City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma)

(6036-03)

Version 1.0 May 2024

Qualification Handbook

Qualification at a glance

Subject area	Building Services Engineering (BSE)
City & Guilds number	6036
Age group approved	19+ (Adult only)
Entry requirements	Learners will hold the Level 2 Diploma in Plumbing Studies (6035-02) or other awarding organisation equivalent to complete this qualification satisfactorily
Assessment	Multiple choice question (MCQ) question paper(s), practical assignment(s)
Grading	Pass/Fail
Approvals	Full approval required
Support materials	Sample assessments
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates
Occupational Standard	ST0303

Title and level	City & Guilds qualification number	Regulatory reference number	GLH	TQT
City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma)	6036-03	610/3904/4	445	568

Version and date	Change detail	Section
1.0 May 2024	Initial version	All

Contents

1 Introduction

What is this qualification about?

Area	Description
Who is the qualification for?	This qualification is aimed at adults aged 19+ wishing to gain the knowledge required at Level 3 to commence a career within the plumbing and heating sector.
What does the qualification cover?	This qualification covers topics to do with health & safety, planning and supervision, cold and hot water systems design and central heating systems, as well as sanitation, rainwater and environmental systems.
What opportunities for progression are there?	The qualification will support progression onto a plumbing & heating apprenticeship. The job outcome once the learner has joined and completed an apprenticeship will be a plumbing and domestic heating engineer.
Who did we develop the qualification with?	N/A
Is it part of an apprenticeship framework or initiative?	ST0303 Plumbing and Domestic Heating Technician

Content coverage and mapping

Occupational standards

This qualification has been developed to cover as many of the Knowledge, Skills and Behaviours (KSBs) in the relevant Occupational Standard as it may be reasonable to attain by undertaking a course of education or training. While KSBs in a relevant Occupational Standard cannot reasonably be obtained within a course of education or training in an educational setting, City & Guilds seeks the validation from credible employers to ensure that the qualification is fit for purpose.

The knowledge and skills content within this qualification has been amplified to reflect the KSBs. High level mapping to the KSBs in the Occupational Standard can be found in the Qualification structure section. Detailed mapping at topic level can be found in Appendix 1 within this qualification handbook.

The table below shows the Occupational Standard the qualification aligns to:

Qualification	Occupational Standard title/reference
City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma)	Plumbing and Domestic Heating Technician/ST0303

2 Employer Engagement

City & Guilds would like to take this opportunity to thank all the employers, trade associations, professional bodies, providers, subject matter experts and consultants who have dedicated time to review and validate this qualification. These stakeholders have been used throughout the development and validation of this qualification to ensure the qualification meets the requirements of the Occupational Standard and the needs of industry. Employer validation recognises the demand or likely demand for learners who have completed the City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma). This collaborative work is to ensure that a learner studying the City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) has the best opportunities available to them as they progress through their career with a solid base as a starting point.

3 Qualification structure

Structure

To achieve the City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) learners must achieve:

City & Guilds unit number	Unit title	GLH
Mandatory units:		
Learners must achieve all the City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) mandatory units.		
301	Cold water systems	75
302	Hot water systems	70
303	Central heating systems	98
304	Sanitation and rainwater systems	44
305	Electrical work and the control of plumbing and domestic heating systems	64
306	Domestic fuel systems and environmental technologies	43
307	Planning and supervision for building services engineering projects	51

Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT comprises of the following two elements:

1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate centre of education or training.

Title and level	GLH	TQT
City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) (6036-03)	445	568

4 Centre requirements

Approval

Full approval

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the document **Centre Approval process: Quality Standards** for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area(s) for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Assessors

Staff delivering these qualifications are able to take on the role of the assessors in the practical assessment(s) and must still meet the occupational expertise requirements.

Continuing Professional Development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes account of any national or legislative developments.

Physical resources

Centres must be able to demonstrate that they have access to the equipment and technical resources required to deliver this qualification and its assessment.

- Specialist plumbing tools such as blowtorches, soldering equipment, pipe benders/cutters, adjustable spanners, screwdrivers, threading kits, files and hacksaws.
- Pipe – copper, LCS and plastic.
- Gutters and fixings.
- Waste and soil pipework.
- Traps.
- A selection of fittings and fixings such as float operated valves, service valves, cylinders, terminal fittings, emitters, isolation valves, accumulators, mini shock arresters, pressure relief valves, pumps, expansion/pressure vessels, pressure switches (transducers), float switches, gauges and controls, backflow prevention devices and fans.
- Jointing materials.
- Measuring equipment such as a tape measure and a spirit level.
- Commissioning equipment such as a pressure gauge, a thermometer, a weir cup and pressure testing equipment.
- PPE.
- Manufacturer's instructions for all equipment.
- Making-good materials such as filler, paint and sandpaper.

- Plumbing systems: direct and indirect cold water, boosted cold water, vented hot water, unvented hot water, sanitation and rainwater.
- Plumbing components: sanitary appliances (WC, bath, sink), wash hand basin (WHB) and drain valves.
- Thermal insulation materials.
- Heating systems: fully pumped, 3 x two-port valves (S-plan plus), S-plan and combination.
- Heating appliances (boilers).
- Heat-emitting devices and associated seals: panel radiators, underfloor heating, towel rails and low surface temperature (LST) radiators.
- Heating components such as safety controls and diverter valves.
- Heating controls such as thermostats, zone valves, programmers, auto bypass valves and thermostatic radiator valves (TRVs).
- Electrical components such as micro switches, relays, pressure switches, printed circuit boards, optimizers, frost stats, wi-fi routers, wi-fi range extenders, isolators, circuit breakers, fuses, switches, socket outlets, miniature circuit breakers (MCBs), residual current devices (RCDs), fuse boxes and wiring centres.

Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions of Recognition. For more information on both CASS and City & Guilds Quality Assurance processes visit: the What is CASS? and Quality Assurance Standards documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, internal quality assurers must:

- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres and to monitor the assessment and internal quality assurance carried out by centres. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments within and between centres by the use of systematic sampling
- ensure centres are rotating usage of assignment versions
- provide feedback to centres and to City & Guilds.

Learner entry requirements

Learners will hold the Level 2 Diploma in Plumbing Studies (6035-02), or other awarding organisation equivalent, in order to complete this qualification satisfactorily.

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- any support and guidance they may need when working towards their qualification
- any units they have already completed or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme, so the learner fully understands the requirements of the qualification, their responsibilities as a learner and the responsibilities of the centre. This information can be recorded on a learning contract.

Learners will hold the Level 2 Diploma in Plumbing Studies (6035-02), or other awarding organisation equivalent, in order to complete this qualification satisfactorily.

Age restrictions

This qualification is approved for learners aged 19 or above.

Access to assessment and special consideration

City & Guilds has considered the design of this qualification and its assessments in order to best support accessibility and inclusion for all learners. We understand however that individuals have diverse learning needs and may require reasonable adjustments to fully participate. Reasonable adjustments, such as additional time or alternative formats, may be provided to accommodate learners with disabilities and support fair access to assessment. Access arrangements are adjustments that allow candidates with disabilities, special educational needs, and temporary injuries to access the assessment and demonstrate their

skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

The Equality Act 2010 requires City & Guilds to make reasonable adjustments where a disabled person would be at a substantial disadvantage in undertaking an assessment.

It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the JCQ access arrangements and reasonable adjustments and Access arrangements - when and how applications need to be made to City & Guilds for more information. Both are available on the City & Guilds website:
http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/access-arrangements-reasonable-adjustments

5 Delivering the qualification

Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

Inclusion and diversity | City & Guilds (cityandguilds.com)

Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030 and to develop environmentally responsible operations to achieve net zero by 2040, or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

Our Pathway to Net Zero | City & Guilds (cityandguilds.com)

Centres should consider their own carbon footprint when delivering this qualification and consider reasonable and practical ways of delivering this qualification with sustainability in mind. This could include:

- reviewing purchasing and procurement processes such as buying in bulk to reduce the amount of travel time and energy and considering investing in the use of components that can be reused, instead of disposable or single use consumables
- reusing components wherever possible
- implementing waste procedures (ensuring that waste is minimised and that recycling of components is in place wherever possible)
- minimising water use and considering options for reuse/salvage as part of plumbing activities wherever possible.

Support materials

The following resources are available for this qualification:

Description	How to access
Sample assessments	www.cityandguilds.com
Qualification handbook	www.cityandguilds.com

6 Assessment

Summary of Assessment methods

For City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) candidates must successfully complete:

Assessment component	Assessment method	Description and conditions
350 Plumbing systems	Externally marked MCQ exam	This assessment covers units 301, 302, 303 and 304. The '350 Plumbing systems' exam is externally set and externally marked and will be online only. The exam is designed to assess the candidate's depth and breadth of understanding across content in units 301, 302, 303 and 304 (and should only be attempted following completion of these units), using multiple choice questions and will be sat under invigilated examination conditions. See Joint Council for Qualifications (JCQ) requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the unit content. Sample assessment materials can be downloaded from the City & Guilds website. Live assessment will be delivered by the City & Guilds online platform E-volve.

Assessment component	Assessment method	Description and conditions
351 Supervisory, electrical, fuel and environmental systems	Externally marked MCQ exam	This assessment covers units 305, 306 and 307. The '351 Supervisory, electrical, fuel and environmental systems' exam is externally set and externally marked and will be online only. The exam is designed to assess the candidate's depth and breadth of understanding across content in units 305, 306, and 307 (and should only be attempted following learner completion of these units), using multiple choice questions and will be sat under invigilated examination conditions. See JCQ requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the unit content. Sample assessment materials can be downloaded from the City & Guilds website. Live assessment will be delivered by the City & Guilds online platform E-volve.

Assessment component	Assessment method	Description and conditions
352 Plumbing and heating design	Internally marked practical assignment	This assessment covers units 301, 302, 303, and 304. The '352 Plumbing and heating design' assignment is externally set and internally marked with external verification. The assignment is designed to assess the candidate's depth and breadth of knowledge, skills and understanding across content in the qualification, at the end of their period of learning, and will be completed under invigilated, controlled assessment conditions. See JCQ requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the qualification content. Sample assessment materials can be downloaded from the City & Guilds website. Assignment material availability will be communicated through the publication of a key date schedule.

Assessment component	Assessment method	Description and conditions
353 Plumbing and heating installation and maintenance	Internally marked practical assignment	This assessment covers units 301, 302, 303, 304 and 305. The '353 Plumbing and heating installation and maintenance' assignment is externally set and internally marked with external verification. The assignment is designed to assess the candidate's depth and breadth of knowledge, skills and understanding across content in the qualification, at the end of their period of learning, and will be completed under invigilated, controlled assessment conditions. See JCQ requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the qualification content. Sample assessment materials can be downloaded from the City & Guilds website. Assignment material availability will be communicated through the publication of a key date schedule.

Scheme of assessment overview

For City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) candidates must successfully complete:

Candidates must complete **all** assessment components					
Assessment component	**Method**	**Duration**	**Marks**	**Marking**	**Grading**
350	On-demand E-volve online MCQ	1 hour 40 mins	65	Externally marked	Pass/fail
351	On-demand E-volve online MCQ	1 hour 40 mins	65	Externally marked	Pass/fail
352	On-demand practical assignment	1 hour 30 minutes	N/A	Internally marked and externally verified	Pass/fail
353	On-demand practical assignment	9 hours 30 minutes	N/A	Internally marked and externally verified	Pass/fail

Candidates must pass all assessment components to achieve the qualification.

Assessment specifications

The assessment specification outlined in the table below highlights, at a high-level, the way that the qualification content will be assessed within the **350 Plumbing Systems** assessment**:**

Unit	Outcome	Number of marks	Percentage %
301	LO1 Size and select cold water systems and components for dwellings	2	3%
	LO2 Commission cold water systems and components	3	5%
	LO3 Perform fault diagnosis and rectification procedures on cold water systems	1	2%
	LO4 Carry out service and maintenance of cold water systems	4	6%
302	LO1 Size and select hot water systems and components for dwellings	3	5%
	LO2 Perform a soundness test and commission hot water systems and components	5	8%
	LO3 Perform fault diagnosis and rectification procedures on hot water systems	1	2%
	LO4 Carry out service and maintenance of unvented hot water systems	6	9%
303	LO1 Size and select central heating systems and components for dwellings	2	3%
	LO2 Perform a soundness test and commission central heating systems and components	17	26%
	LO4 Decommission central heating systems	2	3%
	LO5 Perform fault diagnosis and rectification procedures on central heating systems	3	5%
	LO6 Carry out service and maintenance of central heating systems	6	9%
304	LO1 Understand the methods of selecting and sizing sanitary pipework systems for appliances and components in domestic dwellings	3	5%
	LO2 Perform fault diagnosis and rectification procedures for sanitary appliances and pipework systems	1	2%
	LO3 Carry out service and maintenance for sanitary appliances and pipework systems	5	8%
	LO5 Perform fault diagnosis and rectification procedures on rainwater systems	1	2%
	Total	65	100%[1i]

[1] These percentages have been rounded up to the nearest whole percentage number

Permitted materials: N/A

Graded: Pass/fail

Pass mark: the pass mark for this examination is set at approx 60%

This boundary may be subject to slight variation to ensure fairness should any variations in the difficulty of the individual assessment versions be identified.

The assessment specification outlined in the table below highlights, at a high-level, the way that the qualification content will be assessed within the **351 Supervisory, electrical, fuel and environmental systems** assessment:

Unit	Outcome	Number of marks	Percentage %
305	LO1 Perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems	13	20%
	LO2 Apply industry standard safe isolation procedures	2	3%
306	LO1 Understand factors affecting fuel selection	10	15%
	LO2 Know combustion processes of fuel supply systems	7	11%
	LO3 Know principles of chimney and flue systems	4	6%
	LO4 Know basic operating principles of micro-renewable energy technologies	2	3%
	LO5 Understand requirements for installing micro-renewable energy systems to existing systems	6	9%
307	LO1 Understand responsibilities of roles working in the building services industry	7	11%
	LO2 Know how to compile risk assessments and method statements for building service engineering projects	5	8%
	LO3 Understand requirements for the planning of work programmes	1	2%
	LO4 Understand potential issues, risks and changes that may impact building services engineering projects	4	6%
305	LO1 Perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems		
306	LO2 Know combustion processes of fuel supply systems		
	LO3 Know principles of chimney and flue systems	4	6%
307	LO1 Understand responsibilities of roles working in the building services industry		
	LO2 Know how to compile risk assessments and method statements for building service engineering projects		
	Total	65	100%

Permitted materials: N/A

Graded: Pass/fail

Pass mark: the pass mark for this examination is set at approx 60%

This boundary may be subject to slight variation to ensure fairness should any variations in the difficulty of the individual assessment versions be identified.

Assessment objectives

The following assessment objectives are used within the **350 Plumbing systems** assessment.

The weightings for how the assessment objectives are applied in the assessment are shown in the table below:

Assessment objective	Description	Weighting in Assessment 350
AO1a Demonstrate knowledge of the content	The ability to demonstrate basic recall of relevant knowledge in response to straightforward questioning	20 marks – 30%
AO1b Demonstrate understanding of the content	The ability to demonstrate understanding of principles and concepts beyond recall of definitions	39 marks – 60%
AO2 Apply knowledge and understanding of the content to different situations and contexts	Applying knowledge and understanding taking the understanding of generalities and applying them to specific situations	6 marks – 10%

The following assessment objectives are used within the **351 Supervisory, electrical, fuel and environmental systems** assessment.

The weightings for how the assessment objectives are applied in the assessment are shown in the table below:

Assessment objective	Description	Weighting in Assessment 351
AO1a Demonstrate knowledge of the content	The ability to demonstrate basic recall of relevant knowledge in response to straightforward questioning	20 marks – 30%
AO1b Demonstrate understanding of the content	The ability to demonstrate understanding of principles and concepts beyond recall of definitions	42 marks – 65%
AO2 Apply knowledge and understanding of the content to different situations and contexts	Applying knowledge and understanding taking the understanding of generalities and applying them to specific situations	3 marks – 5%

The two tables below detail, at a high-level, the practical assessment coverage.

352 Plumbing and heating design assignment

Unit	Task*
301, 302, 303, 304	Design a cold/hot/sanitation and rainwater/central heating system

Permitted materials: Permitted materials will be given to candidates by centres.

Graded: Pass/fail

*Candidates will be provided with **one** task in the design assignment which will be sampled from one of the units 301, 302, 303 or 304.

353 Plumbing and heating installation and maintenance assignment

Unit	Task**
301, 302, 303, 304, 305	Maintain a cold/hot/sanitation and rainwater/central heating system
301, 302, 303, 304, 305	Commission a cold/hot/sanitation and rainwater/central heating system
303	Install and decommission an S-plan plus sealed central heating system
305	Wire and test electrical components
305	Identify electrical faults

Permitted materials: Permitted materials will be given to candidates by centres.

Graded: Pass/fail

Candidates must gain a pass in all tasks within the assignment to achieve a pass overall.

** Candidates will be provided with one assignment consisting of **five** tasks in total, as detailed in the table above. For the maintenance and the commission tasks, each assignment version will cover a different system (from different units) and will not duplicate skills tested. For example, a candidate completing maintenance of a hot water system will never be required to undertake a task commissioning a hot water system in the same version.

Availability of assessments

Assignment material availability will be communicated through the publication of a key date schedule. This schedule will include when assignment materials will be released to centres.

All assessments that are on E-volve are on-demand and can be booked by the centre when the candidate is ready to be entered for the assessment.

Retakes/resits

Multiple choice test(s)
Candidates who have failed an online MCQ question paper assessment are permitted up to **four** resits of the assessments before re-registration is required.

Assignment(s)
Candidates who have failed one or more tasks in the assignment(s), will be advised to complete a further period of learning before then resitting fully, all tasks, within a different version of the assessment. Candidates can resit a different version of the assignment up to maximum of **three** times before re-registration is required.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification. RPL can be used to exempt learners from areas of learning previously achieved, but does not exempt them from assessment.

RPL is not allowed for this qualification.

7 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours (GLH)
- unit aim
- assessment type
- learning outcomes, which are comprised of a number of topics
- content elements
- supporting information
- relationship to Occupational Standards inc reference.

Delivery of units

This qualification comprises a number of **units**. A unit describes what is expected of a learner to complete this qualification.

Each **unit** is divided into **learning outcomes** which describe in further detail the knowledge and skills that a learner should possess.

Each **learning outcome** has a set of **topics** (knowledge or skills) that are simple and concise statements that indicates to a learner something specific they will be learning in relation to the learning outcome. It provides clarity to a learner at a high level on what they should be expecting to learn or be able to do, in relation to a specific area of the learning outcome.

Content (what needs to covered). The content elements define the 'depth and breadth' to which the teaching/learning must be delivered.

It is important that these sections define all the essential content that must be covered for learners to achieve the learning outcome. It is the information in this section that learners will be assessed on.

Unit 301 Cold water systems

Unit level:	3
Guided Learning Hours (GLH):	70
Unit aim:	This unit covers the design, installation, maintenance, decommissioning and commissioning of a range of cold water systems and component types in domestic dwellings and light commercial properties using scientific and mechanical principles. In addition, this unit will give learners a high-level understanding of water regulations and how to interpret them in practice.
Assessment method:	Multiple choice question (MCQ) question paper Practical assignment(s)
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Size and select cold water systems and components for dwellings
2. Commission cold water systems and components
3. Perform fault diagnosis and rectification procedures on cold water systems
4. Carry out service and maintenance of cold water systems

Learning outcome 1

Size and select cold water systems and components for dwellings

Topic	Content What needs to be covered:
1.1 Interpret factors which affect the selection of cold water systems for dwellings	**1.1.1** How the following factors affect the selection of cold water systems: a) homeowner/end user needs b) building layout and features c) energy efficiency d) environmental impact e) occupancy and purpose f) appliance location g) cost h) storage type/location. **1.1.2** Types of cold water systems for dwellings: a) boosted cold water systems b) direct water systems c) indirect water systems.

Topic	Content What needs to be covered:
1.2 Interpret information sources required to size and select cold water systems and components	**1.2.1** The purpose of different sources of information required and how they impact design work on cold water systems: a) statutory regulations b) industry standards c) manufacturer technical instructions d) verbal/written feedback from the homeowner/end user e) plans f) drawings g) specifications h) codes of practice i) pre-determined data. **1.2.2** Factors to be taken into consideration when interpreting information sources: a) where to locate b) energy efficiency c) homeowner/end user needs d) building layout and features e) environmental impact f) occupancy and purpose g) appliance location h) cost i) storage type/location j) legislation.
1.3 Design temperatures within cold water systems	**1.3.1** Design temperatures recommended in line with current water regulations: a) Cold water supplies should be prevented from exceeding 25°c for cold water systems as detailed in ACoP L8. **1.3.2** How design temperatures affect the following cold water system components: a) pipework i. condensation considerations ii. frost protection b) storage i. frost protection ii. undue warming c) appliance outlet i. outlet temperature.

Topic	Content What needs to be covered:
1.4 Control measures for Legionella and bacterial growth	**1.4.1** Control measures and process to be followed as detailed in ACoP L8: a) correct supply temperature of 25°c in line with current water regulations b) flushing and disinfection of systems as per manufacturer's guidance after flushing – using chlorine with no more than 50ppm when handing back to the end user (in light commercial properties only) c) removal of pipework deadlegs d) system monitoring (6 monthly – in light commercial properties only).
1.5 Calculate requirements of cold water system components used in dwellings	**1.5.1** Calculations follow suitable industry format conventions for quotation and tender, and use basic line drawings for the following components: a) cold water storage cistern capacity b) pipework size c) accumulator d) safety device e) booster pump.
1.6 Interpret system information to complete detailed materials list	**1.6.1** A detailed materials list for dwellings in accordance with: a) design calculations b) manufacturer information c) property requirements d) quantities and grades. **1.6.2** Materials list to include requirements of: a) pipework b) consumables c) fittings d) components e) appliances.

Topic	Content What needs to be covered:
1.7 Present calculations and documentation in an industry standard format for quotation and tender	**1.7.1** Documentation presented as required by the homeowner/end user for the specific job, and in line with industry standard conventions/templates: a) drawings of layout b) schematic drawings. **1.7.2** Quotation to cover: a) details of materials b) labour cost.

Learning outcome 2

Commission cold water systems and components

Topic	Content What needs to be covered:
2.1 Operational checks required during commissioning	**2.1.1** How to carry out operational checks during commissioning on sanitary ware and appliances on new and existing cold water systems: a) temperature i. thermometer b) flow rate i. weir cup/flow cup c) pressure i. pressure gauge d) operation of controls i. taps ii. valves.
2.2 Complete information on commissioning documentation	**2.2.1** Information to be detailed: a) homeowner/end user details b) commissioning engineer details c) appliances d) commissioning procedure information e) service interval record f) service centre.

Topic	Content What needs to be covered:
2.3 Actions that must be taken when commissioning reveals defects	**2.3.1** Actions to be taken when malfunctioning components are revealed: a) inform homeowner/end user b) inform manufacturer if component is still under warranty c) rectify defect i. temporary decommission ii. permanent decommission d) re-commission system e) handover to homeowner/end user. **2.3.2** Defects revealed during commissioning checks and their associated causes – performance checked against manufacturer's data: a) leaks i. leakage from below ground cold water service pipework ii. leakage or ineffective operation of terminal fittings iii. leakage or ineffective operation of float operated valves iv. leakage or ineffective operation of stop and service valves b) malfunctions i. accumulator ii. mini shock arrester iii. blockages iv. system debris v. pump failure vi. control failure vii. pressure relief valve discharge viii. incorrect support to system pipework and storage cisterns ix. excessive noise in pipework systems x. cistern failure c) pressure issues i. incorrect pressures.
2.4 Carry out handover procedure to end user	**2.4.1** Procedure for new and existing cold water systems: a) providing system operating information to homeowner/end user b) completion of relevant documentation c) notification of works carried out.

Topic	Content What needs to be covered:
2.5 Carry out commissioning procedures for cold water systems	**2.5.1** Commissioning procedure for new and existing cold water systems in line with manufacturer's instructions and regulations: a) visual inspection i. pipework ii. fittings iii. components b) fill and vent c) soundness test d) flush i. system additives: neutraliser, cleanser, water softener ii. disinfection e) operational checks i. temperature ii. flow rate iii. pressure iv. operation of controls f) commissioning documentation g) handover procedure h) rectification of issues/defects.

Learning outcome 3

Perform fault diagnosis and rectification procedures on cold water systems

Topic	Content What needs to be covered:
3.1 Sources of information used to establish diagnostic requirements	**3.1.1** The purpose of the following documents/information and how they are used to establish diagnostic requirements of specific system components: a) manufacturer's instructions i. installation instructions ii. performance data b) fault diagnosis flow chart i. manufacturer's technical support ii. spare parts list c) service history i. previous documentation ii. benchmark documentation (including Benchmark Logbook) d) homeowner/end user feedback.
3.2 Carry out diagnostic checks for common faults	**3.2.1** Checks for common faults carried out in line with the manufacturer's instructions: a) incorrect pressures b) accumulator/expansion vessel failure c) blockages d) system debris e) pump failure f) control failure g) pressure relief valve discharge h) incorrect support to system pipework and storage cisterns i) excessive noise in pipework systems j) cistern failure k) leakage from below ground cold water service pipework l) leakage or ineffective operation of: i. terminal fittings ii. float operated valves iii. stop and service valves.

Topic	Content What needs to be covered:
3.3 Carry out repair and rectification procedures to deal with common faults	**3.3.1** Procedures to be followed to carry out repair and rectification: a) notify homeowner/end user b) safely isolate c) decommission d) rectify fault e) re-commission f) handover. **3.3.2** Common faults: a) incorrect pressures b) accumulator/expansion vessel failure c) blockages d) system debris e) pump failure f) control failure g) pressure relief valve discharge h) incorrect support to system pipework and storage cisterns i) excessive noise in pipework systems j) cistern failure k) leakage from below ground cold water service pipework l) leakage or ineffective operation of: i. terminal fittings ii. float-operated valves iii. stop and service valves.

Learning outcome 4

Carry out service and maintenance of cold water systems

Topic	Content What needs to be covered:
4.1 Information required to establish the periodic servicing requirements of system components	**4.1.1** Information required for servicing requirements within manufacturer's instructions/specification, performance data and job schedules for system components: a) pumps b) expansion/pressure vessels c) pressure switches (transducers) d) float switches e) gauges and controls f) booster (pump) set to a system g) backflow prevention devices as per current water regulations i. mechanical: types BA, CA, DA, DB, DUK1, EA, EB, EC, ED, HA, HC, HUK1, LA, LB ii. non-mechanical: types AA, AB, AC, AD, AF, AG, AUK1, AUK2, AUK3, DC.
4.2 Carry out periodic servicing requirements of system components	**4.2.1** Servicing to be carried out in line with manufacturer's instructions and job schedules for system components: a) pumps b) expansion/pressure vessels c) pressure switches (transducers) d) float switches e) gauges and controls f) booster (pump) set to a system g) backflow prevention devices.

Topic	Content What needs to be covered:
4.3 Routine checks required on cold water components and pipework as part of a periodic maintenance programme	**4.3.1** Routine checks required to ensure correct performance to minimise waste: a) visual inspection of pipework for leakage, adequate support and insulation b) effective operation of terminal fittings i. basin ii. bath iii. sink iv. shower v. shower mixer c) effective operation of float-operated valves i. Portsmouth type ii. brass diaphragm iii. plastic diaphragm iv. equilibrium (Torbeck) d) effective operation of service valves i. gate valve ii. Ballofix type valve iii. full way spherical plug iv. stop value (crutch head) e) condition of storage cisterns i. plastic ii. coffin type iii. galvanised steel f) expansion vessel condition and pressure i. bladder type ii. diaphragm type g) strainer/filter inspection and cleaning h) pump operation i) float and pressure switch operation j) pressure relief valves operation.
4.4 Carry out routine checks required on cold water components and pipework as part of a periodic maintenance programme	**4.4.1** Routine checks to cover: a) visual inspection of pipework for leakage, adequate support and insulation b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of service valves e) condition of storage cisterns f) expansion vessel condition and pressure g) strainer/filter inspection and cleaning h) pump operation i) float and pressure switch operation j) pressure relief valves operation.

Topic	Content What needs to be covered:
4.5 Carry out service and maintenance of systems	**4.5.1** Service carried out in line with manufacturer's instructions for the following systems: a) boosted cold water systems i. controls b) direct water systems c) indirect water systems.
4.6 Record information on a maintenance record for cold water systems	**4.6.1** Information to be recorded: a) service number b) date c) engineer name d) company name.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Visits to/engagement with local manufacturers should be provided throughout the delivery.
- Learners could be provided with template commissioning documentation for completion, or incomplete/poorly completed documents to identify issues.
- Centres must ensure they keep up to date on current industry practice.
- When referring to legislation as part of delivery, the most current version of guidance must be delivered.
- Where relevant, as part of content delivery, learners should be encouraged to consider (for example through classroom-based discussion) responsibilities in relation to maintaining security of homeowner/client data and current data protection/security considerations.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019
- Peter Tanner and Stephen Lane City & Guilds Plumbing Book 1, Second Edition, Hodder Education, 10 Jun. 2022
- Laurrie Young and Graham Mays Water Regulations Guide, Second Edition, Water Regulations Advisory Scheme (WRAS), 1 Sept. 2000.

Websites

- Water Regulations Water Regs UK Limited - Fluid Categories
- Water Regulations Water Regs UK Limited - Home
- Water Regulations The Water Supply (Water Quality) Regulations 2016 (legislation.gov.uk)
- Support for Plumbing and Heating Contractors https://aphc.co.uk/
- Chattered Institute of Plumbing and Heating Engineering https://www.ciphe.org.uk/
- WRAS Approvals https://www.wrasapprovals.co.uk/

Unit 302 Hot water systems

Unit level:	3
Guided Learning Hours (GLH):	70
Unit aim:	This unit covers the selection, planning, soundness testing, fault diagnosis and rectification, service and maintenance of hot water systems in domestic dwellings and light commercial properties using scientific and mechanical principles.
Assessment method:	Multiple choice question (MCQ) question paper Practical assignment(s)
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Size and select hot water systems and components for dwellings
2. Perform a soundness test and commission hot water systems and components
3. Perform fault diagnosis and rectification procedures on hot water systems
4. Carry out service and maintenance of unvented hot water systems

Learning outcome 1

Size and select hot water systems and components for dwellings

Topic	Content What needs to be covered:
1.1 Interpret factors which affect the selection of hot water systems for dwellings	**1.1.1** How the following factors affect the selection of hot water systems for dwellings: a) homeowner/end user needs b) building layout and features c) energy efficiency d) environmental impact e) occupancy and purpose f) appliance location g) cost h) storage type/location i) legislation. **1.1.2** Types of hot water systems for dwellings: a) unvented hot water systems b) vented hot water systems c) point of use water systems.
1.2 Interpret information sources required to size and select hot water systems and components	**1.2.1** The purpose of different sources of information required and how they impact design work on hot water systems: a) statutory regulations b) industry standards c) manufacturer technical instructions d) verbal/written feedback from the homeowner/end user e) plans and drawings f) specifications g) pre-determined data. **1.2.2** Factors to be taken into consideration when interpreting information sources: a) where to locate b) energy efficiency c) homeowner/end user d) building layout and features e) environmental impact f) occupancy and purpose g) appliance location h) cost i) storage type/location j) legislation.

Topic	Content What needs to be covered:
1.3 Design temperatures within hot water systems and layouts	**1.3.1** Design temperatures recommended in line with current water regulations and Building Regulations Approved Documents Part G and Part L: a) stored no less than 60°c b) distributed at no less than 55°c c) terminal fittings to sanitary appliances in domestic dwellings i. sink 55°c ii. bath 41°c iii. basin 44°c iv. bidet 38°c d) terminal fittings in schools and public buildings not to exceed 43°c e) stored hot water not to exceed 100°c. **1.3.2** How design temperatures affect the following hot water components: a) pipework i. insulation requirements b) secondary circulation i. bronze pump ii. trace heating c) storage i. cylinder ii. tanks iii. thermal store d) appliance outlet i. taps ii. shower mixer iii. thermostatic mixing valve (TMV).
1.4 Control measures for Legionella and bacterial growth	**1.4.1** Control measures and process to be followed as detailed in ACoP L8: a) correct temperatures stored at no less than 60°c in line with current water regulations b) flushing and disinfection of systems as per manufacturer's guidance after flushing – with no more than 50ppm when handing back to the end user (in light commercial properties only) c) removal of pipework deadlegs d) system monitoring (6 monthly – in light commercial properties only).

Topic	Content What needs to be covered:
1.5 Calculate requirements of hot water system requirements used in dwellings	**1.5.1** Calculations follow suitable industry format conventions for quotation and tender, and use basic line drawings for the following components: a) storage requirements b) pipe size.
1.6 Select hot water components using design calculations	**1.6.1** Components to be selected: a) storage cylinder b) pipe c) pump d) expansion vessel e) safety device.
1.7 Interpret system information to complete a detailed materials list	**1.7.1** A detailed materials list for dwellings in accordance with: a) design calculations b) manufacturer information c) property requirements d) quantities and grades. **1.7.2** Materials list to include requirements of: a) pipework b) consumables c) fittings d) components e) appliances.
1.8 Present calculations and documentation and information in an industry standard format for quotation and tender	**1.8.1** Documentation presented as required by the homeowner/end user for the specific job, and in line with industry standard conventions/templates: a) drawings of layout b) schematic drawings. **1.8.2** Quotation to cover: a) details of materials b) labour cost.

Learning outcome 2

Perform a soundness test and commission hot water systems and components

Topic	Content What needs to be covered:
2.1 Operational checks required during commissioning of an unvented hot water system	**2.1.1** How to carry out operational checks during commissioning on sanitary ware and appliances using the equipment listed: a) temperature i. thermometer b) flow rate i. weir cup/flow cup c) pressure i. pressure gauge d) operation of controls i. taps ii. valves.
2.2 Complete information on commissioning documentation	**2.2.1** Information contained in an industry standard Benchmark Logbook for an unvented hot water system: a) homeowner/end user details b) commissioning engineer details c) appliance and time control details d) commissioning procedure information e) service interval record f) service centre.

Topic	Content What needs to be covered:
2.3 Actions that must be taken when commissioning reveals defects	**2.3.1** Actions to be taken when malfunctioning component checks are revealed: a) inform homeowner/end user b) inform manufacturer if component is still under warranty c) rectify defect (i) temporary decommission (ii) permanent decommission d) re-commission system e) handover to homeowner/end user. **2.3.2** Defects revealed during commissioning checks – performance checked against manufacturer's data: a) leaks b) malfunctioning components c) motorised valves not operating d) incorrect pressures e) expansion vessel failure i. baffle type (mega flow) ii. separate expansion vessel f) blockages g) system debris h) pump failure i) thermostat failure i. cylinder stat ii. high limit stat iii. emersion stat j) programmer failure k) expansion valve opening i. pressure ii. temperature l) incorrect support to hot water system pipework and storage cisterns m) excessive noise in pipework systems n) CWSC cistern failure o) hot water storage cylinder/emersion heater failure p) pressure issues i. pressure relief valve failure.

Topic	Content What needs to be covered:
2.4 Carry out hand over procedure to the homeowner/end user	**2.4.1** Procedure for new and existing hot water systems: a) providing system operating information to homeowner/end user b) completion of relevant documentation c) notification of works carried out.
2.5 Carry out commissioning procedures for hot water systems	**2.5.1** Commissioning procedure for new and existing hot water systems: a) visual inspection b) fill and vent c) soundness test d) flush e) operational checks: i. temperature ii. flow rate iii. pressure iv. operation of controls f) commissioning documentation g) handover procedure h) rectification of issues/defects.

Learning outcome 3

Perform fault diagnosis and rectification procedures on hot water systems

Topic	Content What needs to be covered:
3.1 Sources of information used to establish diagnostic requirements	**3.1.1** The purpose of the following documents/information and how they are used to establish diagnostic requirements of specific system components: a) manufacturer's instructions i. installation instructions ii. performance data b) fault diagnosis flow chart i. manufacturer's technical support ii. spare parts list c) service history i. previous documentation ii. benchmark documentation d) homeowner/end user feedback.
3.2 Carry out diagnostic checks for common faults	**3.2.1** Checks for common faults carried out in line with the manufacturer's instructions: a) motorised valves not operating b) incorrect pressures c) expansion vessel failure d) blockages e) system debris f) pump failure g) thermostat failure h) programmer failure i) expansion valve failure j) pressure relief valve failure k) stratification of cylinders l) incorrect support to hot water system pipework and storage cisterns m) excessive noise in pipework systems n) cistern failure o) hot water storage cylinder/heater failure.

Topic	Content What needs to be covered:
3.3 Carry out repair and rectification procedures to deal with common system faults	**3.3.1** Procedures to be followed to carry out repair and rectification: a) notify homeowner/end user b) safely isolate c) decommission d) rectify fault e) re-commission f) handover. **3.3.2** Common faults: a) motorised valves not operating b) incorrect pressures c) expansion vessel failure d) blockages e) system debris f) pump failure g) thermostat failure h) programmer failure i) expansion valve failure j) pressure relief valve failure k) stratification of cylinders l) incorrect support to hot water system pipework and storage cisterns m) excessive noise in pipework systems n) cistern failure o) hot water storage cylinder/heater failure.

Learning outcome 4

Carry out service and maintenance of unvented hot water systems

Topic	Content What needs to be covered:
4.1 Information required to establish the periodic servicing requirements of system components	**4.1.1** Information required for servicing requirements in line with manufacturer's instructions, Building Regulations Approved Documents Part G and Part L and job schedules for system components on a recommended annual basis: a) cylinder i. mega flow ii. package type b) isolation valve c) strainer d) expansion vessel i. baffle type (mega flow) ii. separate expansion vessel e) pressure reducing valve i. composite valve ii. separate valve f) expansion (pressure) relief valve i. composite valve ii. separate valve g) temperature relief valve h) balanced cold connection i) check valve i. composite valve ii. type EA iii. type EB j) D1, D2 discharge pipework requirements k) composite valve l) tundish i. type AA m) control thermostat n) overheat thermostat (thermal cut-out) o) wi-fi smart thermostat.

Topic	Content What needs to be covered:
4.2 Carry out periodic servicing requirements of system components	**4.2.1** Servicing to be carried out in line with manufacturer's instructions and job schedules for system components: a) cylinder b) isolation valve c) strainer d) expansion vessel e) pressure reducing valve f) expansion (pressure) relief valve g) temperature relief valve h) balanced cold connection i) check valve j) D1, D2 discharge pipework requirements k) composite valve l) tundish m) control thermostat n) overheat thermostat (thermal cut-out) o) wi-fi smart thermostat.

Topic	Content What needs to be covered:
4.3 Routine checks required on hot water components and pipework as part of a periodic maintenance programme	**4.3.1** Routine checks required to ensure correct performance to minimise waste and energy: a) visual inspection of pipework for leakage, adequate support, and insulation b) effective operation of terminal fittings i. flow rates ii. temperatures c) effective operation of float-operated valves i. setting of correct system levels ii. correct float-operated valve type d) effective operation of service valves i. leakage ii. isolation iii. full flow e) visual inspection of condition of hot water cylinder f) visual inspection of condition of storage cisterns g) visual inspection of unvented cylinder and effective operation of controls h) effective operation of thermostatic control devices i. check operation ii. isolate supply i) temperature and pressure relief valve i. check operation ii. isolate supply j) visual inspection of expansion vessel condition and pressure k) visual inspection of composite valve operation i clean line strainer l) pump operation (secondary circulation bronze pump only).

Topic	Content What needs to be covered:
4.4 Carry out routine checks required on hot water components and pipework as part of a periodic maintenance programme	**4.4.1** Routine checks to cover: a) visual inspection of pipework for leakage, adequate support and insulation b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of service valves e) condition of hot water cylinder f) condition of storage cisterns g) unvented cylinder and controls h) effective operation of thermostatic control devices i) temperature and pressure relief valve j) expansion vessel condition and pressure k) composite valve operation l) pump operation.
4.5 Carry out service and maintenance of systems	**4.5.1** Service carried out in line with manufacturer's instructions for the following systems: a) unvented cylinder b) controls.
4.6 Record information on a maintenance record for hot water systems	**4.6.1** Information to be recorded on an industry standard Benchmark Logbook for an unvented hot water system: a) service number b) date c) engineer name d) company name e) telephone number f) comments g) signature.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Some elements of the electrical unit can be delivered alongside this unit.
- Visits/engagement should be provided to learners throughout the delivery of the unit content where possible for example:
  - local manufacturers
  - local construction sites to observe the installation of hot water systems
  - local employers who employ maintenance staff.
- Centres must ensure they keep up to date on current industry practice.
- Teachers to hold an Unvented Hot Water Systems qualification.
- When referring to legislation as part of delivery, the most current version of guidance must be delivered.
- Where relevant as part of content delivery, learners should be encouraged to consider (for example through classroom-based discussion) responsibilities in relation to maintaining security of homeowner/client data and current data protection/security considerations.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019
- Laurrie Young & Graham Mays, Water Regulations Guide, published by WRAS, 2000
- BS EN 806 – Specification for installations inside buildings conveying water for human consumption (parts 1–5)
- BS 8558 – Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806
- BS 8000 part 15 – Workmanship on building sites. Code of practice for hot and cold water services (domestic scale)

Websites

- Domestic Building Services Compliance Guide www.planningportal.gov.uk
- Building Regulations Approved Documents www.planningportal.gov.uk
- Heating and Hot water Industry Council (HHIC) https://www.hhic.org.uk/

Unit 303 Central heating systems

Unit level:	3
Guided Learning Hours (GLH):	98
Unit aim:	This unit covers the installation, decommissioning, soundness testing, service and maintenance of a range of wet central heating system and heat sources in domestic dwellings using scientific, domestic and mechanical principles.
Assessment method:	Multiple choice question (MCQ) question paper Practical assignment(s)
Links to Occupational standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Size and select central heating systems and components for dwellings
2. Perform a soundness test and commission central heating systems and components
3. Install central heating systems
4. Decommission central heating systems
5. Perform fault diagnosis and rectification procedures on central heating systems
6. Carry out service and maintenance of central heating systems

Learning outcome 1

Size and select central heating systems and components for dwellings

Topic	Content What needs to be covered:
1.1 Interpret factors which affect the selection of central heating systems for dwellings	**1.1.1** How the following factors affect the selection of central heating system's heat sources: a) homeowner/end user needs b) building layout and features c) energy efficiency d) environmental impact e) heat source f) occupancy and purpose g) appliance location h) set up cost i) running cost j) storage type/location k) legislation. **1.1.2** Types of central heating system: a) pumped heating gravity hot water b) fully pumped, 2 x two-port valves (s-plan) c) fully pumped, 3 x two-port valves (s-plan plus) d) fully pumped, three-port valve (mid position/diverting) (y/w plans) e) fully pumped with a low loss header f) low temperature hot water and lower temperature hot water central heating systems.

Topic	Content What needs to be covered:
1.2 Interpret information sources needed when undertaking design work on central heating systems	**1.2.1** The purpose of different sources of information required and how they impact design work on central heating systems: a) statutory regulations b) industry standards c) manufacturer's technical instructions d) verbal/written feedback from the homeowner/end user e) plans and drawings f) specifications g) pre-determined data. **1.2.2** Factors to be taken into consideration when interpreting information sources: a) where to locate b) energy efficiency c) homeowner/end user needs d) building layout and features' environmental impact e) occupancy and purpose f) appliance location g) cost h) storage type/location i) legislation.

Topic	Content What needs to be covered:
1.3 Heat loss and gain, and how this affects heating requirements	**1.3.1** Types of heat loss and gain, and the effect on heating requirements as per Building Regulations Approved Document Part L and current CIBSE domestic heating design guide: a) occupancy i. number of occupants b) solar i. rotation of building: north elevation/south elevation c) building fabric i. type of construction – timber frame, cavity walls, solid brick walls ii. building age iii. glazing – single/double iv. roofing – flat/pitched v. flooring – suspended timber, solid concrete, block and beam, raft d) ventilation (air loss factor 0.33) i. air loss ii. type of room e) internal and external design temperatures i. type of room ii. different design temperatures iii. outside (external) temperatures f) pipework i. concealed pipework ii. surface mounted iii. insulated iv. uninsulated.
1.4 Calculate central heating system requirements used in dwellings	**1.4.1** Calculations of central heating system requirements follow suitable industry format conventions for quotation and tender using drawings and plans: a) total heat load b) emitter load c) hot water allowance d) flow and return temperatures e) pipe size f) pump size g) emitter size h) expansion.

Topic	Content What needs to be covered:
1.5 Select central heating system components in accordance with calculations from predetermined data	**1.5.1** Components to be selected: a) emitter b) boiler c) heat pump d) pipe e) pump f) expansion vessel.
1.6 Interpret system information to complete a detailed materials list	**1.6.1** A detailed materials list for a central heating system in accordance with: a) design calculations b) manufacturer's information c) property requirements d) quantities and grades. **1.6.2** Materials list to include requirements of: a) consumables b) fittings c) components d) appliances.
1.7 Present calculations and documentation in an industry standard format for quotation and tender	**1.7.1** Documentation presented as required by the homeowner/end user for the specific job, and in line with industry standard format conventions/templates: a) drawings of layout b) schematic drawings. **1.7.2** Quotation to cover: a) details of materials b) labour cost.

Learning outcome 2

Perform a soundness test and commission central heating systems and components

Topic	Content What needs to be covered:
2.1 Information sources required to complete testing and commissioning	**2.1.1** Required information sources: a) manufacturer's instructions b) British Standards c) Chartered Institute of Building Services Engineer (CIBSE) guide (Guide B) d) building regulations.
2.2 Fill and vent central heating systems	**2.2.1** Follow processes/methods for filling and venting an open vented and sealed - filling loop central heating systems using the following components: a) sealed – filling loop i. internal – built into gas appliance ii. external – type EC/ED backflow protection, demountable braded hose b) open-vented i. feed and expansion cistern – correct level for FE cistern, radiator air vents, automatic air vents AAV, manual air vent
2.3 Visual inspection of a central heating system to confirm that it is ready to be soundness tested	**2.3.1** Understand methods for the visual inspection of central heating systems in accordance with BS EN 14336: a) integrity of connections i. soldered fittings ii. compression fittings iii. press fit iv. push-fit fittings b) adequate clipping as per BS EN 806 Part 4 c) sufficient pipework protection (if required) i. pipe lagging ii. frost protection d) readiness for testing i. ensuring all drain off valves are closed ii. ensuring pressure relief valves are closed e) adherence to standards i. building regulations ii. British Standards iii. water regulations.

Topic	Content What needs to be covered:
2.4 Soundness test to industry requirements on central heating system following visual inspection	**2.4.1** Processes/methods for soundness testing following visual inspection: a) notify homeowner/end user b) initial fill c) stabilisation – time period as per regulations d) test to required pressure and pipework type – 1.5 times working pressure e) check for leaks f) check pressures after test period as per BS EN 806-4 g) complete documentation and notify as required. **2.4.2** Soundness test on different types of pipework materials: a) metal – copper tubes, low carbon steel pipes i. initial fill ii. stabilisation iii. test to required pressure iv. check for leaks v. check pressures after test period of 1 hour – no pressure loss b) plastic – elastomeric pressure pipe systems i. initial fill ii. stabilisation iii. test to required pressure iv. check for leaks v. check pressures after test period: test type A, test type B.
2.5 Flushing requirements including the use of system additives for new and existing central heating systems	**2.5.1** Processes/methods of flushing requirements for new and existing central heating systems as per BS 7593: a) cold water flush b) hot water flush c) cleansing. **2.5.2** The reasons for using system additives: a) neutralisers – to neutralise the water supply b) cleanser – to clean the system c) inhibitor – to prevent corrosion d) descaler – to remove scale in the system.

Topic	Content What needs to be covered:
2.6 Carry out a soundness test on a central heating system	**2.6.1.** Soundness test, including the type of test required for the system, and the test pressures/durations in line with BS EN 806-4: a) metal b) plastic.
2.7 Operational checks required during commissioning	**2.7.1** How to carry out operational checks during commissioning: a) flow and return temperatures b) flow rate c) pressure d) filters e) system balance i. thermostatic radiator valves (TRVs) ii. lockshields iii. automatic bypass f) controls i. programmer ii. room stat iii. programmable room sats iv. programmable TRVs v. frost stat. **2.7.2** Potential implications of checks not being accurate: a) homeowner/end user dissatisfaction i. complaints ii. lack of return/future business b) safety i. risk of injury ii. risk of damage iii. risk of prosecution c) ineffective system i. higher running costs ii. insufficient heating iii. reduced efficiency.

Topic	Content What needs to be covered:
2.8 Information detailed on commissioning documentation	**2.8.1** Information to be included on the benchmark documentation: a) job address b) business details c) appliance details (i) data plate – serial number, model number d) central heating flow temperature e) central heating return temperature f) primary filter fitted i. type ii. make iii. model g) system type i. Y-plan ii. S-plan iii. S-plan plus h) appliance(s) installed as required by manufacturer's instillation instructions.
2.9 Complete information commissioning documentation	**2.9.1** Completion of information on benchmark documentation: a) job address b) business details c) appliance details i. data plate – serial number, model number d) central heating flow temperature e) central heating return temperature f) primary filter fitted i. type ii. make iii. model g) system type i. Y-plan ii. S-plan iii. S-plan plus h) appliance(s) installed as required by manufacturer's instillation instructions.

Topic	Content What needs to be covered:
2.10 Actions that must be taken when commissioning reveals defects	**2.10.1** Defects revealed during commissioning checks – performance checked against manufacturer's data: a) pipework faults i. leaks ii. mechanical damage b) component faults i. intermittent ii. persistent c) appliance faults i. intermittent ii. persistent d) performance faults i. manufacturer's build quality ii. manufacturer's warranty scheme. **2.10.2** Actions and considerations to be undertaken and investigated when malfunctioning component checks are revealed: a) inform homeowner/end user b) gather resources i. benchmark history ii. manufacturer's services guide iii. internet services guide c) check availability of materials/parts i. stock item ii. special order iii. back order d) consider timescales e) consider site-specific issues i. type of building ii. location of building f) consider specific homeowner/end user needs i. domestic ii. light commercial iii. retail g) rectify defect h) re-commission system i. fill ii. test iii. check iv. handover.

Topic	Content What needs to be covered:
2.11 Procedure for handover to the homeowner/end user	**2.11.1** The purpose of the handover procedure for new and existing central heating systems: a) system controls i. programmer ii. room stat iii. cylinder stat iv. programmable room stat v. heating app b) maintenance requirements and the differences between them i. service plan – annually/biannually c) system/appliance efficiency guidance – EPC rating d) warranty requirements i. manufacturer's warranties ii. installer's warranty iii. extended warranty e) completion of relevant documentation i. benchmark documentation. **2.11.2** Handover procedure considerations to homeowner/end user: a) to be carried out in a professional manner b) following employer set procedures and best practice c) consideration of type of homeowner/end user for delivery method i. in person ii. over the phone iii. by email d) use of appropriate terminology e) potential implications of miscommunication or communication breakdown f) identifying and overcoming barriers.

Topic	Content What needs to be covered:
2.12 Carry out commissioning procedures for central heating systems	**2.12.1** Commissioning procedures to be carried out on new and existing central heating systems: a) visual inspection b) fill and vent c) soundness test d) flush e) operational checks i. temperature ii. flow rate iii. pressure iv. operation of controls f) commissioning documentation g) handover procedure i. to be carried out in a professional manner ii. following employer set procedures and best practice iii. consideration of type of homeowner/end user for delivery method • in person • over the phone • by email iv. use of appropriate terminology v. potential implications of miscommunication or communication breakdown vi. identifying and overcoming barriers.

Learning outcome 3

Install central heating systems

Topic	Content What needs to be covered:
3.1 Safely install central heating systems	**3.1.1** Install as detailed in manufacturer's instructions, Approved Document Part L, CIBSE (Chartered Institute of Building Services Engineers) guide and BS 7671: a) boiler/jig b) circulating pump c) motorised valve d) filter e) expansion vessel f) radiator g) radiator valves h) underfloor heating i) controls j) valves k) pipework i. LCS ii. plastic iii. copper.

Learning outcome 4

Decommission central heating systems

Topic	Content What needs to be covered:
4.1 Procedures for decommissioning central heating systems	**4.1.1** Procedures to be followed to ensure decommissioning is carried out safely: a) notify homeowner/end user b) safely isolate fuel according to type and industry standards i. gas and LPG – Gas Safety (installation and use) regulations ii. oil – Oil Firing Technical Association (OFTEC) regulations iii. electric – IEE regulations 18th edition c) safely isolate electricity supply to the system as appropriate d) isolate water supply i. FE cistern (open-vented system) ii. filling loop (sealed system) e) apply warning notices and signs f) drain system to a suitable location g) appropriately dispose of contents and any additives h) continuity bonding as required according to type and industry standards i. gas and LPG – Gas Safety (installation and use) regulations ii. electric – IEE regulations 18th edition i) temporary capping of pipework sections as required j) notify building users i. owner ii. landlord iii. occupant iv. tenant k) alternative source of heat or supplies as required. **4.1.2** Decommissioning types: a) permanent – when a system is removed and not reinstalled b) temporary – when a system is taken out of action for upgrade or repair.

Topic	Content What needs to be covered:
4.2 Carry out decommissioning procedures of central heating systems	**4.2.1** Types of decommissioning procedures: a) permanent b) temporary.

Learning outcome 5

Perform fault diagnosis and rectification procedures on central heating systems

Topic	Content What needs to be covered:
5.1 Sources of information used to establish diagnostic requirements	**5.1.1** The purpose of the documents/information and how they are used to establish the diagnostic requirements of specific system components: a) information from the homeowner/end user b) visual inspection c) operational checks d) manufacturer's instructions i. installation instructions ii. performance data e) manufacturer's specifications f) fault diagnosis flow chart i. manufacturer's technical support ii. spare parts list g) service history i. previous documentation ii. benchmark documentation. **5.1.2** System faults: a) pumping over b) persistent venting c) emitter cold spots d) stuck TRVs e) motorised valves not operating f) incorrect pressures g) expansion vessel failure h) heat exchanger fault i) blockages j) pump failure k) thermostat fault l) programmer fault m) pressure release valve fault n) incorrect support to system pipework o) feed and expansion cistern failure p) leakage or ineffective operation of: i. terminal fittings ii. stop and service valves iii. pipework.

Topic	Content What needs to be covered:
5.2 Carry out diagnostic checks for common faults	**5.2.1** Checks for common faults carried out in line with the manufacturer's instructions: a) pumping over b) persistent venting c) emitter cold spots d) stuck TRVs e) motorised valves not operating f) incorrect pressures g) expansion vessel failure h) heat exchanger i) blockages j) pump failure k) thermostat l) programmer m) pressure relief valve discharge n) incorrect support to system pipework and components o) excessive noise in pipework systems p) feed and expansion cistern failure q) leakage or ineffective operation of: i. terminal fittings ii. stop and service valves iii. pipework.

Topic	Content What needs to be covered:
5.3 Carry out repair and rectification procedures to deal with common faults	**5.3.1** Procedures to be followed to carry out repair and rectification: a) notify homeowner/end user b) safely isolate c) decommission d) rectify fault e) re-commission f) handover. **5.3.2** Common faults a) pumping over b) persistent venting c) emitter cold spots d) stuck TRVs e) motorised valves not operating f) incorrect pressures g) expansion vessel failure h) heat exchanger i) blockages j) pump failure k) thermostat l) programmer m) pressure relief valve discharge n) incorrect support to system pipework and components o) excessive noise in pipework systems p) feed and expansion cistern failure q) leakage or ineffective operation of: i. terminal fittings ii. stop and service valves iii. pipework.

Learning outcome 6

Carry out service and maintenance of central heating systems

Topic	Content What needs to be covered:
6.1 Types of information required to establish the periodic servicing requirements of system components	**6.1.1** Information required for establishing periodic servicing requirements in line with manufacturer's instructions and job maintenance schedules for system components: a) emitter i. type ii. style iii. heat output b) pipe i. size ii. material c) pump i. domestic ii. light commercial d) expansion vessel i. bladder type ii. diaphragm iii. size.
6.2 Select the information required to establish the periodic servicing requirements of system components	**6.2.1** Select the information required for establishing periodic servicing requirements in line with manufacturer's instructions and job maintenance schedules for system components: a) emitter i. type ii. style b) pipe i. size ii. material c) pump i. domestic ii. light commercial d) expansion vessel i. bladder type ii. diaphragm iii. size.

Topic	Content What needs to be covered:
6.3 Routine checks required on central heating components and pipework as part of a periodic maintenance programme	**6.3.1** Routine checks required to ensure correct performance as per manufacturer's recommendations: a) visual inspection of pipework for leakage, adequate support and insulation b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of valves e) condition of cisterns f) effective operation of thermostatic control devices g) temperature and pressure relief valve h) expansion vessel condition and pressure i) pumps j) heat emitter k) performance checks.
6.4 Carry out routine checks required on central heating components and pipework as part of a periodic maintenance programme	**6.4.1** Routine checks to cover: a) visual inspection of pipework for leakage, adequate support and insulation b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of valves e) condition of cisterns f) effective operation of thermostatic control devices g) temperature and pressure relief valve h) expansion vessel condition and pressure i) circulating pumps j) heat emitter k) performance checks l) replacement of inhibitor if required.

Topic	Content What needs to be covered:
6.5 Types of information to be provided on a maintenance record for central heating systems	**6.5.1** Information to be recorded by the engineer on a maintenance record: a) job address b) business details c) appliance details i. data plate – serial number, model number d) central heating flow temperature e) central heating return temperature f) primary filter fitted i. type ii. make iii. model g) system type i. Y-plan ii. S-plan iii. S-plan plus h) appliance(s) installed as required by manufacturer's instillation instructions i) manufacturer's instructions, warranties and Benchmark Logbook given to homeowner/end user j) homeowner/end user signature agreeing to handover of the system/appliance.
6.6 Carry out service and maintenance of systems and controls	**6.6.1** Service and maintenance carried out as detailed in manufacturer's instructions: a) visual inspection b) check inhibitor level c) clean magnetic filter d) check temperatures e) check controls f) complete maintenance documentation g) handover system to homeowner/end user.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Some unit elements have similarities that could link with the hot water system unit (Unit 302).
- Visits to/engagement with local manufacturers should be provided throughout the delivery.
- Centres must ensure they keep up to date on current industry practice.
- When referring to legislation/guides as part of delivery, the most current version of guidance must be delivered.
- Where relevant as part of content delivery, learners should be encouraged to consider (for example through classroom-based discussion) responsibilities in relation to maintaining security of homeowner/client data and current data protection/security considerations.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019
- CIBSE (Chartered Institute of Building Services Engineers) guide

Websites

- Building Regulations Approved Documents www.planningportal.gov.uk

Unit 304 Sanitation and rainwater systems

Unit level:	Level 3
Guided Learning Hours (GLH):	44
Unit aim:	This unit covers the design of sanitation and rainwater systems for installation in domestic and light commercial properties using scientific and mechanical principles. It also covers the routine maintenance and fault finding for these systems.
Assessment method:	Multiple choice question (MCQ) question paper Practical assignment(s)
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Understand methods of selecting and sizing sanitary pipework systems for appliances and components in domestic dwellings
2. Perform fault diagnosis and rectification procedures for sanitary appliances and pipework systems
3. Carry out service and maintenance for sanitary appliances and pipework systems
4. Understand methods of selecting and sizing rainwater system components for dwellings
5. Perform fault diagnosis and rectification procedures on rainwater systems

Learning outcome 1

Understand methods of selecting and sizing sanitary pipework systems for appliances and components in domestic dwellings

Topic	Content What needs to be covered:
1.1 Interpret factors that affect the selection of sanitary appliances and pipework systems for dwellings	**1.1.1** How the following factors affect the selection of sanitary appliances and pipework systems for dwellings, and the information contained within the approved documents relating to the minimum sanitary provision and pipework layout in accordance with Approved Document Part F, Approved Document Part G, Approved Document Part H, BS EN 12056, BS 6465 part 2 and BS 8000 part 13: a) homeowner/end user needs b) building layout and features c) energy efficiency d) environmental impact e) cost f) legislation g) appliance type h) drainage system type i) pipework routes j) access requirement.
1.2 Information sources needed when undertaking work on sanitary appliances and pipework systems	**1.2.1** The purpose of different sources of information required and how they impact design work when selecting sanitary appliances and pipework systems: a) statutory regulations b) industry standards c) manufacturer's technical instructions d) verbal/written feedback from the homeowner/end user e) plans f) drawings g) specifications h) number of appliances i) pre-determined data. **1.2.2** Factors to be taken into consideration when interpreting information sources: a) homeowner/end user needs i. domestic ii. light commercial iii. retail b) building layout, size and features environmental impact i. type

Topic	Content What needs to be covered:
	ii. style iii. period c) occupancy and purpose i. number of occupants ii. building's purpose d) appliance location and spacing requirements as per BS6465-2 e) cost depending on i. type ii. style iii. number of appliances f) legislation i. building regulations ii. British Standards iii. water regulations g) energy efficiency i. building regulations h) environmental impact i. system type ii. greywater recycling iii. rainwater harvesting i) appliance type i. WC ii. bath iii. basin iv. bidet v. sink vi. shower vii. urinal viii. wetroom j) drainage system type i. system type ii. public sewer iii. private sewer iv. septic tank v. combined foul and surface water vi. greywater recycling vii. rainwater harvesting viii. reed type k) pipework sizes i. WC 100mm

Topic	Content What needs to be covered:
	ii. bath 40mm iii. basin 32 mm iv. bidet 32mm v. sink 40/50mm vi. shower 40mm vii. urinal 32/40mm viii. wetroom 50mm l) pipework routes as per Approved Document Part H, BS8000 and BS12056-1 (intumescent collar) m) access requirement as per regulations and specification.
1.3 Interpret information sources required to size and select sanitary appliances and pipework systems	**1.3.1** The sources of information required when selecting sanitary appliances and pipework systems and how to interpret them: a) regulations b) industry standards c) manufacturer's technical instructions d) verbal/written feedback from the homeowner/end user e) plans f) drawings g) specifications h) pre-determined data. **1.3.2** Factors to be taken into consideration when interpreting information sources: a) where to locate b) homeowner/end user needs c) building layout and features' environmental impact d) occupancy and purpose e) appliance location f) cost g) legislation h) energy efficiency i) environmental impact j) appliance type k) drainage system type l) pipework sizes m) pipework routes as per Approved Document Part H n) access requirement as per regulations and specification.

Topic	Content What needs to be covered:
1.4 Calculate sanitary pipework system requirements	**1.4.1** Calculations follow suitable industry format conventions for quotation and tender, and use basic line drawings, for the following components: a) system type b) pipe size c) gradient d) diameter e) length f) material.
1.5 Select sanitary system components using design calculations	**1.5.1** Sanitary system components: a) pipe work size b) fittings c) macerator d) appliances.
1.6 Interpret system information to complete a detailed materials list	**1.6.1** A detailed materials list in accordance with: a) design calculations b) manufacturer information c) property requirements d) homeowner/end user preference e) quantities and grades. **1.6.2** Materials list to include requirements of: a) pipework b) consumables c) fittings d) components e) appliances.
1.7 Present calculations and documentation in an industry standard format for quotation and tender	**1.7.1** Documentation presented as required by the homeowner/end user for the specific job, and in line with industry standard conventions/templates: a) drawings of layout b) schematic drawings. **1.7.2** Quotation to cover: a) details of materials b) labour cost.

Learning outcome 2

Perform fault diagnosis and rectification procedures for sanitary appliances and pipework systems

Topic	Content What needs to be covered:
2.1 Sources of information used to establish diagnostic requirements	**2.1.1** The purpose of the following documents/information and how they are used to establish diagnostic requirements of specific system components: a) homeowner/end user knowledge b) manufacturer's instructions c) installation instructions d) performance data e) fault diagnosis flow chart f) manufacturer's technical support g) spare parts list h) service history i) previous documentation j) benchmark documentation.
2.2 Carry out diagnostic checks for common faults	**2.2.1** Checks for common faults carried out in line with manufacturer's instructions where applicable: a) leaks b) blockages c) inadequate or broken support d) trap seal loss e) debris f) cistern faults g) appliance faults h) WC macerator's failure i) waste water lifters' failure j) sink waste disposal units' failure k) air admittance valves' failure l) pipework m) condensing boiler condensate n) wastewater lifter.

Topic	Content What needs to be covered:
2.3 Carry out repair and rectification procedures to deal with common faults	**2.3.1** Procedures to be followed to carry out repair and rectification: a) notify homeowner/end user b) decommission c) rectify fault d) re-commission e) handover. **2.3.2** Common faults: a) leaks b) blockages c) inadequate or broken support d) trap seal loss e) debris f) cistern faults g) appliance faults h) WC macerator's failure i) wastewater lifters' failure j) sink waste disposal units' failure k) air admittance valves' failure l) pipework m) condensing boiler condensate n) wastewater lifter.

Learning outcome 3

Carry out service and maintenance for sanitary appliances and pipework systems

Topic	Content What needs to be covered:
3.1 Information required to establish the periodic servicing requirements of system components	**3.1.1** Information required for servicing requirements in line with manufacturer's instructions and job schedules for system components: a) macerator i. manufacturer's instructions ii. installation instructions iii. performance data iv. fault diagnosis flow chart v. manufacturer's technical support vi. spare parts list vii. service history (if available) viii. maintenance plan ix. previous documentation b) appliances i. manufacturer's technical support ii. manufacturer's cleaning and care instructions.
3.2 Select information required to establish the periodic servicing requirements of system components	**3.2.1** Selecting information to be carried out as required in line with manufacturer's instructions and job schedules for system components: a) macerator i. manufacturer's instructions ii. installation instructions iii. performance data iv. fault diagnosis flow chart v. manufacturer's technical support vi. spare parts list vii. service history (if available) viii. maintenance plan ix. previous documentation b) appliances i. manufacturer's technical support ii. manufacturer's cleaning and care instructions.

Topic	Content What needs to be covered:
3.3 Routine checks and performance test required on sanitary appliances and pipework systems as part of a periodic maintenance program	**3.3.1** Routine checks required when carrying out periodic maintenance: a) visual inspection of pipework for leakage and adequate support b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of valves e) temperature checks f) condition of cisterns g) operation of flushing cisterns/mechanisms h) fitting of effective waste outlet plugs i) effective operation of appliance traps/self-sealing valves j) pumps k) performance checks l) appliance support. **3.3.2** Performance test as per Building Regulations Approved Document Part H on above-ground drainage systems covering sanitary appliances: a) WC b) basin c) bath d) shower e) bidet f) urinal g) sink.

Topic	Content What needs to be covered:
3.4 Carry out routine checks required on sanitary appliances and pipework systems as part of a periodic maintenance program	**3.4.1** Routine checks to cover: a) visual inspection of pipework for leakage and adequate support b) effective operation of terminal fittings c) effective operation of float-operated valves d) effective operation of valves e) condition of cisterns f) operation of flushing cisterns/mechanisms g) fitting of effective waste outlet plugs h) effective operation of appliance traps/self-sealing valves i) pumps j) performance checks k) appliance support. **3.4.2** Performance test as per Building Regulations Approved Document Part H on above-ground drainage systems covering sanitary appliances: a) WC b) basin c) bath d) shower e) bidet f) urinal g) sink.
3.5 Record information on a maintenance record for sanitary appliances and pipework	**3.5.1** Information to be recorded: a) date b) company's name c) engineer's name d) manufacturer's name e) test results f) performance results g) signature h) comments i) telephone number.

Learning outcome 4

Understand methods of selecting and sizing rainwater system components for dwellings

Topic	Content What needs to be covered:
4.1 Interpret factors which affect the selection of rainwater systems for dwellings	**4.1.1** How the following factors affect the selection of rainwater systems for dwellings for new systems, existing systems and system replacements. Considerations in relation to current regulations, BS EN 12056 Part 3, Approved Document Part H and manufacturer's instructions: a) homeowner/end user needs b) building layout and features c) energy efficiency d) environmental impact e) cost f) legislation g) rainfall intensity h) roof area i) roof pitch j) running outlet position k) gutter fall l) changes of direction in the gutter run.
4.2 Interpret information sources required to size and select rainwater systems components	**4.2.1** The purpose of different sources of information required and how they impact design work on rainwater systems: a) statutory regulations b) industry standards c) manufacturer's technical instructions d) verbal/written feedback from the homeowner/end user e) plans f) drawings and specifications g) pre-determined data. **4.2.2** System components: a) fittings b) pipe (RWP) c) terminations d) brackets/clips.

Topic	Content What needs to be covered:
4.3 Calculate rainwater system requirements for dwellings	**4.3.1** Calculations follow suitable industry format conventions for quotation and tender, and use basic line drawings, in line with Approved Document Part H and manufacturer's instructions, for the following components: a) roof area b) gutter size c) performance requirements d) rainfall intensity.
4.4 Select rainwater system components using calculations from predetermined data	**4.4.1** Rainwater system components: a) fittings b) pipe (RWP) c) termination d) brackets/clips.
4.5 Interpret system information to complete a detailed materials list	**4.5.1** A detailed materials list for dwellings in accordance with: a) design calculations b) manufacturer's information c) property requirements d) homeowner/end user preference e) quantities and grades. **4.5.2** For the following materials: a) pipe (RWP) b) consumables c) fittings d) components e) gutter.
4.6 Present calculations and documentation in an industry standard format for quotation and tender	**4.6.1** Documentation presented as required by the homeowner/end user for the specific job, and in line with industry standard conventions/templates: a) drawings of layout b) schematic drawings. **4.6.2** Quotation to cover: a) details of materials b) labour cost.

Learning outcome 5

Perform fault diagnosis and rectification procedures on rainwater systems

Topic	Content What needs to be covered:
5.1 Sources of information used to establish diagnostic requirements	**5.1.1** The purpose of the following documents/information and how they are used to establish diagnostic requirements of specific system components: a) manufacturer's instructions i. installation instructions ii. performance data b) fault diagnosis flow chart i. manufacturer's technical support ii. spare parts list c) service history i. previous documentation ii. benchmark documentation.
5.2 Carry out diagnostic checks for system faults	**5.2.1** Checks for common faults carried out in line with the manufacturer's instructions and Approved Document H: a) leaks b) blockages/debris c) inadequate or broken support d) broken gutter/pipe (RWP) e) incomplete systems f) incorrect fall g) lack of provision for expansion and contraction h) incorrect gutter size.

Topic	Content What needs to be covered:
5.3 Carry out repair and rectification procedures to deal with system faults	**5.3.1** Procedures to be followed to carry out repair and rectification: a) notify homeowner/end user b) decommission c) rectify d) re-commission e) handover. **5.3.2** Faults: a) leaks b) blockages/debris c) inadequate or broken support d) broken gutter/pipe (RWP) e) incomplete systems f) incorrect fall g) lack of provision for expansion and contraction h) incorrect gutter size i. deep flow ii. normal flow.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Visits to/engagement with local manufacturers should be provided throughout the delivery.
- Delivery of unit content may be supported through contextualisation including:
  - reviews of current manufacturer's instructions, their websites and training videos
  - review of Approved Document Part H
  - exploration of the local area for possible visual faults in installation.
- Centres must ensure they keep up to date on current industry practice.
- When referring to legislation/guides as part of delivery, the most current version of guidance must be delivered.
- Where relevant as part of content delivery, learners should be encouraged to consider (for example through classroom-based discussion) responsibilities in relation to maintaining security of homeowner/client data and current data protection/security considerations.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019

Websites

- Building Regulations Approved Documents www.planningportal.gov.uk

Unit 305 Electrical work and the control of plumbing and domestic heating systems

Unit level	3
Guided Learning Hours (GLH)	64
Unit aim	This unit is for plumbing and domestic heating technicians, carrying out work on electrical supplies and circuits for the control of plumbing and domestic heating systems using scientific and mechanical principles that: • do not require the addition of a circuit to the existing fixed electrical installation • will only be associated with the disconnection, installation and connection of electrical equipment and components associated with the supply and control of plumbing and domestic heating systems.
Assessment method	Multiple choice question (MCQ) question paper Practical assignment
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems
2. Apply industry-standard safe isolation procedures
3. Carry out the safe installation, testing and decommissioning of electrical systems
4. Carry out the identification of faults and safe repair of electrical work

Learning outcome 1

Perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems

Topic	Content What needs to be covered:
1.1 Limitations of responsibility when carrying out work on electrical supplies and circuits for the	**1.1.1** Limitations of responsibility when carrying out work: a) work that does not require the addition of a circuit to the existing fixed electrical installation

Topic	Content What needs to be covered:
control of plumbing and domestic heating systems	b) work only on the disconnection, installation and connection of electrical equipment and components associated with the supply and control of plumbing and domestic heating systems.
1.2 Applications, advantages, and limitations of electrical supplies	**1.2.1** Purposes of electrical supplies, low voltage, extra low voltage (ELV) and low voltage single- and multi-phase provision for: a) control i. control panel ii. environmental control b) communication i. data ii. telephone iii. CAT5 cable c) heating i. boiler/heat source ii. programmer iii. room stat iv. cylinder stat v. wireless controls d) lighting i. LED ii. fluorescent e) power. **1.2.2** Advantages and limitations of electrical supplies: a) low voltage i. advantages: ease of installation, availability of components ii. limitations: risk of electric shock b) ELV and low voltage single- and multi-phase provision i. advantages: safety of installer and consumer; applications where low voltage would be unsuitable: swimming pools, wet areas ii. limitations: transformers required, potentially increasing installation and maintenance cost

Topic	Content What needs to be covered:
1.3 Purpose and application of different electrical equipment cables/wiring	**1.3.1** The purpose and application of electrical equipment: a) isolators b) circuit breakers c) fuses d) switches e) socket-outlets/fused-spurs/unfused-spurs f) earthing protection g) motor control equipment h) control panels – environmental control i) control devices – electrical, electronic, electro-mechanical. **1.3.2** The purpose and application of cables/wiring: a) PVC flat profile (twin and earth) b) flex – heat resistant (butyl) and rubber.

Topic	Content What needs to be covered:
1.4 Purpose and application of different plumbing and heating component requirements	**1.4.1** The purpose and application of different plumbing and heating component requirements: a) cable types b) circuit protection requirements c) termination methods d) integration of controls e) component isolation. **1.4.2** The purpose and application of plumbing and heating components: a) heat source i. ground-source heat pump ii. air-source heat pump iii. boiler fuel b) central heating controls i. zone valves (two-port, three-port, mid-position and diverter) ii. programmer iii. thermostats iv. wi-fi smart heating controls v. programmable room stat vi. optimiser vii. frost stat viii. cylinder stat c) immersion heater d) instantaneous shower e) shower pump f) jacuzzi bath/hot tub g) macerator WC h) heat producing or cooling appliances i) pumps j) fans.

Topic	Content What needs to be covered:
1.5 Appropriate industry standards and regulations relevant to carrying out work on electrical supplies and circuits for the control of plumbing and domestic heating systems	**1.5.1** Industry standards and how they impact works carried out: a) IET Wiring Regulations (BS 7671 18th edition) b) onsite guide (BS 7671) c) IET Guidance Notes. **1.5.2** Regulations and how they impact works carried out: a) Building Regulations Approved Document Part P – defined scope (domestic) b) Electricity at Work Regulations (commercial) c) Construction Design and Management Regulations (CDM).
1.6 Documentation that is required to verify that the plant and equipment is fit for purpose	**1.6.1** Documentation required to verify plant and equipment is fit for purpose and safe to use: a) manufacturer/operator instructions b) current maintenance/service records c) record of current PAT Test d) operator training records e) risk assessment. **1.6.2** Plant and equipment: a) generators b) transformers for low-voltage hand tools c) lifting equipment i. pallet truck ii. sack trolly d) access equipment i. scaffolding ii. ladders iii. mobile access tower iv. scissor lifts v. mobile elevating work platforms (MEWPs).

Topic	Content What needs to be covered:
1.7 Produce a risk assessment and method statement for electrical work to be carried out	**1.7.1** Risk assessment and method statement for the electrical work to be carried out, in accordance with: a) the plumbing and domestic heating system's design b) the conditions of the working environment c) organisational procedures i. information management ii. project management iii. risk assessment and management iv. hierarchy of controls/mitigations v. implementing and monitoring health and safety requirements and issues vi. implementing and monitoring issues relating to the natural environment vii. homeowner/end user service viii. accident reporting ix. emergencies x. communication with relevant people: • homeowner/end user • homeowner/end user representatives • site supervisors/contract manager • other contractors/trades • members of the public • work colleagues.
1.8 Select personal protective equipment (PPE)	**1.8.1** Selecting the appropriate PPE that is required for carrying out plumbing and heating electrical work: a) clothing protection and high visibility b) eye protection c) hand protection d) head protection e) foot protection f) hearing protection g) respiratory protection h) vibration protection i) harnesses.

Topic	Content What needs to be covered:
1.9 Confirm the status of the electrical supply using the correct tools	**1.9.1** Status of the electrical supply: a) live b) dead. **1.9.2** Live and dead status of electrical supplies confirmed using the required tools: a) approved voltage tester b) proving unit.
1.10 Confirm that the electrical supply is suitable for the plumbing and domestic heating systems	**1.10.1** Suitability of supply and electrical safe zones as detailed in onsite guide BS7671: a) identify Electrical Zones in bathrooms b) identify Electrical Zones for cables within the building.
1.11 Select electrical equipment, cables/wiring and components for a materials list	**1.11.1** Electrical equipment, cables/wiring and components must be: a) of the right type and size b) fit for purpose in accordance with the plumbing and domestic heating system's design.

Learning outcome 2

Apply industry-standard safe isolation procedures

Topic	Content What needs to be covered:
2.1 Electrical isolation prior to commencing work	**2.1.1** The purpose of the correct isolation process prior to commencing work: a) disconnection i. identify ii. isolate iii. check iv. test v. prove vi. confirm b) installation i. carry out work c) connection i. reinstate supply. **2.1.2** Understanding the method of safe isolation of the components: a) miniature circuit breaker (MCB) i. identify and prove supply ii. lock off iii. keep key on person iv. place sign b) residual current device (RCD) i. earth test ii. lock off c) fuse box main switch i. switch off.
2.2 Carry out the safe isolation of electrical equipment and components associated with the electrical supply	**2.2.1** Isolation of electrical equipment associated with electrical supply of the plumbing and domestic heating system following safe isolation procedures; the steps required to carry out a safe isolation procedure; and the implementation of safe isolation procedure on an installation: a) isolators b) circuit breakers c) fuses d) switches e) socket-outlets/fused-spurs f) earthing protection g) motor control equipment

Topic	Content What needs to be covered:
	h) control panels – environmental control i) control devices – electrical, electronic, electro-mechanical. **2.2.2** Isolation of electrical components associated with electrical supply of the plumbing and domestic heating system following safe isolation procedures; the steps required to carry out a safe isolation procedure; and the implementation of safe isolation procedure on an installation: a) boiler b) central heating controls i. zone valves (two-port, three-port, mid-position and diverter) ii. programmer iii. timer iv. thermostats v. programmable room stat vi. optimizer vii. frost stat viii. wiring centre ix. cylinder stat x. wi-fi routers xi. wi-fi range extenders c) wiring centres d) immersion heater e) instantaneous shower f) shower pump g) jacuzzi bath/hot tub h) macerator WC i) heat producing or cooling appliances j) circulating pumps k) fans. **2.2.3** Electrical supply: a) ELV and/or low voltage single-phase provision for: i. control ii. communication iii. heating iv. lighting v. power.

Learning outcome 3

Carry out the safe installation, testing and decommissioning of electrical systems

Topic	Content What needs to be covered:
3.1 Carry out disconnection and installation of electrical equipment, cables/wiring and components associated with the electrical supply	**3.1.1** Disconnection and installation of electrical equipment associated with the electrical supply and control of the plumbing and domestic heating system in accordance with the requirements of industry-recognised methods and procedures, and manufacturer's instructions: a) isolators b) circuit breakers c) fuses d) switches e) socket-outlets/fused-spurs f) earthing protection g) motor control equipment h) control panels – environmental control i) control devices – electrical, electronic, electro-mechanical. **3.1.2** Disconnection and installation of cables/wiring and components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with the requirements of industry-recognised methods and procedures, and manufacturer's instructions: a) PVC flat profile (twin and earth) b) flex – heat resistant (butyl) rubber. **3.1.3** Disconnection and installation of electrical components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with the requirements of industry-recognised methods and procedures, and manufacturer's instructions: a) boiler b) central heating controls i. zone valves (two-port, three-port, mid-position and diverter) ii. programmer iii. timer iv. thermostats v. programmable room stat

Topic	Content What needs to be covered:
	vi. optimizer vii. frost stat viii. wiring centre ix. cylinder stat x. wi-fi routers xi. wi-fi range extenders c) wiring centres d) immersion heater e) instantaneous shower f) shower pump g) jacuzzi bath/hot tub h) macerator WC i) heat producing or cooling appliances j) circulating pumps k) fans. **3.1.4** Electrical supply: a) ELV and/or low voltage single-phase provision for: i. control ii. communication iii. heating iv. lighting v. power.
3.2 Verify that the electrical equipment, cables/wiring and components are in accordance with the requirements of the plumbing and domestic heating system	**3.2.1** Verification requirements of hot water and heating systems in compliance with wiring diagrams: a) hot water systems i. vented systems ii. unvented systems b) heating systems i. S-plan ii. S-plan plus iii. combination boilers.

Topic	Content What needs to be covered:
3.3 Confirm that the electrical equipment, cables/wiring and components comply with current standards	**3.3.1** Confirm that the electrical equipment, cables/wiring and components comply with current standards: a) insulation i. used in wiring and components b) mechanical strength i. of cables and components c) protection i. circuit protection devices required to protect wiring and components of the installation.
3.4 Undertake functional testing of the electrical equipment and components	**3.4.1** Carry out functional testing on circuits when both open and closed, to ensure power is reaching the required components and that isolation is effective in accordance with: a) Industry-recognised methods and procedures b) manufacturer's instructions c) types of electrical test i. polarity ii. insulation resistance iii. earth continuity.

Learning outcome 4

Carry out the identification of faults and safe repair of electrical work

Topic	Content What needs to be covered:
4.1 Diagnose electrical faults and deficiencies on plumbing and domestic heating system components	**4.1.1** Electrical faults and deficiencies on plumbing and domestic heating systems in accordance with industry-recognised methods and procedures, and manufacturer's instructions. Deficiencies: a) inadequate earthing provision b) defective cable routing and condition c) defective termination d) incorrect polarity e) provision of inadequate circuit protection device. **4.2.2** Electrical deficiencies on plumbing and domestic heating system components in accordance with industry-recognised methods and procedures, and manufacturer's instructions. Components: a) appliance components i. micro switches ii. relays iii. pressure switches iv. printed circuit boards v. pumps vi. fans b) control components i. thermostats ii. programmers/timers iii. electrically operated control valves iv. wiring centres.

Topic	Content What needs to be covered:
4.2 Rectify electrical faults and deficiencies on plumbing and domestic heating system components	**4.2.1** Electrical faults and deficiencies in plumbing and domestic heating systems in accordance with industry-recognised methods and procedures and manufacturer's instructions. Deficiencies: a) inadequate earthing provision b) defective cable routing and condition c) defective termination d) incorrect polarity e) provision of inadequate circuit protection device. **4.2.2** Electrical deficiencies in plumbing and domestic heating system components in accordance with industry-recognised methods and procedures, and manufacturer's instructions. Components: a) appliance components i. micro switches ii. relays iii. pressure switches iv. printed circuit boards v. pumps vi. fans b) control components i. thermostats ii. programmers/timers iii. electrically operated control valves iv. wiring centres.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Visits to/engagement with local electrical manufacturers and electrical contractors should be provided throughout the delivery.
- This unit could be delivered alongside or after the delivery of units 302 and 303.
- Centres must ensure they keep up to date on current industry practice.
- When referring to legislation/guides as part of delivery, the most current version of guidance must be delivered in accordance with updates to BS 7671 and Approved Document Part P.
- Where relevant as part of content delivery, learners should be encouraged to consider (for example through classroom-based discussion) responsibilities in relation to maintaining security of homeowner/client data and current data protection/security considerations.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019
- Onsite Guide to BS 7671 Wiring Regulations ISBN-10 1839532270
- Student's Guide to the IET Wiring Regulations (Electrical Regulations) ISBN-10 1839532602

Websites

- Building Regulations Approved Documents www.planningportal.gov.uk

Unit 306 Domestic fuel systems and environmental technologies

Unit level	3
Guided Learning Hours (GLH)	43
Unit aim	This unit covers factors affecting fuel selection, the combustion processes of fuel supply systems and the operating principles of chimney and flue systems using scientific, domestic and mechanical principles. This unit also introduces learners to micro-renewable energy technologies and the installation requirements.
Assessment method	Multiple choice question (MCQ) question paper
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Understand factors affecting fuel selection
2. Know combustion processes of fuel supply systems
3. Know principles of chimney and flue systems
4. Know basic operating principles of micro-renewable energy technologies
5. Understand requirements for installing micro-renewable energy systems to existing systems

Learning outcome 1

Understand factors affecting fuel selection

Topic	Content What needs to be covered:
1.1 Types of fuels used in appliances	**1.1.1** Requirements for fuels: a) source b) distribution c) storage requirements d) fuel type. **1.1.2** Types of fuels and storage: a) natural gas i. National Grid pipework b) liquified petroleum gas (LPG) (butane/propane) i. bottled ii. large tank c) oil i. bunded tank d) solid fuel i. wood: dry store ii. coal: bunker iii. peat: dry store e) sustainable sources (biomass) i. biomass: hopper/silo/underground.

Topic	Content What needs to be covered:
1.2 Factors which affect the selection of fuels	**1.2.1** Factors to consider when selecting fuels: a) homeowner/end user preference b) availability i. location: off grid/on grid c) appliance type i. gas boiler ii. oil boiler iii. electrical boiler iv. biomass boiler v. solid-fuel burner vi. combined heat and power (CHP) vii. combined cooling heat and power (CCHP) viii. district heating d) fuel storage requirements i. location ii. space iii. ventilation iv. proximity to dwelling v. safety vi. delivery requirements vii. container storage requirements (if applicable) e) environmental considerations i. planning approval ii. planning restrictions f) smoke control legislation – Clean Air Act 1993 g) cost.

Topic	Content What needs to be covered:
1.3 Sources of information for fuel supply installation	**1.3.1** Considerations in relation to information sources: a) British Standards i. BS 7671 IET Wiring regulations ii. S 2869 – fuel oil b) regulations i. The Gas Safety (Installation and Use) Regulations ii. Approved Document Part J – combustion appliances and fuel storage systems c) manufacturer's instructions: as per appliance type d) guidance notes produced by regulatory bodies and professional associations, and the requirements for competent person schemes i. HSE ii. Gas Safe iii. OFTEC iv. Heating Equipment Testing and Approval Scheme (HETAS) v. Microgeneration Certification Scheme (MCS).
1.4 Regulatory bodies that govern the installation of fuel types	**1.4.1** Regulatory bodies (organisations set up by the government to monitor, control and guide various sectors within industry), fuel system bodies and registration requirements: a) Gas Safe – UK registration body for the installation, maintenance and repair of gas installations and appliances b) OFTEC – registration body for the installation and maintenance of oil-fired heating appliances and fuel systems c) HETAS – official body that is recognised by the UK Government for approving solid fuel and biomass domestic heating systems, fuels and appliances.

Topic	Content What needs to be covered:
1.5 Storage requirements for fuels	**1.5.1** Specify the requirements for storing fuels as detailed in industry guidance focusing on: a) protection of the environment b) type of storage c) location of tanks and cylinders d) ventilation requirements e) availability f) storage requirements i. pressure ii. location iii. safety measures iv. environmental protection measures g) smoke control legislation h) cost. **1.5.2** Fuel types and storage a) natural gas i. National Grid pipework b) LPG (butane/propane) i. bottled ii. large tank c) oil i. bunded tank d) solid fuel i. wood: dry store ii. coal: bunker iii. peat: dry store e) sustainable sources (biomass) i. biomass: hopper/silo/underground.
1.6 Factors which can affect storage requirements for fuels	**1.6.1** Factors that affect storge requirements as per regulations for different fuel types: a) space b) delivery requirements c) ventilation d) safety e) weather conditions f) distribution g) proximity to dwelling.

Learning outcome 2

Know combustion processes of fuel supply systems

Topic	Content What needs to be covered:
2.1 The combustion process	**2.1.1** Combustion is an exothermic chemical reaction in which a fuel reacts violently with oxygen to produce heat and light. For combustion to take place there must be three components: a) fuel b) ignition c) oxygen.
2.2 The main chemical constituent of combustion	**2.2.1** The main chemical constituents (elements) of complete and incomplete combustion including the chemical formulas: a) complete combustion – complete combustion of hydrocarbons produces CO2 and water vapour. Hydrocarbon+ oxygen ⟶ water+ carbon dioxide (CH4+202 ⟶ 2H20+CO2) incomplete combustion – incomplete combustion occurs when the products of combustion are different than those produced for complete combustion. Oxygen + hydrogen carbon ⟶ water + carbon monoxide (O2+CH4 ⟶ H2O + CO).
2.3 Causes of incomplete combustion	**2.3.1** Causes of incomplete combustion: a) lack of oxygen b) too much fuel c) vitiated air d) flame impingement.
2.4 Signs of incomplete combustion in or around a fuel-burning appliance	**2.4.1** Signs of incomplete combustion: a) yellow flame – caused by combustion and a lack of oxygen b) floppy flame – caused by combustion and a lack of oxygen c) sooting – black carbon being produced from the incomplete combustion process d) staining – a dark brown stain or scorch on or around the appliance.

Topic	Content What needs to be covered:
2.5 Symptoms of CO poisoning	**2.5.1** Symptoms of CO poisoning: a) a tension-type headache b) a redness to the cheeks – the look of being flushed (without the fever) c) dizziness d) nausea and sickness e) tiredness and confusion f) severe stomach cramp g) shortness of breath.
2.6 Types of CO detectors and their purpose	**2.6.1** Purpose of all types of CO detectors to BS EN 50291 (to warn of the presence of small amounts of carbon monoxide in a space or room): a) biometric sensor – gel changes colour when it absorbs CO and triggers alarm b) metal oxide semiconductor – silica chip detects CO and triggers alarm c) electrochemical sensor – electrodes are immersed in a chemical, and changes in electrical current are detected when CO is present, which triggers the alarm.
2.7 Ventilation requirements for combustion appliances	**2.7.1** Ventilation requirements for heat-producing combustion appliances: a) combustion air: fuel ratio for complete combustion to occur 2:1 b) cooling air: room-sealed or balanced flue appliances do not require a separate provision for combustion air c) natural ventilation: all open-flued appliances that burn fossil fuels will need to replace air to the room where the appliance is installed.

Topic	Content What needs to be covered:
2.8 Different types of ventilation	**2.8.1** Types of ventilation: a) natural i. air brick ii. air vent/grill b) mechanical i. fanbased component **2.8.2** Ventilation is used to: a) moderate internal temperatures b) control internal humidity c) replenish necessary oxygen d) reduce condensation, odours, dust, bacteria and carbon dioxide e) create air movement – this improves thermal comfort.
2.9 Installation practices for ventilation for combustion appliances	**2.9.1** Installation practices for ventilation must be correctly followed, positioned/installed in accordance with: a) the appliance manufacturer's instructions b) Approved Document Part F – Ventilation 2010 with 2013 amendments c) British Standard BS 5440 Part 2 Specification for the installation and maintenance of ventilation provision for gas appliances. **2.9.2** Installation practices: a) adequately sized b) continuous size c) sleeved d) permanently open e) fly screen removed f) correctly positioned.

Learning outcome 3

Know principles of chimney and flue systems

Topic	Content What needs to be covered:
3.1 Operating principles of chimney and flue systems	**3.1.1** Requirements of flues and chimneys to safely remove the products of combustion from burning fossil fuels to the outside air, where they can do no harm. Operating principles: a) remove combustion products b) draw in combustion air.
3.2 Types of chimney and flue systems	**3.2.1** Flue types and how they are divided into three basic categories (A, B and C). Categories further divided by the addition of a second number which identifies if the flue is natural draught or has a fan, and if the fan is located upstream or downstream of a heat exchanger. Types: a) open-flued i. type B b) room-sealed i. type C c) flueless i. type A.
3.3 Components within chimney and flue systems	**3.3.1** Components within open flues: a) primary flue – section from boiler to draft divertor b) draught diverter – allows air to be drawn in from the surrounding area c) secondary flue – section from draft divertor to terminal d) terminal – exterior and products of combustion escape though the terminal.
3.4 Effects of layout on chimney and flue systems	**3.4.1** Factors that affect the performance of a chimney and flue systems: a) height b) internal temperature c) external temperature d) air quality e) humidity f) route g) bends h) termination.

Topic	Content What needs to be covered:
3.5 Main types of chimney and flue constructions	**3.5.1** Chimney and flue constructions: a) rigid chimney types i. brick/masonry ii. pre-cast flue blocks b) rigid metallic (single- and double-wall flues) c) flexible metallic liner installation (types and suitability). **3.5.2** Factors to be considered in the types of construction: a) key measurements b) dimensions c) terminal types where a guard is required d) jointing methods e) guidance in relation to instillation of a chimney and flue i. manufacturer's instructions ii. British Standards relating to brick and masonry – BS 1857 (chimneys since 1966); pre-cast flue blocks – BS 1858; ridged metallic – BS 1856-1; and flexible metallic liner installation – BS 1856-1, BS 1856-2 and BS 715.
3.6 References to termination requirements for chimney and flue systems in relevant documents	**3.6.1** Locate flue termination requirements from relevant guidance documents: a) British Standards i. BS 5440 ii. BS EN 1856 iii. BS 5871 iv. BS EN 1857 v. BS EN 1858 b) building regulations i. Approved Document Part J c) manufacturer's instructions.

Topic	Content What needs to be covered:
3.7 Basic inspection and testing procedures for chimney and flue systems	**3.7.1** The inspection and testing of flues and chimneys to ensure that they continue to work correctly and safely as detailed in BS 5440-1. Inspection and testing procedure: a) visual inspection b) flue flow test c) spillage test d) flue gas analysis – the requirement for domestic gas appliances to be tested using a flue gas analyser to ensure that the appliances are operating safely and to maximum efficiency. **3.7.2** The materials required to test a chimney: a) matches b) smoke pellets.

Learning outcome 4

Know basic operating principles of micro-renewable energy technologies

Topic	Content What needs to be covered:
4.1 Basic operating principles of heat-producing, micro-renewable energy technologies	**4.1.1** Basic operating principles and components of heat-producing, micro-renewable energy technologies: a) solar thermal (hot water) i. flat panel connector ii. evacuated tube collector b) ground-source heat pump i. horizonal loops ii. vertical loops iii. slinkies c) air-source heat pump i. heat exchanger ii. compressor iii. expansion valve d) biomass i. burner ii. silo iii. hopper iv. auger (Archimedes screw).
4.2 Basic operating principles of heat-led, micro-combined heat and power	**4.2.1** Basic operating principles of heat-led, micro-combined heat and power: a) fuel sources i. gas b) components i. engine burner ii. Stirling engine generator iii. supplementary burner iv. heat exchanger c) efficiencies i. 80% heat, 15% power (electricity).

Learning outcome 5

Understand requirements for installing micro-renewable energy systems to existing systems

Topic	Content What needs to be covered:
5.1 Suitability of building location and features when installing micro-renewable energy systems	**5.1.1** Building location and features: a) structural integrity b) orientation c) listed buildings i. grade 1 ii. grade 2 d) environmental conditions e) adjacent structures and obstructions f) geographical elements. **5.1.2** Micro-renewable energy systems: a) solar thermal (hot water) b) ground-source heat pump c) air-source heat pump d) biomass e) combined heat and power (CHP) f) rainwater harvesting g) greywater reuse h) solar photovoltaic i) micro-wind j) microhydro.
5.2 Regulations affecting installation of micro-renewable energy systems	**5.2.1** Regulations: a) Building Regulations Approved Documents: i. Part A: structures ii. Part E: electrical (defined scope) iii. Part G: hot water and hygiene iv. Part H: drainage and rainwater v. Part L: energy efficiency. b) town and country planning regulations i. local authority ii. building control.

Topic	Content What needs to be covered:
5.3 Permitted developments under town and country planning regulations in relation to the deployment of technologies	**5.3.1** Current restrictions applied to the installation of the technologies in line with local planning requirements. Permitted developments: a) solar thermal (hot water) b) ground-source heat pump c) air-source heat pump d) biomass.
5.4 Parts of regulations that apply in relation to the installation of environmental technologies	**5.4.1** Parts of regulations: a) Part A: structures b) Part E: electrical (defined scope) c) Part G: hot water and hygiene d) Part H: drainage and rainwater e) Part L: energy efficiency f) town and county planning regulations g) water regulations. **5.4.2** Environmental technologies: a) solar thermal (hot water) b) ground-source heat pump c) air-source heat pump d) biomass e) micro-combined heat and power (heat-led) f) water conservation i. rainwater harvesting ii. greywater recycling.

Topic	Content What needs to be covered:
5.5 Advantages and disadvantages associated with environmental technologies	**5.5.1** Advantages and disadvantages associated with each of the environmental technologies: a) solar thermal (hot water) i. advantages: reduced carbon emissions, lower energy costs, low maintenance, improved energy performance certificate rating ii. disadvantages: not compatible with all existing hot water systems, less solar energy available in the winter months, high initial installation costs, requires an auxiliary heat source b) ground-source heat pump i. advantages: reduced carbon emissions, typical efficiencies between 300% and 500%, low maintenance, improved energy performance certificate rating ii. disadvantages: not usually suitable for connection to existing heating systems using panel radiators, high initial installation costs, ground-source installations require a large ground area or a borehole c) air-source heat pump i. advantages: reduced carbon emissions, typical efficiencies between 300% and 500%, low maintenance, improved energy performance certificate rating ii. disadvantages: not usually suitable for connection to existing heating systems using panel radiators, high initial installation costs, air-source installations can present a noise issue d) biomass i. advantages: carbon neutral, technology does not rely on building orientation or weather conditions to operate, generally considered to be an inexhaustible fuel source, producing biomass fuel is very cheap compared to the cost of finding and extracting fossil fuels ii. disadvantages: requires a suitable flue/chimney, initial installation costs can be off-putting, larger appliances typically require a large space to bulk-store fuel, sometimes considered less suitable for smaller properties e) micro-combined heat and power (heat-led) i. advantages: domestic units now similar in size to central-heating boilers, produce free electricity while generating heat, do not rely on building orientation or weather conditions to operate effectively

Topic	Content What needs to be covered:
	ii. disadvantages: more expensive than central-heating boilers, not suitable for properties with low heat demand, limited electrical generation capacity, low-carbon rather than zero-carbon f) water conservation – rainwater harvesting i. advantages: reduction in the use of wholesome water, reduction in water bills, water does not require treatment prior to use, less complicated than greywater recycling ii. disadvantages: quantity of water is limited to the collection area, the quantity is limited to the rainfall in the area, initial installation costs are high, water meter should be fitted g) water conservation – grey-water recycling: i. advantages: reduction in water bills, reduction in the demand for wholesome water, wide range of system designs, potential to provide more re-useable water than rainwater harvesting ii. disadvantages: long payback period, difficult to integrate into existing system, only certain appliances can be supplied by greywater recycling, potential cross-contamination risk, water heater will need to be fitted on the property supply, need for filtering and pumping contribute to the property's carbon footprint.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Visits to/engagement with local manufacturers should be provided throughout the delivery.
- Local site visits to places where renewable energy systems are being installed, and master classes delivered by renewable energy companies.
- Opportunity to look at the systems as part of a practical/hands-on demonstration by centres.
- This unit could be delivered alongside, or after, the delivery of units 302 and 303.
- Centres must ensure they keep up to date on current industry practice.
- When referring to legislation/guides as part of delivery, the most current version of guidance must be delivered in accordance with updates to BS 7671 and Approved Document Part P.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019

Websites

- Building Regulations Approved Documents www.planningportal.gov.uk
- Energy Saving Trust's website https://energysavingtrust.org.uk/
- Gas Safe https://www.gassaferegister.co.uk/
- HETAS https://www.hetas.co.uk
- OFTEC https://www.oftec.org/

Unit 307 Planning and supervision for building services engineering projects

Unit level	3
Guided Learning Hours (GLH)	51
Unit aim	This unit covers the knowledge and understanding of planning and supervision procedures in the building services engineering sector. The scope of this unit will cover different homeowner/end user customer types, the responsibilities of individuals on site and communication methods when dealing with customers, employees and other service users.
Assessment method	Multiple choice question (MCQ) question paper
Links to Occupational Standard	Plumbing and domestic heating technician ST0303 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcomes

1. Understand responsibilities of roles working in the building services industry
2. Know how to compile risk assessments and method statements for building service engineering projects
3. Understand requirements for the planning of work programmes
4. Understand potential issues, risks and changes that may impact building services engineering projects

Learning outcomes 1

Understand responsibilities of roles working in the building services industry

Topic	Content What needs to be covered:
1.1 Types of building services industry customers	**1.1.1** Types of industry customers: a) private customer i. homeowner ii. tenant b) contracting customer i. sole trader ii. limited company iii. public limited company c) internal customer i. within the same company.

Topic	Content What needs to be covered:
1.2 Methods of communication and high-quality customer service to meet individual needs when dealing with customers and site management	**1.2.1** Different types of communication between various stakeholders and the site management team to establish individual needs: a) stakeholders: i. customers/clients/homeowners/end users ii. client representatives iii. supervisors/site or contract managers iv. other contractors/trades v. members of the public vi. work colleagues b) different types of communication: i. variation orders ii. site meetings/toolbox talks iii. safety memos/briefings iv. work quality management systems v. ordering plant and materials vi. customer liaison and hierarchy systems – chain of command vii. coordination and liaison with other trades viii. site procedures ix. escorted site visitors by purchasers/end users. **1.2.2** Methods of communication and the principles of high-quality customer service used to meet individual stakeholder needs, including specific property protection measures and communication preferences: a) principles of high-quality customer service i. regular communication ii. protecting customer property iii. personal conduct and presentation in a professional manner b) direct communication i. written • email • letter ii. text messaging iii. face to face/telephone iv. quotations/estimates c) indirect communication i. through customer representatives ii. through managing agents iii. through other trades.

Topic	Content What needs to be covered:
1.3 Supervisory and craft team roles associated with work in the building services engineering industry	**1.3.1** Differences between the job roles to include limitations and supervisory responsibilities of: a) management b) craftspeople c) apprentices d) specialist consultants. **1.3.2** Supervisory roles: a) architect b) quantity surveyor c) buyer/estimator d) site engineer e) project manager/clerk of works f) structural engineer g) building services engineer h) contracts manager i) health and safety manager. **1.3.3** Craft team roles: a) craft/trade chargehand b) general operative c) trade supervisor d) apprentices e) specialist consultants f) level-two craft-level qualified staff g) level-three craft-level qualified staff.
1.4 Potential visitors that may be present on building services engineering sites	**1.4.1** Visitors: a) inspectors i. building control ii. water iii. HSE iv. electrical services b) members of the public c) delivery drivers.

Topic	Content What needs to be covered:
1.5 Identify responsibilities under legislation for building services engineering project site requirements	**1.5.1** Knowledge that legislation exists, where to reference current versions, and responsibilities under each in relation to own role (there is not a requirement to know full details of legislation content). Key responsibilities when supervising staff working under key legislation: a) duty of care and application of Construction Design and Management (CDM) regulations/Health and Safety at Work Act (HASWA) b) identifying when direct supervision or detailed direction is required – correct training and allocation of work c) inductions for site d) checking of competences. **1.5.2** Legislation: a) Health and Safety at Work Act (HASWA) b) Construction Design and Management (CDM) c) Management of Health and Safety at Work Regulations d) Control of Substances Hazardous to Health (COSHH) e) Provision and Use of Work Equipment Regulations (PUWER) f) Electricity at Work Regulations (EWR) g) Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) h) Building Regulations.

Learning outcome 2

Know how to compile risk assessments and method statements for building service engineering projects

Topic	Content What needs to be covered:
2.1 Information required to carry out risk assessments for building service engineering projects	**2.1.1** Information required to carry out risk assessments: a) levels of hazard/risk: identify hazard b) persons affected: who might be harmed and how c) evaluation of risks and potential precautions d) risk calculation formula i. quantitative method ii. ranking of risk e) record findings and implement f) review of assessment – amend if necessary/required. **2.1.2** Considerations of how the information is used: a) formats b) forms/paperwork c) frequency d) action of reviews e) storage and security of risk assessment f) review and reference requirements.
2.2 Requirements for method statement production for areas of work with safety risks	**2.2.1** Considerations when producing the method statements: a) formats b) forms/paperwork c) safe systems of work d) delivery and communication methods (toolbox talks) e) how the method statement relates to the risk assessment. **2.2.2** Requirements needed for completing the method statement: a) description of work requirements as per scope of contract b) company details c) site details d) safety equipment e) PPE requirements f) health and safety contacts g) equipment requirements h) permit requirements.

Topic	Content What needs to be covered:
2.3 Duties of supervising staff in relation to risk assessment and method statement compilation	**2.3.1** Duties of supervising staff: a) confirmation of competence of operatives to undertake work b) confirmation if direct supervision or detailed direction is required c) identification of any specific health and safety issues d) planning safe working for subordinates e) adjusting work schedules when health and safety problems delay work.

Learning outcome 3

Understand requirements for the planning of work programmes

Topic	Content What needs to be covered:
3.1 The types of work programme used for building service engineering projects	**3.1.1** Consideration that there may be established protocols in place or templates for format of work that should be checked and adhered to and that the format of work program may differ according to type of work/project: a) private installation work b) private service/maintenance work c) new-build installation contract work d) service/maintenance contract work **3.1.2** Types of work programme: a) bar chart b) Gantt chart.
3.2 The process for planning work activities aligned to job specifications	**3.2.1** Process for planning: a) work activities i. scope ii. purpose iii. requirements b) identification of work responsibilities c) external factors that affect timeframe i. labour resources ii. planning with other trades d) resources required against job specification i. materials availability ii. materials delivery iii. plant iv. vehicles v. equipment e) contingency planning.

Topic	Content What needs to be covered:
3.3 Pricing work and presenting quotes for building service engineering projects	**3.3.1** When pricing work and presenting quotes methods of contract management, of pricing works and the presentation to homeowner/end user should be considered: a) methods of contract management i. fixed cost ii. variable cost iii. cost plus iv. materials list v. bill of quantities vi. schedule of rates vii. profit margin b) methods of pricing works i. quotations ii. estimates iii. invoices/statements iv. statutory cancellation rights c) presentation/handover to homeowner/end user i. cover letter ii. email iii. tender iv. handover in person – written/verbal.

Learning outcome 4

Understand potential issues, risks and changes that may impact building services engineering projects

Topic	Content What needs to be covered:
4.1 How variations to specifications can affect a project	**4.1.1** Variations to specifications can be prescribed by: a) the work environment b) the homeowner/end user. **4.1.2** Considerations when variations are required from either the work environment or requested by the homeowner/end user and variation orders issued: a) specification changes b) materials c) additional time d) additional costs.
4.2 Potential risks when monitoring work progress against a work schedule	**4.2.1** Potential risks: a) safety b) cost effectiveness c) waste management d) quality e) methods of staff management f) availability of materials. **4.2.2** Considerations when identifying potential risks: a) safety management and performance b) management of payments c) schedule of works d) environmental/recycling legislation ensuring specification and industry standards e) works allocation/monitoring or workload f) formal and informal management of staff.

Topic	Content What needs to be covered:
4.3 Potential causes of project delays and interruptions	**4.3.1** Impacts and considerations of project delays and interruptions: a) considerations of impact on progress of the delays and interruptions, and potential mitigations to reduce/lessen the impact b) impacts of planning work with/around other trades, and potential knock-on implications for them. **4.3.2** Causes of delays and interruptions: a) weather i. heat – snow, heatwave ii. flood iii. storm b) availability of resources i. supply chain shortages/availability c) materials i. supply chain shortages/availability d) equipment/plant e) labour i. skills shortage f) site conditions i. location type g) defective workmanship h) lack of coordination/communication i. planning/supervision/management i) change in specification i. client ii. architect.

Supporting information

Guidance for delivery

Considerations for centres when delivering unit content include:

- Delivery of content may be supported through the implementation of 'risk assessment workshops' with learners.
- Role play activities could be used as part of classroom content delivery to support development of handover to homeowner/end user skills.
- Centres must ensure they keep up to date on current industry practice.
- Wherever possible, centres should consider giving learners access to real-life examples of current documentation types and templates used in industry such as materials lists, quotes etc.
- Learners could develop planning skills through activities to develop/review planning charts for current local BSE projects.

Suggested learning resources

Books

- Peter Tanner and Stephen Lane, The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Diploma (8202) and Level 3 Diploma (6035), City & Guilds, 2019

Websites

- Building Regulations Approved Documents www.planningportal.gov.uk

Appendix 1 Qualification content mapping to Occupational Standard (ST0303)

The table below contain the mapping of the occupational standard ST0303 Knowledge, Skills and Behaviours (KSBs) to the City & Guilds Level 3 Technical Occupational Entry in Plumbing and Heating (Diploma) (6036-03).

The KSB reference to each unit in this document is not exhaustive.

Unit	Knowledge, Skills, and Behaviours (KSBs) reference
301 Cold water systems	K1, K2, K4, K8 S1, S2, S4 B4, B7
302 Hot water systems	K1, K2, K4, K8 S1, S2, S4 B4, B7
303 Central heating systems	K1, K2, K3, K4, K8 S1, S2, S4 B1, B3, B4, B7
304 Sanitation and rainwater systems	K1, K2, K4, K8 S1, S2, S4 B1, B4, B7
305 Electrical work and the control of plumbing and domestic heating systems	K1, K3, K4 S1, S3, S4 B4, B7
306 Domestic fuel systems and environmental technologies	K1, K4, K5, K6 B5
307 Planning and supervision for building services engineering projects	K1, K7, K8 S4 B1, B4, B5, B6

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centre document library** on **www.cityandguilds.com** or click on the links below:

Centre Handbook: Quality Assurance Standards

This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

Centre Assessment: Quality Assurance Standards

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

Access arrangements: When and how applications need to be made to City & Guilds provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **Centre document library** also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

Useful contacts

Please visit the Contact us section of the City & Guilds website, **Contact us.**

City & Guilds

For over 140 years, we have worked with people, organisations and economies to help them identify and develop the skills they need to thrive. We understand the life-changing link between skills development, social mobility, prosperity and success. Everything we do is focused on developing and delivering high-quality training, qualifications, assessments and credentials that lead to jobs and meet the changing needs of industry.

We partner with our customers to deliver work-based learning programmes that build competency to support better prospects for people, organisations and wider society.
We create flexible learning pathways that support lifelong employability because we believe that people deserve the opportunity to (re)train and (re)learn again and again – gaining new skills at every stage of life, regardless of where they start.

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