

EAL Building Services Engineering (Level 3) - Electrotechnical Installation C00/4278/8

Qualification Manual

Version 1.3 – November 2022



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Version information

Version and publication date	Changes
v1 June 2021	Original document
v1.1 December 2021	Updated website link for Assessment Pack Structure of the qualification text updated
v1.2 September 2022	Minor update to Delivery outcomes (depth of content) in Unit 315E, 1.3: Inclusion of references to British Standards. Unit 317E, 1: Inclusion of diverted neutral current. Inclusion of PEIs in relation to safe isolation (multiple supplies). Other minor updates for BS 7671 A2.
v1.3 November 2022	Unit 302: Removal of reference to ARBED, and inclusion of UKCA marking.

Qualification purpose

	Description
Who is the qualification for?	<p>The EAL Building Services Engineering (Level 3) - Electrotechnical Installation qualification has been developed to allow those in work-based learning to demonstrate and enhance their occupational knowledge, skills and understanding within their BSE trade</p> <p>It is aimed at learners who have either achieved the Foundation in Construction and the Built Environment (Level 2), or will be completing the Core in Construction and Building Services Engineering (Level 2) learning and assessments while in their apprenticeship. This qualification will enable learners to go on to study other Level 3 BSE courses relevant to their choice of trade.</p> <p>It is suitable for:</p> <ul style="list-style-type: none"> • learners aged 16+ currently working in the trade area • learners who have either passed the Foundation in Construction and the Built Environment qualification or will be completing their Foundation learning and assessments while in their apprenticeship • learners who have completed the EAL Progression in Building Services Engineering (Level 2) in the electrical pathway.
What does the qualification cover?	<p>Learners will develop their knowledge, skills and understanding for the trade, as contained in the recognised standards.</p> <p>The qualification will allow learners to plan and perform projects in their trade, against recognised standards, before reviewing and evaluating the quality of the project outputs.</p> <p>The qualification will be portable throughout the UK and is aimed to develop learners' ability to meet the demands of the BSE sector in Wales.</p>
What opportunities for progression are there?	<p>On completion, the qualification will provide learners with the skills and knowledge required for the learner to be capable of working in their trade across the UK.</p>

	Description
Who did we develop the qualification with?	The content has been developed by the Consortium ¹ in conjunction with stakeholders, tutors, training providers and employers from across the sector.

Qualification aims and objectives

This qualification enables learners to develop their:

- ability to effectively plan work projects using the appropriate skills for their trade in a work environment
- ability to effectively review and evaluate the quality of their completed work for their trade in the work environment
- knowledge and understanding of the tools, techniques, materials, and technologies used in their trade, and how they have changed over time
- employability skills and their ability to utilise them in a work environment
- understanding of social, economic, and environmental sustainability
- occupational knowledge and understanding of their trade
- occupational performance of their trade in a work context.

¹ The consortium consists of the City & Guilds of London Institute and EAL who worked jointly to develop and deliver all of the qualifications in the Construction and BSE suite

Qualification structure

Rule of combination

To achieve the EAL Building Services Engineering (Level 3) - Electrotechnical Installation qualification learners must successfully undertake all the units in this qualification **achieving a Pass grade or higher in the assessment methods and successfully complete the safety critical assessment.**

Unit	Unit title	GLH
301	Understanding Building Services Engineering Practice in Wales	40
302	Working in The Building Services Engineering Sector in Wales	40
304	Planning and Evaluating Work in the Building Services Engineering Sector in Wales	35
303	Understand Health and Safety and Environmental Legislation in The Building Services Engineering Sector	21
304E	Understand How to Install Enclosures for Electrical Cables, Conductors and Wiring Systems	70
305E	Understand How to Install and Connect Electrical Cables, Conductors, Wiring Systems and Equipment	67
306E	Understand How to Inspect and Test De-Energised Electrical Circuits	25
307E	Understand Intermediate Electrical Science and Principles	80
312	Apply Health and Safety and Environmental Legislation in the Building Services Engineering Sector	15
313	Establish and Maintain Relationships in the Building Services Engineering Sector	26
314	Coordinate a Work Site in the Building Services Engineering Sector	28

315E	Installation of Wiring Systems	170
316E	Install and Connect Electrical Cables, Conductors, Wiring Systems and Equipment	80
317E	Inspect, Test and Commission Electrical Systems and Equipment	72
318E	Identify and Rectify Faults in Electrical Systems and Equipment	47
319E	Understand Advanced Electrical Science and Principles	100
N/A	Assessments (Graded and Safety Critical Assessment)	131
Total GLH		1047

Guided Learning Hours (GLH) and Total Qualification Time (TQT)

Guided Learning Hours (GLH) gives an indication to centres of the amount of supervised learning and assessment that is required to deliver a unit and can be used for planning purposes.

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and undertaking some formative assessment activities.

Credit is calculated using a formula that equates to the TQT value divided by 10.

The TQT for the qualification is specified below.

Qualification	TQT	Credits
EAL Building Services Engineering (Level 3) - Electrotechnical Installation	1211	121

Centre requirements

This qualification will require centre and qualification approval. This will include both desk-based and face to face activity.

Centre approval is based upon an organisation's ability to meet the centre approval criteria. The approval requirements for this qualification can be found in the following document:

- Application for Centre & Qualification Approval.

Prospective centres will be advised to seek centre and qualification approval, as appropriate, prior to starting to deliver the qualification.

EAL aims to provide the centre and qualification approval decision within 30 working days of the submission of the completed application, with four possible outcomes:

- Centre approval and qualification approval granted
- Centre approval and qualification approval granted subject to action plan
- Centre approval and qualification approval withheld subject to action plan
- Centre approval and qualification approval denied.

Centre and qualification approval are deemed to have been granted when EAL confirms the status in writing to the centre, and not before.

Centres will be required to apply for approval for this qualification and to meet the specific centre requirements outlined in this document related to delivery staff and assessor competence. These requirements will be checked and monitored as part of the qualification approval process and on-going monitoring of this qualification.

Registration, results issuing and certification

Please consult the EAL website for details on qualification registration and certification processes, timelines, and procedures.

Quality assurance

Internal quality assurance

The focus of internal quality assurance for this qualification is:

- the quality assurance of assessment procedures, including standardisation of assessment practice across different assessors within the centre
- ensuring the approximate GLH figures for the Practical Project are consistently met, with significant or continued variance investigated
- internal standardisation of learner marks awarded for the Practical Project.

All centres approved to deliver this qualification must have robust internal quality assurance (IQA) processes in place. This will help ensure that Internal Quality Assurance procedures:

- provide accuracy and consistency between Assessors in the use and interpretation of the guidance in the qualification and/or assessment documentation
- maintain validity and reliability of assessment decisions and continue to meet approval criteria.

IQA evidence will be scrutinised as part of EAL's external quality assurance activities. Centres will be expected to retain evidence in-line with the requirements of EAL- Quality Assurance Requirements detailed within the EAL Centre recognition document which can be viewed via EAL Smarter Touch and should be retained for a minimum of three years.

Internal quality assurers

The centre must provide EAL with the details of personnel who they plan to undertake Internal Quality Assurance (IQA), so that they can be approved prior to them carrying out this role. Prior to the first assessments taking place, Internal Quality Assurer's (IQAs) must also complete EAL training. This is to ensure the reliability of assessment at centres over time.

IQAs must:

- prepare for and participate in relevant EAL meetings and events, such as induction, Continuing Professional Development (CPD)/training and standardisation events, and ensure any personal action/ improvement plans are achieved, within agreed timescales and to the required standards
- technically and occupationally competent in the trade area or related BSE area evidenced by having a building services engineering related qualification or proven sector competence/experience at least equivalent to the level of the qualification, to enable them to conduct their role as an IQA. This evidence is quality assured by EAL
- be working towards (registered before carrying out any quality assurance activity), or have achieved the following units:
 - Understanding the Principles and Practices of Internally Assuring the Quality of Assessment*
 - Internally Assure the Quality of Assessment*
- * Legacy Qualifications (D32/D32/D34, A1 and V1) will be accepted
- be able to demonstrate evidence of being up to date with the relevant trade/industry. This can be evidenced for example by either accessing trade publications, undertaking courses of learning, attending networking events relevant to this qualification and/or attending industry events.

The IQA has a pivotal role in ensuring that centre marked assessment is standardised. They should work with assessors to ensure that the correct procedures are always being followed and ensure that assessment decisions taken by different assessors are consistent, fair, and reliable. Key activities will include:

- meeting with assessors (individually and collectively) throughout the qualification to discuss quality assurance and standardisation issues and provide support and guidance where needed
- observing assessors and giving them feedback to help improve their assessment technique
- sampling evidence across different cohorts to ensure that appropriate standards have been met
- arranging cross-marking of assessments to compare results and agree benchmarks in line with EAL training.

EAL will provide guidance to centre IQAs throughout the change management process.

External quality assurance

The Practical Project is internally assessed and externally verified.

The Professional Discussion is externally assessed and externally verified.

Our team of technically competent, External Quality Assurers (EQAs) will externally verify centre assessment decisions and internal quality assurance processes to ensure the validity and reliability of results. Our EQAs follow robust verification processes. They monitor centres' assessment systems, practice, and outcomes in line with regulatory requirements. Their sampling strategies are based on 'CAMERA' (ensuring a representative sample of Candidates/Learners, Assessors, Methods of assessment, Evidence, Records, Assessment sites).

EAL will:

- carry out necessary quality assurance of this assessment which can include direct observation, assessment sampling, and feedback from learners,
- have a robust appeals procedure in place for learners.

External quality assurers

EQAs are inducted, trained, and standardised to ensure a consistent approach. They are regularly updated on changes to qualifications and subject to ongoing monitoring and sampling of their work. Thorough vetting ensures required knowledge, including attainment of EQA Training Assessment and Quality Assurance (TAQA) qualifications. All Building Services Engineering (BSE) and Construction EQAs will be briefed on the Sector Review including the new qualification suite.

External Quality Assurers must:

- be accountable to EAL
- have achieved or be working towards the TAQA award have achieved V2 or D35 and possess CPD evidence of practicing to the TAQA Standards and
- understand the assessment process and apply the marking process consistently
- have no conflict of interest with the assessment centre, in order to maintain objectivity
- have requisite and relevant technical/occupational understanding in the qualification(s)/unit(s) being externally quality assured
- be able to provide centres with advice and guidance on assessment and IQA procedures.

They must be able to demonstrate evidence of being up to date with the relevant trade/industry. This can be evidenced for example by either accessing trade publications, undertaking courses of learning, attending networking events relevant to this qualification and/or attending industry events. EAL will:

- carry out necessary quality assurance of the assessment process which can include direct observation, assessment sampling, and feedback from learners
- have a robust appeals procedure in place for learners.

Roles, responsibilities and quality assurance

Internal assessor profile

The centre must provide EAL with the details of personnel who they plan to undertake assessment, so that they can be approved prior to them carrying out this role. Prior to the first assessments taking place; assessors must also complete EAL training. This is to ensure the reliability of assessment at centres over time.

Assessors must be working towards (registered before carrying out any assessments) or have achieved the following units:

- Unit: Understanding the Principles and Practices of Assessment*
- Unit: Assess occupational competence in the work environment*
- Unit: Assess vocational skills, knowledge and understanding*

and continue to practice to that standard.

* Legacy Qualifications (D32/D32/D34, A1 and V1) will be accepted.

Assessors must be occupationally competent. Evidence which supports this is by the assessor holding a relevant NVQ or equivalent* to the full occupational competence threshold of the trade and/or having registration with a relevant trade body or having appropriate recognition which clearly evidences the assessor as competent in the trade.

*Assessors who qualified before NVQs were developed should provide evidence of how they are occupationally competent (such as through a CV or CPD Log together with any relevant references).

Internal assessor requirements

Internal Assessors must:

- carry out and document assessment in line with EAL and regulatory arrangements including:
 - acting in a professional and courteous manner at all times when conducting the assessment
 - marking the assessments, in accordance with grading criteria
- maintain a knowledge of assessment policies and procedures
- maintain and document CPD (to be submitted on request)
- understand the sector, the qualification, and the assessment requirements
- be occupationally competent
- produce clear, accurate and concise documentation and relevant records (written and electronic), and ensure they are controlled and administered in accordance with the awarding bodies procedures
- make robust assessment decisions
- handle relevant information in accordance with GDPR requirements
- prepare for and participate in relevant EAL meetings and events – such as induction, CPD/training, and standardisation events, and ensure any personal action/ improvement plans are achieved, within agreed timescales and to required standards

- report to the IQA any suspicion of malpractice or maladministration, including academic misconduct
- declare any conflicts of interest (such as between the assessor and the learner)
- provide access to information and records when requested
- complete and submit all reports within specified timeframes.

Expert witness (to provide supporting evidence for Practical Project)

Expert witnesses who work with the learner on a regular basis can be nominated and confirmed with the learning provider/centre to support evidence gathering while apprentices undertake the Practical Project. Expert witnesses do not make assessment decisions/judgements, their role is to provide information, context and an experienced perspective on the work completed by the learner as part of their specified project task(s).

In order to be confirmed as an expert witness employer representative(s) must:

- be occupationally competent – holding a relevant qualification, being able to demonstrate relevant experience in the industry/trade and/or being a member of/or recognition by a relevant trade body
- understand the sector, the qualification, and the assessment requirements.

External assessor profile (for the Professional Discussion)

Assessors for the Professional Discussion assessment will be appointed by EAL and will conduct the assessment on behalf of EAL. They will be independent of the centre. Prior to the first assessments taking place; assessors must also complete EAL training.

Assessors must be working towards or have achieved a relevant recognised assessor qualification **and** continue to practice to that standard. Assessors who hold earlier qualifications (A1, D32 or D33) should have CPD evidence to the most current standards.

Assessors must be occupationally competent. Evidence which supports this is by the assessor holding a relevant NVQ* to the full occupational competence threshold of the trade and/or having registration with a relevant trade body or having appropriate recognition which clearly evidences the assessor as competent in their trade.

*Assessors who qualified before NVQs were developed should provide evidence of how they are occupationally competent (such as through a CV together with any relevant references).

Prior to the first assessments taking place; assessors must also complete EAL training. This is to ensure the reliability of assessment over time.

External assessor requirements (for the Professional Discussion)

External Assessors must:

- fully prepare the Professional Discussion utilising the project evidence
- carry out and document the Professional Discussion assessment in line with EAL and regulatory arrangements including:
 - acting in a professional and courteous manner at all times when conducting the assessment on behalf of the Consortium
 - arriving at the centre at least 45 minutes prior to the assessment and staying at the centre for the duration of the assessment (when conducting a face-to-face assessment)
 - marking the Assessments, in accordance with grading criteria
- maintain a thorough knowledge of assessment policies and procedures
- maintain and document CPD (to be submitted on request)
- understand the sector, the apprenticeship, and the assessment requirements
- be familiar with the latest technologies used within the industry
- be occupationally competent
- produce clear, accurate and concise documentation and relevant records (written and electronic), and ensure they are controlled and administered in accordance with the awarding bodies procedures
- make robust assessment decisions
- handle relevant information in accordance with and GDPR requirements
- prepare for and participate in relevant EAL meetings and events – such as induction, CPD/training and standardisation events, and ensure any personal action/ improvement plans are achieved, within agreed timescales and to required standards
- report to EAL any suspicion of malpractice or maladministration, including academic misconduct
- declare any conflicts of interest (such as between the assessor and the apprentice)
- provide access to information and records when requested
- complete and submit all reports within specified timeframes.

They must be able to demonstrate evidence of being up to date with the relevant trade/industry. This can be evidenced for example by either accessing trade publications, undertaking courses of learning, attending networking events relevant to this qualification and/or attending industry events.

External associates/appointees

Associates/Appointees are the terms adopted by EAL to refer to individuals appointed by City & Guilds or EAL to undertake specific roles on their behalf, for example, External Quality Assurers (EQAs).

There are criteria set by EAL to ensure that all associates/appointees have the right occupational knowledge, experience, and skills to perform the specific role.

EAL will ensure that all associates/appointees undertaking a quality assurance role in centre approval, qualification approval and assessment decisions are trained, appropriately qualified and occupationally competent. Training and attendance at standardisation events are mandatory.

All associates/appointees are performance managed by staff within EAL. If concerns are identified with an individual, EAL will take corrective action which may include improvement actions and close monitoring or in some instances quality issues in performance may lead to EAL's contract with the associate/appointee being terminated.

EAL will ensure that sufficient bilingual associates/appointees are recruited to meet the needs of Welsh-medium centres and learners. The level of quality assurance activity will be consistent across provision in both English and Welsh mediums. Provision will be made for monitoring and standardisation to take place for both languages.

Welsh context

For individuals who have not previously conducted assessment activities in Wales, it is suggested that having an awareness of Welsh language and an understanding of Welsh culture, policy and context would be beneficial to support their roles.

Continuing professional development

Centres are expected to support their staff in ensuring that their knowledge and competence in the occupational area is current and of best practice in delivery, mentoring, training, assessment and quality assurance and that it takes account of any national or legislative developments.

Delivering the qualification

Learner entry requirements

EAL does not set entry requirements for this qualification. However, centres must ensure that learners have the potential and opportunity to gain the qualification successfully.

If taken as part of an apprenticeship, then specific requirements must be met as part of the apprenticeship framework.

Entries for the qualification can be made via Online Services, see the EAL website for further details.

Age restrictions

EAL cannot accept any registrations for learners under 16 years of age as this qualification is not approved for those under 16.

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- support and guidance, they may need when working towards their qualification
- any learning and attainment already completed which is relevant to the qualification (e.g. a relevant trade from the Progression in Building Services Engineering (Level 2))
- recognition of prior achievement can be gained for Test 1 where learners have achieved the Progression in Building Services Engineering (Level 2) in the same trade
- the appropriate type and level of qualification.

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

Support materials

The following resources are available for this qualification:

Description	How to access
Assessment Pack	EAL Online Services or www.skillsforwales.wales

Internal quality assurance

Centres must have a written Internal Quality Assurance strategy.

This will help ensure that Internal Quality Assurance procedures:

- provide accuracy and consistency between Assessors in the use and interpretation of the guidance in the qualification and/or assessment documentation
- are efficient and cost effective.

Moderation of internal assessment arrangements

External Quality Assurance processes are in place for checking the validity and reliability of assessment decisions made by centre staff, as appropriate to this qualification.

The Practical Project will be internally assessed and subject to risk-based monitoring and sampling by external quality assurers to ensure the consistency and validity of centre assessment decisions. Quality assurance activities will be undertaken by appropriately qualified and trained assessment associates. In all instances of sampling for quality assurance purposes, formal written feedback will be provided by EAL.

Significant non-compliance or areas of concern identified during external monitoring will be subject to investigation by EAL. As a result of this activity appropriate improvement actions and/or sanctions may be put in place. In some instances, investigations may result in de-registration for the centre(s) in question.

Internal appeal

Centres must have an internal process in place for learners to appeal the marking of internally marked assessments. The internal process must include learners being informed of the results the centre has given for internally assessed components, as they will need these to make the decision about whether or not to appeal.

Malpractice

Please refer to the EAL Malpractice & Maladministration Policy. This policy applies to anyone involved in the development, delivery and award of EAL approved qualifications or units, within or outside the UK; who identifies or suspects potential malpractice/maladministration. The policy provides definitions and the process by which a suspected or alleged instance of malpractice or maladministration can be reported. It also describes responsibilities and the way EAL will manage such cases to ensure that all malpractice and maladministration investigations are conducted in a consistent manner. Centres can access this in the document tab on EAL Smarter Touch.

Examples of learner malpractice are detailed below (please note that this is not an exhaustive list):

- falsification of assessment evidence or results documentation
- plagiarism of any nature
- collusion with others
- copying from another learner (including the use of ICT to aid copying), or allowing work to be copied
- deliberate destruction of another's work
- false declaration of authenticity in relation to assessments
- impersonation.

These actions constitute malpractice, for which a penalty (e.g. disqualification from assessment) will be applied.

Please refer to the form in the document *Managing cases of suspected malpractice in examinations and assessments*.

Access arrangements

Access arrangements are adjustments that allow individuals with additional needs and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

It is the responsibility of the centre to ensure at the start of a programme of learning that learners will be able to access the requirements of the qualification.

Please refer to the EAL Reasonable Adjustment & Special Considerations policy the document is available on EAL Smarter Touch: <https://eal.org.uk/support/document-library/centre-support/policies-and-important-documents/44-reasonable-adjustments-and-special-considerations-policy>.

Special consideration

We can give special consideration to learners who have had a temporary illness, injury or indisposition at the time of assessment.

Applications for either access arrangements or special consideration should be submitted to EAL by the Centre Coordinator at the centre. For more information, please consult the current version of the EAL Reasonable Adjustment & Special Considerations policy *the* document is available on EAL Smarter Touch: <https://eal.org.uk/support/document-library/centre-support/policies-and-important-documents/44-reasonable-adjustments-and-special-considerations-policy>.

Summary of assessment

This qualification is assessed using the following assessment methods:

Assessment type	Approach to assessment	Weighting (Contribution to overall qualification grade)
On-Screen Assessment (Tests: 1, 2, 3)	Externally-set, externally-marked	20%
Practical Project	Internally-set, internally-marked, externally verified	60%
Professional Discussion	Externally-set, externally-marked, externally verified	20%
Safety Critical Test (practical assessments)	Externally-set, internally-marked	N/A

The Safety Critical Test consists of practical assessment tasks. It is a 'hurdle test' only and does not contribute toward the grade of this qualification, it must be passed for the qualification to be awarded.

An Assessment Pack detailing the requirements of the assessment can be downloaded from EAL Online Services or www.skillsforwales.wales.

Details of coverage of each assessment can be found in the assessment specifications within the Assessment Pack.

Recognition of prior achievement can be gained for Test 1 where learners have achieved the EAL Progression in Building Services Engineering (Level 2) in the electrical pathway, further details of this are available within the Assessment Pack.

Assessment timings and phasing

The following must be applied to the assessment of this qualification:

- all units must be undertaken, and related requirements must be completed and assessed within the learner's period of registration.

Assessments can be taken on-demand, centres must ensure that learners have undertaken all required learning and are adequately prepared to undertake each assessment.

The Employer Confirmation must have been completed prior to commencement of the Professional Discussion.

Learners must have completed the Practical Project assessment prior to undertaking the Professional Discussion assessment.

Result release

On-screen assessment

On-screen assessments are auto-marked and results will be received by the centre the same day the assessment is completed. A result release process will be followed by EAL when new assessment versions are released.

Practical Project

Practical Projects are internally marked and externally verified. Provisional marks awarded following internal assessment are translated into grades using the marking and grading tables provided in the Assessment Pack, provisional grades are then submitted to EAL Online Services.

The assessor will use the Practical Project grading table within the Assessment Pack to calculate a provisional grade for the learner. Notification of this provisional grade will be given to the learner within one week of completion of the assessment, with guidance given on the provisional nature of the grade. Provisional results will be subject to both internal and external quality assurance.

Professional Discussion

The Professional Discussion is externally marked and externally verified. The marking and grading tables provided in the Assessment Pack will be used by the external assessor to mark and allocate a grade. The provisional mark for this assessment will be released by EAL within 30 working days of the Professional Discussion taking place.

On receipt of the internally-assessed grades for the Practical Project; the grades for this, and the on-screen assessment and Professional Discussion will be aggregated based on the assessment weighting, in line with the grade aggregation guidance provided within the Assessment Pack, and an overall qualification grade awarded which will be issued by EAL.

Overall qualification results

Provisional grades for the Practical Project and Professional Discussion must be provided to learners within one week of completion of each assessment. Guidance should be given around the provisional nature of these results, with recognition that they will undergo internal and external quality assurance activities, and final qualification grading by EAL.

Final qualification grades will be notified to centres following completion of external quality assurance activities. This notification will be within eight weeks of centre submission of learner results for the Practical Project (following successful completion of the On-screen assessment and Professional Discussion).

Resubmission/re-sit of assessment

If the learner fails to successfully achieve any of the assessments, they are permitted to re-sit/resubmit.

Guidance on the re-sit/resubmission procedures for each assessment can be found in the Assessment Pack for this qualification which can be downloaded from EAL's website.

If a learner is required to re-sit or resubmit any of the assessments, appropriate feedback and support must be provided to enable the learner to do so within an appropriate timeframe. If a learner does not meet the required marking criteria the centre should work with the learner to address criteria failed and opportunities for improvement to support them in preparing to reach the standard required.

If learners are unhappy with their assessment outcomes they should be informed of their right to appeal.

Centres must record any actions taken and/or any additional support given to the learner. There will be no limit on the number of resits or resubmissions which can take place.

For further information on the approach to resubmitting/resitting any specific assessments, please see information within the Assessment Pack.

Assessment specifications

On-screen assessment

The test specifications for the three On-screen assessments can be found in the Assessment Pack

Recognition of prior achievement can be gained for Test 1 where learners have achieved the Progression in Building Services Engineering (Level 2) in the **same trade**, further details of this are available within the Assessment Pack.

Test 2 will cover the generic and trade-based knowledge and understanding content contained in the level 3 qualification only, it is open book and learners will require BS 7671.

Test 3 covers the knowledge and understanding of the following two units:

- Unit 303: Understand Advanced Electrical Science and Principles
and
- Unit 319E: Understand Health and Safety and Environmental Legislation in The Building Services Engineering Sector.

Safety Critical Test (practical assessment)

The purpose of the safety critical assessment is to ensure learners are equipped with the key relevant skills to work safely.

Key points:

- The assessment has a set time and is marked at the centre by an assessor. Learners may only achieve a Pass or be referred.
- The assessment does not contribute toward the grade of this qualification.
- Time on each task is finite and cannot be shared between tasks.
- Learners who fail either component task are permitted to re-take after any appropriate feedback and subsequent learning has taken place.
- The assessment must be achieved for the qualification to be awarded.

The safety critical assessment has component tasks which cover:

- Safe isolation
- Connection and termination
- Inspection and testing
- Fault finding.

Practical Project

Please refer to the Practical Project section of the Assessment Pack.

Professional Discussion

The Professional Discussion will be conducted by the external assessor. The centre will be required to agree a date for the discussion with EAL and to ensure that a suitable assessment environment is provided for this discussion. The Employer Confirmation must be completed before the point of booking the discussion with EAL. The unit content covered by the Professional discussion is outlined in the table below.

Learner reflection on the Practical Project: It will utilise the project evidence to augment the Professional Discussion. What the learner did, and why they did it.	
Reflection on knowledge and understanding of and skills of:	Unit ref
1.1 Organise the resources required 1.2 Set success criteria for the task(s) 1.3 Carry out effective planning 1.4 Rationalise why the proposed approach is the most appropriate 1.5 Recognise cost and waste implications of the work 1.6 Manage risks associated with completing the task and recognise the steps to be taken to stop risks becoming problems 1.7 Identify the handover requirements of work. 2.1 Review the appropriateness of success criteria set 2.2 Evaluate the resource selection and usage 2.3 Evaluate the finished output 2.4 Evaluate own performance 2.5 Review the achievement of timescales 2.6 Evaluate the handover.	304 – (LO1, LO2)
2.1 How to develop and maintain productive working relationships 2.2 How to communicate effectively with clients, employers, colleagues and with other stakeholders throughout built environment projects.	302 – LO2
4.1 The considerations required when performing building services engineering work on pre-1919 buildings and structures 4.2 Post-1919 and modern construction techniques and building services 4.3 The new and emerging technologies in the building services engineering trade and the impact they are having/may have on existing practice.	301 – LO4

Qualification grading

This qualification is graded **Pass, Merit, Distinction**. If a learner fails, they will not receive a certificate.

Details of how these grades can be achieved and are calculated can be found in the Assessment Pack.

Content key

The information below aims to provide an overview of how unit content is structured and how the areas of content relate to each other as well as qualification delivery and assessment.

Learning outcomes

Learning outcomes group together chunks of related practical skills and/or knowledge and are presented as the result of the learning process i.e. what learners must understand or be able to do following teaching and learning. All learning outcomes are supported by a number of assessment criteria. In the below for example, this learning outcome is about the different processes for stacking, storing and preparing.

Learning outcome:

2. Understand the processes of *stacking, storing and preparing materials* for building brick, block and stone walls.

Criteria

Assessment criteria break down the learning outcome into smaller areas to be covered, these criteria are what will be assessed in connection with the learning outcome. In the below for instance, assessment criteria 2.1 is about the reasons for stacking and storing materials, which has been written and will be assessed against the learning outcome.

Criteria

2.1 Reasons for *stacking and storing* materials

Range

Range contains information about the breadth required for a specific assessment criterion, for example, the actual reasons for stacking and storing materials. The range is not an exhaustive list, there may be other examples that could fit within that topic area, however those that are listed in the range are key for the delivery of the unit content – **all elements listed in the range must be covered as part of the delivery of the unit.**

Range: *Protection, efficiency, security*

Depth of content

Depth of content outlines the depth of coverage that needs to be covered. This allows the teaching to be focused at the right level in order for the learner to be ready for assessment. For example, 'learners should recognise the reasons' highlights that learners need to have some understanding of the 'how' or 'why' in relation to the range.

Delivery outcomes (depth of content)

*2.1 Learners will recognise the reasons for **storing** materials prior to use to protect them from the weather, damage, and theft. Learners will also recognise the reasons for **stacking and storing** materials for efficiency in relation to **preparing** for work.*

Unit content

Unit 301: Understanding Building Services Engineering Practice in Wales

GLH: 40

What is this unit about?

The purpose of this unit is for learners to explore and understand the wide and changing scope of the construction sector in Wales from pre-1919 practices to future development. It will provide an overview and set the scene for working in the building services engineering sector in Wales.

Learners will develop their knowledge, understanding and where relevant skills of:

- the trade relevant bodies and organisations within the building services engineering sector
- connected practice in the construction and building services engineering
- the changing construction and built environment sector
- the changes in building services engineering materials, tools, and techniques over time
- the relationship between trades and the environment.

Learners may be introduced to this unit by asking themselves questions such as:

- Why do tradespeople require cards for access to commercial sites?
- What impact does my trade have on other trades?
- Why does the construction and built environment sector change over time?
- What influences the changes to materials, tools, and techniques used in the trade?
- What impact may my trade have on the environment?
- What impact does my trade have on other trades?

It is recommended this unit is delivered prior to Unit 302.

Learning outcome:**1. Know the relevant trade bodies and organisations within the building services engineering sector****Criteria**

- 1.1 The trade bodies and organisations relevant to the trade
- 1.2 The role of the relevant trade bodies and organisations
- 1.3 The competence card schemes within the building services engineering sector and the types of cards available
- 1.4 Professional registration as an Engineering Technician

Learning outcome:**2. Understand connected practice in construction and building services engineering****Criteria**

- 2.1 Interdependencies between trades

Learning outcome:**3. Know the changing construction and built environment sector****Criteria**

- 3.1 The factors influencing pre-1919 construction
Range: geographical influences, local need, sourcing of materials
- 3.2 The factors influencing post 1919 to modern construction
Range: supply chain, industry demand, population, materials (standardisation, innovation)
- 3.3 The factors influencing 21st century construction
Range: climate change, carbon footprint, resource availability, materials, new methods and techniques

Learning outcome:

4. Know the changes in building services engineering materials, tools, and techniques over time

Criteria

- 4.1 The considerations required when performing building services engineering work on pre-1919 buildings and structures
- 4.2 Post-1919 and modern construction techniques and building services
Range: evolution of buildings; modern heating and ventilation systems, electrical installations, water and waste management systems
- 4.3 The new and emerging technologies in the building services engineering trade and the impact they are having/may have on existing practice

Learning outcome:

5. Understand the relationship between trades and the environment

Criteria

- 5.1 Industry regulation and sustainability and the natural environment
- 5.2 Ecological considerations and principles
- 5.3 Sustainable approaches
Range: heat recovery and ventilation, rainwater harvesting, fuel cells, solar panels, heat and cooling pumps, zero-carbon buildings
- 5.4 Waste disposal in building services
Range: waste reduction, waste disposal, recycling principles in the learners' trade area

Delivery outcomes (depth of content)

1.1 – 1.2

Learners will know the trade bodies and organisations relevant to the trade and their roles: ECA, JIB, Certsure, NICEIC, ELECSA, NAPIT, IET, and CIBSE.

Learners will have an awareness of some being industry owned and controlled, others commercial organisations, and some are professional engineering institutions. Learners will know the role of competent person schemes offered by the relevant bodies. Learners will have an awareness of Unite the Union, and their services/benefits.

1.3

Learners will know the card/recognition schemes for their trade: ECS, and types of cards available.

Learners will know the role of card issuers, and registration requirements and the need for industry recognised qualifications.

1.4

Learners will recognise the potential benefits of professional registration as an Engineering Technician (EngTech) with the IET such as: higher earning potential, improved career prospects and employability, enhanced status leading to higher self-esteem, international recognition of competence and commitment, evidence of expertise, greater influence within own organisation and industry, and recognition as a counter signatory.

2.1

Learners will appreciate the relationships between their chosen trade and other trades in different contexts from new build to repairing traditional structures. Learners will understand how individual trades work with each other and interact. This could be shown on a Gantt chart with an overview of dependencies. Learners will understand for example first and second fix, and the types of problems that can arise and how to mitigate them. Interdependencies can be linked to safe working practices, planning, type of premises/context, and good working relations and communication. Learners will understand how different trades interact across different scenarios and how these interactions and roles have changed overtime.

In learning outcome 3 the learner will gain a holistic understanding of the construction sector. It is recommended this outcome is delivered before outcome 1 of Unit 302.

3.1

Learners will appreciate local needs (types and uses of structures, needs of industry, cultural needs). Geographical influences- local availability of resources, local climate (weather considerations) locally influenced methods and styles; local distinctiveness. Learners will know the basic qualities and uses of mortars, aggregates, binders, internal and external functional and decorative finishes, stone, slate, timber, and earth. Learners will develop an understanding of construction materials available within their locality including an understanding of local geology, and the accessibility of these materials, including local quarries and transportation links both past and present. Learners will know permeable nature of lime and earth mortars. Specific to this time period, learners will develop an understanding of the transportation and supply chain of materials; the benefits of using materials available within the region local to work sites, and the barriers/problems associated with using materials not local to work sites.

3.2

Learners will know the developments in transport that influenced the supply chain since the industrial revolution. An awareness of the sources of building materials, comparing materials found locally and those imported to a region and the distance and method used for transportation.

The learner will know that for traditional buildings, the choice of materials also often reflected the status of the building (decorative design features etc.) Learners will know basic qualities of construction materials: concrete slabs, brick and block, steel, glass, plastics, composite materials, standardisation of materials, and damp-proof membranes. The role that materials such as cement, glass and steel have played in the industry, and the effect that material innovations have had on the scale and speed of construction. Learners will understand why damp-proof membranes (DPC, DPM) are included in post-1919 builds.

3.3

Learners will know the increasing pressures of climate change and the carbon footprint of the construction industry. Recognising benefits from energy efficiency and embodied energy. Learners will understand the importance of the Well-being of Future Generations (Wales) Act 2015 for the construction industry. Learners will need to know the qualities and uses of different types of materials such as lime and natural building materials and engineered materials. Comparing carbon footprint and relative longevity and sustainability of these materials such as insulation, bricks, timber, plasterboard, and plastics. Recognising the need for sustainability of traditional and vernacular buildings, including the re-use of buildings, rather than their demolition and the construction of new ones. The thermal performance of traditional buildings.

Learners will appreciate the reasons for and recognise new methods and techniques: off-site manufacturing; modular buildings, prefabricated construction components and digital construction technologies.

4.1

Learners will know the typical methods of construction for pre-1919 buildings that they may work in including solid stone, brick, and timber walling; traditional flooring and roofing. Recognising the risks and potential results of applying the wrong materials/techniques to structures. Learners will appreciate the considerations for routing and installing building services. The older building services currently in service or in situ relevant to the trade: types of historic wiring, and older colours, imperial sized conduits, and cables.

Learners will appreciate the life span of a building service and what constitutes unsafe or unsound building service that should be recommended to be removed (key requirements only). The actions to be taken where unsafe building services are discovered. The lifespan of a building service – as applicable: due to overload, corrosion, electrolysis, age, wear and tear, environmental conditions, verdigris/oxidation of copper, usage, changes to regulations, materials, and safety requirements etc. Cover the key requirements only as this unit is not about periodic inspection of services.

4.2

The learner will understand the development of brick cavity methods of construction and later variations of cavity wall design. The main tools, materials and techniques and their application in current practice in the building services engineering trade, which enables the safe and effective planning, installation, and commissioning of the building service. The materials that can be detrimental to the building service such as polystyrene insulation causing 'plasticiser migration' from PVC. Reference to the Building Regulations applicable to installation of the service (key requirements only).

4.3

Learners will have an awareness of the new/emerging technologies relevant to their trade (and main advantages and disadvantages): environmental technologies (solar PV), electric vehicle charging points, smart metering, and battery technologies, smart homes, controls, 3D modelling/printing, and immersive technology. Learners will know how to access information on new developments in their trade – such as through professional engineering institutions, industry bodies and trade associations, articles, trade press, formal CPD, manufacturers information etc. Learners will be able to recognise how keeping up to date with industry initiatives and developments can help BSE businesses, the sector, and the environment.

Note that learning outcome 5 can be delivered with Unit 303

5.1

Learners will know the key aspects of the Environment (Wales) Act 2016, Environmental Protection Act, The Hazardous Waste Regulations, The Site Waste Management Plans Regulations, Pollution Prevention and Control Act, Control of Pollution Act, The Waste Electrical and Electronic Equipment Regulations. Relevant aspects of BREEAM and

Passivhaus codes of good practice. The Conservation of Habitats and Species Regulations 2010 and the Penalties for breaking the law (e.g. disturbing a bat roost or a Newt Colony). Recap/cover Control of Substances Hazardous to Health (COSHH) Regulations as relevant.

Learners will know the key aspects of PAS 2030 (and 2035) and the PAS 2030 installer scheme (a scheme that supports those installing energy efficiency measures). For BSE, PAS 2030 covers heating, electrical and renewable technologies. Learners will know how design of the building services can help with energy efficiency. Link to smart homes and smart technologies, such as sensors and controls. The essentials of building energy management systems. Link to the environmental technologies covered in learning outcome 2. Cover main aspects of relevant Building Regulations Part L, and Documents L1A and L1B, and the Domestic Building Services Compliance Guide.

5.2

Learners will have an awareness of ecological considerations and principles and how this relates to their trade. A basic appreciation of endangered habitats, areas of flood plains, biodiversity offsetting, and wildlife legislation, and primary protected species.

5.3

Learners will be able to identify the sustainable considerations used in CBE and recognise the scope of their use to maintain a healthy building. Learners will also be able to identify the ways in which buildings can off-set their carbon footprint.

5.4

Learners will know how different materials can reduce environmental impact in their trade area, and the principles of the '3 Rs' of waste management (reduce, re-use and recycle). The learner will be aware of the importance of accurately ordering materials in order to reduce site waste and save money (and reduce waste disposal costs). Storing materials in an appropriate manner and appropriate sorting of waste on-site. Learners will be aware of good practice guidance such as WRAP for industry waste management. The nature of recyclable and biodegradable materials and the impact on landfill and cost to the environment. Recognising how scrap materials can hold value (such as copper as it is a finite resource) and the public register of scrap metal dealers in Wales. How to dispose of hazardous waste including cement-bonded and fibrous asbestos waste collection. The use of licensed waste carriers, brokers and dealers. The consequences to self, others, and the environment of not following best practice, and relating statutory requirements in relation to waste disposal.

Unit 302: Working in The Building Services Engineering Sector in Wales

GLH: 40

What is this unit about?

This unit provides the learner with a holistic understanding of the built environment in Wales, how it has changed, and the need for a safe built environment and delivering safe projects/work.

Learners will also appreciate the importance of planning and reviewing work, and how to carry out effective planning and evaluation. Learners will understand the importance of working and communicating effectively with others.

Learners will develop their knowledge, understanding and where relevant skills of:

- the built environment in Wales
- how to work effectively with others.

Learners may be introduced to this unit by asking themselves questions such as:

- What is meant by the built environment?
- What factors influence change in the built environment?
- Why is it important to have productive working relationships?

It is recommended prior to undertaking this unit learners should have been taught Unit 301.

Learning outcome:

1. Understand the built environment in Wales

Criteria

1.1 Building stock in Wales

Range: forms, purposes, energy efficiency, performance

1.2 Factors influencing change in the built environment in Wales

Range: political, environmental, social, technological, legal, and economic

1.3 Safety of the built environment

Range: design, compliance with regulations and industry guidance, utilising appropriate materials

Learning outcome:

2. Understand how to work effectively with others

Criteria

2.1 How to develop and maintain productive working relationships

2.2 How to communicate effectively with clients, employers, colleagues and with other stakeholders throughout built environment projects

Delivery outcomes (depth of content)

In learning outcome 1 the learner will gain a holistic understanding of the construction sector. This outcome builds upon the Unit 301.

1.1

Learners will recognise the forms and purposes of the following:

Houses: attached and detached:pre-1919: solid stone, solid brick and traditional timber frame. Learners will recognise terraces of the industrial revolution with the polite and vernacular architecture of less industrial times.

Cavity wall structures: brick and brick and block, modern timber frame – timber with block outer (a response to material standardisation and improvements in material strength). Learners will consider the re-use of buildings and buildings available for multiple/adaptable purposes. Learners will appreciate bridges and roads as part of the built environment.

Learners will understand the need for energy efficient housing including an awareness of the following factors:

- Retrofit - bringing the buildings up to current regulatory standards
- The need for compliance with Building Regulations
- BREEAM (this is the UK's most widely used means of reviewing and enhancing the environmental performance and minimising the environmental impacts of both new and existing buildings)
- Passivhaus (Passivhaus buildings provide a high level of occupant comfort while using very little energy for heating and cooling. They are built with meticulous attention to detail and rigorous design and construction according to principles developed by the Passivhaus Institute in Germany and can be certified through an exacting quality assurance process).

1.2

Learners will recognise PESTLE influences such as:

- political: how government initiatives/changes in government affect the construction sector and the built environment, laws, taxes and how this affects demand
- environmental: targets to cut emissions, preservation of the natural/built environment
- social: age of population/demographic, cultural requirements, population growth
- technological: new technologies and application of technology, changes in materials and innovations
- legal: new/changes to regulations etc. such as the Building Regulations consent/planning permissions, safety of buildings and building services
- economic: affordability, unemployment/employment, and the economy.

Learners will identify the key reasons for increases and decreases in housing demand over the last 100 years and the way that this has caused fluctuations in housebuilding. Prefabrication and mass housing booms: post WWII war housing, off-site modern prefabrication. Flats and high rise apartments. Learners will understand the purpose behind

pre-fabrication – largely economies of scale and ability and need to provide better quality housing within a short time frame. Learners will understand the importance of energy efficiency and embodied energy in meeting the zero-carbon target. Learners will have an appreciation of the sustainability and carbon saving value of maintaining and repairing the current housing stock compared to replacing the existing 20th century buildings with new buildings.

1.3

Learners will be able to identify advances in architectural design and material science, and their influence on modern construction, while also recognising the requirement for a focus on long term user safety when adapting, creating, and maintaining buildings. This will include building materials, products and services and the role of the CDM Regulations (The Construction (Design and Management) Regulations). The foreseeable necessary information to be provided for future maintenance, repairs, and cleaning of the building. Learners will have an awareness of the WELL Building Standard. (WELL is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being, through air, water, nourishment, light, fitness, comfort and mind). Learners will understand quality assurance marking of products (such as the UKCA mark) and the applicability of the Construction Products Regulations. The Building Regulations guidance Approved Document 7: materials and workmanship, the BSI Kitemark, the Declaration of Conformity, and trade specific requirements for products (such as BASEC approved cables). Learners will also have awareness of other applicable guidance such as RSPA (Royal Society for the Prevention of Accidents) safer by design.

Learners will understand the implications to a lack of regard to safety (using examples such as asbestos and the Grenfell Tower disaster). They will have an awareness of the Welsh Government's plan to reform regulations and fire safety in high rise buildings, and the actions with regards to the 'Road Map to Safer Buildings in Wales'.

Learners will understand the considerations and implications of making changes to buildings and the responsibilities of the customer/client and the contractor. How this relates to the Building Regulations and relevant Approved Documents and technical guidance. Learners will know that there are different applicable requirements in Wales and England (e.g. the requirement for automatic fire suppression in Wales). Learners will understand the need for relevant consent/permissions for work to be carried out (which could be required for minor work on a listed building in Wales), complying with Building Regulations (following Approved Documents) and utilisation of appropriate materials.

Learners will understand it is incumbent on the contractor to carry out safe work and deliver safe projects for the customer/client. Learners will understand the consequences of not carrying out safe work/delivering unsafe projects/work. Learners will understand the importance of using suitable materials, parts and products that are appropriate for the building task, and that maintain the safety of buildings for building users for the long term. Learners will understand that importance of deferring to qualified colleagues, when and if

necessary, to check or complete work to ensure that the safety of building/premises users is maintained.

2.1

Learners will appreciate the range of communication techniques and mediums and their suitability e.g. face to face, active/passive listening, written, oral, and electronic. Learners will understand the importance of the needs of individuals by applying the principles of equality and diversity.

Learners will understand how to maintain and encourage both formal and informal good working relationships to promote goodwill and trust with the relevant people. This can involve keeping promises and undertakings, being honest and building constructive relationships, co-operating, and having appropriate and good dialogue.

Learners will recognise the stages of Tuckman's team-development model as:

- forming
- storming
- norming
- performing.

Learners will understand how to discuss proposals with relevant people and discuss alternative suggestions - appreciating that they should encourage questions and requests for clarification and comments.

Learners will recognise the benefits of a high-performance team. Learners will understand how to resolve differences of opinion in ways which minimise offence and maintain the goodwill, trust, and respect, and why this is important.

2.2

Learners will understand how to confirm and communicate the requirements relating to the work to the relevant people e.g. colleagues, employers, customers, contractors, suppliers of products and services and those affected by the work/project with the right level of detail and with an appropriate degree of urgency. These details can involve work progress, results, achievements, occupational problems, occupational opportunities, health and safety requirements and the coordination of work (e.g. with other trades/colleagues). Learners will recognise the benefits of good customer care to current and potential future customers (such as referrals, repeat business, good feedback, satisfied customers, more revenue opportunity).

Learners will understand the possible impact of the work (e.g. noise and vehicles) to those in the vicinity of the work (such as residential neighbours) and recognise their customer care extends to these potential future customers.

Unit 304: Planning and Evaluating Work in the Building Services Engineering Sector in Wales

GLH: 35

What is this unit about?

This unit provides the learner with the competencies of how to plan and evaluate work in their trade. Learners will be able to plan work to ensure that it is carried out safely and to any relevant industry standards; acceptance and success criteria that apply.

Learners will be able to organise resources and plan the use of these resources and their time. Learners will organise their own work activities, dealing with typical problems that arise in their work, and seeking advice from others if required. Learners will be able to communicate the work requirements to customers, colleagues, and members of the public other trades.

Learners will be able to evaluate their completed work and how effective they were in planning and performing stages; identifying strengths and weaknesses and using reflective practice to facilitate continual improvement.

Learners will develop their knowledge, understanding and skills of:

- how to calculate costs and determine resource requirements
- planning work
- the importance of evaluation of the work.

Learners may be introduced to this unit by asking themselves questions such as:

- What is meant by a resource?
- Why is planning important?
- What is likely to happen if a new task is not properly planned?
- What is evaluation, and why is it important?
- How will I evaluate the completed work to measure my success?

Learning outcome:

1. Plan the work required to complete the task(s)

Criteria

1.1 Organise the resources required

Range: tools, plant, equipment, products, materials

1.2 Set success criteria for the task(s)

1.3 Carry out effective planning

Range: timescales, scheduling, quality, cost

1.4 Rationalise why the proposed approach is the most appropriate

1.5 Recognise cost and waste implications of the work

Range: financial, environmental

1.6 Manage risks associated with completing the task and recognise the steps to be taken to stop risks becoming problems

Range: nature of the task, other trades, resources, the work environment, timescales, contingent tasks, alterations, access, any other relevant external factors

1.7 Identify the handover requirements of work

Range: information, documentation, communication

Learning outcome:

2. Evaluate the work completed against the task brief and success criteria

Criteria

2.1 Review the appropriateness of success criteria set

2.2 Evaluate the resource selection and usage

Range: tools, plant, equipment, products, materials

2.3 Evaluate the finished output

Range: fit-for-purpose, safe, meets task brief/acceptance criteria, success criteria

2.4 Evaluate own performance

Range: methods, techniques, processes, effectiveness, strengths, weaknesses, lessons learnt, continual improvement

2.5 Review the achievement of timescales

2.6 Evaluate the handover

Delivery outcomes (depth of content)

1.1

Learners will be able to identify resources from available data, using estimation techniques as required (such as: analytical (bottom up), comparative (top down/historic), and parametric). Learners will have an appreciation of the 'estimating funnel'. Learners will recognise types of resources as: consumable (replenishable), such as materials and money and re-useable, such as plant, equipment, and people.

Learners will be able to organise the resources required to carry out the task/s. Learners will be able to recognise the need for, and plan the use of tools, plant, equipment, products, and materials. Learners will understand how to seek clarification and advice where the resources required are not available e.g, from: the customer/customer's representative, manufacturer's technical information, trade literature or referring to the organisation's procedures.

1.2

Learners will be able to identify success criteria for the task and the key elements of the work, and which areas may be challenging and the steps they can take to reduce these challenges. The risks to achieving the success criteria these challenges could create and the steps they will take if the challenge creates a problem. Learners will understand (and know the difference between) typical success factors and success criteria.

1.3

Learners will use effective planning methods to calculate the time required to successfully complete tasks, scheduling task activities to enable tasks to be completed to the standard required within the timescale set. Learners will identify different types of dependencies between tasks and factor this into their planned phasing of work. Learners will rationalise why the approach planned for tasks is the most appropriate and will allow them to achieve quality and timescale requirements.

1.4

Learners will be able to identify work methods that will make the best use of resources and meet project, statutory and contractual requirements. Learners will understand the need to carefully consider the scope of the work to avoid underestimating what is required.

1.5

Learners will be able to plan the use of methods of work to help achieve zero or low carbon outcomes and be considerate of resource usage and wastage – evidencing an environmental and financial awareness. Learners will understand planning methods, and planning for efficiency, cost control/savings, limited wastage, timely delivery, and a clear handover.

1.6

Learners will understand in the planning stage that problems can be anticipated and therefore can be more easily managed (proactive approach instead of reactive). Learners will be able to carry out mitigation planning for potential problems/issues. Recognising problems can arise from the weather conditions, nature of the task, other trades, resource availability etc. Learners will be able to assess the effects resulting from alterations to the

work programme and be able to manage risks (within their control) that would impact on completing the tasks.

1.7

Learners will be able to communicate progress to relevant stakeholders such as employer/supervisor or the customer. Learners will know the measures to manage access to the site (Section 3 of Health and Safety at Work etc. Act 1974 requires the conducting of business without putting members of the public at risk). This includes the public and other workers who may be affected by the work. Learners will be able to identify the relevant document (as appropriate) required for a handover and be able to plan the handover, using the appropriate information, documentation, and communication (and demonstration) methods as relevant to the completed trade service provided.

2.1

The learner will be able to evaluate whether the success criteria supported successful and efficient achievement of the task, did they create any unnecessary hurdles/barriers? Learners will reflect on whether different/additional criteria may have helped.

2.2

The learner will be able to evaluate their resource selection and usage, the appropriateness of tool selection, the quantity of materials selected, efficiency of material selection and usage. Evaluation of impact to cost and the environment.

2.3

The learner will be able to evaluate the quality of their completed work to industry standards and safety requirements. Learners will be able to evaluate the work to the task brief and the employer/customer requirements.

2.4

The learner will be able to evaluate the overall fit and finish, and reflect on what could they have done differently to improve their output. Learners will be able to evaluate their own strengths, weaknesses, and areas for improvement. Learners will be able to communicate their lessons learnt when required.

2.5

The learner will be able to recognise the reasons for any delays, and evaluate how these could have been avoided, and how they may be mitigated in future. Learners will recognise reasons for any time savings, and take lessons learnt into future planning.

2.6

The learner will be able to evaluate the quality and clarity of the information provided in the handover and to what degree the handover was successful and the communication method/s used.

Unit 303: Understand Health and Safety and Environmental Legislation in The Building Services Engineering Sector

GLH: 21

What is this unit about?

This unit covers the knowledge and understanding required for establishing and maintaining working practices and procedures across a specified range of building services engineering sector installation and/or maintenance activities that consider health and safety, the natural environment, and the working environment. This would include identifying hazards and risks, applying appropriate procedures and working practices to protect yourself and others.

The learner will possess knowledge and understanding to be able to use building services engineering sector equipment, components, materials and substances effectively, efficiently, in accordance with the specification giving consideration to the natural environment and the working environment in terms of waste materials and if appropriate water usage.

Learners will develop their knowledge and understanding of:

- relevant industry standards and regulations
- responsibilities in accordance with organisational procedures
- the application, advantages and limitations of different working practices
- materials and substances that can potentially be harmful
- the documentation associated with the organisational procedures' requirements
- dealing with the presence of harmful materials and substances
- how to locate relevant health and safety information needed to complete the installation and/or maintenance
- hazards and risks
- the methods for handling of hazardous materials and substances
- safe use, maintenance, handling, transport, and storage of resources
- the warning signs for hazardous materials and substances
- the methods for the safe transport and/or disposal of waste material, substances, and liquids
- procedures relevant to reporting issues.

Learners may be introduced to this unit by asking themselves questions such as:

- What are industry standards and regulations and how will these affect me?
- What are the different working practices used within BSE and what are the advantages and limitations of these practices?
- What harmful materials and substances could be encountered in BSE and how should they be dealt with?
- What is classed as a hazard or a risk?
- How do you safely transport and/or dispose of waste material, substances, and liquids?

Learning outcome:

1. Understand appropriate industry standards and regulations

Criteria

1.1 Sources of information

Range: statutory regulations, Building Regulations, industry standards, manufacturer technical instructions

Health and safety legislation: general legislation, construction specific legislation, building services specific legislation

Health and safety guidance: non-statutory regulations, approved code of practice, Health and Safety Executive (HSE) Guidance Notes

1.2 Health and safety/environmental legislation

Range: The Health and Safety at Work etc. Act, The Electricity at Work Regulations, The Management of Health and Safety at Work Regulations, Workplace (Health and Safety and Welfare) Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Working at Height Regulations, Personal Protective Equipment at Work Regulations, Manual Handling Operations Regulations, Provision and Use of Work Equipment Regulations, Control of Asbestos at Work Regulations, Environmental Protection Act, The Hazardous Waste Regulations, Pollution Prevention and Control Act, Control of Pollution Act, The Control of Noise at Work Regulations, The Waste Electrical and Electronic Equipment Regulations

Learning outcome:

2. Know your responsibilities in accordance with organisational procedures

Criteria

2.1 Members of the construction team

Range: construction team, employers (including employer representatives), designers, main contractors, sub-contractors, employees, self-employed (labour only), clients (customers)

2.2 Enforcing authorities

Range: Health and Safety Executive, Local Authority

2.3 Control measures of inspectors

Range: improvement notice, prohibition notice, powers of prosecution, role in providing advice and guidance

Learning outcome:

3. Understand the application, advantages, and limitations of different working practices

Criteria

3.1 Working practices

Range: competent persons, electrical safe isolation procedure, permits to work, selection and checking correct power tools, hand tools and portable electrical equipment, safe working practices with equipment and materials: portable power tools (e.g. cartridge gun, drills, grinders) signs and guarding, tools and materials storage facilities, dangerous substances, e.g. cutting compounds and adhesives

Learning outcome:

4. Know how to recognise materials and substances that can potentially be harmful

Criteria

4.1 Common building materials and services components that may contain asbestos

Range: flue, soil, rainwater pipes, gutters, tanks and cisterns, Artex, small gaskets and seals, bath panels/panelling, floor tiles, plaster and decorative finishes, in electrical accessories (flash guards and matting in fuse carriers and on distribution board covers)

4.2 The types of asbestos

Range: white asbestos (chrysotile), brown or grey asbestos (amosite), blue asbestos (crocidolite), asbestos cement materials

4.3 Commonly encountered substances

Learning outcome:

5. Understand the documentation associated with the organisational procedures' requirements

Criteria

5.1 The strategies used to prevent accidents during work activities

Range: method statements, permit to work systems, risk assessments, safety notices, CSCS card and CSCS affiliated cards

Learning outcome:

6. Understand the organisational procedures for dealing with the presence of harmful materials and substances

Criteria

6.1 The procedures that must be used to safely work with asbestos cement-based materials

Range: work activities for licensed and unlicensed work, licensing requirements for asbestos removal organisations, safe disposal requirements, protection of the workforce and members of the public

Learning outcome:

7. Know where and how to locate relevant health and safety information needed to complete the installation and/or maintenance activity in accordance with organisational procedures

Learning outcome:

8. Know what constitutes a hazard or risk

Criteria

8.1 Site hazards

Range: construction sites (all property types), in industrial and commercial premises (occupied and unoccupied refurbishment), in dwellings (occupied and unoccupied refurbishment), vehicle use (driving time limits, driving duress)

8.2 Common electrical dangers encountered

Range: faulty electrical equipment, signs of damaged or worn electrical cables – power tools and property hard wiring system, trailing cables, proximity of cables to services pipework, buried/hidden cables, inadequate overcurrent protection devices, electric shock, burns, fires and explosions

8.3 General hazards

Range: presence of dust and fumes, handling and transporting equipment or materials, contaminants and irritants, fire, working at height, hazardous malfunctions of equipment, improper use, maintenance and storage of tools and equipment, bacteria from vermin

Learning outcome:

9. Understand the methods for handling of hazardous materials and substances in accordance with organisational procedures

Criteria

9.1 Commonly encountered substances

Learning outcome:

10. Understand the organisational procedures, suppliers' and manufacturers' instructions for safe use, maintenance, handling, transport, and storage of:

- tools, plant, and access equipment
- equipment and components
- materials and substances

Criteria

10.1 Access equipment to permit work at heights

Range; step ladders, ladders, harnesses, roof ladders and crawling boards, mobile tower scaffolds, fixed scaffolds and edge protection, mobile elevated work platforms including scissor lifts and cherry pickers

10.2 Personal protective equipment (PPE)

Range: clothing protection including high visibility, eye protection, hand protection, head protection, foot protection, hearing protection, respiratory protection, vibration protection, harnesses

10.3 Excavations and confined spaces

Learning outcome:

11. Understand the warning signs for hazardous materials and substances

Criteria

11.1 How the hazards of some substances and mixtures can be identified from the labels on packaging

Range: Globally Harmonised System (GHS) on the classification and labelling of hazardous substances and mixtures categorisation and hazard classes: physical hazards, health hazards, environmental hazards, the presentation of information (GHS pictogram and signal word)

Learning outcome:

12. Understand the methods for the safe transport and/or disposal of waste material, substances, and liquids in accordance with:

- organisational procedures
- suppliers' and manufacturers' instructions

Criteria

12.1 How to deal with commonly encountered substances

Learning outcome:

13. Understand the organisational procedures relevant to reporting issues

Criteria

13.1 The procedures for reporting issues relating to:

- health and safety
- harmful substances and material
- emergencies on-site

Delivery outcomes (depth of content)**1**

Learners will recognise the health and safety legislation and regulations and relevant guidance materials applicable to building services engineering work, they will also get an understanding of the legal status and relationship between the documents.

2

Learners will be able to identify the responsibilities of members of the construction team.

Learners will be aware of the types of procedures in an organisation and how these impact on them and who to ask or where to find these organisational procedures.

Learners will also develop an understanding of the HSE and the Local Authority's role in enforcing health and safety and the control measures of inspectors, including their role in providing advice and guidance

Learners will know why it is important to report any hazards to the environment that arise from work procedures. The actions to be taken in situations which exceed their level of responsibility for health and safety in the workplace. Learners will be able to specify appropriate responsible persons to whom health and safety and welfare related matters should be reported such as the employer, supervisor, customer/client, safety officers, HSE inspectors, trades union representative and environmental health officers.

3

Learners will understand safe working practices within the BSE environment and how these are applied and some of the limitations and advantages using specific practices.

4

Learners will be able to state the types of asbestos that may be encountered in the workplace and the common building materials and services components that may contain asbestos.

5

Learners will be able to define strategies used to prevent accidents during work activities. Learners will have knowledge of PASMA requirements.

6

Learners will be able to define the procedures that must be used to safely work with asbestos cement-based materials, and the key health dangers of asbestos exposure.

7

Learners will be able to state how to obtain health and safety information and documentation relevant to their work and where this is obtained from.

8

Learners will understand what is meant by the terms hazard and risk in relation to health and safety. The specific hazards associated with the building services work and the organisational procedures for a range of health and safety related matters. Learners will be able to identify types of site hazards that may be encountered while at work or by members of the public, the identification of common electrical dangers encountered, and

the identification of general hazards involved in the work. Recognising that bacteria from vermin can lead to Weil's disease.

9

Learners will know how to deal with commonly encountered substances. The procedures that should be followed in the case of accidents which involve injury, including the requirements for the treatment of electric shock/electrical burns. Appropriate procedures which should be followed when emergency situations occur in the workplace. The ways in which the environment may be affected by work activities such as land contamination, air pollution and pollution of water courses. The current requirements and good working practices for processing waste on-site. The requirements and good working practices for recycling and dealing with hazardous waste and landfill.

10

Learners will be able to state the procedures for manual handling, including the assessment of a safe load and the safe kinetic lifting technique.

Learners will understand the procedure that should be applied for tools and equipment that fail safety (user) checks. The methods of safe supply for electrical tools and equipment on-site battery powered and 110 V and 230 V supplies. The safe isolation procedure when replacing attachments to power tools (drill bits and cutting blades).

Learners will be able to identify situations where it may be necessary to work at height and state how to select appropriate access equipment to permit work at heights. The safety checks to be carried out on access equipment. Working in areas of restricted movement e.g. under suspended timber floors in roof spaces and confined spaces.

Learners will be able to identify the three elements of the fire triangle and how combustion takes place and identify the dangers of working with heat producing equipment and how to prevent fires occurring. Learners will know the procedures for dealing with small, localised fires and firefighting equipment: tackling fires to aid escape, types of extinguisher, selection of extinguisher by fire type, the method of use and the evacuation procedures. The appropriate protective clothing and equipment that is required for identified work tasks.

11

Learners will have an awareness of the Globally Harmonised System (GHS) on the classification and labelling of hazardous substances and mixtures.

- physical hazards: Explosives, flammable gases, oxidising liquids, corrosive to metals
- health hazards: Acute toxicity, Skin corrosion/irritation, eye damage/irritation, Respiratory/skin sensitisation.
- environmental hazards: Hazardous to the aquatic environment
- presentation of information: GHS pictogram and signal word (Danger or Warning) and hazard statement (causes serious eye damage, toxic if swallowed, etc.) and Precautionary statement (wear eye protection, do not eat, drink, or smoke when using this product, etc.).

12 - 13

Within this outcome learners will know how to use adhesives correctly. Learners will be able to state the requirements for first aid provision in the workplace. Why it is important

not to misuse first aid equipment/supplies and to replace first aid supplies once used. The actions that should be taken when an accident or emergency is discovered (including evacuation). Identification of the procedures for dealing with minor injuries such as cuts, minor burns, objects in the eye, exposure to fumes); and major injuries such as: bone fractures, unconscious co-workers, electric shock, and concussion.

Learners will understand the recording procedures for accidents and near misses at work to include statutory requirements, accident books and the details to be recorded on a simple accident/incident report form.

Unit 304E: Understand How to Install Enclosures for Electrical Cables, Conductors and Wiring Systems

GLH: 70

What is this unit about?

This unit covers the knowledge and understanding for the installation of enclosures for electrical cables, conductors and wiring systems internally and externally for electrical systems. Learners will gain the key knowledge and understanding of electrical systems and circuits and their requirements.

The learner must be able to comply with the procedures and methods for installing enclosures for electrical cables, conductors and wiring systems in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment, and the natural environment.

Learners will know the different types of enclosures for electrical cables, conductors and wiring systems, their limitations, applications and the techniques for the positioning, fitting, fixing and connection of the enclosures, their components, and accessories.

Learners will develop their knowledge and understanding of:

- the operation, applications, advantages, and limitations of different electrical systems
- the appropriate industry standards, regulations, and requirements relevant to installing enclosures
- the applications, advantages, and limitations of types of enclosures.

Learners may be introduced to this unit by asking themselves questions such as:

- What types of circuits supply electrical loads?
- What is meant by earthing?
- What are the different types of wiring systems used?

Guidance: within this unit learners will know the main relating requirements of the IET On-Site Guide.

Learning outcome:**1. Understand the operation, applications, advantages, and limitations of different electrical systems****Criteria**

1.1 The types and requirements of typical circuits

Range: lighting circuits, ring final socket circuits, standard radial final socket circuits, standard circuit arrangements for loads and equipment, components of lighting and power circuits, division of an installation into circuits, polarity requirements for circuits, general requirements of isolation and switching

1.2 Earthing systems and earthing and protective conductors

Range: characteristics of earthing systems: TN-S, TN-C-S and TT, protective conductors and the purpose of earthing and protective conductors when used for protection, components which provide automatic disconnection of supply (including exposed conductive parts and extraneous conductive parts), components of the earth loop impedance path, general requirements for the installation of main protective bonding

1.3 Devices used for safety and protection in electrical systems

Range: overcurrent and overcurrent protection: the types of and reasons for overcurrent, fuses, circuit breakers, RCDs, RCBOs, characteristics, general applications, maximum disconnection time for standard circuits, an awareness of SPDs and AFDDs

Learning outcome:**2. Understand the appropriate industry standards, regulations, and requirements relevant to installing enclosures****Criteria**

2.1 Industry standards and regulations

Range: the requirements of the IET On-Site Guide, recognition of the main industry standards and regulations

2.2 How to produce a risk assessment and method statement for the work to be carried out

2.3 How to verify that job information and documentation is current and relevant and that the plant, instruments, access equipment and tools are fit for purpose

2.4 The applications, advantages, and limitations of types of personal protective equipment

Learning outcome:**3. Understand the applications, advantages, and limitations of types of enclosures****Criteria**

3.1 The applications, advantages, and limitations of types of enclosures

Range: conduit (PVC and metallic), trunking (PVC and metallic), cable tray, cable basket, ladder- systems, ducting, modular wiring systems, busbar systems and lighting track

3.2 The industry recognised methods for determining the type and size of enclosures

3.3 How to interpret diagrams and drawings to locate site services and identify the planned location of the enclosures and equipment

3.4 The methods and techniques for fitting, fixing, and connecting the selected enclosures and their components and accessories in accordance with:

- the electrical system's design
- manufacturers' instructions

Delivery outcomes (depth of content)

1

Learners will know and understand typical single-phase circuits. The different circuits and wiring layouts used for lighting: the circuit diagrams for one-way, two-way, intermediate including the conversion method. The typical wiring diagrams. The joint box method, and loop in method of wiring. The block, circuit, and wiring diagrams of circuits. The different components that can be used in lighting circuits including transformers, and an introduction to LED Drivers. Overcurrent protection, different switches: ways, gangs, grid switches, dimmer switches, and back boxes. Cover the lighting outlets and lamps including LED. SELV Transformers, joint boxes, and RB4 and related components. Cover compatibility of dimmer switches with equipment and loads (leading and trailing edge). Learners will appreciate the key aspects of Bluetooth and smart wireless lighting.

Learners will know and understand the requirements of standard ring final socket circuits. Circuits for supplying sockets and connection units and fused connection units (switched and unswitched) to BS 1363 (including USB sockets). The circuit and wiring diagrams of a ring final circuit, and the number of points and number of fused and unfused spurs in relation to sockets (and the requirements for spurs). The maximum floor area, and the division of sockets between circuits. The protective devices and conductor size based on cable type.

Learners will know and understand the requirements of standard radial final socket circuits. Circuits for supplying sockets and connection units and fused connection units (switched and unswitched) to BS 1363 (see circuit types A2 and A3 in the IET OSG). (Refer the learner to number of sockets as shown in the IET On-Site Guide). The general requirements of isolation and switching that apply.

Learners will know and understand the conventional common domestic circuits such as: cooker circuit, shower circuit, immersion heater circuits (see IET OSG and requirements for immersion heater circuits). A basic appreciation of a special location. Cover the circuit and wiring diagrams of common domestic type circuits.

Learners will know and understand why installations are divided up into circuits. (See BS 7671 314: Division of Installation). The typical division of circuits in a dwelling. The requirements for polarity on circuits. The general requirements of isolation and switching that apply (refer to the IET On-Site Guide). The benefit of having the highest rated load next to the consumer unit main switch.

Learners will know and understand the key requirements of electrical systems: earthing systems and earthing and protective conductors: The main underpinning requirements and principles as given in the IET On-Site Guide, with focus principally on simple domestic dwellings and similar installations.

Learners will know and understand the key requirements of electrical systems: overcurrent and overcurrent protection devices. The main aspects of the operation, applications, advantages and limitations of fuses, circuit breakers, RCDs, RCBOs for basic single-phase circuits. The types and reasons for overcurrent: earth fault, short circuit, and overload principally on simple domestic dwellings and similar installations. The common types and ratings of overcurrent protection devices, and fusing factor.

2

Learners will appreciate the industry standards and regulations and the legal status of documents used in the electrical industry. British Standards, Statutory documents, Codes of Practice, Electricity at Work Regulations, Electricity Safety, Quality and Continuity Regulations (ESQCR), The Construction (Design and Management) Regulations, BS 7671 Requirements for Electrical Installations, the key requirements of the IET On-Site Guide. IET Guidance Notes, Best Practice guides from the Electrical Safety First. Building Regulations (Wales and England) and Approved Documents. What is meant statutory and non-statutory. The relation of regulations to the Health and Safety at Work etc. Act. The implications of not complying with regulations, documents, and industry guidance. How to interpret sources of information relevant to the installation of wiring systems and equipment.

Learners will know and understand the requirement to follow safe systems of work including risk assessments and method statements.

Learners will appreciate the industry standard documents used for electrical installation including layout plans, technical data, specifications, site drawings. Learners will know and understand the job information and documentation and the importance of verifying and utilising current and relevant information. Verifying issue numbers of drawings as appropriate and ensuring they are using current requirements.

Learners will know and understand the purpose of PPE such as: high visibility clothing, eye protection, hand protection, head protection, foot protection, hearing protection, respiratory protection, vibration protection, and harnesses. The procedures that should be taken to remove or minimise risks before deciding PPE is needed. The appropriate protective clothing, equipment plant, instruments, access equipment and tools that is required for identified work tasks. The different types of measuring and marking out tools and equipment for wiring systems, equipment, and enclosures and how to use them safely.

3

Learners will appreciate the features, applications, advantages, and limitations of different containment systems. The types of wiring systems and associated equipment used in different installations. An introduction (awareness) of the IP Code. The cable capacities of conduit and trunking as given in the IET On-Site Guide. The procedure for selecting an appropriate size of conduit or trunking.

Learners will know and understand the ratios used in drawings, and conversion from site drawings to ascertain material etc. The graphical symbols used in diagrams and drawings:

- switches: one-way, two-way, intermediate, and pull)
- lighting points: incandescent, fluorescent, wall mounted
- socket outlets: switched, and unswitched
- fused connection units, and switched fused connection units
- consumer control unit
- cooker control unit
- integrated meter (kWH meter), fuse and circuit breaker.

Learners will know and understand the drawings which show site layout, location, and component positioning. How to check that the planned locations of wiring systems are visually acceptable and compatible with other services as well as the specification.

Learners will know and understand the how to install typical wiring system containment such as: conduit (PVC and metallic), trunking (PVC and metallic), cable tray, cable basket, ladder-systems, ducting, modular wiring systems, busbar systems and powertrack. The different fixing and securing methods considering the fabric of the structure, the environment and aesthetics. The methods and procedures used for the installation of wiring systems including sets and bends etc. The maximum bending radius of conduit. The importance of fire barriers and how this relates to the installation of containment. The importance that the installation complies with BS 7671, not detrimental to the environment, and is aesthetically pleasing.

Unit 305E: Understand How to Install and Connect Electrical Cables, Conductors, Wiring Systems and Equipment

GLH: 67

What is this unit about?

This unit covers the knowledge and understanding for the selection, installation and connection of electrical cables, conductors, wiring systems, equipment, accessories, and components for electrical systems.

The learner will be able to comply with the procedures and methods for installing and connecting electrical cables, conductors, wiring systems, equipment, accessories, and components in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment and the natural environment.

Their **skills** will cover the different types of cables, conductors, wiring systems, equipment, accessories and components, their limitations, applications and the techniques for their positioning, fitting, fixing and connection.

Learners will develop their knowledge and understanding of:

- the applications, advantages, and limitations of types of electrical cables, conductors, wiring systems, associated equipment, accessories and components
- the industry recognised methods for determining the type, size and rating of electrical cables, conductors, wiring systems, associated equipment, accessories, and components in relation to the electrical system's design
- how to install and connect types of electrical cables, conductors, wiring systems, associated equipment, accessories, and components.

Learners may be introduced to this unit by asking themselves questions such as:

- What types of cables are used?
- How are cables installed?
- Why is designing a circuit important?

Learning outcome:

1. Understand the applications, advantages, and limitations of types of electrical cables, conductors, wiring systems, associated equipment, accessories and components

Criteria

- 1.1 The applications, advantages, and limitations of electrical cables

Range:

- single and multicore thermosetting insulated cables including flexible cables
- single and multicore thermoplastic (PVC) insulated cables including flexible cables
- PVC/PVC flat profile cable
- MICC (with and without PVC sheath)
- SWA cables (XLPE, PVC)
- armoured/braided flexible cables
- data cables
- fibre optic cable
- fire performance cable
- cable glands

- 1.2 The requirements of industrial plugs, sockets, and couplers

Learning outcome:

2. Understand the industry recognised methods for determining the type, size and rating of electrical cables, conductors, wiring systems, associated equipment, accessories, and components in relation to the electrical system's design

Criteria

- 2.1 How to determine the size and rating of electrical cables (basic single-phase circuits to non-reactive loads)

Range: the basic application of diversity, determining the circuit design current, selection of a suitably rated protective device, application of rating factors: Ca, Cg, Cf, Ci, selecting a cable in accordance with the tabulated current carrying capacity, establishing, and confirming the voltage drop is acceptable

Learning outcome:

3. Understand how to install and connect types of electrical cables, conductors, wiring systems, associated equipment, accessories, and components

Criteria

3.1 The methods and techniques for installing and fixing electrical cables, conductors, wiring systems, associated equipment, accessories and components in accordance with:

- the electrical system's design
- manufacturers' instructions

3.2 The different types and methods of terminating and connecting electrical cables and conductors

Delivery outcomes (depth of content)

1

Learners will know and understand the listed range of cables, conductors and associated wiring systems including their common applications, advantages and limitations.

Learners will know the features and characteristics of cables including the operating temperature limits of cables, MICC (with/without PVC sheath) and what the PVC sheath colour indicates, common cable sizes (e.g. what 2L1.5 means in relation to MICC). The different types of glands used for cables (e.g. for SWA: CW, BW etc. and their use). The types of containment systems used in conjunction with cables, and the types of installations where these wiring systems are typically used in domestic, commercial, industrial, and agricultural/horticultural installations. Recognising the common industrial plugs, sockets, and couplers used for 110 V, 230 V and 415 V (BS EN 60309). The application of low temperature PVC insulated and sheathed cable (arctic flex).

2

Learners will know what is meant by diversity factors and the application of IET On-Site Guide in determining the maximum demand of typical circuits after diversity has been applied. The application of IET On-Site Guide in selecting a cable for a given application.

Learners will be accustomed to utilising tabulated data to select a cable for a simple single-phase load considering the circuit design current, selection of the protective device, identifying and using rating factors, selecting a cable, and calculating and confirming voltage drop is acceptable. Learners will know the maximum voltage drop % for single-phase circuits.

3

Learners will know how to install, fix and connect electrical cables, conductors, wiring systems, associated equipment, accessories, and components. The procedures used for selecting and safely using tools and equipment for terminating cables (including the use of eye protection). The bending radius of cables. The methods and techniques used to draw cables into conduit and trunking. The methods used to fix and support cables to buildings and structures in accordance with the key aspects of BS 7671 and the IET On-Site Guide and industry practices. The use of grommets. Considering migration of plasticiser from PVC Cables and the need to keep cables clear of polystyrene granules, and wood preservatives etc. The requirements for cables in joists, wall, or partition. The effects of eddy currents when cables pass through ferrous enclosures (line and neutral together, or a slot cut between). The meaning and requirements for voltage bands (Band I and Band II). The key requirements of proximity of wiring systems to other services.

Learners will know and understand the advantages, disadvantages of connection methods: screw, crimped, soldered, non-screw compression, insulation displacement. The procedures for verifying that terminations and connections are electrically and mechanically sound. The consequences of terminations not being electrically and mechanically sound (the insidious nature of high resistance joints). The different types of crimps, connectors

and terminals commonly used. (Refer to the requirements of accessibility and electrical connections in BS 7671). An awareness of splicing fibre optic cables. The methods and techniques for the connection, termination of the range of cables given and their identification (such as sleeving/tags).

Unit 306E: Understand How to Inspect and Test De-Energised Electrical Circuits

GLH: 25

What is this unit about?

This unit covers the knowledge and understanding of the fundamental inspections and de-energised tests required for single-phase circuits.

The learner will be able to comply with the processes and procedures for fundamental inspections and de-energised tests in accordance with the current versions of the appropriate industry standards and regulations, the specification and industry recognised working practices.

Learners will develop their knowledge and understanding of:

- how to select the instruments to be used for carrying out relevant tests
- the methods and procedures for conducting a visual inspection on the enclosures cables, conductors and wiring systems
- the correct procedure for safe isolation
- the methods and processes to carry out correctly the tests that ensure safe and efficient operation of the electrical system.

Learners may be introduced to this unit by asking themselves questions such as:

- Why is electrical work inspected and tested?
- Why is safe isolation essential?

Guidance: the emphasis in this unit is on the learner correctly carrying out fundamental inspections and de-energised tests on typical common circuits to include ring and radial final circuits and lighting circuits. Learners will be able to utilise test equipment, evaluate test results and record outcomes accurately.

Learning outcome:

1. Understand how to select the instruments to be used for carrying out relevant tests

Criteria

- 1.1 The test instruments required for de-energised tests on standard single-phase circuits
Range: continuity tester, insulation resistance tester, test leads and accessories
- 1.2 How to confirm that the test instruments are fit for purpose and have a current calibration certificate

Learning outcome:

2. Understand the methods and procedures for conducting a visual inspection on the enclosures cables, conductors and wiring systems

Criteria

- 2.1 How to confirm the installed electrical equipment is located and secured correctly and electrically and mechanically sound
- 2.2 How to carry out a visual inspection of the main/key aspects of standard single-phase circuits

Learning outcome:

3. Understand the correct procedure for safe isolation

Criteria

- 3.1 The safe isolation procedure
Range: reasons for safe isolation, pre-isolation considerations to others and connected equipment/circuits, the correct procedure for safe isolation

Learning outcome:

4. Understand the methods and processes to carry out correctly the tests that ensure safe and efficient operation of the electrical system

Criteria

- 4.1 How to carry out de-energised tests on standard single-phase circuits
Range: continuity of protective bonding conductors, continuity of circuit protective conductors, continuity of ring final circuit conductors, insulation resistance, polarity

Learning outcome:**5. Understand methods for providing clear and accurate information to relevant people****Criteria****5.1 How to record outcomes from basic inspections and dead tests clearly and accurately****Delivery outcomes (depth of content)****1**

The learner will understand the fundamental aspects of how to select and safely use test instruments and accessories to carry out de-energised tests on single-phase circuits. The pre-use checks, and the importance of equipment calibration. The application of GS 38.

2

The learner will understand the fundamental aspects of how to carry out a basic visual inspection of completed work against an installation specification and the requirements of the IET On-Site Guide (covering key common aspects). Learners will know how to carry out inspections - such as how to ensure conductors are adequately terminated, and electrically sound (low resistance, doubled over/filling the terminal), mechanically sound ('tug test'), and correct cable identification. The application of the human senses during an inspection. Learners will know that the work should be inspected as it is being completed, and the actions to be taken where non-compliances are found.

3

The learner will understand how to carry out the electrical safe isolation procedure in accordance with the Electrical Safety First's Best Practice Guide No.2. The implications of electrical self-isolation to self, others, and the building's electrical systems. The implications of not carrying out the safe isolation procedure. Safely isolating all forms of energy, including back-up supplies. The requirements of GS 38 for the voltage indicator.

4

The learner will understand how to carry out tests on single-phase de-energised circuits. The pre-test procedure to include nulling leads and selecting the correct scale and setting for the test. Learners will know the reason and procedures for carrying out relevant tests and be able to interpret the test results. Why test instruments, leads and accessories should be handled with care. How to record the outcomes of inspections and tests of simple circuits on relevant documentation, and why this needs to be in a clear and accurate format. The implication of carrying out IR tests which can damage sensitive loads such as dimmer switches and USB outlets in sockets. Dangers of charging capacitors (latent energy).

Unit 307E: Understand Intermediate Electrical Science and Principles

GLH: 80

What is this unit about?

This unit covers the fundamental science and principles relevant to electrical work. These principles underpin the knowledge understanding and performance requirements of all units within this qualification.

Learners will develop their knowledge and understanding of:

- fundamental mathematical principles which are appropriate to electrical installation work
- standard units of measurement used in electrical installation and design work
- basic mechanics and the relationship between force, work, energy, and power
- the fundamental relationship between resistance, resistivity, voltage, current and power
- fundamental principles which underpin the relationship between magnetism, electricity, generation, and supply systems.

Learners may be introduced to this unit by asking themselves questions such as:

- What is the relationship of science and principles to electrical work?
- What is electricity?
- How is electricity generated, transmitted, and distributed to installations?

Learning outcome:

1. **Understand fundamental mathematical principles which are appropriate to electrical installation work**

Criteria

- 1.1 The appropriate mathematical principles which are relevant to electrical work tasks
Range: fractions and percentages, algebra, transposition, indices and square roots

Learning outcome:

2. **Understand standard units of measurement used in electrical installation and design work**

Criteria

- 2.1 The internationally recognised base and derived (SI) units of measurement for general quantities
Range: length, area, volume, mass, density, time, temperature, and velocity
- 2.2 The values of base and derived SI units which apply specifically to electrical quantities
Range: resistance, resistivity, power, frequency, current, voltage, and energy
- 2.3 The appropriate electrical instruments for the measurement of different electrical quantities
Range: resistance, power, current, voltage, and energy

Learning outcome:

3. **Understand basic mechanics and the relationship between force, work, energy and power**

Criteria

- 3.1 What is meant by mass and weight
- 3.2 The principles of basic mechanics as they apply to levers, gears, and pulleys
Range: Class I, Class II and Class III
- 3.3 The main principles of mechanical principles and their inter-relationships
Range: force, work, energy (kinetic and potential), power, and efficiency
- 3.4 Calculation of mechanical energy, power, and efficiency

Learning outcome

4. Understand the fundamental relationship between resistance, resistivity, voltage, current and power

Criteria

- 4.1 The basic principles of electron theory
- 4.2 Materials which are good conductors and insulators
- 4.3 What is meant by resistance and resistivity in relation to electrical circuits
- 4.4 The relationship between current, voltage and resistance in parallel and series D.C circuits
- 4.5 The values of current, voltage and resistance in parallel and series D.C circuits
- 4.6 The values of power in parallel and series D.C circuits
- 4.7 What is meant by the term voltage drop in relation to electrical circuits
- 4.8 The chemical and thermal effects of electric currents

Learning outcome:

5. Understand fundamental principles which underpin the relationship between magnetism, electricity, generation, and supply systems

Criteria

- 5.1 The effects of magnetism in terms of attraction and repulsion
- 5.2 The difference between magnetic flux and flux density
- 5.3 The magnetic effects of electrical currents in terms of:
 - production of a magnetic field
 - force on a current carrying conductor in a magnetic field
 - electromagnetism
 - electromotive force
- 5.4 The basic principles of A.C generation in terms of:
 - a single-loop generator
 - sinewave
 - frequency
 - EMF
 - magnetic flux
 - three-phase systems

5.5 The characteristics of sinewaves

Range: root mean square (rms) value, average value, peak to peak value, periodic time, frequency, and amplitude

5.6 The features and characteristics of a generation, transmission, and distribution system

Range: power stations, fossil fuels, hydro, nuclear, super-grid and standard grid system, transformers, transmission voltages, distribution voltages, sub-stations, above and below ground distribution

Delivery outcomes (depth of content)**1**

Learners will understand how to utilise the fundamental mathematical principles that underpin this unit and electrical work. Learners will understand how to use the basic functions on a scientific calculator and the relevant order of operations and how to transpose simple equations and formulas. The emphasis is on the learner gaining the relevant underpinning mathematical knowledge and skills to succeed in this unit and this qualification.

2

Learners will gain an appreciation of SI units of measurement for both general quantities and electrical quantities. Learners will be able to state units of measurement together with commonly used multiples and submultiples in electrical installation work. Learners will be able to state which instruments are required for the measurement of voltage and energy together with resistance power and current.

3

Learners will gain an appreciation of the difference between mass and weight and the SI units of each. Learners will recognise that mass is a measure of how much matter there is in an object and weight is a measure of the pull of gravity on the object. Learners will understand the main principles of; and the basic mechanical formulas used for: force work energy power and mechanical efficiency %. Learners will know what is meant by mechanical advantage.

4

Learners will gain an appreciation of the fundamental theory of electrical circuits and will be able to calculate resistance and resistivity with the resistivity values of common conductors used for electrical installation. Learners will be able to carry out calculations for voltage current and resistance for resistors in series and parallel circuits and combined combinations. Learners will be able to calculate power dissipated at loads in series and parallel circuits and combined combinations and understand voltage drop in relation to electrical circuits. Learners will know the chemical and thermal effects of electric currents.

5

Learners will gain an appreciation of magnetism and electromagnetism. Learners will be able to identify how a sine wave is generated and the key features and characteristics of sine waves together with determining relevant A.C values: root mean square (RMS) value, average value, peak to peak value, periodic time, frequency, amplitude. Learners will know how electricity is generated, transmitted, and distributed to consumers. The transmission and distribution voltages to different types of consumer and basic power loss. Learners will understand the main characteristics of electrical supplies. The reasons for using alternating current transmission and distribution. The reasons for the neutral conductor. The advantages of distributing loads evenly over the three lines.

Unit 312: Apply Health and Safety and Environmental Legislation in the Building Services Engineering Sector

GLH: 15

What is this unit about?

This is a performance unit and is about establishing and maintaining working practices and procedures to health and safety, the natural environment and the working environment. This includes identifying hazards and risks, applying appropriate procedures and working practices to protect yourself and others.

The learner must possess the skills and knowledge to be able to use building services engineering sector equipment, components, materials and substances effectively, efficiently, and in accordance with the specification giving consideration to the natural environment and the working environment in terms of waste materials.

Learners will develop their skills of:

- the appropriate industry standards and regulations
- relevant organisational procedures
- identification of hazards and risks
- completing documentation
- the organisational procedures to ensure that they will not cause potential hazards and risks
- safe use, maintenance, handling, transport, and storage of resources
- reporting to the relevant people in accordance with organisational procedures potential hazards and risks, potentially harmful materials, and substances
- confirming that the conduct of people when undertaking the installation and/or maintenance activity does not cause potential hazards and risks
- complying with organisational procedures in the event of injuries to self and/or others, emergencies, and evacuation procedures
- the safe transport and/or disposal of waste material, substances, and liquids in accordance with suppliers' and manufacturers' instructions.

Learners may be introduced to this unit by asking themselves questions such as:

- How do I establish and maintain a safe working process?
- What are the types of hazards typically encountered at work?
- How should I respond to an emergency?

Performance Criteria

Learning outcome:

1. Identify the appropriate industry standards and regulations

Learning outcome:

2. Apply relevant organisational procedures

Criteria: organisational procedures:

- 2.1 information management
- 2.2 method statement
- 2.3 project management
- 2.4 risk assessment
- 2.5 implementing and monitoring health and safety requirements and issues
- 2.6 implementing and monitoring issues relating to the natural environment
- 2.7 customer services
- 2.8 accident reporting
- 2.9 emergencies
- 2.10 communication with relevant people

Learning outcome:

3. Identify hazards and risks

Criteria: hazards and risks (internal and/or external):

- 3.1 domestic
- 3.2 non-domestic (commercial, industrial, agricultural, horticultural, leisure and entertainment, residential medical and care facilities, public highways and parks, public services establishments, pre-1919 traditional/historic buildings)

AND

Criteria: site:

- 3.3 new build construction – building or structure
- 3.4 existing building or structure

Learning outcome:

4. Complete documentation in accordance with the requirements of the organisational procedures

Learning outcome:**5. Review the organisational procedures to ensure that they will not cause potential hazards and risks**

Criteria: potential hazards and risks:

- 5.1 disposal of substances and materials
- 5.2 installation and/or maintenance methods and techniques
- 5.3 lifting and handling (manual and mechanically assisted)
- 5.4 presence of vehicle thoroughfares
- 5.5 storage of liquids, substances, and materials
- 5.6 use of appliances, tools, and equipment
- 5.7 use of access equipment
- 5.8 use of personal protective equipment (PPE)
- 5.9 working in a potentially hazardous atmosphere (e.g. presence of asbestos, dust, fumes or vapour)
- 5.10 working at height
- 5.11 working in confined spaces

Learning outcome:**6. Implement organisational procedures, suppliers', and manufacturers' instructions appropriate to the safe use, maintenance, handling, transport and storage of:**

- tools, plant, and access equipment
- equipment and components
- materials and substances

Learning outcome:**7. Report to the relevant people in accordance with organisational procedures potential hazards and risks, and potentially harmful materials, and substances**

Criteria: relevant people:

- 7.1 customers/clients
- 7.2 client representatives
- 7.3 supervisors
- 7.4 site/contract manager
- 7.5 other contractors/trades
- 7.6 members of the public
- 7.7 work colleagues

Learning Outcome:**8. Confirm that the conduct of people when undertaking the installation and/or maintenance activity does not cause potential hazards and risks**

Learning outcome:

- 9. Comply with organisational procedures in the event of injuries to self and/or others, emergencies, evacuation procedures**

Criteria: injuries/emergencies/evacuation:

- 9.1 fire
- 9.2 flood
- 9.3 explosion
- 9.4 toxic atmosphere
- 9.5 electric shock
- 9.6 injury to person(s)

Learning outcome:

- 10. Implement organisational procedures for the safe transport and/or disposal of waste material, substances, and liquids in accordance with suppliers' and manufacturers' instructions**

Unit: 313: Establish and Maintain Relationships in the Building Services Engineering Sector

GLH: 26

What is this unit about?

This unit consists of knowledge, understanding and performance and enables learners to develop and maintain positive relationships with clients and customers associated with the installation and/or maintenance activities in the building services engineering sector in accordance with:

- appropriate industry standards and regulations
- the specification
- working practices
- the working and natural environment.

The learner will have the responsibility for establishing and maintaining client and customer relationships and will be able to:

- present and provide accurate technical and functional information, advice, and guidance
- liaise with clients and customers with respect to their needs and expectations
- respond as appropriate to client and customer needs and expectations.

Learners will develop their knowledge understanding and skills of:

- the types of technical and functional information that is available for the installation and/or maintenance activity
- the procedures for supplying technical and functional information to relevant people
- the importance of customer service in relation to installation and/or maintenance activity
- supplying technical and functional information
- providing accurate guidance and advice to the clients and customers on technical and functional matters
- handover procedures
- maintaining productive working relationships with clients and customers
- respond effectively to requests for technical and functional information
- following procedure for any variations
- complying with organisational standards for appearance and behaviour.

Learners may be introduced to this unit by asking themselves questions such as:

- What is the technical and functional information required for my work?
- How can I provide excellent customer service?
- Why is data protection important?

Learning outcome:

1. Understand the types of technical and functional information that is available for the installation and/or maintenance activity

Criteria

- 1.1 The sources of technical and functional information

Range: manufacturer information and data, supplier information and data, information from their employing organisation, installation specifications, client/customer specifications, specifications, drawings, and diagrams

- 1.2 Interpret technical and functional information and data

Range: manufacturer/supplier information and data; materials, components, equipment, information from their employing organisation, installation specifications, client/customer specifications, specifications, drawings and diagrams

Learning outcome:

2. Understand the procedures for supplying technical and functional information to relevant people

Criteria

- 2.1 The stakeholders that require technical and functional information

Range: clients, customers, major contractors, other services, site managers

- 2.2 The limits of responsibility of own job role with respect to supplying technical and functional information

- 2.3 The methods of providing technical and functional information

- 2.4 The importance of ensuring that:

- information provided is accurate and complete
- information is provided clearly, courteously, and professionally
- copies of information provided are retained
- the installation, on completion, functions in accordance with the specification, is safe and complies with industry standards

- 2.5 The methods for checking that relevant persons have an adequate understanding of the technical and non-technical information provided

Learning outcome:**3. Understand the importance of customer service in relation to installation and/or maintenance activity****Criteria**

- 3.1 The methods and organisational procedures for establishing positive relations with clients and customers
- 3.2 The working requirements and practices of the clients and customers in the working environment where the installation and/or maintenance activity is taking place
- 3.3 The opportunities and regulations that affect the way that technical and functional information is delivered to clients and customers
- 3.4 The clients' and customers' rights including any contractual agreements

Delivery outcomes (depth of content)**1**

Learners will understand what is meant by technical and functional information and their responsibilities (as relevant) for the accurate and precise recording, retention and handover of technical and functional information.

Learners will understand a range of technical and functional information that can be utilised and provided and its implications on the operation of the building services engineering system and/or its equipment, accessories and components that have been installed and/or maintained.

2

Learners will understand situations which warrant written technical and functional information, including appropriate health and safety information. They will understand the procedures for supplying technical and functional information to relevant people.

3

Learners will understand the appropriateness of different customer relations and procedures and they will understand the importance of technical communication to others.

Learners will understand the main requirements to process technical and functional information in compliance with the key principles of the Data Protection Act (the UK's implementation of the General Data Protection Regulation (GDPR)) and the clients/customers basic rights under the Consumer Rights Act. The main points of the Equality Act.

Performance Criteria

Learning outcome:

1. Identify the clients and customers that need to be supplied with technical and functional information

Learning outcome:

2. Obtain the current and relevant technical and functional information that needs to be provided to the clients and customers

Learning outcome:

3. Provide accurate guidance and advice to the clients and customers on technical and functional matters associated with the building services engineering system that has been installed and/or maintained in terms of:
 - health and safety issues
 - safe and effective operation

Learning outcome:

4. Provide information in accordance with organisational procedures

Criteria: organisation procedures:

- 4.1 information management
- 4.2 method statement
- 4.3 project management
- 4.4 risk assessment
- 4.5 implementing and monitoring health and safety requirements and issues
- 4.6 implementing and monitoring issues relating to the natural environment
- 4.7 customer services
- 4.8 accident reporting
- 4.9 emergencies
- 4.10 communication with relevant people

Learning outcome:

5. Demonstrate to the clients and customers, as appropriate, the operation of the building services engineering system that has been installed and/or maintained

Criteria: working environment of the system (internal and/or external):

- 5.1 domestic
- 5.2 non-domestic (commercial, industrial, agricultural, horticultural, leisure and entertainment, residential medical and care facilities, public highways and parks, public services establishments, pre-1919 traditional/historic buildings)

Learning outcome:

6. Confirm in relation to the installation and/or maintenance activity:
- the client and customer expectations and requirements
 - the building services engineering system is in a satisfactory condition
 - the hand over process

Learning outcome:

7. Establish and maintain productive working relationships with clients and customers, including dealing with disagreements in an amicable and constructive way, so that good relationships are maintained

Learning outcome:

8. Respond effectively to requests for technical and functional information from clients and customers

Learning outcome:

9. Report, record and recommend, in accordance with organisational procedures and as appropriate, any variation to the installation and/or maintenance activity to the clients, customers and other relevant people

Criteria: relevant people:

- 9.1 customers/clients
- 9.2 client representatives
- 9.3 supervisors
- 9.4 site/contract manager
- 9.5 other contractors/trades
- 9.6 members of the public
- 9.7 work colleagues

Learning outcome:

10. Comply with organisational standards for appearance and behaviour

Unit 314: Coordinate a Work Site in the Building Services Engineering Sector

GLH: 28

What is this unit about?

This unit consists of knowledge, understanding and performance. It covers how to coordinate the work site for the installation and/or maintenance activities associated with the building services engineering system.

It covers the responsibility for the coordination of the work site and learners must be able to oversee, as relevant, the work of other operatives and/or other contractors, in accordance with relevant industry standards, regulations and the specification, working practices, the working environment and the natural environment to confirm:

- the work to be undertaken
- a programme of work with relevant people
- the organisation of the appropriate resources
- that equipment, accessories and components are fit-for-purpose
- that work is carried out safely
- all relevant documentation is completed accurately.

The learner will understand the extent of their role and responsibilities, including how best to motivate, monitor and communicate with others in accordance with organisational procedures.

Learners will develop their knowledge understanding and skills of:

- the requirements for organising and overseeing work activities
- the procedures for rescheduling work to coordinate with changing conditions in the workplace and to coincide with other trades
- the requirements for organising the provision and storage of resources that are required for work activities
- producing a risk assessment and method statement
- allocating duties and responsibilities to operatives
- coordinate effectively, when relevant, the work of other contractors
- ensuring the work is fit for purpose
- liaising with others to resolve issues.

Learners may be introduced to this unit by asking themselves questions such as:

- How can I plan my own work and that of others, so the work is coordinated, safe, and effective?
- What is the best way to manage resources required for the work?

Learning outcome:**1 Understand the requirements for organising and overseeing work activities****Criteria**

1.1 How to plan and implement:

- the monitoring and implementation of health and safety on the work site
- the work to be undertaken
- the allocation of roles and responsibilities
- the resources required

1.2 The procedures for re-scheduling work to coordinate with changing conditions in the workplace and to coincide with other trades

1.3 How to coordinate operatives you are responsible for in relation to:

- supervision and motivation
- identification of competence
- planning work allocations, duties, and responsibilities

1.4 How to communicate effectively with relevant people

1.5 The current versions of appropriate industry standards and regulations relevant to the identified building services engineering system

1.6 The organisational procedures for:

- completing the necessary documentation
- agreeing a programme of work with relevant people
- confirming that the installation and/or maintenance work is completed

Learning outcome:**2 Understand the requirements for organising the provision and storage of resources that are required for work activities****Criteria**

2.1 The methods that will verify that the equipment, accessories, and components are:

- compatible to the working environment
- in accordance with the specification
- of the required and correct type
- delivered on time and undamaged
- suitable and safely stored

2.2 How to manage the available storage facility at the work site

Delivery outcomes (depth of content)

1

Learners will understand their responsibilities in overseeing and organising work activities and the work environment. Learners will understand how to ascertain the competence of different relevant colleagues and workers, how to allocate work activities and how to monitor that the work is being completed on time to the work schedule.

Learners will understand how to interpret the installation specification and work programme to identify resource requirements. Learners will understand how to create schedules of work including the use of a Gantt chart, and recognise the critical path. Learners will understand how the work completion time is estimated considering influential factors such as the deployment and availability of suitable personnel, the delivery and availability of equipment, components and materials, the weather conditions, and the work to be completed by other services. The procedures for dealing with changes to an original contract specification including variation orders, and day work sheets.

Learners will understand how to plan and implement work allocations and the duties of operatives for whom they are responsible, and their effective coordination.

Learners will ensure that they maintain the safety of the work environment, cost effectiveness, and ensure compliance with the specification and work schedule. Learners will understand how to communicate effectively with others for the purpose of motivation, instruction, monitoring, co-operation, and teamwork.

Learners will recognise the industry standards and regulations relevant to their work: Employment Rights Act, Equality Act, and the Human Rights Act.

2

Learners will understand the requirements for the equipment, accessories, and components and the storage and transportation requirements for the required materials.

Learners will recognise the possible consequences of not completing work within the scheduled time, or not using the specified materials, or not installing materials and equipment as specified, or not meeting the requirements of the programme of work.

Performance Criteria

Learning outcome:

- 1 **Produce a risk assessment and method statement for the work to be carried out on the identified building services engineering system**

Criteria: working environment of the system (internal and/or external):

1.1 domestic

1.2 non-domestic (commercial, industrial, agricultural, horticultural, leisure and entertainment, residential medical and care facilities, public highways and parks, public services establishments, pre-1919 traditional/historic buildings)

Learning outcome:

- 2 **Allocate duties and responsibilities to operatives, when appropriate, to make best use of their competence**

Learning outcome:

- 3 **Instruct the operatives, where relevant, about their duties and responsibilities clearly and concisely**

Learning outcome:

- 4 **Confirm that any instructions given are understood**

Learning outcome:

- 5 **Coordinate effectively, when relevant, the work of other contractors**

Learning outcome:

- 6 **Monitor, as appropriate, that the work of operatives is safe, fit-for- purpose, cost effective and in accordance with:**
 - industry recognised working practices
 - the specification
 - the current versions of appropriate industry standards and regulations

Learning outcome:

- 7 **Ensure that safe and appropriate action is taken promptly where a non-compliance is identified during the programme of work**

Learning outcome:

- 8 Ensure that all documentation associated with the installation and/or maintenance work is in accordance with organisational procedures, the current versions of appropriate industry standards and regulations**

Criteria: organisation procedures:

- 8.1 information management
- 8.2 method statement
- 8.3 maintenance (planned and reactive)
- 8.4 project management
- 8.5 risk assessment
- 8.6 implementing and monitoring health and safety requirements and issues
- 8.7 implementing and monitoring issues relating to the natural environment
- 8.8 customer services
- 8.9 accident reporting
- 8.10 emergencies
- 8.11 communication with relevant people

Learning outcome:

- 9 Liaise with the relevant people to resolve issues which are outside the scope of your job role**

Criteria: relevant people:

- 9.1 customers/clients
- 9.2 client representatives
- 9.3 supervisors
- 9.4 site/contract manager
- 9.5 other contractors/trades
- 9.6 members of the public
- 9.7 work colleagues

Learning outcome:

- 10 Verify that the equipment, accessories, and components are:**

- **Compatible to the working environment**
- **In accordance with the specification**
- **Of the required and correct type**
- **Delivered on time and undamaged**
- **Suitable and safely stored**

Learning outcome:

- 11 Confirm that the installation and/or maintenance work completed is in accordance with:**

- **the specification**
- **the current versions of appropriate industry standards and regulations**

Unit 315E: Installation of Wiring Systems

GLH: 170

What is this unit about?

This unit covers the understanding required for the installation of wiring systems and the performance requirements for the installation of enclosures for electrical cables, conductors and wiring systems internally and externally for electrical systems. (Note that Unit 305 covers the performance requirements for the installation and connection of electrical cables, conductors, wiring systems, equipment, accessories and components for electrical systems).

The learner must be able to comply with the procedures and methods for installing enclosures for electrical cables, conductors and wiring systems in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment and the natural environment.

Learners will develop their knowledge understanding and skills of:

- the operation, applications, advantages, and limitations of different electrical systems
- the appropriate industry standards and regulations relevant to installing enclosures
- the applications, advantages, and limitations of types of enclosures
- selecting electrical equipment
- the installation of enclosures for electrical cables, conductors and wiring systems internally and externally for electrical systems
- the installation of electrical cables, conductors, wiring systems, equipment, accessories, and components for electrical systems.

Learners may be introduced to this unit by asking themselves questions such as:

- What are the different types of earthing systems?
- What are the types of single and three-phase circuits, and what are their features?
- How is BS 7671 applied in electrical installation work?

Guidance: within this unit learners will utilise the requirements of BS 7671. Learners will be able to locate, interpret, apply relevant requirements of the standard. This will develop the learner's knowledge of the main relating requirements of the IET On-Site Guide. The requirements of BS 7671 should be delivered in a similar way to the wiring regulations CPD award, but in an expanded capacity over a longer time frame to enable learners to become familiarised with BS 7671. This will be pivotal in underpinning the entire qualification.

Learning outcome:**1. Understand the operation, applications, advantages, and limitations of different electrical systems****Criteria**

1.1 Types of earthing systems

Range:

- TN-S
- TN-C-S
- TN-C
- TT
- IT

1.2 Types of supply systems

Range: single-phase, three-phase, three-phase and neutral

1.3 Electrical circuits

Range: distribution systems (sub-mains), environmental control/building energy management systems, UPS, closed circuit TV, communication and data transmission systems, protective systems (fire alarm/prevention; unlawful entry; emergency lighting), machine control, heating control, final circuits (including circuits for electric vehicle charging equipment)

1.4 The arrangements for electrical installations and systems with regards to provision for: isolation and switching, overcurrent protection, earth fault protection

1.5 The devices for protection against the risk of fire: AFDDs, RCDs

1.6 The maximum disconnection times for circuits

1.7 Requirements for the protection against overvoltage and the types and applications of SPDs

1.8 Requirements for the protection against undervoltage

1.9 The requirements for protection against electric shock

1.10 The requirements and applications of functional earthing

1.11 How to select suitably sized protective conductors in accordance with BS 7671

Learning outcome:**2. Understand the appropriate industry standards and regulations relevant to installing enclosures****Criteria**

2.1 Industry standards and regulations

Range: interpretation and the application of the main topics in BS 7671, Building Regulations Wales and England (relevant Approved Documents and technical guidance for Wales), industry/manufacturers guidance IET OSG, relevant requirements of the Construction (Design and Management) Regulations, Electricity at Work Regulations, Health and Safety at Work Act, Provision and Use of Work Equipment Regulations, Personal Protective Equipment at Work Regulations

Learning outcome:**3. Understand the applications, advantages and limitations of types of enclosures****Criteria**

3.1 The selection of wiring systems and equipment appropriate to the situation and use utilising BS 7671

3.2 The application of the Degrees of Protection Provided by Enclosures (IP Code)

Learning outcome**4. Understand the appropriate industry standards, regulations, and procedures relevant to installing and connecting electrical cables, conductors, wiring systems, associated equipment, accessories and components****Criteria**

4.1 Industry standards and regulations

Range: interpretation and the application of BS 7671, Building Regulations and relevant Approved Documents and technical guidance, industry/manufacturers guidance, and standards, IET Publications (e.g. Guidance Notes and the IET On-Site Guide)

4.2 The organisational procedures for confirming with the relevant people the appropriate actions to be taken to ensure that any variations to the planned programme of work will not introduce a hazard and have minimum negative impact on the installation work to be undertaken

Learning outcome:**5. Understand the industry recognised methods for determining the type, size and rating of electrical cables, conductors, wiring systems, associated equipment, accessories and components in relation to the electrical system's design****Criteria** (single and three-phase)

5.1 The interpretation of manufacturer's data for the selection and application of connected loads and equipment

5.2 The selection of current using equipment considering energy efficiency

5.3 The application of smart technology when used for convenience, comfort, safety, and security

5.4 The cable selection (circuit design) procedure:

- establishing the maximum demand of an installation after the application of diversity
- determining the circuit design current and selection of a suitably rated protective device
- establishing the installation method reference
- determining appropriate rating factors
- determining the minimum cross-sectional area of live conductors, taking into consideration current carrying capacity and voltage drop
- establishing if the voltage drop is acceptable
- determining if the disconnection time will be met
- evaluating the cables thermal withstand (during a fault)

Delivery outcomes (depth of content)

1.1

Learners will understand the characteristics, applications, advantages, and limitations of earthing arrangements (the earthing arrangements as shown in BS 7671). TN-S, TN-C-S, TN-C, TT, and IT systems (specialist use such as in operating theatres). The meaning of PME, and a PEN conductor. The principle of foundation earthing.

1.2

Learners will understand the characteristics, applications, advantages and limitations of supply systems, this encompasses supplies to an installation from the DNO and supplies to distribution circuits and final circuits (consumer circuits). The situations that have two-phase supplies.

1.3

Learners will gain an understanding of the principles of the range of circuits listed, how these circuits operate where they are applied their advantages and their limitations. Note that some of these circuits complement Unit 319E (e.g. machine control). Learners will recognise the key standards applicable to fire alarms, BS 5839 (in particular applicability of Part 1 and Part 6), and emergency lighting, BS 5266.

1.4 – 1.11

Learners will interpret the requirements of BS 7671 for the topics listed and how these requirements apply. Learners will be able to locate and interpret regulations, utilise tabulated information, perform calculations and evaluate compliance. The requirements for overcurrent protection and earth fault protection including disconnection times in Chapter 41 of BS 7671.

Learners will understand selectivity, breaking capacity, and fault current capacities of devices. The types and uses of RCDs including selectivity between RCDs. They will appreciate moulded case circuit breakers and air circuit breakers.

Learners will understand arc fault protection and the advantages, applications and limitations of arc fault detection devices (AFDDs). The types of arc faults. The use of RCDs when used for protection against the risk of fire. The types and applications of surge protective devices. Refer to the relevant appendix of BS 7671.

Learners will understand the requirements for protection against overvoltage and undervoltage.

Learners will be able to interpret and relate the requirements for protection against electric shock (Chapter 41 of BS 7671). The requirements of functional earthing. The use of Chapter 54 of BS 7671 for selecting suitably sized protective conductors.

2

Learners will understand the application of BS 7671 for the design, selection and erection of electrical installations. Learners will be able to locate, interpret and understand the main topics of BS 7671 and its appendices relating to electrical work in a variety of locations/contexts. Learners will also understand how to interpret the requirements of other related publications listed in the range, and the relationship between the various industry standards and regulations. The scope of Part P in Wales and England (supporting cross border working). Learners will have an awareness of the specialist requirements for electrical equipment in potentially explosive atmospheres.

3

Learners will be able to utilise BS 7671 to select appropriate wiring systems and equipment (for example in a special location) and to account for external influences. With the surge in popularity of hot tubs learners will understand the applicability and relating requirements of BS 7671 (see trade press for examples). Learners will understand the requirements of the IP Code in relation to how this applies to electrical installations and selecting appropriate electrical equipment and enclosures (link to requirements of BS 7671 barriers and enclosures etc.). The factors which affect the selection of wiring systems and equipment: client specification, cost, efficiency of equipment, speed of installation of different wiring systems, ergonomics, and future maintenance of the installation. The considerations of using the metallic enclosure as CPC, (such as greater maintenance requirements). The considerations of selecting enclosures and containment in a range of contexts.

4

Learners will be able to interpret the requirements of BS 7671 for key topics. Learners will understand the requirements as outlined in the Building Regulations (Wales and England) relevant Approved Documents and technical guidance applicable to electrical work. The use of industry / manufacturers guidance, standards, and IET Publications (e.g. Guidance Notes and the On-Site Guide).

5

Learners will understand the importance of sustainability in the selection and application of low energy equipment and controls. (Refer to the relevant appendix of BS 7671, Part L of the Building Regulations and guidance in Approved Documents such as in relation to internal/external lighting, electric heating etc.). Learners will have an awareness of PAS 2030.

Learners will be able to appreciate the application of smart technology (this develops the learner's knowledge of lighting and heating controls). How smart homes can facilitate energy saving, comfort, fire safety, and security, the wiring of smart switches. Learners will develop an understanding of smart offices, and the Internet of Things (IoT).

Learners will be able to utilise BS 7671 and select appropriately sized conductors for given applications (for single and three-phase circuits). Learners will understand the applications of overcurrent protective devices for different types of loads.

Performance Criteria

Learning outcome:

1. **Assess and apply appropriate procedures to include:**
 - adopting appropriate PPE
 - following a safe system of work (e.g. working in accordance with a risk assessment and method statement)
 - selecting appropriate tools/equipment for the installation work

Learning outcome:

2. **Prepare to install wiring systems, enclosures, and associated equipment, to include:**
 - confirming secure site storage facilities for tools
 - equipment, materials, and components
 - selecting materials (equipment and components) in accordance with the installation specification
 - reporting any pre-work damage/defects to existing equipment or building features, to the relevant person (Such as: customer/client, site/line manager)
 - confirming site readiness for installation work to begin
 - confirming authorisation for the installation work to start

Learning outcome:

3. **Use documentation to confirm that materials and equipment is of the correct quantity and is free from damage**

Learning outcome:

4. **Ensure the planned locations for the wiring system and associated equipment are compatible with other building services (e.g. gas, water or other electrical services)**

Learning outcome:

5. **Check the planned locations for the wiring system in terms of:**
 - aesthetic appearance
 - external influences

Learning outcome:

6. Use sources of information to enable the installation of wiring systems, enclosures and associated equipment to be carried out, including:
- specifications
 - work schedules/programmes
 - manufacturer instructions
 - layout drawings
 - other appropriate source of information (e.g. BS 7671, other plans, or diagrams, 'Approved Documents', Building Regulations)

Learning outcome:

7. Use measuring and marking out techniques which are appropriate to the wiring system, wiring enclosure and/or associated equipment that is being installed

Learning outcome:

8. Install cables in accordance with BS 7671, the installation specification and programme of work: Cover Four:
- single core (singles)
 - multicore insulated
 - PVC - PVC flat profile cable
 - MICC
 - fire performance
 - SWA cable
 - GSWB galvanised steel wire braid
 - data cable

Learning outcome:

9. Install the wiring systems in accordance with BS 7671, the installation specification and agreed planned programme of work: Cover Four:
- PVC conduit
 - metallic conduit
 - PVC trunking
 - metallic trunking
 - cable tray
 - cable basket
 - ladder systems
 - ducting
 - modular wiring systems
 - busbar systems or powertrack

Learning outcome:

10. Install electrical equipment and accessories, in accordance with BS 7671, the installation specification, manufacturers' instructions and the programme of work:

Cover Four:

- isolators /switches
- socket outlets
- distribution-boards / consumer control units
- overcurrent protective devices
- luminaires
- data socket outlets
- other appropriate equipment (e.g. heating system components, control equipment)

Learning outcome:

11. Communicate with others professionally and appropriately to aid the effective installation of the wiring system/equipment

Learning outcome:

12. Dispose of waste materials in accordance with site procedures and statutory requirements

Learning outcome:

13. Ensure the installed wiring system/s and enclosure/s meet specified requirements including that they:

- are the correct type and fit for purpose
- are installed in accordance with BS 7671
- meet the installation specification/other relevant plans/instructions
- are installed in accordance with any relevant manufacturer instructions

Unit 316E: Install and Connect Electrical Cables, Conductors, Wiring Systems and Equipment

GLH: 80

What is this unit about?

This is a performance unit, and is for learners who install and connect electrical cables, conductors, wiring systems, equipment, accessories and components for electrical systems. The learner must be able to comply with the procedures and methods for installing and connecting electrical cables, conductors, wiring systems, equipment, accessories and components in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment and the natural environment.

Learners will develop their skills of:

- selecting appropriate tools/equipment to enable termination and connection
- following a safe system of work
- terminating and connecting cables and conductors
- connecting to electrical equipment
- ensuring that terminations and connections are electrically and mechanically sound
- ensuring cables have appropriate identification.

Learners may be introduced to this unit by asking themselves questions such as:

- What are the components required for terminating the range of cables and conductors?
- What are the methods and techniques applied to connect and terminate the range of cables and conductors?
- What regulations apply to connection and termination?

Performance Criteria

Learning outcome:

1. Evaluate and apply appropriate procedures to include:
 - selecting appropriate tools/equipment to enable termination and connection
 - adopting appropriate PPE
 - following a safe system of work (e.g. risk assessment, method statement, permit to work procedure)

Learning outcome:

2. Assess and confirm it is safe to complete termination and connection in terms of:
 - checking for presence of supply/carrying out safe isolation
 - mechanical soundness of the electrical equipment to be connected to
 - checking for unsafe situations

Learning outcome:

3. Terminate and connect cables and conductors in accordance with manufacturers' instructions, BS 7671, and any relevant drawing or specification: Cover Four:
 - single core cable (singles)
 - multicore insulated cable
 - PVC / PVC flat profile cable (twin and earth)
 - MICC cable
 - fire performance (such as FP 200 etc.)
 - SWA cable
 - GSWB galvanised steel wire braid
 - data cable

Learning outcome:

4. Connect to electrical equipment in accordance with manufacturers' instructions, BS 7671, and any relevant drawing or specification: Cover Five:
 - isolators /switches
 - socket outlets
 - distribution-boards / consumer control units
 - luminaires
 - electric motors / motor control equipment
 - overcurrent protective devices
 - earthing terminals
 - control panels
 - data socket outlets or data connections
 - fire detection/alarm components
 - other appropriate equipment (such as: heating system components etc.).

Learning outcome:

5. Terminate and connect conductors, using appropriate methods: Cover Two:

- screwing
- crimping
- soldering
- non-screw compression
- insulation displacement

Learning outcome:

6. Ensure that terminations and connections are electrically and mechanically sound (e.g. by simple inspecting and testing of terminations)

Learning outcome:

7. Ensure cables have appropriate identification in accordance with BS 7671

Unit 317E: Inspect, Test and Commission Electrical Systems and Equipment

GLH: 72

What is this unit about?

This unit covers the understanding and performance requirements for the commissioning of electrical systems and equipment.

The learner must be able to comply with the processes and procedures for the commissioning and handing over of an electrical system and equipment in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment and the natural environment.

Learners will develop their knowledge, understanding and skills of:

- planning of the resources required to carry out the commissioning process
- identification and use of the correct instruments
- inspecting, testing and commissioning electrical systems and equipment to BS 7671
- completion of the relevant documentation
- recording of relevant data and information
- identification and consideration of the customer's need for electrical systems and equipment configuration.

Learners **must** work safely in accordance with the Health and Safety at Work etc. Act and the Electricity at Work Regulations.

Learners may be introduced to this unit by asking themselves questions such as:

- What are the safe working procedures to be followed when inspecting and testing?
- What inspections are carried out?
- What is the sequence of tests to be undertaken?
- What documentation is required?

Guidance: Within this unit learners will follow the requirements of BS 7671, and IET Guidance Note 3 and will be able to carry out the inspection, testing and commissioning. Learners will be able to complete relevant documentation (e.g. an Electrical Installation Certificate and relating schedules (up to a 100 A supply).

This unit build upon the learner's knowledge of the fundamental inspections and de-energised testing methods and requirements for single-phase circuits.

Learning outcome:**1. Understand the requirements for inspection and testing****Criteria**

- 1.1 The requirements of the Electricity at Work Regulations for the safe inspection of electrical systems and equipment
- 1.2 The health and safety requirements which apply when inspecting, testing and commissioning electrical installations and circuits
- 1.3 The safe isolation procedure
- 1.4 The industry practices and organisational procedures to ensure the coordination of site services and the activities of others who may be affected by the inspection and testing
- 1.5 The purpose and requirements of the initial verification of electrical installations
- 1.6 The relevant documents associated with the inspection, testing and commissioning of an electrical installation
- 1.7 The information that is required by the inspector to conduct the initial verification of an electrical installation

Learning outcome:**2. Understand the methods and procedures for conducting an inspection of electrical installations prior to their being placed into service****Criteria**

- 2.1 The appropriate items to be checked during the inspection process
- 2.2 The application of the human senses for initial verification
- 2.3 The requirements for the inspection of electrical installations
- 2.4 The requirements for the inspection to include:
 - special installations and locations as identified in Part 7 of BS 7671
 - IP Classification of equipment

Learning outcome:**3. Understand the methods and processes to carry out correctly the tests that ensure safe and efficient operation of the electrical system****Criteria**

- 3.1 The tests to be carried out on an electrical installation in accordance with the BS 7671 and IET Guidance Note 3
- 3.2 The appropriate instrument for each test to be carried out in terms of the instrument is fit for purpose and identifying the correct scale or setting
- 3.3 The requirements for the safe use of instruments to be used for testing and commissioning
- 3.4 The necessity for test results to comply with standard values and the actions to be taken in the event of unsatisfactory results being obtained
- 3.5 The reason why testing is carried out in the sequence specified in BS 7671 and IET Guidance Note 3
- 3.6 The requirements for testing before circuits are energised
- 3.7 The requirements for testing energised installations

Learning outcome:**4. Understand the requirements for the completion of electrical installation certificates, associated documentation and handover****Criteria**

- 4.1 The procedures for:
 - completion of the relevant documentation
 - recording relevant data and information
 - informing relevant people
 - addressing issues and problems identified
 - ensuring information is passed to the relevant people
- 4.2 How to ensure that the electrical system and equipment is ready for hand over to the customer/client
- 4.3 The organisational procedures for:
 - notifying relevant people of any variations
 - obtaining customer/client acceptance of the electrical system and equipment
 - the completion of all relevant documentation
 - recording of information and/or data in the appropriate information systems

Delivery outcomes (depth of content)

The emphasis in this unit is on initial verification of electrical installations; however, learners will gain knowledge complementary to periodic inspection and testing (e.g. in selecting and using test equipment). Note that this unit re-enforces safety aspects covered in Unit 306E.

1

Learners will understand safe working and working in accordance with risk assessments, permits to work and method statements. The safe use of tools and equipment, safe and correct use of test instruments, the use of PPE and the reporting of unsafe situations (refer to the general requirements given in IET Guidance Note 3). Learners will recognise the danger associated with a diverted neutral current and be able to describe and carry out the safety check procedure to detect possible diverted neutral currents. They will know what should be done if detected.

Learners will understand safe isolation: the requirements of the Electricity at Work Regulations for the safe inspection of electrical systems and equipment. This will include the safety of: those carrying out the work and those using the premises during the inspection. (Refer to the relevant parts of the Electricity at Work Regulations 1989, and the Memorandum of guidance on the Electricity at Work Regulations 1989 (HSR25)). The safe isolation procedure: identification of circuit(s) to be isolated, identifying suitable points of isolation, selecting correct test and proving instruments in accordance with relevant industry guidance and standards (GS 38). The selection of locking devices for securing isolation, use of warning notices, and the appropriate sequence for isolating circuits. Learners will understand the dangers of prosumers electrical installations (PEIs) due to multiple supplies.

Learners will understand the implications of safe isolation. To cover how this relates to the safety of the inspector, other personnel, customers/clients, and the public etc. The effects on the building's systems/circuits/electrical equipment due to the removal of the supply. (Reiterate the implications of not carrying out safe isolation). Learners will understand the implication of not using approved test equipment during safe isolation and that extra low voltage might not be detected. Learners will understand that 50 mA can be potentially lethal, and that safe isolation is carried out so that the point of isolation is always under the control of the appointed person.

Learners will understand the purpose and requirements for initial verification of electrical installations (refer to BS 7671 and IET Guidance Note 3 (General requirements)) and refer to the relevant information given in the chapter for initial verification, Section 511 - compliance with standards). Learners will appreciate the relevant documents associated with the inspection, testing and commissioning of an electrical installation: Electricity at Work Regulations, BS 7671, and IET Guidance Note 3, and HSE Guidance. The

information that is required by the inspector to conduct the initial verification of an electrical installation: BS 7671 and IET Guidance Note 3.

(Refer to the relevant information given in the chapter for initial verification, Section 131, The general characteristics required by Sections 311 to 313, Information required by Regulation 514.9.1 (diagrams, charts, circuit schedules).

2

Learners will be able to identify the appropriate items to be checked during the inspection process for given situations and installations (recap on the application of the human senses appropriate for initial verification and how they are applied). The requirements for the inspection of electrical installations to the current edition of BS 7671 and the relevant information for initial verification. Learners will understand how to inspect typical examples of electrical installations and equipment.

Learners will understand the requirements for the inspection, e.g. earthing conductors, earth electrodes, circuit protective conductors, main and supplementary protective bonding conductors, devices for isolation and switching, type and rating of overcurrent protective devices, type and rating of RCDs and RCBOs, barriers and enclosures, containment systems (steel and plastic), cables, conductors and terminations, electrical accessories. Refer to the complete list of items in BS 7671 and GN3.

Learners will understand the requirements for the inspection of special installations and locations as identified in Part 7 of BS 7671 and IP Classification of equipment. Ensure appropriate coverage of the degrees of protection offered by electrical equipment enclosures and the requirements for given locations and environments (IP Code) BS EN 60529. Delivery of this aspect can also be linked to the requirements for barriers and enclosures during the inspection process.

3

Learners will understand the requirements for the safe use of instruments to be used for testing and commissioning, to include the checks required to prove that test instruments are safe and functioning correctly. The requirements for test leads and probes to comply with HSE Guidance GS 38. The need for instruments to be regularly checked and calibrated.

Learners will understand the requirements for the safe testing and commissioning of electrical installations. The tests to be carried out on an electrical installation in accordance with the BS 7671 and IET Guidance Note 3. The appropriate instrument for each test to be carried out and identifying the correct scale or setting. Why it is necessary for test results to comply with standard values (for safety, and correct function). Understanding that the inspector will need to confirm the results with the installation design criteria and/or BS 7671 as appropriate. The actions to be taken in the event of unsatisfactory results being obtained. And that testing is carried out in the sequence specified in BS 7671 and IET Guidance Note 3 (principally for safety).

Learners will understand the requirements for testing before circuits are energised (complex aspects to develop upon Unit 306E) covering the factors that affect resistance values, interpretation of results from a ring final circuit test, IR testing on three-phase circuits and polarity testing on three-phase circuits. Following the requirements of BS 7671 and IET Guidance Note 3.

Learners will understand the requirements for testing energised installations covering: the procedures for confirming polarity of the incoming supply. The methods for measuring earth electrode resistance to include installations forming part of a TT system and generators and transformers. Earth fault loop paths and the methods for verifying protection by automatic disconnection of supply. The measurement of the external earth fault loop impedance (Z_e) and the system earth fault loop impedance (Z_s). Establishing Z_e by enquiry, calculation of the value of Z_s from given information, comparing measured Z_s values with the maximum tabulated figures as specified in BS 7671 including the application of the correction factor.

Learners will understand the requirements and methods for the measurement of prospective fault current for single and three-phase installations (calculation, measurement, and enquiry). The suitability of protective devices for prospective fault currents. The methods for testing the correct operation of RCDs. The reasons for and methods of verifying phase sequence. The need for functional testing and the items which require functional tests.

4

Learners will understand the appropriate procedures for dealing with clients during the commissioning and certification process. Ensuring the safety of others during the work activities and the importance of keeping clients informed during the process. Labelling electrical circuits, systems and equipment that are still to be commissioned and providing clients with all the appropriate documentation upon work completion. The purposes of certification and associated documentation, the information that must be contained on initial verification documentation and the certification process for a completed installation. The responsibilities of different relevant personnel in relation to the completion of the certification process. The requirements for the recording and retention of completed initial verification documentation in accordance with BS 7671.

(Refer to the model forms provided in BS 7671 and Guidance Note 3, and the notes on the reversal of the model forms. The date for the first periodic inspection and test is required to be considered and recommended by the original installation designer as part of their design).

Performance Criteria

Learning outcome:

1. Carry out safe isolation procedures in accordance with regulatory requirements for electrical installations

Learning outcome:

2. Ensure the health and safety of themselves and others within the work location during inspection, testing and commissioning

Learning outcome:

3. Check the safety of electrical systems prior to the commencement of inspection, testing and commissioning

Learning outcome:

4. Assess whether the safe system of work is appropriate to the work activity

Learning outcome:

5. Carry out a visual inspection in accordance with the requirements of the installation specification, BS 7671 and IET Guidance Note 3

Learning outcome:

6. Complete a schedule of inspections in accordance with BS 7671 and IET Guidance Note 3 making technical decisions

Learning outcome:

7. Select the correct test instruments and their accessories for tests

Learning outcome:

8. Carry out tests in accordance with the installation specification and BS 7671 and manufacturer's instructions:
 - continuity
 - insulation resistance
 - polarity
 - earth fault loop impedance/earth electrode
 - prospective fault current
 - RCD operation
 - functional testing

Learning outcome:

9. Analyse and verify test results reporting all findings to relevant persons, as appropriate: Cover One: (cover one item twice or both items once)
- representatives of other services/colleagues
 - customers/clients

Learning outcome:

10. Complete in accordance with BS 7671 and IET Guidance Note 3:
- an Electrical Installation Certificate (with related schedules)
 - a Minor Electrical Installation Works Certificate

Learning outcome:

11. Complete the handover of electrical systems and equipment to relevant persons including the provision of accurate and complete documentation regarding the completed inspection, testing, commissioning and customer satisfaction

Learning outcome:

12. Demonstrate to the customer/client that the operation of the circuits, equipment and components are in accordance with the installation specification and customer/client requirements

Unit 318E: Identify and Rectify Faults in Electrical Systems and Equipment

GLH: 47

What is this unit about?

This unit covers the understanding and performance requirements for the diagnosis and rectification of faults in electrical systems and equipment.

The learner must be able to carry out the processes and procedures for the identification and rectification of faults in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working environment and the natural environment. Learners must understand and apply the correct methods and procedures when identifying and rectifying faults in electrical systems and equipment.

Learners will develop their knowledge understanding and skills of:

- the identification and use of the correct instruments
- how to identify and locate faults
- how to rectify the faults that are identified, located and diagnosed
- the completion of the relevant documentation
- the recording of relevant data and information.

Learners **must** work safely in accordance with the Health and Safety at Work etc. Act and the Electricity at Work Regulations

Learners may be introduced to this unit by asking themselves questions such as:

- What are the safe working procedures to be followed when carrying out fault diagnosis?
- What methods are used to diagnose and locate faults?

Guidance: Within this unit learners will follow the requirements of BS 7671, and IET Guidance.

Learning outcome

1 Understand the health and safety requirements relevant to fault diagnosis.

Criteria

- 1.1 The dangers of electricity in relation to fault diagnosis work
- 1.2 The health and safety requirements relevant to diagnosing and correcting electrical faults in electrical systems and equipment
- 1.3 The safe working procedures that should be adopted for completion of fault diagnosis and correction work

Learning outcome

2 Understand the importance of reporting and communication in fault diagnosis

Criteria

- 2.1 How to obtain clear and detailed information about the reported fault(s) and any components which need to be replaced from:
 - relevant sources of information
 - relevant documentation
- 2.2 The organisational procedures and industry practices when carrying out the processes for the identification and rectification of faults for:
 - advising the relevant people about the potential disruption and consequences
 - confirming a programme of work with the relevant people
 - ensuring the coordination of site services and the activities of other trades affected

Learning outcome

3. Understand the nature and characteristics of electrical faults

Criteria

- 3.1 The different types and causes and consequences of electrical faults
- 3.2 Typical types of faults and their likely locations in wiring systems and equipment

Learning outcome

4 Understand the fault diagnosis procedure

Criteria

- 4.1 The precautions that must be taken when carrying out fault diagnosis regarding particular locations, equipment and circumstances
- 4.2 The logical stages of fault diagnosis
- 4.3 How to select the instruments to be used and confirming that the instruments are fit for purpose and have a current calibration certificate
- 4.4 The techniques to identify, locate, diagnose and rectify faults

5. Understand the procedures and techniques for correcting electrical faults

Criteria

- 5.1 Typical factors which can affect repair or replacement of equipment
- 5.2 How to repair, remove and replace in accordance with industry practices:
 - electrical cables, conductors and/or the wiring system
 - equipment, accessories, and components
- 5.3 The methods and processes to inspect and test, as appropriate and in accordance with industry practices, repaired and/or replaced:
 - electrical cables, conductors and/or the wiring system
 - equipment, accessories, and components
- 5.4 How to ensure, if the fault(s) cannot be corrected immediately, the safety of the relevant:
 - electrical cables, conductors and/or the wiring system
 - equipment, accessories, and components
- 5.5 The methods to ensure the safe disposal of any waste and that the work area is left in a safe and clean condition
- 5.6 How to provide clear and accurate information to relevant people about the electrical system and equipment in terms of:
 - hand over to the customer/client
 - any variations to the original system and/or its equipment
 - customer/client acceptance of the completed work in accordance with organisational procedures
 - relevant documentation being completed and recorded in the appropriate information systems in accordance with organisational procedures

Delivery outcomes (depth of content)

1

Learners will understand the health and safety requirements relevant to fault diagnosis. The important safe working procedures that should be followed when working around electrical energy (such as the mandatory importance of complying with the Electricity at Work Regulations in particular regulation 14). Health and safety requirements include:

- working in accordance with risk assessments / permits to work/method statements
- safe use of tools and equipment
- safe and correct use of measuring instruments
- provision and use of PPE
- reporting of unsafe situations
- safe working procedures
- effective communication with others. i.e. people on the premises, customers etc.
- use of barriers
- positioning of notices
- safe isolation
- use of equipment to GS 38.

2

Learners will understand the documentation and information relevant to fault diagnosis, such as: BS 7671, certificates/reports, installation specifications, drawings/diagrams, manufacturers' information and operating instructions, maintenance records. Manufacturers data and previous test results can be used to track deterioration and assess the effectiveness of maintenance checks. Speaking to the customer/client in relation to understanding the characteristics and nature of the fault.

3

Learners will be able to identify types, causes and consequences of electrical faults such as:

- loss of supply
- low voltage/voltage drop
- component/equipment malfunction/failure
- operation of overload or fault current devices
- arcing - loose connection
- high resistance - e.g. loose connection etc.
- transient voltages - lightning strike
- excess current - overload
- insulation failure - deterioration, mechanical damage
- short circuit, open circuit and earth fault
- signal faults
- Inherent faults – faults that occur through poor design and incorrect termination (cross connections).

Learners will understand the typical types of faults and their likely locations in wiring systems and equipment. Locations in wiring systems, terminations and connections, equipment/accessories (switches, luminaires, switchgear and control equipment), instrumentation/metering.

4

Learners will understand the precautions that must be taken when carrying out fault diagnosis with regard to particular locations, equipment and circumstances such as: lone working, hazardous areas, fibre optic cabling, electro-static discharge (friction, induction, separation), electronic devices (damage by over voltage), IT equipment (e.g. shutdown, damage), high frequency or capacitive circuits, presence of batteries (e.g. lead acid cells, connecting cells), additional sources of energy (e.g. solar panels, UPS); time-controlled devices (e.g. time-controlled circuits).

Learners will understand the appropriate and logical procedures for carrying out fault diagnosis tests such as six-point, half-split, input to output, cause and effect, and substitution of parts. Learners will understand how to analyse and determine if the test results are acceptable, the dangers of electricity in relation to fault diagnosis work, and the health and safety requirements relevant to diagnosing and correcting electrical faults in electrical systems and equipment.

Learners will understand the logical stages of fault diagnosis. Identification of symptoms, collection, and analysis of data, use of sources/types of information, checking and testing (e.g. supply, protective devices), interpreting results/information, fault correction, functional testing, and restoration.

Learners will understand the resources required for fault diagnosis. The appropriate test instrument/s for fault diagnosis work include/s: voltage indicator, low resistance ohm meter, insulation resistance testers, EFZ and PFC tester, RCD tester, tong tester/clamp on ammeter, phase sequence tester. Learners will understand how test instruments are confirmed to be fit for purpose and functioning correctly.

5

Learners will understand the implications of the fault diagnosis for customers and clients and the communication requirements relevant to fault diagnosis. The implications of fault diagnosis through loss of circuits and equipment use. The communication requirements such as informing relevant persons about information on electrical fault diagnosis and correction work. Why it is important to provide relevant persons with information on fault diagnosis and correction work clearly, courteously, and accurately. Why relevant people need to be kept informed during completion of fault correction work (other workers/colleagues, customers/clients, and representatives of other services).

Learners will understand the factors which can affect the repair or replacement of equipment. Such as: cost, availability of replacement parts, resources and staff, down time

(planning), legal and personal responsibility (e.g. contracts, warranties, relevant personnel), gaining access to systems and equipment, provision of emergency or stand by supplies, and client demand (continuous supply, out of hours working).

Learners will understand the procedures for verifying that the fault has been corrected using technical analysis such as: functional testing/checking and testing. Following the methods to ensure the safe disposal of any waste, that the work area is left in a safe and clean condition and providing clear and accurate information to relevant people about the fault and subsequent outcomes.

Performance Criteria

Learning outcome:

1. Check it is safe to carry out fault diagnosis

Learning outcome:

2. Inform the relevant personnel of the fault diagnosis work (such as personnel on the premises, users of electrical equipment)

Learning outcome:

3. Carry out the safe isolation procedure

Learning outcome:

4. Evaluate and apply appropriate methods to ensure the safety of themselves and others when diagnosing and correcting electrical faults

Learning outcome:

5. Communicate effectively with relevant personnel (e.g. customer, premises manager) to ascertain the nature of the fault

Learning outcome:

6. Select and interpret appropriate documents (e.g. lay-out drawings, schematic diagrams etc) which relate to the electrical systems and equipment being worked upon

Learning outcome:

7. Assess and communicate potential disruption that may be a consequence of fault diagnosis and correction work to relevant people (such as other workers/colleagues, customers/clients)

Learning outcome:

8. Carry out relevant inspections of electrical equipment, analysing findings

Learning outcome:

9. Confirm test instruments are fit for purpose, functioning correctly and correctly calibrated

Learning outcome:

10. Perform suitable diagnostic tests, based on engineering decision, to identify electrical faults: Cover Three:

- loss of supply
- overload
- short circuit
- earth fault
- incorrect phase rotation
- high resistance joints/loose terminations
- component, accessory, or equipment faults
- open circuit
- signal faults

Learning outcome:

11. Use appropriate methods for locating faults including:

- using a logical approach
- using safe working practices
- interpretation of test readings

Learning outcome:

12. Use appropriate instruments correctly to carry out fault diagnosis: Cover Three:

- voltage indicator
- low resistance ohm meter
- insulation resistance tester
- EFLI and PFC tester
- RCD tester
- ammeter
- phase rotation tester
- other appropriate instrument

Learning outcome:

13. Assess the appropriate repairs, removals and replacements and their implications with relevant people. Cover One: (cover one item twice or both items once)

- other workers/colleagues
- customers/clients

Learning outcome:

14. Perform fault correction procedures correctly and safely using appropriate tools, equipment and material

Learning outcome:

15. Assess and verify that replacement components and associated equipment maintain:

- ease of access to enable future maintenance
- compliance with relevant regulations
- compliance with manufacturer's instructions/ organisational procedures

Learning outcome:

16. Apply appropriate procedures to ensure electrical equipment and components are left safe, in accordance with industry regulations, if the fault cannot be corrected immediately based on technical assessment

Learning outcome:

17. Establish and perform an appropriate inspection and testing procedure to confirm that circuits/equipment/ components are functioning correctly after completion of fault correction work

Learning outcome:

18. Record test results and other appropriate information regarding the fault correction work clearly and accurately and report it to relevant people: Cover One: (cover one item twice or two different items once)

- other workers/colleagues
- customers/clients
- representatives of other services

Unit 319E: Understand Advanced Electrical Science and Principles

GLH: 100

What is this unit about?

This unit is designed to enable learners to understand the relationship between electrical scientific principles and the competencies required of a qualified electrical operative. Its content covers the knowledge and understanding required to underpin the application of skills in the installation of electrical systems and equipment.

Learners will develop their knowledge understanding of:

- renewable and other sources of electricity
- the properties of electrical circuits and components
- the operating principles and applications of D.C. machines and A.C. motors
- the principles and applications of electrical lighting systems
- the principles and applications of electrical heating
- the types, applications and limitations of electronic components in electrical systems and equipment.

Learners may be introduced to this unit by asking themselves questions such as:

- What are the renewable sources of electricity relevant to my trade?
- What is the application of transformers and electrical motors?
- What are the types of luminaires that I may install?
- What are the types of electrical heating that I may work with?
- What are the types of electronic components used in electrical systems?

Learning outcome:**1. Understand renewable and other sources of electricity****Criteria**

1.1 The basic operating principles of renewable sources of electricity

Range: solar power (thermal and photovoltaic), wind energy, wave energy, micro-hydro

1.2 The basic operating principles of combined heat and power (CHP) including micro-CHP

1.3 The basic operating principles of other sources of electricity

Range: batteries, cells, UPS systems

1.4 Smart metering

Range: the advantages and limitations of electricity smart meters

Learning outcome:**2. Understand the properties of electrical circuits and components****Criteria**

2.1 The appropriate mathematical principles which are relevant to electrical work tasks

Range: statistics, the trigonometry of right-angled triangles, Pythagorean theorem

2.2 Quantities relevant to electrical work

Range: impedance, inductance, inductive reactance, capacitance, capacitive reactance, power factor

2.3 The relationship between resistance, inductance, capacitance, and impedance

2.4 Calculation of electrical quantities in alternating current circuits

Range: resistance, inductance, inductive reactance, capacitance, capacitive reactance, and impedance

2.5 Operating principles of electro-mechanical components

Range: contactors, relays, and solenoids

2.6 Types of transformers

2.7 The operating principles, applications and limitations of transformers

Range: iron loss, copper loss, relationship between current and voltage, primary and secondary windings, step-up and step-down transformers, primary and secondary voltages, primary and secondary current, kVA rating

2.8 The relationship between kW, kVA_r, kVA and power factor

2.9 Power factor improvement

2.10 Voltage and current in star and delta connected systems

2.11 Advantages of balanced star connected systems

2.12 The neutral current in a three-phase star connected system

Learning outcome:

3. Understand the operating principles and applications of D.C. machines and A.C. motors

Criteria

3.1 The basic types, applications and describe the operating principles of D.C machines

3.2 The operating principles of A.C motors

3.3 State the basic types, applications, and limitations of A.C motors

3.4 The basic operating principles, limitations, and applications of motor control

Learning outcome:

4. Understand the principles and applications of electrical lighting systems

Criteria

4.1 The basic principles and applications of illumination

4.2 The operating principles, types, limitations, and applications of luminaires

Learning outcome:

5. Understand the principles and applications of electrical heating

Criteria

5.1 The basic principles of electrical space heating and electrical water heating

5.2 The operating principles, types, limitations and applications of electrical space and water heating appliances and components

Learning outcome:

6. Know the types, applications, and limitations of electronic components in electrical systems and equipment

Criteria

6.1 The basic operating principles of electronic components and devices

Range: capacitors, resistors, rectifiers, diodes (including Zener, LED and photo); thermistors, diacs, triacs, transistors, thyristors, invertors

6.2 The function and application of electronic components that are used in electrical systems

Range: security alarms, telephones, dimmer switches, heating/boiler controls, motor control, wireless control systems, solar PV systems

Delivery outcomes (depth of content)

1

Learners will understand the main operating principles and characteristics of renewable electrical supplies. Learners will understand the benefits of micro-generation being:

- cutting carbon dioxide emissions
- does not deplete the earth's resources and is a clean fuel
- delivering energy to off the grid locations
- security of supply
- overall energy costs can be vastly reduced
- energy generation efficiency is improved as more than 90% of the fuel is converted to energy, as opposed to traditional power stations which can waste over half of the fuel in transportation before it even reaches the consumer
- less likely to be affected by energy price fluctuations
- combats climate change
- employment opportunities will be created as the industry grows
- promotes energy diversity in a competitive market.

Learners will understand how electricity is generated by reusing heat (CHP and micro-CHP).

Learners will understand the operating principles of batteries and cells, and how energy can be stored – including home storage systems. Capacity and amp-hour calculation. Primary and secondary batteries. Cell types. Storage of batteries. Charging (and overcharging) of batteries. Self-discharge.

Learners will have an understanding of an Uninterruptable Power Supply (UPS). The operation and typical applications of a UPS.

Learners will have an understanding of the advantages and limitations of electricity smart meters such as: no need to submit meter readings, accurate bills, raises awareness of energy consumption, and a selection of good tariffs available. Limitations being the first-generation smart meter can become dumb if switching supplier, inaccurate display, and signal problems. The issues due to micro generation and smart metering (however the technology and infrastructure is constantly improving).

2

Learners will understand the trigonometry of right-angled triangles and Pythagorean theorem to enable them to carry out applicable calculations in this unit. Learners will be able to utilise basic statistics.

Learners will understand alternating current quantities and relating components (inductors capacitors and resistors) and the relationship between alternating current quantities (and resistance). The action of these components in alternating current circuits.

Learners will be able to construct phasor diagrams and understand the resistance, power and voltage triangle. Learners will be able to calculate inductance, capacitance, impedance, inductive reactance and inductive capacitance. Learners will be able to calculate power quantities in single and three-phase circuits (kVA, kVAr, and kW). Learners will understand R,L,C circuits and their relevance to electrical installations. Learners will understand power factor and power factor improvement. Learners will be able to determine the value of capacitance required to improve power factor to a given value. The calculation of power factor and the methods of power factor correction.

Learners will understand the operating principles of electro-mechanical components. Learners will be able to describe the action of these components and how they are applied for circuit control. Learners will recognise relays, solenoids and types of contacts (N/O and N/C). (Explored further in the next learning outcome).

Learners will appreciate the kVA rating of a transformer. The limitations of transformers and the types of losses in transformers. Learners will understand the operating principles of transformers including step-up and step-down and isolating transformers. The primary and secondary windings, and the relationship between current and voltage. Learners will be able to determine by calculation the primary and secondary voltages, primary and secondary current, and primary and secondary turns, and the turns ratio. Learners will be able to identify transformer types such as: potential transformer, current transformer and isolating transformer, and auto transformer.

Learners will be able to calculate values of voltage and current in star and delta connected systems, and will recognise the advantages of having balanced star connected systems. Learners will be able to determine using a phasor diagram, the value of neutral current in an unbalanced star connected system. They will gain a fundamental knowledge of harmonic currents and their implications to electrical installations.

3

Learners will understand the operating principles and applications of D.C machines: series, shunt and compound.

A.C motors will cover:

- single-phase: induction, capacitor start, split phase, universal synchronous
- three-phase: induction and wound rotor.

Learners will be able to recognise and draw simple circuit diagrams to show the arrangements of the motor and their key components. Learners will be able to perform calculations in relation to D.C machines and A.C Motors.

Learners will understand some of the common techniques used to control motors: direct-on-line, star-delta, rotor-resistance, soft-start, variable frequency. Learners will understand motor control operating principles applications and limitations.

4

Learners will be able to perform lighting calculations: inverse square law, cosine law and the lumen method.

Learners will understand the operating principles, limitations and applications of different types of luminaires:

General Lighting Service (GLS):

- tungsten
- halogen.

discharge lighting:

- low- and high-pressure mercury vapour
- low- and high-pressure sodium vapour
- metal halide.

Energy saving:

- compact fluorescent lamps
- LED.

Learners will also gain an appreciation of lighting protocols such as Digital Addressable Lighting Interface (DALI).

5

Learners will understand the basic principles of electrical space heating and electrical water heating covering convection cycle conduction and radiation.

Learners will understand the following appliances and components: immersion heaters, storage heaters, convector heaters, under floor heating, controls, timers and programmers for heating systems (S plan, Y plan, S plan plus).

6

For this outcome learners will be able to identify the electronic components and devices listed, both from circuit symbols and physical appearance. Learners will understand the basic operating principles of these electronic components and devices. Learners will know the markings and colour-coding of components/devices, including where relevant their polarity, and appreciate the safety considerations from potential latent energy stored in capacitors.

Learners will then be able to recognise how these electronic components and devices are utilised within electrical systems.

