Unit 27: Plumbing and Fluid Behaviour in Building Services Engineering

Delivery guidance

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 dynamics, as well as develop skills to design plumbing and above-ground drainage for a property.

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

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 for the design of plumbing and above-ground drainage installations. This will help learners to develop a holistic understanding of such designs.

Approaching the unit

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

Tutors should be aware that some learners may require more support whilst others might need to be challenged with more demanding and complex tasks. Tutors can develop activity sheets that contain extension activities to cater for those learners.

Learners can be supported and challenged during delivery through a variety of methods, including knowledge quizzes, paired or group activities, class discussions and presentations. These will give opportunities for peer learning alongside motivating learners.

Learning aim A

This learning aim focuses on understanding the properties of cold water, as well as the sourcing, cleansing and distribution of cold water, to include relevant standards and regulations. Developing an understanding of pressure and its measurements is also an essential part of this learning aim.

Tutors could start by introducing properties of water, covering definitions, relevant units and notations. This could be followed by 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 water supply in the local area is sourced. A visit to a local water treatment facility would be useful for learners.

Engage learners by using activity sheets to develop an understanding of pressure and how it is measured. Use practical demonstrations or experiments where learners can take pressure measurements themselves, and therefore gain an understanding of the concept of gauge pressure.

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

Learning aim B

Whether content is taught in parallel or in a linear sequence, tutors could use a holistic, project-based approach and combine the delivery of learning aims B and C. These learning aims give learners the opportunity to design a plumbing and overground drainage system in learning aim B and build on their design in learning aim C. Tutors could develop a mock project for learners, or obtain one from any of the industry partners.

Learning aim B is about designing plumbing and above-ground drainage systems for a domestic property. Learners will need to apply their analytical skills to meet the project requirements with the appropriate selection of components.

Tutors will require access to relevant project information, such as services drawings, especially those related to component details, for use as learning resources. Tutors could also contact building services companies who may be willing to help.

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

Learning aim C

This learning aim is about behaviour of fluid in motion called fluid dynamics and its application to building services systems. 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 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 activity sheets for learners to 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.

Tutors will require access to relevant project information, such as services drawings, especially those related to component details, for use as learning resources. Tutors could also contact building services companies who may be willing to help.

Finally, where possible, invite a guest speaker from a manufacturing or consultancy background. The guest speaker should be able to tell learners about 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 of water and how it is sourced, cleansed to the required standards and distributed	**A1** Physical properties and behaviour of water **A2** Sources of cold water **A3** Cleansing process **A4** Standards **A5** Distribution	Analyse a client brief in terms of all the current regulations and requirements.
B Undertake the design of plumbing and above-ground drainage 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 system from a set of criteria and produce a specification for all the elements of the installation.
C Develop and apply the principles of dynamic fluid flow in pipes and ducts.	**C1** Dynamic fluid flow **C2** Pipes and ductwork **C3** Energy loss **C4** Losses in pipes and ductwork	

Assessment guidance

There is a maximum number of two summative assignments for this unit. Tutors should set the assignment briefs within the context of a project. For Assignment 1, which will cover learning aim A, tutors should provide a vocationally-relevant context so that learners could evaluate the distribution and installation of a water supply system.

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.

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Introduction

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

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

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

- 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 the properties, behaviour of water and how it is sourced, cleansed to the required standards and distributed

Learning aim A1

- Begin with a tutor presentation to introduce the topic, showing properties of water using animations, DVDs, pictures, illustrations or web-based videos.
- Next, introduce the concept of a 'fluid'; the types of flow; and fluid properties. Tutors could use illustrations, animations and online web resources to reinforce this learning. Tutors could also use a knowledge quiz as a learning check.
- Use practical laboratory-based activities to demonstrate properties of water, such as density and viscosity. Ask learners to work as a group during these demonstrations and present their findings to their peers though an in-class presentation.
- In a tutor-led class discussion, using illustrations and suitable video clips, introduce the concept of pressure and how it could be measured. Follow up on this by introducing various types of pressure. Hold a Q&A session as a learning check.

Learning aim A2

- Use a tutor 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 of, for example, reservoirs, lakes, shallow and deep wells etc.
- Introduce the concept of soft and hard water. Ask learners to carry out a research activity on how soft and hard water could affect plumbing systems. Provide support and summarise key points after learners have shared their findings.

Learning aim A3

- In a tutor-led class discussion, 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 fit to drink.

Learning aim A4

- For this part of delivery, tutors should gather information about the local standards in addition to the ones by the World Health Organisation (WHO). Spilt class into groups. Provide learners with a copy of the regulations and ask them to prepare a poster in their groups, highlighting one of the key features.
- Learners to present their posters. The focus will be on how these regulations could help to avoid contamination within the water supply systems. Learners should include effects of contaminated water in areas where regulations are not followed.

Learning aim A5

- Introduce how water is distributed from the mains supply to the consumer. Refer to the local water supply system and engage learners by asking about their knowledge of how water reaches their houses. Introduce the concept of pressure required and pipe sizing at various points within the distribution. Apply learning checks using a quiz.
- Invite a guest speaker from the local water supply organisation. The guest speaker should show learners how water is sourced, cleansed and distributed. The guest speaker will make reference to local regulations and standards followed in practice and will show part of the distribution layout showing pipe sizes and pressures.
- To review learning across learning aim A, facilitate a class discussion regarding water properties, cleansing, distribution and regulations and standards involved. Summarise learner feedback and expand on key points as necessary.

Learning aim B: Undertake the design of plumbing and above-ground drainage for a property

Learning aim B1

- Start the delivery of B1 with the help of a project brief. Through a tutor-led discussion, tutors could present it in detail, explaining the types of appliances and components, controls, operational and water conservation features. Use DVD/web-based video resources as appropriate. Tutors can further engage learners throughout with informal Q&A sessions to check 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. Use this to show how sanitary schedules are developed and what various ancillary components are included in these. Learners to share their findings in a class discussion.

Learning aim B2

- Introduce materials and components used in pipework systems, jointing methods and their use. If the campus has a plumbing workshop, this will be an ideal opportunity to show learners various pipe materials and jointing methods. Learners could participate in a jointing task to engage them.
- Ask learners to develop an information leaflet for two of the fittings taken from the unit content. Each group will state about the material, jointing method and where this could be used. Provide support and add where necessary.

Learning aim B3

- Using illustrations and sketches, give an overview of various ways in which hot and cold water systems can be employed. Introduce how Building Information Modelling (BIM) helps to collaborate design activities to resolve any clashes. Engage learners through Q&A and give a quiz as a learning check.
- Ask learners to carry out research on cold and hot water supply systems in groups. Allocate a specific type to each group from the unit content. Each group should produce sketches or annotated illustrations explaining how the system works. All groups then share their findings. Tutors to provide guidance and fill in any missing knowledge gaps as necessary.

Learning aims B4 and B5

- Give a tutor presentation to introduce approaches and systems used in above ground drainage. Make use of project documents, drawings or illustrations focusing on methods of disposal and relevant regulations. Show how rainwater could be disposed of and harvested and introduce greywater recycling.
- Using an example design project, assign small groups of learners 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 to then present to their peers, justifying the design recommendations made.
- Develop a number of task sheets covering design exercises related to a project for a tutor-led activity. These should include types of drainage, systems used for drainage and testing. Support learners as they work 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 and above-ground drainage 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 and apply the principles of dynamic fluid flow in pipes and ducts

Learning aim C1

- Introduce the topic by showing dynamics of fluid flow using animations, DVDs, pictures, illustrations or web-based videos.

- 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.
- Use practical laboratory-based activities to demonstrate conservation of mass using, for example, 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 to hold a Q&A session as a learning check.

Learning aim C2

- In a tutor-led individual activity, 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 for learners to develop their skills in determining flow for a variety of engineering situations. Tutors to provide support throughout. Towards the end of the session, share the correct answers with the class and recap on any areas learners found particularly challenging.

Learning aim C3

- In a tutor-led class discussion, using illustrations and suitable video clips, introduce energy losses using relevant principles. Tutors to hold a Q&A session as a knowledge check.
- Follow this with a presentation showing causes of such energy losses in pipes and ductwork using animations, DVDs, pictures, illustrations or web-based videos.

Learning aim C4

- Use a tutor-led class discussion to ask 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.
- 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 co-efficient, 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 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 individual activity, demonstrate how to use Darcy's and Chezy's formulae, as well as Poiseuille's equation, for various situations. Give appropriately illustrated activity sheets to learners so they can develop their skills in determining losses in pipes and ductwork for a variety of engineering situations. Tutor to provide support

throughout. Towards the end of the session, share the correct answers with the class and recap on any areas learners found particularly challenging.

- Provide learners with an example design project and ask them to extract relevant details. Allocate learners one of the topics in learning aim C. For example, one group could explore design flows at a given point while another group could estimate pipe losses for a given section. Learners to present to their peers.
- 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.

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

This unit links to:

- Unit 14: Low Temperature Hot Water Systems in Building Services Engineering
- Unit 25: Building Services Control Systems
- Unit 26: Heating, Ventilation and Air Conditioning Design
- Unit 28: Electrical Principles and Installation Standards 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 Internationals in Construction. 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.C., *Fluid Mechanics DeMYSTiFieD,* McGraw-Hill Professional, 2009, ISBN 9780071626811.
This book explains fundamental principles relating to fluid mechanics and is relevant to the content of this unit.

Potter, M.C. and Wiggert, D.C., *Schaum's Outline of Fluid Mechanics (Schaums' Outline Series)*, McGraw-Hill Education, 2007, ISBN 9780071487818.
The book has a number of solved examples relevant to the unit and will help learners to practice such questions.

Zaher, M.A., *Building Services*, CreateSpace Independent Publishing Platform, 2012, IBSN 9781478225904
A very good resource to help learners understand principles and operation of air-conditioning, pumps/fans/blowers and plumbing.

Journals

'Building Services and Environmental Engineer (BSEE)' – 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 the CIPHE online journal, which covers a broad range of areas relating to plumbing and heating.

Videos

Go to the 'YouTube' website and search for the following videos:

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

'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.

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.

'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 students to access them through the school/college intranet.