Unit 332: Hot water system planning and design

Sample scheme of learning

Please revise the following text to suit your requirements.

This sample scheme of learning covers both classroom and workshop based learning for Unit 332. It is based on 90 hours over 18 sessions, plus additional hours for independent learning. Some suggestions of independent learning are made in the session plans. **This requires tutors to produce their own support material to enable the learners to achieve.**

This is only an example of a possible scheme of learning. You can use it as it is, adjust it or extract content to suit your delivery needs, or the needs of individual learners. We have endeavoured to make the schemes of learning as flexible as possible: where sessions may be taught out of order, this has been signposted. You may find it useful to use our lesson plan template to translate and adapt the sessions.

The schemes of learning are intended to be learner-focused, and they embrace current pedagogical methodology such as flipped and blended learning. They include the following types of learning tasks:

- **Pre-learning** – tasks for the learner to complete in advance of the session to allow for flipped learning
- **Active learning** – active, experiential and discovery learning approaches
- **Challenge focus** – stretching tasks to challenge more able learners
- **Independent learning** – tasks that learners can complete individually or collaboratively without tutor supervision. These tasks may be given as homework.

Reference is made within the scheme of learning suggested learning materials and other resources required for each session. **Materials will have to be produced by the tutor prior to delivering each session.** Ideas for support material can be found on the internet, by using sites such as:

- www.tripticoplus.com
- www.asdan.org.uk
- www.quizlet.com
- www.worksheetsworks.com
- www.classtools.net

and adapting their base material to suit.

Resources consist of physical equipment required, as well as any technologies needed. Where possible, we have included blended learning activities that make good use of technology so as to help centres to fulfil the minimum amount of digital teaching recommended by the government.

The scheme of learning also signposts opportunities within the unit content to introduce the following wider skills and government initiatives:

- English, mathematics and ICT
- employability skills and behaviours

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- British values (including the Prevent strategy).

Centres should also incorporate the following themes, where appropriate. Although they are not specifically referred to in the scheme of learning, City & Guilds regards these as essential in the teaching of the qualification:

- spiritual, moral, social and cultural issues
- health and safety considerations, in particular the need to impress upon learners the fact that they must preserve the health and safety of others as well as themselves
- environmental education and related European issues.

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Unit 332: Hot water system planning and design

Sample scheme of learning

Course/Qualification: _____ **Tutor's name**: _____

Number of sessions: 18 **Delivery hours**: 90 **Venue**:_____ **Group**: _____

Learning outcomes:	**To enable learners to**:
• understand hot water systems and their layout requirements • use design techniques for hot water systems • commission hot water systems and components • diagnose and rectify faults in hot water systems and components	• understand types of hot water supply systems, design temperatures, components and safety devices • interpret factors affecting hot water systems, referring to information source to enable effective calculations for installation requirements • commission hot water systems to the required industry standard and apply processes of surveys, testing, operational checks, and handover and technical communication to clients • solve problems through diagnosis and rectify faults in hot water systems

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Session 1: Types of hot water supply system **Suggested Teaching Time**: 4.5 hours

Learning Outcomes: 1. Understand hot water systems and their layout requirements

Learners will compare types of hot water supply systems used in dwellings and describe their applicable pipework layout features. Hot water systems include:

- centralised systems – unvented hot water systems and vented hot water systems
- localised systems – unvented point of use heaters and instantaneous heaters
- indirect storage systems
- direct storage systems.

Topics: 1.1 – Types of hot water supply system

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **inspect** an installation at home or work, and identify type and location of hot water system serving the outlets around the building. Learners to **write notes** and take photographs about pipework size, insulation and location of valves to bring into the lesson and **discuss** the appliance purpose and functionality. **Active learning:** • Tutor to give out **Handout 2** on types of DHW system as general information for the lesson. This could include tables stating the positive and negatives for: instantaneous vs. stored, high vs. low pressure and localised vs. centralised. • Tutor to show **Presentation 1** on types of systems, showing design and layouts, as per learning outcome. • Tutor to ask learners about the hot water appliances they've found at home, at work or in their properties. Tutor will create a group **mind map**, incorporating all of the learners' observations, and then extend the **discussion** on typical	**Materials** For the tutor to devise in advance**:** • **Presentation 1** • **Worksheet 1** • **Worksheet 2** • **Worksheet 3** • **Handout 1a** • **Handout 1b** • **Handout 2** **Resources** • Computers/phones and tablets	• Tutor to create a mind map and discuss to check if learners have correctly identified appliance and purpose. • Assess whether learners can confirm that an installation complies with the regulations, by asking questions. • Review learners' response to scenario exercises and peer-assess each other's solutions using **Worksheet 1** to measure quality of observations and level of understanding. • Tutor can ask learners key questions and ask them to write down their thoughts. Then pair them up to discuss their thoughts with another learner, before asking a few groups to share their thoughts with the larger group, regarding types of system. • Ask learners questions when they are

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Key learning activity/approach	Suggested materials and resources	Skills check
domestic installation expectations and common errors, ie hot and cold wrong way round. • Learners to work in pairs to identify the operation of hot water systems by viewing and **discussing** the images of hot water appliances. • Tutor to facilitate a **discussion** with learners about centralised systems, both direct and indirect. • Learners to look over **Handout 1a**, which includes a table stating the positives and negatives of open vented vs. unvented hot water systems, and **Handout 1b**, which involves a diagram about the layout of functional and safety controls on an unvented hot water system. • Learners to complete **Worksheet 2,** involving a series of questions about WRAS, localised/centralised and high/low pressure, using some photos. • Learners to compare and identify typical applications for instantaneous hot water heaters in a centralised and stand-alone environment, and comment on the popular choice of combination boilers. Learners to get into pairs and provide feedback to the class with opinions. (This is preparation for specification options, Topic 2.1.) • Learners to explain in small groups the unique reverse process of a thermal store in comparison to a standard indirect cylinder thermal store. • Group activity in specifying and describing typical applications of combination units. • Tutor to describe localised water heaters **and digital shower** in single occupancy flats or blocks of individual flats, stating advantages and disadvantages. • Tutor-led research on fossil fuels powered existing appliances in the UK used to heat water sources. Learners to		analysing **Handouts 1a** and **1b**, about comparing vented and unvented systems to check knowledge. • Tutor to discuss pipework layouts in **Worksheet 1**, where there are installation issues, and creative thinking; assess how learners can identify the most appropriate way of providing satisfactory solutions.

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Key learning activity/approach	Suggested materials and resources	Skills check
research individually with guidance form the tutor and **present** findings back to the class. • Learners to complete **Worksheet 1.** This could involve learners drawing out a low pressure hot water system suitable for a three-bedroom house, labelling all components and referring to British Standards**.** Once complete, tutor to facilitate a **discussion** regarding different learners' responses to the scenario. • Learners to get into small groups to complete **Worksheet 3**, answering questions about different hot water cylinders, and stating their type and connections; go through answers as a class. • Learners to stay in their groups and tutor to ask questions to each group. The aim is for learners to **generate as many ideas** as possible in response to the specific question and provide feedback to the class as a whole. **Challenge focus:** • More able learners to examine reasons why the government supports renewable energies, and their application to supplement hot water storage heating. Conduct **online research** to find three companies in the UK who make cylinders that can be interfaced with solar energy applications, and write a **short summary** for each one. **Independent learning:** • Download GAH Electrastream user guide (www.gah.co.uk/downloads/GAH-Electrastream-user-guide-installation-instructions.pdf), and identify the differences in how a direct **thermal store** type can heat hot water and radiators. Examine the application of an accumulator in this		

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Key learning activity/approach	Suggested materials and resources	Skills check
situation and write a **short report**.		

Opportunities to develop maths, English, ICT and wider skills:

English:

- **Speaking and listening** skills can be demonstrated in developing the various **discussions** about types of hot water supply system, **giving a point of view**, as well as **allowing** and **responding** to **others' opinions**.
- Learners demonstrate **reading** skills in peer task as they **identify** the **correct information** to answer the comprehension questions about appliance and their functions which are found at home or in the workplace.
- Learners can demonstrate **writing** skills when producing a **report** about identifying differences in how a direct thermal store type can heat hot water and radiators. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used.

ICT:

- Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about identifying differences in how a direct **thermal store** type can heat hot water and radiators.
- More able learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information when examining reasons why the government supports renewable energies.

British values:

- Remind learners about **staying safe online** and raising awareness of the potential risk of radicalisation, as part of the government's '**Prevent strategy**'.
- Remind learners about the **importance** of the **laws of England**, and their **purpose** to **protect citizens** when providing safe, contamination-free and efficient hot water supplies, through the application of Water and Building Regulations by the design of compliant DHW pipework systems within dwellings.

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Session 2: Design temperatures

Suggested Teaching Time: 3 hours

Learning Outcomes: 1. Understand hot water systems and their layout requirements

Learners to identify the recommended design temperatures within hot water systems with consideration of: flow, return, storage and appliance outlet.

Topics: 1.2 – Design temperatures

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to observe temperatures of hot water outlets at home and note any difference between bathroom basin and kitchen sink outlets. Use a temperature measurement instrument if possible. Look at thermostat settings and look to see if there are any TMVs installed. **Make notes** and bring to class. **Active learning:** • Tutor to ask learners about their thoughts regarding the process of hot water temperature ranges at home or at work. • Tutor to present **Presentation 2** on design temperatures within a hot water system, referring to British Standards and Regulations. • Tutor to facilitate a **discussion** with learners about the temperature ranges, and their purpose to prevent microbial growth and protection to prevent scalding: www.hse.gov.uk/healthservices/legionella.htm. • Learners to **split into groups** and **examine** the relationship of the British Standards and Building Regulations with regard to delivery temperature of hot water at outlets. • **Learners to work** in pairs, and **discuss** secondary	**Materials** For the tutor to devise in advance: • **Presentation 2** **Resources** • Computers and hand-held devices • Flip chart • Marker pens	• Tutor can ask learners questions about home and work survey; ask them to explain their thoughts in class. • Check that correct design temperatures have been identified. • Examine responses about microbial growth and proper protection to the public from disease and scalding. • Determine whether learners correctly relate information to relevant standards and regulations. • Identify whether secondary circulation has been understood, and typical example of balancing and control offered during session. • Confirm whether learners know the difference between stored and instantaneous supply of hot water in performance and benefits. • Check awareness of thermal store heating process and temperature control of outlets, plus minimum and maximum temperatures

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Key learning activity/approach	Suggested materials and resources	Skills check
circulation and the relevance of balancing these systems with regard to system temperature control. Note the difference of central heating and bronze circulators. • **Tutor-led discussion** on multi- and single-point appliances, asking learners to identify typical location based on survey at home (pre-learning). • Learners to split into small groups to **discuss** the operational temperature control of **thermal stores**, primary flow and DHW outlet. Identify the reverse principle of indirect cylinders. • **Tutor-led discussion** on TMV and their application to safeguard against scalding, and learners to identify where and when they are required in accordance with G3. • Learners to split into groups for a **brainstorm session.** The aim is for learners to generate as many ideas as possible in response to a legionella control through temperature, cleaning and maintenance with stored hot water. Write up onto a flip chart and **present** back to the class. • Learners to carry out **reflective writing** within **small groups** to refer to the **pre-learning exercise**, and compare notes and images of appliances, temperatures and safety devices identified during the pre-learning survey. • Tutor to ask learners directed questions regarding design temperatures, as a class. **Challenge focus:** • More able learners to get into pairs to attempt to solve water temperature-related problems in a situation set by the tutor.		of primary flows. • Confirm correct specification of TMV, and their purpose in safeguarding against scalding and relevance to regulations. • Lead questions and answers in legionella brainstorm session, and stress the importance of very accurate temperature control and maintenance. • Tutor to check that more able learners provide innovative responses to research that could improve the control and management of water temperature, thereby safeguarding the nation, by asking them questions when feeding back to larger group.

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Key learning activity/approach	Suggested materials and resources	Skills check
Independent learning: • Learners to conduct **online research** to find out the typical location of thermal stores in single-occupancy dwellings. Download manufacturer's literature and compare system components to UV. Write a **short summary** of findings.		

Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about operational temperature control of thermal stores, primary flow and DHW outlet, **giving a point of view**, as well as **allowing** and **responding** to **others' opinions**. • Learners can demonstrate **writing** skills when producing a **reflective writing** about the home survey in the pre-learning exercise Ensure that correct **spelling**, **punctuation** and **grammar** have been applied. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about the typical location of thermal stores in single-occupancy dwellings.	**Employability:** • Learners should have an understanding of the **wider current issues** in the plumbing industry (maintain correct water temperature, solutions to verification of water supplies, etc) from the **brainstorm** session.

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Session 3: System components **Suggested Teaching Time**: 4.5 hours

Learning Outcomes: 1. Understand hot water systems and their layout requirements

By the end of the session, learners should be able to describe the layout and operational requirements of hot water system components, including the location and safety features for unvented/vented hot water systems with consideration of standard components. Learners will also explain the working principles of specialist components used in systems, including:

- infra-red taps
- concussive taps
- combination bath tap and shower head
- flow limiting valve
- spray taps
- shower pumps single impeller
- pressure reducing valves
- shock arresters/mini-expansion vessels
- trace heating alternatives to secondary circulation.

Topics: 1.3 – System components

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to look outside of the classroom environment to **identify** bath shower controls to discover if they are thermostatically controlled, eg learners can check shower rooms at home, gyms or at college to investigate operation of taps (non-concussive) and urinals to see how the flushing system work. Learners should **take photos and videos** of components in operation, and bring them to the session. **Active learning:** • Tutor to show **Presentation 3a** about system components for open vented and unvented systems, and also TMV and trace heating, as per learning outcome. Tutor to then lead a **group**	**Materials** For the tutor to devise in advance: • **Presentation 3a** • **Presentation 3b** • **Handout 3** • **Handout 4** • **Worksheet 4** • **Activity 1a** • **Activity 1b** • **Activity 2**	• Tutor-led discussion on pre-learning exercise; tutor to check and help with identifying and organising information into photo reel sequence or video clip editing. • Group discussion for tutor to confirm accuracy of information and learners' knowledge of typical applications. Relate to pre-learning where appropriate • Check recognition and comprehension through flash card exercise.

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Key learning activity/approach	Suggested materials and resources	Skills check
session discussing the layout of an unvented cylinder, identifying key safety features and their location on a pipework system. • Tutor to give learners **Handout 3** – a diagram on the layout of controls on an unvented hot water system – and **Handout 4**, which should include photos of individual unvented hot water components with arrows showing where on a schematic diagram they are located. • Learners to get into pairs for a **think-pair-share** activity and identify individual components. • Learners to work in groups to complete **Activity 1a and Activity 1b**: a tactile exercise of identifying the purpose of the safety devices using **flash cards.** Create flash cards with function and item for hot water components for **Activity 1a**, and then use actual fittings. Use touch only to explain to the tutor the specific function of the component, stating dimension and orientation (thereby emulating the common hidden tasks of an everyday plumber by locating and identifying hard-to-reach and hidden components). • Tutor-led **discussion** on the methods and purpose of expansion; explore evidence of component operation and failure, and give dimension, function and layout of safety relief discharge pipework. • **Group discussion** about different types of TMV**,** typical applications, temperatures range and common location, referring to the Building Regulations. • Learners to complete **Activity 2**. Use flash cards from **Activity 1a**, and draw hot water systems on a whiteboard for learners to position items correctly. • Tutor to show **Presentation 3b** about infra-red taps, non-concussive taps, combination taps, flow limiters, spray taps, shower pumps, PRV and shock arrestors. Tutor to then lead	**Resources** • Computers and hand-held devices for photos/videos	• Expand option by tactile exercise with components and fittings • Think pair share activity for tutor to confirm correct identification of components. Refer to manufacturer's instructions. • Tutor to assess correct areas of research and information, and case studies relevant to UK market. • Tutor-led discussion where tutor can ask learners questions about terminology, ie upstream and downstream, to confirm understanding. • Check learning recognition by handling components and identifying parts, section, orientation, weight and appearance.

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Key learning activity/approach	Suggested materials and resources	Skills check
a **discussion** about infra-red taps. Learners to explain the typical location and operation principle of this process by using their own photos and information. • Learners to get into groups to discuss the requirements of checking valves to shower mixers and **make a presentation**. Describe energy efficient operation of washbasins spray taps and identify water conservation controls from urinals in college, eg to be identified. Information can be shared in a presentation from pre-learning action survey at home, in videos and photos. • Learners to get into pairs for a **discussion**, identifying shower pumps – either twin or single impeller – in bathroom installation. Some pre-learning references may be used by different learners (Stuart Pumps: www.stuart-turner.co.uk). • Learners to describe the purpose and function of pressure reducing valve and location within a dwelling, eg at entry of house or at appliance, in a tutor-led **discussion.** • Learners to complete **Worksheet 4** individually, answering a series of questions on different types of showers and using some diagrams for identification; then swap with the person next to them for peer review. • **Learners** to use computers to **research online** for shock arrestors and mini-expansion vessels, using the CIPHE guide from the centre's library. They need to describe the problems that they would solve in plumbing installation when feeding back to the class. • Learners to complete set questions in pairs and provide feedback with their experiences from pre-learning survey. **Challenge focus:** • More able learners to solve the problem of water discharge from the safety relief valve, outlining the		

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Key learning activity/approach	Suggested materials and resources	Skills check
necessary rectification. **Independent learning:** • Learners to **read** CIPHE plumbing engineering service design guide manual and **make notes**. They can also turn to the relevant page in their reference books regarding antiseptic qualities of copper and **research** UK manufacturers who are producing copper components to tackle MRSA and infection transmission in hospitals.		

Opportunities to develop maths, English, ICT and wider skills:

English: • Learners to use **reading** skills in the independent learning task to **evaluate** the options given for preventing infection transmission. **ICT:** • Learners have the opportunity to engage in **blended learning** in the research of copper components to combat MRSA task, which makes use manufacturer's instructions and sharing information via email or in the college cloud (Moodle, etc). This is an example of **cloud-based** technology.	**Employability:** • Learners can experience **working in a team** as part of the think-pair-share activity about identifying individual components. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

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Session 4: Safety devices

Suggested Teaching Time: 3 hours

Learning Outcomes: 1. Understand hot water systems and their layout requirements

Learners to describe the function of safety devices used in unvented hot water systems, including:

- control thermostats
- overheat thermostats
- temperature relief valves.

Topics: 1.4 – Safety devices

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to look at thermostats on cylinders at home and on multi-point appliances, and check how they operate. Conduct **online research** to see the operating function and location of safety devices on UV appliances, and compare to thermal store units. Can use the following websites to assist with research: www.heatraesadia.com and www.gah.co.uk/downloads/GAH-Electrastream-user-guide-installation-instructions.pdf. **Active learning:** • Tutor to show **Presentation 4** on safety devices on an unvented hot water system, and ask learners to split into groups to **discuss** location and temperature range of safety devices. • Learner to **discuss in groups** the contents of **Handout 5**. This may include a list of all required temperatures, as per Regulations G, with a photo of each safety device and their associated temperature. • **In pairs**, learners need to examine and define the first tier of UV safety temperature range and operation sequence of	**Materials** For the tutor to devise in advance: • **Presentation 4** • **Handout 5** **Resources** • Safety components	• Appropriate location of safety controls, their function and operating temperatures can be verified by the tutor through a group discussion with learners, highlighting key points for each type in relation to **Presentation** and **Handout**. • Tutor to check whether learners can identify first tier of safety and performance requirements of control thermostat in relation to zone valve and energy source. • Tutor to check whether learners identify second tier of safety and temperature range of energy cut-off thermostat in the control system. • Check that learners, in pairs, identify the purpose, function and location on appliances of third tier of safety, stating different methods of operation. • Check whether learners can identify features and operational range of

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Key learning activity/approach	Suggested materials and resources	Skills check
control thermostat in relation to zone valve and function of energy source developing within the filters. • **Group discussion** to identify the second tier of safety TRV and temperature range, and function of energy cut-off thermostat in the control system**.** Tutor to ask learners how it differs from the first tier of control. • **Learners to work in pairs** to state the purpose and function of third tier of safety, naming its temperature range and location on appliances**.** Tutor to ask learners how it differs from the first and second tiers of control. Monitor progress and offer feedback where appropriate. • **Tutor-led discussion** of features and operational range of thermostats on immersions heaters on hot water systems. Discuss the need for those competent to carry out dead tests during functional testing. • **Learners in groups** to examine and handle independent safety components, giving descriptions and purpose of each when discussing and providing feedback to others in class. • In pairs, learners to answer related questions**.** Feed back answers to class as tutor goes through the answers. **Challenge focus:** • More able learners to examine potential outcomes of incorrectly attached thermostat on a cylinder and write a **report** to a client, explaining them. Present back to the class for a question and answer session. **Independent learning:** • Learners to **investigate** the potential dangers in the safety components' malfunction and if they are incorrectly installed or bypassed, and write a **short report**.		thermostats on immersions heaters. • Tutor can evaluate the general range of learners' knowledge by marking their responses to examining actual safety devices • Tutors can effectively question learners on the safety devices.

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Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills can be demonstrated in developing the **discussion** during the components' tactile examination sessions by **giving a points of view**, as well as **allowing** and **responding** to **others' opinions** in class. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about the operating function and location of safety devices on UV appliances.	**Employability:** • Learners should gain an understanding of the **wider** hot waters appliance **industry** when they are introduced to the **range of job roles** during the managing of safety devices on unvented installations.

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Session 5: Factors affecting hot waters systems

Suggested Teaching Time: 3 hours

Learning Outcomes: 2. Use design techniques for hot water systems

Learners to describe the factors which affect the selection of hot water systems for dwellings, with consideration of:

- customer needs
- building layout and features
- energy efficiency
- environmental impact
- occupancy and purpose
- appliance location
- cost
- storage type and location
- legislation.

Topics: 2.1 – Factors affecting hot waters systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to conduct **online research** about the environmental impact of specifying fossil fuel heat sources and the options offered as solution by appliance manufacturers. **Active learning:** • Tutor to show **Presentation 5** about safety factors affecting hot water systems. Tutor to lead a **discussion** on customers' needs, highlighting the importance of cost-effectiveness, regulations, manufacturer's options and environmental impact when selecting appliances. • Learners to **get into pairs**, and **explain** building layout and features to each other. Identify the building fabric, joist depth, pipe runs and appliance location in relation to plans, noting the scale of drawing.	**Materials** For the tutor to devise in advance: • **Presentation 5** • **Worksheet 5** **Resources** • Interactive whiteboard	• Tutor to verify learners' answers and range of their responses during discussions in class. • Tutor to check learners' answers in the think-pair-share activity by reviewing their notes and asking questions when feeding back to class. • Check quality of responses in relation to environmental impact of product selection. Learner to individually explain reason for selection. • Examine depth of knowledge in regulation application and ErP effect on industry.

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Key learning activity/approach	Suggested materials and resources	Skills check
• Learners to get into groups and **discuss** environmental impact relating to selection of appliances; identify innovative components for installation and explain their decisions. • Learners to get into pairs for the **think-pair-share** activity about components' environmental impact in relation to regulations and manufacturer's technical support. They must write down what they think about the **new ErP** standard and provide feedback to the class. They can use the Spec pro specification tool to help: www.heatraesadia.com/products, as well as the Energy-related Products (ErP) Directive 2009/125/EC: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125. • **Tutor-led discussion** on energy efficiency and regulations relating to installation. Importance of compliance with Part L; learners to identify key points regarding information to be shared with customer notification to BCO. www.planningportal.gov.uk • Learners to individually complete **Worksheet 5**. This may include a list of areas from the **Presentation** for learners to expand on, outlining key points to be considered. Once completed, learners to **discuss** their findings in small groups. • Learners to individually complete questions from **Presentation 5**, and tutor to run through answers as a class. • Learners to read through printed presentation and notes throughout the session, and answer question. **Challenge focus:** • More able learners to download ErP labelling information from manufacturer's website and identify the purpose of a product fiche, and how it would impact on the installation of an unvented cylinder: www.heatraesadia.com/products.		Learners to identify new standards and explain their importance for industry in the UK. • Ask learners about how they would communicate with BCO regarding energy efficient appliances and their individual selections shared in class. • Tutor to check more able learners' understanding in Challenge focus regarding ErP.

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Key learning activity/approach	Suggested materials and resources	Skills check
Independent learning: • Learners to get into pairs and conduct **online research** into retailers, creating a **leaflet** that provides advice on environmental products, finding the clearest and most helpful price, and ErP labelling and product package strategy for the customer and installer.		

Opportunities to develop maths, English, ICT and wider skills:

English: • Learners can demonstrate **writing** skills when producing a **leaflet** about environmental products and ErP labelling. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about advice on environmental products.	**Employability:** • Learners can experience **working in a team** as part of **Worksheet 5** group task when discussing their answers. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately, by presentation and sharing of designs and other ideas.

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Session 6: Information sources

Suggested Teaching Time: 3 hours

Learning Outcomes: 2. Use design techniques for hot water systems

Learners to identify and use information sources that should be referred to when designing hot water systems, including:

- statutory regulations
- industry standards
- manufacturer's technical instructions
- verbal and written feedback from the customer
- plans.

Topics: 2.2 – Information sources

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to access: www.planningportal.gov.uk/buildingregulations to read approved document G3 in relation to hot water services within a dwelling. **Active learning:** • Learners to identify information sources when undertaking design of hot water systems, such as planning in accordance with statutory regulations, industry standards, manufacturer's technical instructions, and verbal and written feedback from the customer, from **Presentation 6** on information sources. • Tutor to give out **Handout 6**, showing a Benchmark vented cylinder commissioning certificate example. • Learners to identify and itemise the relevant Building and Water Regulations and industry standards as quickly as possible, individually. Tutor to ask learners to relate these to itemised areas of work that need to be assessed in the building layout by survey to prepare for effective planning based on customer's initial discussion.	**Materials** For the tutor to devise in advance: • **Presentation 6** • **Worksheet 6** • **Handout 6** **Resources** • Interactive whiteboard • www.opsi.gov.uk/si/si1999/19991148.htm	• Tutor to confirm the accuracy of feedback from learners by reviewing clear and relevant examples of how to research each topic. • Tutor to check learners' thoughts by monitoring discussions during the brainstorm task. • Tutor to verify access methodology and identification of five major reasons for Water Regulation. • Tutor to assess learners' awareness of the important link of Part L to Unit 335, by asking questions. • Tutor to monitor learners' progress during group discussions by observing, and asking and answering questions. • Tutor to check that learners use correct

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Key learning activity/approach	Suggested materials and resources	Skills check
• Learners to get into small groups to **brainstorm.** They should **discuss** the importance of discovering customers' needs and how to interpret that into a particular job, with regard to initial survey, **plans and scale, work planning** and advising on potential changes to schedule. They should then give examples of how they would begin to discover customers' needs and effectively deal with their feedback. • Learners to pay special attention to plans, scale and detail supplied in respect of proposed work. Learners to **make notes** on common scales used on site prep for synoptic assignment. • Learners to revisit the water regulation requirements and recall the reason for their application to building design. • Learners to identify manufacturer's literature and industry standards relating to installation, including the legal requirements and the customer's preferences, thus identifying specific appliance performance capability. • Learners to get into pairs and explain how to commission and notify **planned work** on an appliance and pipework and component performance; in addition, assess the environmental impact of any new planned system in relation to Part L 1 of the Building Regulations. • Learners to get into pairs to **brainstorm** about the types of customer communication, the advantages of each method and dealing with customers' feedback, before feeding back to the class. • Learners to perform a **role play** to show the best way to communicate with customers through effective feedback, answering technical questions in a clear and knowledgeable way. • Learners to complete questions in pairs, and tutor to go through answers at the end of the session.		online tools to research cylinder location and associated pipework in an accurate and specific way. • Tutor to observe learners' role play, and offer feedback and suggestions where appropriate. • Tutor to check responses to **Worksheet 6.** • Tutor to confirm accuracy of learners' responses to quiz questions. • Tutor to assess design and comment on practical application of the Challenge focus exercise.

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Key learning activity/approach	Suggested materials and resources	Skills check
• Tutor to **discuss** the technical preference of a specified appliance in relation to the outcome of a survey of a dwelling or property. Learners to conduct **online research** or use an app to find clear and user-friendly manufacturers' literature which makes information easy to understand for the customer. • Learners to complete **Worksheet 6** on planning work, individually. This may include a table to get learners to list out other trades and their relationship with a plumbing installation; provide feedback in a group **discussion** with tutor input. **Challenge focus:** • More able learners to **plan** and **design** the installation of pipework and fittings to a hot water storage vessel on the first floor of a single-occupancy building. Draw on a sheet of paper and label components. Research design options for pipework and location from manufacturer's literature, eg www.heatraesadia.com. **Independent learning:** • Learners to conduct **online research** by using the Heatrae Sadia webpage and enrol on Spec pro to download design calculation tools.		

Opportunities to develop maths, English, ICT and wider skills:

English: • Learners demonstrate the **writing** skills in letter and emails **when communicating** in **feedback from customer exercise** task. • **Speaking and listening** skills can be demonstrated in a role play	**Employability:** • Learners show an understanding of the **wider** aspects of the **industry** when they are introduced to the **range of job roles** during the clear planning in the brainstorm session, by referencing

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discussion when communicating with a customer by **giving an opinion or offering a solution**, as well as **allowing** and **responding** to **customer preferences and their opinions** about a job.	manufacturer's information, and Building and Water Regulations. • Learners demonstrate they can **actively listen** to a customer during their feedback, **understand** what has been said and **respond/act** accordingly by offering solution or showing flexibility in responding to their request. Learners should be encouraged to use techniques to ensure that they understand the commercial benefits to a company of polite and professional communication with customers.

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Session 7: Calculating system requirements

Suggested Teaching Time: 4.5 hours

Learning Outcomes: 2. Use design techniques for hot water systems

Learners to calculate hot water system requirements for single occupancy dwellings and select hot water components in accordance with design calculations system requirements, including:

- storage requirements
- expansion
- pipe size
- pump size
- components, storage vessels, pipes, pumps, expansion vessels, safety devices and booster pumps.

Topics: 2.3 – Calculating system requirements

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to join 'Copper Club' at Copperplumbing.org.uk for students. Read the sessions on installation. **Active learning:** • Tutor to show **Presentation 7** about calculating the size of hot water system requirements, storage, expansion, pipe size and pump size. • Tutor to download and print off the leaflet from UK Copper Board and hand it out to learners: http://copperplumbing.org.uk/node/558. • Tutor to lead a **discussion** on British Standards BS 6700, BS EN 806 and 8558, and their relevance to calculating hot water requirements in buildings. • Learners to complete a **think-pair-share activity.** They will need to determine suitable pipework diameter for distribution pipework to calorifier on indirect system and consider the	**Materials** For the tutor to devise in advance: • **Presentation 7** • **Handout 7** • **Worksheet 7** **Resources** • Pen • Pencil • Plain drawing paper • Rule • Set square	• Tutor to verify feedback from learners, giving details about the superseded BS 6700 still being relevant for: testing, flushing and disinfection of new systems. • Tutor to check learners' knowledge of UK Copper Board design information (see link). • Tutor to check for evidence of accurate drawing and proof of correct calculation. • Tutor to observe learners during think-pair-share activity and review their opinions when discussing the outcomes. • Tutor to check learners' understanding during group discussions, by asking and answering questions.

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Key learning activity/approach	Suggested materials and resources	Skills check
diameter required for a direct system, such as for a multi-point or combi. Write down thoughts and provide **feedback** to the class. • Tutor to facilitate a **group discussion** by explaining the meaning of effective and equivalent length of pipe. Ask learners to give a typical situation where this information would be important and provide feedback within groups. • Tutor to lead a group **discussion** on pressure loss across the hot water system and at terminal fittings. Learners to make notes in preparation for operation testing in workshop. • Tutor to ask learners to **work out** capacity for a CWSC within a dwelling which has a hot water cylinder and one which provides cold water only. **Discuss** likely usage for a dwelling and diversity factor for different requirements, eg young family of four or two single persons. Refer to BS 6700. • Tutor to give learners **Handout 7**, depicting tables from BS 6700: hot water storage and usage, and facilitate a **discussion** on bronze (and stainless steel) circulators. • Learners to provide feedback to the class, stating typical installations, location, purpose and correct sizing methods. For calculation tools and more information on the topic see: http://productfinder.wilo.com/en/GB/productrange/000000090003cafe00040023/fc_range_description/ • Tutor to ask the class to watch a **video** about centrifugal force on a rotating water container (www.youtube.com/watch?v=Zip9ft1PgV0); then ask learners to **present** information key required with script. • Ask learners to respond to key features in the video and performance criteria between the types of pumps, stating the application and the problem they overcome. Ask learners if they agree with the manufacturer's claims at the end of	• BS EN 8558 • BS EN 806 • BS 6700 • CIPHE design guide	• Ensure that learners have full understanding of effective and equivalent length of pipe through individual questioning. • Verify the effect of pressure loss in relation to outlet fittings and pipe size, etc. • Assess correct methods used to calculate cylinder size. • Check understanding of bronze circulators in secondary circulation. • Assess think-pair-share activity regarding the application of booster pumps. • Check calculation required for booster pump selection and for negative head applications. • Comment on brainstorm session and lead discussion to assess the information that learners provide on the range of applications of pressure vessels. • Tutor to check more able learners' understanding of what is being asked of them in the Challenge focus activity. • Tutor to check learners' answers for **Worksheet 7**.

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Key learning activity/approach	Suggested materials and resources	Skills check
session. • Learners to complete a **think-pair-share activity** and **make notes** to feed back to the group about reasons why booster pumps should be specified in cistern-fed indirect systems. Explain different application and calculation method for different head pressures. • **Group discussion** on calculating negative head and use of pressure vessels on pumps. Refer to pump selector tab on the following link and complete exercise to find the right pump: www.salamanderpumps.co.uk. • Learners to brainstorm examples of different types of pressure vessels and what they are used for in domestic hot water systems. Groups should write their examples on Post-it notes and add them to the whiteboard to stimulate a wider group discussion. • Learners to complete **Worksheet 7** individually. This may include using various scales, with questions about dimensions and lengths, greater details and larger areas, etc. Learners to give it to the tutor to mark. **Challenge focus:** • More able learners to attempt questions about calculating a customer requirement for a specific design. **Independent learning:** • Learners to get into pairs to devise a method of commissioning a system. They should itemise ways in which they could record and verify their information by writing up a **short report**.		

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Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **presenting** can be developed during the brainstorm task about different types of pressure vessels. Learners to use the **correct format** with an **introduction**, **supporting evidence** and **statements**, and **conclusions**. They should adapt the content to **suit the audience** and **purpose**. **Maths:** • Learners will need to **calculate capacity** in a plumbing context, as part of the CWSC task. • Learners will have to **record**, **organise** and **present the data** about commissioning in a **suitable format** to draw useful **conclusions** regarding recording information, as part of writing a **short report** about devising a method of commissioning a system.	**Employability:** • Learners should gain an understanding of **customer expectations** and be able to explain them as a result of offering solutions to technical requests (Challenge focus). They should have an idea of how to **listen to** and **meet customer demands**, as well as deal with those who are **dissatisfied with suggested outcomes of research**.

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Session 8: Installation requirements

Suggested Teaching Time: 3 hours

Learning Outcome: 2. Use design techniques for hot water systems

Learners to identify hot water system installation requirements to ensure adherence to current legislations, including:

- pipe location
- supply pressures
- secondary circulation
- insulation
- temperature control
- outlet requirements
- safety relief pipework.

Topics: 2.4 – Installation requirements

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to create their own **dictionary** of plumbing with definitions, notes and photos, and even video, with the aim to collaborate with others to produce a definitive reference guide. This can be an ongoing exercise throughout the rest of the course. Post the dictionary on the centre's VLE/Moodle and present to other learners when appropriate in sessions. **Active learning:** • **Learners to get into pairs** and describe pipework requirements for single occupancy dwellings, highlighting the importance of correct size, location, insulation, adequate clipping and design temperature performance recommendations in BS 6700. • Tutor to show **Presentation 8** on installation requirements: legislation, location, pressures, secondary circulation, insulation, temperature control, outlets, safety control, etc.	**Materials** For the tutor to devise in advance: • **Presentation 8** • **Handout 8** **Resources** • Interactive whiteboard • WRAS guide	• Tutor to check learners' dictionaries for accuracy by reviewing Moodle activity and commenting where appropriate. • Tutor to check accurate feedback from learners and that they give clear and relevant examples in group discussions. • Tutor to check learners' examples of dynamic and static pressure. • Assess whether pairs of learners offer clear descriptions of pipework requirements. • Tutor to check that learners' feedback is accurate, with clear information, in mind map presentation. • Tutor to check that learners confirm with details the importance of correct

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Key learning activity/approach	Suggested materials and resources	Skills check
• Learners in **groups** to **explain** the purpose differences between static and dynamic pressure in hot water systems. • **Tutor-led discussion** on secondary circulation; learners to take notes and include in portfolio/dictionary. • Learners to get into small groups to **discuss** and draw a **mind map** of their thoughts about insulation application on hot water pipework, stating its value of protection and keeping the system efficient. Learners to feed back their **mind maps** to the class. • Tutor to lead a **discussion** on temperature control of hot water. Learners to identify: the ranges when safety devices operate to prevent maximum temperature of 100°C ever being reached in a domestic hot water system; the storage temperature of hot water in a cylinder and minimum circulating temperatures and delivery times; and instantaneous water heater performance ranges and temperature rises from cold. • **Learner to work in pairs** to determine temperature at outlets on a hot water system in accordance with BS 6700. Include TMV location and purpose to comply with Building Regulation **G3**. • Group **discussion** to describe key features about safety relief pipework, material and components, and check for blockages and termination of pipework in accordance with the Building Regulations approved document G3. • Tutor to give learners **Handout 8**, a diagram of D1 and D2 layout and dimensions. • Learners to complete questions in pairs, eg 'Where would you fit insulation on an unvented cylinder?', and tutor to go through answers at the end of the session. **Challenge focus:** • More able learners to attempt additional questions,		specification of temperature control. • Tutor to ensure that learners, in pairs, give explanation on hot water outlets and application of TMV. • Check learners' responses from group discussion on important details of safety relief pipework. • Tutor to check learners' responses to questions they answered in pairs. • Tutor to ensure that more able learners provide credible and workable solutions to additional questions.

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Key learning activity/approach	Suggested materials and resources	Skills check
specifying a cylinder in a large dwelling and solving existing circulation problems. **Independent learning:** • Learners to **research** manufacturer's commissioning procedures, and identify key information and performance exercises required to test installation in a **short report**.		

Opportunities to develop maths, English, ICT and wider skills:

English: • Learners can demonstrate **writing** skills when producing a **short report** about testing installation. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used. **ICT:** • Learners have the opportunity to engage in **blended learning** in the plumbing dictionary task, which makes use of the centre's Moodle. This is an example of **cloud-based** technology.	**Employability:** • Learners can experience **working in a team** as part of the insulation application mind map exercise. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

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Session 9: Visual inspections (workshop session) **Suggested Teaching Time**: 6 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners will carry out visual inspections, interpreting relevant information sources required to complete commissioning.

Topics: 3.1 – Visual inspections

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Revision of installation requirements, and modification and rectification notes in Topic 2.4. Learners to read manufacturer's instruction for appliances and components to be commissioned. Plan sequence and approach to activities in workshop. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. **Discuss** what is required to work safely and in an organised way in accordance with Building Regulations and British Standards. • Tutor to show **Presentation 9 – Part 1** about commissioning systems: visual inspections. • Tutor to **demonstrate** to learners how to carry out methods of visually inspecting hot water systems and components. • Learners to use manufacturer's instructions and industry standards, Water Regulations and Building Regulations to establish the diagnostic requirements of hot water system components. • **Prepare** plan for individual task and risk assess the area. • Tutor to lead a **discussion** about how to carry out visual inspections and inspect appliances in a hot water system, using **Handout 9.** This will outline a list of factors to be aware	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 1** • **Handout 9** **Resources** • BS EN 8558 • BS EN 806 • BS 6700 • Water Regulations • WRAS guide to water regulations • Building Regulations Approved Document G1, G2, G3 • CIPHE design guide • Manufacturer's instructions	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during demonstration and discussion by asking questions and ensuring that they know what's required of them in the workshop task. • Tutor to ensure effective communication during workshop activity. • Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions.

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Key learning activity/approach	Suggested materials and resources	Skills check
of when carrying out a visual inspection. **Workshop:** • Introduce and identify (ID card) yourself to the client (tutor); notify them about the work to be carried out, and advise them about safety and interruption of supplies. Give expected duration of work and expected outcomes. • Walk around the installation, and check that the installation is **correctly located** and meets industry standards. • Check that all **open ends** are capped off and that all valves are isolated, and ensure that **capillary joints** are soldered and that all **compression** joints are fully tightened. • Inspect sufficiency of **pipe clips**, supports and brackets; also check that they are installed correctly and that all pipework is secure. • Check that all the **equipment** – expansion vessels, tundishes, zone valves, expansion relief and temperature relief valves, strainers, pressure reducing valves, boosting pumps, float switches, accumulators, etc – are installed correctly and that all **joints** and unions on and around the equipment are **watertight.** • Ensure that cisterns and tanks are **supported** correctly and that float-operated valves are provisionally set to the correct water level. • Check **insulation** requirements: 1 metre from appliance minimum. • Check that appliance **isolation valves** and taps are turned off. They can be turned on and tested when the system is filled with water. • Survey to see if **underground services** (scenario) have been installed; check that any pipework is at the minimum depth required by the Water Supply (Water Fittings)	**For workshop appliances** • Unvented and open vented cylinders installations • Combination boilers • Multi- and single-point appliances • Electric point of use appliances • Under and over sink units • Thermal store • Booster pumps set • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • pH meter or litmus test paper • Tools	

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Key learning activity/approach	Suggested materials and resources	Skills check
Regulations. • Learners need to ensure that when visually inspecting on-site, the building inspector and water undertaker are given the opportunity to view and inspect the installation, preferably before it is tested and commissioned, to ensure that the Water Supply (Water Fittings) Regulations have been complied with. Any remedial work pointed out by the water inspector can then be completed without the need to drain the system. **Challenge focus:** • More able learners to conduct **online research** into the manufacturer's lettering on temperature and expansion relief valves to confirm the purpose of an unvented cylinder. **Write a short summary** about the range printed on the component badges and comment on the types of TRV and PRV used on larger and smaller systems. Provide feedback in tutorial and upload to Moodle. **Independent learning:** • Learners to download the warning label required for unvented cylinder during installation and find out details that are required to be recorded there. **Discuss and feedback in next session**.	• Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	

Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor.	**British values:** • Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out diagnostic and successful repair processes to the required British Standards through study and

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ICT: • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	personal research. • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners can show **resilience** by sticking to the testing process throughout the workshop session even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging**.

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Session 10: Filling and venting systems (workshop sessions) **Suggested Teaching Time**: 7.5 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners will fill and vent hot water systems with water at normal operating pressure and check for leakage.

Topics: 3.2 – Filling and venting systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to read manufacturer's instruction for appliances and components to be filled and vented. Plan sequence and approach to activities in advance of the workshop session. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to the upcoming workshop activities. **Discuss** what is required to work safely and in an organised way in accordance with British Standards • Tutor to show **Presentation 9 – Part 2** about filling and venting a system. • Learners to prepare plan for individual task, risk assess the area and carry out filling of system in hot water system, as previously discussed, using **Handout 10.** This will outline a list of factors to be aware of when carrying out a filling and venting procedure. **Workshop:** • **Fill** installation with fluid category 1 water directly from the water undertaker's mains cold water supply. • Fill in **stages** so that the filling process can be managed comfortably.	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 2** • **Handout 10** **Resources** • BS EN 8558 • BS EN 806 • BS 6700 • Water Regulations • WRAS guide to water regulations • Building Regulations Approved Document G1, G2, G3 • CIPHE design guide • Manufacturer's instructions	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during the workshop session and discussion by asking questions and ensuring that they know what's required of them in the workshop task. • Tutor to ensure effective communication during workshop activity. • Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions.

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Key learning activity/approach	Suggested materials and resources	Skills check
• Check for **leaks and** when learners have established that the stage is **leak-free,** they should fill the next stage. When filled, allow **stabilisation** and isolate FOV. • Learners to ensure that the system is at a **normal temperature**, check for **leaks** and **check airlocks** from cistern-fed supplies. • Inspect joints on cylinder and wipe away any **condensation** before re-inspecting. • **Fill cisterns** to capacity and then open gate valve to avoid airlocks. • Check whether the **full pressure** of the water is available and that the pipes are running at full bore. **Challenge focus:** • **Discuss and provide feedback** during the learner group session in tutorial. Discuss the reason for the formation of condensation during fill-up, and how to confirm it is not caused by water, ie a leak. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learners' **plumbing dictionary and personal course portfolio** for the tutor to review.	**For workshop appliances** • Unvented and open vented cylinders installations • Combination boilers • Multi- and single-point appliances • Electric point of use appliances • Under and over sink units • Thermal store • Booster pumps set • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • pH meter or litmus test paper • Tools	

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Key learning activity/approach	Suggested materials and resources	Skills check
	• Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	

Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed when discussing learner plans/approaches to the upcoming workshop activities. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners can show **resilience** by sticking to the testing process throughout the workshop session even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging**.

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Session 11: Soundness testing (workshop session) **Suggested Teaching Time**: 7.5 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners conduct soundness tests on different types of hot water systems, including metal and plastic pipework and components.

Topics: 3.3 – Soundness testing

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to plan sequence and approach to activities in advance of the workshop session. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. **Discuss** what is required to work safely and in an organised way in accordance with British Standards. • Tutor to show **Presentation 9 – Part 3** about soundness testing procedures. • Tutor to give out **Handout 11** about soundness testing procedures. This will include requirements of the regulations and factors to consider when preparing. Learners to also use Water Regulations, manufacturer's instructions and industry standards. • **Prepare plan** for soundness task and **risk assess** the area, eg test hydraulic pump. • Tutor to **lead a discussion** with learners about agreeing a working pressure of the installation. This needs to be tested and apply the formula 1½. Working pressure to determine test pressure.	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 3** • **Handout 11** **Resources** • BS EN 8558 • BS EN 806 • BS 6700 • Water Regulations • WRAS guide to water regulations • CIPHE design guide • Manufacturer's instructions	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during discussion by asking questions and ensuring that they know what's required of them in the workshop task. • Tutor to ensure effective communication during workshop activity. Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to review learners' progress.

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Key learning activity/approach	Suggested materials and resources	Skills check
Workshop: • Introduce and identify (ID card) yourself to the client (tutor); notify them about the work to be carried out and advise them about safety risks of pressure testing, the possibility of blast and the potential hazards of high-velocity missile formation due to pipe fracture and fitting failure. • Learners to **prepare test**, and give client an **expected duration** of the work and expected outcome. • **Walk around** the installation to ensure that there are no plastic components on the metallic pipework installation. • Check that the test to be used is **appropriate for the service of the building** and meets industry standards. • Check requirement to **divide** the vertical pipework into **sections** in the case of a multi-storey installation (scenario). Ensure that it will not leave **pockets of water** that might cause frost damage or corrosion later. • Confirm all valves and equipment can **withstand the test** pressure. If not, remove and install temporary pipework • Confirm if there are **enough operatives** available to conduct the test safely • Assess whether different services are to be **interconnected** as a temporary measure to enable simultaneous testing. • Assess **how long** it will take to fill the system using the available water supply and when to start the test. • Check that the **high points** of the system have an **air vent** or a tap to help with the **removal of air** from the system during the test. These should be closed to prevent accidental leakage. • Blank or **plug any open ends** and isolate any valves at the limit of the test, where the test is being conducted in stages. • Remove any **vulnerable equipment** and components, and	**For workshop appliances** A range of the following: • Unvented and open vented cylinders installations • Combination boilers • Multi- and single-point appliances • Electric point of use appliances • Under and over sink units • Thermal store • Booster pumps set • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator **For test instruments** • Hydraulic pressure test pump • Flow jug or gauge • Pressure gauge	

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Key learning activity/approach	Suggested materials and resources	Skills check
install temporary piping. • **Carry out test** on **copper or low carbon steel pipes. Open the valves** within the section to be tested. • Check that the **test pump is working** correctly, and that the pressure gauge is calibrated and functioning correctly. • **Attach the test pump** to the pipework and install extra pressure gauges if necessary. Check that a **suitable hose** is available for draining-down purposes. • **Release air** from the high points of the system or section and completely fill the system with water. Ensure that the **system is full** and free of air. • When the pressure shows signs of rising, stop and **visually check** the route of the section under test. **Listen** for any sounds of escaping air and visually check for any signs of leakage. • **Pressurise** to 1½ times the (specified) normal operating pressure (1.5 times normal operating pressure or 50% above normal operating pressure). Check to see **if the pressure falls**; check that any isolated valves are not passing water and visually check for leaks. • Leave the system for a period of **30 minutes** to allow for temperature **stabilisation** and then for a further period of **one hour** with no visible pressure loss. • Once the test has **proved that the system is sound**, it should be witnessed and a signature obtained on the **test certificate**. • When the pressure is released, open any air vents and taps to atmosphere before **draining down** the system. • Re-fit any **vulnerable pieces of equipment**, components and appliances. • **Carry out tests A and B on Elastomeric (plastic polybutylene) pressure pipe systems:**	• Calibrated multimeter • pH meter or litmus test paper • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	

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Key learning activity/approach	Suggested materials and resources	Skills check
1. **Test type A:** Follow the same **preparation and system check** as for copper and rigid pipe for both tests. **Slowly fill** the system with water and raise the pressure to **1 bar (100Kpa).** • Check and **re-pump** the pressure to 1 bar if the pressure drops during this period, provided there are **no leaks**. • **Check for leaks**. After **45 minutes**, **increase** the pressure to **1.5** times the normal operating pressure and let the system stand for **15 minutes**. • **Release** the pressure in the system to **one-third** of the previous pressure and let it **stand** for a further **45 minutes**. Confirm that the **test is successful** if there are no leaks. • Once the test has **proved that the system is sound**, it should be witnessed and a signature obtained on the **test certificate**. 2. **Test type B** • **Slowly fill** the system with water and pump the system up to the required pressure. Maintain the pressure for a period of **30 minutes** and note the pressure after this time. Continue with **no further** testing. • Check the pressure after a further **30 minutes.** If the pressure loss is **less than 60Kpa (or 0.6 bar),** the system has **no visible leakage**. • Visually check for leakage for a further **120 minutes**. The test is **successful** if the pressure loss is **less than 20Kpa (0.2 bar).** • Once the test has **proved that the system is sound**, it should be witnessed and a signature obtained on the **test certificate**.		

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Key learning activity/approach	Suggested materials and resources	Skills check
Challenge focus: • **Discuss and provide feedback** during learner group session in tutorial. Identify a process of carrying out separate soundness testing procedures for a gas fired multi-point in one part of a dwelling and one for an unvented cylinder in another area. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learners' **plumbing dictionary and personal course portfolio** for the tutor to review.		

Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners can show **resilience** by sticking to the testing process even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging**.

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Session 12: Flushing systems (workshop session) **Suggested Teaching Time**: 7.5 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners will learn how to flush hot water systems, specifying flushing systems for new and existing hot water systems.

Topics: 3.4 – Flushing systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to plan sequence and approach to activities in workshop. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. • **Discuss** what is required to work safely and in an organised way in accordance with British Standards. Consider the environment regarding chemical and discharge notification to the local water undertaker. • Tutor to show **Presentation 9 – Part 4** about flushing and disinfecting systems. • Tutor to give out **Handout 12** about requirements to consider before carrying out the flushing and disinfection procedure. Learners to get into pairs and prepare plan for the flushing and disinfection task, whilst risk assessing the area. • Tutor to lead a **discussion** about agreeing safe procedure to flush and disinfect. Learners to read **COSHH data sheets** on chemicals before workshop activity. (Data sheets should be visible on the containers/leaflets of the chemicals and should be kept in a file on site or in a designated area in the college or training centre.)	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 4** • **Handout 12** **Resources** • BS EN 8558 • BS EN 806 • BS 6700:1997, clause 3.1.10.1 • Water Regulations • WRAS guide to water regulations • CIPHE design guide (disinfection) • Manufacturer's instructions	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during discussion by asking questions and ensuring that they know what's required of them in workshop task. • Tutor to ensure effective communication during workshop activity. Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions. • Tutor to engage with research on application of biocide, contamination in plastic pipework, and the issue of scale

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Key learning activity/approach	Suggested materials and resources	Skills check
Workshop: • Introduce and identify (ID card) yourself to the client (tutor); notify them about work to be carried out, and advise them about safety risks of human contact with chemicals and dangers to wildlife. • Learners to prepare for flushing. Walk around the installation to **survey individual pipe runs**, and give the client an **expected duration** of the work and expected outcome. • Check that **cisterns** are filled with clean water and that pipework is connected to undertaker's main to **fill break cisterns** on boosted cold water systems. • Carry out flushing to **every length of pipe** to remove debris, flux and swarf. • Before disinfection, learners to risk asses the area. Tutor to explain **disinfection process** using chlorine and highlight all risks to associated staff/persons present in the building. Ensure that **no other household chemicals** such as bleaches come in contact with the process. **Post notices** that state: 'Disinfection in process: Do Not Use' at all outlets and any points of risk of water being drawn off. • Calculate **cistern, appliance, storage vessel and pipework volume**, and apply **chlorinated water** to the system via the cistern. **Measure** concentration of chlorine; ensure minimum of **50ppm** in water**.** Check chlorine level at the end of the test period (1 hour +); **30ppm minimum at furthest outlet.** • **Inform local water undertaker** or the Environment Agency if test water to be discharged directly into a water course or drain. • **Drain** pipework system, and f**lush** with clean water until the free residual chlorine content is no more than that in the water undertaker's mains cold water supply. • Complete the **disinfection record paperwork**, hand over to	**For workshop appliances** • Unvented and open vented cylinders installations • Combination boilers • Multi- and single-point appliances • Electric point of use appliances • Under and over sink units • Thermal store • Booster pumps set • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • pH meter or litmus test paper	and bacteria.

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Key learning activity/approach	Suggested materials and resources	Skills check
the person in charge and **remove signs**. **Challenge focus:** • More able learners to research the application of biocide and if any different contamination problems can occur with plastic pipework and scale build-up in appliances. **Discuss and provide feedback** during **learner** group session in tutorial or upload onto Moodle. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learner's **plumbing dictionary and personal course portfolio** for the tutor to review.	• Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheets **For test instruments and special equipment/materials** • Sterilisation chemicals • Chlorination testing kit • Tools • Materials/sterilisation chemical/ chlorine • PPE, eg gloves, goggles, face mask, plastic apron, long-arm gauntlets • Practical portfolio • Pens and paper • Warning notices	

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Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners are able to prove their **decision-making** skills during the disinfection process to ensure that public health is not put at risk by the correct volume of chemical being applied and its safe and efficient disposal. • Learners can show **resilience** by sticking to the testing process throughout the workshop session even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging**.

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Session 13: Operational checks (workshop session)

Suggested Teaching Time: 7.5 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners will carry out operational checks required during commissioning, including: temperatures, flow rate, pressure, balancing, electrical controls, mechanical controls and functional testing.

Topics: 3.5 – Operational checks

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to plan sequence and approach to activities in the workshop. Read manufacturer's instruction for appliances and components. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. • **Discuss** what is required to work safely and in an organised way in accordance with BS 8000. Carry out operational checks on water systems or components to ensure correct performance in accordance with manufacturer's instructions and industry standards. **Prepare plan** for individual task and risk assess the area • Tutor to show **Presentation 9 – Part 5** about operational checks. • **Tutor to lead a discussion** about carrying out operational checks in accordance with tutor brief/scenario discussion/role play in hot water system components and carry out repair work using **Handout 13.** This will list the operational checks required to carry out the procedure.	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 5** • **Handout 13** **For workshop appliances** A range of the following: • Unvented and open vented cylinders installations • Combination boilers • Multi- and single-point appliances • Electric point of use appliances • Under and over sink units	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during discussion by asking questions and ensuring that they know what's required of them in workshop task. • Tutor to ensure effective communication during workshop activity. Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to review learners' knowledge.

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Key learning activity/approach	Suggested materials and resources	Skills check
Workshop: • Introduce and identify (ID card) yourself to the client (tutor); notify them about work to be carried out, and advise them about safety and interruption of supplies. Give expected duration of work and expected outcome • Learners to visually inspect the area and ensure **safe isolation** of electrical supplies. Ensure **correct operation** of booster pump assembly of flow pressure, switching, noise transmission and backflow protection. • **Test operation of pumps (including bronze circulators) and check** for presence of air, noise transmission, leaks and casings. Measure at pressure and flow inlets and outlets with bourdon gauge. • Check capacitor; repair or replace after checking with a multimeter. Use a flow jug and measure **water flow rate** from outlets in accordance with British Standards. • Check pressure gauge to check operation of **pressure** at outlets. • Check **balance** of hot supplies at appliance after pressure reducing valve (diaphragm) and any other outlets at appliance or fitting. • **Functional test** of immersion or control switches on electric water heater. • **Functional test**: check operation of pump and check **pressure** of pressure vessels. • Functional test of **zone valve** to ensure that the energy source is automatically isolated when spring returns via signal system from thermostat. • Check **water flow** and pressure at outlets and safety discharge device**. Check pressure** relief valve and test **backflow** at test point on double check valve. **Operate** gate	• Thermal store • Booster pumps set • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • pH meter or litmus test paper • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	

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Key learning activity/approach	Suggested materials and resources	Skills check
valves and stop valve to appliances. • Confirm appliance and components operational performance in accordance with the manufacturer's instructions. • Explain outcome to customer, hand over any documents or paperwork and clean area. **Challenge focus:** • **Discuss and provide feedback** during learner group session. • **Research S plan system** (www.honeywell.com) and use of spring return zone valves on unvented hot water primary circuits; compare to other types which are power on/off system, and identify advantages and disadvantages of both for UV systems. **Independent learning:** • Learners to **record** actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learner's **plumbing dictionary and personal course portfolio** for the tutor to review.		

Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry.

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ICT: • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**Employability:** • Learners can show **resilience** by sticking to the testing process even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging**.

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Sessions 14 and 15: Commissioning records and handover procedures

Suggested Teaching Time: 7.5 hours

Learning Outcomes: 3. Commission hot water systems and components

Learners will complete hot water commissioning records, carry out actions if process reveals defects and carry out handover procedures.

Topics: 3.6 – Commissioning records; 3.7 – Handover procedures

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **research** CSCS card requirements and what level you could apply for as a student apprentice or when you are qualified after passing this diploma. **Active learning:** • Tutor to lead a **discussion** about carrying out operational tasks in accordance with tutor brief/scenario discussion/role play in hot water system components and carry out repair work, eg initial introduction of yourself to a client. • Tutor to show **Presentation 9 – Part 6** about commissioning records and handover procedures. Give out **Handout 14** about requirements for commissioning records for hot water systems and outline the relevant legislation. **Workshop:** • Introduce and identify (ID card) yourself to the client (tutor). Carry out a role play, where the learner must notify the client about the commissioning documentation required. • Learners to refer to jobs carried out by identifying tasks, and complete commissioning records to include the date and time, and their name as the commissioning engineer. Hand to colleague and then to tutor for verification. • Write down the **location** of the installation and state the	**Materials** For the tutor to devise in advance: • **Presentation 9 – Part 6** • **Handout 14** **Resources** • BS EN 8558 • BS EN 806 • BS 6700:1997, clause 3.1.10.1 • Water Regulations • WRAS guide to water regulations • Manufacturer's instructions **For workshop appliances** • Unvented and open vented cylinders	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to check learners' understanding during discussion by asking questions and ensuring that they know what's required of them in workshop task. • Tutor to ensure effective communication during workshop activity. Tutor to ensure that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions. • In the **Challenge focus** task, discuss with learners the common issues with the location discharge termination.

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Key learning activity/approach	Suggested materials and resources	Skills check

amount of **hot water storage**.
• Identify the types and **manufacturer of equipment** and **components** installed.
• Explain the **type of pressure test** carried out and its **duration**, and give details of the **disinfection processes**, the disinfection **chemicals** used and the **disinfection readings** to prove outcome.
• Provide information about the **flow rates** and **pressures** at the outlets, and register the recorded **pressures** on both the **suction side** and the **discharge side** of any boosting pumps
• State the expansion vessel/accumulator pressure.
• Ensure that commissioning records are kept in a **file in a secure location**.
• Learners to then complete a **role play**, where they explain to the client that:
  • notification of the installation will be given to **BCO** and **water undertakers**
  • **their name** is included as installing plumber
  • **location** is inserted
  • there is a type of work that needs to be carried out
  • the local building control office (**BCO**) have been informed **five days** before the completion of the work
  • the completed work **complies** with regulation requirements
  • a **building regulations compliance certificate** has been issued.
• Learners to continue the role play but focus on when **handing over** to the customer. The must remember to:
  • explain all **tests** carried out satisfactorily
  • give details on how the **system operates** as planned
  • describe that fittings are **clean and ready to use**
  • explain **how** the system works
	installations
	• Combination boilers
	• Multi- and single-point appliances
	• Electric point of use appliances
	• Under and over sink units
	• Thermal store
	• Booster pumps set
	• Single and twin impeller pumps
	• Bronze circulator
	• Expansion vessels and accumulator
	
	For test instruments
	• Flow jug or gauge
	• Pressure gauge
	• Calibrated multimeter
	• pH meter or litmus test paper
	• Tools
	• Materials
	• PPE
	• Practical portfolio	

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Key learning activity/approach	Suggested materials and resources	Skills check
• **demonstrate** appliances in operation • **advise** on isolation, basic maintenance and safe operations • explain what to do in an **emergency** • provide **as fitted drawing**, showing the position of all isolation valves and backflow prevention devices • write down the job details, the **compliance certification** and the commissioning records • complete **Benchmark book** • inform them that the system **complies** with manufacturer's instructions, relevant standards and regulations • state that this validates their manufacturer's **warranty** • ask client to add **their name** to theirs on the documentation • give **guarantee** of workmanship and company details. **Challenge focus:** • **Discuss and provide feedback** during learner group session in tutorial. **Research** methods of **safeguarding** against hot water scalding hazards when locating safety relief discharge pipework in a public place. Compare death rate through scalding with CO poisoning. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learner's **plumbing dictionary and personal course portfolio** for the tutor to review.	• Pens and paper • Dust sheet • Commissioning, Benchmark and notification sheets (www.wras.co.uk) • Dust sheet	

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Opportunities to develop maths, English, ICT and wider skills:

English: • **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners can show **resilience** by sticking to the testing process even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging.** • Learners can **demonstrate** how they change their **communication style** to suit their audience in handing over to the customer exercise rather than their everyday communication with their supervisor or work colleagues**.** Aim to offer a good, caring and professional image to help gain return work or recommendations for the company.

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Session 16: Diagnostic checks (workshop session)

Suggested Teaching Time: 9 hours

Learning Outcomes: 4. Diagnose and rectify faults in hot water systems and components

Learners will carry out diagnostic checks required for common faults on hot water systems.

Topics: 4.2 – Carrying out diagnostic checks

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **read** manufacturer's instruction for appliances and components, then plan sequence and approach to activities in workshop. Think about what is required to work safely and in an organised way in accordance with BS 8000. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. • Tutor to show **Presentation 10**, which involves information of faults and methods of repair. • Learners to carry out methods of safely isolating hot water systems or components to prevent them being brought into operation before the diagnostic processes and repairs have been fully completed. • Learners to use manufacturer's instructions and industry standards to establish the diagnostic requirements of hot water system components. • Order damaged or defective components from manufacturer's short parts list and specific number needed for the original parts used. • Tutor to review plans, and help learners to prepare plan for individual task and risk assess the area. • Tutor to **discuss** how to carry out the diagnostic tests in	**Materials** For the tutor to devise in advance: • **Presentation 10** • **Handout 15** **Resources** • BS EN 8558 • BS EN 806 • BS 6700 • Building Regulation G3 • CIPHE design guide • Manufacturer's instructions • PPE • Practical portfolio • Pens and paper • Dust sheet **For workshop appliances** • Single and twin	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to workshop activities. • Tutor to monitor learners' progress during scenario/role play and ask questions or offer feedback where appropriate. • Tutor to check learners' responses to the **Handout** and review by marking/asking questions. • Tutor to ensure effective communication during workshop activity. Tutor to ensure that learners have checked the following. 1. **Visual inspection** each test area, identifying details and key points to observe. Survey job detail and record/make notes. 2. **Safe isolation** checks for electrical power and water at appliance. 3. Test operation of **pumps** systems while following logical sequence of testing appliance, and measure water flow and pressure in accordance with the

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Key learning activity/approach	Suggested materials and resources	Skills check

accordance with **scenario/role play**, locate faults in hot water system components and carry out repair work on an unvented cylinder installation.
Workshop:
• Learners to read and refer to **Handout 15** on diagnosing and repairing faults. This can involve a table listing symptoms, faults and repairs.
• Introduce and identify (ID card) yourself to the client (tutor); notify them about the work to be carried out and advise them about safety and interruption of supplies. Give expected duration of work and expected outcome.
• Learners to **record** diagnosis and fault finding event in **Handout 15. Read** and analyse performance flow chart in manufacturer's instructions.
• Tutor to help learners to visually **inspect** the area and ensure that **safe isolation** of electrical supplies to the whole unit is possible.
• **Diagnose faults.**
• **Test operation of pumps (including bronze circulators).**
  • Presence of air, noise transmission, leaks, casings
  • Measure at pressure, and flow inlets and outlets
  • Check capacitor; repair or replace
• **Inspect gauges**
  • Needle position: moving, static; if incorrect reading, replace
• **Check pressure of pressure vessels**
  • Check water flow and pressure at outlets
  • Re-pressurise if pressure too low
  • Check condition/integrity of Schrader valve for let by/ using leak detection fluid/replace
  • Remove and replace bladder/diaphragm if possible or
	impeller pumps
	• Bronze circulator
	• Expansion vessels and accumulator
	• Unvented cylinder
	• Single- and multi-point hot water heaters
	
	For test instruments
	• Flow jug or gauge
	• Pressure gauge
	• Multimeter to GS38
	• pH meter or litmus test paper
	• Tools
		manufacturer's performance criteria.
		4. **Read** technical information for pressure and flow rates in manufacturer's instructions.
		5. **Compare** performance with design criteria.
		6. **Bronze circulator** analyse fault test. Check whether the rotor bar has snapped or if the impeller is jammed or stuck, and either release or replace. Check if the motor burn out case is cracked, and if so replace. Check if the capacitor may be slow starting, and if learner is able then replace it.
		7. **Gauges** – observe needle action against working and static pressure, and replace if required.
		8. **Pressure vessels**. Testing of Schrader valve, leaks, let by; confirm pressure as per manufacturer's instructions design. Operate pumps, check outcome, repair/replace components.
		9. **Electrolytic corrosion** – inspect the specified location, obtain details of water quality, and test water with papers or pH meter analysis. Clean/replacement components.
		10. **Backflow device** – check valve stuck in the open position and hot water circulating through mains supply.
		• Tutor to review learners' knowledge by asking direct questions.

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Key learning activity/approach	Suggested materials and resources	Skills check
replace with new vessel • Check operation of safety relief valves • Ensure flow through tundish and full closing of valve with no leaks • Check labelling on valve to ensure correct installation • Check whether outlet of discharge pipework is safe and complies with Building Regulation G3 • Check operation of single point and multi-point for flow and heat up time • **Specify remedy** • Describe manufacturer's parts list in relation to fault finding process • Decommission appliance • Ensure safe electrical isolation and recheck that water supply is isolated • Carry out repair • Re-commission appliance • Confirm system performance in accordance with the manufacturer's instructions • Clean area, and remove tools and dust sheet • Explain outcome to customer and hand over any documents or paperwork • **Electrolytic corrosion** • Use litmus paper or pH meter to check the pH of the water within a designated vessel • Confirm for hardness (**Calcium Carbonate PPM)** of supply water in conjunction with manufacturer's recommendations • Compare with the cold mains supply • Confirm the manufacturer's advice regarding hard water areas and corrosion prevention		

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Key learning activity/approach	Suggested materials and resources	Skills check
• Make the decision to remedy problem by scale reduction, water treatment device, or replace repair component • **Backflow prevention devices (connected to a system)** • Check for backflow of water into stand by pump circuit on boosted set • If there is backflow, safely isolate and drain local circuit, and then remove and replace check valve. **Challenge focus:** • More able learners to use calibrated multimeter on practice area, isolated by tutor or electrician. Practise dead testing for continuity on length of cable and a switching device. Then, using manufacturer's instructions, carry out dead test on contacts of immersion heater and cylinder thermostat to determine the switching contacts. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and add key features to the work carried out, including descriptions and processes. This should be added to learners' **plumbing dictionary and personal course portfolio** for the tutor to review.		

Opportunities to develop maths, English, ICT and wider skills:

English: • Learners demonstrate **reading** skills in manufacturer's literature tasks, as they **identify** the **correct information** to answer the comprehension questions about routine checks and diagnostics.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the

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• **Speaking and listening** skills in **effective communication** can be developed during the workshop role play task with client/tutor. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	plumbing industry. • Learner to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out diagnostic and successful repair processes to the required British Standards through study and personal research. **Employability:** • Learners can show **resilience** by sticking to the testing process even if it doesn't go well initially. They should be encouraged to remain **flexible**, **positive** and **motivated during a process which can be challenging.** • Learners should demonstrate they can **actively listen** during the effective communication/role play session in the workshop, **understand** what has been said and **respond/act** accordingly by carrying out safe practices and successful diagnosis and repair.

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Sessions 17 and 18: Obtain information on and perform repair/rectify procedures **Suggested Teaching Time**: 9 hours

Learning Outcomes: 4. Diagnose and rectify faults in hot water systems and components

Leaners to be able to obtain information on system faults, and carry out repair and rectification procedures when dealing with faults.

Topics: 4.1 – Obtaining information on system faults; 4.3 – Performing repair and rectification procedures

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to write down a **short summary** of the questions they would ask a customer in order to carry out a successful repair of a faulty hot water storage system and bring to the session. **Active learning:** • Tutor to **discuss** learners' findings, and show the examples of questions to ask customers in **Presentation 11** on servicing and checking the system. • Tutor to facilitate a group **discussion**, asking learners about the importance of reading and deciphering manufacturer's flow charts, and about the process of carrying performance charts to check pressure and flow. • Tutor to ask learners to download manufacturer's technical information and facilitate a group discussion. Explain routine checks and diagnosis on hot water systems, cleaning and reassembly of components, and reassembly of filters. • Tutor should also **describe** manufacturer's commissioning procedures for a pump, give details on repair methods and **explain** checks for correct operation of pressure switches on booster pump set to a system and flow switches. • Give details of procedures used for checking expansion vessels accumulators, gauges and controls.	**Materials** For the tutor to devise in advance: • **Presentation 11** • **Worksheet 8** • **Worksheet 9** **Resources** • Interactive whiteboard • BS EN 8558 • BS EN 806 • BS 6700 • CIPHE design guide • Heatraesadia.com • Manufacturer's instructions • Appliances • Unvented cylinder	• **Tutor will verify** by questioning, including fault history dates, memorable events and characteristics of the problem. • Monitor and assess learners' responses to specific installation requirements and test methods regarding end user-reported technical problems. • Assess understanding of the importance of warranty, regulations and Benchmark requirement. • Verify learners' perception of why manufacture's instructions take precedence over BS. Describe short parts list • Ask questions to ascertain correct processes carried out in **group discussion** when learners explain logical sequence of testing in accordance with the manufacturer's performance criteria. • Examine learners' **worksheets** and modify to suit approach to analysis and repair. • **Evaluate responses to tutor-led**

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Key learning activity/approach	Suggested materials and resources	Skills check
• Tutor can refer to Heatraesadia.co.uk to explain the process for checking for backflow into hot water system via failed check valves. • Tutor to lead a **discussion**, describing routine checks for safety relief valves and line strainers/filters. State the process for checking CWSCs and storage cylinders in relation to domestic demand and larger installations. • Learners to complete questions in pairs, and tutor to go through answers at the end of the session. • Learners to complete **Worksheet 8**. This can include a series of questions about the flow rate from a system, letting by, creaking floorboards, velocity and thermostat positions. Learners then swap with the person next to them for peer review whilst the tutor goes through the answers as a class. • Learners to complete multiple-choice summative test **Worksheet 9** on faults and rectification, and hand it to the tutor to mark. **Challenge focus:** • More able learners to conduct **online research** to explore reasons for aeration problems in unvented hot water supplies. Identify where manufactures give measurements of hardness in water, what their remedies are and what happens if prevention is ignored. **Independent learning:** • Learners to think about the activities in the workshop session regarding fault finding, and **make a list** of PPE and material that would be most appropriate for each scenario.	• Single- and multi-point hot water boilers • Single and twin impeller pumps • Bronze circulator • Expansion vessels and accumulator • PPE • Practical portfolio • Pens and paper • Dust sheet	**discussion** about efficient approach to diagnosis faults and remedies from manufacturer's instructions. • Assess quality of responses about technical information and check key features and descriptions. • Answer questions set by the tutor.

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Opportunities to develop maths, English, ICT and wider skills:

English: • Learners demonstrate **reading** skills in manufacturer's literature tasks as they **identify** the **correct information** to answer the comprehension questions about routine checks and diagnostics. **ICT:** • Learners have the opportunity to engage in **blended learning** by recording faults on training tasks in workshops and transferring to personal course portfolio. This is an example of **cloud-based** technology.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners should gain an understanding of the **wider** plumbing **industry** by communicating with manufacturers online and downloading fault finding information which can improve knowledge of technical terminology and common problems, thus gaining credibility in discussion in interviews when applying for jobs or work experience.

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