Unit 317PH: Understand central heating system installation, commissioning, service and maintenance technique

# Delivery guide

Unit information

The purpose of this unit is for learners to obtain trade experience in plumbing and heating installations.

The purpose of this unit is for learners to explore central heating systems within a domestic property and industrial and commercial building and the competences that underpin work on the different systems. Learners will have the opportunity to:

* install and test central heating systems
* commission central heating systems
* service and maintain central heating systems.

This work will be in accordance with the current versions of the appropriate industry standards and regulations; the specification; industry recognised working practices; the working environment and the natural environment.

Learners may be introduced to this unit by asking themselves questions such as:

* What are complex central heating systems?
* What steps must you take to design a central heating system including appliances, components and accessories?
* What steps are part of commissioning appliances, components and accessories on a central heating system?
* How do you service and maintain appliances, components and accessories on a central heating system?

Learning outcomes

1. Understand the applications, advantages and limitations of appliances, components and accessories
2. Understand the appropriate industry standards and regulations
3. Understand the organisational procedures for confirming with the relevant people the appropriate actions to be taken to ensure that any variations to the planned programme of work will not introduce a hazard and have minimum negative impact on the installation work to be undertaken
4. Understand the appropriate testing procedures for confirming the systems’ integrity
5. Understand how to complete relevant documentation in accordance with organisational procedures
6. Understand the methods for determining the type of size of appliances, components and accessories
7. Understand how to interpret diagrams and drawings for the system to identify the planned location of the appliances, components and accessories
8. Understand the methods and techniques for fitting, fixing and connecting the selected appliances, components and accessories
9. Understand the visual and manual checks required to confirm that the appliances, components and accessories have been fixed, fitted and connected
10. Understand the methods and techniques for commissioning the central heating system
11. Understand the methods for determining the type of size of replacement appliances, components and accessories
12. Understand the methods and techniques for servicing and maintaining appliances, components and accessories
13. Understand the methods and techniques for replacing/repairing the appliances, components and accessories
14. Understand basic fault-finding techniques

Suggested resources

Textbooks

* *Domestic Building Services Compliance Guide* (2018). Crown Copyright.

ISBN 978-1-8594-6880-7

* *HVDH Domestic Heating Design Guide* (2021). London: Domestic Building Services Panel (DBSP).

ISBN 978-1-9120-3488-8

* Maskrey, M. (2019) *The City & Guilds Textbook: Plumbing Book 1 for the Level 3 Apprenticeship (9189), Level 2 Technical Certificate (8202) & Level 2 Diploma (6035) (City & Guilds Textbooks)).* London: Hodder Education.

ISBN 978-1-5104-1648-2

* Tanner, P. and Stephen, L. (2019) *The City & Guilds Textbook: Plumbing Book 2 for the Level 3 Apprenticeship (9189), Level 3 Advanced Technical Certificate (8202) & Level 3 Diploma (6035) (City & Guilds Textbooks).* London: Hodder Education.

ISBN 978-1-5104-1646-8

* Young, L. and Graham, M., (2000) *Water Regulations Guide. Water Regulations Advisory Scheme*. Stockport: WRAS.

ISBN 978-0-9539-7080-3

Websites

* [Baxi Boilers | Homepage](https://www.baxi.co.uk/)
* [BPEC | Central heating system specifications (CHeSS) 2008](https://bpec.org.uk/downloads/CE51%20CHeSS%20WEB%20FINAL%20JULY%2008.pdf)
* [Danfoss | Controls](https://www.danfoss.com/en-gb/)
* [Gas Safe Register | Homepage](https://www.gassaferegister.co.uk/)
* [Grundfos | Homepage](https://uk.grundfos.com/)
* [HETAS | Homepage](https://www.hetas.co.uk/)
* [Honeywell Home | Honeywell Controls](https://heatingcontrols.honeywellhome.com/)
* [Ideal Heating | Benchmark checklist](https://idealheating.com/uploads/documents/benchmark-checklist.pdf)
* [OTFEC | Homepage](https://www.oftec.org/)
* [Planning Portal | Homepage](https://www.planningportal.co.uk/)
* [Worcester Bosch | Homepage](https://www.worcester-bosch.co.uk/)

British Standards

* BS EN 14336. *Heating systems in buildings. Installation and commissioning of water-based heating systems*.

Legislation

* *Building Regulations 2010 Approved Document A: Structure*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6508-0

* *Building Regulations 2010 Approved Document L1A: Conservation of Fuel and Power in New Dwellings*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6743-5

* *Building Regulations 2010 Approved Document L1B: Conservation of Fuel and Power in Existing Dwellings*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6744-2

* [GOV.UK | Domestic Building Services Compliance Guide](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697525/DBSCG_secure.pdf)
* [GOV.UK | The Gas Safety (Installation and Use) Regulations 1998](https://www.legislation.gov.uk/uksi/1998/2451/contents/made)

| **Learning outcomes** | **Criteria** | **Delivery guidance** |
| --- | --- | --- |
| 1. Understand the applications, advantages and limitations of appliances, components and accessories in relation to the working environment | * 1. The working principles of central heating systems, positioning fixing, connection and operation of components | * Learners to be able to describe the working principles of central heating systems, positioning fixing, connection and operation of the following components: * programmer * timer * thermostats * programmable room thermostat * optimiser * frost thermostat * wiring centre * cylinder thermostat * expansion vessel * automatic by-pass * bespoke heat emitters * panel radiators * column radiators * low surface temperature radiators * fan * convectors * plinth heaters * towel warmers * underfloor heating components * manifolds * pump control unit * insulation * pipework * manifold isolation * ball valves * supports * controls * additives * low loss headers * buffers * pressure relief valves * expansion joints * corrosion filters * low loss headers for multiple boiler installation * multiple heat producing appliances installation. * Learners to understand the appropriate positions of motorised zone valves used in controlling different zones and the requirements for zonal area control domestic heating systems. * Learners to have an overview of the time and temperature control strategies for domestic heating systems. * Learners to know the operating principles of devices used in central heating systems to minimise the build-up of sediment. |
| * 1. The expansion and contraction in central heating systems and negative effects | * Learners to develop their understanding of expansion and contraction of pipework in central heating systems and to know the measures to take when installing pipework in different situations, including expansion loops and bellows. |
| * 1. The importance of pump positioning | * Learners to understand the key points to consider when looking at pump position and the factors to consider on positive and negative system pressure. * Learners to be able to explain the requirements for the installation of pump valves. |
| * 1. The operating principles for system controls | * Learners to be able to explain the operating principles of central heating control components including: * time * temperature * weather compensation * delayed start * optimum start * home automation systems * smart control systems and associated equipment * correct connection to home wi-fi networks * internet of things (IoT) * multiple boiler controls * zoning requirements. * Learners to be able to explain multiple boiler installations and the controls required for these system types. |
| * 1. The insulation requirements and system frost protection | * Learners to be able to explain the reasons for insulating central heating pipework to save energy, reduce CO2, improve draw off temperature at the outlet, maintain water temperature and for frost protection. * Learners to be able to describe insulation types (foil backed lagging, nitrile rubber) and areas of the building where pipework must be insulated, for example in lofts and under suspended floors. * Learners to be able to explain the requirements for pipework positioning to prevent undue warming, for example running central heating pipework away from the cold water pipework. * Learners to be able to discuss installation requirements of frost thermostats and pipe thermostats on central heating systems and where these controls may be required. |
| * 1. The operating principles of air and ground source heat pumps | * Learners to be able to describe the operating principles of air source and ground source heat pumps. * Learners to be able to describe the basic operating principles of ground source heat pumps including types of heat collection loop: horizontal and vertical and types: ground to air and ground to water. * Learners to be able to describe the basic operating principles of air source heat pumps: air to air and air to water. * Learners to know how to explain the operating principles of water source heat pumps. |
| 1. Understand the appropriate industry standards and regulations relevant to  * decommissioning * installing and testing * commissioning * service and maintenance of central heating systems | * 1. The zoning and control requirements of central heating systems in accordance with statutory legislation | * Learners to be aware of the zoning and control requirements for buildings over 150m2 as detailed in the Domestic Building Services Compliance Guide. |
| * 1. The information sources required to complete testing and commissioning | * Learners to be able to identify the information sources required to complete testing and commissioning of central heating systems including: * The Water Supply (Water Fittings) Regulations 1999 * BS EN 14336. Heating systems in buildings. Installation and commissioning of water-based heating systems * Manufacturer instructions detailing specific requirements for commissioning central heating system components * Building Regulations * The Domestic Building Services Compliance Guide. |
| 1. Understand the organisational procedures for confirming with the relevant people the appropriate actions to be taken to ensure that any variations to the planned programme of work will not introduce a hazard and have minimum negative impact on the installation work to be undertaken | * 1. What may be communicated to the client through the progress of a job | * Learners to be aware of the information that may be communicated to the client throughout the progress of a job including: * start and finish times * changes to specifications * alternative sources whilst systems are being decommissioned * confirming the location of components * requesting valuable items are removed whilst installation work is undertaken * information regarding delivery orders/deliveries * delays to progress. * Learners to be able to explain suitable communication methods including: * verbal communication * written communication * emails * text messages. * Learners to be able to identify any changes to the work programme and to know how to respond to these changes. |
| * 1. The types of communication that may be required with the site management team | * Learners to be aware of the types of communication that may be required with the site management team including: * architect * quantity surveyor (QS) * buyer/estimator * surveyor * project manager/clerk of works * structural engineer * building services engineer * contracts manager * construction manager. * Learners to be able to explain suitable communication methods such as communicating with the clerk of works to confirm the position of system components, including by: * verbal communication * written communication * emails * text messages. |
| * 1. The importance of complying with company policies and procedures | * Learners to be able to discuss the importance of complying with company policies and procedures and the consequences of not adhering to them for example, not complying with company health and safety policies could result in disciplinary action. |
| * 1. The impact when materials are not delivered on time against the work programme | * Learners to be able to explain the impact when materials are not delivered on time including: * delays in completion * effect on the work programme on other trades * delays affecting other deliveries. |
| * 1. The factors which affect working time allocation to work activities | * Learners to be aware of the factors that affect working time allocation to work activities including: * material availability * labour requirements * staff experience * delivery requirements * labour availability * weather * environmental * client deadlines. * Learners to be able to discuss time management whilst on installations, keeping track of them time using organisational procedures such as timesheets and to be aware of the overall impact these hours could have on any overarching schedule of work. |
| 1. Understand the appropriate testing procedures for confirming the systems’ integrity | * 1. How to fill and vent central heating systems | * Learners to be able to discuss the methods of filling and venting a central heating system. * Learners to be able to explain the process for filling and venting open vented systems as follows: * ensure that all radiator valves and radiator air-release points are closed * ensure that all motorised valves are manually set to the open position for initial system filling * turn on the service valve to the Feed and Expansion (F&E) cistern and allow the system to fill * starting with the furthest away radiator on the downstairs circuit, open the radiator valves and fill and bleed the air from each radiator * check the water level in the F&E cistern. * Learners to be able to explain how to fill and vent a sealed central heating system and to know that it is filled in short bursts via the filling loop after a successful test by: * turning on the filling loop * filling the system up to operating pressure * turning off the filling loop * bleeding the air from the radiators until the pressure has depleted * restarting the process until the system is full. * Learners to be able to describe the process of bleeding a radiator. * Learners to be able to discuss the installation of manual and automatic air vents on system pipework. * Learners to be able to provide examples of filling and venting central heating systems in a variety of settings. |
| * 1. A soundness test to industry requirements on central heating systems pipework and components | * Learners to be able to describe a soundness test using pressure testing equipment to industry requirements on central heating systems with metallic and plastic pipework and components including: * visual inspection * notifying occupants * initial fill * stabilisation * testing to required pressure * checking for leaks * checking pressures after test period * completing documentation and notifying as required. * Learners to be made of aware the equipment used, including test pressure and test durations and to be given the opportunity to use the equipment for a simulated test. * Learners to be shown how to use hydraulic test equipment. * Learners to understand that any leaks must be rectified and re-tested before a test certificate is issued. * Learners to know the reason for a timed stabilisation period prior to carrying out a soundness test. * Learners to know how to fill and vent central heating systems following a successful soundness test. |
| 1. Understand how to complete relevant documentation in accordance with organisational procedures | * 1. The types of information to be provided on commissioning, installation and maintenance records | * Learners to be aware of the information contained on commissioning, installation and maintenance records for example, installation date, type of system installed, name of engineer, parts maintained, pressures, flow rates, temperatures, materials used, test information. * Learners to know the types of information that should be contained within a commissioning document and to be familiar with the Benchmark Logbook. * Learners to be provided with examples of commissioning, installation and maintenance records. * Learners to understand how to comply with the Building Regulations notification requirements. * Learners to know the procedure for notifying relevant authorities of work carried out on central heating systems. * Learners to know the types of additional information that should be contained within a maintenance record for central heating systems. * Learners to be able to give the appropriate advice on the safe use of a central heating system to the customer and to understand that component manufacturer’s instructions should be left and explained to the customer on handover. |
| 1. Understand the methods for determining the type of size of appliances, components and accessories in accordance with industry recognised organisational procedures | * 1. The factors which affect the selection of central heating systems for dwellings | * Learners to be aware of the factors that affect the selection of central heating systems for dwellings including: * size of household * affordability/cost * type of property * customer needs * building layout and features * energy efficiency * environmental impact * occupancy and purpose * appliance location * storage type/location * legislation. |
| * 1. The information sources required to size and select central heating systems and components | * Learners to know the following information sources are required to size and select cold water system components: * Approved Document L – Conservation of fuel and power * L1A is applicable to new dwellings * L1B is applicable to existing dwellings * Approved Document J – Combustion appliances and fuel storage * The Water Supply (Water Fittings) Regulations 1999 * The Domestic Building Services Compliance Guide * manufacturers’ technical instructions * The Gas (Installation and Use) Regulations 1998 * HVDH Domestic Heating Design Guide * The Central Heating System Specifications (CHeSS) * plans and drawings * pre-determined data * specifications * industry standards * verbal and written feedback from the customer. |
| * 1. The principles of heat loss and gain and how this affects heating requirements | * Learners to be able to explain the principles of heat gain. * Learners to know that the heat that a building loses must be replaced with more heat to maintain a comfortable temperature within each room. * Learners to know that heat loss occurs in two ways: * due to ventilation (air changes) * through the fabric of the building. * Learners to know that, in the same way as buildings lose heat in the winter, they can also gain heat in the summer months due to: * surrounding warm air * direct solar radiation. * Learners to know that electrical equipment, pipework and internal occupants also contribute to the heat gain within a building. * Learners to understand the importance of internal and external design temperatures and how these impact on selection and positioning of systems and components. * Learners to know that both heat gain and heat loss need to be taken into consideration when calculating heat requirements of a building and, where required, energy efficiency measures discussed with the customer e.g., loft insulation. |
| * 1. How to calculate central heating system requirements used in dwellings | * Learners to be provided with different sources of information to calculate system requirements including: * total heat load * emitter load * hot water allowance * pipe size * pump size * emitter size * expansion * head pressure and discharge for circulator pumps * size of a suitable boiler for a given central heating system * whole house boiler sizing for replacement boilers as per CHeSS. |
| * 1. How to select central heating components in accordance with calculations from predetermined data | * Learners to be provided with system requirements and different sources of information to select system components using pre-determined data including: * emitter * pipework * boiler * pump * expansion vessel. * Learners to determine how to make the required selection of components. |
| 1. Understand how to interpret diagrams and drawings for the central heating system to identify the planned location of the appliances, components and accessories | * 1. Interpret information to complete a detailed materials list | * Learner to be aware of how to interpret information from a range of sources including diagrams and drawings to complete a detailed material list. Material lists should include quantities, colours/grades/sizes of: * pipework * consumables * fittings * components * fixings. * Learners to be aware that when ordering from a plumber’s merchant, product codes should also be included. * Learners to be shown how to prepare a quotation from design information and calculations and to understand the method of presenting and producing a tender. * Learners to be introduced to the use of scale drawings and to understand the formula to determine full scale measurements from the drawings. * Learners to be able to develop this understanding and look at the contents of drawings, plans and specifications. |
| * 1. Present calculations and information in a suitable format for quotation and tender | * Learners to be aware of the methods to present calculations and information in various formats. * Learners to know that scale drawings are produced to show the customer the proposed final installation. * Learners to know that technology and bespoke computer programmes, 3D drawings and artist impressions can be produced showing what the installation will look like when completed. * Learners to know that spreadsheets can be used to present design calculations. Functions can also be added to automatically calculate data. * Learners to know that Word documents and spreadsheets can be used to produce quotes, material lists and write job specifications to supplement drawings. * Learners to be given the opportunity to present calculations using a range of formats and to prepare line drawings to present design calculations. * Learners to know the process of using specifications when carrying out design calculations. * Learners to understand the method of presenting and producing a tender. |
| 1. Understand the methods and techniques for fitting, fixing and connecting the selected appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturers’ instructions | * 1. How to install central heating systems | * Learners to know the procedures to follow to install the following components, appliances and accessories in compliance with manufacturer instructions, industry requirements and current regulations and standards: * boiler/jig * pump * motorised valve * expansion vessel * radiator * radiator valves * underfloor heating * controls * valves. * Learners to know the documentation that needs to be followed when fitting components, appliances and accessories. * Learners to be aware of how to connect hot water pipework to components using LCS, plastic and copper pipework. * Learners to be given the opportunity to install hot water systems in a realistic working environment. |
| 1. Understand the visual and manual checks required to confirm that the appliances, components and accessories have been fixed, fitted and connected in accordance with:  * the plumbing and heating system’s design * the working environment * organisational procedures | * 1. A visual inspection of a central heating system to confirm that it is ready to be soundness tested | * Learners to know the reasons for a visual inspection prior to charging a system with water. * Learners to know the visual checks required for a central heating system before it is filled. * Learners to be able to explain the steps taken during a visual inspection to confirm the central heating system is ready to be soundness tested including: * checking that all joints have been made correctly * checking that all pipework is secure * checking the installation conforms to the Water Regulations * checking drain-off valves have been closed off * checking radiators have been installed correctly and are level. * Learners to understand the procedure to follow if they identify installation faults on central heating systems whilst carrying out a visual inspection. * Learners to know that any problems, such as insufficient clipping of pipes, should be rectified before testing begins. * Learners to be provided with an overview on: * the method of filling a sealed system with water using a temporary filling loop * the method of filling an open vented system with water through the feed and expansion cistern * why the system should be filled to normal working pressure and inspected for leaks. |
| 1. Understand the methods and techniques for commissioning the central heating system in accordance with:  * the plumbing and heating system’s design * the working environment * organisational procedures | * 1. The flushing requirements, including the use of system additives for new and existing central heating systems | * Learners to be informed of the requirements for flushing a central heating system, both hot and cold, before putting to work and following soundness testing. * Learners to be aware of the flushing requirements, including the use of system additives and inhibitors for new and existing systems as detailed in manufacturer instructions and system additives like neutralisers and cleansers. * Learners to be able to explain the procedures for the use of power flushing machines. |
| * 1. The operational checks required during commissioning | * Learners to be able to describe the operational checks required during commissioning of central heating systems including: * temperature * flow rate * pressures * operation of controls. * Learners to be provided with the opportunity to undertake the commissioning procedure and carry out operational checks including: * how to check the temperature and alter to align to manufacturer and industry standards * how to check the operation of controls. |
| * 1. The commissioning procedures for central heating systems | * Learners to be aware of the commissioning procedure for cold water systems including: * visual inspection * fill and vent * soundness test * flush * operational checks * commissioning documentation * handover procedure. * Learners to know the commissioning procedure that must be followed in-line with the manufacturer instructions and industry guidance. * Learners to understand the commissioning procedure and how to balance the system. |
| * 1. The range of information that would be detailed on commissioning documentation | * Learners to be aware of the information contained on a commissioning record for example: * installation date * type of system installed * name of engineer * serial numbers * heat source * temperatures * flow rates. * Learners to be provided with examples of commissioning records. * Learners to be introduced to the Benchmark Scheme. |
| * 1. The actions that must be taken when commissioning reveals defects | * Learners to be able to identify the actions that must be taken when inspection and testing reveals defects in central heating systems. * Learners to know how to deal with: * systems that do not meet correct installation requirements including insulation requirements * remedial work associated with defective pipe work bracketing * remedial work associated with leakage from pipe work systems * remedial work associated with poor circulation in heat emitters * remedial work associated with flow rate through heating systems. * Learners to be provided with practical examples and asked to come up with solutions to rectify the defects. |
| * 1. The procedure for handing over to the end-user | * Learners to be aware that, once the system has been tested and commissioned, it can be handed over to the customer. * Learners to know the handover process, including: * a full demonstration of any system controls * an overview of system maintenance requirements including durations * an explanation of what to do in the event of an emergency including isolation points and procedures where applicable. |
| 1. Understand the methods for determining the type of size of replacement appliances, components and accessories in accordance with industry recognised organisational procedures | | * Learners to understand the methods for determining the type of size of replacement appliances, components and accessories using design data, pre-installed systems and manufacturer information. * Learners to be provided with examples and to be asked to determine the type of size of replacement appliances, components and accessories. |
| 1. Understand the methods and techniques for servicing and maintaining appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturers’ instructions | * 1. How to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components | * Learners to be able to explain how to the use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of central heating system components. * Learners to be able to provide examples of manufacturer instructions and job maintenance schedules. |
| * 1. The routine checks required on central heating system components and pipework as part of a periodic maintenance programme | * Learners to be able to explain how to how to carry out routine checks on hot water systems and components as part of a periodic maintenance programme including: * visual inspection of pipework for leakage, adequate support and insulation * effective operation of terminal fittings * effective operation of float operated valves * effective operation of service valves * condition of hot water cylinder * condition of cistern * effective operation of thermostatic control devices * temperature and pressure relief valve * expansion vessel * circulating pumps * heat emitter * performance checks * central heating control components including motorised valves, timing devices, thermostats * blockages in heat emitters and pipework by power flushing * specialist controls like weather compensation, delayed and optimum start. * Learners to be given the opportunity to carry out routine maintenance procedures. |
| * 1. The types of information to be provided on a maintenance record for central heating systems | * Learners to be aware of the range of information that would be detailed on maintenance records such as test pressures, durations, test dates, replacement parts, condition reports. * Learners to be provided with examples of maintenance records for them to complete. |
| 1. Understand the methods and techniques for replacing/repairing the appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturers’ instructions | | * Learners to know how to apply the knowledge they have developed on decommissioning systems and working on systems safely. * Learners to understand the methods and techniques for replacing/repairing the appliances, components and accessories in central heating systems. * Learners to be given the opportunity to replace/replace components on central heating systems and to demonstrate the use of appropriate commissioning and testing procedures. |
| 1. Understand basic fault-finding techniques | * 1. The repair and rectification procedures to deal with a range of faults | * Learners to know the fault diagnosis and rectification procedure as follows: * diagnose * notify client * safely isolate * decommission * rectify * recommission * handover. |
| * 1. The methods of obtaining information on system faults | * Learners to be aware of how Information on system faults can be obtained in the following ways: * the customer (end-user) – they will be able to give you an overview of the fault, what is happening, when it happens * carrying out a visual inspection to identify faults on the system * service history – information relating to the system/component faults may be detailed on a maintenance record with remedial actions to be completed * manufacturers’ instructions contain a maintenance section, which will detail common system/component faults. Included in this section may be a flow chart detailing symptoms and checks/repairs * referring to industry standards for system components * manufacturers’ technical instructions will detail replacement part numbers. * Learners to know the methods of repairing faults in central heating system components. Faults to discuss and rectify include: * pumping over * persistent venting * emitter cold spots * stuck Thermostatic Valves (TRVs) * motorised valves not operating * incorrect pressures * expansion vessel failure * heat exchanger * blockages * pump failure * thermostat * programmer * pressure relief valve * incorrect support to system pipework and components * excessive noise in pipework systems * feed and expansion cistern failure * leakage or ineffective operation of terminal fittings, stop and service valves, pipework. * Learners to be able to provide examples of the types of instruments and measuring devices used fault diagnosis techniques, such as pipe thermometers, infrared thermometers and to know the method of checking system components for correct operation. |