

# Unit 16: Mechanical and Electrical Services in Construction

NQF Level 3: BTEC National

Guided learning hours: 60

---

## Unit abstract

The provision of high quality mechanical and electrical building services is essential in the modern world. Building services supply our buildings with cold water that is safe to drink and the means to heat that water and the spaces inside our buildings. They dispose of foul water and they provide power to a variety of electrical systems and appliances.

They do this so effectively that we tend to take them for granted, at least until something goes wrong. It is the provision of high quality building services that differentiate modern buildings from those that were being constructed in previous eras.

A builder must provide the structure within which the services will function. It follows that all builders must therefore have a basic understanding of building services so that they can contribute to their effective integration of these into buildings.

Learners will acquire the basic knowledge and understanding of the provision of services to a building, from the perspective of a builder, including hot and cold water systems, drainage facilities, and the supply of single phase electricity and gas.

## Learning outcomes

On completion of this unit a learner should:

- 1 Understand the principles and practices associated with the provision of hot and cold water systems to buildings
- 2 Understand the principles and practices associated with the provision of above and below ground drainage systems to buildings
- 3 Understand the principles and practices associated with the provision of simple single-phase electrical systems to buildings
- 4 Understand the principles and practices associated with the provision of gas supplies to buildings.

## Unit content

---

### 1 Understand the principles and practices associated with the provision of hot and cold water systems to buildings

*Cold water systems:* distribution of cold water to and in homes; comparison of direct and indirect systems; layouts; specifications; dimensions; capacities; materials used

*Hot water systems:* provision and distribution of hot water in homes; comparison of direct and indirect systems; layouts; specifications; dimensions; capacities; materials used

*Legislation:* awareness of relevant legislation; importance of compliance with such legislation; associated health and safety issues

### 2 Understand the principles and practices associated with the provision of above and below ground drainage systems to buildings

*Above ground drainage:* requirements of systems eg water seal, prevention of disruption of water seal by siphonage, need for ventilation; effect on design of systems; comparison of single-stack and two-pipe systems; layouts; dimensions; specifications; materials used

*Below ground drainage:* requirements of systems eg capacity, fall, ventilation, support, access for maintenance and repair, shortest possible pipe runs; effect on design of systems; separate and combined systems for surface water and foul water; layouts; dimensions; specifications; materials used

*Legislation:* awareness of relevant legislation; importance of compliance with such legislation; associated health and safety issues

### 3 Understand the principles and practices associated with the provision of simple single-phase electrical systems to buildings

*Installation:* requirements of systems (sufficient capacity, prevention of excessive current, protection from shock, prevention of fire, means of isolation); components of domestic systems eg main service fuse, meter, main switch, consumer control unit, residual current devices (rcc), miniature circuit breakers (mcb) or fuses, earth connection, outlet sockets, fuses in plugs and/or appliances; principles and layouts of ring main circuits to socket outlets, radial circuits for lighting, radial circuits for high power appliances such as electric cookers, showers and water heaters

*Legislation:* awareness of relevant legislation; importance of compliance with such legislation; associated health and safety issues

**4 Understand the principles and practices associated with the provision of gas supplies to buildings**

*Installation:* requirements of systems need for adequate supply of ventilation air to support combustion; effective flue arrangements to dispose of combustion products; supply from gas main into building up to and including the gas meter

*Legislation:* awareness of relevant legislation; importance of compliance with such legislation; requirement for connection of appliances to gas installation pipes by competent person; associated health and safety issues

## Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 produce clear and accurate diagrams of functional direct or indirect cold water systems that comply with relevant legislation	M1 specify hot and cold water systems in terms of materials and appropriate dimensions and/or capacities of fittings and components	D1 evaluate the advantages and disadvantages of the direct and indirect systems used in hot and cold water supplies and suggest situations where each might be appropriate
P2 produce clear and accurate diagrams of functional direct or indirect hot water systems that comply with relevant legislation	M2 specify above and below ground drainage systems in terms of materials and appropriate falls, dimensions and/or capacities of fittings and components	D2 justify the use of single-stack above ground drainage systems, and separate below ground drainage systems for foul water and surface water, in modern house building.
P3 produce clear and accurate diagrams of above and below ground functional drainage systems that comply with relevant legislation	M3 distinguish between electrical and gas installations in terms of important health and safety issues.	
P4 produce clear and accurate diagrams of single-phase electrical systems that comply with relevant legislation		
P5 produce clear and accurate diagrams of gas supply systems that comply with relevant legislation.		

## Essential guidance for tutors

---

### Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet or library resources and the use of personal or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

It is important to note that this unit is intended for those working in construction rather than in building services engineering. Learners must develop knowledge and understanding of how basic building services are provided to buildings, how they are integrated into buildings and why one system may be preferred to another in a given situation. There is no requirement at this stage for calculations relating to pipe sizing, cable sizing or similar.

The four learning outcomes should be treated separately as they refer to entirely separate building services. It should be noted that the unit content relating to the first three learning outcomes refers in the main to the distribution of each service within the house or, in the case of drainage, inside the house, outside the house and underground. The unit content for learning outcome 4 need go no further than how the gas main is connected to the gas meter. Details of internal distribution to individual gas appliances are not required at this stage, but the learner must be made aware that a 'competent person' must install gas appliances. Learners should also know what is meant here by the term 'competent person'.

It is highly unlikely that learners will have the opportunity to practice the practical installation of building services, and those same services will largely be hidden from view in learners' homes. It is therefore important that learners be given the opportunity to visit building sites and plumbing and electrical installation workshops in colleges or training centres to see services installations that are in full view.

Learners must be made aware of the existence of the legislation and guidance that underpin building services design, distribution and installation, and should be able to name individual pieces of the relevant legislation. There is no requirement for a deeper understanding and a detailed treatment of the legislation should be avoided. The systems covered must however comply with current legislation and learners must be made aware of the need for full compliance.

Learners should be encouraged to use their homes as a learning aid. They can follow water pipes around the building, examine above ground drainage systems, find out where all the stop-cocks are situated, check outside for manholes and rodding points, locate the consumer control unit and try to match fuses and circuit breakers to electrical circuits within the building. Learners should have the opportunity to undertake simple laboratory tests to simulate the various forms of siphonage that can compromise water seals or, where this is impractical, the same principles should be demonstrated by the tutor. Small models can be constructed of domestic hot and cold water systems, drainage systems and low voltage electrical circuits and used to simulate what happens in buildings.

There are several interactive websites relating to building services. These can be accessed on the internet using a decent search engine. These change so often that none are specifically recommended here, but tutors are advised to search these out on a regular basis. Incomplete diagrams can be issued to learners in hard copy for them to complete as part of a formative assessment. Learners can then complete multiple copies until a functional solution is obtained.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

**Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.**

### Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria may be fully addressed by using three assignments. The first of these would cover P1, P2, M1 and D1, the second would cover P3, M2 and D2, and the third would cover P4, P5 and M3.

To achieve a pass grade learners must meet the five pass criteria listed in the grading grid.

For P1, learners must produce clear and accurate diagrams of functional direct or indirect cold water systems that comply with relevant legislation. They must produce separate drawings of direct and indirect functional systems. Line diagrams are permitted but conventional symbols must be used for all components.

For P2, learners must produce clear and accurate diagrams of functional direct or indirect hot water systems that comply with relevant legislation. They must produce separate drawings of direct and indirect functional systems. Line diagrams are permitted but conventional symbols must be used for all components.

For P3, learners must produce clear and accurate diagrams of above and below ground functional drainage systems that comply with relevant legislation. This should include separate drawings of single-stack and two-pipe functional systems for providing above-ground drainage and separate drawings of separate and combined functional systems. Line diagrams are permitted but conventional symbols must be used for all components.

For P4, learners must produce clear and accurate diagrams of single-phase electrical systems that comply with relevant legislation. This should include a diagram of a ring main system that includes a consumer control unit with isolating switch, several 13A socket outlets, one 13A spur socket outlet, and live, neutral and earth cables. They should also produce a diagram of a simple lighting system incorporating several one-way switches and a single two-way switch. Line diagrams are permitted but conventional symbols must be used for all components.

For P5, learners must produce clear and accurate diagrams of gas supply systems that comply with relevant legislation. This should include diagrams showing how buildings are connected to gas mains both with the meter inside the house and on the external wall. The systems drawn must be functional. Line diagrams are permitted but conventional symbols must be used for all components.

To achieve a merit grade learners must meet all of the pass grade criteria and the three merit grade criteria.

For M1, learners must specify hot and cold water systems in terms of materials and appropriate dimensions and/or capacities of fittings and components. This will include all relevant dimensions and pipe diameters, and the capacity of any cisterns, hot water cylinders and so forth. This could be provided as annotation to the diagrams provided for P1 and P2.

For M2, learners must specify above and below ground drainage systems in terms of materials and appropriate falls, dimensions and/or capacities of fittings and components. This will include all relevant dimensions, pipe diameters, angles and/or curve radii as appropriate. This could be provided as annotation to the diagrams provided for P3.

For M3, learners must distinguish between electrical and gas installations in terms of important health and safety issues.

In the case of gas supplies, learners must emphasise the need for a constant and adequate supply of ventilation air to ensure complete combustion of natural gas and the need for effective flue arrangements to remove the products of combustion (flue gases). There is no requirement for learners to go into detail about standard and balanced-flue outlets. In the case of electricity supplies, learners must consider the factors (cables of sufficient capacity, prevention of excessive currents, protection from shock, prevention of fire and means of isolation) that must be taken into account and the way in which the components (fuses, mains switch, circuit breakers, earth connection) and wiring systems address these factors. The evidence should be in the form of a report containing text and images, supported by tables, charts, graphs and calculations where relevant.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the two distinction grade criteria.

For D1, learners must evaluate the advantages and disadvantages of the direct and indirect systems used in hot and cold water supplies and suggest situations where each might be appropriate. Learners must then select appropriate systems for given situations and justify the selections made in terms of the advantages and disadvantages cited. Examples of suitable evidencing approaches are as for M3.

For D2, learners must justify the use of single-stack above ground drainage systems, and separate below ground drainage systems for foul water and surface water, in modern house building. Learners must then select appropriate systems for given situations and justify the selections made in terms of the advantages and disadvantages cited. Examples of suitable evidencing approaches are as for M3 and D1.

### **Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications**

This unit builds upon the knowledge, understanding and skills contained in the core units together with similar units at Higher National and degree level.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The unit provides opportunities to gain Level 3 key skills in communication and information and communication technology. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

### **Essential resources**

Centres should ideally have access to online technical and manufacturers' literature or hard copies where this is not possible. The use of readily available visual aids is considered to be highly advantageous. These can be either in the form of sectioned models or as part of live installations. Centres that run plumbing, gas fitting and electrical installation training courses would be well advised to make use of such facilities for demonstration purposes. Centres without such advantages should arrange visits to engineering and construction sites and manufacturers' premises instead. Centres should have access to sets of architectural drawings, heating system installations and schematic drawings to support the learning process and to facilitate assessments. It is anticipated that most learners will wish to use ICT to produce their reports and many may wish to use CAD techniques to produce their drawings. This implies access to such facilities. Many learners will have access to ICT at home or at work, but not all will have access to CAD facilities at work and few will have it at home. Centres should give some consideration to how they could meet this need for the disadvantaged learner.

**Indicative reading for learners**

Garrett R H – *Hot and Cold Water Supply* (Blackwell Science (UK), 2000)  
ISBN 0632049855

Hall F and Greeno R – *Building Services Handbook* (Butterworth-Heinemann, 2003)  
ISBN 0750661437

Harrison H and Trotman P – *Building Services* (IHS BRE, 2000) ISBN 1860814247

HSE – *Electricity at Work: Safe Working Practices* (HSE Books, 2003) ISBN 0717621642

Knight J – *Newnes Building Services Pocket Book* (Butterworth-Heinemann, 2003)  
ISBN 0750657855

Saxon F – *Tolley's Domestic Gas Installation Practice: 2 (Gas Service Technology)*  
(LexisNexis UK, 2001) ISBN 075451434X

Scaddon B – *Electrical Installation Work* (Butterworth-Heinemann, 2002)  
ISBN 0750656417

Stokes G – *Handbook of Electrical Installation Practice* (Blackwell Science (UK),  
2003) ISBN 0632060026

Young L and Mays G – *Water Regulations Guide* (WRC Publications, 2000)  
ISBN 0953970809

## Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> <li>identifying and describing the common modern telecommunication systems that are supplied to buildings</li> <li>comparing the various ways in which telecommunication systems enter buildings</li> <li>distinguishing between electrical and gas installations in terms of important health and safety issues</li> <li>evaluating the advantages and disadvantages of the direct and indirect systems used in hot and cold water supplies and suggesting situations where each might be appropriate</li> <li>justifying the use of single-stack above ground drainage systems, and separate below ground drainage systems for foul water and surface water, in modern house building.</li> </ul>	<p>C3.1a Take part in a group discussion.</p> <p>C3.1b Give a talk of at least eight minutes using an image or other support material.</p> <p>C3.2 Read and synthesise information from at least <b>two</b> documents about the same subject.  Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write <b>two</b> different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.</p>

<b>Information and communication technology Level 3</b>	
<b>When learners are:</b>	<b>They should be able to develop the following key skills evidence:</b>
<ul style="list-style-type: none"> <li>• using the internet, CD ROMs and DVD ROMs to research their reports and ICT to produce the report</li> <li>• using CAD techniques to produce the required layout diagrams.</li> </ul>	<p>ICT3.1 Search for information, using different sources, and multiple search criteria in at least one case.</p> <p>ICT3.2 Enter and develop the information and derive new information.</p> <p>ICT3.3 Present combined information such as text with image, text with number, image with number.</p>