electrical machines, electrical losses

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1695
Ofqual unit ref:	D/651/8298
Unit Title:	Working with technology, equipment and systems required for electrical engineering maintenance
Level:	3
Credit value:	16
GLH:	120
TQT:	160
Unit aim(s):	This unit allows learners to develop their knowledge and skills in technology, equipment and systems required to maintain electrical engineering systems.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K37, K38, K39, K40, S28, S33, S34

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the functions and applications of electrical circuits	1.1 Explain the functions and applications of electrical circuits
	1.2 Analyse the differences between each type of electrical circuits
	1.3 Describe the practical applications of each type of electrical circuit
2. Know and understand the types of diagrams used when working with electrical plant and systems.	2.1 Describe each type of diagram used when maintaining electrical systems
	2.2 Explain the various symbols and abbreviations used in electrical diagrams.
	2.3 Evaluate the advantages and disadvantages of each type of diagram
	2.4 Explain the selection of the most appropriate type of diagram for various practical applications
	2.5 Explain how different types of diagram can be used in conjunction with each other
	2.6 Describe how to locate the appropriate diagrams and to confirm that they are correct to use
	2.7 Explain how to make corrections, updates and improvements to drawings following organisational procedures
3. Know and understand the types of cables used in the installation and maintenance of electrical plant and systems	3.1 Explain the characteristics of each cable type
	3.2 Describe applications of each cable type
	3.3 Identify and describe cables within the wider industrial application
	3.4 Provide examples of the application of a variety of cables within the electrical application
	3.5 Explain the parameters for cable selection for application and source of information

4. Know and understand methods of cable termination when maintaining electrical plant and systems.	4.1 Describe types of connection for electrical cables.
	4.2 Explain the advantages and disadvantages of each type of connection.
	4.3 Provide examples of the application of a variety of cable termination types
5. Be able to select, check and use tools when maintaining electrical plant and systems	5.1 Select safety tools and Personal Protective Equipment (PPE)
	5.2 Perform checks prior to using safety tools and PPE
	5.3 Carry out maintenance whilst using safety tools and PPE.
	5.4 Confirm that tools are in the correct condition following their use
	5.5 Ensure that tools which are deemed to be damaged or not operating correctly are appropriately dealt with
6. Be able to prepare and conduct terminations on electrical cables.	6.1 Explain the safety considerations when preparing and terminating cables
	6.2 Select the most appropriate connections for the application
	6.3 Select the tools and equipment required
	6.4 Prepare cables for termination and complete the termination
	6.5 Review and record that the termination has been successful
7. Be able to set up and adjust electrical plant and systems	7.1 Select, interpret and use the appropriate technical information from different sources
	7.2 Select the appropriate equipment
	7.3 Install equipment, following the appropriate procedures
	7.4 Set up electrical plant, equipment and systems
	7.5 Test the plant, equipment and systems using appropriate procedures and equipment

8. Be able to use innovative engineering technology	8.1 Demonstrate using computer aided design (CAD) models and drawings
	8.2 Demonstrate using hardware to access data
	8.3 Carry out maintenance actives using existing and new technologies

Range Statements:

Learning outcome 1
Functions and applications of electrical circuits including but not limited to:

- Safety systems (fire alarm, security systems, emergency lighting)
- Power distribution
- Energy conversion
- Energy storage
- Signal transmission and processing
- Control
- Domestic applications
- Industrial applications
- Communications
- Transport systems (automotive, aerospace, railways)
- Energy/power generation (renewable and non-renewable)
- Medical equipment
- Consumer electronics

Learning outcome 2
Types of diagrams associated with electrical systems, their advantages and disadvantages and where to locate them using revision control, including:

- Schematic Diagrams
- Engineering Drawings
- P&ID
- Exploded Diagrams
- Circuit and Wiring Diagrams
- Logic Diagrams
- Orthographic Drawings.
- Printed Circuit Boards (PCB's)

Symbols associated with electrical schematic diagrams as specified in:

- IEC 60617
- BS EN 3939:2001 is related to filler metals for brazing.
- BS 8888 standard covers new engineering drawing standard for multiple industries, including electrical

Learning outcome 3
Different types of cable associated with their job role, as well as their specification and application. Learners should also be aware of other types of cable within their sector.
Types:

- Unscreened
- Screened, EMI requirements, shielded cables, foil, braided, combination
- Armoured, Steel Wire Armoured (SWA),
- Single core
- Multi core
- Twisted pair
- Twin and earth
- Co-axial
- Fiber-optic
- Power
- Low Voltage, Medium Voltage, High Voltage, Extra High Voltage
- Ethernet
- Fire Resistant
- Conductor types
- Portable tools and equipment
- Cable conductor size: Standard Wire Gauge (SWG) imperial units, Cross-sectional area (CSA) metric units
- Parameters for cable selection in accordance to BS 7671:2018 IET Wiring Regulations: current carrying capacity, conductor cross-sectional area, single phase/three phase/AC/DC, ambient temperature, operating temperature, voltage drop, interface reference method

Learning outcome 4
Types of cable connections and identify in which situation they would be used, including their advantages and disadvantages, including

- IET Wiring Regulations (BS7671)
- Conductance
- Insulation
- Mechanical strength
- Strain relief (cables and connections)
- Protection
- Ingress Protection (IP) rating
- Types:
- Crimping
- Soldering
- Screw on
- Terminals
- Clamp on
- Push in

- Plugs and Sockets;

Learning outcome 5
Select electrical maintenance tools and, test and measurement equipment, suitable for the task. Carryout checks to ensure the safety and functionality of the tools and equipment, including checking any regulatory checks and inspections as still current such as Portable Application Testing (PAT) and calibration. Use the tools and equipment in line with operation and care requirements. Tools and equipment may include but is not limited to:

- Hand tools
- Multimeters
- Oscilloscopes
- Megohmmeters (Megger)
- Clamp meters
- Earth resistance testers
- Circuit breaker testers
- Thermal imaging camera (Thermography equipment)
- Battery tester
- Leakage current tester

Learning Outcome 6
Select the most appropriate cable terminations for the practical application, taking into consideration:

- IET Wiring Regulations (BS7671)
- Conductance
- Insulation
- Mechanical strength
- Protection
- Ingress Protection (IP) rating
- Types (Crimping; Soldering; Screw on; Clamp on; Push in; Plugs and Sockets)

Learners should also be able to select and use the equipment required and confirm that the cables are terminated correctly.

Learning outcome 7
Set up and adjust electrical systems, devices and equipment to ensure the plant and equipment operates efficiently and safely over time. All adjustments are to comply with the relevant safety standards and regulations. These tasks may include:

- Installation of electrical equipment
- Wiring and cabling
- Commissioning electrical plant and systems
- Checking and adjusting protection devices
- Checking and adjusting control systems
- Adjusting Voltage settings

- Carrying out lubrication, cleaning and tightening of electrical components and equipment
- Tug tests of connections
- Adjusting Frequency drives
- Commissioning, functional testing
- Handover procedures

Learning outcome 8
Utilise engineering software to aid maintenance tasks on electrical equipment and systems, including:

- Manipulating 3D models to understand assembly and disassembly
- Interpret 2D engineering drawings for complex electrical circuits
- Interpret 2D and 3D layouts for printed circuit board (PCB's)
- Using tablets accessing engineering data
- Using 3D viewers accessing engineering data

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1696
Ofqual unit ref:	Y/651/8296
Unit Title:	Undertake maintenance, inspection, calibration and testing activities for electrical systems
Level:	3
Credit value:	16
GLH:	124
TQT:	164
Unit aim(s):	This unit allows learners to develop their knowledge and skills to maintain electrical systems through inspection, calibration and testing activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K41, K42, S31, S32, S35, S37

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to inspect, maintain, calibrate and test electrical plant, equipment and systems.	1.1 Explain various types of maintenance techniques and different levels of maintenance
	1.2 Explain the considerations when determining whether to replace or repair components and equipment
	1.3 Describe the processes and procedures when removing equipment from a system
	1.4 Explain the requirements when replacing equipment, including sources of information and practical consideration
	1.5 Describe reasons that equipment may need to be cleaned
	1.6 Explain how to set up and adjust various types of electrical equipment
	1.7 Describe the purpose of functional testing, test requirements and provide examples of how to carry it out
2. Know and understand how to select, use, care for and calibrate tools and equipment used in electrical maintenance	2.1 Explain the tools and equipment, providing examples of when they may be used
	2.2 Explain how to know if the tools and equipment are in good condition and suitable for use
	2.3 Explain how to care for the tools and equipment, including pre-use, post-use and storage
	2.4 Explain which tools and equipment may require calibration and why
	2.5 Explain quarantine requirements for tools and equipment out of calibration date

3. Be able to conduct inspections and carry out testing on electrical systems.	3.1 Consider the safety considerations whilst inspecting and testing
	3.2 Select equipment for inspecting and testing
	3.3 Demonstrate inspection and testing of electrical plant, equipment and systems
4. Be able to remove and replace electrical components within plant, equipment and systems.	4.1 Select the safety and operational considerations when removing and replacing electrical components
	4.2 Demonstrate the removal and replacement of electrical components
	4.3 Appropriately dispose of the replaced equipment
5. Be able to identify any requirements to clean electrical and be able to complete the task	5.1 Identify when cleaning of electrical parts and equipment is required.
	5.2 Implement the safety considerations when cleaning equipment, including using cleaning agents.
	5.3 Select tools and other items which may be required when cleaning equipment.
	5.4 Demonstrate the cleaning of various electrical components.
6. Be able to complete functional testing of electrical equipment and systems	6.1 Interpret functional test requirements
	6.2 Select the processes and procedures to follow when conducting a functional test
	6.3 Implement the safety and operational considerations when completing a functional test
	6.4 Implement the communication and documentation/records requirements when conducting a functional test, including handover
	6.5 Demonstrate examples of conducting functional testing

Range Statements:

Learning outcome 1
Learners should know:

- how to correctly conduct electrical maintenance of plant and equipment in line with task requirements and company procedures including inspecting and testing electrical aspects of plant, removing and replacing electrical parts, setting up and adjusting electrical aspects of plant, and cleaning parts.
- how to correctly carryout functional testing to confirm operation in line with task requirements.

Learning outcome 2
Learners should know how to select, use, care for and calibrate electrical maintenance tools and equipment. Tools and equipment may include but is not limited to:

- Hand tools
- Multimeters
- Oscilloscopes
- Megohmmeters (Megger)
- Voltage indicator
- Proving unit
- Clamp meters
- Continuity tester
- Earth resistance testers
- Circuit breaker testers
- Thermal imaging camera (thermography equipment)
- Battery tester
- Leakage current tester

Learning outcome 3
Carry out inspection and testing of electrical plant and equipment. These checks and tests may include but is not limited to:

- Sensory checks: visual, noise, smell, touch (vibrating unit, hot motor, burnt coils)
- Insulation resistance checks
- Resistance checks
- Continuity checks
- Balance checks
- Voltage tests
- Current tests
- Earth resistance testing
- Electrical bonding testing
- Functional tests
- Load tests

- RCD tests
- MCB tests
- Earth Loop impedance testing
- Thermographic surveys

Learning outcome 4
Remove and replace electrical components in accordance with their job role and sector. Common electrical equipment may include:

- Motors and drives
- Transformers
- Generators
- Switches
- Bus bars
- Contactors
- Relays
- Resistors
- Capacitors
- Connectors
- Cables and wiring
- Fuses & protection equipment
- Power sources
- Power supplies

Learning outcome 5
Clean electrical equipment as required within their job role and using the most appropriate method. This may include:

- Cleaning dust and debris from external surfaces
- Cleaning electrical contacts and connectors
- Cleaning parts in equipment (switches, contactors, etc.)
- Clean the electrical enclosure
- Cleaning connections and wires
- Cleaning circuit boards and components

Learning Outcome 6
Conduct functional testing of the system on completion of maintenance activities. Key points:

- Follow re-energising procedure
- Perform functional testing
- Confirm equipment and systems are operating as expected
- Monitor system to ensure operating correctly.
- Complete maintenance records
- Notify relevant personnel equipment is operational

- Handover process

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1697
Ofqual unit ref:	A/651/8297
Unit Title:	Undertake safe isolation and deisolation of electrical systems whilst conducting maintenance activities
Level:	3
Credit value:	11
GLH:	76
TQT:	111
Unit aim(s):	This unit allows learners to develop their knowledge and skills to safely isolation and deisolate electrical systems to undertake maintenance activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K34, S27, S36

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to isolate and deisolate when working with electrical systems	1.1 Identify types of isolation/deisolation required with working with electrical systems
	1.2 Explain the regulations associated with isolating/deisolating electrical systems
	1.3 Describe organisational processes and procedures to be followed when isolating and deisolating electrical systems
	1.4 Describe physical isolation procedures for electrical systems
	1.5 Describe physical deisolation procedures for electrical systems
	1.6 Describe organisational processes and procedures to be followed when deisolating and handing back electrical systems
	1.7 Identify relevant types of stored energy and source
2. Be able to confirm electrical isolation has been completed, including testing for dead	2.1 Identify that electrical systems have been isolated
	2.2 Select processes and procedures for ensuring safe isolation of equipment
	2.3 Select, check and use testing equipment to carry out isolation checks
	2.4 Demonstrate practical application of electrical isolation techniques
	2.5 Demonstrate dead testing of electrical systems
	2.6 Confirm isolations prior to starting work on electrical systems
	2.7 Demonstrate the process if isolation is not correct

3. Be able to complete deisolation of electrical and connected services and confirm deisolation has been completed	3.1 Identify all services which require deisolation
	3.2 Select equipment for deisolation
	3.3 Demonstrate the deisolation of various types of services
	3.4 Test that services have been correctly deisolated
	3.5 Follow organisational procedures to record the completion of report issues damaged or malfunctioned equipment which has been deisolated
4. Be able to reconnect the various equipment required when maintaining electrical systems	4.1 Identify the equipment to be reconnected
	4.2 Select equipment and tools to be used when reconnecting electrical systems
	4.3 Reconnect equipment, following appropriate procedures
	4.4 Confirm equipment has been successfully reconnected
	4.5 Demonstrate handover of equipment

Range Statements:

Learning Outcome 1

Learners should know and understand the requirements of safe isolation of the appropriate plant and equipment including testing for dead in line with the task requirements and the company procedures. Key points:

- Identify all sources of electrical energy
- Understand requirements to notify all personnel affected by the isolation process
- Understand that only authorised personnel involved in isolation/de-isolation process
- Understand how to isolate equipment from energy source
- Apply lockout devices (may be multiple)
- Apply tagout, attach warning tags to lockouts
- Identify test for dead equipment using appropriate

Learning outcome 2
Confirm the safe isolation of the appropriate plant and equipment has been applied and test for dead in line with the task requirements and the company procedures. Key points:

- Confirm safe isolation has been applied
- Test for dead using appropriate equipment (apply prove-test-prove with dead testing equipment)

Safety Note: Learners are not permitted to test for dead on their own as part of isolation activities and require qualified personnel to be present at all times

Learning outcome 3
Conduct and confirm electrical and connected services deisolation correctly in accordance with regulation and company procedures. Key points:

- Confirm that all safety checks and maintenance tasks have been completed successfully
- Verify equipment condition
- Ensure personnel safety
- Ensure that any locks and tags applied during isolation are removed
- Maintain clear communication between personnel involved in the de-isolation process
- Ensure system is ready to re-energise
- Re-energise system gradually
- Monitor system
- Functional testing
- Return to normal operations
- Complete maintenance records

Safety Note: Learners are not permitted to deisolate on their own and require qualified personnel to be present at all times

Learning outcome 4
Reconnect equipment, following company procedures, noting the checks required when reconnecting. Includes electrical systems but also cables, pipework, power supply.

Evidence Guidance:

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Workplace evidence should be used where possible however due to safety implications all skills Assessment Criteria containing "isolation"; "deisolation"; and "test" should **only** be delivered in a Realistic Work Environment.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1698
Ofqual unit ref:	R/651/8294
Unit Title:	Diagnose electrical system faults and implement problem solving techniques
Level:	3
Credit value:	11
GLH:	76
TQT:	107
Unit aim(s):	This unit allows learners to develop their knowledge and skills to be able to identify and diagnose faults and implement problem solving techniques for electrical equipment and systems.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K43, K44, K45, S29, S30

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the common failure modes for electrical equipment and control systems	1.1 Describe the common failure modes for electrical equipment and systems
	1.2 Explain practical examples of common failure modes for electrical equipment and systems
2. Know and understand the fault finding and rectification techniques and use of diagnostic equipment when maintaining electrical systems	2.1 Explain fault finding techniques appropriate for electrical equipment and electrical systems
	2.2 Describe the safety considerations when fault finding within electrical equipment and electrical systems
	2.3 Explain the operation of diagnostic equipment which can be used when maintaining electrical equipment and electrical systems
	2.4 Explain the rectification techniques when fault finding has occurred within electrical equipment and electrical systems
	2.5 Explain the safety considerations when rectifying faults
3. Know and understand problem solving and critical reasoning techniques when maintaining electrical systems	3.1 Explain problem solving techniques that would be used within electrical equipment and electrical systems
	3.2 Explain situations where problem solving techniques would be used
4. Be able to apply fault finding and rectification techniques, including the use of diagnostic equipment when maintaining electrical systems	4.1 Determine the safety considerations when fault finding and rectifying faults
	4.2 Select fault finding techniques
	4.3 Determine faults in electrical equipment and electrical systems using the appropriate techniques.
	4.4 Select diagnostic equipment to be used when fault finding.

	4.5 Carry out fault finding using the appropriate diagnostic equipment.
	4.6 Rectify faults in electrical equipment and electrical systems.
	4.7 Confirm the fault is rectified and the system is operating as required.
5. Be able to apply problem solving and critical reasoning techniques when maintaining electrical systems	5.1 Demonstrate the identification of faults or discrepancies when maintaining electrical equipment and electrical systems.
	5.2 Demonstrate the use of data, drawings and other appropriate information.
	5.3 Maintain the electrical equipment and electrical system using the plan generated.
	5.4 Develop and implement solutions for when maintaining electrical equipment and electrical systems does not go to plan.
	5.5 Demonstrate review of the process when completed and implementation of any learning.

Range Statements:

Learning outcome 1
Different types of plant and equipment associated with their job role may include but are not limited to: electrical outlets and switches; switchgear; isolators; electrical panels and distribution boards; transformers; motors; generators, control systems (PLC and SCADA); boilers and heaters; fuses, circuit breakers, surge protection devices (SPD); cables and wiring, miniature circuit breakers (MCB), overload relays, residual current devices (RCD)

System failure modes may include:

- Wiring and connection failures (open circuit; short circuit; earth faults; loose or corroded connections/conductors)
- System failures with design current, fault current
- Insulation failures
- Electrical component failures (circuit breaker failures; motor failures; generator failures, capacitor failures; battery failures)
- Power supply failures (blackout; brownout; overvoltage; undervoltage)

Learning outcome 2 and 4
Learners should know and apply the different fault finding and diagnostic methods available within their sector, including diagnostic equipment. These may include:

- 6-point method (utilise a systematic approach to fault finding with executing multiple steps in sequence)
- Electrical test equipment for checking: (voltage; continuity; resistance; insulation resistance; current; unbalance, overload characteristics, thermal imaging cameras, heat guns; motor testing; generator testing, protection devices disconnection times, earth loop impedance testing)
- Half split method (apply to circuits to locate origin of fault)
- Unit substitution (replace components, sub-assembly modules for process of elimination)
- Input/output (consider inputs and outputs into a system to focus on problem area)
- Manuals and circuit diagrams
- Sensory checks: visual, noise, smell, touch (vibrating unit, hot motor, burnt coils)
- Diagnostic equipment, vibration analysers, accelerometers, thermocouples, proximity sensors, tachometers

Learning outcome 3
Learners should understand the principles of problem solving and critical reasoning to restore system functionality and identify the root cause of electrical issues. These may include:

- Logical thinking (cause and affect diagrams)
- Pattern recognition
- Root Cause Analysis (RCA)
- Elimination
- PDCA Cycle (plan; do; check; act)
- DMAIC (define; measure; analyse; improve; control)

Learning outcome 5
Learners should be able to apply problem solving techniques and critical reasoning:

- **Six-point technique:** (1) collect evidence; (2) analyse evidence; (3) locate fault; (4) determine cause; (5) rectify fault; (6) verify solution
- **Analyse and evaluate:** Assess the information, identify assumptions, and consider different viewpoints
- **Develop solutions:** Generate potential solutions and evaluate their feasibility and effectiveness.
- **Implement and evaluate:** Put the chosen solution into action and assess its results.
- **Reflect and adjust:** Analyse the outcome, identify areas for improvement, and make necessary adjustments.

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Instrumentation and Control Units

Unit Ref:	1699
Ofqual unit ref:	M/651/8300
Unit Title:	Principles and regulations of instrumentation and control engineering maintenance
Level:	3
Credit value:	12
GLH:	93
TQT:	117
Unit aim(s):	This unit allows learners to develop their knowledge and understanding in regulations, operating principles and calculations required instrumentation and control engineering maintenance.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K46, K49, K51

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the regulations which are applicable to working with instrumentation and control equipment and systems	1.1 Explain the regulations which apply to working with instrumentation and control equipment and systems
	1.2 Discuss the importance of compliance and consequences of non-compliance with the regulations
	1.3 Describe how to comply with the regulations, noting organisational procedures/processes
	1.4 Explain practical application of the regulations
2. Know and understand instrumentation and control engineering principles, terminology and calculations	2.1 Explain the instrumentation and control principles and theories
	2.2 Describe the application of the principles and theories in a practical environment
	2.3 Explain the terminology within the context of a practical workplace environment
	2.4 Identify calculations and units used when working with instrumentation and control systems
3. Know and understand the operating principles of instrumentation and control devices and equipment	3.1 Describe the operating principles of instrumentation and control devices and equipment
	3.2 Explain the selection of devices and equipment based on the parameters and requirements of the process variables
	3.3 Describe the potential consequences of incorrect selection of devices and equipment

Range Statements:

Learning Outcome 1
Regulations and standards:

- Electricity and Work Regulations 1989 and
- BS 7671:2018 IET wiring regulations.
- GS38 guidance document - Electrical test equipment for use on low voltage electrical systems
- BS EN 61508 - Functional safety of programmable safety-related systems
- BS EN 61010 - Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements
- BS EN 61131 – A series of British Standards for programmable controllers (PLCs)
- BS EN 61511 - Functional safety - Safety instrumented systems for the process industry sector

Learning Outcome 2
Principles: Measurement and monitoring; control systems; signal transmission; actuation; automation; safety systems:
Terminology: Process variables; set point; error; controller output; dead time; proportional integral derivative (PID) control; range and span; calibration:
Calculations: Ohm's Law, Watt's Law, Pascal's Law, Pressure, unit conversion; Bernoulli's Theory; Faraday's Law; converting between units (i.e. lb. to kg), Power factor, System Efficiency

Learning Outcome 3
A good understanding of how instruments work, including:

- Bourdon Tubes; Diaphragm Pressure Gauges; Piezoelectric pressure gauges; Manometers; Hydrostatic Pressure
- Thermocouples; Resistance Temperature Detectors (RTD); Bimetallic Thermometers; Thermostats, Infrared Thermometers; Thermistor, Mercury Thermometers
- pH analysers; gas analysers; conductivity meters; Oxygen analysers:
- Buoyancy; Capacitance; Doppler Effect;
- Transducers; Transmitters; Pneumatic Actuators; Hydraulic Actuators, Hydraulic Instrumentation, Pneumatic Instrumentation:
- Analogue and Digital devices and converters, Flow meters, types

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1700
Ofqual unit ref:	R/651/8301
Unit Title:	Undertake maintenance, inspection, calibration and testing activities for instrumentation and control systems
Level: 3	3
Credit value:	18
GLH:	132
TQT:	177
Unit aim(s):	This unit allows learners to develop their knowledge and skills to undertake maintenance activities for instrumentation and control systems including inspection, calibration and testing activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K55, K56, S43, S44, S47, S48, S51

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to inspect, maintain, calibrate and test instrumentation and control equipment	1.1 Explain various types of maintenance techniques and different levels of maintenance
	1.2 Explain the considerations when determining whether to replace or repair components and equipment
	1.3 Describe the processes and procedures when removing equipment from a system
	1.4 Explain the requirements when replacing equipment, including sources of information and practical consideration
	1.5 Describe reasons that equipment may need to be cleaned
	1.6 Explain calibration techniques for various instrument type
	1.7 Explain how to set up various types of instrumentation
	1.8 Describe the purpose of functional testing, test requirements and provide examples of how to carry it out
2. Know and understand how to select, use, care for and calibrate tools and equipment used in instrumentation and control maintenance	2.1 Explain the tools and equipment, providing examples of when they may be used
	2.2 Explain how to know if the tools and equipment are in good condition and suitable for use
	2.3 Explain how to care for the tools and equipment, including pre-use, post-use and storage
	2.4 Explain which tools and equipment may require calibration and why
	2.5 Explain quarantine requirements for tools and equipment out of calibration date

3. Be able to conduct inspections and carry out testing on instrumentation and control systems	3.1 Consider the safety considerations whilst inspecting and testing
	3.2 Select equipment for inspecting and testing
	3.3 Demonstrate inspection and testing of instrumentation and control systems
4. Be able to check the calibration of instruments and systems and make adjustments where required	4.1 Identify whether equipment calibration is 'in date'.
	4.2 Select processes and procedures when calibrating equipment.
	4.3 Calibrate different types of instrumentation and systems.
	4.4 Adjust instrumentation and systems to ensure that they are calibrated correctly.
	4.5 Identify and account for errors which occur when calibrating instrumentation.
	4.6 Demonstrate the use of documentation/records when calibrating equipment, including handover
5. Be able to identify any requirements to clean instrumentation and equipment and be able to complete the task	5.1 Identify when cleaning of instrumentation and control equipment is required.
	5.2 Implement the safety considerations when cleaning equipment, including using cleaning agents
	5.3 Select tools and other items which may be required when cleaning equipment
	5.4 Demonstrate the cleaning of instruments, components, connectors and pipelines utilised in instrumentation and control systems
6. Be able to remove and replace instrumentation and sensors within instrumentation and control systems	6.1 Select the safety and operational considerations when removing and replacing instrumentation and sensors
	6.2 Demonstrate the removal and replacement of instrumentation and sensors

	6.3 Appropriately dispose of the replaced equipment.
7. Be able to complete functional testing of instrumentation and control equipment and systems	7.1 Interpret functional test requirements
	7.2 Select the processes and procedures to follow when conducting a functional test
	7.3 Implement the safety and operational considerations when completing a functional test
	7.4 Implement the communication and documentation/records requirements when conducting a functional test, including handover
	7.5 Demonstrate examples of conducting functional testing

Range Statements:

Learning Outcome 1

Learners should know how to carry out maintenance activities and requirements such as:

- Removing and replacing instruments and sensors
- Installation of I&C equipment and control systems
- Inspecting I&C equipment and control systems
- Testing I&C equipment and control systems
- Cleaning I&C equipment and control systems
- Setting up I&C equipment and control systems
- Calibration of I&C equipment and control systems
- Functional testing of I&C equipment and control systems.

Learning Outcome 2

Learners should know how to select instrumentation and control maintenance tools and equipment suitable for the task, check to ensure functionality and uses them in line with operation, care and calibration requirements. Tools and equipment may include:

- Hand tools
- Measurement and diagnostic equipment and devices
- Signal Generators and Simulators
- Calibration and Test Equipment including software

Learning Outcome 3

Learners should be able to carry out inspection and testing of I&C plant and equipment. These checks and tests may include but is not limited to:

- Sensory inspection: visual, noise, smell, touch
- Functional Testing
- Calibration
- Loop Checking and Verification

- Electrical Safety Testing
- Functional and Performance Testing of Control Systems
- Communication and Data Integrity Testing
- Vibration and Mechanical Testing
- Functional Safety Testing
- Environmental Testing

Learning outcome 4
Learners should know various calibration techniques, tools and equipment and their application, including:

- Comparison Calibration
- Zero-Point Calibration
- Span Calibration
- Linearity Calibration
- Point-to-Point Calibration
- Five-Point Calibration
- Rise and Fall Calibration

Equipment:

- Hand tools
- Measurement devices and diagnostic equipment
- Signal generators and simulators
- Calibration and test equipment including software

Learning outcome 5
Learners should be able to clean parts of the instrumentation and control system as required within their job role and using the most appropriate method. This may include:

- Cleaning Dust and Debris from External Surfaces
- Cleaning Electrical Contacts and Connectors
- Cleaning Parts in Instrumentation (For example, components such as Sensors, Transmitters.)
- Clean the Instrumentation Enclosure
- Cleaning Pipelines and Flow Paths
- Cleaning connections and wires

Learning outcome 6
Learners should be able to remove and replace instruments and sensors in accordance with their job role and sector. Key points may include:

Sensors and Transducers:

- Temperature sensors
- Pressure sensors
- Vibration sensors
- Flow meters

- Level sensors
- Position and motion sensors

Controllers and Process Control Systems:
- Programmable Logic Controllers (PLCs)
- Distributed Control Systems (DCS)
- Supervisory Control and Data Acquisition (SCADA)
- Human-Machine Interfaces (HMI)

Actuators and Final Control Elements:
- Valves and Actuators
- Motors and Drives
- Relays and Contactors

Communication and Networking Equipment:
- Industrial Protocols
- Wireless and IoT (Internet of Things) sensors

Learning outcome 7
Learners should be able to conduct functional testing of the system on completion of maintenance activities. Key points:
- Follow re-energising procedure
- Perform functional testing
- Confirm equipment and systems are operating as expected
- Monitor system to ensure operating correctly.
- Complete maintenance records
- Notify relevant personnel equipment is operational during handover

Evidence Guidance:

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For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1701
Ofqual unit ref:	T/651/8302
Unit Title:	Undertake safe isolation and deisolation of instrumentation and control systems whilst conducting maintenance activities
Level:	3
Credit value:	13
GLH:	87
TQT:	129
Unit aim(s):	This unit allows learners to develop their knowledge and skills to safely isolate and deisolate instrumentation and control systems during maintenance activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K47, K48, S38, S39, S49, S50

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to isolate and deisolate when working with instrumentation and control systems	1.1 Identify types of isolation/deisolation required with working with instrumentation and control systems
	1.2 Explain the regulations associated with isolating/deisolating instrumentation and control systems
	1.3 Describe organisational processes and procedures to be followed when isolating and deisolating instrumentation and control systems, including sources of information
	1.4 Describe physical isolation procedures such as Lockout Tagout (LOTO) for various instrument and system types, including testing/checks
	1.5 Describe physical deisolation procedures for various instrument and system types, including testing/checks
	1.6 Describe organisational processes and procedures to be followed when deisolating and handing back instrumentation and control systems
	1.7 Identify relevant types of stored energy and source
2. Be able to ensure that instrumentation and control systems have been safely isolated	2.1 Identify that the correct instrumentation and control systems have been isolated
	2.2 Select processes and procedures for ensuring safe isolation of equipment
	2.3 Select, check and use testing equipment to carry out isolation checks
	2.4 Confirm isolations prior to starting work on an system/instrument
	2.5 Demonstrate the process if isolation is not correct
	2.6 Conduct and confirm isolations

3. Be able to confirm electrical isolation has been completed, including testing for dead	3.1 Identify electrical isolation processes and procedures
	3.2 Select and check testing equipment to carry out electrical isolation checks
	3.3 Test systems for dead
	3.4 Demonstrate practical application of electrical isolation techniques (including lockout tagout) within the workplace
4. Be able to reconnect the various equipment required when maintaining instrumentation and control systems	4.1 Identify the equipment to be reconnected.
	4.2 Select equipment and tools to be used when reconnecting I&C systems
	4.3 Reconnect equipment, following appropriate procedures
	4.4 Confirm equipment has been successfully reconnected.
	4.5 Demonstrate handover of equipment.
5. Be able to complete deisolation of electrical and connected services and confirm deisolation has been completed	5.1 Identify all services which require deisolation
	5.2 Select equipment for deisolation.
	5.3 Demonstrate the deisolation of various types of I&C services.
	5.4 Test that services have been correctly deisolated.
	5.5 Hand back equipment which has been deisolated

Range Statements:

Learning Outcome 1

Learners should know how to confirm the safe isolation of the appropriate plant and equipment has been applied and test for dead in line with the task requirements and the company procedures. Key points:

- Identify all sources of electrical energy
- Notify all personnel affected by the isolation process
- Only authorised personnel involved in isolation/de-isolation process

- Isolate equipment from energy source
- Apply lockout devices (may be multiple)
- Tagout, attach warning tags to lockouts
- Test for dead using appropriate equipment

Learning Outcome 2
Learners should be able to conduct and confirm the safe isolation of the appropriate plant and equipment has been applied and test for dead in line with the task requirements and the company procedures. Key points:

- Identify all sources of potential energy including electrical power source and other types of stored energy (chemical (batteries), hydraulic/pneumatic (pressurised systems), mechanical (pre-loaded compression spring systems), thermal (gas, steam systems), stored electrical (capacitors))
- Notify all personnel affected by the isolation process
- Only authorised personnel involved in isolation/de-isolation process
- Isolate equipment from energy source
- Apply lockout devices (may be multiple)
- Tagout, attach warning tags to lockouts

Learning outcome 3
Learners should be able to confirm the safe isolation of the appropriate plant and equipment has been applied and test for dead in line with the task requirements and the company procedures. Key points:

- Confirm safe isolation has been applied
- Test for dead using appropriate equipment

Safety Note:
Do not carry out the isolation/deisolation activities on your own as a learner. Always use qualified personnel for the type of isolation such as suitably qualified personnel for electrical, mechanical, gas.

Learning outcome 4
Learners should be able to reconnect equipment, following company procedures, noting the checks required when reconnecting. Includes instrumentation but also cables, pipework, power supply.

Learning outcome 5
Learners should be able to conduct and confirm electrical and connected services deisolation correctly in accordance with regulation and company procedures. Key points:

- Confirm that all safety checks and maintenance tasks have been completed successfully
- Verify Equipment Condition
- Ensure personnel safety

- Ensure that any locks and tags applied during isolation are removed
- Maintain clear communication between personnel involved in the de-isolation process
- Ensure system is ready to re-energise
- Re-energise system gradually
- Monitor system
- Functional testing
- Return to normal operations
- Complete maintenance records

Evidence Guidance:

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Workplace evidence should be used where possible however due to safety implications all skills Assessment Criteria containing "isolation"; "deisolation"; and "test" should **only** be delivered in a Realistic Work Environment.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1702
Ofqual unit ref:	Y/651/8303
Unit Title:	Working with technology, equipment and systems required for instrumentation and control engineering maintenance
Level:	3
Credit value:	16
GLH:	120
TQT:	160
Unit aim(s):	This unit allows learners to develop their knowledge and skills in technology, equipment and systems required for instrumentation and control maintenance.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K50, K52, K53, K54, K60, S40, S45, S46

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand installation of instrumentation and controls equipment.	1.1 Explain the safety and operational considerations when installing instrumentation and control equipment
	1.2 Explain all considerations when selecting the most suitable cable, wiring to use
	1.3 Describe types of connectors, their advantages and disadvantages and provide examples of their use
	1.4 Explain types of conduit or casing available to use and how to select the most suitable for the application
	1.5 Describe how to identify the most appropriate locations for instrumentation and equipment
	1.6 Explain the importance of labelling cables and equipment, including identification of any applicable regulations
2. Know and understand the principles of operation of open and closed loop systems	2.1 Explain the operation of the types of control loop systems
	2.2 Describe the advantages and disadvantages of each type of control loop system
	2.3 Describe the practical applications of each type of control loop system
3. Know and understand the functions and applications of instrumentation and control systems	3.1 Explain the functions and applications of instrumentation and control systems
	3.2 Analyse the differences between each type of instrumentation and control systems
	3.3 Describe the practical applications of each type of instrumentation and control systems

4. Know and understand the types of diagrams used when working with instrumentation and control systems	4.1 Describe each type of diagram associated with the maintenance of I&C systems
	4.2 Evaluate the advantages and disadvantages of each type of diagram
	4.3 Explain the selection of the most appropriate type of diagram for various practical applications
	4.4 Explain how different types of diagram can be used in conjunction with each other
	4.5 Describe how to locate the appropriate diagrams and to confirm that they are correct to use (revision control)
	4.6 Explain how to make corrections/updates/improvements to drawings following organisational procedures
5. Know and understand the types of cables used in the installation and maintenance of instrumentation and control systems instrumentation and control systems	5.1 Explain the characteristics of each cable type
	5.2 Describe applications of each cable type
	5.3 Identify and describe cables within the wider industrial application
	5.4 Provide examples of the application of a variety of cables within the instrumentation and control application
	5.5 Explain the parameters for cable selection for application and source of information
6. Be able to select, check and use tools when maintaining instrumentation and control systems	6.1 Select safety tools and Personal Protective Equipment (PPE) for different equipment types
	6.2 Perform checks prior to using safety tools and PPE.
	6.3 Carry out maintenance whilst using safety tools and PPE.
	6.4 Confirm that tools are in the correct condition following their use.

	6.5 Ensure that tools which are deemed to be damaged or not operating correctly are appropriately dealt with.
7. Be able to check instrumentation and control loops	7.1 Ensure that the correct I&C loop is selected for maintenance
	7.2 Select and apply the appropriate technical information to determine checks and paraments.
	7.3 Select the equipment required.
	7.4 Check instrumentation and control loops.
	7.5 Report findings following organisational procedures.
8. Be able to set up and adjust instrumentation and control systems	8.1 Select, interpret and use the appropriate technical information from different sources.
	8.2 Select the appropriate equipment
	8.3 Set up parameters, set points etc.
	8.4 Install equipment, following the appropriate procedures.
	8.5 Calibrate I&C systems, including equipment used and how results are recorded and reported.
	8.6 Test the system using appropriate procedures and equipment.

Range Statements:

Learning Outcome 1

- Select cables/wiring, identifying appropriate the regulations and guidance. Selection is based on capacity, physical attributes, operating conditions and environment.
- Types of connection, their advantages and disadvantages, where they should be used. Includes: screw terminals; push n connectors; 7 pin socket; soldered connections, crimped connections
- Location of components such as: sensors, actuators and panels.
- Knowing where to measure the process variable, not to damage the equipment and where is suitable from a practical operational perspective

Learning Outcome 2
Understand and explain the principles of and provide examples of practical application:

- Open Loop Systems
- Closed Loop Systems
- First Order Systems
- Second Order Systems
- Proportional Integral Derivative (PID) Controller

Learning Outcome 3
Principles of operation of

- Programmable Logic Controllers (PLC)
- Direct Digital Control (DDC)
- Distributed Control Systems (DCS)
- Supervisory Control and Data Acquisition (SCADA)

Learning outcome 4
Types of diagram associated with I&C systems, their advantages and disadvantages and where to locate them. Including;

- Wiring diagrams
- Block diagrams
- Layout diagrams
- Single line diagrams
- One line diagrams
- Earthing diagrams
- Schematic Diagrams
- Engineering Drawings
- Piping and Instrumentation Diagram (P&ID)
- Pictorial diagrams
- Exploded Diagrams
- Circuit Diagrams
- Logic Diagrams
- Orthographic Drawings.
- Isometric drawings
- General assembly drawings
- Component drawings

Learning outcome 5
Different types of cable associated with their function, as well as their specification and application.

They should also be aware of other types of cable within their sector. Key points may include:

- **Types:** Unscreened; Screened; Armoured; Single core; Multi core; Twisted pair; Co-axial; Fiber-optic; Thermocouple cable (Type k and type J)
- Parameters for cable selection in accordance to BS 7671:2018 IET Wiring
- **Regulations:** current carrying capacity, conductor cross-sectional area, single phase/three phase/AC/DC., ambient temperature, operating temperature, voltage drop, interface reference method

Learning outcome 6
Tools and equipment may include:

- Hand tools
- Measurement and diagnostic equipment
- Signal Generators and Simulators
- Calibration and Test Equipment including software
- Control Systems Maintenance Tools including Programmable Logic Controller (PLC)programming, loop controllers and indicators and Supervisory Control and Date Acquisition (SCADA) interface tools
- Actuator and Valve Maintenance Tools
- Personal Protective Equipment (PPE) and Safety Tools

Learning outcome 7
Carry out Loop checking to ensure that all signals and control loops in a system function properly and that sensors, transmitters, controllers, and actuators work together within a system to control processes accurately. These checks may include but is not limited to:

- Verifying signal transmission between sensors and the control system
- Confirming that the control loop operates within specified limits
- Checking the actuator's response to control signals

Learning outcome 8
They should be able to set up and adjust instrumentation and control systems. Key points:

- Install and Mount Equipment
- Configure and Set Parameters in Control System
- Commissioning of Control Loops
- Calibration
- Test System
- Fine-tuning and Adjustments
- Documentation and Handover

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1703
Ofqual unit ref:	F/651/8299
Unit Title:	Diagnose instrumentation and control system faults and implement problem solving techniques
Level:	3
Credit value:	10
GLH:	73
TQT:	104
Unit aim(s):	This unit allows learners to develop their knowledge and skills to be able to identify and diagnose faults and implement problem solving techniques for instrumentation and control equipment and systems.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K57, K58, K59, S41, S42

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the common failure modes for instrumentation and control equipment and control systems	1.1 Describe the common failure modes for instrumentation and control equipment and systems
	1.2 Explain practical examples of common failure modes for instrumentation and control equipment and systems
2. Know and understand the fault finding and rectification techniques and use of diagnostic equipment when maintaining instrumentation and control systems	2.1 Explain fault finding techniques appropriate for instrumentation and control equipment and systems
	2.2 Describe the safety considerations when fault finding within instrumentation and control systems
	2.3 Explain the operation of diagnostic devices and equipment which can be used when maintaining instrumentation and control systems
	2.4 Explain the rectification techniques when fault finding has occurred within instrumentation and control systems
	2.5 Explain the safety considerations when rectifying faults
3. Know and understand problem solving and critical reasoning techniques when maintaining instrumentation and control systems	3.1 Explain problem solving techniques that would be used within instrumentation and control systems
	3.2 Explain situations where each problem solving technique would be used
4. Be able to apply fault finding and rectification techniques, including the use of diagnostic equipment when maintaining instrumentation and control systems	4.1 Determine the safety considerations when fault finding and rectifying faults.
	4.2 Select fault finding techniques
	4.3 Determine faults in I&C systems using the appropriate techniques.
	4.4 Select diagnostic equipment to be used when fault finding.
	4.5 Carry out fault finding using the appropriate diagnostic equipment.

	4.6 Rectify faults in I&C systems.
	4.7 Confirm the fault is rectified and the system is operating as required.
5. Be able to apply problem solving and critical reasoning techniques when maintaining instrumentation and control systems	5.1 Demonstrate the identification of faults or discrepancies when maintaining I&C systems.
	5.2 Demonstrate the use of data, drawings and other appropriate information.
	5.3 Maintain the I&C system using the plan generated.
	5.4 Develop and implement solutions for when maintaining I&C systems does not go to plan.
	5.5 Demonstrate review of the process when completed and implementation of any learning.

Range Statements:

Learning outcome 1
Common I&C equipment:

- Sensors and transducers: temperature sensors; pressure sensors; flow meters; level sensors; vibration, position and motion sensors
- Controllers and process control systems: programmable logic controllers (PLCs); distributed control systems (DCS); supervisory control and data acquisition (SCADA); human-machine interfaces (HMI)
- Actuators and final control elements: valves and actuators; motors and drives; - relays and contactors
- Communication and networking equipment: industrial protocols; wireless and IoT (Internet of Things) sensors
- Failure modes:
  - Non-steady state systems
  - Sensor and transducer failure modes: drift; open circuit; short circuit; environmental damage
  - Signal transmission failure modes: signal loss; noisy signal; latency issues; electromagnetic compatibility (EMC) interference
  - Controller failure modes: Central Processing Unit (CPU) lockup or crashes; incorrect logic execution; communication errors; power supply failure
  - actuator and final control element failure modes: stuck actuators; overheating; slow response; failure to open/close

- Power supply and electrical failure modes: power surge/spikes; voltage drops; voltage tolerance backup battery failure
- Calibration and drift failure modes: loss of sensitivity; offset errors; span errors
- Environmental and mechanical failure modes: temperature extremes, vibration and shock; corrosion and moisture
- Fluids: cavitation, turbulent behaviour, pressure losses

Learning Outcome 2 and 4
Maintenance:

- Routine maintenance: calibration; cleaning; check for physical damage; lubrication
- Predictive maintenance: vibration monitoring of pumps and motors and generators; pressure and temperature monitoring for leaks or blockages; signal trending for performance degradation, temperature sensors of bearing housings, strain gauges of structures and other telemetry systems for measuring operating parameters of dynamic and static electrical and mechanical equipment
- Condition based maintenance. Techniques for monitoring performance of equipment during normal operation detecting step changes, behaviour, trends

Fault Finding and Diagnostic Techniques:

- Symptom Identification
- Data Gathering
- Use of Test Equipment such as: Multimeters; Voltage indicators, Proving units, Oscilloscopes; Clamp meters, Mega (Insulation Resistance Testers), Loop testers
- HART communicators
- Isolation and deisolation
- Visual Inspection, sensory checks
- Signal Testing
- Power Supply Checks
- Connections Checks
- Software/Configuration Checks
- Techniques such as half split, use of senses, unit substitution, 6 step, input and output

Rectification Techniques:

- Recalibration
- system reset
- devise reset
- component replacement
- lubrication and tightening
- wire repair/replacement
- power supply
- Replacement
- sensor replacement

- system update or reinstall
- Reprogramming
- check communication protocols

Learning Outcome 3
Learners should understand the principles of problem solving and critical reasoning to restore system functionality and identify the root cause of I&C issues. These may include:

- Logical thinking (Cause and affect)
- Pattern recognition
- Root Cause Analysis (RCA)
- Elimination
- PDCA Cycle: Plan; Do; Check; Act
- DMAIC: Define; Measure; Analyse; Improve; Control

Learning outcome 5
Learners should be able to identify and demonstrate various types of fault-finding techniques such as: half split, use of senses, unit substitution, 6 point technique: (1) collect evidence; (2) analyse evidence; (3) locate fault; (4) determine cause; (5) rectify fault; (6) verify solution).

Provide examples of where they have been used in a practical environment.

- Identify the problem: Clearly define the issue and its scope.
- Gather information: Collect relevant data, opinions, and perspectives.
- Analyse and evaluate: Assess the information, identify assumptions, and consider different viewpoints.
- Develop solutions: Generate potential solutions and evaluate their feasibility and effectiveness.
- Implement and evaluate: Put the chosen solution into action and assess its results.
- Reflect and adjust: Analyse the outcome, identify areas for improvement, and make necessary adjustments.

Evidence Guidance:

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It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Mechanical Units

Unit Ref:	1704
Ofqual unit ref:	D/651/8305
Unit Title:	Principles of mechanical engineering systems
Level:	3
Credit value:	9
GLH:	67
TQT:	90
Unit aim(s):	This unit allows learners to develop their knowledge and understanding of mechanical engineering principles and theories required for maintenance activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K62, K64

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand mechanical engineering principles, theory, terminology and calculations	1.1 Explain mechanical engineering principles and theories
	1.2 Describe the application of mechanical engineering principles and theories in a practical environment
	1.3 Explain mechanical engineering terminology within the context of a practical workplace environment
	1.4 Identify calculations, units used when working with mechanical systems
2. Know and understand pneumatic and hydraulic system principles and theory	2.1 Explain pneumatic and hydraulic system principles and theories required for mechanical engineering
	2.2 Describe the functions and applications of hydraulic and pneumatic equipment and how to operate and maintain pneumatic and hydraulic systems
	2.3 Explain system parameters and the effects these can have on their operation
	2.4 Explain monitoring devices on mechanical equipment

Range Statements:

Learning outcome 1
Mechanical engineering principles, theory, terminology, and calculations such as:

- SI Units and derived units
- Unit conversion metric and imperial
- Statics; friction, force, torque, equilibrium, tightening torque, torque multiplier ratios, coefficient of friction and inclined planes, lubrication levels for materials in wet and dry conditions
- Newtons Laws (Inertia, Force and Acceleration and Action and Reaction)
- Dynamics; Newton's second law with Force Mass and Acceleration, kinetic energy, work done, gravitational and potential energy
- Density, volume and mass relationship

- Area calculations for geometrical shapes/profiles
- Stress
- Strain
- Young's modulus
- Hooke's Law
- Stress, force and area relationship and calculations
- Types of stress: tensile, compressive, torsional, shear
- Force, mass and acceleration relationship calculations
- Torque tightening, spanner, torque force distance relationship, calculations
- Power, torque and angular speed relationships and calculations for motors and generators
- Factor of safety
- Deformation, elastic region and plastic region of materials
- Thermodynamics, coefficient of thermal expansion, thermal contraction
- Heat transfer, specific heat capacity, latent heat, sensible heat
- Gear types, gear ratios, relationship to speed and number of teeth, torque and speed relationship, gear box efficiency calculations
- Machine efficiency
- Tolerance calculations for bearing fits on drawings/technical specifications
- Gas laws: Charles Law, Boyles Law

Functions and applications of mechanical plant and mechanical equipment such as:

- Power transmission systems; belt drives, chain drives, belts, v-belts (trapezoidal), flat belts, ribbed belts and pulleys, chains and sprockets, pulley systems
- Couplings, rigid, flexible, misalignment, alignment methods
- Laser alignment, soft foot, misalignment, parallel (offset) misalignment, angular misalignment, combined misalignment
- Motion conversion linear and rotary, gears, ball screw actuators
- Bearing types, load types, load directions, applications and selection, preload and lubrication and sealed, fits (clearance fit, transmission - size for size push fit, interference fit), misalignment, friction and lubrication types, sensors temperature and vibration
- Bearing installation and extraction, the use of thermal aids (induction heaters and liquid nitrogen, freezers) for heavy interference fits between bearing and shaft with the aid of thermal expansion (heating of bearing inner diameter) and thermal contraction (freezing of shaft outer diameter)
- Fasteners: types, bolts, screws, nuts, pins, dowels, grub screws, lock nuts, anti-vibration nuts, hexagon socket cap screws, hex head bolts/nuts, pan socket heads, dome socket heads, keys, studs, tie rods, spring washers, locking washers
- Fasteners: materials, bolt grade, tensile strength rating
- Corrosion
- Fasteners: bolt tightening (torque), preload in bolts due to tensile load

- Fasteners: bolt assembly and number of passes to reach target torque, tightening sequence (opposites)
- Fasteners: locking features for anti-vibration
- Fasteners: proof marking checks on assembly to ensure torque settings are correct and to detect loosening or tampering over time
- Spring types, compression springs, helical coil and wave springs (single wave ; crest to crest multi wave), ground ends, extension springs, torsion springs, disc springs
- Energy efficient systems, mechanical losses of rotating equipment generators, electrical motors, hydraulic motors, turbines
- Energy conversion of pumps, generators, and motors
- Safety, locking mechanisms, stored energy mechanical moving parts with gravitational potential energy of heavy parts during dismantling equipment and stored energy of spring-loaded energy (compression springs for bearing preloaded axial cavities)
- Industrial plants
- Automotive
- Aerospace
- Rail
- Heavy machinery
- Utility systems
- Power generation
- Renewable energy: solar, wind turbines, hydrodynamic
- Oil and gas
- Heat exchangers; transference of heat between fluids without mixing, heat transfer, convection, conduction, thermal insulation, radiation, heat transfer laws
- Gear systems; transmit torque, alter speed, change direction of rotation, change axis of rotation
- Structural components; frames and supports
- Structure dampers, springs, isolators

Learning outcome 2

Know how to use hydraulic and pneumatic principles, theory, terminology, and calculations:

- Types of pressure, atmospheric, absolute, vacuum, gauge and differential pressure in systems, static pressure systems, hydrostatic pressure, dynamic pressure systems
- Pascal's Law, force, area and pressure relationship and calculations
- Fluid Mechanics; Bernoulli's Equation, Flow rate, Continuity Equation and calculations
- Energy conversion of pumps, turbines, motors, generators (energy types: electrical, mechanical and fluid energy)
- Conversion of units, metric and imperial units
- Hydrostatic pressure, density of fluid, gravity, height calculations
- Flow, velocity and area relationship and calculations
- Pressure losses

- Turbulent and laminar flow
- Viscosity of fluids, effects of elevated and low temperature
- Coefficient of friction, dry, wet lubricated, slightly lubricated, different materials
- The symbol identification and function of system components used in pneumatic and hydraulic systems such as compressors, actuators, valves, pumps and reservoirs, control the flow of fluids
- Pipe isolation methods, blind spade, spectacle blinds, isolation plugs, valve types: quarter turn valves, gate valves, needle valves, globe valves, double block and bleed systems, regulate, fine tune, direct shut off
- Know how to operate and maintain pneumatic and hydraulic systems correctly and safely
- Understand circuit design and testing
- Understand system parameters and their effects on operation
- Air compressors workings; Increase the pressure of gases
- Sealing systems; Seals, Gaskets, O Rings, Dynamic, Static, Mechanical
- Pumps types - positive displacement: reciprocating pumps (piston, plunger diaphragm); rotary pumps (gear, screw, vane, lobe); linear pumps such as peristaltic)
- Pump types - non-positive displacement: centrifugal (CF) pumps, propeller pumps, axial flow pumps, jet pumps
- Movement of liquids and gases, conversion of mechanical energy to fluid energy
- Functions and applications of hydraulic and pneumatic equipment such as actuators, hydraulic, pneumatic, rotary, electric, electro-mechanical ball screw
- Hydraulic hoses, design factors, burst pressure, working pressure, fittings
- Hydraulic power packs
- Hydraulic circuits, pressure losses and accumulator systems
- Hydraulic single cylinders and double acting cylinders workings of, calculations
- Hydraulic cylinder seal types, dynamic and static
- Piston force, area and pressure relationship calculations
- Hydraulic jacks workings of, calculations
    - Safety risks working on hydraulic systems, stored energy, pressure relief valves and bypass valves

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1705
Ofqual unit ref:	F/651/8306
Unit Title:	Undertake maintenance, inspection, calibration and testing activities for mechanical systems
Level:	3
Credit value:	14
GLH:	108
TQT:	143
Unit aim(s):	This unit allows learners to develop their knowledge and skills to maintain mechanical systems through inspection, calibration and testing activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K65, K66, S56, S57, S58, S60, S61

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to inspect, maintain, calibrate and test mechanical equipment and systems	1.1 Explain the types of maintenance techniques and different levels of maintenance
	1.2 Explain the considerations and requirements to replace or repair components and equipment
	1.3 Describe the processes and procedures when removing parts from the system
	1.4 Describe reasons that equipment may need to be cleaned
	1.5 Explain calibration techniques for mechanical systems, including the equipment that would be used
	1.6 Describe how to use functional testing and test requirements and provide examples of how to carry it out
2. Know and understand how to select, use, care for and calibrate tools and equipment used in mechanical maintenance	2.1 Explain the tools and equipment required for mechanical maintenance and when they would be used
	2.2 Describe key indicators that equipment and tools are in good condition and suitable for use
	2.3 Explain how to care for the tools and equipment, including pre-use, post-use and storage
	2.4 Explain which tools and equipment may require calibration and why
	2.5 Explain quarantine requirements for tools and equipment out of calibration date
	3.1 Consider the safety considerations whilst inspecting and testing

3. Be able to check the condition and operation of mechanical aspects of plant and equipment	3.2 Select equipment for inspecting and testing
	3.3 Demonstrate inspection and testing of mechanical systems
4. Be able to remove, examine and replace mechanical parts	4.1 Select the safety and operational considerations when removing and replacing mechanical parts
	4.2 Demonstrate the removal and replacement of mechanical parts
	4.3 Examine mechanical parts to identify defects
	4.4 Use appropriate disposal methods for replaced equipment and parts
	4.5 Identify and account for errors which occur when calibrating instrumentation.
	4.6 Identify replace or repair strategies for component and equipment
5. Be able to clean and lubricate mechanical parts and equipment	5.1 Identify when cleaning of mechanical parts and equipment is required
	5.2 Implement the safety considerations when cleaning equipment, including using cleaning agents
	5.3 Select tools and other items which may be required when cleaning equipment
	5.4 Demonstrate the cleaning of mechanical parts and equipment
	5.5 Demonstrate how to lubricate mechanical parts and equipment

Range Statements:

Learning Outcome 1

Types of maintenance:

- Conduct planned mechanical maintenance, or routine maintenance in line with task requirements and company procedures including checking condition and operation of mechanical aspects of plant and equipment, removing and replacing mechanical parts, examining mechanical parts for defects, setting up and adjusting mechanical aspects of plant, cleaning parts, and lubricating mechanical assemblies.
- Carryout functional testing to confirm correct operation in line with task requirements.
- Carry out unplanned maintenance or reactive maintenance or breakdown maintenance or corrective maintenance on failed equipment and plant, in line with company requirements onsite and production environments.
- Carry out preventative maintenance programmes to ensure reliability and operational targets of plant and mechanical equipment to prevent failures before they occur, relevant to plants and equipment with continuous running.
- Implement predictive maintenance systems, utilising condition-based monitoring systems/techniques for measuring mechanical parameters such as temperature, vibration, flow rate, speed, torque, and pressure, to monitor performance characteristics of plant and equipment and identify when maintenance action is required.

Levels of Maintenance:

- Typical levels of maintenance in a maintenance repairs and overhaul department in industry:
- Understand the levels of maintenance from daily checks to annual servicing over longer periods.
- Understand the levels of maintenance of safety critical assets and associated frequency of checks to meet customer requirements.
- Understand the levels of maintenance from routine visual checks and measurement checks to component replacement due to failure, sub-assembly replacement due to failure and unit replacement due to failure in service.
- Understand the levels of maintenance to comply with contractual warranty requirements with customer.
- Understand the levels of maintenance for reconditioning units to fully conditioning units and associated functional testing before release to production (handover).
- Understand the levels of maintenance due to upgrading units and reworking units due to known in service failure modes and recalls.

Learning Outcome 2

Types of tools and equipment may include:

- Hand tools
- Hand power tools
- Assembly, disassembly equipment.
- Understand calibration requirements and associated procedures and processes and quarantine areas for out of calibration tools and equipment.
- Measuring devices and testing tools and equipment.
- Understand the importance of Portable Appliance Testing (PAT testing) for equipment used to carry out maintenance.

Learners should know how the following regulations are applicable to maintenance activities in the workplace:

- Health and Safety at Work Act (HSWA): 1974
- Power tools and equipment and applicable regulation Provision and Use of Work Equipment Regulations (PUWER): 1998
- Lifting and Handling equipment and applicable regulation Lifting Operations and Lifting Equipment Regulation (LOLER): 1998
- Pressure equipment and applicable regulation Pressure Systems Safety Regulations (PSSR): 2000
- Manual Handling Operations Regulations: 1992
- The Working at Height Regulations: 2005
- The Confined Spaces Regulations: 1997
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR): 2013
- Control of Substances Hazardous to Health (COSHH) :2002

Learning Outcome 3

Learners should be able to check condition and operation of mechanical aspects of plant and equipment.

This may include types of equipment such as:

- Rotating machinery, motors, generators
- Static machinery, preloaded spring systems, compressors
- Linear motion equipment, hydraulic cylinders/pistons
- Rotary equipment, hydraulic rotary actuators, vane pumps
- Belts, Belt drives, pulley systems
- Chain drives, sprockets, cogs
- Bearings (ball bearings, angular contact ball bearings, roller bearings, taper roller bearings, needle roller bearings, thrust bearings, plain bush bearings)
- Gears, gearboxes, gear trains, multi-stage gear drives, idler gears, driven, driver, (spur, helical, bevel, worm and wheel, planetary, rack and pinion)
- Splines, involute
- Couplings, rigid, flexible
- Rotor shafts, stub shafts, drive shafts

- Valves
- Mechanisms, cam followers
- Pumps positive displacement: reciprocating - piston, plunger, diaphragm, rotary - gear, screw, vane, lobe, linear - peristaltic
- Pumps non-positive displacement: centrifugal (CF) pumps, propeller pumps, axial flow pumps, jet pumps
- Hydraulic systems, oil levels, oil quality
- Hydraulic hoses, fittings and connections and working pressure and burst pressure ratings
- Pneumatic systems
- Seals and Gaskets (static and dynamic seals, and flanges and mechanical seals, slip rings). Check for nicks and damage on installation, wear, back pressure blow outs.
- Seals (e.g. O-rings type) and Gaskets (e.g. Flanged type) consumable items to be replaced after use due to stretch, compression on installation.
- Alignment and adjustment mechanisms
- Control systems
- Heating and cooling systems
- Springs
- Fasteners

Inspection Tools and Equipment:
Be able to carry out different inspections on mechanical components, assemblies, equipment, machines and systems as follows:

- The use of steel rules
- The use of tape measures
- The use of DTI's (Dial Test Indicators) for measuring runout concentricity errors on shafts
- The use straight edges for alignment checks
- The use of laser alignment kit for drive checks
- The use of engineer's square for basic perpendicular checks
- The use of vernier callipers (digital and manual for measurements)
- The use of micrometres (digital and manual for measurements)
- The use of depth gauges
- The use of feeler gauges for tight precision gaps for assembly settings
- The use if shims for precision assembly fits
- The use of torque wrenches (click type with internal spring) for fastener bolt/nut tightening settings and requirement to set back to lowest setting or zero after use to remove tension in spring after use
- The use of torque wrench
- The use of hydraulic torque wrenches for fastener bolt/nut tightening settings
- The use of torque multipliers with high ratios

Learning outcome 4

They should be able to remove and replace mechanical parts within mechanical systems such as:

- Gears
- Pumps
- Belts
- Belt drives
- Pulleys
- Chain drives
- Fasteners
- Sprockets, Cogs
- Springs
- Seals and gaskets
- Mechanical seals
- Bearings
- Valves
- Pipework
- Shafts and couplings
- Frames and structures
- Brackets and fabrication
- Enclosures and housings
- Reservoirs and tanks
- Filters air and hydraulic
- Motors hydraulic
- Motors electric
- Clutches
- Electrical Generators
- Diesel Generators
- Hydraulic actuators
- Electromechanical (ball screw) actuators
- Engines
- Turbines

They should be able to examine mechanical parts for defects such as:

- Visible damage
- Deformation
- Movement of assembly settings
- Wear
- Leaks
- Corrosion
- Maladjustment
- Discolouring
- Cracks
- Hairline cracks
- Internal structural damage

- Scratches, scoring
- Surface indentation
- Fractures
- Tears, splits, holes
- Fraying
- Tension damage (plastic deformation)
- Compression damage (plastic deformation)
- Torsion damage (plastic deformation)
- Shear damage
- Alignment non-compliance (misalignment of assembly; mechanism)
- Permanent joints mechanical
- Non-permanent joints mechanical

Remove or Repair Strategies:

- Determine lead time and associated labour costs and spare costs to repair.
- Determine lead time and associated part costs to replace.
- Determine spare availability and compatibility onsite.
- Determine impact to plant downtime for repair and replace.
- Identify customer contractual requirements for entitlement under warranty schemes

Learning outcome 5

They should be able to remove dust and debris from mechanical parts using methods such as:

- Manual cleaning such as brushes, cloths and compressed air
- Manual cleaning using pressurised water for flushing lines
- Solvents and detergents
- Ultrasonic cleaning
- Pressure washing

They should be able to lubricate mechanical assemblies using methods such as:

- Oils
- Dedicated oil feed
- Oil Spray
- Oil mist
- Greases open
- Greases sealed
- Solid lubricants such as graphite, PTFE polymers, self-lubricating materials
- Dry lubricants (food industry)
- Materials with lubricating properties static and dynamic
- Aware of the uses of restrictions and special lubricants for use in the food industry
- Aware of the associated Control of Substances Hazardous to Health:2002 (COSHH) datasheets for safety guidelines for handling lubricants and lubrication substances

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

- ✓ In a Realistic Work Environment

Unit Ref:	1706
Ofqual unit ref:	J/651/8308
Unit Title:	Undertake safe isolation and deisolation of mechanical systems whilst conducting maintenance activities
Level: 3	3
Credit value:	9
GLH:	62
TQT:	92
Unit aim(s):	This unit allows learners to develop their knowledge and skills to safely isolation and deisolate mechanical systems to undertake maintenance activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K61, S52, S62

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand how to isolate and deisolate when working with mechanical systems	1.1 Identify types of isolation/deisolation required with working with mechanical systems
	1.2 Explain the regulations associated with isolating/deisolating mechanical systems
	1.3 Describe organisational processes and procedures to be followed when isolating mechanical systems
	1.4 Describe physical isolation procedures
	1.5 Describe physical deisolation procedures for mechanical systems, including testing/checks
	1.6 Describe organisational processes and procedures to be followed when deisolating and handing back mechanical systems
	1.7 Identify relevant types of stored energy and source
2. Be able to ensure that mechanical systems have been safely isolated	2.1 Identify that the correct mechanical systems have been isolated
	2.2 Select processes and procedures for ensuring safe isolation of equipment
	2.3 Select, check and use testing equipment to carry out isolation checks
	2.4 Confirm isolations prior to starting work on an system/instrument
	2.5 Demonstrate the process if isolation is not correct
	2.6 Conduct and confirm isolations
3. Be able to complete deisolation of electrical and connected services and confirm deisolation has been completed	3.1 Identify all services which require deisolation
	3.2 Select the required equipment for deisolation.
	3.3 Demonstrate the deisolation of various types of mechanical services.

3.4 Test that services have been correctly deisolated.
3.5 Hand back equipment which has been deisolated

Range Statements:

Learning Outcome 1 and 2
Learners should know the considerations and requirements of the isolation and de-isolation of connected services and be able to do.

- Identify the services to be isolated such as: electrical power, pneumatic pressure and compressed air, hydraulic pressure, steam, hot water, gas, moving loads, spring loaded
- Assessment of Hazards and Risks, Risk Assessments (severity and likelihood calculation and rating) and dynamic risk assessment, New Risk Management
- Use of Isolation Devices such as: Valves and Shutoff Valves, Pressure Relief Valve Systems, Pressure Bypass Valve Systems, Blanking plates, Mechanical Locking Systems such as chains for restricted movement of heavy machinery
- Use of cordoned off area and using relevant signage with informing all personnel in vicinity and all relevant areas in the workplace including the control room managing isolation/deisolation activities
- Use of Lock Out Tag Out (LOTO) processes and procedures with locks, tags, keys on person, master key box, shiftwork, handover
- De-Energise and Isolate Mechanical Equipment
- Confirmation of isolation
- De-Isolation considerations - Key points:
    - Confirm that all safety checks and maintenance tasks have been completed successfully
    - Verify equipment condition
    - Ensure personnel safety
    - Ensure that any locks and tags applied during isolation are removed
    - Maintain clear communication between personnel involved in the de-isolation process and all other personnel in the area
    - Ensure system is ready to re-energise
    - Re-energise system gradually in accordance to company procedure
    - Monitor system
    - Functional testing checks
    - Return to normal operations
    - Complete maintenance records
    - Handover to production in line with procedure
- Special considerations for hazardous materials - Key points:
    - Purge hazardous materials
    - Ventilate the area
    - Containment systems

- Mandatory Personal Protective Equipment (PPE) requirements
- Specialist Personal Protective Equipment (PPE) requirements

(Safety note: Learners should not carry out the isolation/deisolation activities on their own. They should always use qualified personnel for the type of isolation required)

Learning Outcome 3

Learners should be able to conduct and confirm electrical and connected services deisolation correctly in accordance with regulation and company procedures. Key points:

- Confirm that all safety checks and maintenance tasks have been completed successfully
- Verify equipment condition
- Ensure personnel safety
- Ensure that any locks and tags applied during isolation are removed
- Maintain clear communication between personnel involved in the de-isolation process
- Ensure system is ready to re-energise
- Re-energise system gradually in accordance to company procedure
- Monitor system
- Functional testing checks
- Complete maintenance records and documentation
- Handover to production in line with company procedures
- Return to normal operations

(Safety note: Learners should not carry out the isolation/deisolation activities on their own. They should always use qualified personnel for the type of isolation required, i.e. source a qualified electrician to carry out the electrical isolation and deisolation tasks).

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

Workplace evidence should be used where possible however due to safety implications all skills Assessment Criteria containing "isolation"; "deisolation"; and "test" should **only** be delivered in a Realistic Work Environment.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1707
Ofqual unit ref:	K/651/8309
Unit Title:	Working with technology, equipment and systems required for mechanical engineering maintenance
Level:	3
Credit value:	15
GLH:	113
TQT:	148
Unit aim(s):	This unit allows learners to develop their knowledge and skills in technology, equipment and systems required to undertake maintenance activities.
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K63, K70, S53, S59, S64

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand the functions and applications of the mechanical aspects of plant and mechanical equipment	1.1 Describe the mechanical systems and the types of equipment required for installation, maintenance and repair activities
	1.2 Explain the application of the mechanical systems and the types of mechanical equipment required for installation, maintenance and repair activities
	1.3 Evaluate safety considerations with mechanical equipment and the mechanical systems required for maintenance activities
	1.4 Explain indicators that mechanical equipment or systems are not performing as required
2. Know and understand bench fitting techniques used in the installation and maintenance of mechanical systems	2.1 Explain the types of bench fitting techniques used in mechanical maintenance
	2.2 Describe the application of each bench fitting technique
	2.3 Describe how to select the required technique for the installation and maintenance activity
3. Know and understand the types of diagrams used when working with mechanical plant and equipment	3.1 Describe the types of diagram used when maintaining mechanical systems
	3.2 Explain the symbols and abbreviations used in hydraulic and pneumatic diagrams
	3.3 Evaluate the advantages and disadvantages of each type of diagram
	3.4 Determine the most appropriate type of diagram for practical applications
	3.5 Explain how different types of diagram can be used in conjunction with each other
	3.6 Describe how to locate the appropriate diagrams and to confirm that they are correct to use

	3.7 Explain how to make corrections, updates and improvements to drawings following organisational procedures
4. Be able to select, check and use tools when maintaining mechanical systems	4.1 Select and use safety measures and Personal Protective Equipment (PPE) required for maintenance tasks
	4.2 Check tools and equipment required for maintenance tasks are suitable before and after use
	4.3 Demonstrate using tools and equipment required for maintenance tasks
	4.4 Ensure that tools which are deemed to be damaged or not operating correctly are appropriately dealt with
5. Be able to set up and adjust mechanical systems	5.1 Select and use the appropriate technical information to identify requirements for mechanical maintenance
	5.2 Set up and align mechanical systems
	5.3 Calibrate mechanical systems, including equipment used and how results are recorded and reported.
	5.4 Test mechanical systems using appropriate procedures and equipment
6. Be able to apply bench fitting techniques used in the installation and maintenance of mechanical systems	6.1 Select appropriate bench fitting techniques for the required installation and maintenance activity
	6.2 Demonstrate bench fitting techniques used in mechanical installation and maintenance
	6.3 Apply safety considerations when undertaking bench fitting techniques

7. Be able to use innovative engineering technology	7.1 Demonstrate using computer aided design (CAD) models and drawings
	7.2 Demonstrate using hardware to access data
	7.3 Carry out maintenance actives using existing and new technologies

Range Statements:

Learning Outcome 1
Learners should be able to understand and describe required tools and equipment needed for maintenance activities. These will include:

- Safety and risk management risk assessments, dynamic risk assessments
- documentation and procedures, permits to work
- material handling and shaping, joining processes, cutting/grinding processes, hazardous, hot works
- plant and equipment installation, maintenance and repair and replace
- Equipment performance assessment functional checks
- specific knowledge related to their specific area of work.

Learning Outcome 2 and 6
Learners should know and demonstrate bench fitting techniques such as:

- Marking out, using engineer's blue, scribe tools and engineer's rule, use of datums for marking out geometry and profiles
- Filing
- Sawing
- Drilling
- Copy drilling (pilot holes) filing
- Chiselling
- Hand fettling
- Thread cutting (Tap and Die)
- Deburring
- Scraping
- Forming
- Riveting
- Bending and shaping and forming
- Mechanical fastening
- Permanent Joining
- Temporary Joining
- Assembly and fitting
- Soldering
- Preloaded assemblies
- High precision assembly settings

Learning outcome 3
Learners should know the types of diagrams associated with mechanical plant and equipment, their advantages and disadvantages and where to locate them using revision control, including;

- Engineering Component Drawings (Orthographic, Isometric, Auxiliary, Detail and Sectional views)
- Engineering General Assembly (GA) Drawings (Orthographic, Isometric, Auxiliary, Detail and Sectional views)
- Exploded Assembly Drawings
- Hydraulic and Pneumatic Circuit Diagrams
- Schematic Diagrams at Mechanical Plant level
- Bill of Materials (BOM) and parts/items lists for sub-assemblies and general assemblies of mechanical equipment

Should know the symbols associated with hydraulic and pneumatic circuit diagrams as specified in BS ISO 1219-1:2012 Fluid Power systems and components. Graphical symbols and circuit diagrams.

Learning Outcome 4
Learners should know how to select, check and use the necessary tools and equipment for conducting mechanical maintenance of plant and equipment to include the operation, care and calibration of such tools and equipment. This should also include complying with all health and safety and regulatory measures required. Types of tools and equipment may include:

- Hand tools
- Power tools and equipment
- Measuring devices and testing tools and equipment
- Lifting and handling equipment

Learning outcome 5
Learners should be able to set up, align, and adjust mechanical aspects of plant such as:

- Position
- Alignment
- Clearances
- Fits
- Tension
- Compression
- Meshing
- Speed
- Torque tightening
- Pressure Tensile and Compressive Loads (force)

Using tools and equipment such as:

- Hand tools
- Gauges, GO NO GO Gauges, Plugs
- Cranes and hoists
- Gantry Cranes
- Scissor lifts
- Lifting slings
- Eye bolts, eye nuts
- Shackles, strops
- Alignment tools
- Alignment kits (laser)
- Feeler gauges
- Shims
- Micrometres
- Vernier Calipers
- Tension gauges
- Stright edge
- Dial Test Indicators (DTI's)

Learning outcome 7

Learners should be able to utilise engineering software to aid maintenance tasks on mechanical equipment and systems, including:

- Manipulating 3D models to understand assembly and disassembly requirements of mechanical equipment undertaking maintenance in the workplace
- Interpret 2D engineering drawings for hydraulic and pneumatic circuits
- Interpret 2D engineering drawings for mechanical assemblies with exploded engineering drawings and sectional engineering drawings of mechanical equipment
- Using tablets accessing engineering data such as technical specifications, test reports, manufacturer's manuals for mechanical equipment.
- Using 3D viewers accessing engineering data to aid visualising mechanical plant and equipment

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

It is a requirement that workplace evidence is used where possible.

For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

Unit Ref:	1708
Ofqual unit ref:	A/651/8304
Unit Title:	Diagnose mechanical system faults and implement problem solving techniques
Level: 3	3
Credit value:	11
GLH:	77
TQT:	108
Unit aim(s):	This unit allows learners to develop their knowledge and skills to be able to identify and diagnose faults and implement problem solving techniques when maintaining the mechanics of plant and equipment
Assessment requirements:	Portfolio of evidence
Relationship to:	This unit covers the following knowledge and skills criteria from the Engineering Maintenance Technician Apprenticeship standard: K67, K68, K69, S54, S55

Learning Outcome: The learner will:	Assessment Criteria: The learner can:
1. Know and understand common maintenance problems with the mechanics of plant and equipment	1.1 Describe the common maintenance problems related to the mechanical aspects of plant and equipment
	1.2 Explain the impact of maintenance problems on the technician and their workplace
	1.3 Describe how to solve maintenance problems
2. Know and understand the fault finding and rectification techniques and use of diagnostic equipment when maintaining the mechanics of plant and equipment	2.1 Explain fault finding techniques appropriate for the mechanical aspects of plant and equipment
	2.2 Describe the safety considerations when fault finding within the mechanics of the plant and equipment
	2.3 Explain the operation of diagnostic devices and equipment which can be used when maintaining the mechanical aspects of plant and equipment
	2.4 Explain the rectification techniques when fault finding has occurred within mechanics of the plant and equipment
	2.5 Explain the safety considerations when rectifying faults
3. Know and understand problem solving and critical reasoning techniques when maintaining the mechanics of plant and equipment	3.1 Explain problem solving techniques used within mechanical maintenance
	3.2 Describe situations where problem solving techniques would apply
4. Be able to apply fault finding and rectification techniques, including the use of diagnostic equipment in	4.1 Select fault finding techniques and identify mechanical faults
	4.2 Select and use diagnostic equipment to identify mechanical faults
	4.3 Apply rectification techniques to mechanical faults

	mechanical maintenance	4.4 Confirm the fault is rectified and the mechanical plant and equipment is operating as required.
		4.5 Identify and mitigate safety considerations when fault finding and rectifying faults.
5.	Be able to apply problem solving and critical reasoning techniques in mechanical maintenance	5.1 Use problem solving and critical reasoning techniques to restore system functionality
		5.2 Confirm the root cause of the mechanical issue
		5.3 Undertake a review of the process and implement changes

Range Statements:

Learning Outcome 1

Learners should be aware of some of the common maintenance problems associated with mechanical equipment. Such as:

- **Belt problems**: breaking, slipping, cracking, tearing, wearing, splitting
- **Bearing problems**: wear, excessive radial and axial play, insufficient lubrication, overloading, overheating, misalignment, contamination, incorrect fitment during installation, incorrect fitment during extraction, incorrect bearing type, incompatible load direction for application, incorrect load capacity, insufficient life.
- **Pump failures**: cavitation, sealing systems and leakage, blockages, overheating, incorrect pump application (inadequate flow rate capacity), incompatible pressure and pumping mediums, turbulent flow and unstable systems
- **Gearbox failures**: teeth profile wear with increased backlash clearance non-compliance, gearbox setting issues with inadequate backlash causing binding of teeth in mesh and increased friction and overheating, damage to gear teeth/flank/face, tooth breakage due to shock loading, fatigue failures, overload failures due to brittle gear core with failed heat treatment, inadequate lubrication (oil jets, oil mist, grease, oil level sight glass), gearbox leakage, misalignment of gear axis, cracks, shaft interface slippage (anti-rotation failure)
- **Electrical motor failures** – mechanical: vibration, overheating, lubrication failure, high temperature, overload, service factor /duty cycle, mechanical out of balance, overspeed, bearing overload/overheat/contamination, drive shaft shear (over torque)
- **Electrical motor failures** – electrical; short circuit, field winding failures, insulation breakdown, stator failures, rotor failures, core pack/conductors/magnet failures, motor unbalance
- **Hydraulic motor failures**: vibration, oil system contamination, over pressure, high temperature bearing failure, mechanical wear/contamination of bearings, seals and internal components (vanes, moving parts)

- **Valve Issues**: sticking, leaking, corrosion, seizing, erosion, contamination
- **Drive shaft issues**: misalignment, bearing failure, seals failure, wear, runout and concentricity Error, straightness error
- **Heat exchanger issues**: blockages, leaks, corrosion,
- **Structural failures**: cracks, corrosion, welding defects, vibration, fatigue
- **Hydraulic system failures**: leaks, pump failure, fluid contamination, cavitation, turbulent behaviour, valve sticking and seizure, filtration accuracy failure

Learning Outcome 2 and 4

Learners should be aware of and how to use mechanical fault finding and rectification techniques available, including diagnostic equipment. Such as:

- 6-point method (utilise a systematic approach to fault finding with executing multiple steps in sequence). (1) collect evidence; (2) analyse evidence; (3) locate fault; (4) determine cause; (5) rectify fault; (6) verify solution
- Half split method (apply to circuits to locate origin of fault)
- Unit substitution (replace components, sub-assembly modules and whole units for process of elimination)
- Input/Output (consider inputs and outputs of operating parameters into a system to focus on problem area)
- Manufacturer's manuals, technical specifications and hydraulic and pneumatic circuit diagrams and other engineering drawings
- Sensory checks: visual inspection, smells, Hearing (uncharacteristic noises), touch (vibration/heat/wear) e.g. (vibrating unit, hot motor, burnt coils)
- Movement checks
- Measurements devices for dimension/tolerance checks at component and assembly level
- Pressure and flow: Gauges/Meters
- Torque meters (torque measurement of rotating shaft assemblies)
- Tachometers (speed measurement of rotating shafts)
- Laser alignment tools (kits, electronic, software programmes)
- Load testing (static and dynamic)
- Vibration analysis (sensors and analysers)
- Vibration sensors (accelerometers)
- Position (proximity) sensors
- Temperature sensors (thermocouples, RTD PT100)
- Infrared thermography (cameras and heat guns)
- Ultrasonic testing (non-destructive testing using sound waves)
- Oil Health monitoring (oil sample analysis, magnetic chip detection)
- Non Destructive Testing (NDT): Penetrating dyes, X-ray
- Rectification techniques such as: Unit Substitution, component replacement, regular servicing and maintenance, realignment, structural repairs (welding, Brazing, fasteners, reinforcement)

- Pump and valve maintenance: gearbox repairs, cleaning, mechanical balancing, Adjustments
- Diagnostic equipment, vibration analysers, heat guns, thermography cameras, acoustic equipment

Learning Outcome 3 and 5

Learners should understand and apply the principles of problem solving and critical reasoning to restore system functionality and identify the root cause of mechanical issues. These may include:

- Logical thinking (Cause and effect diagrams)
- Pattern recognition, trends in failure modes, step changes in operation/performance
- Root Cause Analysis (RCA)
- Process by Elimination
- PDCA Cycle: Plan; Do; Check; Act
- DMAIC: Define; Measure; Analyse; Improve; Control
- 5 Whys (repetition question approach)
- Fault Tree Analysis (FTA)
- Fishbone diagram (Cause and effect diagrams – illustrative approach)
- Failure Mode and Effect Analysis (FMEA)
- Process Failure Mode and Effect Analysis (PFMEA)
- Brainstorming and group problem solving
- Simulation and modelling of faults (computer based via software simulations and practical testing via representative hardware, operating conditions and environmental conditions)

Evidence Guidance:

The ***Energy & Environment Awards Assessment Strategy for Level 3 Diploma for Engineering Maintenance Technician*** includes a list of suitable evidence types for use within the learner's Portfolio of Evidence. This list is not exhaustive but is designed to provide an indication of what may be used as acceptable sources of evidence. Some sources of evidence will be more relevant to the unit content and the assessment of the learner's skills and/or knowledge than others.

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For this unit, Energy & Environment Awards also allows assessment:-

✓ In a Realistic Work Environment

4 Awarding

Grading

In order to achieve the qualifications listed in this Qualification Specification, learners must "pass" each of the units which comprise the specific qualification. Assessment decisions will be subject to internal and external quality assurance.

Certification

Energy & Environment Awards issues a qualification certificate of achievement for each qualification that has been achieved by the learner. Energy & Environment Awards offers learners an electronic certificate available to the Centre to download from Quartzweb, following the processing of a successful claim, or a physical certificate by exception and at an additional cost, which will be sent directly to the registered Centre. Learners who do not achieve the full qualification, but who have successfully achieved individual unit(s) will be able to receive an electronic unit certificate.

The date of certification is based on the achievement of the final unit.

5 Energy & Environment Awards Policies

Energy & Environment Awards has published comprehensive policies, which are made available to approved Centres and learners on the Energy & Environment Awards Qualifications website at: https://energyenvironmentawards.co.uk/policies-and-fees/. In particular, Centres may find the following policies useful when delivering this qualification.

Appeals / Enquiries

The Energy & Environment Awards Appeals and Enquiries Policy sets out the steps that Centres need to follow in order to escalate with Energy & Environment Awards and the Energy & Environment Awards responsibility and service level agreement in actioning these requests from Centres. Energy & Environment Awards understands that when Centres receive an enquiry regarding a result or a formal appeal from a learner that it is essential that this is responded to, and investigated, in a timely and responsive manner.

Complaints

The Complaints Policy outlines the process for approved Centres or learners to make a complaint, the Energy & Environment Awards process for handling the complaint, including any escalation and associated timescales. All related Centre policies and processes must have been followed prior to a complaint being accepted by Energy & Environment Awards.

Equality, Diversity and Inclusion

Energy & Environment Awards is committed to designing, developing, delivering, assessing and quality assuring qualifications which fully comply with the requirements of Equalities Law. Measures have been taken during the development phase to ensure that no features of this qualification and its associated assessment instruments directly or indirectly disadvantage any learners. Energy & Environment Awards will continue to monitor this qualification through a process of annual review and formal assessment review processes to ensure that this qualification continues to meet the requirements of Equalities law.

If you have any concerns regarding how accessible this qualification is and indeed any other concern relating to equality, diversity and inclusion please contact us.

Examination/Assessment Policies

This Qualification Specification contains specific information relevant to the delivery of this qualification and its associated assessment(s). However, it is also essential that you familiarise yourself with the requirements of all examination / assessment policies, which are appropriate to this qualification, for example the Invigilation Policy, required learner proof of identification and Examination Policy. These policies will contain more detailed information, how to ensure the security of assessment materials at all times and escalation processes should they be required.

Malpractice and Maladministration

Identifying and acting swiftly in response to potential incidents of malpractice and maladministration is an essential part of maintaining the reliability, rigour and validity of the Energy & Environment Awards qualifications' assessments. It is therefore essential that Centres familiarise themselves the Energy & Environment Awards Malpractice and Maladministration Policy prior to delivering this qualification and are well-positioned to report any potential issues in a timely and efficient manner.

Reasonable Adjustments and Special Considerations

Some learners may request that a reasonable adjustment is made to their assessment, often as a result of a disability or a medically diagnosed physical or mental health condition. Centres will need to apply to Energy & Environment Awards for any reasonable adjustment requests to be considered at the point of registering the learner on Quartzweb. Reasonable adjustment requests will be made at the point of registering a learner onto the Certificate and in line with the requirements within the Energy & Environment Awards Reasonable Adjustment and Special Considerations Policy. It is important to allow at least 10 working days before the scheduled assessment to enable any reasonable adjustments to be made.

Similarly, a learner may require a special consideration application being made to Energy & Environment Awards as a result of unforeseen circumstances during or immediately prior to an assessment taking place. In these instances the approved Centre is required to follow the Energy & Environment Awards Qualifications Reasonable Adjustments and Special Considerations Policy.

Recognition of Prior Learning

Energy & Environment Awards has a comprehensive Recognition of Prior Learning (RPL) Policy, which all approved Centres have access to and is available on the Energy & Environment Awards - Qualifications website. This policy outlines the type of evidence required by Energy & Environment Awards when submitting a claim for recognition of prior learning, the criteria Energy & Environment Awards use when making a decision about RPL and the process for both the approved Centre and Energy & Environment Awards.

Recognition of Prior Learning applies to the acceptance of evidence that the learner has completed learning which may exempt them from certain elements of a qualification but it will not exempt them from the assessment(s).

Contact Us

Please do not hesitate to contact the Energy & Environment Awards Qualifications team for any query relating to the delivery, assessment, quality assurance or certification of this qualification. Our team will be happy to help you with any queries you may have.

Telephone: 0121 713 8310, Option 2
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