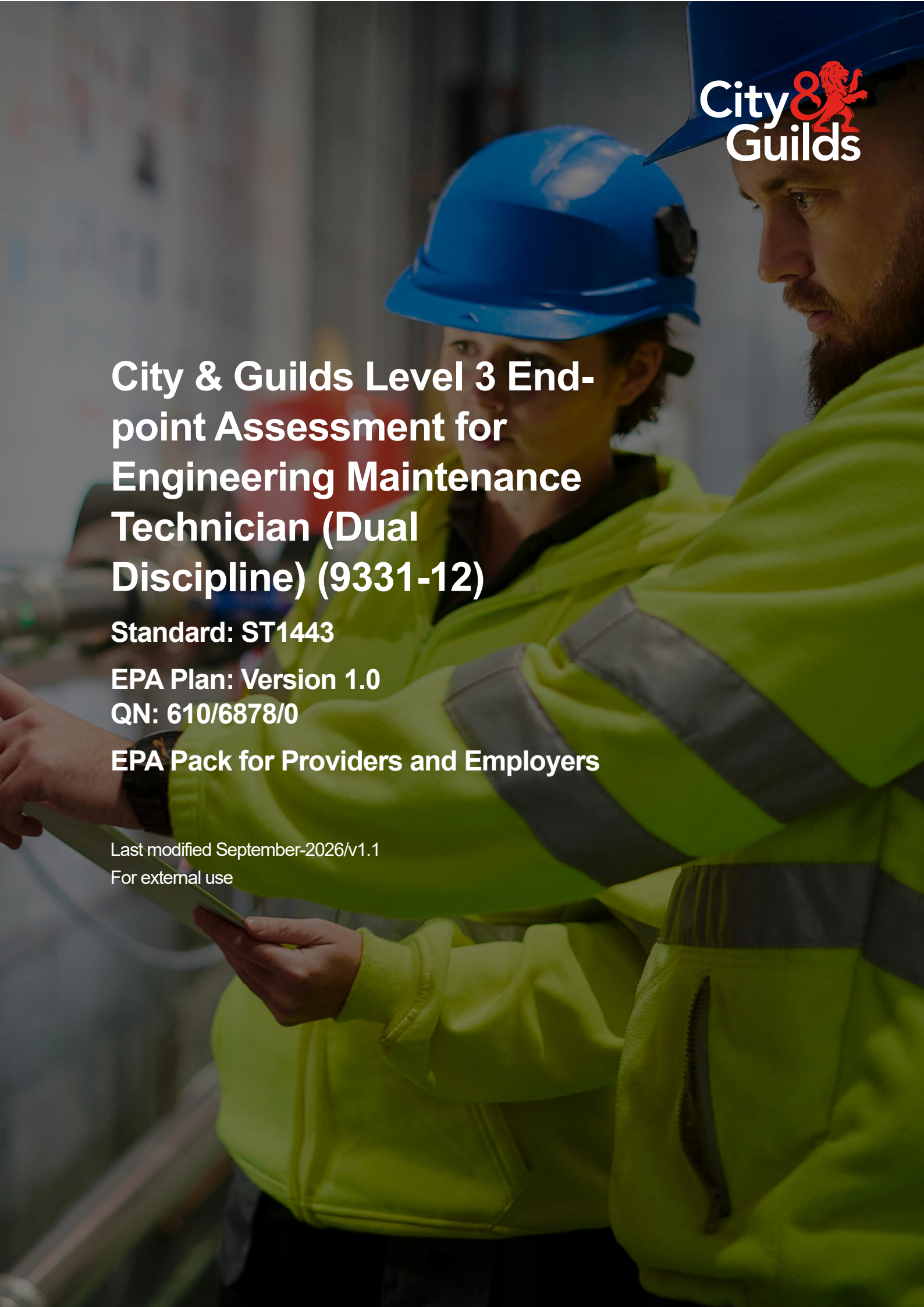

City & Guilds Level 3 End-point Assessment for Engineering Maintenance Technician (Dual Discipline) (9331-12)

Standard: ST1443

EPA Plan: Version 1.0
QN: 610/6878/0

EPA Pack for Providers and Employers

Last modified September-2026/v1.1
For external use

Version	Summary of changes	Section
1.0 June 2026	Initial version	All
1.1 September 2026	Rationale added regarding the assessment of S13 through the Multiple-Choice Test (MCT)	Pg 34

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1. Apprenticeships

This pack will help providers and employers prepare apprentices for the End-point Assessment (EPA) of their City & Guilds Level 3 End-point Assessment for Engineering Maintenance Technician (Dual Discipline) (9331-12). It explains how apprentices will demonstrate the knowledge, skills and behaviours (KSBs) which they developed during their apprenticeship.

This pack is for apprentices who are enrolled on the Level 3 Engineering Maintenance Technician (Dual Discipline) Standard (ST1443) V1.0 and undertaking one of the following options:

- electrical and control and instrumentation engineering maintenance technician
- electrical and mechanical engineering maintenance technician.

This pack must be used alongside the:

- 9331-12 Recording Forms for Providers and Employers (separate forms are provided for each option)
- EPA Documents Library, which includes the Manual for the End-point Assessment Service, information about the EPA Service, policies about malpractice and appeals, FAQS, and a video about the EPA which can be shared with apprentices.

The City & Guilds Manual for the EPA Service includes information on:

- application, registration and booking
- assessment
- results and post results (including resits)
- fees
- quality assurance.

Full-time engineering maintenance technician (Dual Discipline) apprentices will typically spend 42 months on-programme working towards meeting the Standard. The apprentice must spend at least 12 months on-programme and complete the required amount of off-the-job training in line with the apprenticeship funding rules. The employer should ensure that the apprentice has access to development opportunities to gain the KSBs, as outlined in the Standard, and must hold regular progress reviews with the provider and apprentice.

Once the apprentice has completed their training, they should be ready to go through Gateway to the EPA. See the ‘Gateway’ and ‘Assessment instructions’ sections within this pack to understand what happens.

The EPA for this apprenticeship includes the following assessments which can be taken in any order, as requested by the apprentice:

Electrical and control and instrumentation engineering maintenance technician

- 303 Multiple-choice Test (facilitated online via e-volve online assessment platform)
- 703 Observation with Questions (facilitated by an IEPA)
- 713 Interview Underpinned by a Portfolio of Evidence (facilitated by an IEPA)

Electrical and mechanical engineering maintenance technician

- 304 Multiple-choice Test (facilitated online via e-volve online assessment platform)
- 704 Observation with Questions (facilitated by an IEPA)
- 714 Interview Underpinned by a Portfolio of Evidence (facilitated by an IEPA)

Preparing for EPA

In preparation for EPA, providers and employers should:

- read the 'Assessment instructions' sections before reaching Gateway – the EPA Partnership Managers can help with any queries
- review which completed **recording forms and evidence** must be submitted, and when
- use the **recording forms** provided in the format laid out, unless indicated otherwise
- plan the venue and resources required for EPA – make sure the assessment environment is secure and comfortable, without interruptions
- use Proficient to help manage the apprentice's progress through EPA
- for on-site assessment, arrange for a designated contact to be available on the day to ensure the correct resources are available.

To help apprentices prepare for EPA, providers and employers should:

- explain the assessments and **recording forms** to the apprentice – refer to details in the 'Assessment instructions' sections of this pack
- agree a realistic timeframe for submission of evidence that meets the EPA deadlines – any delays in submission of evidence will delay the assessments
- make sure the apprentice has the resources and time to prepare for, and undertake, EPA
- take the apprentice through some mock assessments
- share the EPA Preparation Guide with the apprentice, which includes information about system requirements for virtual meetings
- let City & Guilds know if access arrangements are required to support an apprentice through EPA. Information about City & Guilds access arrangements, including reasonable adjustments is on the City & Guilds website, under EPA Documents Library.

Authenticating the apprentice's work

The independent end-point assessor (IEPA) must ensure all decisions satisfy validity, authenticity, currency and sufficiency (VACS). For evidence produced outside controlled conditions, the apprentice will be required to:

- sign a declaration that the work is their own
- reference all sources.

The employer/provider should also aid authentication by:

- supplementary (oral) questioning to gauge familiarity with the topic
- looking out for any changes to the apprentice's usual writing style, unusual sources/examples or the use of US spellings or phrases that might indicate cutting and pasting from the internet
- requiring access to evidence of steps in the process, for example drafts, notes, planning etc.

City & Guilds have produced forms for use when reviewing evidence produced outside of controlled conditions. These forms include a Declaration of Authenticity form which must be completed when submitting evidence.

City & Guilds Position Statement on Artificial Intelligence

The following guidance on artificial intelligence is designed to help candidates, teachers and assessors to complete non-exam assessments (NEAs), coursework and other internal assessments successfully. Please ensure familiarity with it.

Position Statement on AI | City & Guilds

Health & Safety and Codes of Practice

The importance of safe working practices, the demands of the Health and Safety at Work Act and any Codes of Practice associated with the industry **must** always be adhered to.

Following safe working practices is an integral part of all City & Guilds assessments, and it is the responsibility of the provider and employer to ensure that all the health and safety requirements are in place when apprentices are working on any projects or before apprentices begin any EPA.

Should an apprentice fail to follow correct health and safety practices and procedures during an EPA, the IEPA may advise the apprentice to stop and explain why.

Results submission and feedback

The Multiple-choice Test component will be delivered using the e-volve on-screen test platform. Test results will be available on Walled Garden within 24 hours following the test.

The IEPA will not provide feedback to the apprentice during or immediately following the assessment process. The provider will be informed by the City & Guilds EPA Team of the assessment results.

The IEPA will communicate the grade allocated for each assessment to the Lead Independent End-point Assessor (LIEPA) for quality assurance and sampling. The LIEPA will submit the results to the City & Guilds EPA Team.

Summary feedback will be provided to all apprentices after any grade determination has been carried out. The feedback will cover the areas against which insufficient evidence has been provided, leading to a 'fail'. Our 'end-point assessment feedback' will also cover the areas against which the apprentice's evidence has resulted in the award of a pass, merit or distinction.

If the apprentice has passed EPA, the City & Guilds EPA Team will issue the EPA Statement of Achievement to the provider confirming the grade achieved and will notify Skills England who will issue the apprenticeship certificate.

Professional recognition

This apprenticeship aligns with the Institution of Mechanical Engineers (IMechE) and the Institution of Engineering and Technology (IET) for Engineering Technician (EngTech).

Statement of Achievement

A printed EPA Statement of Achievement will be issued to each successful apprentice.

Providers and employers with access can view and download PDF copies of the Statement 24 hours after the results are published. A PDF supports more efficient processing of funding claims by providing evidence of apprentice certification before the apprentice's paper certificate arrives.

The overall apprenticeship certificate will be issued by Skills England.

Digital credentials

A digital credential is a verified, visual representation of knowledge and skills earned in various learning environments. Please see an example below:

Digital credentials are issued and verified online, making it easy for individuals to demonstrate their competencies to employers, clients and peers online. Each digital credential has a unique URL that can be shared electronically via social media, in an email signature and on a CV. This is a complimentary service in addition to the paper certificate.

For further information, please visit the City & Guilds EPA Digital Credentials webpage and the general terms in respect of our privacy policy or contact digitalsupport@cityandguilds.com.

2. The apprenticeship Standard

Occupation summary

Engineering maintenance technicians work in a range of industries that use plant, equipment and systems. This includes energy, leisure, entertainment, manufacturing, processing and utilities companies. The working environments vary across the industries.

This is a core and options apprenticeship. An apprentice must be trained and assessed against the core and **one** option. The options are:

- 303/703/713 Electrical and control and instrumentation engineering maintenance technician
- 304/704/714 Electrical and mechanical engineering maintenance technician

Occupational duties

This apprenticeship Standard has a number of duties which someone working in the role would typically be able to undertake. These duties are underpinned by a range of KSBs which a successful apprentice will be able to demonstrate:

Core duties (applicable to both options)	KSBs
Duty 1 Maintain and promote work site health, safety and environmental compliance. For example, conduct risk assessments and follow emergency procedures.	K3 K8 K10 K11 K12 K13 K14 K15 K16 K24 K29 K30 K31 S6 S7 S8 S9 S11 S12 S16 S17 S18 S19 S24 B1 B2
Duty 2 Liaise with stakeholders on maintenance work. For example, pre-job briefings, to plan work, to co-ordinate work with other maintenance disciplines, and to provide technical and regulatory advice.	K2 K3 K4 K27 K28 K29 K30 K31 S2 S4 S18 S19 S20 S24 B3 B4
Duty 3 Prepare for engineering maintenance work. For example, organise resources, obtain supplies of consumables and order parts.	K1 K3 K4 K5 K7 K17 K18 K29 K30 K31 S1 S2 S3 S4 S5 S13 S16 S18 S19 S24 B3
Duty 4 Review and accept job requirements. For example, accept safe system of work or permit to work.	K3 K29 K30 K31 S18 S19 S24

Core duties (applicable to both options)	KSBs
Duty 5 Ensure work meets regulatory, industry and company quality standards.	K3 K6 K9 K19 K20 K21 K22 K23 K29 K30 K31 S1 S10 S14 S15 S16 S18 S19 S20 S24
Duty 6 Conduct post-job close out. For example, sign-off job, handover engineering plant and equipment.	K3 K29 K30 K31 S18 S19 S24
Duty 7 Complete engineering maintenance records to company requirements. For example, job reports, stock control records and fault-finding reports.	K3 K12 K17 K25 K29 K30 K31 S13 S18 S19 S21 S22 S23 S24
Duty 8 Contribute to improvement activities. For example, support alternative ways of working to improve safety, reliability, sustainability, reduce cost or drive efficiency. Complete continued professional development.	K3 K17 K26 K27 K29 K30 K31 K32 S18 S19 S24 S25 S26 B5

Electrical and control and instrumentation engineering maintenance technician duties	KSBs
Duty 9 Conduct planned, preventative, and reactive maintenance on electrical aspects of plant, equipment, and systems; and on instrumentation and control aspects of plant, instrumentation and control equipment, and control systems including calibration.	K33 K34 K35 K36 K37 K38 K39 K40 K41 K42 K43 K44 K45 K46 K47 K48 K49 K50 K51 K52 K53 K54 K55 K56 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42 S43
Duty 10 Conduct fault diagnosis and problem solving on electrical plant, equipment, and systems; and instrumentation and control equipment and control systems.	
Duty 11 Remove and replace electrical plant, equipment, and systems; and instrumentation and control equipment and control systems.	
Duty 12 Conduct inspection, examination, and testing of electrical plant, equipment, plant, and systems; and instrumentation and control equipment and control systems.	

Electrical and control and instrumentation engineering maintenance technician duties	KSBs
Duty 13 Ensure availability and performance of electrical and instrumentation and control maintenance tools and equipment.	

Electrical and mechanical engineering maintenance technician duties	KSBs
Duty 14 Conduct planned, preventative, and reactive maintenance on electrical and mechanical aspects of plant, equipment, and systems.	K57 K58 K59 K60 K61 K62 K63 K64 K65 KK66 K67 K68 K69 K70 K71 K72 K73 K74 K75 K76 K77 K78 K79 K80 S44 S45 S46 S47 S48 S49 S50 S51 S52 S53 S54 S55 S56 S57 S58 S59 S60
Duty 15 Conduct fault diagnosis and problem solving on electrical and mechanical aspects of plant, equipment, and systems.	
Duty 16 Remove and replace electrical and mechanical plant, equipment, and systems.	
Duty 17 Conduct inspection, examination, and testing of electrical plant, equipment, and systems; and mechanical aspects of plant.	
Duty 18 Ensure availability and performance of electrical and mechanical maintenance tools and equipment.	

Knowledge, skills and behaviours (KSBs)

Apprentices must demonstrate all of the core KSBs as well as the KSBs that are applicable to the selected option.

Ref.	Core knowledge and understanding	Assessment method
K1	Sectors in which engineering maintenance takes place. Impact of sector on maintenance activities.	Interview Underpinned by a Portfolio of Evidence
K2	Maintenance disciplines and functional areas and how they work together.	Interview Underpinned by a Portfolio of Evidence
K3	Individual maintenance technician's roles and responsibilities. Escalation procedures.	Interview Underpinned by a Portfolio of Evidence
K4	Business operation considerations: quality, cost, delivery, and ethical practices.	Observation with Questions
K5	Planning, prioritisation, organisation, and time management techniques.	Observation with Questions
K6	Equipment life cycle considerations.	Multiple-choice Test
K7	Maintenance strategies: planned preventative maintenance (PPM), condition-based maintenance (CBM), scheduled maintenance, total productive maintenance (TPM), breakdown and run to failure maintenance.	Multiple-choice Test
K8	Health and safety regulations – key features and impact on role: ATEX - safety requirements for workplaces and equipment used in explosive atmospheres, Control of Asbestos Regulations, Control of Major Accident Hazards (COMAH) Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), Display Screen Equipment Regulations (DSE), Health and Safety at Work Act (HASAWA), Lifting Operations and Lifting Equipment Regulations (LOLER), Management of Health and Safety at Work, Manual Handling Operations	Multiple-choice Test

Ref.	Core knowledge and understanding	Assessment method
	Regulations, Personal Protective Equipment (PPE) at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), Working at Height Regulations, Working in Confined Spaces Regulations, Workplace (health, safety, and welfare) Regulations.	
K9	Work environment hazards and risks. Risk assessments.	Observation with Questions
K10	Safe systems of work.	Observation with Questions
K11	Personal protective equipment (PPE): selection, use, and care.	Observation with Questions
K12	Asset security requirements.	Observation with Questions
K13	Environmental regulations and standards – impact on role: Environmental Management Systems standard, Environmental Protection Act, and Hazardous Waste Regulations.	Multiple-choice Test
K14	The UK's net zero commitment. Principles of sustainability.	Interview Underpinned by a Portfolio of Evidence
K15	Recycling and waste management requirements.	Observation with Questions
K16	Emergency incident and response procedures.	Interview Underpinned by a Portfolio of Evidence
K17	Algebraic methods. Trigonometric methods and 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.	Multiple-choice Test
K18	Properties of engineering materials and impact on use.	Multiple-choice Test

Ref.	Core knowledge and understanding	Assessment method
K19	Sources of engineering information.	Observation with Questions
K20	Engineering standards - British (BSI) and International (ISO).	Observation with Questions
K21	Engineering representations, sketches, drawings, and graphical information conventions.	Multiple-choice Test
K22	Quality management systems.	Observation with Questions
K23	Standard operating procedures (SOPs): what they are and why they are important.	Observation with Questions
K24	Foreign material exclusion requirements.	Observation with Questions
K25	Documentation requirements: documentation control, auditable records.	Observation with Questions
K26	Continuous improvement (CI) systems and techniques.	Interview Underpinned by a Portfolio of Evidence
K27	Team working principles.	Interview Underpinned by a Portfolio of Evidence
K28	Principles of equity, diversity, and inclusion in the workplace.	Interview Underpinned by a Portfolio of Evidence
K29	Verbal communication methods and techniques. Engineering maintenance terminology.	Observation with Questions
K30	Written communication techniques.	Interview Underpinned by a

Ref.	Core knowledge and understanding	Assessment method
		Portfolio of Evidence
K31	Digital and information technology to support engineering maintenance. General data protection regulation (GDPR). Cyber security.	Interview Underpinned by a Portfolio of Evidence
K32	Industry 4.0 - the integration of physical systems with internet connectivity and cloud computing: technologies, systems, and benefits.	Multiple-choice Test
S1	Review and use information. For example, work instructions, drawings, design specifications, and plant configurations.	Observation with Questions
S2	Use planning, prioritising, organising, and time management techniques to plan tasks.	Observation with Questions
S3	Identify and organise resources to complete tasks. For example, consumables.	Observation with Questions
S4	Respond and adapt to work demands. For example, adapt working methods to reflect changes in working environment, re-prioritise workloads to react to breakdowns and fault scenarios.	Interview Underpinned by a Portfolio of Evidence
S5	Identify equipment to work on. Check plant configuration is as defined.	Observation with Questions
S6	Prepare the work area for maintenance tasks.	Observation with Questions
S7	Identify environmental and health and safety hazards and risks and apply control measures.	Observation with Questions
S8	Apply health, safety, and environmental procedures in compliance with regulations, standards, and guidance. For example, signage and barriers, working at height, confined spaces, and COSHH.	Observation with Questions
S9	Follow security procedures. For example, site access, document classification, and securing assets.	Observation with Questions

Ref.	Core knowledge and understanding	Assessment method
S10	Follow emergency incident and response procedures.	Interview Underpinned by a Portfolio of Evidence
S11	Apply sustainability principles. For example, minimising waste.	Interview Underpinned by a Portfolio of Evidence
S12	Segregate items for reuse, recycling, and waste.	Observation with Questions
S13	Use mathematical principles and formulae to support engineering maintenance.	Multiple-choice Test
S14	Apply engineering maintenance standards and procedures.	Observation with Questions
S15	Apply foreign material exclusion procedures.	Observation with Questions
S16	Follow maintenance tools and equipment control procedures. For example, handling and storage.	Observation with Questions
S17	Reinstate the work area.	Observation with Questions
S18	Apply team working principles.	Interview Underpinned by a Portfolio of Evidence
S19	Communicate with others to give and receive information. For example, colleagues, customers, and stakeholders.	Observation with Questions
S20	Escalate issues outside limits of responsibility.	Interview Underpinned by a Portfolio of Evidence

Ref.	Core knowledge and understanding	Assessment method
S21	Record information.	Observation with Questions
S22	Produce or update documents. For example, handover notes and reports.	Interview Underpinned by a Portfolio of Evidence
S23	Identify and highlight issues (red pen) with technical drawings.	Observation with Questions
S24	Use digital and information technology. For example, databases, data sharing platforms, email, management information systems, and word processing. Follow cyber security and GDPR requirements.	Interview Underpinned by a Portfolio of Evidence
S25	Apply continuous improvement techniques to identify improvement suggestions.	Interview Underpinned by a Portfolio of Evidence
S26	Carry out and record planned and unplanned learning and development activities.	Interview Underpinned by a Portfolio of Evidence

Ref.	Core behaviours	Assessment method
B1	Prioritise safe working practices. For example, risk aware, minimise risks, and proactively work towards preventing accidents.	Observation with Questions
B2	Consider sustainability when using resources and carrying out tasks.	Interview Underpinned by a Portfolio of Evidence
B3	Take ownership for the delivery and quality of own work. For example, self-motivated, disciplined in the approach to work tasks, and work carried out in line with standards.	Observation with Questions

Ref.	Core behaviours	Assessment method
B4	Team-focus to meet work goals and support inclusivity. For example, support others, show respect to others, and create and maintain productive working relationships.	Interview Underpinned by a Portfolio of Evidence
B5	Committed to continued professional development to maintain and enhance competence.	Interview Underpinned by a Portfolio of Evidence

Ref.	Electrical and Control and Instrumentation Knowledge	Assessment method
K33	Electrical and control and instrumentation. Electricity at Work regulations. IET wiring regulations.	Multiple-choice Test
K34	Electrical and control and instrumentation. Electrical isolation and deisolation requirements: lockout tagout and testing for dead.	Observation with Questions
K35	Electrical and control and instrumentation. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment.	Multiple-choice Test
K36	Electrical and control and instrumentation. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory and power calculations.	Multiple-choice Test
K37	Electrical and control and instrumentation. Functions and applications of electrical circuits.	Multiple-choice Test
K38	Electrical and control and instrumentation. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics.	Multiple-choice Test
K39	Electrical and control and instrumentation. Different types of cables; their specifications and application.	Multiple-choice Test
K40	Electrical and control and instrumentation. Cable termination methods.	Interview Underpinned by a Portfolio of Evidence

Ref.	Electrical and Control and Instrumentation Knowledge	Assessment method
K41	Electrical and control and instrumentation. Electrical plant, equipment, and systems maintenance requirements: removing and replacing parts, inspecting, testing, setting up, adjusting, cleaning, and functional testing.	Observation with Questions
K42	Electrical and control and instrumentation. Electrical maintenance tools, measurement and test equipment application, operation, care and calibration requirements.	Observation with Questions
K43	Electrical and control and instrumentation. Common electrical plant, equipment, and systems failure modes.	Interview Underpinned by a Portfolio of Evidence
K44	Electrical and control and instrumentation. Electrical fault-finding and rectification techniques; diagnostic equipment.	Interview Underpinned by a Portfolio of Evidence
K45	Electrical and control and instrumentation. Problem solving and critical reasoning techniques.	Interview Underpinned by a Portfolio of Evidence
K46	Electrical and control and instrumentation. Isolation and deisolation of connected services considerations and requirements.	Observation with Questions
K47	Electrical and control and instrumentation. Control and instrumentation engineering principles, terminology, and calculations.	Multiple-choice Test
K48	Electrical and control and instrumentation. Control and instrumentation equipment installation and connection requirements.	Multiple-choice Test
K49	Electrical and control and instrumentation. Operating principles of control and instrumentation devices: flow, level, pressure, and temperature instruments, analysers, transducers, transmitters, gauges, and pneumatics.	Multiple-choice Test
K50	Electrical and control and instrumentation. Open and closed loop systems. First and second order control systems. Proportional–integral–derivative controller (PID controller or three-term controller).	Multiple-choice Test
K51	Electrical and control and instrumentation. Functions and applications of control and instrumentation systems: programmable logic controller (PLC), Direct Digital Control (DDC), Distributed Control System (DCS), and Supervisory Control And Data Acquisition (SCADA).	Multiple-choice Test

Ref.	Electrical and Control and Instrumentation Knowledge	Assessment method
K52	Electrical and control and instrumentation. Types of control and instrumentation diagrams.	Multiple-choice Test
K53	Electrical and control and instrumentation. Control and instrumentation equipment and control systems maintenance requirements and methods: removing and replacing instruments and sensors, inspecting, testing, cleaning, setting up, calibration, and functional testing.	Observation with Questions
K54	Electrical and control and instrumentation. Control and instrumentation maintenance tools and equipment application, operation, care and calibration requirements.	Observation with Questions
K55	Electrical and control and instrumentation. Common control and instrumentation equipment and control system failure modes.	Interview Underpinned by a Portfolio of Evidence
K56	Electrical and control and instrumentation. Control and instrumentation maintenance fault-finding and rectification techniques; diagnostic equipment.	Interview Underpinned by a Portfolio of Evidence

Ref.	Electrical and Control and Instrumentation Skills	Assessment method
S27	Electrical and control and instrumentation. Confirm safe electrical isolation lockout tagout method has been applied and test for dead.	Observation with Questions
S28	Electrical and control and instrumentation. Select, check, and use electrical maintenance tools, measurement, and test equipment. Select, check, and use control and instrumentation maintenance tools, measurement, and test equipment.	Observation with Questions
S29	Electrical and control and instrumentation. Use electrical diagnostic equipment and apply fault finding and rectification techniques. Use control and instrumentation diagnostic equipment and apply fault finding and rectification techniques.	Interview Underpinned by a Portfolio of Evidence
S30	Electrical and control and instrumentation. Apply problem solving and critical reasoning techniques.	Interview Underpinned by a Portfolio of Evidence

Ref.	Electrical and Control and Instrumentation Skills	Assessment method
S31	Electrical and control and instrumentation. Inspect and test electrical aspects of plant. For example, visual checks, insulation and continuity checks, thermographic surveys, and voltage levels.	Observation with Questions
S32	Electrical and control and instrumentation. Remove and replace electrical parts.	Observation with Questions
S33	Electrical and control and instrumentation. Prepare and terminate electrical cables.	Interview Underpinned by a Portfolio of Evidence
S34	Electrical and control and instrumentation. Set up and adjust electrical aspects of plant.	Observation with Questions
S35	Electrical and control and instrumentation. Clean parts. For example, removal of dust and debris.	Observation with Questions
S36	Electrical and control and instrumentation. Conduct and confirm electrical and connected services isolation and deisolation.	Observation with Questions
S37	Electrical and control and instrumentation. Conduct functional testing.	Observation with Questions
S38	Electrical and control and instrumentation. Inspect and test control and instrumentation systems.	Observation with Questions
S39	Electrical and control and instrumentation. Check calibration and make adjustments.	Observation with Questions
S40	Electrical and control and instrumentation. Check loop function.	Observation with Questions
S41	Electrical and control and instrumentation. Set up and adjust control and instrumentation systems.	Observation with Questions
S42	Electrical and control and instrumentation. Remove and replace instruments and sensors.	Observation with Questions
S43	Electrical and control and instrumentation. Re-connect instrumentation power supply, cables, pipework, and services.	Observation with Questions

Ref.	Electrical and Mechanical Knowledge	Assessment method
K57	Electrical and mechanical. Electricity at Work regulations. IET wiring regulations.	Multiple-choice Test
K58	Electrical and mechanical. Electrical isolation and deisolation requirements: lockout tagout and testing for dead.	Observation with Questions
K59	Electrical and mechanical. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment.	Multiple-choice Test
K60	Electrical and mechanical. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory, and power calculations.	Multiple-choice Test
K61	Electrical and mechanical. Functions and applications of electrical circuits.	Multiple-choice Test
K62	Electrical and mechanical. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics.	Multiple-choice Test
K63	Electrical and mechanical. Different types of cables; their specifications and application.	Multiple-choice Test
K64	Electrical and mechanical. Cable termination methods.	Interview Underpinned by a Portfolio of Evidence
K65	Electrical and mechanical. Electrical plant, equipment, and systems maintenance requirements: removing and replacing parts, inspecting, testing, setting up, adjusting, cleaning, and functional testing.	Observation with Questions
K66	Electrical and mechanical. Electrical maintenance tools, measurement, and test equipment application, operation, care and calibration requirements.	Observation with Questions
K67	Electrical and mechanical. Common electrical plant, equipment, and systems failure modes.	Interview Underpinned by a Portfolio of Evidence
K68	Electrical and mechanical. Electrical fault-finding and rectification techniques; diagnostic equipment.	Interview Underpinned by a Portfolio of Evidence

Ref.	Electrical and Mechanical Knowledge	Assessment method
K69	Electrical and mechanical. Problem solving and critical reasoning techniques.	Interview Underpinned by a Portfolio of Evidence
K70	Electrical and mechanical. Isolation and deisolation of connected services considerations and requirements.	Observation with Questions
K71	Electrical and mechanical. Mechanical principles, terminology, and calculations: stress, strains, bending moment, heat transfer, fluid dynamics.	Multiple-choice Test
K72	Electrical and mechanical. Function and application of mechanical elements of plant and equipment.	Multiple-choice Test
K73	Electrical and mechanical. Pneumatic and hydraulic system principles: Air compressors, hydraulic pumps, filters, regulators, lubricators.	Multiple-choice Test
K74	Electrical and mechanical. Mechanical maintenance requirements and techniques: removing and replacing parts, inspecting, testing, setting up, adjusting, cleaning, and lubricating.	Observation with Questions
K75	Electrical and mechanical. Mechanical maintenance tools and equipment application, operation, care, and calibration requirements.	Observation with Questions
K76	Electrical and mechanical. Common maintenance problems relating to mechanical aspects of plant and equipment.	Interview Underpinned by a Portfolio of Evidence
K77	Electrical and mechanical. Mechanical maintenance fault-finding and rectification techniques; diagnostic equipment.	Interview Underpinned by a Portfolio of Evidence
K78	Electrical and mechanical. Bench fitting techniques: cutting threads, mechanical fitting, and joining.	Interview Underpinned by a Portfolio of Evidence
K79	Electrical and mechanical. Different types of mechanical fasteners and their uses.	Multiple-choice Test
K80	Electrical and mechanical. Types of diagrams used to represent mechanical installations and assemblies; symbols and abbreviations used to represent parts in diagrams.	Multiple-choice Test

Ref.	Electrical and Mechanical Skills	Assessment method
S44:	Electrical and mechanical. Confirm safe electrical isolation lockout tagout method has been applied and test for dead.	Observation with Questions
S45	Electrical and mechanical. Conduct and confirm electrical and connected services isolation and deisolation.	Observation with Questions
S46	Electrical and mechanical. Select, check, and use electrical and mechanical maintenance tools, measurement, and test equipment.	Observation with Questions
S47	Electrical and mechanical. Use electrical and mechanical diagnostic equipment and apply fault finding and rectification techniques.	Interview Underpinned by a Portfolio of Evidence
S48	Electrical and mechanical. Apply problem solving and critical reasoning techniques.	Interview Underpinned by a Portfolio of Evidence
S49	Electrical and mechanical. Inspect and test electrical aspects of plant. For example, visual checks, insulation and continuity checks, thermographic surveys, and voltage levels.	Observation with Questions
S50	Electrical and mechanical. Remove and replace electrical parts.	Observation with Questions
S51	Electrical and mechanical. Prepare and terminate electrical cables.	Interview Underpinned by a Portfolio of Evidence
S52	Electrical and mechanical. Set up, align, and adjust electrical aspects of plant.	Observation with Questions
S53	Electrical and mechanical. Clean parts. For example, removal of dust and debris.	Observation with Questions
S54	Electrical and mechanical. Conduct functional testing.	Observation with Questions
S55	Electrical and mechanical. Check condition and operation of mechanical aspects of plant and equipment. For example, pumps.	Observation with Questions
S56	Electrical and mechanical. Remove and replace mechanical parts.	Observation with Questions

Ref.	Electrical and Mechanical Skills	Assessment method
S57	Electrical and mechanical. Examine mechanical parts for defects. For example, pump seals.	Observation with Questions
S58	Electrical and mechanical. Set up, align, and adjust mechanical aspects of plant.	Observation with Questions
S59	Electrical and mechanical. Lubricate mechanical assemblies.	Observation with Questions
S60	Electrical and mechanical. Apply bench fitting techniques.	Interview Underpinned by a Portfolio of Evidence

Overall grade

This EPA is graded fail, pass, merit or distinction. The IEPA will individually grade the Observation with Questions and Interview Underpinned by a Portfolio of Evidence.

Information about how each assessment method is graded can be found in the 'Assessment instructions' sections of this pack. The apprentice will fail an assessment method if they do not meet the criteria.

In order to achieve an overall EPA **pass**, apprentices must achieve a pass in all the assessment methods.

In order to achieve an overall EPA **merit,** apprentices must achieve a distinction in the Observation with Questions and a pass in the Multiple-choice Test and Interview Underpinned by a Portfolio of Evidence.

In order to achieve an overall EPA **distinction**, apprentices must achieve a pass in the Multiple-choice Test and a distinction in both the Observation with Questions and the Interview Underpinned by a Portfolio of Evidence.

Grades from individual assessment methods will be combined in the following way to determine the grade of the EPA as a whole:

703/704 Observation with Questions	713/714 Interview Underpinned by Portfolio of Evidence	303/304 Multiple-choice Test	Overall grading
Any grade	Any grade	Fail	Fail
Any grade	Fail	Any grade	Fail
Fail	Any grade	Any grade	Fail
Pass	Pass	Pass	Pass
Pass	Distinction	Pass	Pass
Distinction	Pass	Pass	Merit
Distinction	Distinction	Pass	Distinction

The overall EPA grade will be capped at a **pass** if the apprentice has had to resit or retake any assessment method, however the grade the apprentice has achieved for each component is not capped and will be identified on the Statement of Achievement.

3. Gateway

The EPA period will only start when the **employer** is satisfied that the apprentice is consistently working at, or above, the level of the Standard. The apprentice must be able to evidence that they fully demonstrate the Occupational Standard and required level of professional competence in an authentic workplace context. In making this decision, the employer could take advice from the provider, but the ultimate decision is made solely by the employer.

If there is a **provider** working alongside the employer, they should support the apprentice's preparation for Gateway.

The apprentice must provide the following at Gateway:

- confirmation that they are ready to take the EPA
- confirmation of the achievement of English and mathematics qualifications in line with the apprenticeship funding rules
- a portfolio of evidence for the Interview Underpinned by a Portfolio of Evidence (accompanied by the signed and dated recording forms).

Any assessment materials relating to national security must not be submitted to City & Guilds.

The following should be completed on Proficient:

- Gateway Declaration Form signed by the apprentice
- Gateway Declaration by the provider, on behalf of the employer and tutor, confirming that the apprentice has completed the minimum time required on-programme, in line with the apprenticeship funding rules
- Gateway questions including initial information about the maintenance task(s) that the apprentice will be undertaking for the Observation with Questions.

City & Guilds will confirm when all the Gateway requirements have been met.

The 'Assessment instructions' sections provide additional details about the evidence which must be submitted at Gateway.

4. Timetable for End-point Assessment

The EPA period is typically completed within four months of the EPA Gateway, starting when City & Guilds has confirmed that all Gateway requirements have been met.

Further information about the booking process and timelines can be found in the City & Guilds Manual for the End-point Assessment Service.

Optional planning meetings will be provided for this Standard. The EPA Partnership Managers can provide additional guidance.

Ongoing during on-programme	Evidence and forms
Provider and employer • Reviews progress as part of their regular performance management process and ensures apprentice's performance is on track • Identifies any gaps and creates a plan with the apprentice • Enrols apprentice on Proficient (checking that the apprentice is enrolled onto the correct option and Standard) and provides 'Expected date ready for EPA'	Completes: • Gateway questions on Proficient
Apprentice • Completes training to develop the knowledge, skills and behaviours (KSBs) outlined in the Apprenticeship Standard (Section 2 of this pack) • Fulfils the English and Mathematics requirements in line with the apprenticeship funding rules • Compiles a portfolio of evidence	Collates: • Portfolio of evidence (typically during the last 12 months of the apprenticeship)
Gateway process	**Evidence and forms**
Employer • Reviews progress and confirms that the apprentice is ready for EPA • Reviews the evidence to confirm that it is appropriate and sufficient to meet the Standard	Signs: • Portfolio of evidence reference form and declaration of authenticity • Gateway questions on Proficient • Apprentice Gateway Declaration

• Plans the maintenance task(s) to be completed in the observation with questions	
Apprentice • Attends the optional EPA planning meeting • Must have been on programme for the minimum time required, in line with the apprenticeship funding rules • Plans the maintenance task(s) to be completed in the observation with questions • Completes and submits evidence and forms	Submits to provider: • Apprentice Gateway Declaration • Portfolio of evidence • Portfolio of evidence reference form and declaration of authenticity
Provider – on Proficient • Books EPA on Proficient, in line with City & Guilds; booking timelines are in the EPA Manual • Makes City & Guilds aware of any additional needs of the apprentice so that they can review reasonable adjustments – see the current policy on the City & Guilds website, under EPA Documents Library • Completes Provider Gateway Declaration **on behalf of the employer and tutor** • Uploads evidence and forms onto Proficient	Complete on Proficient: • Provider Gateway Declaration • Preferred (optional) planning meeting date form (on behalf of the employer) • Gateway questions Signs: • Declaration of authenticity Uploads onto Proficient: • Apprentice Gateway Declaration • Portfolio of evidence, accompanied by the relevant portfolio of evidence reference form and declaration of authenticity forms
City & Guilds EPA Gateway Team • Formally confirms when all the Gateway requirements have been met	N/A
City & Guilds EPA Team • Agrees on a mutually convenient date for the optional EPA planning meeting with the provider and IEPA • Agrees on a mutually convenient date for the EPA events with the provider and IEPA	N/A
Post Gateway	**Evidence and forms**
• Employer, provider, apprentice and IEPA attend the (optional) planning meeting	N/A
End-point Assessment	**Evidence and forms**
Apprentice • CompletesEPAs	N/A
Employer • Ensures the apprentice has access to the resources required for the assessments (see the Resources section)	N/A
Provider • Submits evidence and forms	N/A
IEPA	Completes:

• Reviews the portfolio of evidence prior to the interview assessment • Carries out EPAs • Marks each assessment, communicates the results to the LIEPA • Provides feedback for assessments in Proficient	• IEPA recording forms • Overall grade recording form • Feedback form
LIEPA • Samples and quality-assures the assessments	Reviews: • IEPA recording forms • Overall grade recording form • Feedback form
City & Guilds EPA Team • Communicates the results to the provider via Proficient • Processes the overall result if the apprentice has passed all the assessments and advises Skills England, who issue the certificate. The data will be provided to Skills England.	N/A

Summary timescales

Readers should check the previous Timetable and the Assessment Instruction sections of this document for the detailed requirements for each stage.

Further information on EPA Service Timelines can be found on www.cityandguilds.com.

On programme	Enrol apprentice on Proficient, including 'expected date ready for EPA' Collate portfolio of evidence
Gateway process	Provider submits required evidence and forms on Proficient Portfolio of evidence submitted Completes Gateway questions
Gateway	Assessment components can only be booked after Gateway has been approved
Planning meeting	(Optional) planning meeting takes place a minimum of ten working days after Gateway
Observation with Questions	City & Guilds must give the apprentice 2 weeks' notice of the observation with questions
Interview Underpinned by a Portfolio of Evidence	City & Guilds must give the apprentice 2 weeks' notice of the interview
Multiple-choice Test	The apprentice must be given at least 2 weeks' notice of the date and time of the multiple-choice test

End-point Assessment completed

5. End-point Assessment resources

Assessment method	Resources required
Observation with Questions	Realistic working environment reflecting typical working conditions on actual plant and equipment with normal personnel available, eg operators, manager/supervisors. Under exceptional circumstances, the Observation with Questions can be carried out in a simulated environment. This must be agreed with the City & Guilds EPA Operations team. The environment should include sufficient space for the City & Guilds IEPA to observe and take notes. A separate room must be made available for the IEPA which is free from distractions and interruptions. Any organisation/task-specific PPE must be made available to the IEPA.
Interview Underpinned by a Portfolio of Evidence	A quiet room, free from distractions and interruptions. It must be away from the pressures of work activities, in a controlled environment. This will be on either the employer's or provider's premises. Access to water and cups. Where applicable, internet access and suitable equipment for remote assessment, as outlined in the EPA Manual.
Multiple-choice Test	IT systems set up to receive e-volve tests, as set out in the EPA Manual. An invigilator. A suitably controlled and invigilated environment that is a quiet room, free from distractions and influence. It must be away from the pressures of work activities. This will be on either the employer's or provider's premises.

6. Assessment information: 303/304 Multiple-choice Test

Overview

The Multiple-choice Test gives the apprentice the opportunity to demonstrate the knowledge mapped to this assessment method. Apprentices will complete one Multiple-choice Test covering knowledge for the **core** and their selected **option**.

Rationale

This assessment method is being used because it can assess knowledge, is easy to administer and can be conducted remotely and administered to multiple apprentices at the same time, potentially reducing cost.

In accordance with Skills England's EPA requirements for this standard, S13 is assessed through the Multiple-Choice Test (MCT) using scenario-based questions that assess the application of knowledge and understanding within realistic engineering maintenance contexts.

Number of questions	50
Marks available	50
Grading	P/X To achieve a **pass**, the apprentice must achieve a minimum of 35 marks (70%)
Type of questions	Multiple choice
Duration	75 minutes
Marking	The test will be carried out online and marked electronically
Permitted materials	Closed book: This means the apprentice cannot refer to reference books or materials during the test
Equipment	Scientific calculator
Location	A suitably controlled and invigilated environment that is a quiet room, free from distractions and influence

Assessment specifications

9331-303 Electrical and Control and Instrumentation engineering maintenance technician

KSB	KSB statement	Questions	%
K6	Core: Equipment life cycle considerations.	1	2%
K7	Core: Maintenance strategies: planned preventative maintenance (PPM), condition-based maintenance (CBM), scheduled maintenance, total productive maintenance (TPM), breakdown and run to failure maintenance.	2	4%
K8	Core: Health and safety regulations – key features and impact on role: ATEX - safety requirements for workplaces and equipment used in explosive atmospheres, Control of Asbestos Regulations, Control of Major Accident Hazards (COMAH) Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), Display Screen Equipment Regulations (DSE), Health and Safety at Work Act (HASAWA), Lifting Operations and Lifting Equipment Regulations (LOLER), Management of Health and Safety at Work, Manual Handling Operations Regulations, Personal Protective Equipment (PPE) at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), Working at Height Regulations, Working in Confined Spaces Regulations, Workplace (health, safety, and welfare) Regulations.	4	8%
K13	Core: Environmental regulations and standards – impact on role: Environmental Management Systems standard, Environmental Protection Act, and Hazardous Waste Regulations.	2	4%
K17	Core: Algebraic methods. Trigonometric methods and 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.	2	4%
K18	Core: Properties of engineering materials and impact on use.	2	4%
K21	Core: Engineering representations, sketches, drawings, and graphical information conventions.	2	4%

KSB	KSB statement	Questions	%
K32	Core: Industry 4.0 - the integration of physical systems with internet connectivity and cloud computing: technologies, systems, and benefits.	3	6%
S13	Core: Use mathematical principles and formulae to support engineering maintenance.	2	4%
K33	Electrical and control and instrumentation. Electricity at Work regulations. IET wiring regulations.	3	6%
K35	Electrical and control and instrumentation. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment.	3	6%
K36	Electrical and control and instrumentation. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory and power calculations.	3	6%
K37	Electrical and control and instrumentation. Functions and applications of electrical circuits.	3	6%
K38	Electrical and control and instrumentation. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics.	2	4%
K39	Electrical and control and instrumentation. Different types of cables; their specifications and application.	2	4%
K47	Electrical and control and instrumentation. Control and instrumentation engineering principles, terminology, and calculations.	2	4%
K48	Electrical and control and instrumentation. Control and instrumentation equipment installation and connection requirements.	2	4%
K49	Electrical and control and instrumentation. Operating principles of control and instrumentation devices: flow, level, pressure, and temperature instruments, analysers, transducers, transmitters, gauges, and pneumatics.	3	6%
K50	Electrical and control and instrumentation. Open and closed loop systems. First and second order control systems. Proportional–integral–derivative controller (PID controller or three-term controller).	2	4%
K51	Electrical and control and instrumentation. Functions and applications of control and instrumentation systems:	3	6%

KSB	KSB statement	Questions	%
	programmable logic controller (PLC), Direct Digital Control (DDC), Distributed Control System (DCS), and Supervisory Control And Data Acquisition (SCADA).		
K52	Electrical and control and instrumentation. Types of control and instrumentation diagrams.	2	4%
	Total	**50**	**100%**

9331-304 Electrical and mechanical engineering maintenance technician

KSB		KSB statement	Questions	%
K6	Core: Equipment life cycle considerations.	1		2%
K7	Core: Maintenance strategies: planned preventative maintenance (PPM), condition-based maintenance (CBM), scheduled maintenance, total productive maintenance (TPM), breakdown and run to failure maintenance.	2		4%
K8	Core: Health and safety regulations – key features and impact on role: ATEX - safety requirements for workplaces and equipment used in explosive atmospheres, Control of Asbestos Regulations, Control of Major Accident Hazards (COMAH) Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), Display Screen Equipment Regulations (DSE), Health and Safety at Work Act (HASAWA), Lifting Operations and Lifting Equipment Regulations (LOLER), Management of Health and Safety at Work,	4		8%

KSB		KSB statement	Questions	%
	Manual Handling Operations Regulations, Personal Protective Equipment (PPE) at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), Working at Height Regulations, Working in Confined Spaces Regulations, Workplace (health, safety, and welfare) Regulations.			
K13	Core: Environmental regulations and standards – impact on role: Environmental Management Systems standard, Environmental Protection Act, and Hazardous Waste Regulations.	2		4%
K17	Core: Algebraic methods. Trigonometric methods and 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.	2		4%
K18	Core: Properties of engineering materials and impact on use.	2		4%
K21	Core: Engineering representations, sketches, drawings, and graphical information conventions.	2		4%
K32	Core: Industry 4.0 - the integration of physical systems with internet connectivity and cloud	3		6%

KSB		KSB statement	Questions	%
	computing: technologies, systems, and benefits.			
S13		Core: Use mathematical principles and formulae to support engineering maintenance.	2	4%
K57		Electrical and mechanical. Electricity at Work regulations. IET wiring regulations.	3	6%
K59		Electrical and mechanical. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment.	3	6%
K60		Electrical and mechanical. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory, and power calculations.	3	6%
K61		Electrical and mechanical. Functions and applications of electrical circuits.	3	6%
K62		Electrical and mechanical. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics.	2	4%
K63		Electrical and mechanical. Different types of cables; their specifications and application.	2	4%
K71		Electrical and mechanical. Mechanical principles, terminology, and calculations: stress, strains,	3	6%

KSB	KSB statement	Questions	%
	bending moment, heat transfer, fluid dynamics.		
K72	Electrical and mechanical. Function and application of mechanical elements of plant and equipment.	3	6%
K73	Electrical and mechanical. Pneumatic and hydraulic system principles: Air compressors, hydraulic pumps, filters, regulators, lubricators.	3	6%
K79	Electrical and mechanical. Different types of mechanical fasteners and their uses.	3	6%
K80	Electrical and mechanical. Types of diagrams used to represent mechanical installations and assemblies; symbols and abbreviations used to represent parts in diagrams.	2	4%
	Total	**50**	**100%**

Assessment instructions

Delivery

The Multiple-choice Test is structured to give the apprentice the opportunity to demonstrate the knowledge mapped to this assessment method to the highest available grade. The test is computer-based via City & Guilds' e-volve platform.

A minimum of two questions will be included that assess S13 'Use mathematical principles and formulae to support engineering maintenance'. These questions will be scenario based to assess the application of mathematical principles and formulae in an engineering maintenance context.

The apprentice must be given at least two weeks' notice of the date and time of the test.

Administration

The apprentice must have 75 minutes to complete the test. The test is closed book which means that the apprentice cannot refer to reference books or materials whilst completing the test. A scientific calculator is allowed to be used during the test.

Assessment location

The apprentice must take the test in a suitably controlled and invigilated environment that is a quiet room, free from distractions and influence.

KSBs and amplification

In order to support teaching and learning, knowledge statements assessed through the multiple-choice tests have been amplified. The full amplification can be found in **Appendix 1.**

Grading

The Multiple-choice Test will be graded fail or pass.

Grade	Marks	%
Fail	34	68%
Pass	35	70%

7. Assessment information: 703/704 Observation with Questions

Overview

The IEPA will observe the apprentice in their workplace and will ask questions, giving the apprentice the opportunity to demonstrate the KSBs mapped to this assessment method. The apprentice will complete their day-to-day duties under normal working conditions. The assessment will take place in a realistic working environment that does not require special clearance.

Rationale

This assessment method is being used because it is a practical role and the assessment can take place in a real work setting, giving employers assurance about an apprentice's competence. The familiar setting should also allow apprentices to perform at their best whilst allowing for holistic assessment of the KSBs. This assessment method is cost effective and tasks completed during assessment should contribute to workplace productivity, making use of the employer's resources and equipment.

Number of questions	The IEPA will ask a minimum of six questions.
Grading	P/D/X To achieve a **pass** the apprentice must demonstrate all of the pass grading descriptors. To achieve a **distinction**, the apprentice must demonstrate all of the pass descriptors and all of the distinction descriptors.
Type of assessment	Observation with Questions
Duration	Five hours. The IEPA can increase the time by up to 10%
Permitted materials	Apprentices are allowed access to the documentation that they would usually use in their daily work. This includes organisation-specific work instructions and job cards where required.
Location	The Observation with Questions will be conducted face to face at the apprentice's normal place of work.
Resources	Apprentices must have access to the resources they use to complete their usual daily work activities.

Assessment specifications

The apprentice will be assessed against the **core** and one **option**.

9331-703 Electrical and Control and Instrumentation Engineering Maintenance Technician

Description	Coverage	KSBs	Grade
Observation with Questions	Core - Organising own work	K4, K5, S2, S3	P/D/X
	Core - Maintaining workplace health, safety, security and environmental compliance	K9, K10, K11, K12, K15, S7, S8, S9, S12, B1	
	Core - Using work information and following working practices	K19, K20, K22, K23, K24, S1, S5, S6, S14 S15, S16, S17, S23, B3	
	Core - Completing work records	K25, S21	
	Core - Communicating with others	K29, S19	
	Conducting planned electrical and control and instrumentation maintenance	K34, K41, K42, K46, K53, K54, S27, S28, S31, S32, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43	

9331-704 Electrical and Mechanical Engineering Maintenance Technician

Description	Coverage	KSBs	Grade
Observation with Questions	Core - Organising own work	K4, K5, S2, S3	P/D/X
	Core - Maintaining workplace health, safety, security and environmental compliance	K9, K10, K11, K12, K15, S7, S8, S9, S12, B1	
	Core - Using work information and following working practices	K19, K20, K22, K23, K24, S1, S5, S6, S14 S15, S16, S17, S23, B3	

Description	Coverage	KSBs	Grade
	Core - Completing work records	K25, S21	
	Core - Communicating with others	K29, S19	
	Electrical and Mechanical - Conducting planned electrical and mechanical maintenance	K58, K65, K66, K70, K74, K75, S44, S45, S46, S49, S50, S52, S53, S54, S55, S56, S57, S58, S59	

Assessment instructions

Duration

The Observation with Questions will take five hours. The IEPA may increase the time of the assessment by up to 10% to allow the apprentice to complete a task or respond to a question if necessary. The time for questioning is included in the overall assessment time.

The apprentice may choose to end the assessment method early, but the apprentice must be confident they have demonstrated competence against the assessment requirements for the assessment method. The IEPA cannot suggest or choose to end the assessment early, unless in an emergency. The IEPA will explain to the apprentice the implications of ending the assessment early or may suggest that the assessment continues. The IEPA will record the apprentice's request to end the assessment early.

Delivery

The IEPA will observe one apprentice at a time to ensure quality and rigour of the assessment and will be as unobtrusive as possible.

Assessment location

The Observation with Questions must take place at the apprentice's normal place of work, for example the employer's or a customer's premises. In **exceptional circumstances**, ie where national security clearance, nuclear licensed clearance or live gas site safety concerns prevent the IEPA from being able to access an employer's or customer's premises, the IEPA will take advice from the City & Guilds EPA team on access arrangements and how to record assessment evidence in line with the employer's requirements. In these circumstances, it

may be necessary for the assessment to take place in a simulated environment, eg a training provider's premises, a training facility in the employer's premises, a test centre or a similar simulated environment.

In all cases where a simulated environment is requested, it must relate to the apprentice's natural work environment and must be agreed with the City & Guilds EPA team prior to the assessment taking place.

Resources

The apprentice will need access to the documentation and resources they use in their daily work. Equipment and resources needed for the observation must be confirmed to be available prior to the assessment and must be in good and safe working condition. Please ensure that any specific PPE required for the premises is provided to the IEPA on the day of the assessment.

Administration

The City & Guilds EPA team will arrange the date and time of the Observation with Questions with the employer/provider and apprentice.

Prior to the assessment

Planning

The provider, employer and apprentice must plan the maintenance task(s)/work to be undertaken, ensuring that the tasks/work will enable the apprentice to demonstrate the KSBs and grading descriptors in the specification, within the five hour (+10%) assessment time.

The provider must also complete the Gateway questions that relate to:

- the assessment location/venue, eg access requirements such as site induction, where the assessment will be carried out and if there are any exceptional circumstances that may necessitate a simulated environment
- details of the planned maintenance task(s), eg the nature of the task(s) and if there are likely to be any pre-installed aspects (n.b. only certain skills statements are allowed to have pre-installed aspects, see as follows).

It is strongly recommended a planning meeting is arranged with the employer, apprentice and IEPA present. Suggested dates for the planning meeting must be provided at Gateway.

An optional planning document is provided in **Appendix 4** to support employers/providers and apprentices to plan the maintenance tasks. If a planning meeting has been arranged, this document can be used to support the discussion with the IEPA in the meeting.

Pre-installed aspects

If demonstration of the following skills will not naturally occur in the work/tasks the apprentice will be undertaking, then it is possible to include minimal pre-installed aspects to replicate real scenarios. Skills where pre-installed aspects are permissible are as follows:

- S32 Remove and replace electrical parts
- S39 Check calibration and make adjustments
- S41 Set up and adjust control and instrumentation systems
- S42 Remove and replace instruments and sensors
- S56 Remove and replace mechanical parts
- S58 Set up, align, and adjust mechanical aspects of plant

Any pre-installed aspects relating to these skills must be communicated and agreed with the IEPA prior to the start of the assessment (the planning document can be used to capture this information).

During the assessment

The IEPA will observe the apprentice undertaking planned maintenance task(s) that demonstrate the **core** and relevant **option** requirements:

Core requirements

- Organising own work
- Maintaining workplace health, safety, security and environmental compliance
- Using work information and following working practices
- Completing work records
- Communicating with others

Electrical and control and instrumentation engineering maintenance technician apprentices must cover the core requirements and:

- safe electrical isolation and de-isolation procedures including re-connecting instrumentation power supply, cables, pipework and services
- selecting, checking and using tools and equipment in line with task requirements
- inspection and testing
- removing and replacing electrical parts, instruments and systems
- setting up and adjusting electrical aspects of plant and equipment
- checking calibration and loop function
- cleaning parts
- conducting functional testing

Electrical and mechanical engineering maintenance technician apprentices must cover the core requirements and:

- checking and confirming safe isolation and de-isolation
- selecting, checking and using tools and equipment in line with task requirements
- checking the operation and condition of electrical and mechanical aspects of plant and equipment
- examining mechanical parts for defects
- setting up and adjusting mechanical aspects of plant and equipment
- removing and replacing electrical parts
- cleaning parts, lubricating mechanical assemblies
- conducting functional testing.

It is important that employers/providers and apprentices refer to the assessment specification found in this section and the relevant core and option KSBs and grading descriptors in **Appendix 2** when planning the work to be undertaken.

Photographs

If the IEPA intends to take photographs during the observation, eg of the various stages of the work being carried out, then permission will be sought from both the employer and apprentice prior to the assessment.

Questioning

The IEPA will ask the apprentice at least six questions as part of the assessment, ensuring that they do not disrupt the apprentice's flow as they are completing the task(s). If questioning occurs after the observation, then this will take place in a quiet room, free from distractions and influence. The IEPA's questions will be included in the overall five hours of assessment time.

Grading

The Observation with Questions will be graded fail, pass or distinction. The IEPA is fully responsible for making the grading decision. The results will not be shared with you on the day of the assessment.

8. Assessment information: 713/714 Interview Underpinned by a Portfolio of Evidence

Overview

In the interview, the IEPA asks the apprentice questions giving them the opportunity to demonstrate the KSBs mapped to this assessment component. The apprentice can refer to and illustrate their answers with evidence from their submitted portfolio of evidence. The City & Guilds EPA team will arrange the dates and times for the interview with the employer/provider and apprentice.

Rationale

This assessment method is being used because it allows for the holistic assessment of KSBs that do not occur on a predictable or regular basis. It also allows for the assessment of responses where there are a range of potential answers. The interview can be conducted remotely if required.

Number of questions	The IEPA will ask a minimum of ten questions. Follow-up questions may be asked where clarification is required. Whilst the portfolio of evidence is not directly assessed, the IEPA will use it to prepare their questions and guide the interview.
Grading	Pass/Fail/Distinction The apprentice must demonstrate all the pass grading descriptors to achieve a **pass**. The apprentice must demonstrate all the pass and distinction grading descriptors to achieve a **distinction**.
Type of assessment	Interview Underpinned by a Portfolio of Evidence
Duration	90 minutes. The IEPA can increase the time by 10% if required.
Permitted materials	Portfolio of evidence
Location	Employer or provider premises, in a quiet room free from distractions. The interview can be conducted face to face or by video conferencing.

Resources	A suitable room for the interview to take place that is quiet and free from distractions and influence. Seating area or room for any other apprentices to wait (if appropriate). Access to water and cups. Internet access and suitable equipment such as use of video link. If a video link is used appropriate measures must be in place to ensure that City & Guilds is satisfied that the responses given are those of the apprentice, eg use of a 360-degree camera to allow the assessor to look around the room during the interview.

Assessment specifications

The apprentice will be assessed on the core and one option.

713 Electrical and control and instrumentation engineering maintenance technician

Description	Coverage	KSBs	Grade
Interview underpinned by a portfolio of evidence	Core - Impact of the sector on maintenance activities	K1	X/P/D
	Core - Role and responsibilities	K2, K3, K16, S4, S10, S20	
	Core - Working sustainably	K14, S11, B2	
	Core - Participating in continuous improvement	K26, S25, S26, B5	
	Core - Teamworking	K27, K28, S18, B4	
	Core - Produce written documents	K30, S22	
	Core - Digital and information technology	K31, S24	
	Electrical and Control and Instrumentation maintenance problem solving and fault finding	K43, K44, K45, K55, K56, S29, S30	
	Cable installation and termination	K40, S33	

714 Electrical and mechanical engineering maintenance technician

Description	Coverage	KSBs
Interview Underpinned by a Portfolio of Evidence	Core - Impact of the sector on maintenance activities	K1
	Core - Role and responsibilities	K2, K3, K16, S4, S10, S20
	Core - Working sustainably	K14, S11, B2

Description	Coverage	KSBs
	Core - Participating in continuous improvement	K26, S25, S26, B5
	Core - Teamworking	K27, K28, S18, B4
	Core - Produce written documents	K30, S22
	Core - Digital and information technology	K31, S24
	Electrical and Mechanical maintenance problem solving and fault finding	K67, K68, K69, K76, K77, S47, S48
	Cable installation and termination techniques	K64, S51
	Bench fitting techniques	K78, S60

Assessment instructions

Duration

The interview must last for 90 minutes. The IEPA can increase the time of the interview by up to 10% to allow the apprentice to respond to a question if necessary.

The apprentice may choose to end the assessment method early but must be confident they have demonstrated competence against the assessment requirements for the assessment method. The IEPA cannot suggest or choose to end the assessment early, unless in an emergency. The IEPA will explain to the apprentice the implications of ending the assessment early or may suggest that the assessment continues. The IEPA will record the apprentice's request to end the assessment early.

Delivery

The interview will be structured to give the apprentice the opportunity to demonstrate the KSBs mapped to this assessment method to the highest available grade. During the interview, the IEPA will ask the apprentice at least nine questions based on the apprentice's submitted portfolio of evidence and the grading descriptors. The purpose of the questions is to assess the apprentice's competence against the required core and option themes. Coverage of the themes is shown in the assessment specification for this assessment method.

Assessment location

The interview may be conducted in person or remotely. The interview must take place in a suitable venue, for example, the employer's or provider's premises. The assessment location will be agreed by the City & Guilds EPA team. The employer/provider is responsible for ensuring that the assessment can take place in appropriate surroundings which are free from distractions and influence. This could include ensuring that appropriate signposting and other arrangements are in place to maintain a suitable environment throughout the duration of the assessment activity.

The IEPA will verify the identity of the apprentice and ensure the apprentice is not being aided during the interview.

Administration

The date and time of the interview must be planned in advance to ensure that the apprentice has sufficient time to prepare. The apprentice must have at least two weeks' notice of the date of the interview.

Portfolio of Evidence requirements (including authentication of)

The apprentice will compile their portfolio during the on-programme period of the apprenticeship, usually towards the end of the apprenticeship in the last 12 months. The evidence can be produced in electronic format or scanned/photographed to give a clear electronic representation, as it must be submitted electronically for End-point Assessment.

The apprentice's portfolio of evidence must only contain evidence related to the KSBs that will be assessed during the interview assessment.

Evidence must be mapped against the KSBs and can demonstrate more than one KSB; a qualitative as opposed to quantitative approach is suggested.

Types of evidence

The portfolio of evidence should cover the specific activities/jobs the apprentice has undertaken which demonstrate the KSBs mapped to this assessment component. It is recommended that a maximum of three activities/jobs will be covered by the portfolio of evidence. These activities/'jobs' can be evidenced in a variety of ways and will typically include 10 pieces of discrete evidence, for example:

- workplace documentation and records: for example maintenance records, fault investigation reports
- witness statements, eg from a manager or a customer
- annotated photographs, eg of a specific activity carried out
- video clips with a maximum total duration of 10 minutes; the apprentice must be in view and identifiable.

This is not a definitive list and other evidence sources can be included.

The portfolio of evidence should not include reflective accounts or any methods of self-assessment. Any employer contributions should focus on direct observation of performance, for example, witness statements, rather than opinions.

All evidence must be of the apprentice's own work and, for any group work, must clarify and focus only on their contribution.

Where necessary, confidentiality and data protection requirements must be adhered to, eg permissions for use of video/images containing identifiable third parties (eg clients), anonymised documentation and permissions from clients when submitting designs and plans commissioned by them.

Selecting evidence

Before selecting the evidence to form the portfolio, the apprentice should review the assessment requirements and specification to confirm:

- the KSBs to be covered by the portfolio
- the type of evidence that can be presented (see above)
- the amount of evidence that should be presented
- the period of time from which the evidence should have originated (usually this will be towards the end of the apprenticeship).

To assemble their portfolio, the apprentice should consider all the evidence they have available that shows they have met the requirements being assessed. Evidence collected towards the end of their apprenticeship programme, as they become independent in their work, is likely to provide the most holistic evidence – ie covering a number of criteria at once. From this, they should select evidence that **most efficiently** meets all the relevant criteria and which demonstrates their **best performance**. While there may be some overlap between the evidence collected, multiple pieces of evidence showing coverage of the same criteria should not normally be submitted for End-point Assessment.

There are two questions that an apprentice should consider when selecting work to form their portfolio:

1. *Which pieces holistically (most efficiently) give evidence that together cover all of the relevant criteria?*
2. *Is this the **best** evidence I have, showing that I have met all of the requirements for the higher grade?*

Confirming the evidence selection

When the apprentice has selected the evidence to form their portfolio, this must be reviewed by the employer/provider to ensure:

- all assessment requirements have been met
- there is no unnecessary duplication of evidence against the same criteria

- the work selected represents the best evidence available in relation to grading requirements
- the clarity of any images or scanned evidence is sufficient to determine the quality of the original evidence
- authenticity of evidence has been established.

The provider/employer is responsible for providing guidance to the apprentice on compiling the portfolio of evidence whilst on programme. The employer should provide suitable work for the apprentice to apply themselves to and discuss at interview.

The provider/employer is responsible for the review of the portfolio of evidence and if, in its entirety, it does not contain sufficient evidence to meet the Standard then it will be deemed not yet ready to submit. The apprentice must be advised by the employer/provider about the shortfalls in evidence and how this can be addressed.

A portfolio of evidence checklist has been provided in **Appendix 5** to support the apprentice and employer/provider in the preparation and submission of the portfolio of evidence.

Preparing the portfolio of evidence for submission

The portfolio of evidence and completed **portfolio of evidence reference form** must be reviewed by the employer/provider and the apprentice to ensure it meets the requirements of the Standard and to confirm that the apprentice is ready for EPA.

The evidence will not be directly assessed but the IEPA will use the information provided to base their questions on. The City & Guilds EPA team may ask for further clarification if required.

The evidence provided must be valid and attributable to the apprentice and the submitted portfolio must be accompanied by the signed **declaration of authenticity**. In the cases of national security, arrangements may be made between City & Guilds and the employer for the redaction of information in the evidence, as per the employer's security policy, or where this is not possible, on-site reviewing of the evidence prior to the interview taking place.

Submission to City & Guilds

The following documents must be submitted to City & Guilds at Gateway:

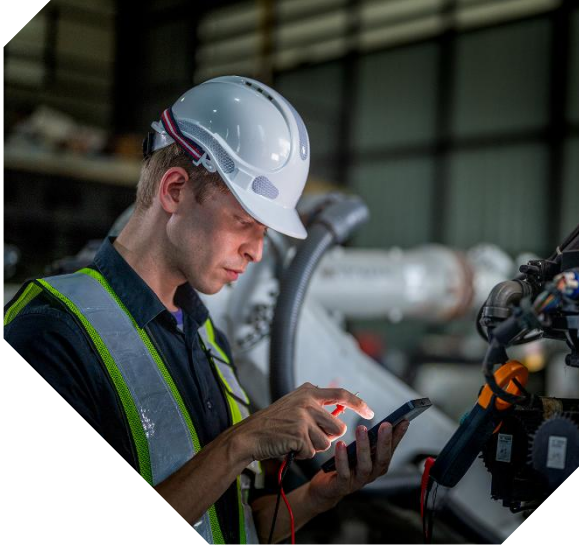
- portfolio of evidence
- declaration of authenticity (signed by the apprentice, provider and employer representative)
- portfolio of evidence reference form.

KSBs and grading descriptors

A mapping table detailing KSBs assessed using this method and grading descriptors can be found in Appendix 2.

Grading

The interview will be graded fail, pass or distinction. The IEPA is fully responsible for making the grading decision. The results will not be shared with you on the day of the assessment.



9. Resits and retakes

Apprentices who fail one or more assessments will be offered the opportunity for a resit or retake at their employer's discretion.

- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

The employer and City & Guilds will agree the timescale for a resit or retake. A resit is typically taken within two months of the EPA outcome notification. The timescale for a retake is dependent on how much re-training is required and is typically taken within four months of the EPA outcome notification.

Any failed assessment method must be resat or retaken within a six-month period from the EPA outcome notification, otherwise the entire EPA will need to be resat or retaken in full.

Resits or retakes must not be offered to an apprentice wishing to move from pass to a higher grade.

The overall EPA grade will be capped at a pass if the apprentice has had to resit or retake any assessment method, however the grade the apprentice has achieved for each component is not capped and will be identified on the statement of achievement.

303/304 Multiple-choice Test

If the retake or resit relates to the multiple-choice test, the apprentice will be presented with a new randomised online multiple-choice test.

703/704 Observation with Questions

If the resit or retake relates to the observation with questions, the IEPA will observe the apprentice under the same circumstances.

713/714 Interview Underpinned by a Portfolio of Evidence

If the resit or retake relates to the interview underpinned by a portfolio of evidence, the IEPA will question the apprentice on the same subject area but using a different set of questions.

The interview will be carried out in the same way as the original assessment. The IEPA may review the portfolio of evidence again to ensure all the KSBs are evidenced.

Submission must include

An updated portfolio reference form if required. These must refer to the version of recording forms originally submitted.

10. Security, confidentiality and copyright of End-point Assessment materials

The following Terms of Use apply to the use of any City & Guilds EPA Assessment Materials ("EPA Assessment Materials"), included with the EPA Pack or otherwise provided by City & Guilds to the Customer from time to time under City & Guilds' EPA Service, by Customers. They form part of the Agreement between City & Guilds and the Customer for provision of City & Guilds' EPA Service in accordance with the Manual for the End-point Assessment Service (hereafter the Manual).

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- (where any EPA Assessment Materials are dated examinations), the City & Guilds invigilation instructions; and
- any conditions contained in a document itself.

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Terms of Use

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- **only** use any EPA Assessment Materials for the purpose of formal, summative EPA assessment in connection with the Agreement and not for any other purpose (including, but not restricted to, teaching, revision, as practice assessments or for commercial purposes);
- **not** make copies of any EPA Assessment Materials, whether in whole or in part, at any time;
- handle and store any EPA Assessment Materials securely at all times;
- ensure that:
    - any EPA Assessment Materials are made accessible to Apprentices only during formal EPA assessment as governed by the assessment conditions specified for the individual Apprenticeship Standard;

    - whilst the portfolio of an Apprentice may contain EPA assessment results referenced to the EPA assessment taken from time to time, they do not at any time contain the EPA Assessment Materials, unless otherwise stated in the individual Apprenticeship Standard; and the content of any EPA Assessment Materials is not made public in any format, whether in part or in full, at any time;
- **under no circumstances** share any EPA Assessment Materials with any third-party organisation or individual;
- seek written permission from City & Guilds if they wish to convert any EPA Assessment Materials for storage, retrieval and delivery in electronic form (ie, using some form of e-assessment or e-learning system) from time to time; and
- provide access, on request, to City & Guilds to any system(s) on which any EPA Assessment Materials appear, are stored or delivered from time to time.

Appendix 1 KSB amplification for 303/304 Multiple-Choice Tests

K6 Equipment life cycle considerations

Topic	Content – What needs to be covered
6.1 Stages of equipment life cycle	6.1.1 Stages of equipment life cycle a) Concept and planning: Identifying requirements, feasibility studies and risk assessments b) Design and procurement: Material selection, specification writing and supplier evaluation c) Installation and commissioning: Site preparation, alignment and initial testing d) Operation and utilisation: Day-to-day use, performance monitoring and minor adjustments e) Maintenance and renewal: Applying strategies to preserve or restore functionality f) Decommissioning and disposal: Safe shutdown, dismantling, recycling or scrapping
6.2 Factors for equipment life cycle	6.2.1 Factors for equipment life cycle a) Cost-effectiveness i) Total cost of ownership (TCO): Balancing upfront cost of initial investment against ongoing expense of maintenance and operational costs b) Reliability and availability i) Mean time between failures (MTBF) ii) Redundancy iii) Critical analysis c) Technology life cycle planning i) Obsolescence ii) Upgradability iii) Artificial intelligence (AI) d) Net zero targets, energy efficiency, carbon footprint and net zero impacts e) Health and safety integration i) Compliance with health and safety regulations ii) Risk mitigation strategies

K7 Maintenance strategies: planned preventative maintenance (PPM), condition-based maintenance (CBM), scheduled maintenance, total productive maintenance (TPM), breakdown and run to failure maintenance

Topic	Content – What needs to be covered
7.1 Maintenance strategy methods	7.1.1 Maintenance strategies and systematic methods used to manage the reliability, availability and performance of plant, equipment and systems a) Planned preventive maintenance (PPM): Time- or usage-based routines performed at fixed intervals to prevent failure b) Condition-based maintenance (CBM): Triggered by monitored data indicating degradation c) Total productive maintenance (TPM): Holistic, collaborative approach aiming for zero defects and breakdowns i) Daily checks ii) Autonomous maintenance iii) Focused improvement iv) Training d) Breakdown or run-to-failure maintenance: Reactive approach where maintenance is only performed after equipment failure e) Scheduled maintenance: Calendar- or meter-based overhauls, often overlapping with PPM
7.2 Selecting suitable strategies for equipment optimisation	7.2.1 Factors influencing the selection of maintenance strategies a) Use failure modes and effects analysis (FMEA) or risk matrices and risk scoring to determine appropriate strategies to maintain the upkeep of critical assets b) Cost-benefit analysis: Comparison of strategy costs verses potential downtime, repair and safety impacts c) Technology and data requirements: CBM requires sensors and analytics, TPM requires workforce engagement and training d) Life cycle alignment: Strategy selection should correspond to equipment stage – new install vs ageing asset e) Regulatory and safety compliance: Maintenance must meet legal standards and reduce risk to personnel and environment

K8 Health and safety regulations – key features and impact on role: ATEX - safety requirements for workplaces and equipment used in explosive atmospheres, Control of Asbestos Regulations, Control of Major Accident Hazards (COMAH) Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), Display Screen Equipment Regulations (DSE), Health and Safety at Work Act (HASAWA), Lifting Operations and Lifting Equipment Regulations (LOLER), Management of Health and Safety at Work, Manual Handling Operations Regulations, Personal Protective Equipment (PPE) at Work Regulations, Provision and Use of Work Equipment

Regulations (PUWER), The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), Working at Height Regulations, Working in Confined Spaces Regulations, Workplace (health, safety, and welfare) Regulations

Topic	Content – What needs to be covered
8.1 Features of health and safety legislations and regulations relevant to engineering maintenance	8.1.1 Hazardous environments and substances a) ATEX – Equipment and safety in explosive atmospheres; requires identification of hazardous zones and compliant systems b) DSEAR – Management of flammable/explosive substances; requires risk controls and safe storage c) COSHH – Control of hazardous substances; requires safe handling, PPE and exposure monitoring 8.1.2 Workplace safety and general duties a) HSWA – Primary legislation that sets overarching duties for health, safety and welfare at work b) Management of Health and Safety at Work Regulations – Requires risk assessments and health and safety arrangements 8.1.3 Equipment and operational safety a) PUWER – Ensures work equipment is suitable, maintained and safely operated b) LOLER – Regulates lifting equipment and operations; requires inspection and safe use 8.1.4 Manual tasks and ergonomics a) Manual Handling Regulations – Prevents injury from lifting/moving loads; requires risk assessment and training b) Display Screen Equipment (DSE) Regulations – Covers safe use of screens; requires workstation assessments 8.1.5 Incident and emergency management a) RIDDOR – Requires reporting of injuries, diseases and dangerous occurrences b) COMAH – Controls major accident hazards; requires emergency planning and risk control 8.1.6 Working conditions and environments a) Working at Height Regulations – Requires fall protection and safe access planning b) Confined Spaces Regulations – Requires permits-to-work and emergency procedures c) Workplace (Health, Safety and Welfare) Regulations – Covers ventilation, lighting, cleanliness and welfare facilities d) PPE Regulations – Requires provision, use and maintenance of appropriate protective equipment
8.2 Impact of health and safety regulations	8.2.1 Hazardous environments and substances a) ATEX and DSEAR

on engineering maintenance roles	i) Hazardous zones and equipment compliance ii) Conditions for working with explosive or flammable substances b) COSHH i) Exposure risks and control measures for hazardous substances ii) PPE requirements and chemical system considerations 8.2.2 Workplace safety and general duties a) HSWA and Management of Health and Safety Regulations i) Safety responsibilities of employers and employees ii) Risk management expectations iii) Workplace conditions and behavioural standards 8.2.3 Equipment and operational safety a) Inspection and maintenance expectations for work equipment (PUWER) b) Lifting equipment safety and operational standards (LOLER) c) Documentation and compliance requirements (PUWER, LOLER) 8.2.4 Manual tasks and ergonomics a) Manual handling risk factors and control measures (Manual Handling Regulations) b) Ergonomic setup and screen use considerations (DSE Regulations) c) Training and procedural expectations (Manual Handling, DSE) 8.2.5 Incident and emergency management a) Reporting obligations and incident categories (RIDDOR, COMAH) b) Emergency planning and escalation procedures (COMAH) c) Risk reduction and compliance monitoring (RIDDOR, COMAH) 8.2.6 Working conditions and environments a) Fall protection and access planning (Working at Height Regulations) b) Permit-to-work systems and confined space entry protocols (Confined Spaces Regulations) c) Environmental safety expectations (Confined Spaces Regulations) 8.2.7 PPE use and maintenance a) PPE Regulations i) PPE types and suitability for tasks ii) Inspection and maintenance standards for PPE iii) Storage and usage expectations

K13 Environmental regulations and standards – impact on role: Environmental Management Systems standard, Environmental Protection Act, and Hazardous Waste Regulations

Topic	Content – What needs to be covered
13.1 Features of environmental regulations and standards	13.1.1 Scope, purpose and key requirements of environmental regulations and standards a) Environmental Management Systems standard (ISO 14001) i) Environmental management framework for continual improvement ii) Sets expectations for monitoring, reporting and compliance b) Environmental Protection Act (EPA) i) UK legislation for pollution control and waste management ii) Defines responsibilities for waste producers and handlers iii) Awareness of statutory nuisance and proper waste handling c) Hazardous Waste Regulations i) Governs classification and disposal of hazardous waste ii) Required documentation and safe handling procedures iii) Impacts apprentice responsibilities in waste segregation and record-keeping d) Waste Electrical and Electronic Equipment (WEEE) i) Disposal and documentation of electrical/electronic waste
13.2 Application of environmental regulations and standards in engineering maintenance	13.2.1 Environmental practices and procedures in engineering maintenance a) Environmental impacts of maintenance work i) Emissions ii) Waste b) Sustainable practices i) Energy-efficient methods c) Recycling and segregation of materials e) Procedures for managing loss of containment (spill response) f) Maintaining records i) Waste transfer notes ii) Audit logs

K17 Algebraic methods Trigonometric methods and 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

Topic	Content – What needs to be covered
17.1 Algebraic and trigonometric methods	17.1.1 Use of algebraic and trigonometric methods to support engineering calculations

in engineering maintenance	a) Types of algebraic expressions i) Linear ii) Quadratic iii) Simultaneous equations b) Methods of rearranging and solving equations c) Use of substitution and factorisation d) Trigonometric functions in right-angled triangles i) Sine ii) Cosine iii) Tangent e) Use of Pythagoras' theorem f) Standard area and volume formulae for common shapes
17.2 Statistical methods to display data	17.2.1 Use of statistical techniques to interpret and present engineering data a) Definitions and uses of mean, mode and median b) Methods of presenting data (tables, bar charts, histograms) c) Purpose of statistical analysis in engineering (identifying trends in failure rates)
17.3 Elementary calculus in engineering contexts	17.3.1 Use of basic calculus concepts to understand change and trends in engineering systems a) Concept of a coefficient and its role in equations b) Gradient of a curve: interpretation and calculation c) Rate of change: understanding variable changes over time or distance

K18 Properties of engineering materials and impact on use

Topic	Content – What needs to be covered
18.1 Properties of engineering materials	18.1.1 Types and effects of material properties and failure modes a) Chemical properties: i) corrosion resistance ii) reactivity with other substances b) Electrical properties: i) conductivity ii) resistivity iii) dielectric strength c) Mechanical properties: i) tensile strength ii) hardness iii) ductility iv) toughness d) Physical properties: i) density ii) melting point iii) opacity iv) magnetism

	e) Thermal properties: i) thermal conductivity ii) expansion iii) heat resistance
18.2 Material properties and impact on use	18.2.1 Material properties and impact on use a) Identifying material suitability – matching material properties to operational requirements during part replacement or fault diagnosis b) Identifying degradation factors: i) environmental exposure (moisture, temperature, UV) ii) mechanical stress iii) chemical exposure iv) fatigue c) Considerations for selection: i) cost ii) availability iii) sustainability iv) compatibility with existing systems d) Examples of poor material selection: i) corrosion due to incompatible metals ii) premature wear due to incorrect hardness iii) deterioration due to environmental factors

K21 Engineering representations, sketches, drawings, and graphical information conventions

Topic	Content – What needs to be covered
21.1 Types and purposes of engineering drawings	21.1.1 Types and uses of engineering representations and graphical formats a) Assembly drawings: show how components fit together; used for installation and maintenance reference b) Detail drawings: provide dimensions, tolerances and material specifications for specific individual parts c) General arrangement (GA) drawings: show the overall layout of systems or equipment in context d) Isometric sketches: represent 3D objects in 2D; useful for visualising components and assemblies e) Orthographic projections: 2D views: include front, top and side f) Piping and instrumentation diagrams (P&ID): show process flow, instrumentation and control systems g) Schematics: represent electrical or fluid systems using standard symbols and connections h) Circuit diagrams: show electrical connections and component layout for building and troubleshooting circuits.

21.2 Conventions and interpretation of engineering drawings	21.2.1 Conventions and interpretation of engineering drawings a) Common line types and their meanings i) Hidden ii) Centre iii) Cutting plane b) Use of scale, dimensions and tolerances c) Common standard symbols used in mechanical, electrical and fluid systems – standard refence IEC 60617 / BS8888 / ISO1219 i) Diameter ii) Straightness iii) Perpendicularity iv) Parallelism v) Concentricity vi) Switch vii) Resistor viii) Lamp ix) Motor x) Solenoid xi) Valve xii) Cylinder xiii) Compressor xiv) Pump xv) Reservoir d) Title blocks, revision history and drawing numbering systems

K32 Industry 4.0 - the integration of physical systems with internet connectivity and cloud computing: technologies, systems, and benefits

Topic	Content – What needs to be covered
32.1 Principles and benefits of Industry 4.0	32.1.1 Key principles of Industry 4.0 in engineering environments a) Cyber-physical systems (CPS): physical equipment integrated with digital control and monitoring b) Internet of Things (IoT): connected sensors and devices that share data in real time c) Cloud computing: remote access to data and systems for monitoring and diagnostics d) Real-time data: live system feedback used for performance monitoring and fault detection e) Predictive maintenance: using data to anticipate and prevent equipment failures f) Interconnectivity: systems, machines and people linked for improved communication and control g) Technician awareness: understanding how these principles affect maintenance tasks and system reliability 32.1.2 Benifits of Industry 4.0 in engineering environments

	a) Reduced downtime: predictive tools identify faults before failure b) Improved efficiency: automation and data feedback streamline operations c) Remote access: technicians can monitor and diagnose systems off-site d) Faster fault response: real-time alerts enable quicker interventions e) Informed decisions: access to live and historical data supports maintenance planning f) Enhanced safety: automated systems detect hazards and reduce manual checks g) Digital records: maintenance activities and system status are logged automatically
32.2 Technologies and systems enabling Industry 4.0	32.2.1 Key technologies and systems enabling Industry 4.0 a) Sensors and IoT devices: collect and transmit operational data b) Edge computing: processes data locally for faster response times c) Automation systems: programmable logic controllers (PLCs) and robotics d) AI and machine learning: analyse data trends to support predictive maintenance e) Human-machine interfaces (HMIs): allow technicians to interact with smart systems f) Integrated software platforms: link maintenance, operations and data analytics
32.3 Connectivity and cloud computing in Industry 4.0	32.3.1 Role of internet connectivity and cloud platforms in integration a) Internet connectivity: enables machines, sensors and systems to share data in real time b) Cloud platforms: store and process equipment data remotely for analysis and monitoring c) Digital twins: virtual models simulate asset performance and support planning d) Cloud-based analytics: support predictive maintenance by identifying trends and risks e) Remote diagnostics: technicians access system data off-site to identify faults f) CMMS tools: cloud-based systems used to log faults, schedule tasks and track asset history g) Technician awareness: understanding how connectivity and cloud systems improve fault detection and maintenance efficiency

S13 Use mathematical principles and formulae to support engineering maintenance

Topic	Content – What needs to be covered

13.1 Mathematical methods used in engineering maintenance	13.1.1 Mathematical principles and formulae used to support engineering maintenance within typical engineering context a) Algebraic applications: Rearranging equations to isolate unknowns in maintenance calculations i) Ohm's Law (V = I x R) used to find voltage, current or resistance in a circuit ii) Force over Area (P=F/A) iii) Torque formula (T = F × r) for mechanical assemblies or tightening electrical connections b) Statistical applications: Interpreting results for decision-making i) Mean (average: ∑x/n) ii) Mode (most frequent value) iii) Median (middle value after sorting) iv) Basic variability (range as max-min; standard deviation as $\sqrt{[\sum(x-\mu)^2/n]}$; outliers as values >3 SD from mean) c) Trigonometric applications: i) Use of sine, cosine and tangent to resolve forces and angles ii) Bolt preload force components in angled flanges iii) Shim sizing for machinery levelling based on misalignment angles d) Performing calculations during preparation, fault diagnosis, testing or improvement maintenance e) Rounding appropriately and cross-checking results against tolerances or historical data

K33 Electrical and control and instrumentation. Electricity at Work regulations. IET wiring regulations

Topic	Content – What needs to be covered
33.1 Roles and responsibilities under electrical regulations	33.1.1 Employer roles and responsibilities a) Provide appropriate training for the task(s). b) Ensure that all workplace electrical equipment and systems are safe and maintained correctly to prevent accidents c) Conduct risk assessment on a regular basis to identify potential electrical hazards d) Arrange routine inspections, testing and maintenance of electrical equipment (portable appliance testing (PAT) 33.1.2 Employee roles and responsibilities a) Follow your employer's safety procedures when working with electrical systems b) Complete safety training as required by employer c) Report any electrical faults, damage or unsafe conditions immediately d) Never attempt to repair an electrical system or equipment unless you are qualified to do so

	33.1.3 Self-employed roles and responsibilities a) Self-employment status does not exempt you from health and safety laws b) Take reasonable care for their own safety and the safety of others c) Report any electrical faults, damage or unsafe conditions immediately d) Conduct risk assessment to identify potential electrical hazards
33.2 Compliance with electrical regulations	33.2.1 Regulation compliance An awareness of the contents of the EAWR and IET wiring regulations to ensure compliance when completing maintenance activities: a) Electricity at Work Regulations (EAWR) i) Installation, maintenance and inspection of electrical systems ii) Isolation procedures and prevention of danger from live conductors iii) Emphasis on competence, testing and risk assessment before commencing work b) IET wiring regulations (BS7671) i) Role in ensuring electrical safety and system reliability ii) Used as a reference during installation, maintenance, testing and certification iii) Installation characteristics and selection of equipment iv) Environments (internal, external, moisture/IP considerations) v) Importance of updates and periodic revisions vi) IET On-site Guide (OSG) 33.2.2 Documentation and record keeping a) Electrical installation certificates b) Portable appliance test (PAT) c) Permit to work d) Risk assessment e) Test records and maintenance logs f) Audit trails for compliance g) Consequences of non-compliance i) Legal penalties and enforcement actions ii) Increased risk of electric shock, arc flash, fire and fatalities iii) Impact on business reputation, insurance and operational continuity
33.3 Application and scope of IET wiring regulations	33.3.1 Relationship between BS7671 and EAWR a) BS7671 provides technical standards supporting EAWR compliance b) EAWR is statutory law; BS7671 is a code of practice 33.3.2 Protective measures a) Protection against electric shock: automatic disconnection, insulation, barriers

	b) Protection against thermal effects: overload protection, fire prevention 33.3.3 Cable selection and installation a) Use of BS7671 tables for current-carrying capacity and voltage drop b) Selection of protective devices i) Fuses ii) Circuit breakers iii) Residual Current Device (RCDs) iv) Arc Fault Detection Devices (AFDDs) c) Earthing requirements and bonding methods d) Installation methods suitable for environment and load 33.3.4 Inspection, testing and certification a) Initial verification and periodic inspection b) Functional testing and fault diagnosis c) Completion of electrical installation certificates and test records
33.4 Safe use of electrical systems	33.4.1 Electrical hazards and risk awareness a) Electric shock b) Arc flash c) Fire d) Burns e) Equipment failure risks f) Hazard identification g) Risk assessment and control measures i) Barriers ii) Insulation iii) Enclosures iv) Automatic disconnection 33.4.2 Safe working practices and emergency response a) Safe isolation (lockout/tagout procedures, verification of dead circuits using approved test equipment) b) Permit-to-work systems (when and why permits are required) c) Maintaining a safe working environment i) Clear access ii) Dry conditions iii) Adequate lighting iv) Adequate ventilation v) Clear signage d) Emergency response procedures for electric shock and fire incidents 33.4.3 Safe use of tools and equipment a) Insulated tools b) Condition monitoring 33.4.4 Protective equipment

	a) Insulating gloves b) Arc-rated clothing c) Eye protection d) Safety footwear

K35 Electrical and control and instrumentation. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment

Topic	Content – What needs to be covered
35.1 Single-phase systems	35.1.1 Characteristics of single-phase systems and equipment a) Series and parallel AC circuits b) Typical applications c) Voltage and frequency standards d) Waveform characteristics e) Advantages and disadvantages
35.2 Three-phase systems	35.2.2 Characteristics of three-phase systems and equipment a) Series and parallel AC circuits b) Typical applications c) Voltage and frequency standards d) Waveform characteristics e) Advantages and disadvantages f) Balanced vs unbalanced loads
35.3 Electrical machines	35.3.1 Transformers a) Principle of operation b) Turns ratio and its effect on voltage/current 35.3.2 Motors and generators a) Operation of three-phase induction motors b) Star/delta starting methods c) Basic generator principles
35.4 Monitoring and protective equipment	35.4.1 Measurement tools a) Multimeters i) Voltage ii) Current iii) Resistance b) Oscilloscopes (waveform analysis) c) Clamp meters and insulation testers

	35.4.2 Fault detection and safety a) Testing procedures for single- and three-phase circuits b) Electrical hazards and shock protection i) Electrostatic Discharge (ESD) Straps ii) Grounding iii) RCD types (AC, C, F, B and S) c) Safe isolation procedures

K36 Electrical and control and instrumentation. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory, and power calculations

Topic	Content – What needs to be covered
36.1 Circuit terminology	36.1.1 Fundamental electrical quantities a) Definition of voltage (potential difference), current and resistance b) Explanation of charge, energy and power in electrical systems c) Relationship between conductors, insulators and semiconductors d) Units of electrical measurement (volt, ampere, ohm, watt, coulomb) 36.1.2 Circuit components and configuration a) Identification and function of resistors, capacitors, inductors, sources and switches b) Series and parallel connections – effect on total resistance, current and voltage c) Distinction between open circuits, short circuits and loaded circuits d) Concept of nodes, branches and loops in circuit analysis
36.2 Ohms Law and circuit relationships	36.2.1 Application of Ohm's Law a) Relationship between voltage (V), current (I) and resistance (R): $V = I \times R$ b) Practical examples in series and parallel resistive circuits c) Impact of changing resistance or voltage on current flow
36.3 Transformer theory	36.3.1 Basic operating principle a) Principle of electromagnetic induction b) Function of primary and secondary windings c) Concept of mutual induction and magnetic coupling 36.3.2 Transformer types and construction

	a) Identification of step-up and step-down transformers b) Core materials and their influence on efficiency c) Importance of laminated cores and lamination thickness to reduce eddy current losses d) Importance of transformer cooling e) Insulation methods
36.4 Power calculations	36.4.1 Electrical power a) DC power formula: P = V × I b) AC power components: i) Active (real) power (P = V × I × cos φ) ii) Reactive power (Q = V × I × sin φ) iii) Apparent power (S = V × I) c) Use of power factor to assess circuit efficiency

K37 Electrical and control and instrumentation. Functions and applications of electrical circuits

Topic	Content – What needs to be covered
37.1 Circuit configurations and principles	37.1.1 Types of circuit configurations a) Series circuits i) Characteristics and current flow ii) Voltage distribution and limitations b) Parallel circuits i) Characteristics and load sharing ii) Fault tolerance and redundancy c) Series-parallel combinations i) Typical applications 37.1.2 Impact of configuration on performance a) Voltage and current relationships b) Load balancing and energy efficiency c) Safety considerations for each configuration
37.2 Practical applications of electrical circuits	37.2.1 Industrial and commercial systems a) Distribution boards b) Motor Control Centres (MCCs) c) Control circuits for i) Lighting ii) Heating iii) Motor drives 37.2.2 Low-voltage and extra-low-voltage systems a) Typical uses in automation b) Safety systems and compliance 37.2.3 Integration with other technologies a) Electrical circuits combined with i) Mechanical systems ii) Pneumatic systems iii) Electronic systems

37.3 Electrical components and their functions	37.3.1 Active components a) Semiconductors i) Diodes – rectification ii) Transistors – switching and amplification 37.3.2 Passive components a) Resistors – current control b) Capacitors – energy storage and filtering c) Inductors – magnetic energy storage 37.3.3 Control and protection devices a) Circuit breakers – overload protection b) Fuses – short-circuit protection c) Relays – switching control 37.3.4 Transformers and contactors a) Voltage regulation b) Motor control applications 37.3.5 Impact of component selection a) Performance implications b) Reliability and safety considerations

K38 Electrical and control and instrumentation. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics

Topic	Content – What needs to be covered
38.1 Types and purpose of electrical diagrams	38.1.1 Purpose of diagrams a) Illustrate electrical systems and component relationships b) Communicate design intent for installation and maintenance c) Accurate representation for design, fault diagnosis and maintenance d) Comparison between functional, schematic and pictorial diagrams 38.1.2 Types of electrical diagrams a) Circuit (schematic) diagrams – show electrical connections and logic flow b) Wiring diagrams – indicate physical wiring routes, conductor types and terminal points c) Layout diagrams – depict physical placement of components in panels or assemblies d) Orthographic diagrams – represent components in three standard views for fabrication or mounting e) Block diagrams – provide simplified overview of system operation and component interaction

38.2 Symbols and abbreviations in electrical schematics	38.2.1 Standard electrical symbols – standard reference IEC 60617 a) Resistors i) Fixed ii) Variable b) Capacitors c) Inductors d) Diodes e) Transistors i) NPN ii) PNP f) Transformers g) Relays h) Switches i) SPST ii) SPDT iii) DPST iv) DPDT i) Fuses j) Motors i) AC ii) DC iii) Servo iv) Stepper k) Light Emitting Diodes (LED) l) Sensors i) Light dependent resistor (LDR) ii) Thermistor 38.2.2 Symbols for system elements a) Power sources i) AC supply ii) DC supply iii) Battery b) Ground connections i) Protective earth ii) Chassis ground iii) Signal ground c) Measurement points i) Ammeter ii) Voltmeter 38.2.3 Line types and notations a) Indicating connections, junctions and crossovers 38.2.4 Abbreviations and annotation a) R = resistor, L = inductor, SW = switch, M = motor b) Labelling conventions for terminal points, wire numbers, reference designators c) Common conventions for labelling, routing and earthing

38.3 Interpretation of diagrams and documentation	38.3.1 Reading and cross-referencing a) Circuit, wiring, and layout diagrams for complete system understanding 38.3.2 Recognising system function a) Signal flow, power distribution and control sequences 38.3.3 Linking diagrams to SOPs a) Role of SOPs in guiding safe and consistent electrical work b) Document control systems for revision management and traceability c) Understand title blocks, borders and revision codes for traceability 38.3.4 Compliance and safety a) Accurate interpretation ensures compliance with standards and safe working practices b) Apply British Standards for technical documentation, including line types, scales, tolerances and revision control c) Importance of standardisation for clarity and troubleshooting

K39 Electrical and control and instrumentation. Different types of cables; their specifications and application

Topic	Content – What needs to be covered
39.1 Cable selection and practical applications	39.1.1 Cable types and their applications a) Single core: A single insulated conductor, typically PVC or XLPE insulated i) Commercial and industrial distribution circuits installed in containment (tray, trunking, conduit) ii) Switchgear and control panels iii) Circuits requiring good heat dissipation and straightforward grouping b) Multi-core: Multiple insulated conductors contained within one sheath i) Control, signalling and instrumentation systems ii) Multi-phase power circuits in industrial environments iii) Situations requiring compact routing with reduced cable clutter c) Flexible cords: Fine-stranded conductors with flexible insulation and sheathing (PVC or rubber/EPR)

	i) Portable, movable or vibrating industrial equipment ii) Machinery and tools that require repeated flexing iii) Temporary connections where flexing is expected (where permitted) d) Steel Wire Armoured (SWA): Power cables with galvanised steel wire armour, its primary function is mechanical protection i) External, exposed or buried commercial/industrial installations ii) Distribution circuits requiring impact, crushing or abrasion protection iii) Environments where mechanical resilience is critical e) Mineral Insulated Copper Cable (MICC): Copper conductors embedded in compressed magnesium oxide, with a copper sheath and optional LSF jacket i) Fire survival circuits (emergency lighting, alarms, life safety systems) ii) High temperature industrial environments iii) Installations requiring long-term reliability and chemical/heat resistance 39.1.2 Voltage classification a) Extra low voltage (ELV): Typically used for signalling, control, instrumentation and other low-energy systems b) Low voltage (LV): Up to 1000 V AC, used widely in commercial and industrial electrical distribution c) Medium voltage (MV): General industrial site distribution and large equipment feeds d) High voltage (HV): Used for transmission networks and high-power industrial processes 39.1.3 Materials a) Conductors i) Copper: High conductivity, excellent mechanical strength, widely used in most cable types ii) Aluminium: Lightweight and cost effective; commonly used in larger power-distribution cables b) Insulation i) PVC: General purpose insulation ii) XLPE: Higher temperature rating and improved current-carrying capacity

	iii) Rubber (EPR): Enhanced flexibility and heat resistance for flexible cords or harsh environments 39.1.4 Cable components a) Conductor b) Insulation c) Sheath d) Armour e) Outer jacket 39.1.5 Cable identification a) Reading cable designations (6242Y, NYY, SY, CY, SWA) b) Colour coding of conductors according to harmonised standards c) Importance of correct identification for maintenance and safety 39.1.6 Selection Criteria a) Determination of cable type and size based on: i) Load current ii) Voltage drop iii) Short-circuit capacity iv) Environmental and installation conditions b) Consideration of derating factors and future load growth c) Selection for flexibility, mechanical protection, and thermal performance d) Use of manufacturer data sheets and regulatory tables for design verification
39.2 Cable specifications and regulatory standards	39.2.1 Specification parameters a) Current-carrying capacity b) Voltage rating c) Temperature rating d) Insulation resistance and mechanical protection 39.2.2 Cable sizing a) Use of derating factors and installation conditions 39.2.3 Regulatory compliance a) Application of BS 7671 / IET Wiring Regulations for cable selection and installation b) Use of manufacturer data and certification for conformity
39.3 Cable installation methods	39.3.1 Installation practices a) Routing and securing of cables to prevent strain, heat buildup or interference b) Installation zones and routing requirements

	c) Use of glands, bushings and sealing devices for entry points and junctions d) Inspection, testing and certification following installation

K47 Electrical and Control and instrumentation. Control and instrumentation engineering principles, terminology, and calculations

Topic	Content – What needs to be covered
47.1 Control and instrumentation engineering principles	47.1.1 Core principles a) Force i) Definition: Push or pull acting on an object (Newton's laws) ii) Units: Newton (N) iii) Application: Actuator sizing, valve operation b) Stress i) Formula: σ = F/A (force per unit area) ii) Importance in sensor housings and mounting brackets c) Conductivity i) Electrical and thermal conductivity in sensor materials ii) Impact on signal integrity and heat dissipation d) Power i) Electrical power: P = V × I ii) Mechanical power in actuators and drives e) Current and voltage i) Role in signal transmission and control circuits ii) Safe operating ranges for instrumentation devices f) Feedback loop controls i) Open-loop vs closed-loop systems ii) PID control principles (Proportional, Integral, Derivative) iii) Application in temperature and pressure control. g) System integration i) Linking sensors, controllers and actuators ii) Communication protocols (4–20 mA, Modbus) h) Signal processing i) Filtering, amplification and conversion (analogue to digital) ii) Importance for accurate measurement iii) Reliability and robustness iv) Factors affecting system uptime v) Redundancy and fail-safe design i) Algorithms i) Control logic for automated systems ii) Examples: PID tuning, adaptive control j) Locking and interlocking i) Safety interlocks for hazardous operations ii) Mechanical vs electrical interlocks k) Measurement and calibration

	i) Importance of calibration for accuracy ii) Traceability and standards (ISO, BS) l) Efficiency and performance i) Energy efficiency in control systems ii) Performance metrics (response time, accuracy) m) Safety i) Safe isolation and emergency shutdown systems ii) Hazard analysis for instrumentation loops
47.2 Terminology	47.2.1 Key terminology used in control and instrumentation systems a) Sensor and transducer i) Sensor: Detects physical, electrical and mechanical quantity ii) Transducer: Converts one form of energy to another b) Actuator i) Converts control signal into mechanical movement ii) Types: Pneumatic, hydraulic, electric actuators c) Analogue vs digital signals i) Analogue: Continuous signal, voltage or current variation ii) Digital: Discrete signal, binary representation iii) Impact on system design: Accuracy, noise immunity, compatibility d) Control loop parameters i) Setpoint: Desired value for process variable ii) Process variable: Actual measured value iii) Error signal: Difference between setpoint and process variable e) Hysteresis and deadband i) Hysteresis: Lag between input change and output response ii) Deadband: Range where no control action occurs f) Instrument performance terms i) Resolution: Smallest detectable change in measurement ii) Accuracy: Closeness to true value iii) Repeatability: Ability to produce consistent results under same conditions g) Calibration and zeroing i) Calibration: Adjusting instrument to known standard ii) Zeroing: Setting baseline reference point h) Control loop components i) Controller: Compares setpoint and process variable ii) Sensor: Measures process variable iii) Final control element: Actuator or valve that adjusts process i) Communication protocols

	i) Common examples: 4–20 mA current loop, Modbus, Profibus
47.3 Calculations	47.3.1 Engineering calculations a) Power and energy i) Electrical power: P = V × I ii) Mechanical power: P = (torque × speed) / constant b) Pressure and force i) Pressure = Force / Area ii) Application in pneumatic/hydraulic loops c) Flow rate and volume i) Q = A × v (area × velocity) ii) Application in fluid control loops d) Temperature and heat transfer i) Conduction, convection and radiation principles ii) Sensor compensation for thermal effects e) Trigonometry and geometry i) Used for sensor placement and alignment f) Friction i) Impact on valve actuation and energy loss g) SI units i) Correct conversions for documentation

K48 Electrical and Control and instrumentation. Control and instrumentation equipment installation and connection requirements

Topic	Content – What needs to be covered
48.1 Control and instrumentation equipment	48.1.1 Equipment a) Sensors and transmitters i) Pressure ii) Temperature iii) Time iv) Fluid flow v) Heat vi) Level vii) PH value b) Controllers i) Proportional Integral Derivative (PID) ii) Programmable Logic Controllers (PLCs) iii) Programmable Automation Controllers (PACs) iv) Distributed Control Systems (DCS) c) Actuators i) Control valves ii) Motor control units d) Meters i) Analogue ii) Digital e) Monitoring i) Human Machine Interface (HMI) ii) DATA acquisition iii) Digital indicators

	iv) Supervisory Control and Data Acquisition (SCADA) f) Enclosures g) Cables h) Conduit i) Safety detection i) Flame ii) Gas iii) Smoke
48.2 Installation and connection requirements	48.2.1 Safety a) Safe use of equipment b) Lockout/tagout c) Risk assessments d) Permit to work e) Method statements f) Standard Operating Procedure (SOP) g) Cable routing and strain relief techniques h) Environmental protection (IP ratings, hazardous area considerations) i) Earthing and shielding for instrumentation cables j) Compliance with IEC standards for installation 48.2.2 Connection procedures a) Lockout/tagout b) ESD precautions c) Dismantling techniques d) Reassembly e) Calibration f) Testing 48.2.3 Connection methods and fittings a) Mechanical fittings i) Compression ii) Threaded iii) Pneumatic b) Electrical connections i) Terminals • Fork • Ring • Spade • Bullet ii) Crimps iii) Solder c) Electrical insulation i) Polytetrafluorethylene (PTFE) ii) Polyvinyl Chloride (PVC) iii) Polyethylene (PE) iv) Silicone 48.2.4 Cable types a) Multicore b) Multipair c) Fibre-optic

	d) Data e) Coaxial 48.2.5 Cable construction a) Steel Wire Armoured (SWA) b) PVC c) Polyethene d) Fire resistance

K49 Electrical and Control and instrumentation. Operating principles of control and instrumentation devices: flow, level, pressure, and temperature instruments, analysers, transducers, transmitters, gauges, and pneumatics

Topic	Content – What needs to be covered
49.1 Operating principles of measurement and monitoring	49.1.1 Pressure instrument a) Types i) Gauge ii) Absolute iii) Differential pressure b) Sensing principles i) Bourdon tube (mechanical deflection under pressure) ii) Diaphragm/capsule (elastic deformation) iii) Strain gauge (resistance change under strain) iv) Piezoelectric (voltage generation under pressure) 49.1.2 Temperature instruments a) Sensing principles i) Resistance Temperature Detector (RTD) Resistance increases with temperature (Pt100/Pt1000) ii) Thermocouples: Seebeck effect – voltage generated at junction of dissimilar metals iii) Thermistors: Resistance increases with temperature (NTC/PTC) iv) Infrared sensors: Detect thermal radiation for non-contact measurement 49.1.3 Flow instruments a) Operating principles i) Differential Pressure (DP): Based on Bernoulli's principle – pressure drop across restriction (orifice, venturi, nozzle) ii) Magnetic Flowmeter: Faraday's Law – voltage induced in conductive fluid moving through magnetic field iii) Coriolis Flowmeter: Detects mass flow via tube vibration and phase shift iv) Ultrasonic Flowmeter: Measures transit-time or Doppler shift of sound waves in fluid

v) Vortex Flowmeter: Detects vortices shed by bluff body proportional to flow velocity

49.1.4 Level instruments

a) Operating principles
   i) Hydrostatic: Pressure at bottom of tank proportional to liquid height (ρgh)
   ii) Differential Pressure: Measures pressure difference between top and bottom of vessel
   iii) Ultrasonic: Time-of-flight of sound waves reflected from liquid surface
   iv) Radar (FMCW or pulse): Electromagnetic waves reflected from surface; unaffected by vapour/dust
   v) Capacitive: Change in capacitance as level changes between probe and tank wall
   vi) Displacer: Buoyancy principle – force on displacer changes with liquid level

49.1.5 Analysers

a) Liquid analysis
   i) pH: Potential difference across glass electrode and reference electrode
   ii) Conductivity: Measures ionic concentration via electrical conductance
   iii) Dissolved oxygen: Polarographic or optical sensing of oxygen in liquid
   iv) Turbidity: Light scattering by suspended particles
b) Gas analysis
   i) Non-Dispersive Infrared (NDIR): Absorption of IR radiation by gas molecules
   ii) Paramagnetic O_2: Magnetic susceptibility of oxygen compared to other gases
   iii) Electrochemical cells: Voltage/current generated by chemical reaction with target gas

49.1.6 Transducers

a) Principle: Convert one form of energy to another (mechanical displacement – electrical signal).
b) Examples
   i) Linear Variable Differential Transformer (LVDT): Converts linear motion to electrical signal
   ii) Strain Gauge: Converts strain into resistance change
   iii) Piezoelectric: Converts pressure or vibration into voltage
c) Role: Often paired with transmitters for signal conditioning

49.1.7 Transmitters

a) Principle: Convert sensor signal into standardised output for control systems
b) Signal standards
   i) Analogue: 4–20 mA current loop, 1–5 V
   ii) Digital: HART, Foundation Fieldbus, Profibus PA

	c) Function: Scaling, damping, diagnostics, communication with control system 49.1.8 Gauges a) Pressure gauges: Bourdon tube, diaphragm, capsule types; mechanical indication b) Temperature gauges: Bimetallic strip, liquid-filled systems, expansion principles c) Role: Local indication for operators; accuracy classes defined by standards 49.1.9 Pneumatics a) Signal standard: 3–15 psi (0.2–1.0 bar) pneumatic control signals b) Components and principles i) I/P Converter: Converts electrical signal (current) to pneumatic pressure ii) Positioner: Pneumatic feedback device for accurate valve positioning iii) Actuators: Pneumatic cylinders or diaphragms convert air pressure to mechanical motion iv) Air preparation: Filter–Regulator–Lubricator (FRL) ensures clean, dry air supply
49.2 Operating principles of control devices	49.2.1 Signal conditioning and transmission a) Transmitters: Standardise and transmit signal to control system b) Displays/gauges: Provide local indication of process variables 49.2.2 Control and logic devices a) Controllers: Implement control algorithms (PID basics) b) Logic solvers: Safety Instrumented Systems (SIS) for shutdown logic 49.2.3 Output elements a) Actuators: Convert control signal to mechanical movement (valves, dampers) b) Valves: Control flow using throttling or on/off action; pneumatic/electric actuation 49.2.4 Analytical devices a) Analysers: Measure chemical/physical properties for process control

K50 Electrical and Control and instrumentation. Open and closed loop systems. First and second order control systems. Proportional–integral–derivative controller (PID controller or three-term controller)

Topic	Content – What needs to be covered
50.1 Operating principles of open and closed loop systems	50.1.1 Open loop systems a) Control system that operates without feedback b) Key components (sensors, actuators) c) Performance i) speed ii) reliability iii) accuracy 50.1.2 Closed loop systems a) Control system uses feedback to compare the actual output b) Key components (sensors, controllers, feedback elements) c) Performance considerations i) speed ii) reliability iii) accuracy
50.2 Control systems	50.2.1 First order system a) System type b) Applications c) Characteristics i) Transfer ii) Response iii) Time 50.2.2 Second order system a) System type b) Applications c) Characteristics i) Transfer ii) Response iii) Time
50.3 PID controller applications	50.3.1 Controller types a) Proportional Integral Derivative (PID) – (also referred to as three-term controller) i) System type ii) Applications iii) Function iv) System isolation v) Effects b) Real-world examples in process industries i) Temperature control ii) Flow regulation

K51 Electrical and Control and instrumentation. Functions and applications of control and instrumentation systems: programmable logic controller (PLC), Direct Digital Control (DDC), Distributed Control System (DCS), and Supervisory Control And Data Acquisition (SCADA)

Topic	Content – What needs to be covered
51.1 Functions of control and instrumentation systems	51.1.1 Programmable Logic Controller (PLC) a) Purpose: Discrete and sequential control b) Characteristics i) Modular design ii) Real-time operation c) Methods of programming i) Ladder logic ii) Text-based iii) Flow charts iv) Function blocks d) Typical uses i) Machine automation ii) Production iii) Safety interlocks 51.1.2 Direct Digital Control (DDC) a) Purpose: HVAC and building automation b) Characteristics i) Digital signal processing ii) Centralised control c) Typical uses i) Temperature ii) Humidity iii) Energy management 51.1.3 Distributed Control System (DCS) a) Purpose: Process control in large-scale plants b) Characteristics i) Hierarchical architecture ii) Redundancy iii) Scalability c) Typical uses i) Chemical ii) Oil and gas iii) Power generation 51.1.4 Supervisory Control And Data Acquisition (SCADA) a) Purpose: Remote monitoring and supervisory control b) Characteristics i) HMI interfaces ii) Telemetry iii) Data logging

	c) Typical uses i) Water treatment ii) Energy grids iii) Pipelines 51.1.5 Integration principles a) How PLC, DDC, DCS and SCADA interact in hybrid systems b) Communication protocols (Modbus, Profibus, Ethernet/IP)
51.2 Application of control and instrumental systems	51.2.1 Sectors a) Oil and gas i) Pipeline monitoring via SCADA b) Chemical c) Pharmaceutical i) Batch control using DCS d) Automotive i) Robotic assembly lines with PLCs e) Energy infrastructure f) Healthcare g) Food and beverages 51.2.2 Emerging trends a) IIoT (Industrial Internet of Things) integration b) Cloud-based SCADA solutions c) Cyber security measures for industrial control systems
51.3 Cyber security, maintenance, and performance of C&I systems	51.3.1 Cyber security and data integrity a) Risks in networked control systems b) Common mitigation strategies i) Firewalls ii) Passwords iii) Antivirus iv) Encryption v) Role-based access 51.3.2 Maintenance and life cycle considerations a) Firmware updates and patching b) Backup and disaster recovery planning c) Obsolescence management

K52 Electrical and Control and instrumentation. Types of control and instrumentation diagrams

Topic	Content – What needs to be covered
52.1 Types of control and instrumentation diagrams	52.1.1 Types and purpose of diagrams a) Process and Instrument Diagram (PID) i) Process flow ii) Instrumentation details iii) Feedback loops b) Schematic diagrams i) Fault finding and troubleshooting c) Block diagrams

	i) High-level representation of groups of system components and signal flow d) Pipework and piping i) Illustrate physical routing of pipes and connections e) Wiring and circuit diagrams i) Electrical connections ii) Cable positioning f) Logic diagrams i) Cause and effect ii) Function block iii) Ladder logic g) Control system architecture diagrams i) Show overall control system structure and hierarchy h) Detail drawings i) Provide fine details for fabrication or assembly i) Component drawings i) Dimensions and tolerances ii) Operation j) General assembly (GA) drawings i) Physical layout and assembly k) Instrumentation index i) List of instruments 52.1.2 Documentation and reference materials a) Standard Operating Procedures (SOPs) – document operational steps b) Method statements – describe work execution approach c) Data charts and handbooks – provide reference data and standards 52.1.3 Differences a) Functional vs physical representation b) Use in design, installation and maintenance 52.1.4 Symbols and abbreviations – standard reference ISO1219/IEC 60617 a) Valve symbols i) Pressure relief ii) Check iii) Flow b) Line symbols i) Solid thick line ii) Solid thin line iii) Dashed line iv) Solid line with perpendicular marks c) Instrument identification i) Circle ii) Square iii) Hexagon iv) Diamond inside a square d) Centre line

52.2 Documentation and revision control	52.2.1 Interpretation and compliance a) Interpretation of title blocks i) drawing title ii) drawing number iii) scale iv) project v) revision status b) Revision codes and change tracking c) Compliance with ISO/IEC standards for technical documentation d) Linking diagrams to SOPs, method statements and maintenance records

K57 Electrical and Mechanical. Electricity at Work regulations. IET wiring regulations

Topic	Content – What needs to be covered
57.1 Roles and responsibilities under electrical regulations	57.1.1 Employer roles and responsibilities a) Provide appropriate training for the task(s). b) Ensure that all workplace electrical equipment and systems are safe and maintained correctly to prevent accidents c) Conduct risk assessment on a regular basis to identify potential electrical hazards d) Arrange routine inspections, testing and maintenance of electrical equipment (portable appliance testing (PAT) 57.1.2 Employee roles and responsibilities a) Follow your employer's safety procedures when working with electrical systems b) Complete safety training as required by employer c) Report any electrical faults, damage or unsafe conditions immediately d) Never attempt to repair an electrical system or equipment unless you are qualified to do so 57.1.3 Self-employed roles and responsibilities a) Self-employment status does not exempt you from health and safety laws b) Take reasonable care for their own safety and the safety of others c) Report any electrical faults, damage or unsafe conditions immediately d) Conduct risk assessment to identify potential electrical hazards
57.2 Compliance with electrical regulations	57.2.1 Regulation compliance An awareness of the contents of the EAWR and IET wiring regulations to ensure compliance when completing maintenance activities: a) Electricity at Work Regulations (EAWR) i) Installation, maintenance and inspection of electrical systems

	ii) Isolation procedures and prevention of danger from live conductors iii) Emphasis on competence, testing and risk assessment before commencing work b) IET wiring regulations (BS 7671) i) Role in ensuring electrical safety and system reliability ii) Used as a reference during installation, maintenance, testing and certification iii) Installation characteristics and selection of equipment iv) Environments (internal, external, moisture/IP considerations) v) Importance of updates and periodic revisions vi) IET On-site Guide (OSG) 57.2.2 Documentation and record keeping a) Electrical installation certificates b) Portable appliance test (PAT) c) Permit to work d) Risk assessment e) Test records and maintenance logs f) Audit trails for compliance g) Consequences of non-compliance i) Legal penalties and enforcement actions ii) Increased risk of electric shock, arc flash, fire and fatalities iii) Impact on business reputation, insurance and operational continuity
57.3 Application and scope of IET wiring regulations	57.3.1 Relationship between BS 7671 and EAWR a) BS 7671 provides technical standards supporting EAWR compliance b) EAWR is statutory law; BS 7671 is a code of practice 57.3.2 Protective measures a) Protection against electric shock: automatic disconnection, insulation, barriers b) Protection against thermal effects: overload protection, fire prevention 57.3.3 Cable selection and installation a) Use of BS 7671 tables for current-carrying capacity and voltage drop b) Selection of protective devices i) Fuses ii) Circuit breakers iii) Residual Current Device (RCDs) iv) Arc Fault Detection Devices (AFDDs) c) Earthing requirements and bonding methods d) Installation methods suitable for environment and load 57.3.4 Inspection, testing and certification a) Initial verification and periodic inspection b) Functional testing and fault diagnosis

	c) Completion of electrical installation certificates and test records
57.4 Safe use of electrical systems	57.4.1 Electrical hazards and risk awareness a) Electric shock b) Arc flash c) Fire d) Burns e) Equipment failure risks f) Hazard identification g) Risk assessment and control measures i) Barriers ii) Insulation iii) Enclosures iv) Automatic disconnection 57.4.2 Safe working practices and emergency response a) Safe isolation (lockout/tagout procedures, verification of dead circuits using approved test equipment) b) Permit-to-work systems (when and why permits are required) c) Maintaining a safe working environment i) Clear access ii) Dry conditions iii) Adequate lighting iv) Adequate ventilation v) Clear signage d) Emergency response procedures for electric shock and fire incidents 57.4.3 Safe use of tools and equipment a) Insulated tools b) Condition monitoring 57.4.4 Protective equipment a) Insulating gloves b) Arc-rated clothing c) Eye protection d) Safety footwear

K59 Electrical and mechanical. Principles of single phase and three-phase equipment, plant, and systems, the operation of motors and generators, and the use of monitoring and protection equipment

Topic	Content – What needs to be covered
59.1 Single-phase systems	59.1.1 Characteristics of single-phase systems and equipment a) Series and parallel AC circuits b) Typical applications c) Voltage and frequency standards d) Waveform characteristics

	e) Advantages and disadvantages
59.2 Three-phase systems	59.2.1 Characteristics of three-phase systems and equipment a) Series and parallel AC circuits b) Typical applications c) Voltage and frequency standards d) Waveform characteristics e) Advantages and disadvantages f) Balanced vs unbalanced loads
59.3 Electrical machines	59.3.1 Transformers a) Principle of operation b) Turns ratio and its effect on voltage/current 59.3.2 Motors and generators a) Operation of three-phase induction motors b) Star/delta starting methods c) Basic generator principles
59.4 Monitoring and protective equipment	59.4.1 Measurement tools a) Multimeters i) Voltage ii) Current iii) Resistance b) Oscilloscopes (waveform analysis) c) Clamp meters and insulation testers 59.4.2 Fault detection and safety a) Testing procedures for single- and three-phase circuits a) Electrical hazards and shock protection i) Electrostatic Discharge (ESD) Straps ii) Grounding iii) RCD types (AC, C, F, B and S) c) Safe isolation procedures

K60 Electrical and mechanical. Electrical engineering principles: circuit terminology, Ohm's Law, transformer theory, and power calculations

Topic	Content – What needs to be covered
60.1 Circuit terminology	60.1.1 Fundamental electrical quantities a) Definition of voltage (potential difference), current and resistance

	b) Explanation of charge, energy and power in electrical systems c) Relationship between conductors, insulators and semiconductors d) Units of electrical measurement (volt, ampere, ohm, watt, coulomb) 60.1.2 Circuit components and configuration a) Identification and function of resistors, capacitors, inductors, sources and switches b) Series and parallel connections – effect on total resistance, current and voltage c) Distinction between open circuits, short circuits and loaded circuits d) Concept of nodes, branches and loops in circuit analysis
60.2 Ohms Law and circuit relationships	60.2.1 Application of Ohm's Law a) Relationship between voltage (V), current (I) and resistance (R): V = I × R b) Practical examples in series and parallel resistive circuits c) Impact of changing resistance or voltage on current flow
60.3 Transformer theory	60.3.1 Basic operating principle a) Principle of electromagnetic induction b) Function of primary and secondary windings c) Concept of mutual induction and magnetic coupling 60.3.2 Transformer types and construction a) Identification of step-up and step-down transformers b) Core materials and their influence on efficiency c) Importance of laminated cores and lamination thickness to reduce eddy current losses d) Importance of transformer cooling e) Insulation methods
60.4 Power calculations	60.4.1 Electrical power a) DC power formula: P = V × I b) AC power components: i) Active (real) power (P = V × I × cos φ) ii) Reactive power (Q = V × I × sin φ) iii) Apparent power (S = V × I) c) Use of power factor to assess circuit efficiency

K61 Electrical and mechanical. Functions and applications of electrical circuits

Topic	Content – What needs to be covered
61.1 Circuit configurations and principles	61.1.1 Types of circuit configurations a) Series circuits i) Characteristics and current flow

	ii) Voltage distribution and limitations b) Parallel circuits i) Characteristics and load sharing ii) Fault tolerance and redundancy c) Series-parallel combinations i) Typical applications 61.1.2 Impact of configuration on performance a) Voltage and current relationships b) Load balancing and energy efficiency c) Safety considerations for each configuration
61.2 Practical applications of electrical circuits	61.2.1 Industrial and commercial systems a) Distribution boards b) Motor Control Centres (MCCs) c) Control circuits for i) Lighting ii) Heating iii) Motor drives 61.2.2 Low-voltage and extra-low-voltage systems a) Typical uses in automation b) Safety systems and compliance 61.2.3 Integration with other technologies a) Electrical circuits combined with i) Mechanical systems ii) Pneumatic systems iii) Electronic systems
61.3 Electrical components and their functions	61.3.1 Active components a) Semiconductors iii) Diodes – rectification iv) Transistors – switching and amplification 61.3.2 Passive components d) Resistors – current control e) Capacitors – energy storage and filtering f) Inductors – magnetic energy storage 61.3.3 Control and protection devices d) Circuit breakers – overload protection e) Fuses – short-circuit protection f) Relays – switching control 61.3.4 Transformers and contactors c) Voltage regulation d) Motor control applications 61.3.5 Impact of component selection c) Performance implications d) Reliability and safety considerations

K62 Electrical and mechanical. Types of diagrams used to represent circuits; symbols and abbreviations used to represent components in electrical schematics

Topic	Content – What needs to be covered
62.1 Types and purpose of electrical diagrams	62.1.1 Purpose of diagrams a) Illustrate electrical systems and component relationships b) Communicate design intent for installation and maintenance c) Accurate representation for design, fault diagnosis and maintenance d) Comparison between functional, schematic and pictorial diagrams 62.1.2 Types of electrical diagrams a) Circuit (schematic) diagrams – show electrical connections and logic flow b) Wiring diagrams – indicate physical wiring routes, conductor types and terminal points c) Layout diagrams – depict physical placement of components in panels or assemblies d) Orthographic diagrams – represent components in three standard views for fabrication or mounting e) Block diagrams – provide simplified overview of system operation and component interaction
62.2 Symbols and abbreviations in electrical schematics	62.2.1 Standard electrical symbols – standard reference IEC 60617 a) Resistors i) Fixed ii) Variable b) Capacitors c) Inductors d) Diodes e) Transistors i) NPN ii) PNP f) Transformers g) Relays h) Switches i) SPST ii) SPDT iii) DPST iv) DPDT i) Fuses j) Motors i) AC ii) DC iii) Servo iv) Stepper k) Light Emitting Diodes (LED) l) Sensors i) Light dependent resistor (LDR)

	ii) Thermistor 62.2.2 Symbols for system elements a) Power sources i) AC supply ii) DC supply iii) Battery b) Ground connections i) Protective earth ii) Chassis ground iii) Signal ground c) Measurement points i) Ammeter ii) Voltmeter 62.2.3 Line types and notations a) Indicating connections, junctions and crossovers 62.2.4 Abbreviations and annotation a) R = resistor, L = inductor, SW = switch, M = motor b) Labelling conventions for terminal points, wire numbers, reference designators c) Common conventions for labelling, routing and earthing
62.3 Interpretation of diagrams and documentation	62.3.1 Reading and cross-referencing b) Circuit, wiring, and layout diagrams for complete system understanding 62.3.2 Recognising system function a) Signal flow, power distribution and control sequences 62.3.3 Linking diagrams to SOPs a) Role of SOPs in guiding safe and consistent electrical work b) Document control systems for revision management and traceability c) Understand title blocks, borders and revision codes for traceability 62.3.4 Compliance and safety a) Accurate interpretation ensures compliance with standards and safe working practices b) Apply British Standards for technical documentation, including line types, scales, tolerances and revision control c) Importance of standardisation for clarity and troubleshooting

K63 Electrical and mechanical. Different types of cables; their specifications and application

Topic	Content – What needs to be covered
63.1 Cable selection and practical applications	63.1.1 Cable types and their applications a) Single core: A single insulated conductor, typically PVC or XLPE insulated i) Commercial and industrial distribution circuits installed in containment (tray, trunking, conduit) ii) Switchgear and control panels iii) Circuits requiring good heat dissipation and straightforward grouping b) Multi-core: Multiple insulated conductors contained within one sheath i) iControl, signalling and instrumentation systems ii) Multi-phase power circuits in industrial environments iii) Situations requiring compact routing with reduced cable clutter c) Flexible cords: Fine-stranded conductors with flexible insulation and sheathing (PVC or rubber/EPR) i) Portable, movable or vibrating industrial equipment ii) Machinery and tools that require repeated flexing iii) Temporary connections where flexing is expected (where permitted) d) Steel Wire Armoured (SWA): Power cables with galvanised steel wire armour, its primary function is mechanical protection i) External, exposed or buried commercial/industrial installations ii) Distribution circuits requiring impact, crushing or abrasion protection iii) Environments where mechanical resilience is critical e) Mineral Insulated Copper Cable (MICC): Copper conductors embedded in compressed magnesium oxide, with a copper sheath and optional LSF jacket i) Fire survival circuits (emergency lighting, alarms, life safety systems) ii) High temperature industrial environments

	iii) Installations requiring long-term reliability and chemical/heat resistance 63.1.2 Voltage classification a) Extra low voltage (ELV): Typically used for signalling, control, instrumentation and other low-energy systems b) Low voltage (LV): Up to 1000 V AC, used widely in commercial and industrial electrical distribution c) Medium voltage (MV): General industrial site distribution and large equipment feeds d) High voltage (HV): Used for transmission networks and high-power industrial processes 63.1.3 Materials a) Conductors i) Copper: High conductivity, excellent mechanical strength, widely used in most cable types ii) Aluminium: Lightweight and cost effective; commonly used in larger power-distribution cables b) Insulation i) PVC: General purpose insulation ii) XLPE: Higher temperature rating and improved current-carrying capacity iii) Rubber (EPR): Enhanced flexibility and heat resistance for flexible cords or harsh environments 63.1.4 Cable components a) Conductor b) Insulation c) Sheath d) Armour e) Outer jacket 63.1.5 Cable identification a) Reading cable designations (6242Y, NYY, SY, CY, SWA) b) Colour coding of conductors according to harmonised standards c) Importance of correct identification for maintenance and safety 63.1.6 Selection Criteria a) Determination of cable type and size based on: i) Load current ii) Voltage drop iii) Short-circuit capacity

	iv) Environmental and installation conditions b) Consideration of derating factors and future load growth c) Selection for flexibility, mechanical protection, and thermal performance d) Use of manufacturer data sheets and regulatory tables for design verification
63.2 Cable specifications and regulatory standards	63.2.1 Specification parameters a) Current-carrying capacity b) Voltage rating c) Temperature rating d) Insulation resistance and mechanical protection 63.2.2 Cable sizing b) Use of derating factors and installation conditions 63.2.3 Regulatory compliance c) Application of BS7671 / IET Wiring Regulations for cable selection and installation d) Use of manufacturer data and certification for conformity
63.3 Cable installation methods	63.3.1 Installation practices a) Routing and securing of cables to prevent strain, heat buildup or interference b) Installation zones and routing requirements c) Use of glands, bushings and sealing devices for entry points and junctions d) Inspection, testing and certification following installation

K71 Electrical and mechanical. Mechanical principles, terminology, and calculations: stress, strains, bending moment, heat transfer, fluid dynamics

Topic	Content – What needs to be covered
71.1 Mechanical principles, terminology and techniques	71.1.1 Principles of mechanical systems a) Laws of motion b) Conservation of energy c) Conservation of momentum d) Heat transfer e) Fluid dynamics f) Bending moments g) Friction h) Power i) Forces j) Thermal expansion and contraction k) Mechanical advantage 71.1.2 Key terminology used in mechanical systems a) Acceleration b) Velocity c) Friction d) Force

	e) Stress (including tensile, compressive and shear) f) Strain g) Torque h) Power i) Pressure j) Thermal/heat
71.2 Mechanical calculations	71.2.1 Mechanical calculations and applications a) Stress and strain i) Calculate tensile stress in loaded components ii) Calculate compressive stress in loaded components iii) Determine stress and strain in structural components during operation iv) Assess material suitability for given load conditions b) Fluid dynamics i) Calculate flow rate in pipes and hydraulic circuits ii) Determine pressure drop across valves and fittings iii) Apply Bernoulli's principle for energy balance in fluid systems c) Bending moments i) Calculate bending moments in structural components ii) Determine maximum deflection for structural integrity iii) Apply calculations to machine frames and supports d) Power i) Calculate energy and power required for pumps, compressors and motors ii) Determine torque and speed relationships in drive systems iii) Assess energy efficiency in mechanical systems e) Heat transfer i) Calculate heat dissipation in bearings and gearboxes ii) Determine cooling requirements for hydraulic systems iii) Apply conduction, convection and radiation principles in design f) SI units i) Ensure correct unit conversions in calculations ii) Apply standard units for force, pressure and energy, power, temperature, torque, distance, time, velocity, acceleration iii) Maintain consistency in technical documentation

K72 Electrical and mechanical. Function and application of mechanical elements of plant and equipment

Topic	Content – What needs to be covered
72.1 Functions of mechanical components	72.1.1 Function of mechanical components a) Gears: Transmit torque/power and change speed/direction i) Gear ratio principles ii) Backlash

	iii) Lubrication requirements iv) Common failure modes b) Belts and pulleys: Transfer motion between shafts i) Belt tensioning ii) Slip prevention iii) Material selection for durability c) Shafts: Transmits torque/power and rotation i) Load capacity ii) Alignment iii) Fatigue considerations d) Chains: Transmit power with positive engagement i) Chain pitch ii) Lubrication iii) Wear inspection e) Levers: Amplify force i) Pivot point design f) Linkages: Convert motion types i) Four-bar linkage principles ii) Tolerance control g) Bearings: Reduce friction and support loads i) Types (ball, roller, plain) ii) Lubrication systems iii) Failure analysis h) Springs: Absorb shock and store energy i) Spring rate ii) Fatigue life iii) Material properties i) Cylinders: Provide linear motion i) Pneumatic vs hydraulic cylinders ii) Sealing integrity iii) Stroke length j) Valves and actuators: Control fluid flow and movement i) Actuation methods (manual, electric, pneumatic) ii) Response time iii) Safety interlocks k) Cams and followers: Convert rotary to reciprocating motion i) Cam profile design ii) Follower wear iii) Lubrication
72.2 Applications of mechanical components	72.2.1 Applications a) Locking devices i) Positive restraint: Split pins, tab washers, locking wire ii) Frictional restraint: Adhesive, nylon insert, serrated washers, locking nut b) Power transmission i) Belts ii) Gears iii) Pulleys iv) Chains and sprockets v) Couplings

	vi) Shafts c) Motion control i) Levers ii) Linkages iii) Cams d) Overload protection i) Torque limiter ii) Slip clutch iii) Separation type e) Shock/vibration and flexibility i) Springs 72.2.2 Mechanisms a) Four-bar linkages: Used in robotic arms and presses b) Crank-slider mechanisms: Common in reciprocating pumps and engines c) Cam and follower systems: Found in automated packaging machines d) Ratchet and pawl: Used in lifting devices and indexing systems e) Geneva wheel: Provides intermittent motion in conveyors f) Toggle mechanisms: Used in clamping and press operations
72.3 Sealing and jointing methods used in mechanical assemblies	72.3.1 Types of sealing and jointing methods a) Gaskets: Material selection for temperature and pressure conditions b) Bellows: Used for vibration isolation and thermal expansion c) Compression: Common in pipe joints; torque control critical d) Capillary: Brazed joints for leak-proof seals e) Heat-shrink (interference): Used for shaft-hub connections; requires precise tolerances f) Welding, brazing and soldering: Structural integrity and inspection standards g) O-rings, lip seals, gas seals, mechanical seals, labyrinth seals: Selection based on fluid/gas type, pressure, temperature and speed; failure analysis for leakage prevention

K73 Electrical and Mechanical. Pneumatic and hydraulic system principles: Air compressors, hydraulic pumps, filters, regulators, lubricators

Topic	Content – What needs to be covered
73.1 Principles of pneumatic and hydraulic systems	73.1.1 Principles of hydraulic systems a) Fluid pressure and flow i) Pascal's Law and its application in hydraulic systems ii) Relationship between pressure, force and area

	b) Return path i) Closed-loop circulation of hydraulic fluid ii) Reservoir function and fluid recovery c) Control i) Directional control valves ii) Flow control for speed regulation d) System applications i) Lifting equipment, presses, injection moulding machines brakes, steering systems e) Open loop vs closed loop systems i) Characteristics, advantages and limitations 73.1.2 Principles of pneumatic systems a) Air flow principles i) Compressibility of air and its effect on system design ii) Pressure-volume relationship (Boyle's Law) iii) Pascal's Law and its application in pneumatic systems b) Return path (exhaust) i) Venting and exhaust systems c) Control i) Directional valves, speed control via flow regulators d) System applications i) Robotics, material handling, packaging machinery, air brakes, industrial automation systems e) Open loop vs closed loop systems i) Energy efficiency and control precision
73.2 Components of pneumatic and hydraulic systems	73.2.1 Air compressors a) Types i) Reciprocating piston ii) Rotary screw iii) Centrifugal b) Characteristics i) Pressure range ii) Flow rate iii) Duty cycle c) Application i) Automation ii) Robotics iii) HVAC iv) Spray painting v) Powered tooling d) Maintenance i) Sensory inspection ii) Planned maintenance iii) System diagnostics iv) Lubrication checks v) Filter cleaning and replacement vi) Condensate drainage 73.2.2 Hydraulic pumps

	a) Main types i) Gear pumps ii) Vane pumps iii) Piston pumps b) Characteristics i) Flow rate ii) Pressure capability iii) Efficiency c) Applications i) Presses ii) Lifting equipment iii) Mobile plant iv) Brakes v) Steering systems vi) Air brakes vii) Industrial automation systems d) Maintenance i) Seal inspection ii) Fluid level checks iii) Contamination control/condition monitoring e) Safety i) Avoid overpressure ii) Correct coupling alignment 73.2.3 Hydraulic and pneumatic accumulators a) Types i) Bladder ii) Piston iii) Diaphragm b) Applications i) Shock absorption ii) Emergency power supply iii) Load balancing and pressure holding c) Maintenance i) Pressure checks ii) Seal integrity d) Safety i) Controlled charging and discharging 73.2.4 Reservoir (tank) a) Characteristics i) Capacity ii) Material construction b) Maintenance i) Cleanliness ii) Fluid level monitoring 73.2.5 Lubricators a) Purpose i) Introduce controlled lubrication into pneumatic systems

	b) Types i) Oil mist lubricators c) Characteristics i) Adjustable oil feed ii) Compatibility with system d) Applications i) Extend life of pneumatic tools and actuators e) Maintenance i) Refill oil ii) Clean sight glass f) Safety i) Avoid over-lubrication to prevent contamination 73.2.6 Valves a) Purpose i) Isolation ii) Control (speed) iii) Direction flow b) Types and applications i) Flow control valves ii) Directional control valves iii) Pressure control valves iv) Relief valves v) Sequencing valves vi) Counterbalance valves vii) Check valves (non-return valve) viii) Solenoid valves ix) Manually operated valves 73.2.7 Pressure regulators a) Types i) Direct acting ii) Pilot-operated iii) Self-relieving b) Characteristics i) Adjustable range ii) Response time c) Applications i) Control pressure for actuators and tools d) Maintenance i) Calibration ii) Leak checks 73.2.8 Filters a) Types i) Inline filters ii) Return line filters iii) Suction filters iv) Combined filter/regulators devices b) Characteristics

	i) Micron rating ii) Flow capacity iii) Applications iv) Protect valves and actuators from wear c) Maintenance i) Regular replacement ii) Monitoring differential pressure d) Safety i) Ensure correct installation to prevent leaks 73.2.9 Pipework and fittings a) Connect system components b) Materials i) Steel ii) Copper iii) Brass iv) Flexible hoses 73.2.10 Air coolers and water separators a) Purpose i) Remove moisture and cool compressed air b) Applications i) Improve system efficiency c) Maintenance i) Drain water traps ii) Clean cooling fins 73.2.11 Gauges and measurement a) Types i) Pressure gauges ii) Flow meters iii) Temperature indicators b) Applications i) System performance monitoring c) Maintenance i) Calibration ii) Visual inspection
73.3 Safety and maintenance practices for pneumatic and hydraulic systems	73.3.1 Safety precautions a) Safe isolation procedures: Lockout/tagout for hydraulic and pneumatic systems b) Depressurisation: Controlled release of stored energy c) Securing components: Prevent accidental movement of actuators d) Working in confined spaces: Ventilation and monitoring e) Waste disposal and environmental considerations: Disposal of oils and filters in compliance with environmental standards 73.3.2 Maintenance procedures and good practices a) Cleanliness standards: Importance of contamination control

	b) Use of appropriate tools and equipment: Torque wrenches, pressure gauges c) Safe equipment handling: Lifting and moving heavy components d) Safety precautions during maintenance: PPE, hazard awareness e) Change management: Documenting modifications and updates f) Proof marking: Marking the orientation of components in an assembly g) Pressure/force assembly and release h) Destructive removal: Drilling, cutting, grinding, filing i) Torque: Correct sequence of removing and assembling mechanical fasteners

K79 Electrical and mechanical. Different types of mechanical fasteners and their uses

Topic	Content – What needs to be covered
79.1 Mechanical fastener types and applications	79.1.1 Types of mechanical fasteners a) Nuts i) Hexagon and heavy hexagon ii) Square nuts iii) Flange nuts iv) Lock nuts v) Wing nuts vi) Acorn/cap nuts b) Bolts i) Hexagon bolt ii) Eye bolt iii) U-bolt iv) Anchor bolt v) Flange bolt vi) Machine/set bolt vii) Shoulder bolt viii) Stud bolt c) Screws i) Machine screw ii) Set/Grub screw iii) Lead screw d) Self-tapping screws i) Thread-forming screws ii) Thread-cutting screws iii) Self-drilling screws e) Rivets i) Solid rivets ii) Blind rivets (pop rivets) iii) Tubular rivets iv) Split rivets v) Flush rivets (countersunk rivets) vi) Self-piercing rivets

	f) Washers i) Plain washers ii) Spring washers iii) Locking washers g) Snap rings/circlips i) Internal types ii) External types 79.1.2 Application of mechanical fasteners a) Joining moving parts (hinges) b) Maintenance and repair (nuts, bolts, screws) c) Permanent joining (rivets) d) Load distribution (washers) 79.1.3 Identification, fitting and removal of fasteners a) Metric/SI units measurement b) Imperial measurement c) Hand tools i) Spanners ii) Sockets iii) Screwdrivers iv) Pliers (including circlip) d) Power tools i) Pneumatic ii) Hydraulic iii) Electric (portable drill) e) Torque loading i) Where to find fastener torque values ii) Factors that influence torque values

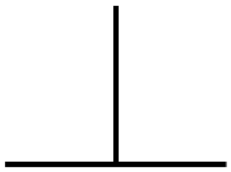
K80 Electrical and mechanical. Types of diagrams used to represent mechanical installations and assemblies; symbols and abbreviations used to represent parts in diagrams

Topic	Content – What needs to be covered
80.1 Types of diagrams and technical documentation	80.1.1 Types of diagrams and drawings used in mechanical engineering and their primary uses a) Orthographic (1st Angle and 3rd Angle) – used for accurate component views for manufacturing and assembly b) Isometric – used for 3D representation of components c) Oblique – used for pictorial representation d) Schematic diagrams – used for fault finding, troubleshooting, diagnostics e) Exploded diagrams – used to illustrate assemblies and disassembly of components f) General Assembly (GA) – used to represent complete assemblies and their arrangement g) Detail drawings – used for precise component details h) Conventional drawings, sketches and diagrams

	i) CAD drawings including 3D modelling j) Standard Operating Procedures (SOP) – used for maintenance procedures k) Method statements – used for manufacturing activities l) Manufacturer and data sheets – used for reference during maintenance and assembly
80.2 Symbols and abbreviations used in diagrams	80.2.1 Symbols and abbreviations used in diagrams and drawings – Standard reference BS8888 a) Tolerance (maximum and minimum values) b) Radius c) Diameter d) Material e) Position f) Threads g) Countersink h) Counter-bore i) Cross-sectional views j) Enlarged views k) Scale (1/1, 2/1, 1/2, 4/1, 10/1, 100/1) l) Surface finish m) Welding i) Butt ii) Fillet n) Projection (symbol) o) Geometric i) Squareness ii) Flatness iii) Concentricity iv) Parallelism

Symbols bank for multiple-choice tests

Core – K21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	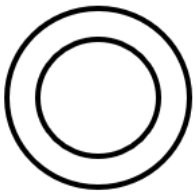	
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	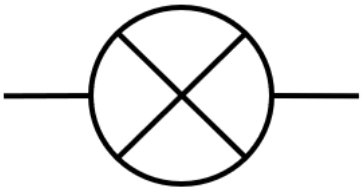	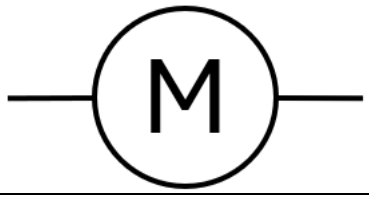
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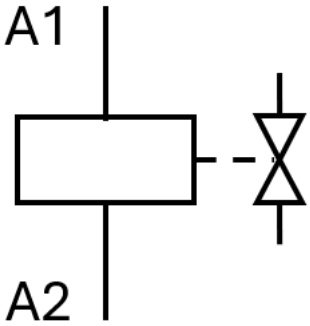		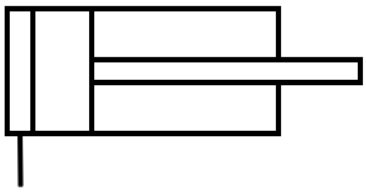
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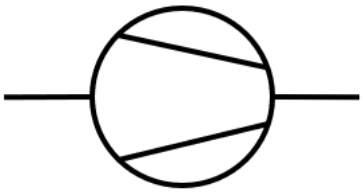
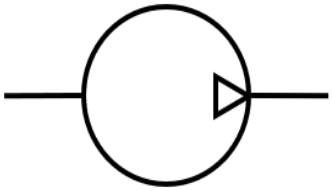
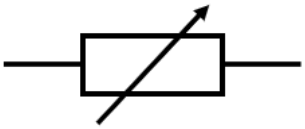
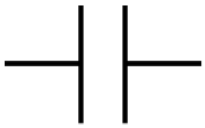
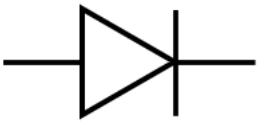
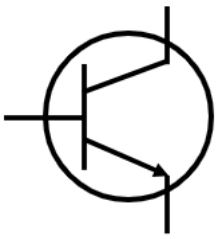
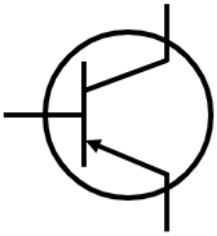
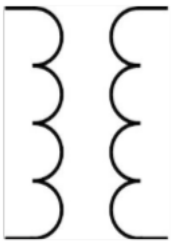
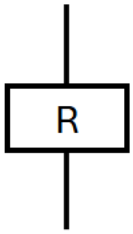
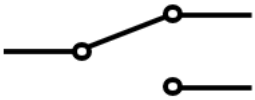
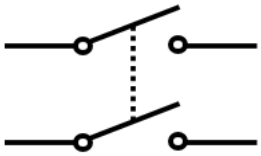
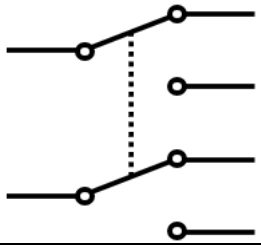
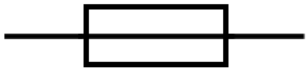
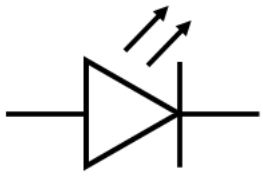
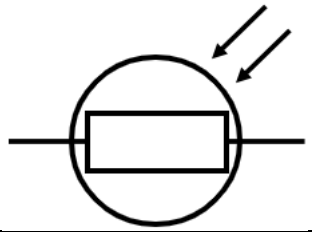
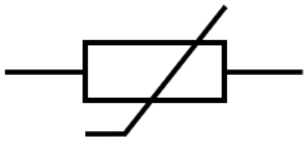
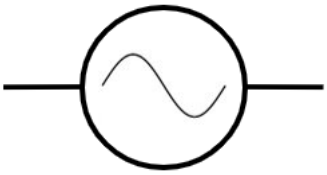
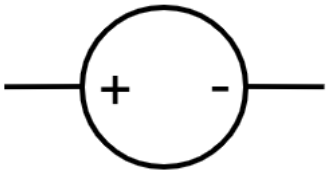
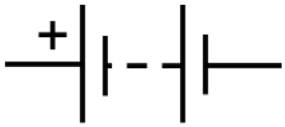
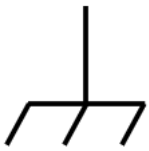
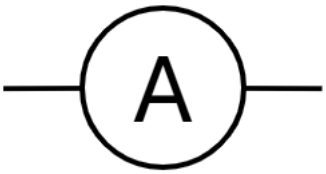
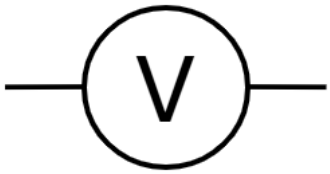
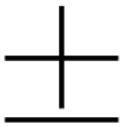
		
Compressor- ISO 1219	Pump- ISO 1219	Reservoir- ISO 1219

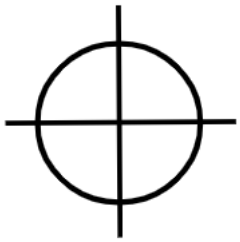
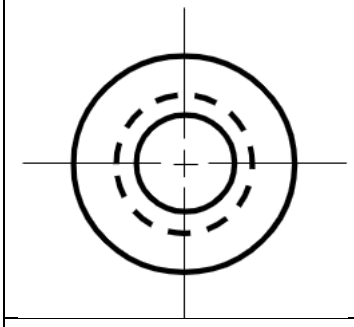
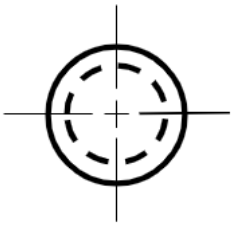
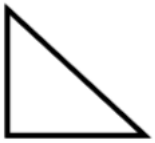
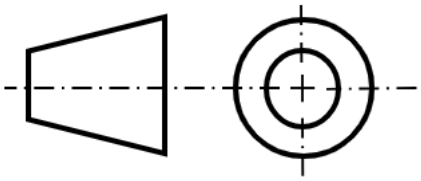
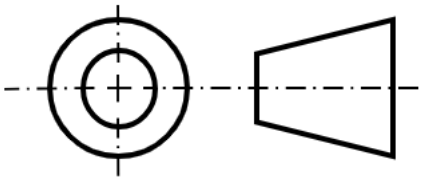
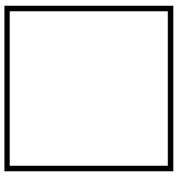
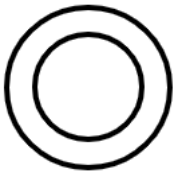
Electrical and control and instrumental/Electrical and Mechanical- K38/K62 - IEC 60617

		
Fixed resistor	Variable resistor	Capacitor
		
Inductor	Diode	NPN transistor
		
PNP transistor	Transformer	Relay
		
SPST switch	SPDT switch	DPST switch
		
DPDT switch	Fuse	AC motor
DC/Servo motor	Stepper motor	

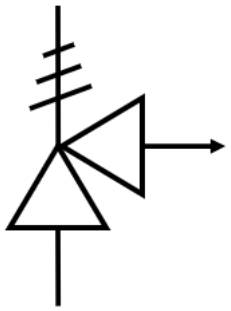
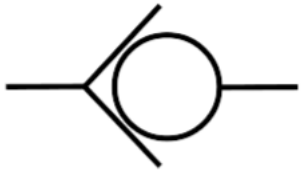
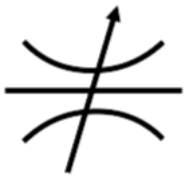
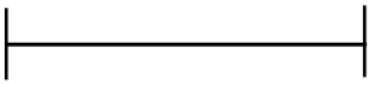
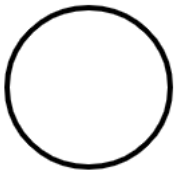
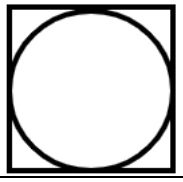
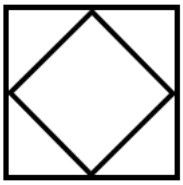
		
Light Emitting Diode (LED)	Light Dependent Resistor (LDR)	Thermistor
		
AC supply	DC supply	Battery
		
Protective earth	Chassis ground	Signal ground
		
Measurement point - ammeter	Measurement point - voltmeter	

Mechanical- K80 – BS8888

		
Tolerance: plus or minus symbol followed by the acceptable limit	Radius, abbreviation: Letter R followed by the value e.g.R6	Diameter

DIA	MTL	
Diameter alternative, abbreviation	Material, abbreviation	Position (true position)
		
Internal thread	External thread	Countersink
Counter-bore	Surface finish	Butt weld
		
Fillet weld	First-angle projection	Third-angle projection
		
Square	Flatness	Concentricity
Parallelism		

Electrical and control and instrumental - K38 - IEC 60617

		
Pressure relief valve	Check valve	Flow valve
Solid thick line – visible edge, outline	Solid thin line –dimension, extension, leader line	Dashed line – hidden detail
		
Solid line with perpendicular marks – dimensions	Circle – discrete, stand alone instrument	Circle inside a square -shared display/control instrument
		
Diamond inside a square – Programmable Logic Controller (PLC)function	Hexagon – computer function	Centre line

Appendix 2 – KSBs and grading descriptors for 703/704 Observation with Questions

Theme KSBs	Pass Apprentices must demonstrate all of the pass descriptors	Distinction Apprentices must demonstrate all of the pass descriptors and all of the distinction descriptors
Core – Organising own work	Uses planning, prioritising, organising and time management techniques and identifies and organises resources required to plan and complete tasks with consideration for quality, cost, delivery and ethical practices. (K4, K5, S2, S3)	Justifies their planning decisions in terms of efficiencies they achieved and the balance of quality, cost, delivery and ethical practice. (K4, K5, S2)
Core – Maintaining workplace health, safety, security and environmental compliance	Identifies potential hazards and risks in the work environment and applies control measures in line with safe systems of work. (K9, S7)	Explains the importance of applying health, safety and environmental procedures in their work. (K10, S8)
	Prioritises safe working practices by applying health, safety and environmental procedures in compliance with regulations, standards and guidelines including selection, use and care of personal protective equipment. (K10, K11, S8, B1)	
	Follows asset security procedures in line with task and company requirements. (K12, S9)	None
	Segregates items for reuse, recycling and waste in line with the company's recycling and waste management requirements. (K15, S12)	None
Core – Using work information and following working practices	Reviews and uses information including engineering information to plan and complete tasks. (K19, S1)	None
	Identifies equipment to work on and checks plant configuration is as defined, identifying and highlighting issues with drawings in line with company procedures. (S5, S23)	None

	Prepares the work area for maintenance to meet task requirements in line with company procedures. (S6)	None
	Takes ownership for the delivery and quality of work by applying BSI and ISO engineering maintenance standards and procedures in line with standard operating procedures (SOPs). (K20, K22, K23, S14, B3)	None
	Applies foreign material exclusion procedures in line with task requirements and company procedures. (K24, S15)	None
	Follows maintenance tools and equipment control requirements in line with company procedures. (S16)	None
	Reinstates the work area in line with task requirements and company procedures. (S17)	None
Core – Completing work records	Records information for work tasks in line with their company procedures for documentation control and auditable records. (K25, S21)	None
Core – Communicating with others	Uses verbal communication methods and techniques and industry terminology suitable for the context. (K29, S19)	None
Electrical and control and instrumentation engineering maintenance technician grading descriptors		
Conducting planned electrical and control and instrumentation maintenance K34, K41, K42, K46, K53, K54, S27, S28, S31, S32, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43	Confirms the electrical isolation, lockout tagout, method has been applied and tests for dead, in line with task requirements and company procedures. Confirms the electrical isolation, lockout tagout, method has been applied and tests for dead, in line with task requirements and company procedures. Conducts and confirms isolation of connected services in line with task	

	requirements and company procedures. Re-connects instrumentation power supply, cables, pipework, and services in line with task requirements and company procedures. Conducts and confirms electrical and connected services deisolation in line with task requirements and company procedures. (K34, K46, S27, S36, S43) Selects electrical and control and instrumentation maintenance tools, measurement, and test equipment to meet task requirements. Checks to ensure functionality, and uses in line with operation, care and calibration requirements. (K42, K54, S28) Conducts planned electrical maintenance 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. (K41, S31, S32, S34, S35) Conducts planned control and instrumentation maintenance in line with task requirements and company procedures including inspecting and testing control and instrumentation systems, checking calibration and making adjustments, checking loop function, setting up and adjusting control and instrumentation systems, cleaning parts, and removing and replacing instruments and sensors. (K53, S38, S39, S40, S41, S42) Conducts functional testing to confirm operation in line with task requirements and company procedures (S37)	Justifies their approach to planned electrical maintenance. (K41, S31, S32, S34, S35, S37)

		Justifies their approach to planned control and instrumentation maintenance. (K53, S38, S39, S40, S41, S42)
Electrical and mechanical engineering maintenance technician grading descriptors		
Conducting planned electrical and mechanical maintenance K58, K65, K66, K70, K74, K75, S44, S45, S46, S49, S50, S52, S53, S54, S55, S56, S57, S58, S59	Confirms safe electrical isolation, lockout tagout, method has been applied and tests for dead in line with task requirements and company procedures. Conducts and confirms isolation of connected services in line with task requirements and company procedures. Conducts and confirms electrical and connected services deisolation in line with task requirements and company procedures. (K58, K70, S44, S45) Selects electrical and mechanical maintenance tools, measurement, and test equipment to meet task requirements. Checks to ensure functionality and uses in line with operation and care requirements. (K66, K75, S46) Conducts planned electrical maintenance 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. (K65, S49, S50, S52, S53)	Justifies their approach to planned electrical maintenance. (K65, S49, S50, S52, S53)

	Conducts planned mechanical 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. (K74, S55, S56, S57, S58, S59) Conducts functional testing to confirm operation in line with task requirements and company procedures. (S54)	Justifies their approach to planned mechanical maintenance. (K74, S55, S56, S57)

Appendix 3 – KSBs and grading descriptors for 713/714 Interview Underpinned by a Portfolio of Evidence

Theme KSBs	Pass	Distinction
Core – Impact of sector on maintenance activities	Explains the impact of the sector that they work in on their maintenance activities. (K1)	N/A
Core – Role and responsibilities	Outlines their role as a maintenance technician including their limits of responsibility and how they escalate issues in line with company procedures. (K3, S20)	N/A
	Describes how they respond and adapt to meet demands in their work with different maintenance disciplines and functional areas. (K2, S4)	N/A
	Describes how they have or would respond in an emergency situation in line with their company's emergency incident procedures. (K16, S10)	N/A
Core – Working sustainably	Describes how they consider and apply principles of sustainability when using resources and carrying out tasks to support the UK's net zero commitment. (K14, S11, B2)	Justifies their application of sustainability practices in maintenance activities. (K14, S11, B2)
Core – Participating in continuous improvement	Describes how they have applied continuous improvement (CI) techniques to identify viable suggestions in line with the company's CI processes. (K26, S25)	Justifies the potential impact of their improvement suggestions with consideration to benefits and potential risks. (K26, S25)
	Describes planned and unplanned learning and development activities they have carried out and recorded to meet personal development needs, showing a commitment to future CPD. (S26, B5)	N/A
Core – Teamworking	Describes how they apply team working principles to meet work goals and support inclusivity in line with their company's policy on equity, diversity and inclusion. (K27, K28, S18, B4)	N/A

Core – Produce written documents	Describes how they apply written communication techniques to produce or update documents in their work that are suitable for the context. (K30, S22)	N/A
Electrical and control and instrumentation engineering maintenance technician grading descriptors		
Electrical and control and instrumentation maintenance problem solving and fault finding K43 K44 K45 K55 K56 S29 S30	Describes how they use electrical diagnostic equipment and apply fault finding, rectification, problem solving, and critical reasoning techniques identify and rectify common electrical plant, equipment, and systems failure modes in line with task requirements and company procedures.	Justifies diagnostic methods they have used in the identification and rectification of electrical plant and equipment faults and system failure modes.
	Describes how they use control and instrumentation diagnostic equipment and apply fault finding, rectification, problem solving, and critical reasoning techniques to identify and rectify common control and instrumentation system failure modes in line with task requirements and company procedures. (K43, K44, K45, K55, K56, S29, S30)	Justifies diagnostic methods they have used in the identification and rectification of control and instrumentation system failure modes. (K43, K55, S30)
Cable installation and termination K40 S33	Describes how they prepare and terminate cables using methods in line with the task requirements and company procedures. (K40, S33)	None
Electrical and mechanical engineering maintenance technician grading descriptors		
Electrical and mechanical maintenance problem solving and fault finding K67 K68 K69 K76 K77 S47 S48	Describes how they use electrical diagnostic equipment and apply fault finding, rectification, problem solving, and critical reasoning techniques identify and rectify common electrical plant, equipment, and systems failure modes in line with task requirements and company procedures.	Justifies diagnostic methods they have used in the identification and rectification of electrical plant and equipment faults and system failure modes.
	Describes how they use mechanical diagnostic equipment and apply fault finding, rectification, problem solving, and critical reasoning techniques to identify and rectify common problems relating to mechanical aspects of plant and equipment in line with task	Justifies diagnostic methods they have used in the identification and rectification of issues relating to mechanical aspects of

	requirements and company procedures. (K67, K68, K69, K76, K77, S47, S48)	plant and equipment. (K67, K76, S48)
Cable installation and termination K64 S51	Describes how they prepare and terminate cables using methods in line with the task requirements and company procedures. (K64, S51)	None
Bench fitting techniques K78 S60	Describes how they apply bench fitting techniques including cutting threads, mechanical fitting, and joining in line with task requirements and company procedures. (K78, S60)	None

Appendix 4 9331-12-703/704 Observation with Questions – planning checklist/template

This document aims to support employers/providers and apprentices to plan and prepare for the 700/701/702 Observation with Questions assessment. It does not need to be uploaded; however, it may support completion of the Gateway questions and preparation for the (optional) planning meeting.

Option			
Apprentice name		Enrolment number	
Assessment venue			

You should refer to the assessment specification, KSBs and grading descriptors to ensure that the scope of work will provide the apprentice with the opportunity to demonstrate the KSBs and grading descriptors to the best of their ability.

Observation with Questions	
Outline of the maintenance task(s)	
Timings (if applicable); n.b. the planned task(s) must be able to be completed within the five hour assessment time which will also include IEPA questions.	
Will any of the task(s) require 'pre-installed' aspects (ie skills that may not be able to be demonstrated through naturally occurring tasks)? n.b. minimal pre-installed aspects are allowed for the following skills but must be agreed with the IEPA: • S32 Remove and replace electrical parts	

• S39 Check calibration and make adjustments • S41 Set up and adjust control and instrumentation systems • S42 Remove and replace instruments and sensors • S56 Remove and replace mechanical parts • S58 Set up, align, and adjust mechanical aspects of plant	
Have you confirmed any additional requirements to the City & Guilds EPA team, eg access requirements for the venue/assessment location, induction training?	
Have you booked/prepared a separate room for the IEPA that will be free from distractions and interruptions?	

Appendix 5 – Portfolio of evidence checklist

Apprentice portfolio of evidence checklist		Tick when confirmed
1.	Is all evidence signed by the apprentice and dated?* E-signatures are also acceptable	
2.	Is all evidence valid, authentic, current and sufficient (VACS)?	
3.	Does evidence clearly show it is the apprentice's individual work (and if involved in teamwork, is it clear what specific contribution the apprentice made)?	
4.	Does the evidence clearly demonstrate the apprentice's relevant knowledge?	
5.	Has the apprentice completed the portfolio reference form? And has all evidence been referenced, where applicable?	
6.	Does it showcase the apprentice's best pieces of work?	
7.	Have duplicate and irrelevant pieces of evidence been removed?	
8.	Is there sufficient evidence to cover the whole of the KSBs and grading descriptors that are referenced?	
9.	Are any witness testimonies or employer references tailored to the apprentice, where applicable?	
10.	Has any client/customer reference information been anonymised?	
11.	Are all external sources of information appropriately documented and referenced to the original source, showing clear understanding of how they relate to the KSBs?	
12.	Has the appropriate stakeholder(s), eg employer/training provider, checked whether the apprentice's portfolio meets all the required KSBs and grading descriptors?	

*Where witness testimonies are included as a piece of evidence, these do not need to be signed by the apprentice but instead must be signed/authenticated.

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We work with Governments, employers, training providers, colleges and industry stakeholders to design and deliver high-quality training, qualifications, assessments and credentials that lead to meaningful career progression. We understand the life changing link between skills development, social mobility and success. Our solutions span critical sectors including construction, engineering, transport, energy and electrical, serving over 1 million learners annually.

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City & Guilds

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