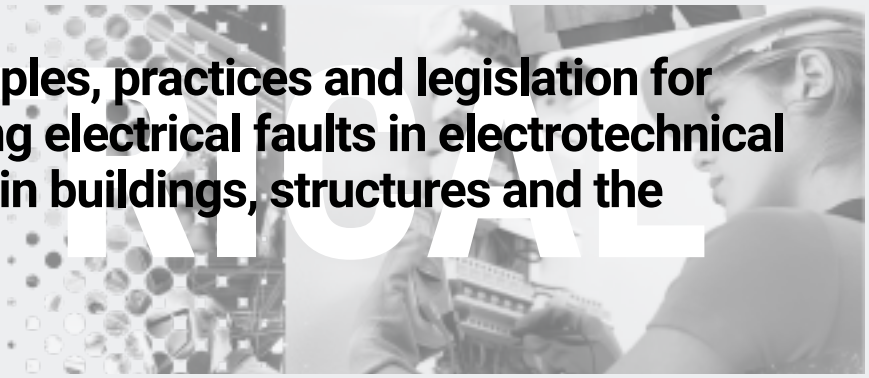
Delivery Unit

Level 3

Understanding the principles, practices and legislation for diagnosing and correcting electrical faults in electrotechnical systems and equipment in buildings, structures and the environment



Unit Code: QELTK3-007

58 GLH

Delivery Unit

Unit Aim

This Knowledge Unit aims to provide learners with the knowledge and understanding of the principles, practices and legislation associated with diagnosing and correcting electrical faults in electrotechnical systems and equipment in buildings, structures and the environment in accordance with statutory and non-statutory regulations and requirements. Its content is the knowledge needed by a learner to underpin the application of skills used for fault diagnosis and correction in electrotechnical systems and equipment in buildings, structures and the environment.

NOTE: Given the safety-critical nature of this topic it is a requirement that learners will have their knowledge consolidated by the use of "Practical Support Learning" activity in simulated conditions.

Summary of Learning Outcomes

The learner will:

1. Understand the principles, regulatory requirements and procedures for completing the safe isolation of electrical circuits and complete electrical installations.
2. Understand how to complete the reporting and recording of electrical fault diagnosis and correction work.
3. Understand how to complete the preparatory work prior to fault diagnosis and correction work.
4. Understand the procedures and techniques for diagnosing electrical faults.
5. Understand the procedures and techniques for correcting electrical faults.

Assessment

See Section 6 of the Qualification Manual for details of the assessment.

Guidance

The following normative documents are recommended in support of the delivery process:

- BS 7671
- IET On-site Guide
- IET Guidance Note 3
- Electricity at Work Regulations
- BS EN Graphical Symbols
- Building Regulations.

Delivery advice has been given adjacent to the assessment criteria.

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
1. Understand the principles, regulatory requirements and procedures for completing the safe isolation of electrical circuits and complete electrical installations.	**1.1 Specify and undertake the correct procedure for completing the safe isolation of an electrical circuit with regard to:** • **Assessment of safe working practices** • **Correct identification of circuits to be isolated** • **The selection of suitable points of isolation** • **The selection of correct test and proving instruments in accordance with relevant industry guidance and standards** • **The use of correct testing methods** • **The selection of locking devices for securing isolation** • **The use of correct warning notices** • **The correct sequence for isolating circuits.**	Introduce and explain the principles and actions for completing pre work surveys and pre work tests prior to completion of electrical work activities. Outline the requirements for isolating: complete electrical installations; individual electrical circuits and items of fixed equipment. Outline the types of equipment required for completion of safe isolation work activities and explain the industry guidance for the selection of appropriate testing and proving instruments (requirements of GS38). Outline and demonstrate the correct procedures for completing the safe isolation of electrical installations, circuits and fixed items of electrical equipment. Discuss the methods for safely 'securing' the isolation of electrical installations, circuits and fixed items of electrical equipment. State the requirements for using warning notices appropriately and explain why this is important. Summarise the full procedure for completing the safe isolation of electrical installations, circuits and fixed items of electrical equipment. Refer to Electrical Safety First's guide).
	1.2 State the implications of carrying out safe isolations to: • **Other personnel** • **Customers/clients** • **Public** • **Building systems (loss of supply).**	Discuss how completing safe isolation of electrical installations, circuits and items of fixed electrical equipment can affect those listed in 1.2. Outline procedures for passing on information on isolated electrical circuits to others.
	1.3 State the implications of not carrying out safe isolations to: • **Self** • **Other personnel** • **Customers/clients** • **Public** • **Building systems (Presence of supply).**	Discuss the implications of not completing safe isolations for those listed at 1.3 Explain what may happen to people, property and equipment if electrical installations/ circuits are not correctly isolated.

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
1. Understand the principles, regulatory requirements and procedures for completing the safe isolation of electrical circuits and complete electrical installations.	**1.4 Identify all Health and Safety requirements which apply when diagnosing and correcting electrical faults in electrotechnical systems and equipment including those which cover:** • **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.**	Re-cap the health and safety requirements listed in 1.5 from what is covered in QELTK3/001 and QELTK3/003. Discuss the requirements of the bullet points at 1.5 specifically in the context of fault diagnosis and rectification work activities.
2. Understand how to complete the reporting and recording of electrical fault diagnosis and correction work.	**2.1 State the procedures for reporting and recording information on electrical fault diagnosis and correction work.**	Link to QELTK3/003. Discuss the general considerations for completing electrical fault diagnosis and correction work - explain why elements of the process require reporting/ recording. Explain the procedure for reporting the findings of fault diagnosis work so that this can inform fault correction work (i.e. whether to replace or repair). Identify appropriate persons who it may be necessary to inform on the progress/ implications of fault diagnosis and correction work. Discuss the types of information that it may be necessary to pass on to relevant persons, including: job sheets/reports, maintenance schedules, periodic inspection reports etc.
	2.2 State the procedures for informing relevant persons about information on electrical fault diagnosis and correction work and the completion of relevant documentation.	
	2.3 Explain why it is important to provide relevant persons with information on fault diagnosis and correction work clearly, courteously and accurately.	Link to QELTK3/003. Re-cap the principles and procedures for providing technical and functional information clearly, courteously and accurately. Discuss the importance of ensuring information on fault diagnosis is as accurate as possible so that it can be used to inform fault correction strategies (i.e. repair or replacement/ total or partial system shut-down etc).

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
3. Understand how to complete the preparatory work prior to fault diagnosis and correction work.	**3.1 Specify safe working procedures that should be adopted for completion of fault diagnosis and correction work, including:** • **Effective communication with others in the work area** • **Use of barriers** • **Positioning of notices** • **Safe isolation.**	Discuss the steps that should be taken to ensure that fault diagnosis and correction work can be completed safely. Explain why it is important to liaise closely with others (systems users, other trades-persons etc.) before, during and after completion of work activities. Describe the procedure for securing the work area once safe isolation has been achieved and ensuring that the electrical supply remains 'locked off'.
	3.2 Interpret and apply the logical stages of fault diagnosis and correction work that should be followed: • **Identification of symptoms** • **Collection and analysis of data** • **Use of sources/types of information such as the IET Wiring Regulations, installation certificates, installation specifications, drawings/diagrams, manufacturer's information and operating instructions** • **Maintenance records** • **Experience (personal and of others)** • **Checking and testing (e.g. supply, protective devices)** • **Interpreting results/information** • **Fault correction** • **Functional testing** • **Restoration.**	Explain the basic principles and key information on electrical systems which forms a basis for fault diagnosis and correction work, including: • Knowledge about the type of systems to be worked on (i.e. voltage (230V AC single phase/400V AC three phase); Installation type (domestic/commercial/industrial); System type (power/lighting, fire alarm, security, heating etc). • Knowledge from own experience and that of system users. Run through the logical sequence of fault diagnosis and focus on the elements covered in 3.2. Discuss the different sources of information that can help to inform fault diagnosis work - learners to produce a list (should contain the following): • Operating manuals • Wiring and connection diagrams • Manufacturers product data/information • Maintenance records • Inspection and test results • Installation specifications • Drawings • Design data • Site diaries.

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
3. Understand how to complete the preparatory work prior to fault diagnosis and correction work.	**3.3 Identify and describe common symptoms of electrical faults, including:** • **Loss of supply** • **Low voltage** • **Operation of overload or fault current devices** • **Component/equipment malfunction/ failure** • **Arcing.**	Explain that fault finding procedures/ methods are always adapting and changing to take account of new technology changes. Summarise each of the symptoms listed at 3.3 and explain their characteristics e.g. complete loss of supply at origin would suggest a fault with supply company equipment/components etc.
	3.4 State the causes of the following types of fault; • **High resistance** • **Transient voltages** • **Insulation failure** • **Excess current** • **Short-circuit** • **Open Circuit.**	Discuss the likely possible causes of the faults listed at 3.4. Discuss the types of faults that may be expected at the locations listed in 3.5. Explain the types of faults associated with wiring systems, including: problems associated with cable interconnections (joint boxes, extensions, replaced wiring etc). Explain the types of faults associated with terminations and connections, including: poor terminations (those under mechanical stress, strands not fully engaged in terminal, problems with seals, glands, entries etc). Discuss the types of faults associated with equipment/accessories, including: switches, control equipment, contactors, electronic and solid state devices. Discuss the types of faults associated with instrumentation, luminaires, protective devices and flexible cords/ flexes.
	3.5 Specify the types of faults and their likely locations in: • **Wiring Systems** • **Terminations and connections** • **Equipment/accessories (switches, luminaires, switchgear and control equipment)** • **Instrumentation/metering.**	

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
3. Understand how to complete the preparatory work prior to fault diagnosis and correction work.	**3.6 State the special precautions that should be taken with regard to the following:** • **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).**	Discuss the specific precautions that need to be observed for the items at 3.6, elements to cover should include: • Lone working – procedures to follow in case of emergency • Hazardous areas – appropriate PPE, and equipment (Atex requirements etc.) • Fibre-optic cabling – dangers associated with – do not look into FO cable strands • Electro-static discharge – causes of (i.e. friction, induction, separation) handling electro static sensitive items in designated areas only • Electronic devices – danger caused by over voltage, specifically during I&T – usual to disconnect devices before testing. • IT equipment – awareness of not switching off circuits which serve IT systems, and of UPS systems, high frequency or capacitive circuits – usual on long runs of MICC, requirements for discharging capacitive effect (fully qualified electricians only). Presence of batteries – potentially dangerous materials (lead acid cells); potential for arcing across terminals; use in UPS back ups.
4. Understand the procedures and techniques for diagnosing electrical faults.	**4.1 State the dangers of electricity in relation to the nature of fault diagnosis work.**	Re-cap the requirements for working safely and following safe systems of work during fault diagnosis and correction work activities. Discuss the potential dangers of electricity if safe isolation procedures and safe systems of work are not adhered to. Discuss the methods for identifying single phase supply systems (230 V) and multiphase supply systems (400 V). Discuss the requirements of GS 38 in terms of the selection of equipment listed at 4.3. Discuss the circumstances in which the instruments listed in 4.3 may be required for fault diagnosis and correction activities.
	4.2 Describe how to identify supply voltages.	
	4.3 Select the correct test instruments (in accordance with HSE guidance document GS 38) for fault diagnosis work, including: • **Voltage indicator** • **Low resistance ohm meter** • **Insulation resistance testers** • **EFLI and PFC tester** • **RCD tester** • **Tong tester/clamp on ammeter** • **Phase sequence tester.**	

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
4. Understand the procedures and techniques for diagnosing electrical faults.	**4.4 Describe how to confirm test instruments are fit for purpose, functioning correctly and are correctly calibrated.**	Link to unit QELTK3/006. Discuss the process for confirming that the test instruments listed at 4.3 are fit for purpose and functioning correctly. Demonstrate the procedures for confirming that test instruments are fit for purpose and correctly calibrated – oversee learner practice of the same.
	4.5 State the appropriate documentation that is required for fault diagnosis work and explain how and when it should be completed.	Discuss the various types of documentation that is required for fault diagnosis work, including IET certificates, commissioning documents, maintenance records etc – explain how and when these should be handed over.
	4.6 Explain why carrying out fault diagnosis work can have implications for customers and clients.	Outline the ways in which completion of fault diagnosis work can impact upon customers and clients – e.g. if supply needs to be turned off.
	4.7 Specify and undertake the procedures for carrying out the following tests and their relationship to fault diagnosis: • **Continuity** • **Insulation resistance** • **Polarity** • **Earth fault loop impedance** • **RCD operation** • **Current and voltage measurement** • **Phase sequence.**	Discuss the requirements for applying the tests listed at 4.7, re-cap the procedures for carrying out 'non live' tests in a fault diagnosis context continuity (ring final and circuit protective conductors); polarity; insulation resistance. Re-cap the procedures for carrying out 'live' tests in a fault diagnosis context (EFLI; RCD operation; phase sequence).
	4.8 Identify whether test results are acceptable and state the actions to take where unsatisfactory results are obtained.	Discuss the different sources of information (IET standards, manufacturer's info) which contain standard values which can be checked during fault rectification procedures. Describe the actions to take if test results which do not comply with standard values are obtained.

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
5. Understand the procedures and techniques for correcting electrical faults.	**5.1 Identify and explain factors which can affect fault correction, repair or replacement, including:** • **Cost** • **Availability of replacement parts, resources and staff** • **Down time (planning)** • **Legal and personal responsibility (e.g. contracts, warranties, relevant personnel)** • **Access to systems and equipment** • **Provision of emergency or stand by supplies** • **Client demand (continuous supply, out of hours working).**	Discuss the implications of the items listed at 5.1 as they may apply to different work situations. Discuss different scenarios which require fault diagnosis/correction activity – learners to explain how work activities should be tailored to take into account the factors listed at 5.1.
	5.2 Specify the procedures for functional testing and identify tests that can verify fault correction, including: • **Continuity** • **Insulation resistance** • **Polarity** • **Earth fault loop impedance** • **RCD operation** • **Values of current and voltage** • **Phase sequencing.**	Explain the procedures for carrying out functional testing as part of fault diagnosis on components such as: lighting controllers-switches; motors, drives; motor controllers; controls and interlocks; main switches; isolators. Discuss the ways that the test procedures identified in 5.2 can be used to verify fault correction.
	5.3 State the appropriate documentation that is required for fault correction work and explain how and when it should be completed.	Discuss the types of information that should be provided on fault correction work such as, maintenance reports, manufacturer's info, job sheets etc.

Delivery Unit

Learning Outcomes The learner will:	**Assessment Criteria** The learner can:	**Delivery Advice** (not exhaustive):
5. Understand the procedures and techniques for correcting electrical faults.	**5.4 Explain how and why relevant people need to be kept informed during completion of fault correction work including;** • **Other workers/colleagues** • **Customers/clients** • **Representatives of other services.**	Describe the reasons for keeping relevant persons identified in 5.4 informed on fault correction work, including identifying times that system supplies may be isolated and when areas may be barriered off for the completion of work activities.
	5.5 Specify the methods for restoring the condition of building fabric including: • **Brickwork** • **Plastering** • **Decorative finishings** • **Supporting structures.**	Discuss the types of restorative work that it may usually be expected for electricians to complete after fault correction work has finished. Demonstrate the methods and techniques for restoring the building fabric including - patching up plasterwork, ceilings/artex and brickwork, replacing floorboards, skirting boards and worktops etc.
	5.6 State the methods to ensure the safe disposal of any waste and that the work area is left in a safe and clean condition.	Outline the statutory legislation surrounding waste management on construction sites. Explore the various approved methods of the transport and disposal of waste. Give a brief explanation of the possible outcomes of failing to used approved methods of waste disposal.