Unit 333: Central heating 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 333. It is based on 90 hours over 26 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 to 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 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

© 2016 City and Guilds of London Institute. All rights reserved.

- employability skills and behaviours
- 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.

© 2016 City and Guilds of London Institute. All rights reserved.

Unit 333: Central heating system planning and design

Sample scheme of learning

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

Number of sessions: 26 **Delivery hours**: 90 **Venue**:_____ **Group**: _____

Learning outcomes:	**To enable learners to**:
• Understand types of central heating systems and their layout requirements • Use design techniques for central heating systems • Follow installation requirements of central heating systems and components • Understand installation, connection and testing requirements of electrically operated central heating components • Install, connect and test electrically operated central heating systems • Commission central heating systems and components • Diagnose and rectify faults in central heating systems and components	• Understand what pipework layout options are there for central heating systems • Understand what safety hazards are associated with sealed central heating systems • Understand how central heating systems are decommissioned • Understand which components make up underfloor heating systems

© 2016 City and Guilds of London Institute. All rights reserved.

Session 1: Zoning requirements

Suggested Teaching Time: 3 hours

Learning Outcomes: 1. Understand types of central heating system and their layout requirements

Learners will describe zoning requirements for central heating systems in relation to legislations and guidance documents, including:

- Part L building regs
- CHeSS central heating specification
- domestic heating compliance guide
- gas safe installation and use regs
- Part P building regs.

Topics: 1.1 – Zoning requirements

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **look at** a boiler or heat source installation at home or work, and identify the type of appliance and its location. Make a note of the pipework arrangements and fuel type. Determine if it provides energy to heat a hot water cylinder or if it provides instantaneous hot water. Examine how the heating system is controlled, look at any zone valve arrangement and see what types of heat emitters are installed. Learners to **write notes** and take photographs of appliances, pipework and heat emitters, and when in class, **discuss** the appliance type, purpose and functionality. **Active learning:** • Tutor to ask learners about the heating systems they've found at home, at work or in their properties. Tutor will generate a **group discussion**, incorporating all of the learners' observations, and then develop the **outcomes, thoughts and ideas discussed** into a basic understanding	**Materials** For the tutor to devise in advance: • **Presentation 1** • **Worksheet 1** • **Handout 1** • **Handout 2** • **Handout 3** • **Activity 1** **Resources** • Computers/phones and tablets	• Group discussion to check if learners have correctly identified appliances, pipework and purpose. • Assess how learners can identify requirements for heating zones within a building and determine the floor area specifications. • Tutor can ask learners key questions about **Worksheet 1** and to write down their thoughts. Also ask them to share their thoughts and findings with the larger group regarding zoning of systems. • **Assess** whether learners can identify the purpose and relationship between CheSS and the domestic heating compliance guide and Part L by asking questions. • **Tutor to check quality of learners'**

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
of a heating system. • Tutor to prepare and present **Presentation 1**, about zoning requirements in relation to the current legislation and guidance, to include Part L, Part P, CHeSS, DHCG and Gas Safe. Discuss the purpose of Part L of the Building Regulations in relation to central heating system efficiency, and the requirements of separate zones within a range of buildings. • Learners to study **Handout 1** prepared by the tutor about central heating systems, showing diagrams of different systems (S, Y, W and C plan) and how they are controlled. Learners to **make notes and exchange** completed notes with the person next to them; compare findings, including outcomes from pre-learning, and discuss their outcomes such as floor areas through peer review. • Learners to work in pairs to identify the zoning of heating systems, by viewing and **discussing** the moving images of heating appliances. • **Tutor-led discussion** on the control and zoning of underfloor heating, and reasons for its popularity. • Tutor to facilitate a **discussion** with learners about domestic heating compliance and CheSS, highlighting the different aspects and purpose of each document and both their connections to **Part L**. • **Tutor to describe** the range of criteria offered in the domestic heating compliance guide relating to energy sources and heating applications. Discussion with learners about downloaded document to computers or handsets: file:///U:/Downloads/Domestic%20Heating%20Compliance%20Guide.pdf. • Learners to study **Handout 1** and download the PDF		answers in their notes by discussing floor areas in central heating systems, and underfloor heating where there are important installation issues. • **Review** learners' responses to CheSS and Part L to measure quality of observations and understanding. • **Analyse** the outcome of discussion about domestic heating guide and assess understanding of key points, especially the relationship with CheSS and Part L. • Tutor to **check** clarity of learners' responses to **Worksheet 1**. • Check **learners' awareness** of the importance of Gas Safe and HSE in the heating industry, as well as being competent, qualified and registered. • Assess **learners' understanding** of the relationship between Part P and central heating installation. • Assess and **discuss outcome** of learners' responses to **Activity 1**. • Tutor to **check accuracy** of learners' answers to questions. • **Discuss and assess** individual solutions from learners involved in the Challenge focus.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
(http://bpec.org.uk/downloads/CE51%20CHeSS%20WEB%20FINAL%20JULY%2008.pdf) examining the zone specifications and differences in zone control criteria in HR7 and HC7 whilst **making notes**: • Learners to complete **Worksheet 1** prepared by the tutor: a table for learners to define terms from CE51 CHeSS; learners to share completed notes with the person next to them. Compare answers and findings before discussing outcomes through peer review. Use **Handout 2**, prepared by the tutor, describing CheSS. • Learners to **split into groups** and **examine** the importance of Gas Safe, HSE and the Gas Safety Installation and Use Regulations (GSIUR). Installers must be qualified, registered and competent when working on gas fittings to ensure to public safety: www.hse.gov.uk/aboutus/meetings/hseboard/2013/250913/psepb1389-b.pdf. • **Learners in groups** to examine the importance of Part P when installing or servicing central heating systems, and give reasons and purpose of the regulation when discussing and feeding back to each other in class. • **Group work** to discuss **Handout 3** prepared by the tutor, listing and describing the legislation and guidance sources about selecting central heating systems, and compare notes in preparation of **Activity 1**. • Learners to complete **Activity 1**, prepared by the tutor, which covers a range of questions on heating systems and basic components. Once complete, tutor to facilitate a **discussion** regarding different learners' responses to the scenario. • Learners to get into small groups, and tutor to allocate questions to each group. The aim is for learners to **generate**		

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
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 attempt the following question: 'A customer asks you to specify zones and controls for the main dwelling, which is 165m^2 with two bedrooms, and for an extension area of 120m^2. with a bedroom on the first floor. The energy source provides heat for all areas. State the controls required to satisfy Part L1A of the Building Regulations.' **Independent learning:** • Download Honeywell wiring guide (www.honeywell.com) and write a **short summary** identifying the different methods of controlling the systems identified in Topic 1.1.		

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

English: • Learners demonstrate the **writing** skills of **planning** and **drafting** when reading the wiring guide and devising a short summary about the different methods of controlling the systems. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about zoning requirements, **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	**British values:** • Remind learners about **staying safe online** and raise 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 applying the law regarding gas appliances and fittings, ensuring that they are qualified, competent and registered with HSE through the Gas Safe register. • Talk about how learners may come into contact with wider **public**

© 2016 City and Guilds of London Institute. All rights reserved.

about heating systems and their functions which are found at home or in the workplace. **Math:** • Learners will need to **calculate the area** of floors in a plumbing context, as part of the Challenge focus activity. **ICT:** • Learners have the opportunity to engage in **blended learning** in the heat source installation identification task, which makes use of smartphones/cameras. This is an example of **cloud-based** technology.	**institutions**, such as the Health and Safety Executive, the need for learners to **respect** them and why they are **important** in ensuring that safe working practices are followed as part of a plumbing project.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 2: Control systems

Suggested Teaching Time: 4.5 hours

Learning Outcomes: 1. Understand types of central heating system and their layout requirements

Learners will recognise control systems and their components, and be able to describe their various functions and operating principles.

Systems to include:

- combination boiler
- S-plan
- Y-plan
- S-plan plus
- sealed
- multi-zone
- W-plan.

Components include: zone valves (2 port, 3 port, mid position and diverter) programmer, timer, thermostats, programmable room stat, optimizer, frost stat, wiring centre, cylinder stat, expansion vessel and automatic by-pass.
Operating principles to include: time, temperature weather compensation and delayed start.

Topics: 1.2 – Control systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to observe control components at home or at work and record their function in a **short report.** Determine which zones are included in the heating circuit and how the temperature is controlled. **Make notes, photograph** the components and bring to class. **Active learning:** • Tutor to ask learners about their thoughts regarding the operation of components in zones at home or at work. • Tutor to prepare and present **Presentation 2** on control systems in central heating, which should include S, S+, Y, W,	**Materials** For the tutor to devise in advance: • **Presentation 2** **Resources** • Computers and hand-held devices • Flip chart	• Tutor can ask learners questions about their home and work survey on zones, asking them to explain their thoughts in class. • Examine responses about low pressure and sealed systems. • Confirm that learners know the advantages and limitations of combination boilers. • Check awareness of automatic bypass as a stand-alone device or incorporated into

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
multi-zone, open vented and sealed system controls. • Tutor to facilitate a **discussion** with learners about low pressure and sealed, pressurised systems, and relate outcomes to learners' findings at home or work. • **Tutor-led discussion** on combination boilers, asking learners to identify typical location based on information from the textbook or from their survey at home (pre-learning). • Learners to **split into groups** and **explain** to each other the purpose and function of an automatic bypass as a stand-alone device or incorporated into a sealed system. Hole the component, note the calibration and compare it to manufacturer's literature**. Refer to DU145 PDF document via link:** www.honeywelluk.com/products/Valves/Bypass-Valves/DU145. • **Learners to work** in pairs and **discuss** sealed systems, typical pressurisation limits, positioning of expansion vessels and safety relief components. Make comparisons with open vented systems and their operating pressures and safety process. • **Group discussion** to recap information about two-pipe gravity systems and identify the basic control system, noting its limitation and control parameters. • Learners to split into small groups to **discuss** the operational differences between the Y plan and S plan control systems. Identify room heating floor area parameters with different valves. • **Tutor-led discussion** on S plan plus and its application when serving larger areas or dwellings with more than two heating zones. Summary of S and Y plan systems. • **Learners to work** in pairs and explore the functional		a sealed system. • Identify sealed systems and expansion parameters accurately. • Confirm correct specification of two-pipe systems and their purpose. • Analyse quality of responses to operational differences between Y plan and S plan systems and then assess understanding of S plan plus benefits. • Confirm learners' understanding of two- and three-port valves. • Tutor to check that more able learners provide innovative responses to research in brainstorm session regarding the control range and function. • Check understanding of timer and programmer control. • Engage in exercise and assess learners' responses to weather compensation methods. • Evaluate understanding of boiler interlocks and their relevance to Part L. • Assess **reflective writing** about **pre-learning exercise** and presentation. • Check and discuss responses to questions set by the tutor. • Check responses and solutions to the Challenge focus exercise and discuss with the whole class.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
characteristics of two- and three-port zone valves, and make notes. • Learners to split into groups for a **brainstorm session.** The aim is for learners to generate as many variations of zone control, stating user advantages and limitations for cylinder, room, boiler and frost thermostats in domestic environments. Write up onto a flip chart and **present** back to the class. • **Tutor-led discussion** on the typical installation, purpose and function of programmers and timers. Identify key central wiring junction for all components on heating systems, asking learners for common scenario examples in class. • **Learners to work in pairs** to explore the installation location and purposes of weather compensation in relation to delayed start, optimum start and home automation. Provide feedback in class, with opinions on advantages and benefits of applying these components and processes. • Tutor to initiate discussion on boiler interlocks and multiple boiler installations, with learners compiling notes for quiz. • Learners to carry out **reflective writing** within **small groups** to refer to **pre-learning exercise.** Compare notes and images of appliances, components and devices identified during the pre-learning survey. • Learners to attempt **quiz** set by the tutor. **Challenge focus:** • More able learners to get into pairs to attempt to solve a client's request for large installation commission with specific control requests set by the tutor. **Independent learning:** • Learners to conduct **online research** to find out the best		

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
system to control a large building with an unvented cylinder, selecting types of zone valves and control methodologies. 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:

- Learners can demonstrate **writing** skills when producing a **short report** about their home survey in the pre-learning exercise, as well as a **short summary** about the best system to control a large building with an unvented cylinder in the independent learning exercise. Ensure that correct **spelling**, **punctuation** and **grammar** have been applied.
- **Speaking and listening** skills can be demonstrated in developing the various **discussions** about control systems, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**.

ICT:

- Learners have the opportunity to engage in **blended learning** in the control component observation task, which makes use of smartphones/cameras. This is an example of **cloud-based** technology.
- Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about the best system to control a large building with an unvented cylinder.

Employability:

- More able learners should gain an understanding of **customer expectations** and be able to explain them as a result of solving the challenge set by the tuor. They should have an idea of how to **listen to** and **meet customer demands**, as well as deal with those who are **dissatisfied**.
- Learners can experience **working in a team** as part of the brainstorm task. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.
- Learners should demonstrate **self-analysis** by **identifying** the **skills** needed when carrying out the reflective writing task, and use this to evaluate and prioritise their **own strengths** and **skill gaps** for development.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 3: Underfloor heating

Suggested Teaching Time: 3 hours

Learning Outcomes: 1. Understand types of central heating system and their layout requirements

By the end of the session, learners will be able to describe the features and working principles of underfloor heating systems components, including:

- manifolds
- pump control unit
- insulation
- pipework
- manifold isolation ball valves
- supports
- controls.

Learners will also describe the layout and installation requirements of underfloor heating pipework.

Topics: 1.3 – Underfloor heating

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to look at home to **check out** if any of their rooms are heated by underfloor heating. This activity can be carried out in any area where there are no radiators fitted, such as other houses, a gym, restaurant or open plan office. Learners to look at control systems where possible and, if convenient, ask the user their opinion on this method of heating. With permission and where appropriate, **take photos and videos** of components and bring to the session. **Active learning:** • Tutor to prepare and present **Presentation 3**, about how underfloor systems operate and their temperature range system components, and lead a **group session** discussing	**Materials** For the tutor to devise in advance: • **Presentation 3** • **Handout 4** • **Worksheet 2** • **Activity 2** **Resources** • Computers and hand-held devices	• 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 when presented in class. • Group discussion for tutor to confirm that key points of conductivity and radiation are identified and how design temperatures comfort levels are achieved. • Think-pair-share activity for tutor to confirm correct identification of processes required for solid and suspended floors. • Check learners' recognition of

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
the differences between underfloor and heat emitters, identifying the range of applicable heat sources such as ground source. • Tutor to prepare and give learners **Handout 4**, providing information about underfloor heating, which can be referred to during presentation and activity sessions. It should include the operating temperatures of UFH and pipework layout styles. • **Learners to get into groups** to discuss the heating process of conduction and radiation from underfloor sources, and make notes. Discuss in pairs the advantages over heat emitters. Identify the key design temperature range and standard comfort levels. Information can be shared later in presentation. • Learners to get into pairs for the **think-pair-share** activity, and identify different types of pipework and control systems used in solid and suspended floors; then feed back to the class. • Learners to **work in groups** to complete an exercise about identifying the purpose function of manifolds, pumps and valves components, stating the key components. Learners should handle components in class, if possible, and make notes about their specific location on an underfloor system, highlighting key components to control temperature. • Tutor-led **discussion** on the methods and arrangement of pipework patterns laid underfloor, such as snail and series, how to install in rooms of different shapes and zoning areas, and installation methods for solid and floating floors. • **Group discussion** about insulation and joist widths, thermal transmittance and spreader plates. Makes notes and research online manufacturer's specification. • Learners to get into pairs for the **think-pair-share** activity by	• Photos and videos from the pre-learning activity • CIPHE plumbing engineering service design • Manufacturer's instructions • www.wavin.co.uk	components by questioning their responses to handling components and identifying parts, section, orientation, weight and appearance. • Tutor to **assess** correct areas of research on insulation and thermal transmittance from manufacturer's instructions. • Tutor-led discussion where tutor can ask learners questions about pipework pattern in different rooms and zoning options to confirm understanding. • Check for correct answers to **Activity 2**. • Tutor to assess quality of individual responses to questions. • Tutor to assess more able learners by discussing answers and, where possible, expanding the client scenario.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
identifying renewable energies in underfloor heating and their relative controls. Then complete **Worksheet 2** prepared by the tutor using basic room dimensions for learners to design a pipework layout and manifold position. Provide feedback to the class with individual design and ideas. • Complete crossword in **Activity 2** prepared by the tutor on underfloor heating, using eight components used in an UFH system. • Learners to complete questions set by the tutor in pairs and provide feedback with their experiences from the pre-learning survey. **Challenge focus:** • More able learners to offer solutions to installation questions posed by the customer, considering the application of renewable energies, as set by the tutor. **Independent learning:** • Learners to **read** CIPHE plumbing engineering service design guide manual and make notes on the features of the serpentine system to include in **plumbing dictionary**. This can include definitions and explanations of different terminologies found in a plumbing context. • They can also turn to the relevant page in their **textbooks** regarding underfloor heating and **research** UK manufacturers who are producing different types of pipework systems, eg some completely flexible and some which can be permanently hand formed.		

© 2016 City and Guilds of London Institute. All rights reserved.

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

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about underfloor heating, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. • Learners demonstrate **reading** skills when reading the CIPHE plumbing guide manual – **identifying** and **summarising** the **main points** about the features of the serpentine system. **ICT:** • Learners have the opportunity to engage in **blended learning** by examining manufacturer's literature regarding underfloor heating, making use of smartphones/cameras. This is an example of **cloud-based** technology.	**Employability:** • Learners can experience **working in a team** when identifying the purpose function of manifolds, pumps and valves components. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 4: Multiple boiler installations

Suggested Teaching Time: 3 hours

Learning Outcomes: 1. Understand types of central heating system and their layout requirements

Learners to describe the system layout requirements for multiple boiler installations and low loss headers.

Topics: 1.4 – Multiple boiler installations

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to look at multiple boiler appliances at work or at college, with permission, and check how they are located, piped and operate. Carry out **online research** to see if multiple boilers installations provide any advantages over single energy source installations in large domestic or commercial environments. **Active learning:** • Tutor to prepare and present **Presentation 4** about multiple boiler installations and layouts, which includes component parts and low loss headers. Ask learners to split into groups to **discuss** typical location pipework layout features and identify the main difference from a standard domestic installation. • **Group discussion** to identify boiler management control and outdoor sensor in the control system: how they interact with the zone controllers. • **Learners to work in pairs** to state the purpose of primary and secondary circuits, and explain the purpose of shunt pumps in relation to equal velocity/flow rates**.** Tutor to monitor progress and offer feedback where appropriate. • Learners to **discuss in groups** the function and operation of controls in relation to flow rates.	**Materials** For the tutor to devise in advance: • **Presentation 4** • **Activity 3** **Resources** • Interactive whiteboard	• Tutor to check whether learners can identify location of pipework, components and layout features, including energy source, and how they all function. • Tutor to check whether learners can explain boiler management controls in relation to outdoor sensors. • Check that learners in pairs clearly state purpose and function of primary and secondary circuits, and explain the purpose of shunt pumps. • Check that learners can identify controls in relation to flow rates. • Tutor can evaluate comprehension of operation of low loss headers, velocity and the neutral point in a system, as well as what thermal shock is. • Check accurate knowledge of features of low loss headers. • Check and discuss learners' outcomes from **Activity 3**. • Tutor can effectively question learners on

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• **Tutor-led discussion** of features and operation of low loss headers and the neutral point in a system, as well as the relationship between water velocity and temperature, and the prevention of thermal shock. • **Learner in groups** to examine the location and main features of low loss headers, including components such as AAV and drain points. Feed back to the class with comments on example shown in slides and their typical or possible locations. • **Learner in pairs** to complete **Activity 3** prepared by the tutor. Learners to discuss answers in group with tutor comments. The activity should include 10 multiple-choice questions based on multiple boiler installations. • In pairs, learners to answer questions set by the tutor**.** Feed back answers to the class as tutor goes through them. **Challenge focus:** • More able learners to explore potential solutions of a commissioning request for multiple boiler installation in a remote location and then write a **report** to the client explaining options; **present** to the class. **Independent learning:** • Learners to **investigate** multiple boiler installation which incorporates renewable energies sources, and research companies that offer a range of solutions and applications to new and existing buildings in relation to the new BIM requirements. Write a **short report** on the findings and upload to centre's VLE/Moodle.		multiple boiler installations. • Tutor can check more able learners' understanding by reviewing their answers.

© 2016 City and Guilds of London Institute. All rights reserved.

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

English: • **Speaking and listening** skills can be demonstrated in developing the **discussion** about multiple boiler installations, by **giving a point of view** as well as **allowing** and **responding** to **others' opinions** in class. • **Speaking and listening** skills in **presenting** can be developed during the commissioning requests for multiple boilers in a remote location task. More able 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**. • Learners can demonstrate **writing** skills when producing a **report** about multiple boiler installations and renewable energy sources. 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 the advantages of single energy source installations in large domestic or commercial environments. • Learners have the opportunity to engage in **blended learning** in the research task about multiple boiler installations and renewable energy sources, which makes use of the centre's VLR/Moodle. This is an example of **cloud-based** technology.	**British values:** • Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** with advanced heating systems and the country's compliance with new energy requirements such as BIM. **Employability:** • Learners should gain an understanding of the **wider** domestic and commercial heating **industry** when they are introduced to the **range of job roles** during the managing energy control of multiple boiler installations.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 5: Factors affecting design

Suggested Teaching Time: 3 hours

Learning Outcomes: 2. Use design techniques for central heating systems

Learners to describe the factors which affect the selection of central heating systems for dwellings with consideration of:

- customer needs
- building layout and features
- energy efficiency
- environmental impact
- building size
- occupancy and purpose
- fuel availability
- cost
- emitter type
- legislation.

Topics: 2.1 – Factors affecting design

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to conduct **online research** about the impact of new regulations, directives and other factors affecting the selection of energy heat sources and the options presented by appliance manufacturers. **Active learning:** • Tutor to prepare and present **Presentation 5** about factors affecting the design of central heating systems, which should include: customer's need, building size and layout, occupancy, purpose, storage type, heat emitters, fuel, environmental impact, etc. Tutor to lead a **discussion** on customer needs, highlighting the importance of cost effectiveness, regulations, manufacturer's options, type of	**Materials** For the tutor to devise in advance: • **Presentation 5** • **Worksheet 3** **Resources** • Interactive whiteboard • www.wavin.co.uk	• Tutor to verify learners' answers and range of their responses during discussions in class. • Check quality of responses in relation to environmental impact of product selection. Learners to individually explain reason for selection. • Examine learners to identify new standards and explain importance for the industry in the UK. • Check learners' explanations of building layout and features.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
heat emitters and environmental impact when selecting appliances. • Learners to get into groups and **discuss** customer needs about economic and environmental impact relating to selection of appliances in consideration of existing regulations and guides. • Tutor to lead a **group discussion** about customer needs when presenting information at the formative stage of a commission. • Learners to **get into pairs** and **explain** building layout and features to each other. Identify the building fabric, appliance access, disabled access, joist depth, pipe runs and appliance location in relation to plans, noting scale of drawing. • Learners to **brainstorm** types of system, and environmental effect and cost effectiveness of a new heating system; then feed back to the class with their outcomes. • Tutor-led **group discussion** on building layout features and plans in compliance with building and gas regulations and British Standards. Learners to provide feedback in groups and determine best scales for plans and where extra training may be required to complete commission. • Learners to get into pairs for the **think-pair-share** activity about environmental impact in relation to regulations and manufacturer's technical support. They must write down what they think about the **new BIM directive** from the government and **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: www.planningportal.gov.uk/uploads/br/domestic_building_compliance_guide_2010.pdf. • Make **notes** and comment on solar, micro CHP and other		• Discuss outcome of learners' brainstorm on environmental effects and cost effectiveness. • Ask learners how they would communicate with BCO regarding legal requirement with building a gas regulations. • Assess think-pair-share responses about environmental impact in relation to regulations and manufacturer's technical support, as well as their depth of knowledge on how regulation application of BIM and ErP affect the industry. • Tutor to check learners' answers as they work in pairs by reviewing their notes and asking questions when feeding back to the class regarding their own customer feedback process. • Tutor to check answers to questions given to learners. • Tutor to check more able learners' understanding in Challenge focus regarding Part L, BIM and ErP.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
alternative heat sources; provide feedback in group and use as preparation for synoptic assessment. • **Tutor-led discussion** on energy efficiency and regulations relating to installation. Learners to make notes on the 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 work in pairs** and discuss customer feedback approaches. Make notes and devise own methodology or preferred communication processes based on a range of customer requirements. • Learners to individually complete **Worksheet 3** prepared by the tutor, which should be a table listing all the key areas to be considered when designing a central heating system. Learners should expand on each term and, once complete, **discuss** their findings in small groups. • Learners to individually complete questions set by the tutor. • Learners can read through printed presentation and notes throughout the session and answer questions. **Challenge focus:** • More able learners to **research** the new government requirements of BIM and download ErP labelling information from CIBSE (via college library membership) from manufacturer's website. They should **identify** the purpose of a product fiche and how it would impact on the installation of an energy efficient boiler: www.baxi.co.uk. **Independent learning:** • Learners to get into pairs and conduct **online research** into retailers, creating a **leaflet** that provides advice on environmental products in relation to Part L and BIM. Find the clearest and most helpful explanation, as well as ErP		

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
labelling and product package strategy, for the customer and installer.		

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

English:

- **Speaking and listening** skills can be demonstrated in developing the various **discussions** about factors affecting design, by **giving a point of view** as well as **allowing** and **responding** to **others' opinions** in class.
- Learners demonstrate the **writing** skills of **planning** and **drafting** in leaflet task about providing advice on environmental products in relation to Part L and BIM.

ICT:

- Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about the impact of new regulations, directives and other factors affecting the selection of energy heat sources.

British values:

- Remind learners about the **importance** of the **laws of England**, and their **purpose** to **protect citizens**, when discussing the building layout features and plans in compliance with building and gas regulations/British Standards.

Employability:

- Learners will demonstrate their **understanding of customers** by **identifying customer expectations** through **discussions** about the formative stage of a commission.
- Learners can experience **working in a team** as part of the **think-pair-share** activity about environmental impact in relation to regulations and manufacturer's technical support. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 6: Principles of heat loss and gain **Suggested Teaching Time**: 3 hours

Learning Outcomes: 2. Use design techniques for central heating systems

Learners will describe how the principles of heat loss and gain affect heating requirements in a dwelling, with consideration of:

- electrical equipment
- occupancy
- solar
- building fabric
- ventilation
- internal and external temperatures
- pipework heat loss.

Topics: 2.2 – Principles of heat loss and gain

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to prepare for session by **reading** the relevant chapter in allocated textbooks about reasons for heat loss, and find a definition of U value. Learners to add this to their plumbing dictionary. This can include definitions and explanations of different terminologies found in a plumbing context. **Active learning:** • **Learners** to identify information about the principle of heat loss in Watts from building fabric, ventilation and pipework, and make notes about U values during **Presentation 6**, which has been prepared by the tutor and should include: electrical equipment, building fabric, occupancy, ventilation, pipework, temperatures, etc. • Learners to **get into pairs** and explain to each other the	**Materials** For the tutor to devise in advance: • **Presentation 6** **Resources** • Interactive whiteboard • Computers • www.planningportal.gov.uk/buildingregulations re route to Gov.uk	• Tutor to confirm accuracy of feedback from learners by reviewing clear and relevant examples of how to research each topic, eg U values. • Tutor to monitor progress of learners during tutor-led discussions by observing, asking and answering questions. • Check accuracy of learning and interpretation of internal temperature when learners are in pairs. • Tutor to check learners' thoughts by monitoring discussions during the brainstorm task. • Tutor to verify correct information imparted from learners in groups about air

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
basis of internal temperature within buildings in relation to temperature, humidity and ventilation rate. State comfort range for domestic dwellings. • Learners to get into small groups to **brainstorm**. They should identify and state comfort levels for individual rooms within a dwelling, and note the important differences in temperature range for the elderly and infirm. Provide feedback to the class with solutions for a dwelling with mixed ages. • Tutor-led **discussion** on the design of dwellings to compensate for heat loss with regard to external temperatures in the UK. Learners to feed back ideas in groups, highlighting the importance of minimising heat loss through glazing. • Learners in groups to explore the relevance of air changes for individual rooms within buildings and how air enters buildings and escapes. Learners to pay special attention to this process and **make notes** in preparation for **synoptic assignment**. • Learners in pairs to identify heat loss through the building fabric, room size and location of heat emitter, and **make notes** in preparation for heat loss **calculations**. • Tutor-led **discussion** on heat gain in respect of internal and external temperatures, heat transfer between rooms, heat from bodies, light bulbs within a building, and solar gain from external sources and on, for example, south-facing roofs. Learners to make notes and discuss in groups. • Learners to complete questions set by the tutor in pairs, and tutor to go through answers at the end of the session. **Challenge focus:** • More able learners to **plan** and **design** an inner-city dwelling with a south-facing roof and another with a north-facing one. **Draw** on a sheet of paper, and label different appliances and		changes in rooms within a dwelling. • Tutor to assess learners' awareness of heat loss through fabric and glazing. • Tutor to check that learners understand the principles of heat gain form within and outside a building. • Tutor to verify understanding of solar benefits to a dwelling and ratio of heat gain by location and angle of the roof. • Tutor to confirm accuracy of learners' responses to questions. • Tutor to assess design and comment on innovation during practical application of technical planning in the Challenge focus exercise.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
components they would specify. • Conduct **online research** on design options for appliances and components, eg: www.heatraesadia.com and www.baxi.co.uk. **Independent learning:** • Learners to conduct **online research** by using the Heatrae Sadia webpage and enrol on Spec pro to download design calculation tools and find common domestic solar packages for three-bedroom dwellings with one bathroom. Upload solutions and ideas to the centre's VLE/Moodle, and ask learners to comment on others' ideas and suggestions.		

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

English: • Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** about heat loss and definition for U value. **Math:** • Learners can practise using **whole numbers** in a plumbing context. Learners will need to use **addition/subtraction/multiplication/division** in their calculations. Learners should be encouraged to **check that their answer** is correct by using a different calculation method. **ICT:** • Learners have the opportunity to engage in **blended learning** in the independent learning task, which makes use of the centre's	**Employability:** • Learners to suggest various **potential solutions** to the temperature range problem in dwellings with mixed ages and **judge** if the proposed solutions will work or not. Encourage them to work out how to **prevent** the problem occurring in future. • Learners should be encouraged to use newly acquired knowledge and installation techniques to ensure that they understand the **commercial benefits** to a company of polite and **professional communication** with customers when offering solutions to technical problems. • Learners can demonstrate their ability to **generate** and **select new ideas**, and **develop** them more fully as part of the online research task for the independent learning exercise.

© 2016 City and Guilds of London Institute. All rights reserved.

VLE/Moodle. This is an example of **cloud-based** and **communication** technology.	

© 2016 City and Guilds of London Institute. All rights reserved.

Session 7: Calculating central heating system requirements **Suggested Teaching Time**: 4.5 hours

Learning Outcomes: 2. Use design techniques for central heating systems

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

- total heat load
- emitter load
- hot water load
- expansion
- pipe size
- pump size.

Present design calculation to meet formats suitable for quotation and tenders.

Topics: 2.3 – Calculating central heating system requirements

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to go on the Mear website (www.mhmear.com/) and look at the tools they offer for system sizing. Gather information from retailers and assess the type of support they offer to installers with regard to system sizing and compliance with the new ErP and BIM directives. **Make notes** and upload information to the centre's VLE/Moodle after discussion in class. **Active learning:** • Tutor to prepare and present **Presentation 7**, introducing methods of calculating heat loss and target U values, Mear's method, manufacture's and long hand. Learners to **make notes** and **discuss** in groups (www.mhmear.com/; www.starsapp.co.uk/).	**Materials** For the tutor to devise in advance: • **Presentation 7** • **Handout 5** • **Worksheet 4** • **Worksheet 5** **Resources** • Post-it notes • Pens • BS 5449 • BS 6946	• Tutor to check learners' knowledge of Mear's calculator and level of research on ErP and BIM; provide feedback in sessions before class starts. • Tutor to check for comprehension of the different approaches to heat loss: calculations using Mear's tool, manufacture's software and the long hand method. • Tutor to verify feedback from learners, giving details about the **BS 5449 and BS 6946**, and how heat loss occurs in a building.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• **Group discussion** on emitter load, insulation and design temperatures in relation to heat loss. • Tutor to lead a **discussion** on calculations, referring to textbook and to **BS 5449 and BS 6946** when calculating central heating requirements in buildings, including building fabric and ventilation. Learners to take notes and discuss, including **Handout 5**, prepared by the tutor, on references for design, listing all British Standard numbers and guidance documentation. • Learners to complete a **think-pair-share activity** and **make notes** on outcomes to feed back to group about calculation exercises. Summarise heat loss formula. • Learners to download the **whole house method** leaflet (www.energysavingtrust.org.uk/Publications2/Housing-professionals/Heating-systems/Domestic-heating-sizing-method-2010-edition) and complete **Worksheet 4**, prepared by the tutor, which involves learners filling out a sizing plan chart using basic room dimensions and fabrics. • Learners to complete a **think-pair-share activity.** They will need to determine the heat load of a detached bungalow, based on the information given. By working through the exercise in the slides and with guidance from the tutor, they will record their outcomes and information onto their downloaded sheets. Finally, they will calculate the load based on the whole house method. **Write** down thoughts and provide **feedback** to the class. • Tutor to lead a group **discussion** on emitter size, on style type and pipework arrangements, radiator catalogues outputs and design adjustments to BS EN 442. • Tutor to ask learners to examine the formula to **work out** radiator size based on the Mean Water Temperature (MWT), adding the required adjustment factor from tables in textbook.	• CIPHE design guide	• Tutor to check learners' understanding during group discussions by asking and answering questions on emitter load. • Ensure that learners have full understanding of how to access calculation methodologies. • Assess think-pair-share activity regarding heat loss formula. • Check learners' approach to calculation and recording of accurate information during the whole house methodology. Ensure that downloaded material is up to date and recorded on paper or electronically; the bungalow exercise is assessed with feedback from the learners. • Verify the research and calculation of emitter size and incorporation of adjustments from BS and textbook. • Assess correct methods and application of formula to **work out** radiator size based on the Mean Water Temperature (MWT). • Check understanding in group discussion on hot water load requirement, revisiting SHC from Level 2 science. Work through useful links and ask learners to upload to Moodle. • Tutor to check calculations in pairs and discuss outcomes of potential pipework sizes. • Verify the methods used to size pumps

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
Learners to provide feedback to the class about the impact of oversized and undersized emitter. • Group **discussion** on hot water load requirements for heating systems. Review of Level 2 science on Specific Heat Capacity (SHC) with the inclusion of (Δ**t**). Examine examples given by the tutor. • Access links and examine manufacturer's approach to product selection and heat load formula applications: http://home.honeywell.com/; www.climate-eu.invensys.com. • Tutor-led **discussion** on pipe sizing; learners to work through **calculations** in pairs and discuss outcomes of potential pipework sizes. • Learners to **work in pairs** and download link to pump manufacturers (http://uk.grundfos.com/products/find-product/ups2.html#brochures), and follow calculation process for pump sizing. Make notes in preparation for synoptic assessment. • **Group discussion** on calculation and use of pressure/expansion vessel; describe methods of sizing vessels, referring to textbook and BS 5449. Feed back ideas and thoughts about application of vessels and typical solutions to the class in pairs. Learners to download brochure for a range of vessels and apply for free sizing tool to use for this and other units: www.zilmet.co.uk. • Learners to complete **Worksheet 5** prepared by the tutor on calculating pressure vessels, stating criteria like the system capacity and system operating pressure. • **Learners to brainstorm** in small groups about how to present completed designs and calculations in formats which are suitable for quotations and tenders. This will also involve discussing estimations of time to complete work, cost and design options with the customer.		and links to manufacturer's software and product catalogues. • Ensure accurate referencing and calculating when sizing expansion/pressure vessels, by referring to textbook and BS 5449, and download manufacturer's literature and tools. • Tutor to check learners' answers for **Worksheet 5** by marking them. • Assess brainstorm session, and evaluate quality and clarity in the way information is presented to clients in role-play exercise when offering design calculation for quotations and tenders. • Tutor to check learners' responses to questions and encourage discussion of the answers offered. • Check outcomes from more able learners in the Challenge focus task; discuss the practicality of the solutions offered and if the diversity factor was used in their assessments.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• Use **role play** in pairs in group session to achieve effective communication and expression of calculations and plans. Groups could write their comments on **Post-it notes** with alternative or competitive plans to others and add them to the whiteboard to stimulate a wider group discussion. • Learners to complete questions set by the tutor and feed back to the class; then rotate questions. **Challenge focus:** • More able learners to attempt questions set by the tutor about a customer request to extend a property and, if the learner can, calculate whether the boiler will be sufficient for the job. **Independent learning:** • Learners to get into pairs to devise a method of commissioning a new system for where they live. They should itemise sizing, first and second fix the appliance, and then the component choice, and write a **short report**.		

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

English: • **Speaking and listening** skills in **presenting** can be developed during the role-play exercise, when offering quotations and tenders. Learners to use the **correct format** with an **introduction**, **supporting evidence** and **statements**, and **conclusions**. They should adapt the content to **suit the client audience** and **purpose**. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about calculating central heating	**Employability:** • Learners should gain an **understanding of customer expectations when presenting** calculation for quotations 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

requirements, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. • Learners can demonstrate **writing** skills when producing a **short report** about devising a method of commissioning a new system. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used. **Math:** • Learners will have to record, organise and present the data about calculations for quotation and tender in a suitable format to offer technical and commercial conclusions regarding recording information, as part of the independent task. **ICT:** • Learners have the opportunity to engage in **blended learning** in the pre-learning task, which makes use of the centre's VLE/Moodle. This is an example of **cloud-based** technology.	• Learners can experience **working in a team** as part of the brainstorm task. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 8: Selecting components

Suggested Teaching Time: 3 hours

Learning Outcomes: 2. Use design techniques for central heating systems

Learners will select central heating components in accordance with design calculations, including:

- emitters
- boilers
- pipes
- pumps
- expansions vessels.

Topics: 2.4 – Selecting components

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to create their own dictionary of plumbing with definitions of central heating components. This can include definitions and explanations of different terminologies found in a plumbing context. **Make notes** and take photos, or even video, with the aim to collaborate with others to produce a definitive reference guide. Post on the centre's VLE/Moodle and present to other learners during tutorials. **Active learning:** • Tutor to prepare and present **Presentation 8** about selecting components, which should include: emitters, boilers, pipe, pumps and expansion vessels. **Learners to get into pairs** and describe heat emitter requirements and adequate calorifier in relation to calculated system demand. • Learners in groups to **explain** the main requirements of system boilers and their advantages in heating systems. • **Tutor-led discussion** on the importance of correct	**Materials** For the tutor to devise in advance: • **Presentation 8** **Resources** • Interactive whiteboard • Computers • PDF Hep2O price list • PDF Hep2O installer guide • PDF IMI technical guide	• Tutor to check learners' dictionaries for accuracy by reviewing Moodle activity and commenting where appropriate. • Tutor to ensure that learners in pairs give explanation on heat emitter and calorifier requirements. • Tutor to check that learners, in group, offer clear examples of main requirements of system boilers. • Tutor to check that learners confirm the correct specification of combi boilers. • Tutor to engage with mind map session and review quality of suggestions offered by learners, providing feedback accordingly. • Check learners' responses from group discussion on key features of sealed

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
specification of combination boilers; learners to put comments in portfolio/dictionary. • Learners to get into small groups to **discuss** and draw a **mind map** of their thoughts about different boiler/energy heat sources available on the market. Learners to feed back their **mind maps** to the class. • Group **discussion for learners** to describe key features of sealed systems and their independent and integral components, such as expansion vessels, temperature relief valves and filling loops. • **Learners to work in pairs** to determine heat output, location, style and properties of heat emitters, paying special attention to low surface temperature model for places where there is a risk of physical contact, ie nursing homes. • **Learners to get into pairs** and describe pumps and circulator for a range of different applications; provide feedback to the class about the advantages of modern differential pressure controls fitted to pumps. Download information from www.grundfos.co.uk. • Tutor to lead **discussion** on pipework options for installation of heating services. Learners to explore benefits of both copper and plastic, and which situations are best for each. • Refer to the PDF Hep2O installer guide and PDF IMI technical guide (www.plumbcenter.co.uk/wcsstore7.00.00.549.01/ExtendedSitesCatalogAssetStore/images/products/AssetPush/DTP_AssetPushHighRes/std.lang.all/hu/re/Hep2o_Brochure.pdf), and research technical specifications and flow rates; provide feedback to the class in groups. • Learners to complete questions set by the tutor in pairs; tutor to go through answers at the end of the session.		systems. • Assess that pairs of learners offer clear descriptions and specification of emitter requirements in dwellings. • Tutor to check that learners provide accurate feedback about the range and application of pumps and circulators. • Tutor to check accurate feedback from learners and whether they give clear and relevant examples in tutor-led discussions on the benefits of copper and plastic pipework in heating circuits. • Tutor to ensure that more able learners provide credible and workable solutions in the Challenge focus task. Assess within 10% price and material accuracy.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
Challenge focus: • More able learners to attempt **pricing** the first fix plastic pipe and fittings for an extension to an existing heating circuit for a bathroom radiator of 2.5kW output located 2 metres and at 90 degrees from the main 22mm copper pipe run in the landing of a ground floor flat (**PDF Hep2O price list**: www.plumbcenter.co.uk/wcsstore7.00.00.549.01/ExtendedSitesCatalogAssetStore/images/products/AssetPush/DTP_AssetPushHighRes/std.lang.all/hu/re/Hep2o_Brochure.pdf). **Independent learning:** • Learners to **research** installation requirements for plastic pipe used for heating, with relevance to type and protection, barrier and insulation. Note any differences in frictional resistance to copper pipe and whether different calculations are required to size to ensure correct flow rate.		

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

English: • **Speaking and listening** skills in **presenting** can be developed during the mind map task about different boiler/energy heat sources available on the market. 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**. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about selecting components, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**.	**Employability:** • More able learners should gain **commercial awareness** and an understanding of how to **identify competitors** and their differences in **pricing strategy** in the heating circuit extension task. They can be encouraged to **assess** and **compare competitors**.

© 2016 City and Guilds of London Institute. All rights reserved.

ICT: • Learners have the opportunity to engage in **blended learning** in the pre-learning task, which makes use of the centre's VLE/Moodle. This is an example of **cloud-based** technology.	

© 2016 City and Guilds of London Institute. All rights reserved.

Sessions 9 and 10: Positioning, fixing and connecting (workshop) **Suggested Teaching Time**: 6 hours

Learning Outcomes: 3. Follow installation requirements of central heating systems and components

Learners to specify and carry out positioning, fixing and connection of sealed central heating systems, including:

- boilers
- pumps
- motorised valves
- expansion vessels
- isolation valves
- fill points
- radiators
- UFH manifolds and pipework
- cylinders
- automatic bypass.

Topics: 3.1 – Positioning, fixing and connection requirements; 3.2 – Connecting sealed central heating systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to research the specification and connection of sealed systems, and the location of key components within a dwelling with two zones, in the relevant textbook. **Active learning:** • Learners to get into groups and **discuss** customer specification requirements for sealed systems, referring to manufacturer's instruction, textbooks and regulations. • Tutor to lead **group discussion** about customer needs when specifying components at the formative stage of the installation.	**Resources** • Interactive whiteboard • www.planningportal.gov.uk/uploads/br/domestic_building_compliance_guide_2010.pdf • Spec pro from: www.heatraesadia.com/products	• Tutor to **verify** learners' response to textbook research and the range of their thoughts and questions during discussions in class before workshop session. • **Check quality** of responses in relation to efficiency and environmental impact of component specification. Learners to individually explain the reason for their selection and location. • **Assess** learners' responses to customer needs through questioning.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check

• Learners to **get into pairs** and **specify** appliances and components location which work effectively within a building layout (scenario from tutor) and operating features.
• Locate components and appliances for ease of access with regard to maintenance and in consideration of the type of building fabric, disabled access, joist depth and pipe runs. Consider the appliance location in relation to architect's or customer's plans requests.
• Learners to get into small groups to **brainstorm** the most efficient types of system, environmental effect, functionality and cost effectiveness of a new heating system. Create a **short presentation**, and then provide feedback to the class in workshop with their outcomes.
• Learners to get into pairs for the **think-pair-share** activity and begin **connection** of components and pipework in rotation to different scenarios.
  • **Sealed system boiler:** automatic bypass, pumps, expansion vessels, T&PRV and relief pipework
  • **Control systems** zone valves and controls systems
  • **Fill points,** vents points, isolation valves, drain off valves and radiator location
  • **UFH** manifolds, control valves and pipework circuits
• **Tutor-led group discussion** on outcomes of connection process within building layout and compliance with textbook methodology, manufacturer's instructions, Building and Gas Regulations, and British Standards.
• **Learners to provide feedback** in pairs and comment on the experience of connection, giving reason for their methodology.
Challenge focus:
• More able learners to **research** the application of different
		• **Check** learners' explanations, in **pairs**, of component location and fixing within building layout and features.
		• **Ask** learners about decision on connecting in appropriate locations.
		• **Discuss outcome** of learners' brainstorm on types of system, environmental effects and cost effectiveness of their specification.
		• **Assess** the think-pair-share activity responses about connections in a rotation of practical scenarios.
		• Tutor to **check** learners' answers in the discussion activity by reviewing their notes and asking questions about connection methods when providing feedback to the class.
		• Tutor to engage with learners' feedback on experience of the activity and respond to their thoughts and questions.
		• **Tutor** to check more able learners' understanding in the Challenge focus regarding UFH scenario and how to specify effective control of zones.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
types of pipework materials in a system; compare performance and compatibility in a UFH system with additional radiators and specify a control system for three zones (www.baxi.co.uk; www.wavin.co.uk). **Independent learning:** • Learners to get into pairs and conduct **online research** into retailers, creating a **leaflet** that provides advice on new UFH heating installations in suspended floors, and where and when to connect manifold during a first and second fixes.		

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

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about positioning, fixing and connecting, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. • Learners can demonstrate **writing** skills when producing a **leaflet** on providing advice about new UFH heating installations in suspended floors. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used. **ICT:** • Learners could use appropriate **presentation software** to make their group presentations on the most efficient types of system, environmental effect, functionality and cost effectiveness of a new heating system.	**British values:** • Remind learners about the **importance** of the **laws of England**, and their **purpose** to **protect citizens**, when discussing the building layout features and plans in compliance with building and gas regulations/British Standards. **Employability:** • Learners can experience **working in a team** as part of a specification and installation team. Check that learners are **working well together** (letting one another have input with ideas, being positive, motivated, etc) and all are **contributing** in an appropriate way by organised discussion and sharing of methods of connecting, designs and other ideas in first and second fix environment.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 11: Pre-installation checks from fused spurs (classroom and workshop) **Suggested Teaching Time**: 5 hours

Learning Outcomes: 4. Understand installation, connection and testing requirements of electrically operated central heating components

Learners will identify pre-installation checks when supplying control circuits from a fused spur connection unit, including:

- current certification
- rating
- signs of mechanical damage.

Topics: 4.1 – Pre-installation checks from fused spurs

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to download and **read** AD Part P and research minor works certification requirements. **Plan** sequence and approach to activities in workshop. **Active learning:** • Learners to get into pairs and **compare** their pre-installation check plans/approaches to workshop activities. • Tutor to prepare and present **Presentation 9**, regarding current certification, rating and checking for mechanical damage, and emphasise key points of electrical safety. • **Discuss** what is required to work safely by safe isolation and identify the **current rating** of an installation. • Tutor to **demonstrate** to learners how to carry out methods of visually inspecting central heating systems and components from a fused spur within a dwelling. • Learners to individually **inspect** a consumer unit and identify the circuit where the fused spur is to be fitted; **make a selection and give reasons.** • Learners to **examine** and fill out a minor works form to prepare for installation of fused spur in relation to BS	**Materials** For the tutor to devise in advance: • **Presentation 9** **Resources** • BS 7671:2008 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe installation and Use Regulations • Part P and L of the Building Regulations	• Tutor to check learners' understanding by discussing the pre-learning activity in class whilst learners compare their plans/approaches for electrical inspection of fused spur in classroom and workshop activities. • Tutor to check learners' understanding during **Presentation 9** and discuss by asking questions and ensuring that they know what's required of them in workshop inspection task. • Tutor to ensure effective communication during workshop role-play activity when completing minor works form. • Tutor to ensure that learners have fulfilled the appropriate criteria and practical processes during the workshop activity through observation, offering feedback/suggestions for improvement

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
7671:2008. Provide **feedback in pairs to the class with comments**. • Learners to **check rating** and function of RCD in consumer unit. • **Prepare** a written plan for the safe isolation task and risk assess area. • Tutor to lead a **discussion** about how to carry out visual inspections and inspect circuits in a central heating system. **Workshop:** • **Individually** 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 outcomes. • Tutor to lead **group walk** around the installation, and check that the fused spur is correctly located and the cable is properly installed. Make comments on the form. • In groups, ensure that the fuse rating is correct in fused spur and that bonding is correctly installed and of sufficient cross-sectional area (CSA). Identify correct specification on inspection form. • In small groups, inspect whole installation for signs of mechanical damage and any part of the installation that does not meet industry standards. **Make notes** and offer remedies. • In pairs, inspect dimensions around appliance for compliance with the regulations and standards, as well as future access for maintenance and repair, and provide feedback to the tutor on whether there are risks or hazards. • Learners to answer questions asked by their peers in session. **Challenge focus:** • More able learners to examine reason for Part P and what	• Minor works certification **For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels • Programmers • Thermostats • Consumer units • Protected electrical circuit to appliance **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Tools • Materials • PPE • Practical portfolio • Pens and paper	and answering questions. • Check that the BS 7671 and Part P information have been interpreted correctly and information of the inspection recorded. • Verify that appropriate risk assessments are carried out with regard to different aspects of inspection. • Ensure safe isolation where appropriate during inspection. • Confirm RCD checked and correct circuit identified in consumer unit. • Assess correct identification of mechanical damage to existing circuit and ask questions to ascertain the impact this could have on a new proposed installation. • Identify answers and remedies to faults or problems on circuit. • Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate and offering suggestions. • Check responses of pairs to questions. • Engage with more able learners during the Challenge focus task by asking if and how they can carry out a minor work form, and about how to carry out workshop tasks on site.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
qualifications are required for them to complete a minor works form. **Discuss and provide feedback** during learner group session in tutorial; upload to centre's VLE/Moodle. **Independent learning:** • Learners to conduct **online research** about the cable sizing for a final ring main, a radial circuit to an immersion heater and if a fused spur can be interested with a lighting circuit. Provide feedback to the class in the next session.	• Dust sheet	

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

English: • Learners demonstrate the **writing** skills of **planning** and **drafting** in the safe isolation task. • **Speaking and listening** skills in **effective communication** can be developed during the workshop role-play task in completing minor works certificate with client/tutor. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about pre-installation checks from fused spurs, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about identifying BS 7671 cable sizing for training tasks in workshops. • More able learners have the opportunity to engage in **blended learning** when examining the reason for Part P/what qualifications	**British values:** • Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out an electrical inspection, and record-keeping to the required British Standards and manufacturer's requirements through study and personal research. • Remind learners about the **importance** of the **laws of England**, and their **purpose** to **protect citizens**, when discussing the building layout features and plans in compliance with building and gas regulations/British Standards. **Employability:** • Talk about **appropriate learner behaviour** both at college and at work when leading the group to walk around the installation.

© 2016 City and Guilds of London Institute. All rights reserved.

are required to complete a minor works form, which makes use of the centre's VLE/Moodle. This is an example of **cloud-based** technology.	

© 2016 City and Guilds of London Institute. All rights reserved.

Session 12: Wiring diagrams

Suggested Teaching Time: 3 hours

Learning Outcomes: 4. Understand installation, connection and testing requirements of electrically operated central heating components

Learners will draw wiring diagrams for different types of central heating circuits, including:

- S plan
- Y Plan
- multi-zone.

Topics: 4.2 – Wiring diagrams

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to download Honeywell manufacturer's wirings and fault finding guides: file:///U:/Downloads/Wiring-Guide-Issue-16.pdf. Examine the method of colour coding used from a fused spur and where they are located on a wiring centre. **Make notes** to bring to the session. **Active learning:** • Tutor to prepare and present **Presentation 10** on drawing wiring diagrams for S plan, Y plan and multi-zone installations and their associated controls. • Tutor to facilitate a **discussion** with learners about the temperature requirements within a dwelling. • Learners to **split into groups** and **examine** the relationship between CHeSS HR7 and HC7 in relation to wiring heating control systems; discuss outcomes in class. • **Learners to work** in pairs and **discuss** wiring features of an S plan system and copy their own version from **Handout 6**, prepared by the tutor, on wiring up a system and the	**Materials** For the tutor to devise in advance: • **Presentation 10** • **Handout 6** **Resources** • Computers, tablets and hand-held devices • Honeywell wiring boards • Calibrated fused multimeters • Voltage testers • Coloured pens • Pencils • Erasers • Rulers • Set squares	• Tutor can **ask learners questions** about manufacturer's wiring downloads and literature; ask them to explain their thoughts in class. • **Check learners'** understanding of how to read and comprehend methods and systems used in **Handout 6**. • **Examine responses** regarding energy proportional demand in dwellings and the importance of efficient control systems. • **Determine** whether learners correctly relate information about CHeSS to how systems are wired. • **Confirm** that learners comprehend basic wiring requirements and accurately draw an S plan wiring diagram. • **Check** learners' awareness of benefits of the addition of weather compensator to an S plan system. Assess the quality of

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
components. • Tutor to lead a **discussion** on the addition of a weather compensator to an S plan system and the wiring implications. Learners to **write notes**, add compensator to S plan diagram and **discuss** benefits to the end user. • **Group discussion** on wiring of Y and W plan systems. Note the different function of the three-port valves and the purpose of the wirings variations; learners to discuss mid-position valve and diverter functions and then draw the diagrams. • **Tutor-led discussion** on multi-zone wiring (S plan plus), its benefits and purpose. Learners to discuss in class and draw diagram. • Learners to get into small groups for a **brainstorm session.** They should generate as many ideas as possible regarding the remote operation of systems using electronic media, offering advantages and thoughts of possible failures in systems. Provide feedback to the class with tutor interaction. • Learners to attempt questions set by the tutor. **Challenge focus:** • More able learners to **get into pairs** to attempt to solve the problem of radiator circuit operating when there is no call for heat from the controls. **Independent learning:** • Learners to conduct **online research** in manufacturer's web pages to find what zone valve arrangements are permissible for an S plan system which incorporates an unvented cylinder.	• Graph paper	responses in group discussion. • **Identify** whether learners can differentiate between Y and W plan systems and accurately draw the wiring plans for the different systems. • **Confirm** during group discussion on multi-zone system learners' awareness of the benefits of ease of control and effective zoning for the end user. • **Tutor to engage** in brainstorm session regarding the application of smart controls, assess the range of learners' response and provide feedback in class. • Check and discuss responses to questions. • Check responses and solutions to Challenge focus task and discuss with whole class.

© 2016 City and Guilds of London Institute. All rights reserved.

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

English: • Learners demonstrate **reading** skills in the pre-learning task – **identifying** and **summarising** the **main points** about methods of colour coding used from a fused spur and where they are located on a wiring centre. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about wiring diagrams, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about zone valve arrangements for S plan systems with unvented cylinders.	**British values:** • Remind learners about the **importance** of the **laws of England**, and their **purpose** to **protect citizens**, when discussing the building layout features and plans in compliance with building and gas regulations/British Standards. **Employability:** • Learners can experience **working in a team** as part of the brainstorm task. Check that learners are **working well together** (letting one another have input, being positive, motivated, etc) and all are **contributing** appropriately.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 13: Connections, termination and cabling

Suggested Teaching Time: 3 hours

Learning Outcomes: 4. Understand installation, connection and testing requirements of electrically operated central heating components

Learners will specify methods of connection and termination on central heating wiring and identify suitable cables for central heating systems components.

Topics: 4.3 – Connections, termination and cabling

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to research textbooks and manufacturer's instructions about connection components for electrical supplies. **Make notes** to bring into the session. **Active learning:** • Tutor to lead **group discussion** about method of connecting and terminating conductors when installing cables for central heating controls. Learners to discuss and provide feedback in class. • Tutor to prepare and present **Presentation 11** about connections, termination and suitable cabling. Learners to get into groups and **discuss** methods of connecting with practical examples: screw and nut head, pillar head and claw and washer terminals, and hand crimping tools. • Learners to get into pairs for the **think-pair-share** activity and explain process of **connection** of components to assorted terminals and a wiring centre. • Tutor to encourage group **discussion** on outlets and pattresses commonly used to connect supply to a boiler on a heating system, such as fused and unfused outlets, dedicated boiler switches and RCD switches, etc. • Learners to **get into pairs** and **specify** connections,	**Materials** For the tutor to devise in advance: • **Presentation 11** **Resources** • Interactive whiteboard • Fixing and fittings for electrical connections and termination • Hand crimpers • Consumer unit	• Tutor to **verify** learners' response to textbook research and the range of their thoughts, ideas and questions during discussions in class. • **Check quality** of responses in relation to connection and termination of wiring. Learners to individually explain reasons for their selection of fitting and most appropriate application. • **Assess** learners' group discussion response to selecting outlets and pattresses through questioning. • **Check** learners' explanations, in **pairs**, of safe procedures to prevent damage to cables using grommets and glands to ensure effective termination, etc. • **Ask** learners about decision on connecting in appropriate locations. • **Discuss outcome** of learners' brainstorm on types of switching in bathroom or hazardous locations. Learners to feed back their ideas in class.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
grommets and glands, and identify precautions to prevent damage to cable in metal pattress handle components; discuss in class. • Learners to **brainstorm** the most practical and efficient types of switching system to isolate appliances located in bathrooms and other areas where there is a water contact risk. • Tutor to **discuss** methods of connecting and terminating a boiler from a fused spur to a final ring main circuit, and from a junction box directly to a cable. Learners to **make notes** and discuss in class. • Learners to **examine** consumer units to identify suitable circuits to isolate and use for a spur or junction box connection to supply a boiler. Choose the most appropriate cable size for such a circuit. • Learners to provide feedback in class about their individual selections. • Tutor to lead **group discussion** on bonding on exposed pipework at the meter and at the boiler the importance of applying temporary bonding clips for when components are removed during wiring processes. • Learners to complete questions set by the tutor. **Challenge focus:** • More able learners to conduct **online research** into whether a modern boiler would still operate if the phase and neutral were accidently reversed during the wiring process: www.baxi.co.uk. **Independent learning:** • Learners to get into pairs and conduct **online research** about connection methods used on modern pumps and what type		• **Assess** learners' understanding of connection from a fused spur or junction box. • Tutor to **check** learners' answers about correct circuits on consumer units and appropriate cable selection. • Tutor to **engage with learners' feedback** on their experience of the activity; also respond to their thoughts and questions on bonding requirements and the use of temporary bonding clips. • **Check** responses to questions and provide feedback to class. • **Tutor** to check more able learners' understanding in Challenge focus regarding wiring error and outcome in appliance operation.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
of cable is most suitable.		

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

English: • Learners demonstrate **reading** skills in the pre-learning task – **identifying** and **summarising** the **main points** about connection components for electrical supplies. • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about connections, termination and cabling, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about connections, termination and cabling.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the Health and Safety Executive, the need for learners to **respect** them, and why they are **important** in ensuring safe working practices as part of a plumbing project.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 14: Electrical testing procedures **Suggested Teaching Time**: 3 hours

Learning Outcomes: 4. Understand installation, connection and testing requirements of electrically operated central heating components

Learners will explain the purpose of electrical testing procedures for new and existing circuits, including:

- polarity
- earth continuity.

Topics: 4.4 – Electrical testing procedures

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to conduct **online research** into safety and electrical testing procedures before session. **Active learning:** • Tutor to lead **group discussion** about the purpose of testing procedures when installing cables for central heating controls. Learners to discuss and provide feedback in class. • Tutor to prepare and present **Presentation 12** about electrical testing procedures for new and existing circuits which should include polarity and earth continuity. Learners to get into groups and **discuss** the importance of calibration of testing equipment and provide feedback in groups about HSE guidance note GS38. • Learners to get into pairs for the **think-pair-share** activity and explain safe isolation and testing equipment on a proving unit. Learners to consult **Handout 7** prepared by the tutor, describing a proving unit and voltage tester. • Tutor to encourage **group discussion** on locking off and labelling a supply to a boiler on a heating system at the consumer unit and on fused spur outlets.	**Materials** For the tutor to devise in advance: • **Presentation 12** • **Handout 7** • **Handout 8** • **Worksheet 6** • **Worksheet 7** **Resources** • Interactive whiteboard • www.baxi.co.uk • Spec pro from: www.heatraesadia.com/products	• Tutor to **verify** learners' response to online research about safety and electrical testing procedures, and ask questions during discussions in class. • **Check** responses about test procedures and examine learners' depth of understanding on essential testing procedures. • **Ask** learners about calibration of testing equipment during their feedback in class. • **Check** learners' explanations, in **pairs**, of safe isolation procedures and testing instruments. • **Assess** learners' group discussion range of responses to locking off procedures. • **Verify** learners' understanding of earth continuity and polarity test; examine explanations of key discussion points. • Tutor to **check** learners' answers on test equipment, critical probe length and how

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• Learners to **get into pairs** and **specify** the purpose and process required for an earth continuity test and a polarity test; then discuss the key points in class. • Tutor to **discuss** the different types and methods of using test equipment, emphasising the maximum lengths of test probes and fuse protected instruments. Learners to examine test equipment and discuss in class, stating their preferences for testing. • Learners to **examine** testing of test equipment, and the reason and purpose of instrument calibration; then **discuss** in pairs. • Learners to read **Handout 8** prepared by the tutor, outlining the correct sequence for electrical testing. • Learners to **brainstorm** other types of test equipment used in the installation and fault finding of electrical circuits, such as voltage testers, digital clamp meters, insulation and continuity testers, earth loop impedance testers, earth leakage clamps. Write notes and present purpose and applications in class. • Learners to complete **Worksheet 6** prepared by the tutor, asking learners to detail five electrical tests carried out on circuits. • Learners to complete questions in pairs. • Learners to complete questions on **Worksheet 7** prepared by the tutor on live and dead testing; discuss thoughts in class with tutor feedback. **Challenge focus:** • More able learners to conduct **online research** to see if analogue test equipment is still in use – how does its accuracy compare with digital instruments? Write a **short summary** and hand in to tutor.		the user can be protected. • Tutor to **engage with learners' feedback** about the purpose of test equipment calibration. • **Discuss outcome** of learners' brainstorm on types of testing equipment and its use within the plumbing industry. Learners to feed back ideas in class. • **Check** answers to **Worksheet 6**. • **Check** responses to questions and provide feedback to class. • **Tutor to engage** with learners during feedback to answers from **Worksheet 7**. • **Tutor** to check more able learners' understanding in Challenge focus regarding analogue test equipment.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
Independent learning: • Learners to get into pairs and conduct **online or library research** about the most versatile instrument they would use if checking faults on an S plan system in a dwelling. Write a **short report** and hand in to tutor.		

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

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about electrical testing procedures, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. • Learners can demonstrate **writing** skills when producing a **short report** about the most versatile instrument they would use if checking faults on an S plan system. 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 safety and electrical testing procedures, analogue/digital test equipment, and checking faults on an S plan system.	**Employability:** • Learners can experience **working in a team** as part of the **brainstorm** about other types of test equipment used in the installation and fault finding of electrical circuits. Check that learners are **working well together** and all are **contributing** in an appropriate way by organised discussion and sharing of methods of testing system to the appropriate standards.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 15: Carry out pre installation checks for control circuits (workshop) **Suggested Teaching Time**: 5 hours

Learning Outcomes: 5. Install, connect and test electrically operated central heating systems

Learners will carry out pre-installation checks and safe isolation procedures when supplying control circuits. Pre-installation checks to include:

- safe isolation
- current certification
- rating
- signs of mechanical damage.

Topics: 5.1 – Carrying out pre-installation checks for control circuits

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **read** AD Part P, and **research** IEE on site guide from library. Download minor works certification. Plan sequence and approach to activities in workshop. **Active learning:** • Learners to **compare** their pre-installation check plans/approaches to workshop activities. • **Discuss** what is required to work safely by safe isolation and identify the **current rating** of an installation. Tutor to prepare give out **Handout 13**, outlining safe isolation checks. • Tutor to **demonstrate** to learners how to carry out safe isolation, checking current certification, verifying its rating and identifying mechanical damage. • Learners to individually introduce and identify (ID card) themselves to 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 outcomes. • Learners to **risk assess**, in pairs, and survey installation, and	**Materials** For the tutor to devise in advance: • **Handout 13** • **Worksheet 8** **Resources** • BS 7671:2008 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Gas Safe Installation and Use Regulations • Part P and L of the	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches to safe isolation of circuits in workshop. • Tutor to ensure that learners have fulfilled the appropriate criteria and practical processes during the workshop safe isolation, certification ad checks for mechanical damage through observation and offering feedback/suggestions for improvement and answering questions. • Verify risk assessment before safe isolation of correct circuit. • Tutor to ensure effective communication during workshop role-play activity when completing minor works form. • Check that the BS 7671 and Part P

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
safely isolate circuit to be tested from the consumer unit to the circuit where fused spur is to be fitted and dead test for presence of current. • Learners to **examine** existing paperwork and fill out the minor works form to prepare for installation of fused spur in relation to BS 7671:2008. Provide **feedback in pairs** to class with comments to tutor. • Learners to **confirm rating** and function of RCD in consumer unit and register information on commission sheets. • In pairs, inspect whole installation for signs of **mechanical damage** and whether any part of the installation does not meet industry standards. **Make notes** and **remedy fault** if requested. • In pairs, **inspect** dimensions around proposed appliance installation for compliance with the regulations and standards, and future access for maintenance and repair; feed back to the tutor if there are risks or hazards. • Learners to complete **Worksheet 8**. **Challenge focus:** • More able learners to check polarity at boiler on dead test to ensure correct operation. Use multimeter on correct setting and provide feedback to the tutor. Test the continuity and resistance of a synchron motor on a zone valve. Feed back outcome in class, giving reason if there are failures in mechanical operation. **Independent learning:** • Learners to conduct **online research**, reporting procedures for minor works certificates with the local authority when installing a fused spur and if altering the equipotential bonding on existing pipework. Learners to provide feedback	Building Regulations • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Insulated tools • PPE • Practical portfolio • Pens and paper • Dust sheets • Certification • IEE on site guide **For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels • Honeywell wiring centres • Programmers • Thermostats • Consumer units • Protected electrical circuit to appliance	information have been interpreted correctly, and information of the inspection recorded and conveyed to the client. • Verify that appropriate ongoing risk assessments are carried out during different aspects of inspection. • Ensure safe isolation where appropriate during inspection of selected circuits. • Confirm RCD checked and rated and the correct circuit identified in consumer unit. • Assess correct identification of mechanical damage to circuit and check to ascertain the impact this could have on an installation. Confirm suggested remedies to faults or problems on the circuit. • Engage with more able learners during the Challenge focus, by asking them if they can translate the outcomes to onsite work applications.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
to the class with outcomes.		

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

English:

- Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** to help with planning the sequence and approach to activities in the workshop.
- **Speaking and listening** skills can be demonstrated in developing the various **discussions** about pre-installation checks for control circuits, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**.

ICT:

- Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about report procedures for minor works certificates.

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.
- Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out electrical isolation, and record-keeping to the required British Standards, Building Regulations and manufacturer's requirements through practical application in the workshop, transferable to on-site work.

Employability:

- Learners should demonstrate they can **actively listen** during the tutor demonstration, **understand** what has been said and **respond/act** accordingly by asking appropriate questions. Learners should be encouraged to use techniques to ensure they understand the how to carry out safe isolation, eg **repeating back** what was said, **summarising** or **asking clarifying questions**.
- 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 16: Electrical wiring on control systems (workshop) **Suggested Teaching Time**: 4 hours

Learning Outcomes: 5. Install, connect and test electrically operated central heating systems
Learners will carry out electrical wiring of central heating control systems.

Topics: 5.2 – Electrical wiring on control systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to revise the Honeywell manufacturer's wirings and fault finding guides, and download versions to handsets. **Make notes** and prepare some questions to ask in class. **Active learning:** • Tutor to start with a **Q&A session** about the Honeywell manufacturer's wirings and fault finding guides so learners can ask their questions. • Learners to risk assess work area and plan work. Carry out safe isolation. • **Learners to work** in pairs and **begin to wire** S plan on circuit boards or installation connected to appliances. • **Learners to work** in pairs and **begin to wire** Y plan on circuit boards or installation connected to appliances. • **Learners to work** in pairs and **begin to wire** W plan on circuit boards or installation connected to appliances. • **Learners to complete** each system, carry safe isolation continuity and performance test, and confirm correct wiring. **Challenge focus:** • More able learners to **get into pairs** to attempt adding	**Resources** • BS 7671:2008 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Insulated tools • PPE • Practical portfolio • Pens and paper • Dust sheet • Certification • IEE on-site guide	• Tutor can **ask learners questions** about manufacturer's wiring downloads and literature; ask them to explain their thoughts and ask questions before installation in class. • **Check learners'** understanding of risk assessment, safe isolation and planning for work. • **Determine** whether learners correctly follow wiring procedures for S plan installations. • **Check** that learners install wiring correctly with no exposed conductor, using correct insulated tools. • **Identify** whether learners can differentiate between Y and W plan systems, and accurately install the wiring plans for the different systems. • **Confirm** correct operation of all components in each system and request remedies for any failed sections. • Check responses and solutions to the Challenge focus activity and discuss with

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
weather compensator to an S plan circuit. **Independent learning:** • Learners to **investigate** requirements for functional testing and calibration legislation for test equipment. Write a **short summary** of findings and hand in to tutor.	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels • Honeywell wiring centres • Programmers • Thermostats • Consumer units • Protected electrical circuit to appliance	the whole class.

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

English: • Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** to help with planning questions for the session. • Learners can demonstrate **writing** skills when producing a **short summary** about functional testing and calibration legislation for test equipment. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used.	**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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 17: Inspecting and testing central heating controls (workshop) **Suggested Teaching Time**: 3 hours

Learning Outcomes: 5. Install, connect and test electrically operated central heating systems

Learners will carry out inspections and testing of completed central heating controls systems with considerations of:

- visual inspections
- polarity
- earth continuity
- functional testing.

Topics: 5.3 – Inspecting and testing central heating controls

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to conduct online research or turn to the relevant chapter in textbooks to find out about operational features of installed central heating electrical systems. **Make notes** to bring to session. **Active learning:** • Tutor to lead **group discussion** about carrying out visual inspections and operating existing controls to verify operation of components. • Learners to carry out visual inspections and manually test user controls to assess correct operation of system. Learners to discuss and provide feedback in class. • Learners to **work in pairs** to test for polarity using correct instruments during a dead test. Feed back outcome with tutor. • Learners to **get into pairs** and confirm earth continuity of the selected systems, and make notes of any reading and share with the group. • Learners to **individually** carry out functional testing on a	**Resources** • BS 7671:2008 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Insulated tools • PPE • Practical portfolio • Pens and paper	• Tutor to **verify** learners' response to textbook research, as well as the range of their thoughts, ideas and questions during discussions in class before workshop session. • **Check quality** of responses in relation to inspection and testing of completed circuits. • **Check** that learners, in **pairs**, carry out correct processes when checking for polarity. • **Check** that learners, in **pairs**, carry out correct processes when checking for earth continuity. • Ask about appropriate application of temporary earth clamps. • Asses learners who individually carry out functional testing to the required standard

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
range of components selected by the tutor, eg pump, fan synchron motor. • Tutor to lead **group discussion** and gather feedback from outcomes of learner activities. • Learners to complete all commission sheets. **Challenge focus:** • More able learners to **investigate** the possible outcome if there were two means of isolation installed on a completed heating system: www.baxi.co.uk. **Independent learning:** • Learners to get into pairs and conduct **online research** on commissioning procedures for appliances, recommended service intervals and how often should an expansion vessel be re-commissioned.	• Dust sheet • Certification • IEE on-site guide **For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels • Honeywell wiring centres • Programmers • Thermostats • Consumer units • Protected electrical circuit to appliance	and make correct evaluations of the testing readings. • **Ask** learners about decisions they made on testing processes. • **Tutor** to check more able learners' understanding in the Challenge focus regarding the potential outcome of the installation of two means of isolation.

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

English: • Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** about operational features of installed central heating electrical systems.	**British values:** • Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for

© 2016 City and Guilds of London Institute. All rights reserved.

• **Speaking and listening** skills can be demonstrated in developing the various **discussions** about inspecting and testing central heating controls, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • Learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about commissioning procedures for appliances.	learners to **respect** them, and why they are **important** in the plumbing industry. **Employability:** • Learners can experience **working in a team** as part of a testing and inspection team. Check that learners are **working well together** (letting each other have input with ideas and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing). • 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 18: Visual inspections (workshop session) **Suggested Teaching Time**: 3 hours

Learning Outcomes: 6. Commission central heating systems and components

Learners will carry out visual inspections required when commissioning central heating systems, interpreting information from required sources.

Topics: 6.1 – Visual inspections

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **read** manufacturer's instructions 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 prepare and present **Presentation 13** on commissioning, which should include: visual inspection, filling and venting the system, soundness testing, flushing, operational checks and handing over. (This presentation will be required for the next few sessions.) • Tutor to **demonstrate** to learners how to carry out methods of visually inspecting central heating systems and components. • Learners to use manufacturer's instructions, industry standards, Gas and Water Regulations, and Building Regulations to establish the diagnostic requirements of hot water system components. • **Prepare** plan for individual task and risk assess area. • Tutor to lead a **discussion** about how to carry out visual	**Materials** For the tutor to devise in advance: • **Presentation 13** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• Tutor to check learners' understanding by discussing pre-learning activity in class whilst learners compare their plans/approaches for visual inspection procedures for workshop activities. • Tutor to check learners' understanding during initial 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 role-play 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. • Check that the manufacture's information has been interpreted correctly and the relevant regulation adhered to. • Verify that appropriate risk assessments are carried out with regard to different aspects of inspections.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
inspections and inspect appliances in a central heating system. **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 outcomes. • Walk around the installation and check that the installation is **correctly located** and meets industry standards. • Inspect dimensions around appliance for compliance with the regulations and standards, and future access for maintenance and repair. • Safe isolation of all services – gas/oil, electricity and water – must be verified and isolation points accessible. • 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** – boilers, radiators, radiator valves, pressure vessels, zone valves, circulators, temperature relief valves – is installed correctly and that all **joints** and unions on and around the equipment are **watertight.** • Ensure that F&E cisterns and tanks are **supported** correctly and that float-operated valves are provisionally set to the correct water level. • Verify that the filling loop is disconnected after filling the system. • Check that appliance **isolation valves** are turned off. They	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	• Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions • Ensure safe isolation where appropriate during inspection. • Check that all potential sources of leaks are inspected and confirmed watertight.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
can be turned on and tested when the system is filled with water. **Challenge focus:** • More able learners to research online the manufacturer's commissioning instructions regarding acceptable CO/CO_2 ratio for efficient and environmental friendly performance for gas and oil firing appliances. Compare ratios to other fuels such as wood and biomass, and **discuss and provide feedback** during learner group session in tutorial/upload to Moodle. **Independent learning:** • Learners to write out agreed procedures for inspection after the workshop, and add to their own plumbing dictionaries.		

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

English: • Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** about appliances and components to be commissioned. **ICT:** • More able learners have the opportunity to engage in **blended learning** in the Challenge focus task, which makes use of the centre's VLE/Moodle. 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. • Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out inspection, diagnostic and successful repair processes to the required British Standards and manufacturer's requirements through study and personal research. **Employability:** • Learners can experience **working in a team** as part of a testing and inspection team. Check that learners are **working well**

© 2016 City and Guilds of London Institute. All rights reserved.

	together, letting each another have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing. • 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 19: Filling and venting systems (workshop sessions) **Suggested Teaching Time**: 3 hours

Learning Outcomes: 6. Commission central heating systems and components

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

Topics: 6.2 – Filling and venting systems

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to **read** manufacturer's instructions for appliances and components to be filled and vented at normal operating pressure. Plan sequence and approach to activities in advance of the workshop session. **Active learning:** • Learners to individually **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 re-cap **Presentation 13** on commissioning. • Learners to prepare plan for individual task and risk assess area. Also, carry out filling of system in cold water system, in accordance with a tutor discussion using **Handout 9**; tutor to prepare the handout on the filling and venting procedures. **Workshop:** • **Fill** installation with fluid category 1 water directly from the water undertaker's mains cold water supply. • Organise stages so that the filling process can be managed comfortably. • Check for **leaks** and when learners have established that the stage is **leak-free,** they should fill the next stage. When filled,	**Materials** For the tutor to devise in advance: • **Presentation 13** • **Handout 9** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• 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 of filling and venting, by discussion and by asking questions and ensuring that they know what's required of them in the workshop task. • Tutor to ensure effective communication about processes during role-play workshop activity. • Tutors to ensure that learners have fulfilled the appropriate criteria during the workshop **filling and venting** activity through observation and offering feedback/suggestions for improvement and answering questions. • Verify that the whole system has been thoroughly vented, that no airlocks remain and that the circulators are air-free. • Tutor to review learners' dictionaries and personal course portfolios, correcting

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
allow **stabilisation** and isolate FOV of F&E. • Learners to ensure that the system is at a **normal temperature**, check for **leaks** and **check airlocks** from F&E cistern-fed supplies. • Inspect joints on boiler, radiators and cylinder, and then wipe away any **condensation** before re-inspecting. • **Vent** at highest points and at pumps, ensuring that any AAV are resealed after filling. • **Vent** the circulator. **Challenge focus:** • More able learners to **discuss** and provide **feedback** during learner group session in tutorial, giving reasons for air collecting at high points and types of problems that airlocks can produce in a system filled with an F&E cistern. **Independent learning:** • Learners to record filling and venting procedures/outcomes, and give descriptions to the processes. This should be added to learners' **plumbing dictionary and personal course portfolio** for tutor to review.	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Calibrated multimeter • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	where appropriate, offering suggestions for improvement and answering any questions.

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

English:	British values:
• Learners demonstrate **reading** skills in the pre-learning task, as they **identify** the **correct information** about appliances and	• Talk about how learners may come into contact with wider **public institutions**, such as the British Standards, and the need for

© 2016 City and Guilds of London Institute. All rights reserved.

components to be filled and vented at normal operating pressure. **ICT:** • Learners have the opportunity to engage in **blended learning** in the independent learning task, which makes use of the centre's VLE/Moodle. This is an example of **cloud-based** technology.	learners to **respect** them, and why they are **important** in the plumbing industry. • Learners to develop their **self-knowledge**, **self-esteem** and **self-confidence** when carrying out inspection, diagnostic and successful repair processes to the required British Standards and manufacturer's requirements through study and personal research. **Employability:** • Learners can experience **working in a team** as part of a testing and inspection team. Check that learners are **working well together**, letting each other have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing. • 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 20: Soundness testing (workshop session) **Suggested Teaching Time**: 4 hours

Learning Outcomes: 6. Commission central heating systems and components

Learners to conduct soundness testing on central heating systems, including metal and plastic pipework and components.

Topics: 6.3 – 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, identify equipment required and then **compare** their plans/approaches to workshop activities. **Discuss** what is required to work safely and in an organised way in accordance with British Standards **and recognised testing procedures**. • Tutor to re-cap **Presentation 13** on commissioning. • Tutor to prepare and give out **Handout 10**, outlining the soundness test procedures. Learners to also refer to water regulations, approved testing procedure from **Learning Outcome 1**, manufacturer's instructions and industry standards. • **Prepare plan** for soundness task and **risk assess** the area, eg test hydraulic pump. In large systems or individual zone, work in pairs. • Tutor to **discuss, and ask question, about safe use of equipment** with learners about agreeing a working pressure of the installation. Assess risks of components being blown off.	**Materials** For the tutor to devise in advance: • **Presentation 13** • **Handout 10** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• 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, including risks involved in the process. • Tutor to ensure clear and effective learner communication during the workshop activity. • Tutor to confirm that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Ensure risk assessment is carried out on the potential danger of components being blown off during soundness pressure test. • Inspect plan for zonal testing. • Verify full venting during test, high points and circulators.

© 2016 City and Guilds of London Institute. All rights reserved.

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 pressure testing, 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 check if there any plastic components on the metallic pipework installation and review test procedure. • 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** if a large or multi-zoned circuit is to be tested. • Confirm that all valves and equipment can **withstand the test** pressure. If not, remove and install temporary pipework. • Confirm that there are **sufficient operatives** available to conduct the test safely. • 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 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 accurately calibrated and functioning	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Hydraulic testing equipment • Calibrated multimeter • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	• Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
correctly. • **Attach the test pump** to the pipework and install extra pressure gauges if necessary. • Ensure 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 supervisor 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, eg Hep20 or John Guest Speedfit:** 1. **Test type A:** Follow same **preparation and system check** as for copper and rigid pipe for both tests. **Slowly**		

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
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**. **Challenge focus:** • More able learners to **discuss and provide feedback** during tutorial session. They should identify a practicable on-site		

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
process of carrying out separate soundness testing procedures with mixed materials on the same system, and work out what to do if you discover an unknown material in the pipework system. Upload findings to centre's VLE/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. • Download manuals from two different manufactures on their specific testing processes for plastic pipework. This should be added to learners' **plumbing dictionary and personal course portfolio** for tutor to review.		

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

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about soundness testing, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • More able learners have the opportunity to engage in **blended learning** in the Challenge focus task, which makes use of the centre's VLE/Moodle. 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 experience **working in a team** as part of a testing and inspection team. Check that learners are **working well together**, letting each other have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing.

© 2016 City and Guilds of London Institute. All rights reserved.

	• 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 21: Flushing systems (workshop session) **Suggested Teaching Time**: 4 hours

Learning Outcomes: 6. Commission central heating systems and components

Learners will learn how to flush central heating systems, specifying flushing systems and explaining requirements including the use of additives.

Topics: 6.4 – 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 re-cap **Presentation 13** on commissioning. • Tutor to give out **Handout 11: Flushing systems**, outlining the complete flushing procedure and chemical treatment. Learners to get into pairs and prepare plan for the flushing and treatment task, whilst risk assessing the area. • Tutor to lead a **discussion** about agreeing safe procedure to flush and chemically treat a central heating system. Learners to read manufacturer's literature and relevant **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 13** • **Handout 11** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• 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 that learners have fulfilled the appropriate criteria during the workshop activity through observation and offering feedback/suggestions for improvement and answering questions. • Tutor to ensure effective communication during workshop activity, especially when learners explain chemical treatment process. • Assess learners' explanations for cold and hot flushes. • Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any

© 2016 City and Guilds of London Institute. All rights reserved.

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 related to chemical treatment.
• Learners to prepare for flushing. Walk around the installation to **survey individual pipe runs,** and give the client an **expected duration** of work and expected outcome.
• Check that F&E **cisterns** are filled with clean water and that pipework is connected to undertaker's main.
• Carry out flushing **to the whole pipework system**:
  • **cold** flushing after soundness test
  • **hot** flush to remove excess residues
• Learners to individually explain chemical treatment of a system to the tutor and risk asses the area.
• Explain in pairs how to calculate **system pipework volume** and apply **chemicals** to system via cistern (use separate dosing apparatus for sealed systems).
Challenge focus:
• **Discuss and provide feedback** during learner group session in tutorial or end of practical session. Research the application of chemical cleansing and see if all boiler manufactures require this process. If not then find the reason why and upload results to Moodle.
Independent learning:
• Learners to investigate manufactures of magnetic cleaning apparatus, and look at new innovations in the UK and the plumbing problems they solve. This should be added to learners' **plumbing dictionary and personal course portfolio** for the tutor to review.
	For workshop appliances
	• Open vented boilers
	• System boilers
	• Combination boilers
	• Radiators
	• Circulator
	• Pressure vessels
	For test instruments
	• Flow jug or gauge
	• Pressure gauge
	• Hydraulic testing equipment
	• Calibrated multimeter
	• Tools
	• PPE
	• Practical portfolio
	• Pens and paper
	• Dust sheet
	For test instruments and special equipment/materials
	• Chemical corrosion inhibitor, cleaners
		questions.
		• Tutor to engage with learners' research about the application of manufacturer's variations on requirements, in order to treat systems.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
	• PPE, eg gloves, goggles, face mask, plastic apron • Practical portfolio • Pens and paper • Warning notices	

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

English:

- **Speaking and listening** skills can be demonstrated in developing the various **discussions** about flushing systems, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**.

ICT:

- More able learners have the opportunity to engage in **blended learning** in the Challenge focus task, which makes use of the centre's VLE/Moodle. 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 experience **working in a team** as part of a testing and inspection team. Check that learners are **working well together**, letting each other have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing.
- Learners can show **resilience** by sticking to the flushing 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 22: Operational checks (workshop session) **Suggested Teaching Time**: 4 hours

Learning Outcomes: 6. Commission central heating systems and components

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

Topics: 6.5 – Operational checks during commissioning

Key learning activity/approach	Suggested materials and resources	Skills check
Pre-learning: Learners to plan a sequence and approach in preparation for activities in workshop. **Read** relevant section in textbook and refer to manufacturer's instruction for appliances and components. **Active learning:** • Learners to get into pairs and **compare** their plans/approaches to workshop activities. • **Discuss** in groups what is required to work safely and in an organised way in accordance with BS 8000. Carry out operational checks on central heating systems or components to ensure correct performance in accordance with manufacturer's instructions and industry standards. • Tutor to re-cap **Presentation 13** on commissioning. • **Prepare plan** for individual task and risk assess area. • **Tutor to lead** a group **discussion** about carrying out an operational check in accordance with tutor brief/scenario discussion/role play in central heating system components and carry out repair work using **Handout 12** prepared by the tutor, outlining all the operational checks required.	**Materials** For the tutor to devise in advance: • **Presentation 13** • **Handout 12** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• 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 meaningful and 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. • Check functional testing procedures and confirmation of correct system performance. • Tutor to engage in research in Challenge focus activity for a totally independent system. • Tutor to review learners' dictionaries and

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
Workshop: • Introduce and identify (ID card) yourself to 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 system control and **interlock** function. • **Test operation of circulating pumps and check for** presence of air, noise transmission, leaks and casings. Measure at pressure and flow inlets and outlets with bourdon gauge, either installed on sealed system or at test point on pipework. • Check flow and return appliance and at radiators and balance system. • **Functional test** of immersion or control switches on electric water heater. • **Functional test**: check operation of pump, interlocks and process of air pressure switch, and check **safe sequence of operation**. • 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 (if a Combi). • **Check pressure** relief valve and test **backflow** at test point on double check valve. • **Operate** gate valves and stop valves to appliances. • Confirm appliance and components operational performance in accordance with the manufacturer's instructions. • Explain outcome to customer, hand over any documents or	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Hydraulic testing equipment • Calibrated multimeter (GS38 compliant) • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	personal course portfolios, correcting where appropriate, offering suggestions for improvement and answering any questions.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
paperwork and clean the area. **Challenge focus:** • More able learners to devise a fully controlled system that does not rely on energy AC from the national grid. • **Discuss and provide feedback** during learner group session in tutorial/upload to centre's VLE/Moodle. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information regarding functional testing and requirements of using instruments to GS38. This should be added to learners' **plumbing dictionary and personal course portfolio** for tutor to review.	**For test instruments and special equipment/materials** • Practical portfolio • Pens and paper • Warning notices	

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

English: • **Speaking and listening** skills can be demonstrated in developing the various **discussions** about operational checks, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**. **ICT:** • More able learners have the opportunity to engage in **blended learning** in the Challenge focus task, which makes use of the centre's VLE/Moodle. 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 experience **working in a team** as part of testing in pairs/small groups. Check that learners are **working well together**, letting each other have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing.

© 2016 City and Guilds of London Institute. All rights reserved.

	• 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**.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 23: Handover procedures

Suggested Teaching Time: 3 hours

Learning Outcomes: 6. Commission central heating systems and components

Learners will carry out handover procedures and give an explanation of the ErP requirements.

Topics: 6.6 – Handover procedures following commissioning

Key learning activity/approach	Suggested materials and resources	Skills check

Pre-learning: Learners to conduct **online research** on ErP requirements from manufacturer's web pages and think about how to explain this information to a customer.
Active learning:
• Tutor to lead a **discussion** about handing over and explaining **ErP** requirements to a customer with tutor brief/scenario discussion/role play in central heating systems.
Workshop:
• 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
  • explain relevance of the **ErP** (Energy-related Products) to customers and how certain combinations of appliances can increase or decrease the overall efficiency of an installed system
  • explain how this information is located on each appliance and manufacturers must comply since September 2015 and produce **product fiche** data to help with the selection and coordination of the most efficient systems for the end user
  • give details on how the **system operates** as planned
	Resources
	• BS 5449
	• BS 6946
	• BS 6700
	• CIPHE design guide
	• Manufacturer's instructions
	• Domestic heating compliance guide
	• Gas Safe Installation and Use Regulations
	• Part P and L of the Building Regulations
	
	For workshop appliances
	• Open vented boilers
	• System boilers
	• Combination boilers
	• Radiators
	• Circulator
		• 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.
		• Ensure that the ErP process is explained to the end user, as well as how the energy source and combination of appliances affect the rating of the whole system.
		• Tutors 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

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• describe that fittings are **clean and ready to use** • explain **how** the system works • **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 job details, and **compliance certification** and 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 **improving efficiency of new systems in relation to the ErP directive** and compare the effect of electrical and gas energy sources on similar system with regard to efficiency rating. • Note how the rating for electrical energy ranges in relation to the fuel used at an electricity generating power station. **Independent learning:** • Learners to record actions and outcomes, as well as any additional new information, and add key features to the work carried out, including descriptions and processes. This	• Pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Hydraulic testing equipment • Calibrated multimeter (GS38 compliant) • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet **For test instruments and special equipment/materials** • Practical portfolio • Pens and paper • Warning notices	questions. • In the **Challenge focus** discuss with learners how the European ErP directive has a new rating for electrical energy production.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
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 can be demonstrated in developing the various **discussions** about handover procedures, **giving a point of view** as well as **allowing** and **responding** to **others' opinions**.

ICT:

- More able learners have the opportunity to engage in **blended learning** in the Challenge focus task, which makes use of the centre's VLE/Moodle. 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 experience **working in a team** as part of a testing and inspection team. Check that learners are **working well together**, letting each other have input with ideas, and all are **contributing** in an appropriate way by organised discussion and sharing of methods of functional and operational testing.
- 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 with regard to **ErP** in the handing over to the customer exercise rather than using their everyday communication with their supervisor or work mates. For example, no jargon will be used.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 24: Diagnostic checks (workshop session)

Suggested Teaching Time: 4 hours

Learning Outcomes: 7. Diagnose and rectify faults in central heating systems and components

Learners will carry out diagnostic checks required for common faults on central heating systems.

Topics: 7.2 – 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 and research diagnostic methodologies from textbooks. Consider 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 individual plans/approaches to workshop diagnostic activities. • Tutor to **check individual plans**, and assist learners to prepare for individual tasks and risk assess the area. • Learners to **safely isolate** central heating systems and components to prevent them being brought into operation before the diagnostic processes and repairs have been fully completed. • Tutor to hand out **manufacturer's instructions** and industry standards to show the diagnostic requirements of heating system components. • **Explain process** of ordering replacements for damaged or defective components from manufacturer's short parts list and specific number needed for the original parts used. • Tutor to **discuss** how to carry out the diagnostic tests in accordance with **scenario/role play**, locate faults in cold	**Materials** For the tutor to devise in advance: • **Handout 12** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE designg • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• 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 ensure effective communication during workshop role-play activity. Tutor to ensure that learners have checked the following. 1. **Safe isolation** checks for electrical power and water at appliance. 2. **Read** technical information for pressure and flow rates in manufacturer's instructions. 3. Test operation of **pumps** and zone valves while following the agreed sequence of testing appliance, and measure pressure in accordance with the manufacturer's performance criteria. 4. **Analyse fault** procedure for impeller

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check

water system components and carry out repair work on an unvented cylinder installation.
Workshop:
• Read and refer to **Handout 12** prepared by the tutor, outlining all the diagnostic checks required.
• 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.
• **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**: presence of air, noise transmission, leaks and casings
  • Measure at pressure, and flow inlets and outlets
  • Check capacitor; motor repair or replace
• **Check pressure of pressure relief valves.**
  • Check water flow and pressure at outlets
• **Electrolytic corrosion within radiator and pipework**
  • Check the colour of the water within a designated vessel
  • Cold spots in radiators
  • Make decision to remedy problem by installing a device to remove magnetite or flush and chemical cleanse
  • **Thermostats** manual and electrical testing with multimeter/check temperature at outlets
  • **zone valve**, manual lever and synchron motor test
  • **TRV** release and check operation
  • **pump over**, visual at F&E
	For workshop appliances
	• Open vented boilers
	• System boilers
	• Combination boilers
	• Radiators
	• Circulator
	• Pressure vessels
	
	For test instruments
	• Flow jug or gauge
	• Pressure gauge
	• Hydraulic testing equipment
	• Calibrated multimeter (GS38 compliant)
	• Tools
	• Materials
	• PPE
	• Practical portfolio
	• Pens and paper
	• Dust sheet
		jammed or stuck, motor burn-out and capacitor starting.
		5. **Examine** the process of testing pressure relief valves.
		6. **Electrolytic corrosion**: ensure corrosion is detected and problem located.
		• Tutor to review learners' dictionaries and personal course portfolios, correcting where appropriate.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• **Programmers**, electrical performance check • **Flame rectification** fault finding flow chart • **Specify remedy** to diagnosed problems. • **Action plan**. **Challenge focus:** • More able learners to use calibrated multimeter on practice area, isolated by tutor or electrician. Practise dead testing and then fault find for component failure on a zone valve motor and a pump capacitor on a wiring centre. **Independent learning:** • Learners to record actions and outcomes, as well as any additional information, and include their own ideas and discoveries, adding key features to the work carried out including descriptions and processes. This should be added to learners' **plumbing dictionary and personal course portfolio** for tutor to review.	**For test instruments and special equipment/materials** • Practical portfolio • Pens and paper • Warning notices	

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. • 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:** • 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 personal research. **Employability:** • Learners should demonstrate they can **actively listen** during the effective communication/role-play session in the workshop,

© 2016 City and Guilds of London Institute. All rights reserved.

	understand what has been said and **respond/act** accordingly by carrying out safe practices and successful diagnosis and repair in relation to industry standards.

© 2016 City and Guilds of London Institute. All rights reserved.

Session 25 and 26: Obtain information on and perform repair/rectify procedures (workshop sessions) **Suggested Teaching Time**: 6 hours

Learning Outcomes: 7. Diagnose and rectify faults in central heating 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: 7.1 – Obtaining information on system faults; 7.3 – 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 pump failure fault on a heating system and bring to the class. **Active learning:** • Tutor to **discuss** learners' findings from the pre-learning exercise and share the examples of questions to ask customers. • Tutor to prepare and present **Presentation 14** on the connection and testing of the electrically operated components in a central heating system; ask **learners to download** manufacturer's technical information and electronic fault finding tools, and **facilitate a discussion**. • Tutor to facilitate a group **discussion**, asking learners about the importance of reading and deciphering manufacturer's flow charts, and ask about the process of carrying component performance within a system. Learners to examine **Handout 13,** which outlines the correct safe electrical isolation procedure. • Tutor should also **describe** the manufacturer's commissioning procedures and give details on repair methods for a range of heating components.	**Materials** For the tutor to devise in advance: • **Presentation 14** • **Handout 13** **Resources** • BS 5449 • BS 6946 • BS 6700 • CIPHE design guide • Manufacturer's instructions • Domestic heating compliance guide • Gas Safe Installation and Use Regulations • Part P and L of the Building Regulations	• **Tutor will verify** by questioning, including fault history dates and characteristics of problem. • **Assess understanding** of the importance of manufacturer's instructions, warranty requirements, regulations and benchmark form completion. • **Verify learners' comprehension** of manufacturer's instructions and their precedence over BS. Describe short parts list. • **Monitor and assess** learners' responses to specific installation problems and malfunctions, and test methods. • **Ask** learners to explain logical sequence of testing in accordance with the manufacturer's performance criteria. • **Assess learners' responses** to tutor-led discussion about effective action carried out to diagnose and remedy faults, remedies from manufacturer's instructions, flow carts and learners' own methods

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
• **Learners, in pairs, to carry out repairs** for motors on zone valve and pumps using a calibrated multimeter, a system and flow switches. • Learners to give details of procedures used for checking and replacing defective valves, and repairing TRVs and blocked pipework. • Tutor can refer to baxi.co.uk to explain the process for checking ignition failure of boiler with flame rectification system. • Learners to **actively fault find** and solve boiler ignition process failure using flow charts and testing equipment. • Tutor to lead a **discussion**, describing routine checks for safety relief valves. • Tutor to explain process for checking and remedying pump over problems in F&E cistern. • Learners, in pairs, to explain completion of rectification process to the client (tutor or learner role play) and explain preventative steps, ie install a magnetic filter. **Challenge focus:** • More able learners to conduct **online research** to explore how to remove magnetite from heating systems. • Play videos to class (www.adey.com/video) and explain remedies to common heating circulation problems. **Independent learning:** • Learners to think about the activities in the workshop session regarding fault finding, and **make a list** of PPE and equipment they would carry to enable a solution to a range of problems, such as cold spots in radiators and blockages that would be most appropriate for each scenario.	**For workshop appliances** • Open vented boilers • System boilers • Combination boilers • Radiators • Circulator • Pressure vessels **For test instruments** • Flow jug or gauge • Pressure gauge • Hydraulic testing equipment • Calibrated multimeter (GS38 compliant) • Tools • Materials • PPE • Practical portfolio • Pens and paper • Dust sheet	• Assess quality and effectiveness of practical actions. • Research technical information, and add key features and descriptions to your **plumbing dictionary**.

© 2016 City and Guilds of London Institute. All rights reserved.

Key learning activity/approach	Suggested materials and resources	Skills check
	For test instruments and special equipment/materials • Practical portfolio • Pens and paper • Warning notices • www.adey.com/video	

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

English: • Learners can demonstrate **writing** skills when producing a **short summary** about the questions they would ask a customer in order to carry out a repair of a pump failure fault on a heating system. Check that learners have used **formal language** appropriately. Ensure that correct **spelling**, **punctuation** and **grammar** have been used. **ICT:** • More able learners have the opportunity to use **advanced search techniques** to **locate, select and evaluate** relevant online sources that provide suitable information about removing magnetite from heating systems.	**Employability:** • Learners should gain an understanding of the **wider** construction **industry** by communicating with manufacturers via their online resources and downloading fault finding information which can improve knowledge of **technical terms**, jargon, and common problem-solving methods. These processes can help learners to gain credibility during discussions in interviews by referring to their practical knowledge, which is useful to employers, when applying for jobs or work experience.

© 2016 City and Guilds of London Institute. All rights reserved.