



# Unit 28: Electrical Principles and Installation

## Standards in Building Services Engineering

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### Delivery guidance

The focus of this unit should be on developing knowledge and understanding of electrical installations that provide power within domestic environments.

Drawings, illustrations, images, animations and video clips are all useful resources to explain the principles governing design of electrical installations and associated components. Such resources are freely available online and can be easily incorporated into tutor presentations.

Involving local professionals and experts from the building services engineering design and installation sector as guest speakers would be a good way to enthuse learners as they gain an insight into the current practices within the industry.

You could either develop a mock project brief or adapt an actual case study or design example, which can be used as a learning resource (ideally throughout the delivery of the unit). This would help learners to develop a holistic understanding of the subject.

### Approaching the unit

#### Learning aim A

Learning aim A is about understanding legal and regulatory requirements relevant to electrical installation in a domestic environment. These include legislation and regulations relating to health and safety, earthing and circuit protection, as well as those relating to space use.

Start by explaining how unsafe electrical installations could be if no standards are followed. You could show reports or video clips of relevant accidents and incidents. This would help learners to appreciate the rationale behind various types of legislation.

Support and challenge learners during delivery through a variety of means – such as knowledge quizzes, paired/group activities, class discussions and presentations – to give opportunities for peer learning alongside motivating the learners.

#### Learning aims B and C

Whether content is taught in parallel or in linear sequence, you could adopt a holistic project-based approach in combining the delivery of learning aims B and C, as these have a significant overlap in terms of their content. You could develop a project brief for learners, develop one involving learners or make use of an industry project.

Learning aim B is about designing an electrical installation for a domestic property. Learners will need to apply their analytical skills to meet the project requirements with the appropriate selection of components. They will develop skills to assess the power requirements for each individual room. They will learn about techniques used in domestic wiring for electrical lighting, and will be able to select appropriate circuits,



sensors, detectors and outputs for data, security and fire protection systems. This learning will help them to produce a comprehensive design for a given scenario.

In learning aim C, learners will develop the specification for materials, components and ancillary equipment to ensure safe distribution of electricity. This includes selection of suitable consumer units, and production of materials and equipment schedules for a given scenario.

You will require access to relevant project information such as drawings, circuit diagrams, layouts and component details. You will need examples of electrical components and fittings, as well as product information, catalogues and electrical standards. You could contact the building services companies, who are always willing to help.

Finally, where possible, invite a guest speaker, who could be from a design, installation or manufacturing background. The guest speaker should be able to share with learners the current approaches and design practices ensuring safety and compliance with legislation.



## Assessment model

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Understand the regulations and legislation applicable to electrical installations	<b>A1</b> Regulations and legislation <b>A2</b> Earthing, bonding and circuit protection <b>A3</b> Units and calculations <b>A4</b> Terminology, principles and calculations	Analyse a client brief in terms of all legal and electrical requirements.
<b>B</b> Undertake the design of an electrical installation for a property	<b>B1</b> Power requirements <b>B2</b> Wiring methods and techniques <b>B3</b> Electrical lighting <b>B4</b> Data, security and fire protection	Develop a system for an electrical installation from a set of given design parameters.
<b>C</b> Develop a specification for materials, components and ancillary equipment for an electrical installation	<b>C1</b> Materials and components <b>C2</b> Consumer units <b>C3</b> Security and fire <b>C4</b> Drawings	As part of the design, produce a specification for all the elements of the electrical installation.

## Assessment guidance

There is a maximum number of two summative assignments for this unit. The assignment briefs should be set within the context of an appropriate project.

For Assignment 1, you should give adequate details about the client requirements so that learners could carry out suitable justification of the legislation and regulations considered relevant to the given project. This includes a client/design brief, design requirements and outline sketches of the property.

For Assignment 2, you should include, in addition to the above, component and material requirements for the system they are going to develop.

Learners will produce a comprehensive design as well as a specification that is detailed in its compilation, and contains full manufacturer details and drawings produced to a professional design standard for a given building.

The selection of all equipment and materials, including a consumer unit, needs to be evaluated in meeting legislative requirements and the design needs of the scenario for the given property. In their evaluation, learners will draw on their knowledge of consumer units and the design of electrical installations to consider the relevance and significance of key aspects of their designs, and the benefits and drawbacks to the design of the electrical installation for the given building.



You could ask for assessment evidence in the form of a report, design calculations, a portfolio of research activities and a presentation. Ask learners, as part of the instructions, to include a list of information sources used.

## Getting started

**This gives you a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.**

### **Unit 28: Electrical Principles and Installation Standards in Building Services Engineering**

#### **Introduction**

Introduce learners to the unit using animations, DVDs, pictures, illustrations or web-based videos relating to electrical installations and the potential hazards of not following the relevant standards.

Engage learners during the delivery of the unit content through knowledge quizzes, paired or group activities, class discussions and presentations, as well as through guest speakers and site visits.

Develop a project brief within the context of a domestic property, such as a small apartment block, which will give plenty of opportunities for learners to collate evidence across all three learning aims for their assessments. This could be a case study or project data obtained through any related industry links. After the initial delivery of each learning aim, use this project as a tool for application of the principles learned.

### **Learning aim A - Understand the regulations and legislation applicable to electrical installations**

#### **Learning aim A1**

- Begin with a tutor presentation to introduce the topic. Make use of video clips to demonstrate the hazards arising from following unsafe working practices. Introduce local and national legislations relevant to health and safety in electrical installations, highlighting key features relevant to site safety, construction site electricity and provision of welfare facilities. Engage learners through questions and answers (Q&A).
- Engage learners through use of project data (drawings and layout) and then introduce relevant standards, workplace safety, safety in design and construction, test requirements and certifications required. Using the project data, lead a class discussion relating to special location considerations such as bathrooms or outdoor locations. Engage learners through Q&A.
- Use a knowledge quiz to check learning so far. Draw on key points and summarise.
- Split learners into groups and allocate each a specific regulation or standard relevant to the client brief, as a group research activity. For example, one group could investigate construction site safety while the other could do safety through design and management. All groups share their findings. Facilitate and add as necessary, collating group notes for the class in a shared access folder.

#### **Learning aim A2**



- Introduce the topic by showing how earthing and bonding work, and why these are necessary. Engage learners through Q&A.
- Using a tutor presentation, introduce safety devices required for circuit protection within the consumer unit, such as various types of circuit breakers and residual current devices.
- Follow this with a group research exercise where learners explore the manufacturers' sites to find products relating to circuit safety, along with technical details. Have Learners share their findings with their peers. Add where necessary and summarise.

#### **Learning aim A3**

- Using a tutor presentation, introduce standard units and calculations used in electrical systems, what these measure and what their relationship is with Direct Current (DC) and Alternating Current (AC) circuits.
- Develop a tutorial exercise relating to calculation of electrical power. Demonstrate how to calculate it by using a step-by-step procedure. After this, ask learners to work in pairs to solve the exercise sheet. Give support as necessary.
- Share the model answers with the learners in terms of both accuracy of answers and how the solutions should be laid out.
- Introduce the concepts of electrical energy and electrical charge, as well as important laws such as Ohm's and Kirchoff's laws. Demonstrate how values of voltage, resistance, power and current are calculated.
- Ask learners to work in pairs on the tutor-developed exercise sheet. Give support as necessary. Share the model answers with the learners in terms of both accuracy of answers and how the solutions should be laid out.

#### **Learning aim A4**

- Using a tutor presentation, introduce important terminology and principles such as potential difference, AC wave forms and electromotive force (emf). Engage learners through Q&A.
- Use a knowledge quiz as a learning check. Give model answers, ask learners to do self-assessment and give constructive and developmental feedback.
- Develop tutorial exercises relating to calculations that learners need to carry out when applying the principles of electricity to the behaviour of simple electrical components. These should include a range of calculations such as magnetic flux, flux density, induced and back emf and inductance. (Please refer to the relevant unit content to ensure full coverage.)
- Demonstrate how to calculate some of these by using a step-by-step procedure. After this, ask learners to work in pairs to solve these exercise sheets. Give support as necessary. Share the model answers with the learners in terms of both accuracy of answers and how the solutions should be laid out.

#### **Learning aim B - Undertake the design of an electrical installation for a property**

**For support resources relevant to this learning aim, please refer to the suggested videos listed in the Resources section at the end of this document.**

- Engage learners to develop an outline of a client brief. You could ask questions such as 'What kind of lighting system would you like in your house?' or 'Would you consider having security and fire protection?' Summarise key points and add as necessary. You could use this brief by adding details as required for this learning aim as well as learning aim C.



- Alternatively, you may wish to revisit the project documents analysed by groups in learning aim A. Learners will require adequate details such as lighting requirements, safety considerations, materials required and performance requirements.

#### **Learning aim B1**

- Use design examples, product videos, drawings or other interactive/graphical resources to give underpinning knowledge about power requirements and wiring methods.
- Ask learners to work in groups. Give a design drawing and ask learners to identify key elements used in the circuit. Allocate each group a specific area to explore. For example, one group will be given cable routing while the other could work on over current protection.
- Lead a class discussion where learners share their findings. Summarise key points, add where necessary and give constructive and developmental feedback.

#### **Learning aim B2**

- Using a tutor presentation, introduce various cable types, wiring and electrical systems and techniques that need to be considered and specified in an electrical installation. Engage learners through Q&A.
- Use a knowledge quiz to assess learners' understanding of suitable wiring techniques and cables. Draw on key points and summarise.
- Invite a guest speaker who has current knowledge and experience of working in a Building Information Modelling (BIM) environment. The guest speaker could bring in examples illustrating benefits and challenges of working in a collaborative environment. Prepare learners for this visit by giving resources related to BIM, and ensuring that they have suitable questions to ask and are making a note of key points during the guest lecture.

#### **Learning aim B3**

- Use a tutor presentation to introduce electrical lighting standards in terms of luminaires required to meet user requirements and standards. Using the example design project, show how electrical lighting circuits are given within premises to satisfy the client needs. Use Q&A to engage learners.
- Use the client brief developed earlier or the example project and ask learners to produce a detailed electrical circuit design, considering the legislative requirements and the client needs. This activity could also be conducted in small groups. The design should include a variety of aspects such as lighting zones, cable routing illumination levels and glare rating. (Please refer to the relevant unit content to ensure full coverage.)
- Have learners prepare and present their design to the class. Ask them to justify their design choices and update plans following constructive and developmental feedback.

#### **Learning aim B4**

- Using the example design project, show how data, fire protection and security systems are given within premises to satisfy client needs. Use Q&A to engage learners.
- Use the client brief developed earlier or the example project and ask learners to produce a detailed design for data, fire and security systems, considering the legislative requirements and the client needs. This activity could also be conducted in small groups. The design should include a variety of aspects, such as local area network (LAN) and wide area network (WAN), alarms and standalone smoke detectors. (Please refer to the relevant unit content to ensure full coverage.)



- Have learners prepare and present their design to the class. Ask them to justify their design choices and update plans following constructive and developmental feedback.

### **Learning aim C – Develop a specification for materials, components and ancillary equipment for an electrical installation**

**For support resources relevant to this learning aim, please refer to the suggested videos listed in the Resources section at the end of this document.**

#### **Learning aim C1**

- Using a tutor presentation, introduce materials and components focusing on characteristics which help to carry and distribute electricity safely. Show examples of how schedules and specifications for materials and components are developed. Engage learners through Q&A.
- Continue with the same project designed during learning aim B. Working in small groups, ask learners to choose suitable materials and components. Allocate a specific area to each group to explore. For example, ask one group to select suitable earthing and bonding, and other groups to select power outlets. (Please refer to the relevant unit content to ensure full coverage.)
- Ask learners to share their findings with the class. Summarise key points, add as necessary and give constructive and developmental feedback.
- Have learners develop schedules and specifications for materials, components and ancillary equipment for the project. Develop a checklist to support learners, based on the unit content.
- Support learners while they are working to develop the specifications, so that they use the correct terminology and style. This activity could also be conducted in one-to-one tutorials with the groups.

#### **Learning aim C2**

- Using design examples, introduce the function of a consumer unit. Focus on its suitability for the given installation, giving adequate zoning and protection, and the need to have a non-combustible enclosure. Engage learners through Q&A.
- Continue with the same project learners are working on for materials and components. Working in small groups, ask learners to choose a suitable consumer unit for the given context. Have learners share their findings with the class. Summarise the key points, add as necessary and give constructive and developmental feedback.
- Ask learners to develop a specification for the selected consumer unit. Develop a checklist to support learners, based on the unit content.
- Support learners while they are working to develop the specifications so that they use the correct terminology and style. This activity could also be conducted in one-to-one tutorials with the groups.

#### **Learning aim C3**

- Using design examples, introduce various security and fire systems, and their capability and characteristics. Engage learners through Q&A.
- Lead a class discussion on the benefits of having a composite security solution where these systems work together. Summarise key points, add where necessary and give constructive and developmental feedback.



- Continue with the same project learners are working on. Working in small groups, ask learners to choose suitable fire and security systems for the project. Have learners share their findings with the class. Summarise key points, add as necessary and give constructive and developmental feedback.
- Ask learners to develop a specification for the fire and security systems. Develop a checklist to support learners, based on the unit content.
- Support learners while they are working to develop the specifications so that they use the correct terminology and style. This activity could also be conducted in one-to-one tutorials with the groups.

#### **Learning aim C4**

- Recap the learning journey in this unit, especially across learning aims B and C. Lead a class discussion to develop an understanding among learners of how various parts of the design integrate and how design is communicated.
- Give learners design drawings as well as as-built drawings. Ask them to work out the difference between the two. Draw their attention to the standard symbols used within drawings.
- Lead a class discussion on how as-built drawings are produced and what the benefits are of producing these.
- Ask learners to present their complete design, along with specifications and schedules of the project, to the class. Learners should be able to give evidence of extensive research carried out to finalise their choices. Ask them to evaluate their design choices and add to them, using constructive and developmental feedback.



## **Details of links to other BTEC units and qualifications, and to other relevant units/qualifications**

This unit links to:

- Unit 25: Building Services Control Systems.

### **Resources**

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Level 3 International Qualifications in Building Services Engineering. Check the Pearson website (<http://qualifications.pearson.com/endorsed-resources>) for more information as titles achieve endorsement.

#### **Textbooks**

*Please note that resources relating to regulations and legislation are for guidance only. You could use these if relevant or refer to your local and national legislation.*

*Requirements for Electrical Installations: IET Wiring Regulations*, 17th edition (Institution of Engineering and Technology, 2015) ISBN 9781849197694. This contains essential regulatory details required for the unit.

*Guide K: Electricity in Buildings* (CIBSE Publications, 2004) ISBN 9781903287262. This is helpful for dealing with electrical services in buildings.

*On-site Guide: IET Wiring Regulations*, 17th edition (Institution of Engineering and Technology, 2015) ISBN 9781849198875. This is an essential quick-reference guide to BS 7671.

Stokes, G – *Handbook of Electrical Installation Practice*, 4th edition (Wiley-Blackwell, 2003) ISBN 9780632060023. As the name suggests, this is a handbook covering all aspects of electrical installations in a concise manner.

#### **Journals**

*Electrical and Mechanical Contractor* (Electrical Contractors' Association)

*Professional Electrician and Installer* (Hamerville Magazines Ltd)

*Building Services Engineering Research & Technology (BSERT)* (Sage Publishing). This is CIBSE's quarterly journal, containing useful research relevant to all aspects of building services engineering.

#### **Videos**

- YouTube video: 'Electrical Wiring: Electrical circuits wiring tutorial'.  
A useful video tutorial for electrical wiring, covering electrical circuits wiring.
- YouTube video: a useful clip titled 'What is Electrical Bonding & Grounding and why it's Important'.



- YouTube video: 'Small Yellow Book – On Site Guide'. A video clip explaining amendments to onsite electrical installation requirements.

### **Websites**

*The following websites are useful in terms of understanding current practices and future trends relating to electrical installations. Again, these are for guidance only and could be used if relevant to your local situation.*

Visit the Electrical Contractors' Association website

Visit the Joint Industry Board for the Electrical Contracting Industry

Visit the Chartered Institute of Building Services Engineers (CIBSE) website – the professional body for building service engineers. The website contains information about the codes, products and industry updates.

Visit the Modern Building Services (MBS) website – this site covers a wide range of building services engineering sectors.

Visit the Building Services and Environmental Engineer (BSEE) website – an industry journal published monthly, containing in-depth technical features on subjects relating to building services.

*Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.*