Unit 320PH: Performing electrical work on plumbing and heating systems

# Delivery guide

Unit information

The purpose of this unit is for learners to obtain trade experience in plumbing and heating installations.

The purpose of this unit is for learners to explore electrical systems within a domestic property and industrial and commercial building and the competences that underpin work on the different systems. Learners will have the opportunity to:

* inspect and pre-commission electrical systems
* decommission/install and test electrical systems
* commission electrical systems
* maintain electrical systems.

This work will be 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.

This unit is for people who are required to carry out work on electrical supplies and/or circuits for the control of plumbing and heating systems which:

* do not require the addition of a circuit to the existing fixed electrical installation
* will only be associated with the disconnection, installation and/or connection of electrical equipment and components associated with the supply and/or control of mechanical services systems.

The person performing this work must be able to comply with the correct procedures and practices for disconnecting, installing and/or connecting electrical equipment and components that supply and/or control plumbing and heating systems. This work must be in accordance with the current versions of the appropriate industry standards and regulations, the specification, industry recognised working practices, the working and natural environment. It will not involve the testing and commissioning of the fixed electrical installation and its constituent parts. They must know and understand the types, applications and limitations of electrical supplies, safe isolation and control equipment, earthing and overcurrent protection and cables/wiring associated with plumbing and heating systems.

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

* What are the advantages and disadvantages of different electrical equipment, cables/wiring, accessories and components?
* How do you select and install electrical systems and components?
* What steps are part of commissioning and maintaining electrical systems and components?
* How do you carry out functional testing on electrical systems and components?

Learning outcomes

1. Understand the limitations of your responsibility when carrying out work on electrical supplies and/or circuits for the control of mechanical building services systems
2. Understand the applications, advantages and limitations of electrical supplies
3. Understand the applications, advantages and limitations of different electrical equipment, cables/wiring, accessories and components in relation to the working environment
4. Understand the appropriate industry standards and regulations relevant to carrying out work on electrical supplies and/or circuits for the control of mechanical building services systems
5. Identify methods for selecting electrical equipment, cables/wiring, accessories and components to ensure that they are fit for purpose
6. Carry out the methods and techniques for disconnecting, installing and/or connecting electrical equipment, cables/wiring, accessories and components
7. Interpret diagrams and drawings for the mechanical building services system
8. Carry out industry recognised methods and procedures for the functional testing of the electrical equipment, accessories and components associated with the electrical supply and/or control of the mechanical building services system
9. Identify and rectify electrical faults in the mechanical building services system.

Suggested resources

Textbooks

* Institution of Engineering and Technology (IET) (2018*) IET On-Site Guide (BS 7671:2018) (Electrical Regulations)*. London: IET.

ISBN 978-1-7856-1442-2

Maskrey, M. (2019) *The City & Guilds Textbook: Plumbing Book 1 for the Level 3 Apprenticeship (9189), Level 2 Technical Certificate (8202) & Level 2 Diploma (6035) (City & Guilds Textbooks).* London: Hodder Education. ISBN 978-1-5104-1648-2

* Tanner, P. and Stephen, L. (2019) *The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Certificate (8202) & Level 3 Diploma (6035) (City & Guilds Textbooks).* London: Hodder Education.

ISBN 978-1-5104-1646-8

Websites

* [CEF | Homepage](https://www.cef.co.uk/)
* [Electrical Safety First | Best Practice Guides](https://www.electricalsafetyfirst.org.uk/professional-resources/best-practice-guides/)
* [NICEIC | The Memorandum of Guidance on the Electricity at Work Regulations 1989](http://www.niceic.com/docusign/n/HSR25-2nd-edition-dis.pdf)
* [The IET | Homepage](https://www.theiet.org/)

British Standards

* BS 7671:2018+A1:2020. *Requirements for Electrical Installations. IET Writing Regulations*.

Legislation

* *Building Regulations 2010 Approved Document P: Electrical safety – Dwellings*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6485-4

* [HSE | The Electricity at Work Regulations 1989](https://www.hse.gov.uk/pubns/books/hsr25.htm)

| **Learning outcomes** | **Criteria** | **Delivery guidance** |
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| 1. Understand the limitations of your responsibility when carrying out work on electrical supplies and/or circuits for the control of mechanical building services systems | | * Learners to understand the limitations of responsibility when carrying out work on electrical supplies and/or circuits for the control of mechanical building services systems. * Learners to be familiar with plumbing and domestic heating systems, which: * do not require the addition of a circuit to the existing fixed electrical installation * will only be associated with the disconnection, installation and/or connection of electrical equipment and components associated with the supply and/or control of plumbing and domestic heating systems. * Learners to be aware that the person performing this work must be able to comply with the correct procedures and practices for disconnecting, installing and/or connecting electrical equipment and components that supply and/or control plumbing and domestic heating systems. * Learners to be familiar with the requirements of the Electricity at Work Regulations 1989, Regulation 16 and HSE publication The Memorandum of Guidance on the Electricity at Work Regulations 1989 (HSR25). * Learners to be able to perform the electrical safe isolation procedure in accordance with industry guidance such as Health & Safety Executive GS 38 and the Electrical Safety First’s Guidance for low voltage installations. * Learners to know the dangers associated with electricity given that as little as 50mA can be lethal. |
| 1. Understand the applications, advantages and limitations of electrical supplies | * 1. Electrical systems | * Learners to be aware of the working principles for both alternating and direct current supplies and generation, transmission and distribution of the electrical supply grid. * Learners to be able to explain what is meant by Root Mean Square (RMS) and frequency. * Learners to be able to discuss the purpose of electrical components at entry to the property including: * main fuse (single phase) and cable head connection * meter * consumer unit * main earth terminal. * Learners to be able to identify the applications, advantages and limitations of extra low voltage (touch voltage) and/or low voltage single/multi-phase provision for electrical supplies including: * control * communication * heating * lighting * power. * Learners to know how single and 3 phase supplies are utilised and what is meant by RMS and frequency. * Learners to know the application, advantages, disadvantages and the limitations of a range of different cables including twin and earth (thermoplastic), PVC singles, fire resistant, Steel Wire Armoured (SWA) and thermosetting. * Learners to be aware of specific applications for cables such as those used as the final connection to water heaters. * Learners to be able to discuss the system layout features for electrical circuits in dwellings including: * ring main circuit * radial circuit * fixed appliance supplies (cooker, immersion heater, instantaneous shower, lighting, macerator WC, central heating controls, shower pump/jacuzzi, heat producing or cooling appliances). * Learners to be able to explain the requirements for electrical systems and Residual Current Device (RCDs) as described in IET On-Site Guide (BS 7671:2018), including the limitations and sizing of ring and radial circuits, circuits supplying individual appliances and circuit protection devices (type/size). * Learners to know the requirements for protecting socket-outlets or when cables are not enclosed in metal enclosures or embedded in walls by 50mm. * Learners to know the differences involved with electrical loads, especially within central heating systems. * Learners to be aware that Appendix H (Standard Circuits) details the limitations and sizing of ring and radial circuits, alongside the requirements to provide water heaters >15 litres with a dedicated supply. * Learners to be able to discuss the purpose and requirements of earthing systems including: * main earthing systems * TT system * TN-S system * TN-C-S system * protective equipotential bonding * high risk rooms (zones) in dwellings * supplementary earthing (bonding). |
| 1. Understand the applications, advantages and limitations of different electrical equipment, cables/wiring, accessories and components in relation to the working environment | * 1. Electrical equipment | * Learners to be able to identify all the basic components that make up an electrical circuit such as an ‘18th Edition consumer Unit’ (split board, highest loads positioned nearest the switch) and types of protective devices including breaking capacity. * Learners to be able to identify the applications, advantages and limitations of different electrical equipment including: * isolators * circuit breakers * fuses * switches (double pole switch/isolation for large loads) * socket-outlets/fused-spurs * earthing protection * motor control equipment * control panels (environmental control) * control devices (electrical, electronic, electro-mechanical) * smart controls. * Learners to be able to explain the requirements for electrical equipment as described in IET On-Site Guide including Class 1 and 2 equipment. * Learners to know what is meant by basic and fault protection, alongside Class 2 equipment. * Learners to understand how earthing requires all electrical connections to be in low resistance to avoid electrical fires and to ensure a fault current will remain high and lead to a quick disconnection of the protective device in the required time. |
| * 1. Cables and wiring | * Learners to be able to identify the applications, advantages and limitations of different electrical cables including: * thermosetting insulated cables including flexes * single and multicore thermoplastic and thermosetting insulated cables * flat profile cable * mineral insulated cables * single wire armoured cables * armoured/braided flexible cables and cords * fire resistant cable. * Learners to be able to explain the requirements for cabling and wiring in the IET On-Site Guide. |
| * 1. Components | * Learners to be able to identify the applications, advantages and limitations of different electrical components including: * boiler * central heating controls (2 port, 3 port, mid position and diverter), programmer, timer, thermostats, programmable room stat, optimiser, frost stat, cylinder stat * wi-fi routers * wi-fi range extenders * wiring centres * immersion heater * instantaneous shower * shower pump * jacuzzi bath/hot tub * macerator WC * heat producing or cooling appliances * pumps * fans. |
| * 1. Working environment (internal or external) | * Learners to have an understanding of applications, advantages and limitations of different electrical equipment, cables/wiring, accessories and components in relation to different working environments including: * commercial * industrial * domestic * agricultural * horticultural * leisure and entertainment * residential medical and care facilities * public services establishments * pre-1919 traditional/historic buildings. |
| 1. Understand the appropriate industry standards and regulations relevant to carrying out work on electrical supplies and/or circuits for the control of mechanical building services systems | * 1. Electrical systems | * Learners to know the inspection process using relevant human senses and to know how dead and live tests are applied and sequenced to a variety of different voltage and phasing requirements. * Learners to be able to identify electrical supplies and/or circuits for the control of mechanical building services systems, extra low voltage and/or low voltage single/multi-phase provision for electrical supplies including: * control * communication * heating * lighting * power. |
| * 1. The information sources required to complete testing and commissioning | * Learners to be able to discuss the requirements of the statutory legislation and guidance information that applies to the electrical supply and control of domestic mechanical services systems and their components including: * Electricity at Work Regulations 1989 * BS 7671:2018+A1:2020 * IET guidance notes * British Standards * manufacturer instructions * Building Regulations 2010 Approved Document P: Electrical safety – Dwellings. * Learners to be aware of the range of information that would be detailed on a minor works certificate for an electrical system or component. * Learners to be able to interpret the requirements of Part P of the Building Regulations and to know how the installation of a new circuit differs from alterations, especially in certification. * Learners to know that installing a spur socket would require a minor electrical installation works certificate. * Learners to be able to establish: * system earthing arrangement * Zs (earth fault loop impedance) at distribution board * presence of adequate main protective conductors and equipotential bonding conductors * type and rating of protective device * R1 + R2 values * continuity of ring final circuit conductors * insulation resistance and polarity (which can be carried out visually) * RCD operation. * Learners to be able to prove RCD operation for a given circuit. * Learners to be aware of the notification requirements, including the type of work that requires notification. * Learners to be able to explain the procedure for notifying works carried out to the relevant authority. * Learners to be aware of the correct testing equipment to be used when carrying out tests on faulty components and systems. |
| 1. Identify methods for selecting electrical equipment, cables/wiring, accessories and components to ensure that they are fit for purpose | * 1. The electrical supply is suitable for the plumbing and domestic heating systems | * Learners to know the common types of cables and accessories used in a domestic setting and how to use sources of information such as the IET On-Site Guide to select a cable for a given application including: * thermosetting insulated cables including flexes, single and multicore * thermoplastic and thermosetting insulated cables * flat profile cable * mineral insulated cables * single wire armoured cables * armoured/braided flexible cables and cords * fire resistant cable. * Learners to be aware of maximum demand requirements when connecting to existing installations as detailed in the IET On-Site Guide. * Learners to be able to state the procedure for sizing electrical materials and components, including basic cable sizing and basic circuit protection device sizing procedure as detailed in the IET On-Site Guide. * Learners to be given the opportunity to carry out cable and circuit protection device sizing. * Learners to be aware of standards relating to cables/wiring, accessories and components. |
| 1. Carry out the methods and techniques for disconnecting, installing and/or connecting electrical equipment, cables/wiring, accessories and components in accordance with:  * the mechanical building services (plumbing and heating) system’s design * manufacturers’ instructions * the correct procedures for safe isolation | * 1. The correct means of electrical isolation prior to commencing work | * Learners to be able to test the equipment required to prove that circuits to be worked on are dead including: * approved voltage indicating device * proving unit. * Learners to be able to specify the electrical industry agreed procedure for safe isolation of electrical circuits (referring to the guidance from Electrical Safety First) as follows: * select the approved voltage indicating device and test on a known supply * locate and identify the isolation point for the equipment to be worked on * isolate the supply and prevent re-energisation * verify that the equipment is dead * fit warning labels * re-check the approved voltage indicating on a known supply for correct function. * Learners to be able to explain the methods of ensuring that circuits cannot be re-activated while work is taking place on them including: * use of locking devices * device retention (fuse removal). * Learners to perform a safe isolation procedure and to understand the importance of safe isolation, in accordance with industry approved procedures (referring to the guidance from Electrical Safety First). * Learners to be able to connect and terminate electrical cables in accordance with industry approved procedures to ensure connections are electrically and mechanically sound. |
| * 1. The status of the electrical supply | * Learners to know the status of the electrical supply (live, dead). * Learners to be able to identify the situations in which dead testing of components can be carried out. * Learners to be able to identify the situations in which live testing of components may be necessary and the safety precautions required. |
| * 1. The safe isolation of electrical equipment and components associated with the electrical supply of the plumbing and domestic heating system | * Learners to be able to discuss the safe isolation of electrical equipment including: * isolators * circuit breakers * fuses * switches * socket outlets/fused-spurs * motor control equipment * control panels * environmental control * control devices (electrical, electronic, electro-mechanical, smart controls). * Learners to be able to explain the safe isolation of electrical supply including: * extra low voltage * low voltage single. * Learners to understand phase provision for: * control * communication * heating * lighting * power. * Learners to be able to discuss the safe isolation components associated with plumbing and domestic heating systems including: * boiler * central heating controls * zone valves (2 port, 3 port, mid position and diverter) * programmer * timer * thermostats * programmable room stat * optimiser * frost stat * wiring centre * cylinder stat * wi-fi routers * wi-fi range extenders * wiring centres * immersion heater * instantaneous shower * shower pump * jacuzzi bath/hot tub * macerator WC * heat producing or cooling appliances * pumps and fans. * Learners to understand the consequences of not performing the safe isolation procedure properly for themselves, other workers, members of the public/people on the premises. |
| * 1. The work on electrical equipment, cables/wiring and components associated with the electrical supply and control of the plumbing and domestic heating system | * Learners to be able to specify the method of installation and wiring termination for a range of components including: * boiler * central heating controls * zone valves (2 port, 3 port, mid position and diverter) * programmer * timer * thermostats * programmable room stat * optimiser * frost stat * wiring centre * cylinder stat * wi-fi routers * wi-fi range extenders * wiring centres * immersion heater * instantaneous shower * shower pump * jacuzzi bath/hot tub * macerator WC * heat producing or cooling appliances * pumps and fans. * Learners to be able to discuss the types of cable termination methods approved for use in dwellings including: * screw terminals * pillar terminals * claw and washer terminals * crimping * strip connectors. |
| * 1. The electrical equipment, cables/wiring and components are in accordance with the requirements of the plumbing and domestic heating system | * Learners to understand the electrical circuitry and electrical equipment associated with plumbing and domestic heating systems, the types of controls and their operation and purpose. * Learners to understand how this circuitry enables the plumbing/domestic heating system to function as intended/as per system design. |
| * 1. The electrical equipment, cables/wiring and components are of proper construction in accordance with the requirements of the plumbing and domestic heating system | * Learners to know the requirements for protecting cables installed in the building fabric and terminating in enclosures including: * protection methods in wall and floor surfaces * embedded (sheathing) – depth of cover, application of RCD protection * exposed (mini-trunking) * within ducting * within timber stud partitions * within timber floor structures * junction boxes * switch/socket boxes * countersunk * pattresses * surface mounted * wiring centres. * Learners to be able to explain IP codes relevant to components of plumbing and domestic heating systems. |
| 1. Interpret diagrams and drawings for the mechanical building services system to identify the location of the:  * site services * electrical equipment, accessories and components | * 1. The electrical equipment, cables/wiring and components are in accordance with the requirements of the plumbing and domestic heating system | * Learners to be able to interpret circuit and wiring diagrams to safely and correctly connect electrical equipment to ensure correct function of the plumbing/domestic heating system. * Learners to be able to interpret diagrams and drawings for the mechanical building services system to identify the location of the site services. * Learners to be provided with examples of diagrams and drawings. |
| * 1. The electrical equipment, cables/wiring and components are of proper construction in accordance with the requirements of the plumbing and domestic heating system | * Learners to be able to interpret circuit and wiring diagrams to: * safely and correctly connect electrical circuits and equipment to ensure correct function of the plumbing/domestic heating system * be able to ensure that cables have adequate mechanical protection * identify the location of the electrical equipment, accessories and components. * Learners to be provided with examples of circuit and wiring diagrams. |
| 1. Carry out industry recognised methods and procedures for the functional testing of the electrical equipment, accessories and components associated with the electrical supply and/or control of the mechanical building services system | | * Learners to know industry recognised methods and procedures for the functional testing of the electrical equipment, accessories and components associated with the electrical supply and/or control of the mechanical building services system. * Learners to be able to carry out functional testing of installed systems to confirm correct operation. * Learners to be able to carry out visual inspections of their completed work. |
| 1. Identify and rectify electrical faults in the mechanical building services system in accordance with:  * industry recognised methods * the limitations of your responsibility | * 1. How to rectify electrical faults and deficiencies on plumbing and domestic heating systems | * Learners to understand the importance of ensuring the electrical work is safe and has been carried out in accordance with industry approved procedures and in compliance with BS 7671:2018+A1:2020. * Learners to understand the typical faults that occur on electrical circuits for mechanical building services systems and how to identify and rectify these faults, including faults on appliance and control components. * Appliance components: * micro switches * relays * pressure switches * printed circuit boards * pumps * fans. * Control components: * thermostats * programmers/timers * electrically operated control valves * wiring centres. * Learners to 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 (loose connection etc.) * 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 to be able to follow the logical stages of fault diagnosis as follows: * identification of symptoms * collection and analysis of data * use of sources/types of information * checking and testing (supply, protective devices) * interpreting results/information * fault correction * functional testing * restoration. * Learners to be able to discuss the methods of correcting deficiencies in electrical components: * inadequate earthing provision * defective cable positioning (aged cables/proximity to other services) * failed electrical components * incorrect polarity * provision of inadequate circuit protection devices. * Learners to know the factors which can affect repair or replacement of equipment such as: * cost * availability of replacement parts * resources and staff, down time (planning) * legal and personal responsibility (contracts, warranties, relevant personnel) * gaining access to systems and equipment * provision of emergency or stand-by supplies * client demand (continuous supply, out of hours working). * Learners to be able to determine and follow the procedures for verifying that the fault has been corrected suitably for the situation using technical analysis such as functional testing/checking. * Learners to be able to demonstrate how to carry out the inspection and testing of plumbing and domestic heating systems including: * continuity * insulation resistance * polarity * earth fault loop impedance * RCD operation * current and voltage measurement/checking presence of supply * phase sequencing. * Learners to know the methods to ensure the safe disposal of any waste and that the work area is left in a safe and clean condition. |