Pearson BTEC Nationals in Building Services Engineering

Delivery Guide

Pearson BTEC Level 3 National Diploma in Building Services Engineering

Pearson BTEC Level 3 National Extended Certificate in Construction and the Built Environment (360 GLH)

Pearson BTEC Level 3 National Foundation Diploma in Construction and the Built Environment (540 GLH)

Pearson BTEC Level 3 National Extended Diploma in Building Services Engineering

First teaching September 2017

Edexcel, BTEC and LCCI qualifications

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All information in this specification is correct at time of publication.

Welcome to your BTEC National delivery guide

This delivery guide is a companion to your BTEC Level 3 National specifications, Authorised Assignment Briefs (AABs) and Sample Assessment Materials (SAMs). It contains ideas for teaching and learning, including practical activities, realistic scenarios, ways of involving employers in delivery, ways of managing independent learning and how to approach assessments. The aim of this guide is to show how the specification content might work in practice and to inspire you to start thinking about different ways to deliver your course.

The guidance has been put together by tutors who have been close to the development of the qualifications and so understand the challenges of finding new and engaging ways to deliver a BTEC programme in the context of the new qualifications from 2017.

Guidance around what you will need to consider as you plan the delivery of the qualification(s) has been provided. You will find information around the structure of your course, how you may wish to build the course for your learners, suggestions for how you could make contact with employers and information around the other support and resources available to you.

Unit-by-unit guidance has been provided, which includes suggestions on how to approach the learning aims and unit content, as well as ideas for interesting and varied activities. You will also find coverage of assessments, including useful advice about external assessment, as well as tips and ideas around how to plan for and deliver your assignments.

You will also find a list of carefully selected resources for each unit. The lists include suggestions for books, websites and videos that you can either direct your learners to use or that you can use as a way to complement your delivery.

We hope you will find this guidance relevant and useful.

Enjoy your course!

What's new

The BTEC Level 3 Nationals 2017 are the result of more than three years' consultation with employers, higher education institutions, and many thousands of tutors and managers in colleges and schools. Our aim has been to ensure that the BTEC Level 3 Nationals continue to allow a recognised and well-respected route into employment or higher education by meeting the needs of these key stakeholders and that learners continue to enjoy a stimulating course of study and develop the skills and attributes that will enable them to progress.

As a result of this consultation and on the advice of employers, higher education institutions and most importantly of those of you who teach BTEC, some key changes have been made to the BTEC Level 3 Nationals. These are described throughout this delivery guide and include the following.

- **Updated content and a larger proportion of mandatory content** – both employers and universities said they wanted a greater consistency in coverage of the subject for BTEC learners. Employers wanted to see systematic coverage of core knowledge and skills for their sector, and for the Nationals to reflect up-to-date industry practice.
- **The reintroduction of external assessment** – employers were keen to see an element of rigour and consistency across the country in terms of assessment, while higher education institutions wanted learners to be better prepared for meeting deadlines and preparing for formal exams, where appropriate. Both were keen to see learners applying their knowledge and skills to new contexts through synoptic projects and assessments.

- **A focus on employability skills** – the BTEC approach to learning, through projects, practical assignments, group work and through simulating the world of work, has always supported the development of employability skills, e.g. self-management. In the new Nationals, the balance of cognitive and skills work has been carefully calibrated to ensure that learners get a range of different opportunities across their course.
- **Broader assessment in internal units** – the assessment criteria for each unit are carefully structured to set a clear level of demand. Distinction criteria encourage and require depth of study, including demonstration of the application of knowledge and understanding as well as a synoptic element for the learning aim or unit.
- **Alignment with DfE criteria for performance measures for 16–19 year olds in England** – all new BTECs are designed as either Applied General qualifications or Tech Levels to fulfil criteria for inclusion in 2018 performance tables and funding for 16–19 year olds and 19+ learners.

To support transition to the BTEC Level 3 Nationals 2017, we are providing a support programme with exemplar and practice materials, and training is available. Please see the *Support and resources* section for details of the support and the link to sign up to training, which will be available from 2017 and throughout the lifetime of the qualification.

Notes:

The specification tells you what must be taught and what must be assessed. This delivery guide provides suggestions and ideas on how you could do this.

The suggestions given in this delivery guide link with the Authorised Assignment Briefs provided by Pearson, but they are not compulsory. They are designed to get you started and to spark your imagination.

Contents

OVERVIEW

Delivery Guides as support

In the specification, the 'Unit content' tells you what must be taught and the 'Assessment criteria' what must be assessed. The 'Essential information for assessment decisions' explains what the assessment criteria mean.

This delivery guide provides suggestions and ideas on how to plan and deliver the qualification, and includes a summary of recent changes.

Unit-by-unit guidance has been provided that includes suggestions on how to approach the learning aims and unit content. Teaching, learning and formative assessment activities are also suggested. You will also find delivery plans to help you timetable your course and ensure your learners are well prepared for internal and external assessments.

Links to carefully selected resources are provided for each unit. The lists include suggestions for books, websites and videos that will help you plan and deliver your course. Alternatively, you may wish to direct your learners to these resources.

Use the delivery guides as model templates or an interpretation on which you can base your own plan. Every delivery guide presents each unit as an exemplar, highlighting building services engineering links to motivate tutors and learners.

Significant changes for those teaching to the new 2017 specification

The BTEC Level 3 Nationals 2017 contain significant changes to the previous 2010 version. These changes reflect the views and demands of construction teaching practitioners, those working in the building services engineering sector and government bodies with oversight of the qualifications.

For those familiar with the older 2010 specification, these changes are summarised in the table below:

Change	**New 2017**		**Old 2010**	
Programme Name	Construction and the Built Environment (Building Services Engineering)		Construction and the Built Environment (Building Services Engineering)	
Qualification Names/GLH	No equivalent		Certificate	180 GLH
	Extended Certificate (Construction & the Built Environment)	360 GLH	Subsidiary Diploma (Construction & the Built Environment)	360 GLH
	Foundation Diploma (Construction & the Built Environment)	540 GLH	90 – credit Diploma (Construction & the Built Environment)	540 GLH
	Diploma	720 GLH	Diploma	720 GLH
	Extended Diploma	1080 GLH	Extended Diploma	1080 GLH
Mandatory Units	Between 4 and 9. All qualifications		Between 1 and 7 Diploma/Extended only	
Optional Units	Choose from up to 32 dependent on qualification		Choose from up to 33 dependent on qualification	
Assessment	Internal through assignment and up to 3 External depending on qualification		Internal only through assignments	

Structure

Unit (number and title)	Unit size (GLH)	Extended Certificate (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)			Extended Diploma (1080 GLH)		
				CBE	C	BS	CBE	C	BS
1 Construction Principles	120	M	M	M	M	M	M	M	M
2 Construction Design	120	M	M	M	M	M	M	M	M
3 Tendering and Estimating	120						M	M	M
4 Construction Technology	60	M	M	M	M	M	M	M	M
5 Health and Safety in Construction	60	M	M	M	M	M	M	M	M
6 Surveying in Construction	60		O	M	O		M	O	
7 Graphical Detailing in Construction	60		O	M	O	O	M	O	O
8 Building Regulations and Control in Construction	60		O	M			M	O	
9 Management of a Construction Project	60			O	O	O	M	O	O
10 Building Surveying in Construction	60		O	O			O	O	
11 Site Engineering for Construction	60		O	O	M		O	M	
12 Low Temperature Hot Water Systems in Building Services	60			O		O	O		O
13 Measurement Techniques in Construction	60		O	O	O		O	O	
14 Provision of Primary Services in Buildings	60		O	O		M	O		M
15 Further Mathematics for Construction	60				M	O	O	M	O
16 Work Experience in the Construction Sector	60						O	O	O
17 Projects in Construction	60			O	O	O	O	O	O
18 Building Information Modelling	60			O	O	O	O	O	O
19 Quantity Surveying	60		O	O		O	O		O
20 Quality Control Management in Construction	60			O			O	O	O
21 Building Services Science	60					M	O		M
22 Economics and Finance in Construction	60						O		
23 Construction in Civil Engineering	60				M		O	M	
24 Planning Application Procedures in Construction	60						O		
25 Property Law	60						O		
26 Conversion, Adaptation and Maintenance of Buildings	60						O		
27 Building Services Control Systems	60					O			O
28 Ventilation and Air Conditioning Design	60					O			O
29 Use of Static and Dynamic Fluids in Building Services	60					O			O
30 Plumbing Technology in Building Services	60					O			O
31 Electrical Principles in Building Services	60					O			O
32 Electrical Installation Standards, Components and Design	60					O			O
33 Measurement Techniques in Building Services	60					O			O
34 Building Regulations and Control in Building Services	60					O			O
35 Principles and Applications of Structural Mechanics	60				O			O	
36 Public Health Engineering	60				O			O	
37 Specialist Civil Engineering Techniques	60				O			O	
38 Highway Construction and Maintenance in Civil Engineering	60				O			O	

Overview of the Building Services qualification suite

The level 3 Nationals in Building Services Engineering are a suite of qualifications that focus on different progression routes, allowing learners to choose the one best suited to their aspirations. Pearson has developed the content of the new BTEC Nationals in collaboration with employers and representatives from higher education and relevant professional bodies. This ensures that content is up-to-date and that it includes the knowledge, understanding, skills and attributes required in the sector.

Whereas the previous Nationals were internally assessed only, this new suite of qualifications has three different types of assessment: internal, external and synoptic. There is also more of an emphasis on developing and utilising links with employers. This may require a review of how the units are delivered and assessed, providing a unique opportunity to create project-based assessments that map across more than one unit, and to embrace employer engagement when developing realistic briefs and case studies.

These qualifications are aimed at supporting post-16 learners to choose specialist pathways within building services engineering related industries by giving them technical skills and required knowledge and hence enable them to follow their desired career goals such as through employment or suitable higher education courses. As mentioned earlier, the employers must have significant involvement in these programmes.

In the Building Services Engineering sector, these are:

- Pearson BTEC Level 3 National Extended Certificate in Construction and the Built Environment (360 GLH)
- Pearson BTEC Level 3 National Foundation Diploma in Construction and the Built Environment (540 GLH)
- Pearson BTEC Level 3 National Diploma in Building Services Engineering (720 GLH)
- Pearson BTEC Level 3 National Extended Diploma in Building Services Engineering (1080 GLH)

All qualifications in the suite share some common units and assessments, allowing learners some flexibility in moving between qualifications where they wish to select a more specific progression route. The published programme specification provides an overview of various qualification sizes clearly highlighting both mandatory (M) and optional (O) units. Some units are mandatory across all qualification sizes, while some units are mandatory only for larger size of the qualification. While choosing the optional units, consideration must be given to possible coordinated delivery across units, as well as to the efficient use of resources.

Making the right choice for your learners

You should support learners in making the right choice that aligns well with future aspirations, such as starting a degree or a specific job role in the industry.

For example, the **Extended Diploma** is largest size of qualification within the suite:

- It is equivalent in size to 3 A levels and allows the learner to develop a substantial common core of knowledge.
- Learners have the choice to study topics in depth across a full range of optional units.
- Learners will develop the broader skills highly valued by higher education institutions, such as critical thinking.
- A range of written and verbal communication skills required in the construction sector will be covered.

Hence, such a qualification would suit learners if they are studying full time over a period of two years and want to pursue a career in building services engineering. It may be the case that they wish to proceed directly into employment as, for example, a technician (as this qualification is intended to meet the requirements of registering as a technician). Alternatively, this qualification will also allow learners to progress into higher education.

For each qualification, no prior study of the sector is needed, but the learner should normally have a range of achievement at level 2, in GCSEs or equivalent qualifications, including English, mathematics and science.

The smaller size qualifications, such as the **Foundation Diploma**, cater for learners who wish to learn about construction alongside other areas of study, such as an A level, and as a support in their progression to higher education.

Making contact with employers

The employers in the construction industry range from small design consultancies to large national and international construction companies. Depending on the size of the qualification, business models of varying sizes will benefit learners, as well as the optional units that you have chosen.

If the centre has well established construction programmes, you could start by contacting employers who are already on the customer database. If this is not possible, developing a list of local companies using internet-based searches is a good start. You could also develop a list of relevant staff within, for example, the local council, Highway Agency and Environment Agency. You should also look to build links with professional bodies such as the Chartered Institute of Building (CIOB), Chartered Institute of Building Services Engineers (CIBSE) and Institution of Civil Engineers (ICE).

Making contact with employers via email or phone is a good start, but ensure that you are clear regarding the unit content in advance. You should also be flexible with the timing of any site visits or guest speakers. While talking to employers, it is always worthwhile to articulate the mutual benefits of developing a positive relationship between the centre and the employers. For example, one of the benefits that they are likely to receive from this relationship could be by offering work placements, which will give them opportunities for low-risk employee recruitment, while also contributing towards the local and national skills agenda.

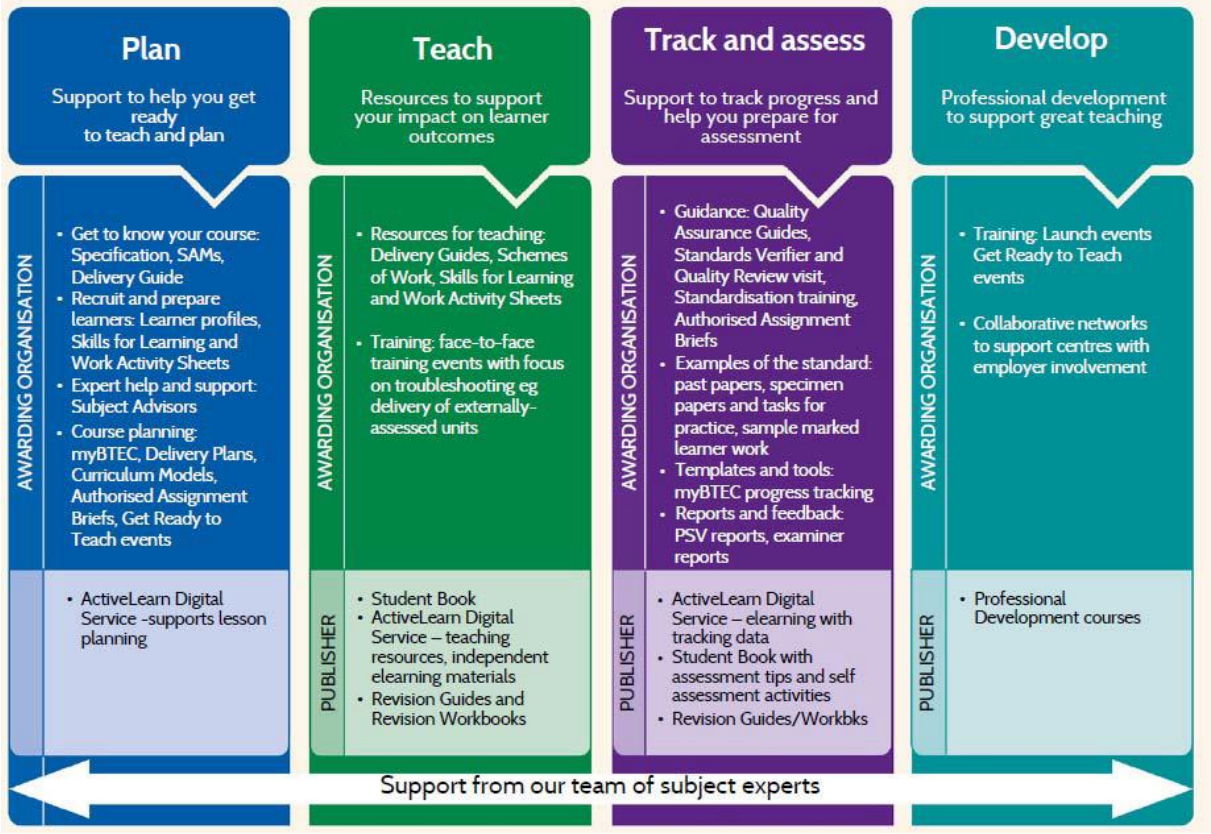
SUPPORT AND RESOURCES

There are a wealth of resources available to ensure that you feel confident delivering your BTEC National qualification throughout your entire course.

All the 'Awarding Organisation' resources can be found on the Pearson Qualifications website here:
http://qualifications.pearson.com/en/qualifications/btec-nationals/construction-and-the-built-environment-2017.html

As well as the free resources supporting the qualification, provided by Pearson as an Awarding Organisation, Pearson Learning Services ('Publisher' in the tables below) provides a range of engaging resources to support BTEC Level 3 Nationals, including:

- Student books in e-book and print formats
- Revision guides and revision workbooks in e-book and print formats
- Teaching and assessment packs, including e-learning materials via the ActiveLearn Digital Service



In addition to the 'publisher' resources listed above, publishers other than Pearson may produce textbooks that are endorsed for BTEC. Check the Pearson website (http://qualifications.pearson.com/en/support/published-resources.html) for more information as titles achieve endorsement.

There are also a number of people who are available for you to speak to:

- **Standards Verifiers** – they are subject specialists who can support you with ensuring that your assessment plan is fit for purpose and whose role is to confirm that you are assessing your learners to national standards as outlined in the specification by providing quality assurance through sampling.
- **Curriculum Development Managers (CDMs)** – they are regionally based and have a full overview of the BTEC qualifications and of the support and resources that Pearson provides. CDMs often run network events.
- **Customer Services** – the 'Support for You' section of our website gives the different ways in which you can contact us for general queries. For specific queries, our service operators can direct you to the relevant person or department.

Subject Advice
TeachingConstruction@pearson.com

Training for the new BTEC Level 3 Nationals can be found on the Pearson website here: http://qualifications.pearson.com/en/support/training-from-pearson-uk.html

Unit 27: Building Services Control Systems

Delivery guidance

Approaching the unit

The focus during the delivery of 'Unit 27: Building Services Control Systems' should be on developing knowledge and understanding of the purpose and function of building services control systems, and the operational characteristics of control components and devices.

Drawings, illustrations, images, animations and video clips are all useful resources to explain the principles governing control systems as well as to understand operational characteristics of control devices. Such resources are freely available online and can be easily incorporated into tutor presentations.

In addition to this, site visits to a large project or to a manufacturing facility where learners could have first-hand experience of both electrical and mechanical control systems such as heating, ventilation, air conditioning, refrigeration and lighting are also useful. The number and frequency of such site visits would vary according to your delivery schedule and availability of the site(s).

Involving local professionals and experts from the building services engineering design and construction sector as guest speakers will be helpful, in order to enthuse learners as they gain an insight into the current practices within the industry.

Tutors could either develop a 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.

As this unit concentrates on different forms of technology applied to various mechanical and electrical building engineering services, it would be appropriate to deliver this unit at a point where learning on other building services units has happened, or is happening alongside this unit.

Delivering the learning aims

Learning aim A

Learning aim A focuses on the principles underpinning building control systems, such as control loops and control modes. It will enable learners to develop an understanding of these principles that will help them to appreciate operational features of devices and systems, as well as their purposes.

Throughout the delivery of this learning aim, engage learners with knowledge quizzes, paired and/or group activities, class discussions and presentations. These provide learners with opportunities for peer learning.

Tutors could introduce control loops and modes by using animations, DVDs, examples, illustrations or web-based videos (some suggested resources have been provided in the 'Resources' section). Once the basic principles have been understood, learners can participate in more 'in-depth' group activities and class discussions. For example, learners can comment upon the rationale behind a specific control system in terms of its use and benefits.

Further activities may include conducting independent research and small group presentations on control modes and the operational characteristics of various control systems.

Site visits are key to engaging learners. For example, an early visit to a site where a range of control systems is being installed will help to consolidate learner understanding

of the content within learning aim A. The site visit will also reinforce learning about legislative requirements and approaches to providing building control systems.

Learning aims B and C

Learning aim B and learning aim C could be delivered using a project-based approach. These learning aims deal with the application of the principles learned in learning aim A and are very practical in nature. Learners have to produce a complete system design and justify their selection of the various systems and components.

For the delivery of these learning aims, the introduction of systems and control components followed by well-structured research tasks would be beneficial for learners.

Tutors could then introduce real-life case studies of large commercial or industry projects. Learners would require access to project drawings, manufacturer's specifications, design data and project reports to quote some examples. Tutors could contact the companies for such information, which are often more than willing to help.

Tutors could also arrange for a guest speaker to visit the centre, such as a site manager, design engineer or a technical staff member working at the local council. The guest speaker could share some examples with learners of current design and installation principles that are found within the industry.

Ensure that the appropriate safeguards are in place during the site visit, and coordinate with site staff in advance so that all parties are aware of the learning opportunities during the visit. Reinforce this learning in class, using project-related data.

Learners need to consolidate their knowledge through the use of case studies, which can include interesting problem-solving challenges for them. For example, tutors could task learners with exploring the challenges and impacts of using alternative types of sensors, actuators, controlled devices and controllers for given, specific building services installations. To provide access to more case studies, tutors could either approach companies for relevant information, or download examples from the web.

Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
A Understand the principles associated with building services control systems	**A1** Control loops **A2** Modes of control **A3** Operational features **A4** Purpose of control systems	Analyse a client brief in terms of the modes of control and operational features.
B Apply the principles of building services control systems and the function and operational characteristics of control systems	**B1** Generic functions **B2** Safety controls and functions of safety control systems **B3** Operational characteristics of control devices and components **B4** The role of the computer technology in control systems	Develop a control system for a scenario, from a set of criteria. As part of the solution, produce a specification for all elements of the installation.
C Develop an appropriate specification and schematic drawings for building services control systems	**C1** Control functions **C2** Control strategies **C3** Drawings	

Assessment guidance

There is a maximum number of two summative assignments for this unit. The assignment briefs should be set within the context of a large building services engineering project, such as a commercial or an industrial building.

For learning aim A, give learners a case study containing adequate details about a building services control system, so that they could justify the proposed control system as well as the use of various control components and their operational features. The justification must relate to the given case study, drawing on their experience and knowledge of the factors to consider in the design of any building services control system.

For learning aims B and C, tutors should include sufficient details so that learners could produce system design and justify the selection of systems and components. Involving local employers in the assessment or using one of the industry projects will be beneficial for the learners.

Submitted assessment evidence could be in the form of a project or an investigative report and a proposal. Tutors could ask learners to include drawings, sketches, illustrations, manufacturers' data and a list of information sources used.

Getting started

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

Unit 27: Building Services Control Systems

Introduction

Introduce learners to the unit using animations, DVDs, pictures, illustrations or web-based videos relating to the building services control systems used within the context of a large construction project.

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 large building services engineering project, such as a commercial or an industrial building, which will provide 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.

Well-organised site visits are invaluable for the delivery of this unit. Visits will need to be timetabled carefully to ensure that learners have sufficient knowledge across the learning aims to fully benefit from the experience. The site visits for this unit could also be done in conjunction with the visits from other units. It is critical to coordinate with the site staff in advance to confirm the:

- health and safety requirements
- type of control systems and components used
- extent to which the site staff could engage (project presentation, access to drawings, project data).

Learners could prepare checklists before the visits, so that they can record details of the different components and processes relating to the control systems. If finding appropriate sites proves difficult, tutors could instead use project examples through DVDs or other project data.

Learning aim A – Understand the principles associated with building services control systems

- The delivery of this learning aim would benefit from a site visit for learners to examine the installation of building services control systems. If a visit is not possible, use of online resources and video clips can enhance tutor-led presentations and classroom-based activities.
- For the delivery of learning aim A1, tutors could begin with delivering a presentation to introduce the topic by showing how control loops work using animations, DVDs, illustrations or web-based videos. This should include open, closed, single and multi-loops. Facilitate a class discussion on the benefits and drawbacks of each type.
- For the delivery of A2, learners are to consider the various modes of control. Tutors could give learners a group research activity where they are to find examples of each mode (e.g. two-position, proportional and integral controls). They are to summarise the key points, presenting their findings back to the class and including any additional information as necessary.
- In the following session, for the delivery of learning aim A3, tutors can deliver a presentation on the operational features of control systems, while also using examples. This should include the performance of control systems in terms of

speed, accuracy and reliability for different construction scenarios. Apply learning checks through a knowledge quiz or a Q&A session.

- For a group activity, issue learners with a set of example project documents, including details of building control systems, design brief, design requirements and the final design. Form learners into small groups and assign them a specific topic out of the unit content for this learning aim. For example, 'Group A' are to identify the operational features of the given control system. All groups are to share their findings. Tutors would facilitate a class discussion and include any additional information as necessary, collating group notes for the class in a shared access folder.
- Learners are required to know the legislative requirements as part of the delivery of learning aim A4, including the use and benefits of control systems. Tutors can deliver a presentation to introduce relevant regulations. Use the previous project data to provide examples of compliance. Tutors can also give learners summary handouts that include the key features of regulations, which learners could apply to the design brief.
- Lead a class discussion regarding the use and benefits of control systems. This could be conducted in small groups, providing learners with some 'What If?' scenarios to emphasise the need for suitable controls. Summarise the key points and include any additional information as necessary.
- Use a knowledge quiz to check learning before starting designing the systems. Tutors can use the same example project data and ask questions to assess learning so far. Provide model answers, ask learners to do self-assessments and provide them with constructive and developmental feedback.
- To review learning across this topic, facilitate a class discussion, asking learners to justify the selection of systems and components for the example project. Learners can then summarise their feedback and expand on the key points as necessary.
- For the summative assessment, learners are to analyse a client brief in terms of the modes of control and operational features. Give learners a case study containing adequate details about a building services control system, so that they can justify the proposed control system as well as the use of various control components and their operational features. The justification must relate to the given case study, drawing on their experience and knowledge of the factors to consider in the design of any building services control system.

Learning aim B – Apply the principles of building services control systems and the function and operational characteristics of control systems

Learning aim C – Develop an appropriate specification and schematic drawings for building services control systems

- Start the delivery of learning aims B and C using a group research activity. For the delivery of learning aims B1 and B2, learners are to form into small groups to carry out research on the functions of various control systems. Allocate a specific system to each group, taking guidance from the unit content in the specification. For example, one group could work on heating and ventilation control systems (e.g. temperature, humidity, air quality and flow), while another group could be given lighting control systems (e.g. lighting levels, time and pollution). Ensure that each group also researches the use of these control systems to protect building users from potential accidents and health issues, such as combustion, leak detection and carbon monoxide.
- All groups are to produce a presentation in order to share their findings. Tutors can facilitate a class discussion and include any additional information as necessary, collating group notes for the class in a shared access folder.
- For the delivery of learning aim B3, tutors can deliver a presentation introducing

the operational characteristics of control devices and components. Form learners into groups and ask each group to produce a poster for a given topic (take guidance from the unit content). For example, one group could explore sensors while the other could consider actuators. Each group will present their posters to their peers. Use this opportunity to apply learning checks, summarise learner findings and include any additional information where necessary.

- Learners will benefit from a guest speaker for the delivery of learning aim B4. The guest speaker could be from a design, manufacturing or installation/maintenance background. The role of the computer technology in control systems is a very broad subject, yet it is likely to attract attention of learners. Prepare learners by providing them with relevant reading materials that would help them to draft questions they can ask during the guest lecture. Ensure that the guest lecturer is aware of the unit content and the level of the qualification. Facilitate the guest lecture (capture it on video if possible) and collate the information, holding a Q&A session afterwards to answer any learner queries.
- Facilitate a knowledge quiz to assess learners' understanding of control systems and components, drawing on the key points and summarise.
- For learning aim C, tutors are to develop a design brief covering requirements for a commercial or industrial building, ensuring that learners have the opportunity to design systems at the appropriate level.
- Form learners into small groups. Each group is tasked to investigate suitable control devices and associated manufacturers' data. They are to produce a detailed system design including sensors, actuators and controllers, as well as all of the relevant components. Learners could prepare and present their project schematic to the class. Ask them to justify their control strategy and schematic drawings.
- Support learners while they are working to develop the systems and specifications, so that they use the correct terminology and style. This activity could also be conducted in one-to-one tutorials with the groups.
- Ask learners to present their complete design along with specifications to the class. Learners should be able to provide evidence of extensive research carried out to finalise their choices. Provide constructive and developmental feedback.

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

This unit links to:

- Unit 12: Low Temperature Hot Water Systems in Building Services
- Unit 28: Heating, Ventilation and Air Conditioning Design
- Unit 30: Plumbing Technology in Building Services Engineering
- Unit 31: Electrical Principles in Building Services Engineering
- Unit 32: Electrical Installation Standards, Components and Design

Resources

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

Textbooks

Burberry P, *Environment and Services* (Mitchell's Building Series), (8th edition), Routledge, 2015 ISBN 9781138167780 – This book explains the principles of service installations and environmental considerations, and is relevant to the content of this unit.

Chartered Institute of Building Services Engineers, *CIBSE Guide H: Building Control Systems*, Routledge, 2000 ISBN 9780750650472 – This book contains extensive details of modern control systems and relevant information technology.

Hall F and Greeno R, *Building Services Handbook* (8th edition), Routledge, 2015 ISBN 9781138805637 – a handbook covering all aspects of building services in a concise manner

Zaher M, *Building Services* (Kindle Edition), Amazon Media EU S.à r.l., 2012 ASIN B00GWXW5QG – a very good resource to help understand principles and operation of air conditioning, pumps, fans, blowers and plumbing

Journals

Building Services and Environmental Engineer (BSEE) (Datateam Business Media) – an industry journal published monthly and contains in-depth technical features on subjects relating to building services.

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.

P & HE Journal (Chartered Institute of Plumbing and Heating Engineers (CIPHE)) – This is CIPHE online journal, which covers a broad range of areas relating to plumbing and heating.

Videos

'Siemens' – Access the website and select the 'Company' tab, then 'About Siemens', 'Businesses' and 'Building Technologies' to find a video clip called 'Environmentally-friendly buildings and infrastructures' that provides an overview of control systems.

Tutors can access the *YouTube* website and search for the following videos:

- 'Building Energy Management System Review' by AESCO PTY LTD.
- 'HVAC Controls Building Automation Systems' by Nakenterprise – explains the past, present and future of HVAC control systems
- 'AHU (air handling unit) working through BMS system (HVAC stream)' by techguru.

Websites

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

'Chartered Institute of Plumbing and Heating Engineers (CIPHE)' – website for the relevant professional body, containing information about the codes, products and industry updates

'Heating Equipment Testing & Approval Scheme (HETAS)' – the official body to approve biomass and solid fuel heating appliances, fuels and services – The website has useful resources about relevant products.

'Modern Building Services (MBS)' – website covering a wide range of building services engineering sectors

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.

Unit 28: Heating, Ventilation and Air Conditioning Design

Delivery guidance

Approaching the unit

Efficient ventilation is essential for healthy living and working. Design innovation, legislation and management are some of the exciting aspects of today's technology that ensure modern buildings have clean and comfortable environments. By enrolling in 'Unit 28: Heating, Ventilation and Air Conditioning Design', learners will gain knowledge about the operational characteristics, principles and effective installation of heating, ventilation and air conditioning designed systems within modern commercial, residential or industrial buildings. The skills they will acquire focus on design requirements for ducting and applying appropriate components. This is an internally assessed optional unit within the BTEC Level 3 National in Building Services Engineering qualification suite.

While the overall emphasis of this unit is to give learners the knowledge and skills relating to ventilation and air conditioning design and installations in modern buildings, this unit would benefit from employer involvement in the form of guest speakers, vocational visits and technical workshops involving staff from local construction organisations. This will be engaging for learners, as it gives them the opportunity to experience a real-life vocational environment and contact with the employer. This will also give them an insight into employees' experiences, leading to a contribution of ideas and insights that will aid in the development of their summative assignments.

The key content areas for learning aim A are the consideration of appropriate ventilation and air conditioning plants, equipment and materials, and the use of air terminal devices to comfortably and efficiently control airflow. Learners will study characteristics and selection of suitable ductwork materials and service components for ventilation and air conditioning systems. Lastly, the focus will be on the different elements of air-handling units and plants. There will be consideration of the benefits of these systems.

Learning aim B focuses on key appropriate design considerations for heating and cooling, performance requirements and an evaluation of ventilation systems and methodologies.

The focus of learning aim C is on the efficient and safe design of heating, ventilation and air conditioning systems and the selection and specifications of air-terminal device ductwork and fans so that they meet the system's performance requirements.

Tutors will need to plan for the needs of learners through different differentiation strategies, collaboration and independent activities. Learners will also bring their own knowledge and skills through their experiences in previous educational settings or perhaps as employees when carrying out work experience or in a part-time job.

There should be an emphasis on learner progression and delivery methods across all learning aims. This can be achieved through a varied approach, including presentations, tutor-led or class discussions, individual activities, group work, practical demonstrations, independent research, knowledge quizzes and assignment writing. Tutors can arrange for learners to visit different industrial settings within the heating, ventilation and air conditioning sectors and/or for guest speakers to come in and visit the centre. These employees can be from various user organisations, which would be beneficial to learners in gaining an understanding of the different types of organisations within the industry.

To make learners achieve all the learning aims, tutors can engage them by accessing online resources to pertinent information and images or videos from websites, such as Google® and YouTube®, and the recommended text books (see 'Resources' section). The unit must be delivered in a setting that can give learners access to appropriate teaching and learning rooms and IT and practical equipment.

When delivering the unit content, it is critical that tutors ensure that activities are innovative and interesting, preparing learners with the necessary skills and knowledge while engaging their interest. Lessons should be varied and not all identical with information being conveyed in different ways with a range of different activities in each lesson. These are vocational qualifications and so, where possible, practical activities should be included (e.g. different control systems and using open or closed loop).

Level 3 learners should be encouraged to be more independent in their thinking, so it is important to implement more research tasks and small group presentations throughout the delivery of the unit. Consider using the latest technologies to engage learners and present current scenarios, including the latest control systems, using the internet of things (IoT) and mobile phones.

All practical activities should be carried out in accordance with regulations and legislation, and collaboration through group work should also be encouraged along with independent learner research.

Tutors can deliver the learning aims using a wide range of teaching and learning strategies as indicated in the delivery guidance above. These must cover information on requirements, performance and the evaluation of the different types of systems. Tutors can illustrate points with reference to examples within businesses, i.e. manufactures, suppliers and installation providers.

For learning aim A, tutors can ask learners to share their experiences. This could include site visits, employer workshops and technician guest speakers. Tutors are to demonstrate the features, benefits and drawbacks of ventilation and air conditioning systems, identifying all of the individual components within the system and their operational features. This should include air-terminal devices (which control the flow of air) and ductwork (which carries the pipes and air for heating and cooling systems. Jointing relates to the assembly of the system. The knowledge gained from these sessions will provide learners with a foundation to develop their knowledge and skills further through group work, class discussions, practical tasks and independent activities. When planning, tutors should allow time for learners to reflect, feed back and review, and have an iterative approach.

For learning aims B and C, the focus is on the consideration of appropriate systems for heating and cooling that support the user and building. Tutors should provide relevant presentations and industrial specifications or standards, using real-world examples or case studies, such as Mitsubishi, Electrolux, Hitachi and De'Longhi, containing full manufacturer details. Tutors should also facilitate the development of accurate and professional line drawings for a given scenario or case study. The tutor will develop learners' skills in the selection of air-terminal devices, ducting and associated ancillary components. Planning should introduce good practice and an opportunity to share relevant experiences.

For learning aim C, the focus is on the evaluation of the design of the heating and cooling system and equipment, including relative flow rates and associated components, ducting, fans and plant. Learners will need to focus on the relevant calculations, layout of systems, equipment and diagrams and industrial standards.

Tutors will need to give learners the opportunity to work through calculations and specifications for airflow rates, such as mass and volumetric flow rates, seasonal psychrometric cycles and thermal requirements and supply conditions. This should also include air-terminal devices – throw and resistance, ductwork – duct sizes using pressure drop and/or constant velocity methods, as well as total, static and velocity pressure. Tutors can carry out these activities through small group work or group activities, class discussions, practical tasks and individual research and evaluations.

Delivering the learning aims

Throughout the delivery, the content of this unit should relate to a number of units in this qualification, which will help to motivate learners.

Learning aim A

Learning aim A is about understanding the types of structural members and how these behave under various loading conditions. This learning aim provides the underpinning knowledge required to develop skills in structural mechanics.

The sessions could start by introducing how several types of loads act on structures. Make full use of animations, DVDs, pictures, illustrations or web-based videos. Then, introduce concepts such as compression, tension, deflection, stress and strain, as well as any structural materials used (e.g. steel, timber and reinforced concrete) by touring the campus building and asking learners to identify the structural materials that they can see.

Once learners have grasped the concepts, introduce how the behaviour of structural members could be shown graphically and explain their impact on structural design. Engage learners by demonstrating examples, such as loading types, types of forces and loading configurations, and then give learners activity sheets where they can practise developing these skills.

Introduce calculations related to section properties, such as stress, strain, modulus of elasticity and the factor of safety.

Learners can be supported and challenged during unit delivery through a variety of means, such as knowledge quizzes, paired or small group activities and class discussions, which will give learners opportunities for peer learning.

Learning aims B and C

Learning aim B is concerned with the analysis of beams, columns and frames. It should be emphasised that this analysis gives an essential base for the design, which is covered in learning aim C.

A holistic project-based approach could be adopted, where the delivery of learning aims B and C could be combined, as these have a significant overlap in terms of their content. Learners could complete a project, which will give them an opportunity to demonstrate the skills to analyse beams, columns and frames and to design beams, columns and mass retaining wall. Structural engineering consultancies can be contacted in order to obtain analysis and design examples.

Introduce the learning aims by solving examples in a step-by-step manner. Develop work sheets covering beams, columns, frames and retaining walls so that learners can practise the analysis techniques. The example project can be used, which learners could then analyse and design.

Learning aim D

Learning aim D could be delivered through a tutor-led research activity. Explore opportunities where learners could visit a technology exhibition and use this for both delivery and assessment of this learning aim.

It is important to have access to relevant project information, such as drawings, especially those related to layout, material specifications and loading conditions.

Finally, where possible, invite a guest speaker from design background. The guest speaker should be able to share with learners the current approaches and design practices in the industry.

Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
A Understand the operational characteristics of ventilation and air conditioning requirements for buildings	**A1** Air-terminal devices **A2** Ductwork, jointing and systems **A3** Air-handling units	Analyse a brief in terms of the components used and their operational features.
B Apply the principles of ventilation, warm-air heating and air conditioning requirements for simple single-zone air conditioning installations and buildings	**B1** Requirements **B2** Design conditions **B3** Ventilation systems	Develop a ventilation and air conditioning system for a scenario, from a set of criteria. Produce a ventilation and air conditioning strategy and schematic drawings.
C Develop appropriate systems and specifications for ventilation and air conditioning systems, ductwork, plant and equipment	**C1** Air flow rates and supply conditions **C2** Air-terminal devices **C3** Ductwork and fans **C4** Air conditioning plant	

Assessment guidance

This unit is internally assessed through two independent tasks: one for learning aim A and the other for both learning aims B and C. Learners are to create a portfolio of evidence for each of the required assessment criteria to track progress throughout the unit. This could include annotated notes, accurate drawings, photographic evidence, ICT presentations and media clips. Tutors are to ensure that learners are logical in their approach and refer to the location, i.e. when on an industrial visit, and evidence, i.e. the photographic material annotated and the date of production (or when this evidence was collected).

For both assessments, the client brief and the design task must give evidence of what is required to achieve: 'Pass', 'Merit' or 'Distinction'.

Evidence produced for the assessment task for learning aim A could include a differentiated written report analysing a brief in terms of the components used and their operational features. For the assessment task for learning aims B and C, learners can develop ventilation and air conditioned system for a scenario from a set of criteria, as well as a ventilation and air conditioning strategy with schematic drawings. Tutor and peer facilitation is an important formative support here, as is the feedback from employers or technicians, following the visits or guest speakers, in order to implement any improvements for learners' summative assignments.

All learners must independently generate individual evidence that can be authenticated. They can also produce photographic and annotated evidence of progress. Tutors to give observation evidence or witness statements from the area where learners are working, such as an educational workshop or a placement and/or visit to an industrial site.

Getting started

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

Unit 28: Heating, Ventilation and Air Conditioning Design

Introduction

Learners are to develop the knowledge and understanding of ventilation and air conditioning design and installations in modern buildings. For some learners, this course may be a different vocational setting, i.e. a focus on the industrial specifications. Be aware that many learners will have encountered ventilation and air conditioning systems in everyday life without appreciating the theory and practical requirements behind them.

The unit can begin with an introduction to the requirements of the unit, i.e. learning aims, assessment criteria and requirements for the summative assessments. Tutor can cover any key terminology required for the unit, and class discussions may be facilitated to collate learner educational or employment experience.

Learning aim A – Understand the operational characteristics of ventilation and air conditioning requirements for buildings

- For topic A1, tutor could deliver a presentation or arrange an industrial visit to a local firm explaining the operational characteristics of the ventilation systems. This should include reference to key terms, operational features and the different materials that can be used. Demonstrate or display working ventilation systems, if available, while learners make notes or develop diagrams or photographs. Tutors and/or employers could hold a Q&A session to answer any learner queries, and tutor can use observation sheets or witness statements that learners can use for their portfolios.
- Tutors could deliver a presentation about the control of air quality and direction of air discharge in supply and extract devices, including operational features, installation requirements, materials, suction dynamics and hoods/other extract devices used in commercial kitchens or industrial applications. As the sessions progress, learners could develop their own glossary of key terminology, features and materials.
- Learners could get into small groups and be provided with a case study using a company, such as Mitsubishi, Hitachi, De'Longhi or Electrolux to create installation requirements and applications of supply and extraction air-terminal devices. They can discuss their feedback with the rest of the class. Learners could then individually sketch out supply and extraction air-terminal devices.
- For topic A2, tutor could plan a technical workshop educational technicians or employers from local firms using a carousel of activities that include both written and practical tasks. These can have tutor observation sheets focusing on the following:
  - characteristics and features of jointing
  - the relationship between physical properties of ductwork and application
  - flexible and fire-rated ductwork
  - criteria for selection of materials and shape
  - published standards and specifications for ductwork.
- Tutors could deliver a presentation explaining the characteristics and selection of appropriate ductwork and materials. Learners are to individually produce real or scale model ductwork and create the appropriate sketches.
- Tutor to deliver a presentation demonstrating the characteristics of appropriate ductwork service components. Learners are to sketch out the ancillary components

such as vibration isolators, take offs, turning vane, and smoke and fire dampers. Facilitate a class discussion to answer any learner queries.

- Learners to get into small groups to assemble and join different ductwork with reference to standards and specifications. Tutor to facilitate.
- For topic A3, tutor to plan a technical workshop or a visit to an air-handling plant. Introduce fans, characteristics, operational features, application of fans and the types of drive. Learners to make notes, diagrams and produce photographic evidence. Tutors to facilitate a class discussion to compare drawings and answer any queries.
- Learners could form into groups of two to conduct online research to find out more about heater/cooler batteries and air-handling units, before feeding back to the class.
- Tutor to deliver a presentation illustrating the general characteristics of heat-recovery devices. Learners to identify and sketch out the components, then facilitate a class discussion to compare drawings and answer any queries.
- Tutor to deliver a presentation illustrating the general characteristics of air cleaning devices and humidifiers. Learners are to form into groups of two to research and present a factsheet to include:
  - key terms, types of filters, filter testing methods and the general characteristics, operational features and application of filters and dust collection/removal.
  - information on the installation and connection of these devices. Learners to present their work. Peers to evaluate.
- Tutor to deliver a presentation illustrating the general characteristics of refrigeration units. Learners to identify and sketch out the components, then facilitate a class discussion to compare drawings and answer any queries.
- Learners to start preparing for their summative assignment for learning aim A. This involves reinforcing the differentiated assessment criteria for summative assignment writing, discussing the different units to be included, i.e. air-terminal devices, ductwork and air handling units, relevant annotated diagrams or photographic evidence, prevention of plagiarism.
- Address any learner misunderstandings through tutor/peer facilitation session. This can include mini- and end-of-session plenaries to evaluate learner performance by asking them what went well, what they could have improved or change for next time etc.

Learning aim B – Apply the principles of ventilation, warm-air heating and air conditioning requirements for simple single-zone air conditioning installations and buildings

- Learning aim B builds upon the work that learners have completed throughout learning aim A. The summative assignment concerns both learning aims B and C in one assessment, and explores the design work within heating, ventilation and air conditioning systems.
- Learners could get into small groups and share educational and/or employment experiences of working with heating and cooling systems, i.e. discuss what they know, need to know etc.
- Tutor could deliver a presentation or facilitate a class discussion on the differentiated assessment criteria and requirements for the summative assignment.
- For topic B1, tutor could invite various guest speakers, such as educational organisation technicians, or arrange for vocational visits that can form the basis of tutor-led discussions on:
  - reasons for heating and cooling systems
  - environmental requirements and considerations, e.g. noise limitation and visual aesthetics

- statutory requirements, such as health and safety
- identification of locations with specific requirements, i.e. internal/external fitment air conditioning, warm air conditioning etc.
- sources of heat gain to buildings
- evaluation of different systems
- performance requirements for proposed installations.

- Learners could prepare a report on the key considerations, including appropriate diagrams. They could independently research these areas, which will provide them with the background knowledge required for the summative assignment.
- For topic B2, tutors could deliver a presentation on the methods of specifying ventilation rates and the selection of ventilation rates for specific locations.
- Learners could get into small groups to complete tutor-devised worksheets on ventilation rates to reinforce understanding.
- Learners could get into small groups and conduct online research into exposure limits (i.e. OEL, WEL, MEL). They can develop a presentation in their groups and present to the rest of the class.
- Tutor to facilitate a class discussion to reinforce the key points and terminology or address any misunderstandings. Tutor and peers to evaluate their performance so far.
- Tutor can arrange for a guest speaker from industry (or a site visit) that will focus on the selection of internal and external design conditions for warm air heated and air conditioned rooms, as well as the impact of room velocity and temperature on comfort. A Q&A could follow to answer any learner's query.
- Learners to estimate heat gains and cooling loads using tabulated data and 'rules of thumb' in small groups, then share information and rank in order of importance through a class discussion. Learners to edit and upgrade work following this activity.
- For topic B3, learners could conduct independent research into the following key terms: natural ventilation, passive stack ventilation, mechanical ventilation, mixed mode and local exhaust ventilation (LEV). They are to include relevant diagrams with their definitions and explanations.
- Learners could get into small groups and conduct online research to prepare a leaflet, factsheet or written report on the different ventilation systems and methodologies. References to the following criteria must be included:
  - operating principles
  - key performance characteristics
  - evaluation of the selection of different methods, i.e. comfort, environmental considerations and installation.
- Learners to get into small groups to complete a practical task. They can be provided with a given practical environment (or case study if unavailable) and they are to create installation requirements and applications of ventilation systems. They will need to document their evidence and complete independent research, which can be evidenced by tutor observation sheets
- Throughout the sessions time to be planned for mini- and end-of-session plenaries. This should give opportunities question and answer sessions, reflection and amendment of learner evidence to upgrade work and evaluate performance, e.g. what went well and areas of development.
- Learners to start preparing for their summative assignment for learning aims B and C. This involves reinforcing the differentiated assessment criteria for summative assignment writing, discussing the scenario and the necessary comprehensive designs required for a detailed ventilation and air conditioning system. This should include relevant annotated diagrams and/or photographic evidence and advice on

the prevention of plagiarism.

- Address any learner misunderstandings through tutor/peer facilitation session. This can include mini- and end-of-session plenaries to evaluate learner performance by asking them what went well, what they could have improved or change for next time etc.

Learning aim C – Develop appropriate systems and specifications for ventilation and air conditioning systems, ductwork, plant and equipment

- Learning aim C builds upon the work covered by learners in learning aim B, as the summative assignment focuses on both learning aims B and C. Tutor to recap the previous learning across the sessions for learning aim B and outline the requirements for the completion of the summative assignment.
- For topic C1, tutor to deliver a presentation on airflow rates for mechanical supply and extract ventilation systems.
- Tutor to prove calculations for learners to solve themselves by using the presentation notes and visiting the 'Comair Rotron®' website (see 'Resources' section).Tutor to also facilitate mini plenaries to check learning.
- Tutor could organise a site visit to investigate supply air conditions, both mass and volumetric. Learners to take notes and practise appropriate calculations for a simple building that uses heating, ventilation or air conditioning system(s). Tutor to answer any learner queries.
- Tutor to demonstrate the reasons for the design and determination of appropriate airflow requirements (e.g. the mass and volumetric flow rates) required to maintain room conditions for warm-air heating and single-zone air conditioning application and plotting summer and winter psychrometric cycles. Learners to complete a tutor-devised worksheet to practise these calculations.
- Industrial visit – focus on good air distribution, layout of efficient extractor devices and examination of different ventilation systems and warm air heating and air conditioning installations. Industrial diagrams to be made available for learners. Learners to take notes and to further practise appropriate calculations for a simple building that uses a heating, ventilation or air conditioning systems. Tutor to answer any learner queries.
- For topic C2, learners could get into small groups to prepare a presentation (or other media format, i.e. video about air terminal devices). The presentation needs to cover the following criteria:
  - selection of air terminal devices and booths, canopy hoods and extractor devices using manufacturer's catalogues or website and manufacturer's specifications, i.e. De'Longhi
  - consideration of throw, resistance and noise characteristics
  - production of relevant air-terminal device specifications and schedules.
- Tutor to facilitate and plan mini plenary or Q&A sessions to address any learner misunderstandings. End-of-session plenaries to focus on evaluation of performance, such as what went well and what can be improved.
- Tutor will need to plan time within this learning aim for learners to reflect on their evaluations and add these to their summative assignments.
- For topic C3, tutor could deliver a presentation on the selection and parameters for ductwork. This presentation to focus on the explanation of different duct diagrams (i.e. a heating coil, air-handling unit, air conditioning for different rooms and return ducts). Ensure that learners include diagrams in their work design and develop their own annotated drawings as a practice for the summative assignment.
- Tutor could arrange a site visit, so that learners could 'work' with technicians to see the format of calculations for duct sizes.

- Learners to watch 'YouTube' videos for computer software advice, and learn how to carry out manual calculations (see 'Resources' section). Tutor to facilitate a Q&A session and assist learners with performing these calculations.
- Learners to get into small groups to complete a given practical task. In each environment, or case study if unavailable, learners are to create installation requirements and applications of ductwork systems for a suitable building considering pressure drops, fans, noise requirements etc. They can continue this over several sessions, and route ductwork appropriately and all supports, considering the appropriate legislation.
- Tutor could arrange an industrial visit for learners to experience the application, installation, maintenance and testing of ductwork and fans via the manufacturer's specification. A Q&A session could follow, with the inclusion of witness statements.
- For topic C4, tutor could deliver a presentation on air conditioning plants that includes reference to space requirements, accommodation of air-handling devices, refrigeration/chiller plant and fans and structural and building work requirements.
- Learners could form into groups of two to develop a spider diagram of the key points and links from the tutor presentation.
- Learners could then conduct independent research into preventative maintenance and repairs. This can be followed by a plenary session for learners to share and evaluate their information.
- Address any learner misunderstandings through tutor/peer facilitation session. This can include mini- and end-of-session plenaries to evaluate learner performance by asking them what went well, what they could have improved or change for next time etc. Allocate time for learners to complete their summative assignments.

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

This unit links to:

- Unit 12: Low Temperature Hot Water Systems in Building Services
- Unit 21: Building Services Science
- Unit 27: Building Services Control Systems
- Unit 29: Use of Static and Dynamic Fluids in Building Services Engineering
- Unit 30: Plumbing Technology in Building Services Engineering
- Unit 33: Quantity Surveying Measurement Techniques in Building Services Engineering
- Unit 34: Building Regulations and Control in Building Services Engineering

Resources

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

Textbooks

Althouse A, Bracciano A, Bracciano D and Turnquist C, *Modern Refrigeration and Air Conditioning* (20th Edition), Goodheart–Willcox, 2016 ISBN 9781631263545

Cook N, *Refrigeration and Air-conditioning Technology*, Macmillan Education, 1995 ISBN 9780333609583

Modern Refrigeration and Air-conditioning (Modern Refrigeration and Air Conditioning), Hardcover, 29 January 2016

These are relevant texts for industrial, vocational and technical learners.

Journals

REHVA: Federation of European Heating, Ventilation and Air Conditioning Associates – search the website for the journal article 'Standards for Ventilation and Indoor Air Quality in relation to the EPBD' (PDF) by Bjarne W. Olesen.

Videos

Tutors can access '*YouTube*' and search for the following videos:

'Duct Designing Software' by IBScad Info

'Prolisp – HVAC Utilities – Ductulator' by ProlispCAD

'Calculating Duct Size' by CTESkills.com

'Air Duct Calculators (Ductulator)' by MicroMetl Corporation

'How to Quickly Size Ductwork!' by David Jones

'Duct Size – How to size a duct system for a house' by SuperCool Slide Rule

Websites

'Arca 53' – this website includes notes (written by Stephen Frazer) used for lectures in the Building Services Engineering industry. Click on the 'Air Conditioning' tab, then the 'Psychrometrics: Page 16/17' to find examples of summer and winter cycle calculations (for learning aim C).

'Comair Rotron®' – it is a website that includes information on airflow rates for mechanical supply and extracts ventilation systems (for learning aim C).

'Health and Safety Executive (HSE)' – click on the 'COSHH' tab followed by 'COSHH basics' and then 'Exposure limits' for information about exposure (for learning aim B).

'Modernize' – search the website for 'HVAC Ducting Size Calculations' for information on how to calculate square footage, use a HVAC ducting calculator and includes an online friction loss calculator.

'The Engineering ToolBox' – search the website for 'Air Ducts Sizing' for information on the velocity method, constant pressure loss (or equal friction loss) and static pressure recovery methods.

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Unit 29: Use of Static and Dynamic Fluids in Building Services Engineering

Delivery guidance

Approaching the unit

During the delivery of this unit, the focus will be on developing the knowledge and skills that will enable learners to gain an understanding of fluid statics and dynamics, as well as design fluid flow systems for a given project.

Illustrations, images, animations and video clips are all useful resources to help explain the various types of fluid flow and fluid properties. Such resources are freely available online and can be easily incorporated into the tutor presentations.

In addition to this, tutors could use simple laboratory experiments to demonstrate, for example, Bernoulli's theorem and pressure measurements. This would be of great benefit to learners. Involving local professionals and experts from the building services engineering sector as guest speakers will be helpful to enthuse learners as they gain exposure to the current practices in the industry.

Tutors can develop a number of activity sheets, including practice questions to support learners in developing the skills to determine fluid properties.

Delivering the learning aims

Throughout the delivery, tutors should relate the content of this unit to the number of units in this qualification, which will help to motivate learners.

For learning aims A and B, tutors should be aware that some learners may require more support while others might require to be challenged with more demanding and complex tasks. Tutors can develop activity sheets that contain certain extension activities to cater for such learners.

Learning aim A is about understanding the physical properties of fluids at rest and types of fluid flow. Developing an understanding of pressure and its measurements is an essential part of this learning aim.

Tutors could start by introducing fluid properties using animations, DVDs, pictures, illustrations or web-based videos. Tutors could use simple laboratory experiments to reinforce learning. One example could be to demonstrate how density and viscosity change with temperature through tutor-led activities.

Engage learners by using activity sheets to develop an understanding of relationship between pressure and head of water. Use practical demonstrations or experiments where learners could take pressure measurements themselves, and therefore, gain an understanding of the concept of gauge pressure.

Tutors could then give learners an activity sheet where they must determine the pressure in manometres containing different liquids. Learners will be able to work independently or in pairs to develop the required skills, and tutors could review and summarise activities, sharing correct answers with the class before progressing to further activities that challenge learners' application of the skills to engineering-related problems.

Learners can be supported and challenged during delivery through a variety of means – such as knowledge quiz, paired or group activities, class discussions and presentations – to provide opportunities for peer learning alongside motivating the learners.

Learning aim B is about behaviour of fluid in motion called fluid dynamics. Fluid flow in pipes as well as in ducts is included. Tutors could use laboratory experiments to demonstrate principles of conservation of energy, such as by using a Venturi metre to reinforce Bernoulli's theorem. This would be of great benefit to the learners, as it underpins the application of fluid dynamics in engineering contexts.

Engage learners by using animations, DVDs, pictures, illustrations or web-based videos. Tutors could use a number of activity sheets where learners can develop their skills in applying principles of fluid dynamics to engineering-related situations.

Part of learning aim C is about developing an understanding of energy losses. Tutors could use videos and animations for this purpose. Tutors could also use laboratory demonstrations where pressure readings can be taken at various points in a simple pipe network to estimate the energy losses. This can be followed up by sharing the manufacturers' data, as well as tables of such losses through fittings and fixtures.

The second part of this learning aim is about selecting appropriate components. Tutors could use a case study where pumps, fans and compressors have already been selected for a system. Tutors could then use a real or mock project brief, where learners choose the components along with justification.

Tutors require access to relevant project information, such as drawings – especially those related to component details, as you would use these as learning resources – and tutors could contact the building services companies who are always willing to help.

Finally, where possible, invite a guest speaker who could be from a manufacturing or consultancy background. The guest speaker should be able to share with learners the current approaches and design practices, ensuring efficiency and environmental sustainability.

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Understand the properties, behaviour, theory and applications of static fluid systems	**A1** Physical properties **A2** Behaviour of fluids **A3** Principles of pressure **A4** Pressure recording devices	Analyse a building services system in terms of the physical properties and behaviour of the fluids.
B Apply the principles of dynamic fluid flow in pipes and ducts	**B1** Dynamic fluid flow **B2** Pipes and ductwork	Evaluate a fluid flow system for a given scenario. As part of the evaluation, produce a report that covers the selection of components, how fluids behave and the potential energy losses within the system.
C Develop appropriate fluid flow systems	**C1** Energy loss **C2** Losses in pipes and ductwork **C3** Pumps, fans and compressors	

Assessment guidance

There is a maximum number of two summative assignments for this unit. Tutors should set the assignment briefs within a context that allows learners to choose the suitable components. For assignment 1, which will cover learning aim A, tutors should provide a vocationally relevant context to the tasks, so that learners can carry out suitable analysis. Learning aims B and C will be addressed in assignment 2, and you should include (in addition to the above) the relevant components and material requirements.

Tutors could ask for assessment evidence in the form of a report and a portfolio containing diagrams and specifications. Ask learners, as part of the instructions, to include sketches, illustrations and a list of information sources used.

Getting started

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

Unit 29: Use of Static and Dynamic Fluids in Building Services Engineering

Introduction

Introduce learners to the unit using animations, DVDs, pictures, illustrations or web-based videos relating to fluid properties and pressure measurement.

Engage learners during the delivery of this unit through knowledge quiz, paired or group activities, class discussions and presentations, as well as through laboratory demonstrations and guest speakers.

Learning aim A – Understand the properties, behaviour, theory and applications of static fluid systems

- For the delivery of topic A1, tutors could begin with a presentation to introduce the topic by showing fluid properties using animations, DVDs, pictures, illustrations or web-based videos.
- Following on from this, tutors could introduce the concept of a 'fluid', the types of flow and fluid properties. Tutors could then use illustrations, animations and online web resources to reinforce this learning. Tutors could also use a knowledge quiz as a learning check.
- Tutors could use practical laboratory-based activities to demonstrate fluid properties, such as density and viscosity. Tutors could ask learners to work as a group during these demonstrations and present their findings to their peers through an in-class presentation.
- For the delivery of topic A2, tutors could introduce the fluid behaviour and significance of Reynold's number. Ask learners to work in groups and conduct online research into how Reynold's number could be used to predict the type of flow. Ask learners to present their findings to their peers. Tutors could draw upon important points and summarise their findings.
- For the delivery of topic A3, there could be a tutor-led class discussion to introduce the concept of pressure, head and their relationship. This can be done by using illustrations and suitable video clips. Follow up on this by introducing various types of pressure. Tutor can then hold a Q&A session as a learning check.
- For the delivery of topic A4, tutors could use practical laboratory-based activities to demonstrate pressure measurements using manometres. Working in groups, learners could then take readings of manometric levels and share their findings with the class.
- Tutors could demonstrate how to calculate manometric pressure using different liquids. Tutors could use appropriately illustrated activity sheets where learners have to develop their skills in determining pressure for a variety of engineering situations. Tutors could provide support throughout and then could conclude the session, share the correct answers with the class and recap on any areas that learners found particularly challenging.
- To review learning across this topic, facilitate a class discussion, analysing fluid properties, types of flow and pressure measurements. Summarise learner feedback and expand on key points as necessary.

Learning aim B – Apply the principles of dynamic fluid flow in pipes and ducts

- For the delivery of topic B1, tutors could begin with a presentation to introduce the topic by showing dynamics of fluid flow using animations, DVDs, pictures, illustrations or web-based videos.
- Following on from this, start a tutor-led class discussion asking simple questions, such as 'what happens when a fluid starts to move?' Tutors could use illustrations, animations and online web resources to reinforce this learning, as well as a knowledge quiz as a learning check.
- Tutors could use practical laboratory-based activities to demonstrate conservation of mass using, e.g. a Venturi metre. During demonstrations, engage learners not only by taking readings and sharing their findings, but also through discussion about mass and energy conservation.
- Follow this with a tutor-led research activity, where learners have to find out about various parts of Bernoulli's equation and how each of these could vary. Ask learners to share at least one example of its application, and share with their peers during an in-class presentation.
- In a tutor-led class discussion using illustrations and suitable video clips, introduce learners to various energy forms, flow characteristics and significance of viscosity. Tutors could hold a Q&A session as a learning check.
- For the delivery of topic B2, tutors could demonstrate how to use continuity, steady flow and Bernoulli's equations to solve simple and continuous flow problems in pipes and ductwork. Tutors could use appropriately illustrated activity sheets that learners could use to develop their skills in determining flow for variety of engineering situations. Tutors could provide support throughout and then could conclude the session, share the correct answers with class and recap on any areas learners found particularly challenging.

Learning aim C – Develop appropriate fluid flow systems

- For the delivery of topic C1, tutors could begin with a presentation to introduce the topic by showing energy losses in pipes and ductwork using animations, DVDs, pictures, illustrations or web-based videos.
- Following on from this, start the delivery of topic C2 with a tutor-led class discussion asking simple questions, such as 'what happens when a fluid moves through fittings and fixtures?' Tutors could use illustrations, animations and online web resources to reinforce this learning. Tutors could use a knowledge quiz as a learning check.
- Tutors could use practical laboratory-based activities to demonstrate energy loss through friction and fittings and fixtures. This experiment could be based on a simple pipe network where pipes have different friction coefficient, are of different diameters and are connected using various fittings and fixtures, such as valves, bends and tees. During demonstrations, engage learners not only by taking readings and sharing their findings, but also through discussion about the magnitude of loss.
- Follow this with a tutor-led research activity, where learners have to find out about pressure loss factors in pipes and equivalent pipe lengths. Ask learners to share at least one example of its application and share with their peers during in-class presentation.
- In a tutor-led class discussion, using illustrations and suitable video clips, introduce energy losses using relevant principles. Tutors could hold a Q&A session as a learning check.
- In a tutor-led individual activity, demonstrate how to use Darcy's and Chezy's formulae for various situations. Tutors could use appropriately illustrated activity sheets where learners can develop their skills in determining losses in pipes and ductwork for a variety of engineering situations. Tutor could provide support

throughout and could conclude the session, share the correct answers with the class and recap on any areas learners found particularly challenging.

- For the delivery of topic C3, tutors could introduce the operating and design principles for pumps, fans and compressors using illustrations, animations and video clips. Use a Q&A session as a learning check.
- Tutors could introduce a group activity where learners have to conduct online research into pumps, fans and compressors. Allocate each group suitable components, e.g. one group could research centrifugal pumps while another could research reciprocating pumps. Learners will present their findings to their peers in class. Tutors could draw upon key points and summarise their findings.
- Follow this by facilitating a tutor-led class discussion using a case study. Each group will be allocated a component or section of the project, and then learners have to identify various components used, why these have been used and how these match with the pipe and ductwork system. Each group could do a structured presentation in-class, where tutors then summarise the rationale behind the selection of components.
- Use a knowledge quiz to assess learners' understanding of design factors and components, drawing upon the key points and summarise.
- Use an example design project with details of pipe and ductwork system and where pumps, fans and compressors have been used in a variety of ways, e.g. pumps in series and in parallel. Working in small groups, assign learners a section of the project or specific components, and task them to research the design specifications and present to their peers. For example, tutors could ask a group to study the pipe network, select a suitable pump and suggest how performance could be improved.
- Support learners while they are working on the project so that they use the correct terminology and style. This activity could also be conducted in one-to-one tutorials with the groups.
- Ask learners to present their selection along with specifications of pipe and duct work to the class. Learners should be able to provide evidence of extensive research carried out to finalise their choices. Ask them to justify their choices and add 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 12: Low Temperature Hot Water Systems in Building Services
- Unit 27: Building Services Control Systems
- Unit 28: Heating, Ventilation and Air Conditioning Design
- Unit 30: Plumbing Technology in Building Services Engineering
- Unit 31: Electrical Principles in Building Services Engineering

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Nationals in Construction and the Built Environment. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Greeno R, *Building Services Handbook* (8th Edition), Routledge, 2015 ISBN 9781138805637 – As the name suggests, a handbook covering all aspects of building services in a concise manner

Potter M, *Fluid Mechanics: Demystified,* McGraw-Hill Education, 2009 ISBN 9780071626811 – This book explains fundamental principles relating to fluid mechanics and is relevant to the content of this unit.

Potter M and Wiggert D, *Schaum's Outline of Fluid Mechanics (Schaums' Outline Series)*, McGraw-Hill Education, 2008 ISBN 9780071487818 – This book has a number of solved examples relevant to the unit and will help learners to practise such questions.

Zaher M, *Building Services* (Kindle Edition), Amazon Media EU S.à r.l, 2012 ASIN B00GWXW5QG – A very good resource to help understand principles and operation of air-conditioning, pumps/fans/blowers and plumbing

Journals

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.

P & HE Journal (Chartered Institute of Plumbing and Heating Engineers (CIPHE)) – this is CIPHE online journal, which covers a broad range of areas relating to plumbing and heating.

Videos

Tutors should go to the 'YouTube' website and search for the following videos:

'Bernoulli's principle 3D animation' by Creative Learning – a 3D animation to explain Bernoulli's principle

'Different types of flows: steady, uniform, laminar and turbulent flows etc.' by Thandi Beer – a useful resource explaining different types of fluid flow

'Flow Visualization part 1' by VerraStrngNUCF – a very reliable resource to help visualise fluid flow

'Pressure Drop Along A Pipe (Interactive)' by LearnChemE – this is a useful resource to understand pressure loss in a pipe.

Websites

'Building Services and Environmental Engineer (BSEE)' – An industry journal published monthly and contains in-depth technical features on subjects relating to building services

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

'Chartered Institute of Plumbing and Heating Engineers (CIPHE)' – Website for the relevant professional body, containing information about the codes, products and industry updates

'Modern Building Services (MBS)' – Website covering a wide range of building services engineering sectors

http://www.rics.org/uk/apc/pathway-guides/construction-pathway-guides/quantity-surveying-and-construction/ – The Professional Body for Surveying as a whole with information on standards and career development pathways in Quantity Surveying.

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.

Unit 30: Plumbing Technology in Building Services Engineering

Delivery guidance

Approaching the unit

The focus during the delivery of this unit will be on developing the knowledge and skills that will enable learners to design plumbing, above-ground drainage and gas installations for a domestic or simple non-domestic property.

Illustrations, images, animations and video clips are all useful resources to explain how plumbing, drainage and gas installations work in a domestic or simple non-domestic property. Such resources are freely available online and can be easily incorporated into tutor presentations.

In addition to this, site visits would be of great benefit to learners and could include a treatment facility or an under-construction site where first fix has been completed. Involving local professionals and experts from the building services engineering sector as guest speakers will be helpful, in order to enthuse learners as they gain exposure to the current practices in the industry.

Tutors could either develop a mock project brief or adapt an actual case study or design example that 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.

Delivering the learning aims

Throughout the delivery, tutors should relate the content of this unit to a number of units on this qualification, which will help to motivate learners.

Learning aim A is about understanding sourcing, cleansing and distribution of cold water, including relevant standards, regulations and effects of contaminated water supply to an area.

Tutors could start by introducing how cold water is sourced, cleansed and distributed using animations, DVDs, pictures, illustrations or web-based videos. Tutors could then introduce an example of how local water supply in the local area is being sourced. A visit to local water treatment facility would be of benefit to the learners.

Engage learners to help them develop an outline of a client brief and then introduce regulations and calculations. Learners will need to understand the importance of assessing the practical and functional uses of the system, and be able to demonstrate their problem-solving skills.

Learners can be supported and challenged during delivery through a variety of means – such as knowledge quiz, paired/group activities, class discussions and presentations – to provide opportunities for peer learning alongside motivating the learners.

Whether the content is taught in parallel or in a linear sequence, tutors 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. Tutors could develop a new mock project for learners, or expand upon the one developed in learning aim A.

Learning aim B is about designing plumbing, gas installations and above-ground drainage for a domestic or simple non-domestic property. Learners will need to apply their analytical skills to meet the project requirements with the appropriate selection of components. In learning aim C, learners will be developing the specification for materials, components and equipment for plumbing and gas installations.

Tutors will require access to relevant project information, such as drawings, especially those related to component details, as these would be used as learning resources. Tutors could also contact the building services companies who are always willing to help.

Finally, where possible, invite a guest speaker who could be from manufacturing or design consultancy background, gas suppliers or from green companies. The guest speaker should be able to share with learners the current approaches and design practices, ensuring efficiency and environmental sustainability.

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Understand how cold water is sourced, cleansed to the required standard and distributed to the consumer	**A1** Sources of cold water **A2** Cleansing process **A3** Standards **A4** Distribution	Analyse a client brief in terms of all the current regulations and requirements.
B Undertake the design of plumbing, above-ground drainage and gas installations for a property	**B1** Appliances and components **B2** Materials and components **B3** Hot and cold water systems **B4** Types of drainage **B5** Drainage systems, materials and testing	Develop a system for a domestic installation, from a set of criteria. As part of the solution, produce a specification for all the elements of the installation.
C Develop a specification for materials, components and ancillary equipment for a plumbing and gas installation	**C1** Gas supplies **C2** Gas installations **C3** Features and characteristics **C4** Regulations and standards	

Assessment guidance

There are a maximum number of two summative assignments for this unit. The recommended approach is to set assignment briefs within the context of a domestic property; however, it may be appropriate to instead assess in the context of a non-domestic property, for apprentices working on commercial projects or for those aspiring to work in this context. For assignment 1, which will cover learning aim A, tutors should provide adequate details about the client requirements so that learners can justify the regulations and requirements considered. Learning aims B and C will be addressed in assignment 2, and tutors should include (in addition to the above) component and materials requirements.

Tutors could ask for assessment evidence in the form of a project report and a portfolio containing drawings and specifications. As part of the instructions, ask learners to include sketches, illustrations and a list of information sources used.

Getting started

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

Unit 30: Plumbing Technology in Building Services Engineering

Introduction

Introduce learners to the unit using animations, DVDs, pictures, illustrations or web-based videos relating to the design of plumbing, below-ground drainage and gas installations.

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

Well-organised site visits (where learners can see water treatment and fittings, fixtures and installations) are invaluable to the delivery of this unit. They will need to be timetabled carefully to ensure that learners have sufficient knowledge across the learning aims to fully benefit from the experience. They could also be done in conjunction with other unit site visit requirements.

You would need to coordinate with the site staff to ascertain:

- health and safety requirements
- type of project
- construction stage
- extent to which site staff could engage (project presentation, access to drawings, design data).

Learners could prepare checklists before the visit so that they can record details of elements, components and processes.

If finding appropriate sites proves difficult, tutors could instead use project examples through DVDs or other project data.

Learning aim A – Understand how cold water is sourced, cleansed to the required standard and distributed to the consumer

- For the delivery of topic A1, tutors could begin with a presentation to introduce the topic by showing the water cycle and how cold water is sourced using animations, DVDs, pictures, illustrations or web-based videos, e.g. reservoirs, lakes, shallow and deep wells.
- For the delivery of topics A2 and A3, tutors can facilitate a discussion to introduce the water-cleansing process. Use animations and video clips and use a Q&A session as a learning check. If possible, arrange a site visit where learners can gain an understanding of the methods of cleaning water before it is deemed clean and fit to drink.
- For the delivery of topic A4, tutors can use a case study to demonstrate how water is distributed, e.g. mains supply, the requirements of pressure and applicable regulations, e.g. World Health Organization (WHO) standards. Use a knowledge quiz as a learning check, asking learners to annotate the answers on given drawings.
- Following on from this with a tutor-led discussion, tutors can ask learners to consider an outline of a client brief. Tutors can ask questions such as 'what types of installations would you like in your house?' or 'would you consider minimising carbon emissions or lowering costs?' Summarise the key points and fill any missing gaps as necessary.
- Working in small groups, learners could then develop a client brief for a given scenario. They will need to take into account the building use, client needs and environmental considerations. Groups could then present their recommendations to

the class.

- To review learning across this topic, facilitate a class discussion, evaluating factors to be considered while designing plumbing, below-ground drainage and gas installations. Tutors to summarise learner feedback and expand on key points as necessary.

Learning aim B – Undertake the design of plumbing, above-ground drainage and gas installations for a property

- Tutors can start the delivery of this learning aim with the project brief developed in learning aim A. For the delivery of topic B1, tutors could present the content in more detail, explaining the types of appliances and components, systems, performance and environmental requirements, controls, external factors and use of Building Information Modelling (BIM). Use DVD/web-based video resources as appropriate. Tutors can further engage learners throughout with informal Q&A sessions to check their understanding. If possible, arrange for a site visit.
- For a group activity, issue learners with a set of example project documents, including a client brief, design requirements and the final design. Split learners into groups and assign a specific topic out of the unit content for this learning aim. For example, group A can identify how client requirements have been satisfied for BIM. All groups could then share their findings. Tutors could provide guidance and fill in any missing knowledge gaps as necessary, collating group notes for the class in a shared access folder.
- Tutors could give learners a knowledge quiz to assess their understanding of design factors and components. Draw upon the key points and then summarise.
- Using an example design project, assign small groups of learners with a design task to research and develop. For example, you could ask a group to study the drainage solution and identify the type of drainage used to ensure efficient and effective removal of effluent, wastewater and surface water from the building. Groups could then present to their peers, justifying the design recommendations made.
- Develop a number of task sheets covering design exercises related to the mock project for a tutor-led activity. These should include materials and components, hot and cold water systems, types of drainage, systems used for drainage and testing. Support learners while they are working to solve the tasks. This activity could also be conducted in small groups.
- Learners can then apply this knowledge analysis to their own design for plumbing, above-ground drainage and gas installations.
- Learners can prepare and present their project analysis to the class. Ask them to justify their design choices and update their plans following constructive and developmental feedback.

Learning aim C – Develop a specification for materials, components and ancillary equipment for a plumbing and gas installation

- The focus in this learning aim is on gas installations.
- Tutors could use the same mock project as used for learning aim B. However, fundamental knowledge about sources, distribution and transportation of gas to the end users will need to be introduced for the delivery of topic C1. Tutor can use animations, DVDs, pictures, illustrations or web-based videos.
- In a tutor-led class discussion, introduce the properties and combustion characteristics of natural and commercial liquid petroleum gas (LPG) supplies. Use animations and video clips and a Q&A session as a learning check.
- In a tutor-led group exercise, for the delivery of topics C2, C3 and C4, ask learners to carry out research on types of gas installations, features and characteristics and relevant regulations and standards. Ensure that the unit content is adequately covered. Learners could present their findings to the class, while tutors should draw

out key points and summarise them.

- Working in small groups, assign learners materials, components and ancillary equipment. Ask them to research the design specifications and present their findings to their peers. For example, tutors could ask a group to study the relevant applicable regulations and then present to the class.
- Tutor could facilitate a practical activity, asking learners to use their design of the mock project and develop specification for materials, components and ancillary equipment. Tutor could also develop a checklist to support learners, based upon 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.
- Ask learners to present their completed design along with specifications of mock project to the class. Learners should be able to provide evidence of extensive research carried out to finalise their choices. Ask them to justify their design choices and add 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 12: Low Temperature Hot Water Systems in Building Services
- Unit 21: Building Services Science
- Unit 27: Building Services Control Systems
- Unit 29: Use of Static and Dynamic Fluids in Building Services Engineering
- Unit 33: Quantity Surveying Measurement Techniques in Building Services Engineering
- Unit 34: Building Regulations and Control in Building Services Engineering

Resources

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

Textbooks

Burberry P, *Environment and Services (Mitchells Building Series)* (8th Edition), Routledge, 2015 ISBN 9781138167780 – this book explains principles of services installations and environmental considerations and is relevant to the content of this unit.

Greeno R, *Building Services Handbook* (8th Edition), Routledge, 2015 ISBN 9781138805637 – as the name suggests, a handbook covering all aspects of building services in a concise manner

Zaher M, *Building Services* (Kindle Edition), Amazon Media EU S.à r.l, 2012 ASIN B00GWXW5QG – a very good resource to help understand principles and operation of air conditioning, pumps/fans/blowers and plumbing

Journals

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.

P & HE Journal (Chartered Institute of Plumbing and Heating Engineers (CIPHE)) – this is CIPHE online journal, which covers a broad range of areas relating to plumbing and heating.

Videos

Tutors can go to the 'YouTube' website and search for the following videos:

'All About Home Heating Systems' by Hofpodcast – an interesting podcast titled *All About Home Heating Systems*

'How to Design and Install a Drainage System for your Home' by Jeff Wortham – a useful video to help understand domestic drainage system

'HVAC Design: Understanding Heating, Ventilation & Air Conditioning Systems' by Autodesk Sustainability Workshop – a fun to watch resource to understand how heating, ventilation and air conditioning systems work

'Pipe Sizing' by Reza Gh – this is a useful resource for pipe sizing.

Websites

'Building Services and Environmental Engineer (BSEE)' – An industry journal published monthly and containing in-depth technical features on subjects relating to building services

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

'Chartered Institute of Plumbing and Heating Engineers (CIPHE)' – Website for the relevant professional body, containing information about the codes, products and industry updates

'Heating Equipment Testing & Approval Scheme (HETAS)' – The official body to approve biomass and solid fuel heating appliances, fuels and services. The website has useful resources about relevant products.

'Modern Building Services (MBS)' – Website covering a wide range of building services engineering sectors

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Unit 31: Electrical Principles in Building Services Engineering

Delivery guidance

Approaching the unit

'Unit 31: Electrical Principles in Building Services Engineering' is an optional unit that will give learners the knowledge and understanding of the principles of electricity that underpin electronics, electrical systems and larger installations.

Tutors should support theoretical content with practical experimentation wherever possible, clearly identifying applications within building services engineering at each stage. Tutors will require access to a range of test equipment, electronic and electrical components and circuits for use throughout much of the teaching and learning process.

While teaching the content, aim to:

- link theory with practice throughout
- use theoretical calculations to predict circuit behaviour and then confirm it through experimentation
- familiarise learners with circuits and equipment specifications used in appliances and building services installations
- use case study examples wherever possible
- involve visiting guest speakers from an electrical design and installation background to add context and demonstrate the real-life relevance of the course content.

Delivering the learning aims

Tutors delivering this unit have the opportunity to include a wide range of activities and presentation techniques. These will include tutor-led demonstrations, supervised practical investigations, visiting guest speakers, independent research and working with case study material.

Tutors should aim to give learners a balanced mix of theoretical understanding and practical experience. The unit should not be seen as a purely academic exercise. At all times, tutors should aim to integrate real-life applications and case studies that consider industrial best practice. Wherever possible, methods of delivery should be activity based and could include laboratory work, product investigations and the completion of basic design proposals and specification relating to case study materials.

A wide range of resources and documentation should be available to learners and be referenced in case studies. These might include IEE Regulations, Chartered Institute of Building Services Engineers (CIBSE) Guides, industry codes of practice, British Standards and Building Regulations.

Learning aim A

Learning aim A introduces the theoretical principles governing the behaviour of electricity and electrical circuits. This includes the fundamental units for electrical quantities, how these are calculated and instructions on the safe use of common instruments used to measure electrical quantities.

Most concepts covered in the learning aims can be demonstrated using direct current (DC) but alternating current (AC) should also be introduced (AC theory is expanded upon in learning aim B). This will be required when carrying out a product analysis on an electrical product or appliance to evaluate its power consumption and running costs during the assessment for learning aim A.

It is important for tutors to maintain links between theoretical calculations and practical activities. Ask learners to make predictions of circuit behaviour based on calculations and then ensure that they are able to demonstrate these using real circuits. Learners will need access to a range of electrical measuring equipment and instrumentation, including a multimeter (or separate ammeter, voltmeter, ohmmeter), wattmeter and oscilloscope. Safe working methods and procedures are vital whenever working with electricity, which need to be emphasised during any practical work.

Learning aim B

Learning aim B provides the theoretical background on the operation of a range of electrical components and their applications. The terminology used to describe AC and DC electricity and their behaviour must be established early on in the delivery of this learning aim. This will allow learners to move on to looking at components and establishing how they behave in the laboratory. Use practical demonstration and structured practical activities to introduce a range of components and their activities. Analysing component behaviour in a practical setting and then introducing the theoretical principles that explain the behaviour will make the content more accessible to learners. Calculations can then be used to predict the behaviour of experimental set-ups. Learners will also be required to produce electrical circuit diagrams to explain how the components are connected in a domestic appliance and how these work together to meet the overall requirements of that appliance. Here, case study examples of electrical circuits used in washing machines, dishwashers or other similar appliances can be used in teaching and learning to explain the roles of various components, their functions and their roles in providing the required circuit performance.

Learning aim C

Learning aim C examines the behaviour of circuits used in electrical systems and installations and introduces three-phase AC circuits commonly encountered in building services. Again, where practical and possible, the behaviour of AC circuits should be demonstrated and involve practical investigations carried out by learners (this could involve modelling circuit behaviour in suitable circuit simulation software). The effects of circuit resistance, capacitance and inductance in AC circuits should be investigated in this way before intruding upon the necessary calculations required to quantify and predict their behaviour.

Learning aim C also examines in detail the role of transformers and rotating machines (motors, generators etc). Practical demonstrations should be used to support learning throughout. Research activities can be undertaken on the importance of transformers or rotating machines in a building services context. For instance, learners might research the role of transformers in electrical distribution through the national grid or the use of motors to power lifts in high-rise buildings. A visiting speaker from an electrical contractor might be used to help work through case study examples of electrical installation design and development to include component choice and circuit selection.

Health and safety is of paramount importance throughout the delivery of this unit. The potential hazards present when working with electricity need to be emphasised to learners and be effectively controlled through risk assessment and close supervision of practical work. Circuit simulation software can be used as an alternative to some practical experimentation activities but maximising hands-on experience for learners is important.

Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
A Understand and apply appropriate methods to determine quantities associated with electricity	**A1** Units **A2** Calculations **A3** Instruments	Analyse a product to determine the quantities of electricity consumed, including the use of supporting calculations.
B Apply the principles of electricity and the behaviour of simple electrical components for different applications	**B1** Terminology **B2** Principles and calculations **B3** Behaviour **B4** Components and applications	Develop a system for an industrial installation, from a set of criteria. As part of the solution, produce a specification for all the elements of the installation.
C Examine electrical circuits and components within an electrical system or installation	**C1** Circuits **C2** Transformers **C3** Rotating machines	

Assessment guidance

In the assessment for learning aim A, learners must carry out a detailed analysis of an electrical product or appliance in order to establish its power consumption and running costs. Examples of suitable appliances include electric fan heaters, portable dehumidifiers and refrigerators. The evidence generated could be in the form of a portfolio, including:

- circuit diagrams explaining the appliance electrical system
- details of the test equipment used to take readings from different elements of the system
- calculations used to determine power consumption
- other supporting written notes and annotated images.

The assessments for learning aims B and C are combined into a single assignment. The first part of the assignment will deal with the circuit design for a domestic appliance that will meet the requirements of a client brief. Learners will calculate the power consumption of the circuit and explain the behaviour of each of the major components and how these contribute to meeting the overall performance requirements of the appliance.

Learners must also justify the selection of the circuit used, including the choice and specification of the transformers and rotating machines used, discussing their relative advantages, disadvantages and potential alternatives. The evidence generated could be in the form of a portfolio, including circuit diagrams, component manufacturers' data sheets, diagrams, calculations used to determine component and overall system performance and a written report justifying the selection and use of each element of the system.

Getting started

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

Unit 31: Electrical Principles in Building Services Engineering

Introduction

Introduce the unit by asking learners to consider the importance of electricity in relation to building services engineering and justify why an in-depth understanding of electricity and its application is important.

This could be achieved by considering a series of different systems and then assessing the impact of a power cut (e.g. heating, ventilation and air conditioning (HVAC) systems, lifts, escalators, lighting, security).

This unit contains theory, demonstrations, practical investigations, case studies and a range of other learning activities. Ask learners to maintain a learning log to record their progress in this unit. This will include notes, photographs, sketches etc and will be useful to refer back to when completing assignment activities.

Learning aim A – Understand and apply appropriate methods to determine quantities associated with electricity

- Introduce the fundamental and derived SI units for electrical quantities (see the criteria listed for topic A1 in the unit specification). Learners to draw a spider diagram to record the definitions of quantities and their units. Learners work in pairs to research how these are measured in practice and feed back their findings to the group.
- Introduce and demonstrate the use of instruments (listed in topic A3 in the unit specification) used to measure electrical quantities, such as a multimeter, ammeter and voltmeter. Set up a series of experiment stations where pairs of learners are asked to select suitable instruments and measure various electrical quantities.
- Explain the relationships between electrical quantities in both DC and AC circuits. Illustrate each relationship and/or formula with a practical example where calculations are supported by measurements, such as the:
    - application of Ohm's Law and Kirchhoff's Laws to DC circuits with resistors in series, parallel and series/parallel combinations
    - calculation and measurement of electrical charge, energy and power
    - resistivity of materials – using resistivity to calculate the resistance of a component from its length and cross-sectional area. Experimentally determine the resistivity of a conductor with uniform cross-sectional area by measuring the resistance of known lengths and plotting a straight-line graph of 'R versus L'.
- Investigate the practical methods of measuring the power consumption of an electrical product or appliance in a series of workshop activities using instruments to measure voltage and current for each of the major components. Examine how analytical calculations are used to predict power consumption during product design.

Learning aim B – Apply the principles of electricity and the behaviour of simple electrical components for different applications

- Approach this learning aim by considering each of the components and applications (listed in topic B4 in the unit specification) in turn and introducing relevant terminology (from topic B1 in the unit specification), principles and calculations (from topic B2 in the unit specification) and behaviours (from topic B4 in the unit specification) for each. In each case, practical demonstration and measurement

should precede the introduction of theoretical concepts and calculations.

- Electrical conductors and insulators:
  - Building on previous work on resistivity, ask learners to classify physical samples of materials as 'conductors' or 'insulators' according to their resistivity. Recap on the calculations involving Ohm's Law.
- Electrical cells and batteries:
  - In a tutor-led presentation, use a simple cell to introduce the concept of electromotive force (e.m.f.), potential difference and conventional and electron current flow in DC circuits.
  - Ask learners to investigate common types of battery and their applications. Feed this information back to the group.
- Electrical generators:
  - Through a tutor-led practical demonstration, show learners the generation of an e.m.f. in a conductor moving through a magnetic field.
  - In a tutor presentation, introduce and explain Faraday's Law and Lenz's Law.
  - Practise calculations involving magnetic flux, magnetic flux density and induced e.m.f.
  - Demonstrate how these basic principles are used in a generator to generate electricity. This can be done by rotating the armature of a simple DC electric motor (or other suitable apparatus) and displaying the electrical output on an oscilloscope.
  - In a tutor presentation, explain how high-output electrical generators function and why their output is in the form of an AC sine wave.
- Resistors:
  - Introduce resistor colour codes and ask learners to work in pairs to practise identifying resistors of different values. They can then check these using an ohmmeter.
  - Carry out a tutor-led class discussion regarding the use of resistors in practical applications.
- Capacitance and capacitors:
  - Introduce the simple flat plate capacitor and explain how this is used to store electrical charge.
  - Learners to practise calculations involving electrostatic field strength between the plates of a capacitor.
  - Carry out a tutor-led practical demonstration showing learners the charging and discharging of electrolytic capacitors.
  - Facilitate a class discussion about the use of capacitors in practical applications.
- Inductors and inductance:
  - Carry out a tutor-led practical demonstration to show learners the behaviour of an inductor in the laboratory, such as electric current and the heating effects of current in thermostats and protective devices.
  - Introduce the concepts of the underlying behaviour of inductors, self-inductance, mutual inductance and the generation of back e.m.f.
  - Practise calculations involving self-inductance in a coil, back e.m.f. caused by a collapsing magnetic field and the energy stored in an inductor.
  - Learners to practise calculations involving mutual inductance in a transformer

(this is treated in detail in learning aim C).

- Tutor to demonstrate the behaviour of silicon diodes and how they can be arranged to provide half- or full-wave rectification of an AC signal into DC. Learners to investigate the flow of current through diodes and build simple rectifier circuits to consolidate understanding.
- Tutor to introduce thyristors and demonstrate their characteristics and their use in AC power control circuits. Learners then research practical applications of thyristors and the products in which they are used before sharing their findings with the group.
- Tutor to introduce transistors, integrated circuits, programmable integrated circuits (PICs) and their uses in DC electronics. Ask small groups of learners to investigate applications of microelectronic circuits within building services systems and explain their importance. This might involve sensors used in smart buildings and control of complex systems such as heating or air conditioning.
- Tutor to demonstrate the characteristics of photocells and photovoltaic devices and their applications in control circuitry and the generation of electricity. Ask small groups of learners to investigate the operation and applications of either photocells or photovoltaic cells. Learners will present their finding to the group and debate the relative importance of the two technologies.
- Ask learners to measure the resistance of thermistors at a range of temperatures. Collect these data points and plot a graph on the whiteboard of temperature versus resistance. Discuss the characteristics of thermistors and their use in electronic temperature control circuits.
- Tutor to demonstrate the use of thermocouples. Using the example of a gas safety cut-off valve will also provide the opportunity to introduce the principles of electromagnets and their applications.
- Tutor to demonstrate the operation of electrical solenoids and explain their operation and applications in switching large loads. This will provide an additional opportunity to look at electromagnetism. Compare the switching ability (speed, voltage, current consumption, switching capacity) of solenoids with that of thyristors and transistors.
- Use of AC and DC:
  - Learners to investigate DC and AC voltages using an oscilloscope. Tutor will relate learner observations of the waveforms to the terminology used to describe DC and an AC waveform, including their use in calculations using Ohm's Law.
- Learners to work in groups of three to investigate the heating effects of an electrical current and its applications in fuses, heating elements and thermostats. Their finding will be reported back to the group.

Learning aim C – Examine electrical circuits and components within an electrical system or installation

- Electrical systems in building services engineering invariably use AC, so ensure that learners are comfortable with the basics of AC as covered in learning aim B.
- Split the discussion of circuits into single and three phase. Again, introduce theoretical concepts alongside practical demonstrations of the relevant principles.
- In tutor-led practical demonstrations, display circuit voltage/current waveforms on a multi-channel oscilloscope (on which several can be displayed simultaneously to allow for direct comparisons to be made).
- Tutor-led demonstrations and associated calculations for single-phase circuits:
  - Display AC waveform across a resistor (pure resistance) and simple calculations using Ohm's Law.

- Display AC waveform across a capacitor (pure capacitance) and calculation of capacitive reactance.
- Display AC waveform across an inductor (pure inductance) and calculation of inductive reactance.
- Calculation of total reactance and then impedance in a circuit with resistance, inductance and capacitance
- Calculations of true power, apparent power and power factor
- Demonstrate power factor correction and facilitate a class discussion to explain its benefits. This is common in circuits containing a large inductor, such as the windings in a motor or the ballast in a conventional fluorescent lamp, where correction is achieved by fitting an appropriate parallel capacitor.
- Demonstrate the effects of frequency on reactance and impedance.
- Demonstrate how AC waveforms are represented by phasor diagrams and explore the relationships between current and voltage phasors.
- Explain the principles of AC circuit resonance and demonstrate its effects to learners.

- Tutor-led presentation for three-phase circuits:
  - Explain the principles of three-phase electricity supplies and carry out a tutor-led practical demonstration to display the overlapping phase waveforms on an oscilloscope.
  - Relate the waveforms to their representative phasors and discuss the principles and practical applications of star and delta loading.
  - Show phasor diagrams for balanced and unbalanced loads and explain the advantages of load balancing.
  - Explain the relationship between single-phase and three-phase supplies and their relative advantages and disadvantages in a range of industrial and domestic scenarios. For example, ask learners to investigate and explain why a domestic refrigerator is invariably single phase but commercial freezers are usually three phase. Ask learners to present their findings back to the group.
- Introduce the practical applications of transformers in building services applications. Learners to carry out research into the practical applications of transformers and the differences between the common types of applications (to include step up, step down and isolation). Ask learners to present their findings back to the group.
- Tutor to recap the basic transformer operating principles of mutual inductance that was covered earlier in the unit.
- Tutor to build on learners' basic knowledge by introducing the concept of the transformer as a magnetic circuit. Explain the methods used in transformer design to minimise losses and so maximise efficiency, including cooling methods, material choice and construction methods.
- Explain transformer ratings and allow learners to conduct their own experiments using transformer to demonstrate their characteristics.
- Carry out a tutor-led demonstration showing the transformer input and output AC waveforms and refer to these when drawing associated phasor diagrams for no-load and on-load applications.
- Tutor to demonstrate the calculations necessary to specify transformer performance and determine transformer efficiency. Give learners the opportunity to calculate the specification for transformers in a range of scenarios (e.g. in a mains operated phone charger, a washing machine or an electrical sub-station).
- Introduce the practical applications of rotating machines (motors and generators) in

building services applications.

- Carry out a tutor-led practical demonstration on the construction, starting, control and operation of:
  - AC induction, wound rotor and synchronous motors
  - DC shunt-wound motors.
- Use cutaways or animations to demonstrate the function of motors and generators. Ask learners to make annotated sketches to explain the action and purpose of:
  - the commutator
  - slip rings and brushes
  - armature
  - motor enclosures.
- Explain the relationship between speed and torque and demonstrate how variable frequency inverters are used to provide speed control.
- Ask learners to conduct research into the motors used in a variety of applications and use manufacturer's data to establish the key performance characteristics that are important in each case. Ask learners to then apply the same principles to the selection of suitable motor types and sizes in a range of similar scenarios. For example, specifying an appropriate motor for use in a domestic washing machine, a commercial freezer or a lift in a high-rise building.
- Use input from a guest speaker from an electrical contractor to help small groups of learners work through case studies involving the design of electrical installations to meet given requirements. These should involve justifying the choice of circuit, transformer and rotating machine selected in each case. Formative feedback can be provided to each group from both tutor and the visiting speaker.

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

This unit links to:

- Unit 21: Building Services Science
- Unit 27: Building Services Control Systems
- Unit 32: Electrical Installation Standards, Components and Design

Resources

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

Textbooks

Bird J, *Electrical and Electronic Principles and Technology* (5th Edition), Routledge, 2013 ISBN 9780415662857

Hughes E, Hiley J, Brown K and Smith IM, *Hughes Electrical and Electronic Technology* (12th Edition), Pearson, 2016 ISBN 9781292093048

Robertson CR, *Fundamental Electrical and Electronic Principles* (3rd Edition), Newnes, 2008 ISBN 9780750687379

Websites

http://www.cibse.org/ – the professional body for building services engineering sector as a whole (not specifically electrical principles), including standards, professional development and resources

www.eca.org.uk – Electrical Contractors' Association, ECA

www.jib.org.uk – Joint Industry Board for the Electrical Contracting Industry, JIB

www.jtltraining.com – JTL manages training in the electrical sector in England and Wales, JTL.

www.sectt.org.uk – Scottish Electrical Charitable Training Trust manages electrical apprenticeships in Scotland, SECTT.

www.the-esp.org.uk – The Electrotechnical Skills Partnership, TESP

Videos

Doosan Portable Power: How a Generator Works, Doosan (https://www.youtube.com/watch?v=m-ehwxV4nf0)

How It's Made – 509 Electric Pole Transformers, How It's Made (https://www.youtube.com/watch?v=7i-8luvwx9w)

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.

Unit 32: Electrical Installation Standards, Components and Design

Approaching the unit

The focus during the delivery of this unit should be on developing knowledge and understanding of electrical installations that provide power for properties. This is likely to be for domestic situations but could equally focus on industrial/ commercial installation, where learners are working in an industrial environment e.g. as apprentices. Learners will investigate the development of electrical installations by gaining an understanding of the legislation and regulations applicable, as well as the client's needs and design requirements for a system. Learners must have knowledge of the design of layouts, including the sizing and selection of specific components, cabling and equipment, in order to commission and certify an electrical installation.

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 will be helpful in order to enthuse learners as they gain an insight into 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.

Delivering the learning aims

Throughout the delivery, you should relate the content of this unit to number of units on this qualification, which will help to motivate learners.

Learning aim A

This learning aim focuses on learners being able to understand the legal and regulatory requirements relevant to electrical installation in properties. These include legislation and regulations relating to health and safety, earthing and circuit protection, as well as those relating to space use.

You could start by introducing how unsafe electrical installations could be if no standards are followed. This can be shown through the use of a report or video clips of relevant accidents and incidents. This would help learners to appreciate the rationale behind various types of legislation.

Learners can be supported and challenged during delivery through a variety of means, e.g. knowledge quiz, paired or group activities, class discussions and presentations, which will give opportunities for peer learning.

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

Learning aim B

Learners need to be able to design an electrical installation for a property which may be domestic or commercial. Learners will need to apply their analytical skills to meet the project requirements with the appropriate selection of components.

Learning aim C

In this learning aim, learners will be developing the specification for materials, components and ancillary equipment to ensure safe distribution of electricity.

You will require access to relevant project information, such as drawings, circuit diagrams and layouts, as well as component details. You could contact the building services companies to assist with the delivery of this content, 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 current approaches and design practices, ensuring safety and compliance to regulations.

Assessment model (in internally assessed units)

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

Assessment guidance

There is a maximum number of two summative assignments for this unit. The assignment briefs should be set within the context of a residential project, such as construction of an apartment block.

For learning aim A, you should give adequate details about the client requirements so that learners can carry out suitable justification of the legislation and regulations considered suitable for the given project. This includes a client and/or design brief, design requirements and an outline of sketches of the property.

For learning aims B and C, you should include (in addition to the above) component and materials requirements. Learners must relate to the given scenario throughout their work and whilst carrying out evaluations.

Learners will produce a comprehensive design and a report that is detailed in its compilation, containing 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 upon 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.

Submitted assessment evidence could be in the form of a comprehensive design and a report and contains full manufacturer details and drawings. You could ask learners to include a list of information sources used.

Getting started

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

Unit 32: Electrical Installation Standards, Components and Design

Introduction

Introduce learners to the unit using animations, DVDs, pictures, illustrations or web-based videos relating to the 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 learnt.

Learning aim A: Understand the regulations and legislation applicable to electrical installations

- For the delivery of learning aim A1, you could 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 the Health and Safety at Work etc. Act (1974) and associated regulations, highlighting the key features relevant to site safety and provision of welfare facilities. Engage learners through a Q&A session, to answer any learner queries and test their knowledge.
- Engage learners through use of project data (i.e. drawings and layouts) and then introduce the relevant standards and special location considerations, such as bathrooms or outdoor locations. Engage learners through a Q&A session.
- Give learners a knowledge quiz to check their learning so far. Draw upon the key points and summarise.
- Split learners into small groups and allocate each group with a specific regulation or standard relevant to the client brief as a group research activity. For example, one group could investigate BS7671 whilst another could focus on Construction (Design and Management) Regulations 2015. Each group must produce and deliver a presentation, which also has to include test methods and requirements and certification. Tutors are to facilitate and include any additional information as necessary, collating group notes for the class in a shared access folder.
- For the delivery of learning aim A2, you can deliver a presentation to introduce the topic by showing how earthing and bonding work, why it is necessary to provide these and the statutory measures that must be met. Engage learners through a Q&A session.
- You could deliver learning aim A3 using a presentation, introducing learners to the safety devices required within the consumer unit. Follow this with a group research exercise, where learners are to explore the manufacturers' sites to find the products relating to circuit safety, along with their technical details. Learners are to share their findings with their peers, with tutors including any additional information as necessary.
- Facilitate a tutor-led discussion that revolves around questions such as, 'What kind of lighting system would you like in your house?' or 'Would you consider having security and fire protection?'. Summarise the key points from the discussion in a

mind map on the smartboard.

- Give learners a set of example project documents, including a client brief, design requirements and the final design. Split learners into small groups and assign each group with a specific topic (from the unit content in the specification) for this learning aim. For example, Group A are to identify where permits to work will be required, whilst Group B are to justify the safety devices used. Learners to share their findings with their peers, with tutors including any additional information as necessary and summarise.
- Give learners a knowledge quiz, which can be used as a learning check before starting the design part in learning aim B. You could use the same example project data and ask questions to assess learning so far. Give model answers and ask learners to do self-assessment, providing them with constructive and developmental feedback
- Facilitate a class discussion justifying the regulations and legal requirements needed whilst designing electrical installations. Tutors to include any additional information as necessary and summarise.
- For the summative assessment, learners are to analyse a client brief in terms of all of the legal and electrical requirements. You should give learners adequate details about the client requirements so that they can carry out suitable justification of the legislation and regulations considered suitable for the given project. This includes a client and/or design brief, design requirements and an outline of sketches of the property.

Learning aim B: Undertake the design of an electrical installation for a property

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

- You may wish to revisit the project documents analysed by groups in learning aim A, or develop a new project brief. Learners will require adequate details, such as lighting requirements, safety considerations, materials required and performance requirements.
- For learning aims B1 and B2, use design examples, product videos, drawings or other interactive/graphical resources to give underpinning knowledge about power requirements and wiring methods. This should cover key elements that should be considering in circuit design for construction projects, and the types of cable, wiring and electrical systems that need to be considered and specified in an electrical installation.
- When considering component choices, learners should be encouraged to consider developing or emerging control technologies. E.g. DALI lighting controls (Digital Addressable lighting interface)
- Give learners a knowledge quiz to assess learners' understanding of suitable wiring techniques and cables, drawing upon the key points and summarise.
- Invite a guest speaker who has current knowledge and experience of working in a Building Information Modelling (BIM) environment into the centre. The guest speaker could bring in examples that illustrate the benefits and challenges of working in a collaborative environment. Prepare learners for this visit by providing resources related to BIM and ensure that they have suitable questions to ask the guest speaker. Learners to make a note of the key points during the lecture.
- For learning aims B3 and B4, you can deliver a presentation to introduce electrical lighting standards in terms of luminaries required to meet user requirements and standards. Using the example design project, show how data, fire protection and security systems are provided within a premises, to satisfy the client needs. Use a Q&A session to engage learners.

- Using the client brief developed in learning aim A, ask learners to produce a detailed design considering the legislative requirements and the client needs. This activity could also be conducted in small groups.
- Learners could prepare and present their design to the class. Ask them to justify their design choices and update the plans, following up with constructive and developmental feedback.
- For learning aim C, continue with the same project designed during learning aim B. Working in small groups, learners are to develop a specification for materials, components and ancillary equipment for the project.
- Develop a checklist to help support learners, based upon the unit content. This should include the characteristics of the material and components required, consumer units to suit the installation, the type and selection of security and fire systems, and adherence to the correct communication methods, such as the use of standard symbols and the production of as-built drawings (see unit content in the specification for more information).
- Support learners whilst 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.
- Ask learners to present their complete design, along with specifications of the project, to the class. Learners should be able to give evidence of extensive research carried out in order to finalise their choices. Ask them to evaluate their design choices and include any additional information, 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 27: Building Services Control Systems
- Unit 31: Electrical Principles in Building Services Engineering.

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Nationals in Construction and the Built Environment. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Chartered Institute of Building Services Engineers, *CIBSE Guide K: Electricity in Buildings* (CIBSE Publications, 2004) ISBN: 9781903287262 – this CIBSE publication is helpful to deal with electrical services in buildings.

Institution of Engineering and Technology, *On-site Guide: BS 7671:2008 Wiring Regulations, Incorporating Amendment No. 3*, 17th Edition (Institution of Engineering and Technology, 2015) ISBN: 184919887X – this is an essential quick-reference guide to BS 7671.

Institution of Engineering and Technology, *Requirements for Electrical Installations, IET Wiring Regulations, BS 7671:2008+A3:2015*, 17th Edition (Institution of Engineering and Technology, 2015) ISBN: 9781849197694 – this IET publication contains essential regulatory details required for the unit.

Stokes G, *Handbook of Electrical Installation Practice*, Fourth Edition (Wiley-Blackwell, 2003) ISBN: 9780632060023 – a handbook covering all aspects of electrical installations in a concise manner.

Journals

Building Services Engineering Research and Technology (Sage Publishing) – this is CIBSE's quarterly journal containing useful research relevant to all aspects of building services engineering.

Electrical and Mechanical Contractor Electrical Contractors Association

Professional Electrician and Installer (Hamerville Magazines Ltd)

Building Services and Environmental Engineer (BSEE) – a monthly industry journal containing in-depth technical features on subjects relating to building services.

Videos

Reflex Systems website, A 10 point guide to fire system – contains multiple videos relating to various design guidelines and standards.

Tutors can access YouTube and search for the following videos:

'Electrical Wiring: Electrical circuits wiring tutorial' by BIN Industrial Training – a useful video tutorial for electrical wiring covering electrical circuits wiring.

'Small Yellow Book – On Site Guide BS7671 Amendment 3:2015' by John Ward – a video clip explaining amendments to On Site Guide BS7671.

'What is Electrical Bonding & Grounding and why it's Important – A GalcoTV Tech Tip' by GalcoTV.

Websites

'Electrical Contractors' Association (ECA)' – the UK's leading trade association that represents and supports the interests of businesses and organisations involved in all aspects of electrical engineering and electrotechnical design, installation, inspection, testing, maintenance and monitoring across the UK (excluding Scotland).

'Joint Industry Board for the Electrical Contracting Industry' – sets the standards for employment, welfare, grading and apprenticeship training in the electrical contracting industry.

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

'Modern Building Services (MBS)' – website covering a wide range of building services engineering sectors.

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Unit 33: Quantity Surveying Measurement Techniques in Building Services Engineering

Delivery guidance

Approaching the unit

The focus during the delivery of this unit is on developing the knowledge and skills that will enable learners to understand quantity surveying techniques required to produce bills of quantities.

Illustrations, images, animations and video clips are useful resources to explain quantity surveying techniques. Such resources are freely available online and can be easily incorporated into presentations. However, it is essential that learners have access to building services drawings and specifications.

Involving local professionals and experts from the building services engineering sector as guest speakers will be helpful in enthusing learners as they gain exposure to the current practices in the industry.

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

Delivery of learning aims

Throughout the delivery, tutors should relate the content of this unit to number of units on this qualification, which will help to motivate learners.

Learning aim A

It is about understanding measurement rules in the context of building services. This includes quantity take-offs, use of approximate and accurate quantities and standard methods of measurement (SMM) such as new rules of measurement (NRM).

Tutors could start by introducing the significance of measuring quantities at various stages of a project as well as for various purposes. Tutors could use a case study or an example project, as well as illustrations or web-based videos.

Learners can be supported and challenged during the unit delivery through a variety of means, such as a knowledge quiz, paired or group activities and class discussions and presentations, to give opportunities for peer learning, as well as motivating learners.

Whether content is taught in parallel or in a linear sequence, tutors 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. Tutors could develop a project for learners or use the case study project as in learning aim A.

Learning aim B

Learning aim B is about producing quantities for electrical, mechanical and associated builder's work for a given project using a standard method of measurement.

Learning aim C

Here, learners will be producing bills of quantities for building services.

Tutors will require access to relevant project information, such as drawings and specifications, including layout, materials and component specification.

Finally, where possible, invite a guest speaker from a practice or professional body background. The guest speaker should be able to share with learners the current approaches and practices ensuring efficiency and environmental sustainability.

Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
A Examine the measurement rules for building services	**A1** Introduction to quantity take-offs **A2** Standard methods of measurement	Learners will produce a guidance document for new employees to comprehend the use of quantities in building services and the use of the Standard Method of Measurement.
B Undertake the production of quantities for building services work	**B1** Processes in the production of quantities **B2** Production of mechanical services quantities for a building **B3** Production of electrical services quantities for a building **B4** Builder's work in connection with mechanical and electrical services installations	Learners will carry out a take-off of quantities from tutor-provided drawings for building services works and associated builder's work in connection with services installations. Learners will then produce bills of quantities from tutor-provided drawings for the same works.
C Undertake the production of bills of quantities for building services work	**C1** Composition of bills of quantities **C2** Abstraction of quantities for building services **C3** The production of bills of quantities for building services	

Assessment guidance

There is a maximum number of two summative assignments for this unit. Tutors should set the assignment briefs within a vocationally relevant context. For Assignment 1, which will cover learning aim A, tutors should give adequate details so that learners can justify the use of a recognised standard method of measurement. Learning aims B and C will be addressed in Assignment 2; tutors should include details, such as technical drawings, specifications and layout and component details, to enable learners to compute quantities accurately.

You could ask for assessment evidence in the form of a project report and a portfolio containing calculation of quantities and bills of quantities using a standard method of measurement.

Getting started

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

Unit 33: Quantity Surveying Measurement Techniques in Building Services Engineering

Introduction

Introduce learners to the unit by using case studies or example projects that demonstrate the use of various quantity surveying techniques to produce bills of quantities.

Engage learners during delivery through knowledge quiz, paired or group activities, class discussions and presentations, as well as through guest speakers.

Learning aim A – Examine the measurement rules for building services

- Tutors could begin the delivery of A1 with a presentation to introduce the topic by showing learners examples where estimated and accurate quantities are used in a project.
- Then, using a tutor-led class discussion, explain the information required at various stages of a project using a case study or example building services project. Engage learners through a Q&A session.
- Give learners a copy of the project documents and ask them work in small groups to explain the use of quantities. For example, one group could investigate the accuracy required at tendering stage; while the other group could consider the same at feasibility stage. Summarise the key points and fill any missing knowledge gaps as necessary.
- For the delivery of A2, tutors could facilitate a discussion to introduce the concept of a standard method of measurement. Start a whole-class discussion on the advantages of such an approach.
- Ask learners to work in small groups and investigate the various standard methods used within the industry. For example, one group could investigate SMM7; while the other group could consider new rules of measurement. Ask each group to describe three key features of the allocated method while presenting it to the class. Summarise the key points and fill any missing knowledge gaps as necessary.
- In a tutor-led discussion, introduce how standard methods have evolved over time and what are the basic requirements of such systems. Engage learners through a Q&A session.
- To review learning across this topic, facilitate a class discussion, justifying the use of recognised standard methods, summarising learner feedback and expanding on key points as necessary.

Learning aim B – Undertake the production of quantities for building services work

- Use a case study or an example project that should have adequate details, including layouts, sizes, installation of components, materials and associated builder's work required.
- In a tutor presentation, using a case study, example project or other examples, demonstrate how quantities could be taken off mechanical, electrical and construction drawings. Explain the non-measurable works.
- Ask learners to work in small groups and demonstrate skills in interpreting drawn information. This could be correctly identifying the components, materials, fittings

and installations from the drawings. Support learners during this exercise and share common misinterpretation of the drawn information.

- Then ask learners to produce a take-off for electrical and mechanical services, as well as associated builder's work. Support learners during this exercise and share correct answers.
- Conduct a knowledge quiz for learners to assess their understanding of interpretation and take-off, drawing upon key points and summarising information.
- In a tutor presentation, introduce the use of standard method by showing learners how to use dimension paper. Use video resources as well as completed dimension sheets to develop a clear understanding. Use a Q&A session as a learning check.
- Tutors could develop a number of task sheets covering exercises related to calculation of quantities for the case study or example project. The exercises should cover mechanical and electrical services, as well as builder's work. Demonstrate some example calculations before handing these to the learners and support learners while they are working to solve the tasks. This activity could also be conducted in small groups.
- Give learners a checklist drawn from the unit content to ensure adequate coverage of skills.
- Learners could prepare and present their quantities using a recognised standard method of measurement. Ask them to update and amend documentation (if required), following constructive and developmental feedback.

Learning aim C – Undertake the production of bills of quantities for building services work

- Continue with the same project as used for learning aim B.
- For the delivery of C1, tutors could deliver a presentation to explain the composition of bills of quantities using an example project or case study. Tutor's focus should be the section layout and use of bills of quantities in both trade and elemental format.
- Using the same example project for the delivery of C2, introduce various techniques to produce bills of quantities. Apply learning checks through a Q&A session.
- Using project documentation, demonstrate how the quantities and descriptions are summarised in bills of quantities. Encourage learners to ask questions before starting to work on producing bills of quantities.
- For the delivery of C3, ask learners to work in small groups to produce bills of quantities using a recognised standard method.
- Based upon the unit content, tutors could develop a checklist to support learners. Support learners throughout to ensure that the work is accurate and is presented using vocationally correct format. This activity could also be conducted in one-to-one tutorials with the groups.

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

This unit links to:

- Unit 1: Construction Principles
- Unit 4: Construction Technology
- Unit 7: Graphical Detailing in Construction
- Unit 12: Low Temperature Hot Water Systems in Building Services
- Unit 14: Provision of Primary Services in Construction
- Unit 27: Building Services Control Systems
- Unit 28: Heating, Ventilation and Air Conditioning Design
- Unit 30: Plumbing Technology in Building Services Engineering
- Unit 31: Electrical Principles in Building Services Engineering
- Unit 32: Electrical Installation Standards, Components and Design
- Unit 34: Building Regulations and Control in Building Services Engineering

Resources

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

Textbooks

Hall F and Greeno R, *Building Services Handbook* (8th edition), Routledge, 2015 ISBN 9781138805637 – This handbook covers all aspects of building services in a concise manner.

Lee S, Trench W and Willis A, *Willis's Elements of Quantity Surveying* (11th edition), Wiley-Blackwell Publishing, 2011 ISBN 9781444335002 – This book is a popular text that explains principles of quantity surveying and is relevant to the contents of this unit.

Packer A, *Building Measurement: New Rules of Measurement* (2nd edition), Routledge, ISBN 9781138838147 – This book is a very good resource to help understand principles and operation NRM.

Journals

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.

RICS Construction Journal (Royal Institute of Chartered Surveyors) (RICS) – This is RICS construction online journal that covers a broad range of areas relating to quantity surveying.

Videos

Access 'YouTube' website and search for the following videos:

'Revit Tutorials Simple Material and Quantity Takeoffs' by revitian – It a useful resource to help understand materials take-off using software.

'How to do Material Takeoffs for Ductwork in Revit MEP 2013' by Tyler Disney – It is a useful resource for quantity take-off in ductwork.

'Dimension Paper' by Tim Bateman – It is a video clip explaining the dimension paper.

'Bills of Quantities' by Charles Mitchell – This video gives an overview of format and structure of bills of quantities.

Websites

'Designing Buildings Wiki' – Search for 'New Rules of Measurement'. This website gives structure and applications of new rules of measurement (NRM).

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

'Modern Building Services (MBS)' – This website covers a wide range of building services engineering sectors.

'Building Services and Environmental Engineer (BSEE)' – It is an industry journal published monthly and contains in depth technical features on subjects relating to building services.

'Chartered Institute of Plumbing and Heating Engineers (CIPHE)' – It is a website for the relevant professional body, containing information about the codes, products and industry updates.

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.

Unit 34: Building Regulations and Control in Building Services Engineering

Delivery guidance

Approaching the unit

Building regulations are mandatory for all commercial buildings in order to ensure that users are safe and secure within their environments. Building services are then integrated into the design and construction of the project. To deliver this unit effectively, arranging a site visit would give learners an ideal opportunity to place different types of services into a practical context. Learners would then understand the complexity of an installation, for example, in a hospital. Another excellent source of information on building services and their regulation under the approved documents is to arrange for a guest speaker, such as a building control officer (BCO), to visit the centre.

A number of engaging methods could be used to support the understanding of this unit, for example:

- inviting a building control officer or building services engineer to be a guest speaker
- an analysis of the approved documents from the Building Regulations (2010)
- an analysis of approved regulation applications for commercial buildings.

Delivery of learning aims

The unit is divided into three clear learning aims.

It focuses on the importance of understanding the requirements of the building regulations through the use of the approved documents. Tutors will need to analyse these in terms of those that are applicable to building services, e.g. Part P, which is concerned with electrical installations in domestic and commercial buildings. Several others have significance within building services and guidance is provided in the 'Getting started' table within this guide. This section lightly touches upon the regulations as the following learning aims go on to examine the approved documents in more detail.

Learning aim A

The content in learning aim A covers the Building Act (1984). A summary of the Act would be a useful guide for learners to understand its provisions, and links to such sources have been provided under the 'Resources' section at the end of this guide. The main sections that control construction work to be covered include:

- the application processes of notices and full plans, how this is undertaken, and the documentation involved
- the timeframes and timelines associated with the application and commencement processes
- the statutory inspections required and the personnel involved
- final certification and documentation
- issues concerning non-compliance regarding the regulations.

Learning aim B

It is concerned with the requirements of the regulations within building services applications. Aspects of drainage, sanitation, ventilation and heating and lighting are all covered within the approved documents. These will need to be examined in some detail along with the alternative methods listed within the approved documents and regulations. For example, competent certification schemes where installations are certified as approved through association qualification and certified membership.

This learning aim requires a detailed examination of the approved documents that accompany the building regulations. The specific approved documents that need to be examined are:

- Approved document F – Ventilation
- Approved document G – Sanitation
- Approved document H – Drainage and waste disposal
- Approved document J – Combustion appliances
- Approved documents L – Conservation of fuel and power
- Approved document P – Electrical safety
- Approved document R – Physical infrastructure for high speed electronic communication.

These documents are free and available from the 'Planning Portal' website link that has been provided under the 'Resources' section in this guide.

Learning aim C

It focuses on undertaking a typical building regulations application. In this learning aim, learners have to prepare an application for a submission for a building notice and a full plans application. The main emphasis on the applications should be towards building services within a project.

Tutors will need to cover the compilation of a building regulations application. This is a general application and not specific to building services, which would form part of the learners' completed project. An ideal method to demonstrate this process would be to download the guidance documents provided by each local authority. These detail the application process, the documentation that is required and the type of drawings needed. This is a good opportunity to demonstrate what is required to be submitted. Learners could view actual building regulation applications with completed documentation, drawings and forms.

Similarly, arranging for a design consultant to be a guest speaker would be beneficial to learners, as they can discuss how a building regulations application is made on behalf of a client. The design consultant could demonstrate how to submit an application using live documentation, which would give learners the opportunity to ask questions about the submission process.

Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
A Understand the requirements of building regulations	**A1** The building regulations **A2** Control and implementation of Building Regulations 2010	A written report and presentation to discuss the requirements of Building Regulations 2010 and the different methods of control and of demonstrating compliance with it for building services works
B Examine the requirements of the building regulations within building services applications	**B1** Approved documents with impact on building services design and installations **B2** Alternative methods of achieving compliance	
C Undertake a building regulations application	**C1** Types of application **C2** Preparing a building notice application **C3** Preparing a full plans application	Portfolio of evidence showing the preparation for a full plans building regulations application for a new-build domestic scheme

Assessment guidance

There are two distinct areas of assessment in this unit, including a written report and a portfolio of evidence. To set up the assessment for the report, learners will have to investigate the Building Regulations (2010) and how these control construction works on site. There is a copy of the regulations available on the government legislation website, but be aware that these contain a lot of legal vocabulary that may not be accessible for learners. It would be best to produce this report in the form of a synopsis of the process, e.g. a title page, introduction, flow chart of the processes for notices and full plans, followed by recommendations and references. It is critical that it is in as simple terms as possible, so that it could be given to a third party for them to be able to understand what to do when applying for approval for their project.

Tutors will need to source the set of approved documents indicated in the previous section under learning aim B. These are freely available to download from the 'Planning Portal', and the ones indicated within the unit content are specific to building services. It is worth remembering that formal applications for building regulations approval are not made specifically for building services. These form part of the integrated project for which the approval is given.

The portfolio that learners have to develop will involve the production of drawings of an existing building and its proposed changes. This assessment could be integrated into surveying or building surveying with a linear survey, generating the data to draw an existing building. A scenario could then be included, e.g. a large extension is proposed to be added to the drawn building. Learners would then have to produce a set of drawings for both existing and proposed changes. A specification is then required to accompany the forms and documents for submission. Therefore, the portfolio can be the full submission documentation for a full plans submission. Learners would just have to complete one-building notice form using a local authority template. The full range of assessment criteria can then be assessed through this portal.

Getting started

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

Unit 34: Building Regulations and Control in Building Services Engineering

Introduction

Tutors can select a project that is local to the centre and find some stimulating images of the project. This can then be used as the focus of a class discussion, concerning a series of questions such as:

- 'What do learners think about the project?'
- 'What does the project provide?'
- 'Is it a safe building?'
- 'How has its construction been regulated?'

Learners will now be thinking about how the construction of a building is controlled so that users and stakeholders are safe, secure and healthy within its environment.

Learning aim A – Understand the requirements of building regulations

For learning aim A1, the specifics of the Building Act (1984) and how to find and use the relevant information can be delivered in a variety of different ways, for example:

- Tutors to download a copy of the Building Act (1984) for learners so that they can familiarise themselves with the content. Ensure that it is summarised in as simple English as possible, as it contains a lot of legal terminology that may not be accessible to learners. Print off the content so it can be used for reference.
- Learners to be given some false statements about the Building Act (1984) and asked to prove if they are true or false. Tutors could use flash cards with statements on them, so that learners have to blind select from them to answer.
- Invite a building control officer (BCO) to visit the centre as a guest speaker. They can deliver a talk about their role, the Building Act (1984) and how the regulations developed from this, which will help to place the legislation into context for learners.
- Learners to be presented with a series of statements and asked if they are true or false, e.g. 'Does an inspector have more power than the police?'
- Learners to complete a research task where they are to investigate the powers and regulations produced form the Building Act (1984). Tutors can set questions, and learners will need to manage information effectively to answer them correctly.

The Building Regulations (2010) was developed from the Building Act (1984), which is the primary piece of legislation. For learning aim A2, the specifics of the regulations and how to find and use the relevant information can be delivered in a variety of different ways, for example:

- Tutors could invite a building control officer (BCO) to visit the centre as a guest speaker. They can deliver a talk to learners and engage them in the building control process, using local examples of applications, approvals and enforcement.
- Tutors could also invite an architect or designer to visit the centre to undertake the same process, but from the perspective of the client and how regulations have to be met, while still considering these aspects.
- Tutors to download a copy of the Building Regulations (2010) using the link provided in the 'Resources' section and get learners to examine the content of the regulations.
- Give learners a guide about the regulations for learners for them to read, digest

and then ask questions to consolidate knowledge.

Learning aim B – Examine the requirements of the building regulations within building services applications

Learning aim B becomes more technically challenging, as it is specific to aspects of the installation of building services into a building. For learning aim B1, the following list of methods could be used for each of the approved documents (Parts F, G, H, J, L, P and R).

- Tutors to download the documents and divide the class into small groups, allocating one document per group. Learners then have to read their document and summarise the information in order to deliver a 10-minute presentation, focusing on the building services aspects and how compliance is achieved.
- Tutors to invite a domestic subcontractor from each sector to visit the centre, e.g. electrical and plumbing. They can talk to learners about compliance concerning each approved document.
- Tutors could give learners case studies regarding each aspect that can then be discussed and debated (see links provided in the 'Resources' section). These case studies could be building regulation application documents from a local authority website.

Learning aim B2 focuses on achieving alternative compliance. In order to deliver this content, tutors can refer to the following:

- self-certification schemes in Schedule 3 of the Building Regulations (2010)
- the National House Building Council (NHBC) website, which details certification schemes (a link has been provided under resources)
- within each approved document, there is a list of British and European Standards that are referred to that can be used to demonstrate alternative compliance.

Tutors can ask learners to research the criteria and must explain why they differ to the approved document regulations and guidance.

Learning aim C – Undertake a building regulations application

Learning aim C concerns the types of application, preparing a building notice application and preparing a full plans application. Learners are required to build a portfolio of evidence covering a full plans application and building notice submission. There are strong links to other units within the qualification that can be exploited during the delivery of this learning aim. Opportunities exist for the following:

- Using the processes of measured surveys within *Unit 10: Building Surveying in Construction* for providing the survey of an existing building; data can be used to produce a drawing.
- Tutors can demonstrate how these documents are used and what specific information is required to be submitted. Learners will then know what information is essential to include in these forms.
- Tutors can act out the role of a building control officer and can check learners' submissions. They must officially report regarding compliance with all documentation requirements.
- Tutors can draw upon an existing building within *Unit 7: Graphical Detailing in Construction* to provide a basis for the proposed work that could be added to the drawing. They can also add to an existing drawing produced in this unit for a proposed building alteration or adaptation.
- Tutors to use some of the specifications produced in *Unit 4: Construction Technology* to support the delivery of the building regulations application processes.

Any local authority website can be used to access the formal templates that are used for building notices and full plans applications.

Guidance is available on many authority websites to illustrate differences between the two types of applications in support of understanding content in learning aim C1. A link has been provided in the 'Resources' section for self-build applications, which details the processes in some detail.

Learners have to submit two types of applications as part of the pass criteria assessment. Accessing a local authority website under Building Control provides a lot of information on how this is achieved. Inviting a building control officer to talk to learners would prove a good opportunity to outline the whole process and how this is achieved within given timelines.

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

This unit has links to the following units within the suite of qualifications:

- Unit 7: Graphical Detailing in Construction
- Unit 8: Building Regulations and Control in Construction
- Unit 10: Building Surveying in Construction
- Unit 14: Provision of Primary Services in Construction

The later unit is especially relevant with duplication across this unit that can be used to evidence a number of assessment criteria for both units.

Resources

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Textbooks

Billington MJ, Barnshaw SP, Bright KT and Crooks A, *The Building Regulations: Explained and Illustrated* (14th Revised Edition), Wiley-Blackwell, 2017 ISBN 9781405195027 – This edition provides useful diagrams.

Evans H, *Guide to the Building Regulations* (3rd Revised Edition), RIBA Publishing, 2015 ISBN 9781859466179 – It is a supportive guide on the application of the regulations.

Videos

Access 'YouTube' website and search for the following videos:

'LABC: What is Building Control and how do the Building Regulations help you?' by LABC Building control – This video explains what a Building Regulations application is and how to apply.

'Part P – Building Regulations Electrical Safety' by John Ward – This video gives explanation of Part P, what it is and how to comply with it (applies to England and Wales only).

Websites

'Planning Portal' – This website has approved documents available for download.

'Gov.uk' – Access the 'Legislation.gov.uk' webpage and search for 'The Building Act 1984' and 'The Building Regulations 2010' for more information. You can also search for 'self-certification schemes'.

'Local Authority Building Control (LABC)' – This website contains building regulations approval guidance. It also includes case studies that may be useful for setting assignments for learners.

'City of London' – Search the website for 'Building Act 1984' for a summary of the Building Acts (1984) main powers and sections.

'National House Building Council (NHBC)' – It is the standard setting body and leading home construction warranty and insurance provider for new and newly converted homes in the UK.

'Build It' – This website contains a self-build guide to the building regulations.

Tutors to access a search engine and look for 'Building Regulations: Part F & L' for a PDF document about ventilation, and 'Energy Efficiency and Historic Buildings – Application of Part L of the Building Regulations to historic and traditionally constructed buildings' for a PDF about Part L.

'RTPI UK' – This is a website for The Royal Town Planning Institute (RTPI), which is a membership organisation for Professional Town Planners engaged in providing career development advice, standards and educational resources.

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