Unit 318E: Identify and rectify faults in electrical systems and equipment

# Delivery guide

Unit information

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

Learners 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 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*.

This Delivery guide only covers the knowledge and understanding elements within this unit, not the performance criteria which are specific to each learner’s workplace.

Learning outcomes

1. Understand the health and safety requirements relevant to fault diagnosis
2. Understand the importance of reporting and communication in fault diagnosis
3. Understand the nature and characteristics of electrical faults
4. Understand the fault diagnosis procedure
5. Understand the procedures and techniques for correcting electrical faults

Suggested resources

Textbooks

* *BS 7671 Requirements for Electrical Installations*, 18th edition. London: Institution of Engineering and Technology.

ISBN 978-1-7856-1170-4

* Tanner, P. (2018) *The City & Guilds Textbook: Book 2 Electrical Installations for the Level 3 Apprenticeship (5357), Level 3 Advanced Technical Diploma (8202) & Level 3 Diploma (2365*). London: Hodder Education.

ISBN 978-1-5104-3225-3

Websites

* [SmartScreen | Homepage](https://www.smartscreen.co.uk/)
* [Wikipedia | Electrical fault](https://en.wikipedia.org/wiki/Electrical_fault)
* [YouTube | Asbestos Awareness Toolbox Talk](https://www.youtube.com/watch?v=afUr2JsXE7g)
* [YouTube | GSH Electrical](https://www.youtube.com/channel/UCgtbE9w_d-u2AvPp3WBlPfQ)

British Standards

* BS 7671:2018+A1:2020. *Requirements for Electrical Installations. IET Writing Regulations.*
* BS EN 61010-1:2010+A1:2019. *Safety requirements for electrical equipment for measurement, control and laboratory use – general requirements*.
* BS EN 61557-2:2007. *Electrical safety in low-voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Insulin resistance*.
* BS EN 61557-6:2007. *Electrical safety in low-voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Effectiveness of residual current devices (RCD) in TT, TN and IT systems*.

Legislation

* [HSE | Electrical safety](https://www.hse.gov.uk/toolbox/electrical.htm)
* [HSE | Electrical test equipment for use by electricians GS38](https://www.hse.gov.uk/pubns/priced/gs38.pdf)
* [HSE | The Electricity at Work Regulations 1989](https://www.hse.gov.uk/pubns/books/hsr25.htm)

| **Learning outcomes** | **Criteria** | **Delivery guidance** |
| --- | --- | --- |
| 1. Understand the health and safety requirements relevant to fault diagnosis | * 1. The dangers of electricity in relation to fault diagnosis work | * Learners to understand the dangers of electricity when undertaking fault diagnosis. * Learners to follow operational procedures to ensure contact with live parts is avoided. * Learners to understand that a higher risk of electric shock is present when undertaking electrical fault diagnosis. |
| * 1. The health and safety requirements relevant to diagnosing and correcting electrical faults in electrical systems and equipment | * Learners to understand the relevant parts of the Electricity at Work Regulations 1989 associated with electrical safety. These include: * dead working is the norm * live working only if it is unreasonable to work dead * ensuring adequate space, access and light is available * ensuring the person(s) undertaking the work is competent to carry out their duties * safe use of tools and equipment * safe and correct use of measuring equipment * reporting unsafe situations * safe working procedures * effective communication with other people on the premises * use of barriers * positioning of notices * safe isolation * use of equipment according to HSE GS38. |
| * 1. The safe working procedures that should be adopted for completion of fault diagnosis and correction work | * Learners to understand that safe working procedures must be followed, including: * risk assessments * method statements * permit to work. * Learners to understand the dangers of working at heights. |
| 1. Understand the importance of reporting and communication in fault diagnosis | * 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 | * Learners to understand how to obtain sources of information needed to perform fault diagnosis and rectification. * Learners to understand that sources of information can be obtained from: * persons present when a fault occurred * operating manuals * manufacturers’ workshop manuals * manufacturers’ websites * manufacturers’ help lines. |
| * 1. The organisational procedures and industry practices when carrying out the processes for the identification and rectification of faults, including: * 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 | * Learners to understand the operational procedures and industry practices when carrying out identification and fault rectification. * Learners to understand that relevant people should be informed about disruptions and possible down time during the process of fault diagnosis and rectification. * Learners to understand that some services may not be available during fault diagnosis and rectification, such as light, power and heat. * Learners to understand that coordination of site services and informing other trades of activities is essential during fault diagnosis and rectification. |
| 1. Understand the nature and characteristics of electrical faults | * 1. The different types, causes and consequences of electrical faults | * Learners to understand the different types of faults and their consequences, such as: * short circuit electrical faults, causing high currents and circuit breakers to trip (L-N fault) * short circuit electrical faults to earth, causing high earth currents and residual current devices (RCDs) to trip (L-E fault) * open circuit faults, causing individual circuits to fail * overload faults, causing excessive heat and fire risk and circuit breaker tripping. |
| * 1. Typical types of faults and their likely locations in wiring systems and equipment | * Learners to understand the types of faults and their typical causes and locations, such as: * short circuit (L-N), typically found in wiring due to nails and drills penetrating cables, or failure of equipment * short circuit (L-E), typically found in wiring due to nails and drills penetrating cables, or a line conductor touching an exposed conductive part * open circuit faults, typically found through ageing of the wiring system, breaks in cables and poor or corroded terminations * overload faults, typically caused by misuse of the system, poor system design regarding the division of circuits and consumer overloading of circuits * unexpected tripping of RCD faults, typically caused by the natural residual earth currents of equipment adding together and exceeding the rated residual current of the RCD, such as too many computers connected to the same circuit in industrial or educational establishments. |
| 1. Understand the fault diagnosis procedure | * 1. The precautions that must be taken when carrying out fault diagnosis regarding particular locations, equipment and circumstances | * Learners to be aware of dangers present in particular environments when conducting fault diagnosis and rectification, such as: * lone working * hazardous areas * fibre optic cabling * electro-static discharge (friction, induction, separation) * electronic devices (damage by overvoltage) * IT equipment such as shutdown * high frequency or capacitive circuits * presence of batteries (lead acid cells, connecting cells) * additional sources of energy (solar panels, uninterruptible power supply (UPS)) * time-controlled devices * undisturbed asbestos in older buildings * unfamiliar equipment and layouts * pressure and fatigue caused by overwork and the determination to succeed. * Learners to be familiar with the advice on hazards in the environment, such as: * HSE Electrical Safety (see Suggested resources) * YouTube Asbestos Toolbox Talk (see Suggested resources). |
| * 1. The logical stages of fault diagnosis | * Learners to understand the logical stages of fault finding: * gather information (ask when and how the fault occurred) * analyse information (decide the probable cause) * investigate (find the fault) * rectify or fault correction (safely repair the fault) * checking and testing (tests to ensure fault has been rectified and is safe to put back into service) * interpreting results/information * fault correction * functional testing * restoration. * Learners to complete a practical fault-finding task such as a workshop activity where a fault is intentionally placed on a simulated de-energised ring final circuit (open-circuit loop, high-resistance joint, short circuit etc.) and found using continuity and insulation resistance testing ONLY. |
| * 1. How to select the instruments to be used  and confirming that the instruments are fit for purpose and have a current calibration certificate | * Learners to understand that the basic instrument standards BS EN 61557-2:2007 and BS EN 61557-6 require compliance with BS EN 61010-1:2010+A1:2019. * Learners to understand that: * general checks are made for instrument damage before and after use and test leads conform to HSE GS38. * short circuits can be detected using an insulation resistance tester (dead test) * open-circuit faults can be detected using a low-resistance ohmmeter (dead test) * instruments used for fault location should have a current calibration certificate. * Learners to carry out inspection on instruments and test leads for compliance with requirements of GS38 and the current edition of GN3. * Learners to know the resources required for fault diagnosis, including: * voltage indicator * low resistance ohmmeter * insulation resistance testers * EFZ and prospective fault current (PFC) tester * RCD tester * tong tester/clamp-on ammeter * phase sequence tester. |
| * 1. The techniques to identify, locate, diagnose and rectify faults | * Learners to understand the different techniques used in fault location and rectification, including: * the half-split method (disconnect the circuit at the centre and retest and repeat to narrow down the area the fault is in) * replacement of circuit boards as a complete or partial system * fault finding to individual component level * following manufacturers’ fault location flow diagrams. |
| 1. Understand the procedures and techniques for correcting electrical faults | * 1. Typical factors which can affect repair or replacement of equipment | * Learners to understand the down time costs during fault location and repair and that they must operate within an economical time frame. * Learners to understand that a replacement faulty component may not be the only issue if the cause of failure has not been established. * Learners to be aware of hold ups in effective repair if a source of replacement components is delayed or has to be transported from another country. * Learners to be able to make a judgement in terms of efficiency in whether to replace or repair. * Learners to 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). |
| * 1. How to repair, remove and replace in accordance with industry practices: * electrical cables, conductors and/or the wiring system * equipment, accessories and components | * Learners to understand that, when repairing cables, joins containing screw terminals must be available for inspection and a better solution may be to replace cables completely if in trunking, conduit or surface mounted to comply with BS 7671:2018+A1:2020. * Learners to understand that replaced or repaired cable must meet at least the same specification as that removed, to comply with BS 7671:2018+A1:2020. * Learners to understand that, when replacing equipment accessories and components, the specifications must be at least the same as those replaced, to comply with BS 7671:2018+A1:2020. |
| * 1. The methods and processes to inspect and test, as appropriate and in accordance with industry practices, any repaired and/or replaced: * electrical cables, conductors and/or the wiring system * equipment, accessories and components | * Learners to understand that, after the repair or replacement of cables and conductors, appropriate inspection and testing of the system affected by the repair or replacement must be carried out to meet the requirements of BS 7671:2018+A1:2020. * Learners to understand that, after the repair or replacement of equipment, accessories and components, appropriate inspection and testing of the system affected by the repair or replacement must be carried out to meet the requirements of BS 7671:2018+A1:2020. |
| * 1. 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 | * Learners to understand that if faults to cables, conductors, equipment, accessories and components cannot be corrected immediately, the system must not be left in a condition where danger can arise (disconnection or safe isolation may be necessary). |
| * 1. The methods to ensure the safe disposal of any waste and that the work area is left in a safe and clean condition | * Learners to understand the legal responsibilities of disposal of waste. This includes: * waste being stored and separated safely on site (hazardous, dangerous and general) * waste being collected by a registered waste carrier * waste being disposed of at a licensed facility * waste disposal being covered by a valid waste transfer note or consignment note * waste being disposed of in accordance with the waste hierarchy. * Learners to understand that work areas must be kept clean, tidy and in a safe condition. |
| * 1. How to provide clear and accurate information to relevant people about the electrical system and equipment in terms of: * handover 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 and in accordance with organisational procedures | * Learners to understand that, after repairs have been carried out, clear and accurate information must be provided to relevant persons. * Learners to ensure that: * handover instructions, certification and manufacturers’ instructions are handed to the client and recorded on the appropriate information systems in accordance with organisational procedures * variations to the original electrical installation and how the system now operates are explained * the customer/client accepts the work carried out (signed document of acceptance) or any other organisational procedure. |