Unit 315E: Installation of wiring systems

# Delivery guide

Unit information

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.)

Learners 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 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 and apply relevant requirements of the standard. This will develop learners’ 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.

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 operation, applications, advantages and limitations of different electrical systems
2. Understand the appropriate industry standards and regulations relevant to installing enclosures
3. Understand the applications, advantages and limitations of types of enclosures
4. Understand the appropriate industry standards, regulations and procedures relevant to installing and connecting electrical cables, conductors, wiring systems, associated equipment, accessories and components
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

Suggested resources

Textbooks

* *BS 7671:2018.* *Requirements for Electrical Installations*, *IET Wiring Regulations* (2018) 18th edition. London: Institution of Engineering and Technology.

ISBN 978-1-7856-1170-4

* *IET On-Site Guide (BS 7671:2018) (Electrical Regulations)*, 7th edition. London: Institution of Engineering and Technology.

ISBN 978-1-7856-1442-2

* Tanner, P. (2018) *The City & Guilds Textbook: Book 1 Electrical Installations for the Level 3 Apprenticeship (5357), Level 2 Technical Certificate (8202) & Level 2 Diploma (2365).* London: Hodder Education.

ISBN 978-1-5104-3224-6

* 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

* [City & Guilds | SmartScreen](https://www.smartscreen.co.uk/)
* [Electrical Apprentice | Homepage](https://electricalapprentice.co.uk/)
* [ElectricianCourses 4U | IP Ratings Explained](https://www.electriciancourses4u.co.uk/useful-resources/ip-ratings-explained/)
* [Gov Wales | Building regulations: approved documents](https://www.gov.wales/building-regulations-approved-documents)
* [YouTube | Chris Kitcher](https://www.youtube.com/user/chriskitcher)
* [YouTube | John Ward – Types of Earthing System for Electricity Supplies (UK)](https://www.youtube.com/watch?v=AWxeb2MI37c)

British Standards

* BS 7671:2018+A1:2020. *Requirements for Electrical Installations. IET Writing Regulations*.
* BS 7871-2:1998. *Pneumatic conveying. Glossary of equipment*.

Legislation

* [GOV.UK | The Personal Protective Equipment at Work Regulations 1992](https://www.legislation.gov.uk/uksi/1992/2966/contents/made)
* [HSE | The Construction (Design and Management) Regulations 2015](https://www.hse.gov.uk/construction/cdm/2015/index.htm)
* [HSE | Health and Safety at Work etc Act 1974](https://www.hse.gov.uk/legislation/hswa.htm)
* [HSE | Provision and Use of Work Equipment Regulations 1998 (PUWER)](https://www.hse.gov.uk/work-equipment-machinery/puwer.htm)
* [HSE | The Electricity at Work Regulations 1989](https://www.hse.gov.uk/pubns/books/hsr25.htm)

| **Learning outcomes** | **Criteria** | **Delivery guidance** |
| --- | --- | --- |
| 1. Understand the operation, applications, advantages and limitations of different electrical systems | * 1. Types of earthing systems | * Learners to understand different types of earthing systems and their general layouts, including: * TN-S * TN-C-S * TN-C * TT * IT. * Learners to know the meaning of Protective Multiple Earthing (PME) and a Protective Earthed Neutral (PEN) conductor and the principle of foundation earthing. * Learners to be shown videos covering electricity supplies, such as the John Ward YouTube channel – Types of earthing system for electricity supplies (UK). |
| * 1. Types of supply systems | * Learners to understand the different types of supply systems, including: * single-phase systems * three-phase systems * three-phase and neutral systems. |
| * 1. Electrical circuits | * Learners to understand the types of electrical circuits encountered in electrical installation work, such as: * distribution systems (sub mains) * environmental control/building energy management systems and uninterruptible power supply (UPS) * closed-circuit television (CCTV) * communication * data transmission systems. * Learners to be familiar with protective systems, including: * fire alarms * unlawful entry and emergency lighting systems * machine and heating controls * final circuits including electric vehicle charging equipment. |
| * 1. The arrangements for electrical installations and systems with regards to provision for: isolation and switching, overcurrent protection, earth fault protection | * Learners to refer to the *IET On-Site Guide*, Section 5 and BS 7871-2:1998, Ch 46. * Learners to understand: * the requirements for isolation and switching * the provision for overcurrent protection * the provision for earth fault protection. |
| * 1. The devices for protection against the risk of fire: AFDDs, RCDs | * Learners to refer to BS 7671:2018+A1:2020, regulation numbers 421.1.7 for arc-fault detection devices (AFDDs) and 532, 2.2 for residual-current devices (RCDs) and protection against fire. |
| * 1. The maximum disconnection times for circuits | * Learners to refer to BS 7671:2018+A1:2020, regulation numbers 411.3.2.2 to 411.3.2.4 and Table 41.1. * Learners to understand the maximum disconnection times for electrical circuits in accordance with their earthing system and U-value. |
| * 1. Requirements for the protection against overvoltage and the types and applications of SPDs | * Learners to refer to BS 7671:2018+A1:2020, section 443. * Learners to understand protection against overvoltage and transients. * Learners to understand devices used for the protection against overvoltage e.g., Surge Protection Devices (SPDs). * Learners to understand the different types of SPDs, and their application (see BS 7671:2018+A1:2020, section 534). |
| * 1. Requirements for the protection against undervoltage | * Learners to refer to BS 7671:2018+A1:2020, section 445. * Learners to understand the term ‘undervoltage’ with reference to electrical systems. * Learners to understand how danger caused by undervoltage is overcome, such as with the use of a direct-on-line starter (DOL) for motor control. |
| * 1. The requirements for protection against electric shock | * Learners to refer to BS 7671:2018+A1:2020, Ch 41. * Learners to understand: * how an electric shock can be received * how electric shock hazards can be reduced in electrical circuits * any additional protection against an electric shock to earth. |
| * 1. The requirements and applications of functional earthing | * Learners to refer to BS 7671:2018+A1:2020, Part 2. * Learners to understand: * the term ‘functional earth’ * that a functional earth must have no protective function * that a functional earth must be connected to the main earth. * Learners to be given examples of where functional earthing is used in electrical installations. |
| * 1. How to select suitably sized protective conductors in accordance with BS 7671 | * Learners to refer to BS 7671:2018+A1:2020, Ch 54. * Learners to be able to select a suitably sized buried earthing conductor from Table 54.1 of BS 7671:2018+A1:2020. * Learners to be able to select a suitably sized main protective bonding conductor for both protective multiple earthing (PME) and non-PME earthing systems. * Learner to be able to calculate the minimum size of circuit protective conductor in accordance with the adiabatic equation described in BS 7671:2018+A1:2020. * Learners to be able to select a suitably sized circuit protective conductor from BS 7671:2018+A1:2020, Table 54.7, if an adiabatic calculation is not to be carried out. |
| 1. Understand the appropriate industry standards and regulations relevant to installing enclosures | * 1. Industry standards and regulations | * Learners to interpret and apply the main topics within BS 7671:2018+A1:2020 relevant to installing enclosures. * Learners to interpret and apply industry guidance within the *IET On-Site Guide* relevant to installing enclosures. * Learners to interpret and apply the relevant Approved Documents and technical guidance for Wales and England, for compliance with Building Regulations Wales and England, relevant to installing enclosures. * Learners to interpret and apply industry/manufacturers’ guidance with reference to installing enclosures. * Learners to interpret and apply statutory regulations with reference to installing enclosures, including: * Construction, Design and Management (CDM) Regulations 2015 * Electricity at Work Regulations (EAWR) 1989 * Health and Safety at Work Act 1974 (HASAWA) * Provision and Use of Work Equipment Regulations 1998 (PUWER) * Personal Protective Equipment at Work Regulations 1992 (PPEWR). * Learners to be aware of specialist requirements for electrical equipment in potentially explosive atmospheres. |
| 1. Understand the applications, advantages and limitations of types of enclosures | * 1. The selection of wiring systems and equipment appropriate to the situation and use, utilising BS 7671 | * Learners to refer to BS 7671:2018+A1:2020, Part 5 (Selection and erection of equipment). * Learners to be able to select the correct wiring system in accordance with BS 7671:2018+A1:2020, Ch 52 and the situation of use. * Learners to know the factors which affect the selection of wiring systems and equipment, including client specification, cost, efficiency of equipment, speed of installation of different wiring systems, ergonomics and future maintenance of the installation. * Learners to understand that external influences affect the selection of wiring systems. * Learners to understand that ambient temperature can influence the selection of wiring systems. |
| * 1. The application of the Degrees of Protection Provided by Enclosures (IP Code) | * Learners to refer to BS 7671:2018+A1:2020. * Learners to understand: * that the first character of the IP Code indicates the level of penetration by a solid object * that the second character of the IP Code indicates the level of liquid ingress protection * that a third character can be added to the Code, such as IP XXB, to indicate additional information. * Learners to apply the Code to enclosures and barriers. * Learners to apply the Code to equipment in special locations such as bathrooms and shower rooms (see BS 7671:2018+A1:2020, Section 701). |
| 1. Understand the appropriate industry standards, regulations and procedures relevant to installing and connecting electrical cables, conductors, wiring systems, associated equipment, accessories and components | * 1. Industry standards and regulations | * Learners to refer to BS 7671, the *IET On-Site Guide*, freely available downloads of Approved Documents and technical guidance for Wales and England to comply with Building Regulations. * Learners to know the guidance is relevant onlyto installing and connecting electrical cables, conductors, wiring systems, associated equipment, accessories and components. * Learners to be able to interpret and apply the relevant sections of BS 7671:2018+A1:2020, Part 5. * Learners to be able to interpret and apply the relevant sections of the IET guidance notes and *On-Site Guide* (Appendix C). * Learners to be able to interpret and apply industry/manufacturers’ guidance. |
| * 1. 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 | * Learners to understand: * organisational procedures of a planned programme of work * the procedure for variations of a planned programme of work * the communication channels for confirming that any variations to the planned programme of work will not introduce hazards * that any variations to the planned programme of work must have a minimum impact on the overall work to be completed. * Learners to be shown examples of a work programme, such as a Gantt chart, and to demonstrate how variations of a project can be accommodated without disruption or hazards to the workflow. A practical worked example is available in Tanner, *Book 1*, page 407. |
| 1. 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 | * 1. The interpretation of manufacturers’ data for the selection and application of connected loads and equipment | * Learners to know that the guidance is relevant to both single-phase and three-phase circuits. * Learners to interpret manufacturers’ data relevant to: * the selection and application of the connected load * the selection and application of equipment. |
| * 1. The selection of current using equipment considering energy efficiency | * Learners to consider energy efficiency when selecting current using equipment (see BS 7671:2018+A1:2020, Appendix 17). * Learners to have an awareness of PAS 2030. |
| * 1. The application of smart technology when used for convenience, comfort, safety and security | * Learners to consider the application of smart technology for an electrical installation when used for: * convenience * comfort * fire safety * energy saving * security. |
| * 1. The cable selection (circuit design) procedure | * Learners to be familiar with the two worked example methods in Tanner, *Book 2*, Ch 5 (the single-circuit method and the grid method). * Learners to understand the cable selection design process for electrical circuits by following the approved steps. * Learners to be able to: * determine the maximum demand, including the application of diversity * determine the circuit design current (Ib) and, from this, determine the protective device suitability and rating (In) * establish the installation method to be used * determine which rating factors apply * determine the minimum cross-sectional area of the live conductors considering the current carrying capacity and voltage drop * determine if the voltage drop is acceptable * determine if the disconnection times will be met * evaluate the cables’ thermal withstand (during a fault). |