Unit 316PH: Understand hot water 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 hot water 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 hot water systems
* commission hot water systems
* service and maintain hot water 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 hot water systems?
* What steps must you take to design a hot water system including appliances, components and accessories?
* What steps are part of commissioning appliances, components and accessories on a hot water system?
* How do you service and maintain appliances, components and accessories on a hot water system?

Learning outcomes

1. Understand the applications, advantages and limitations of appliances, components and accessories in relation to the working environment
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 hot water 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 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

* 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

* [Ariston | Water heaters](https://www.ariston.com/en-uk/products/electric-gas-water-heaters/)
* [BSI | Specifications for installations inside buildings conveying water for human consumption – Operation and maintenance](https://shop.bsigroup.com/ProductDetail/?pid=000000000030200074)
* [Grohe | Homepage](https://www.grohe.co.uk/en_gb/)
* [Kingspan | Hot water cylinders](https://www.kingspan.com/gb/en-gb/products/hot-water-cylinders)
* [LPM Heating | The Benchmark Scheme](http://lpmheating.com/pdf/Benchmark.pdf)
* [Megaflo | Megaflo Cylinders](http://www.megaflo-unvented.co.uk/megaflo-cylinders.php)
* [Mirashowers | Homepage](https://www.mirashowers.co.uk/)
* [Pegler Yorkshire | Homepage](https://www.pegleryorkshire.co.uk/)
* [Plasson | Homepage](http://www.plasson.co.uk/)
* [Toolstation | Brassware, Valves and Taps](https://www.toolstation.com/plumbing/brassware-valves-taps/c183)
* [WRAS | Homepage](https://www.wras.co.uk/)

British Standards

* BS EN 806 *Specification for installations inside buildings conveying water for human consumption* (Parts 1–5).

Legislation

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

ISBN 978-1-8594-6508-0

* *Building Regulations 2010 Approved Document G: Sanitation, hot water safety and water efficiency.* Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6600-1

* *Building Regulations 2020 Approved Document L1A: Conservation of fuel and power in new dwellings:* Newcastle upon Tyne: NBS, ISBN 978-1-85946-743-5
* *Building Regulations 2020 Approved Document L1B: Conservation of fuel and power in existing dwellings:* Newcastle upon Tyne: NBS, ISBN 978-1-8594-6744-2
* [HSE | Legionnaires’ disease. The control of legionella bacteria in water systems](https://www.hse.gov.uk/pubns/books/l8.htm)
* [GOV.UK | The Private Water Supplies (Wales) Regulations 2017](https://www.legislation.gov.uk/wsi/2017/1041/contents/made)
* [GOV.UK | The Water Supply (Water Fittings) Regulations 1999](https://www.legislation.gov.uk/uksi/1999/1148/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 hot water systems, positioning fixing, connection and operation of components | * Learners to be able to describe the working principles of hot water systems, including the positioning, fixing, connection and operation of the following components: * cylinders (vented and unvented): various grades available, sizes available, direct, indirect, primatic, quick recovery, dual coil, combination, thermal store * appliances: baths, WCs, over the rim bidets, wash hand basins, sinks, washing machines, dishwashers * taps, outlets and valves: mixer taps, outside taps, pillar taps, bib taps, mixer taps, bi flow mixer taps, ceramic disc taps, infra-red operated taps, concussive taps, flow limiting taps and valves, stop valves, spray taps, servicing valves, full way gate valves, spherical plug valves, thermostatic mixing valve, drain valves, float operated valves (Part 1–4) * water meters * showers: gravity, digital shower valves, bath shower mixer, pumped (single and twin impeller), mixer valve * secondary pump * cisterns. |
| * 1. The expansion and contraction in hot water systems and negative effects | * Learners to develop their understanding of expansion and contraction of pipework. * Learners to know the measures to take when installing pipework in different situations, including expansion loops and bellows. |
| * 1. The location and function of unvented system components | * Learners to be able to describe the function of components in unvented hot water systems. * Safety devices including: * control thermostat * overheat thermostat (thermal cut-out) * temperature relief valve. * Functional devices including: * line strainer * pressure reducing valve * single check valve * expansion device (vessel or integral to cylinder) * expansion relief valve * tundish arrangements * D1 and D2 discharge pipework requirements * application of composite valves. * Learners to be able to specify the layout features for temperature and expansion relief pipe in unvented hot water systems. * Learners to be able to state where safety and functional devices are sited in relation to industry standards and how faults affect the safety of these systems. |
| * 1. Secondary circulation and how trace heating can be used | * Learners to understand what secondary circulation and trace heating is and why it is needed on pipework systems. * Learners to be able to describe the layout features for pipework systems incorporating secondary circulation including: * pump type and location * timing devices * prevention of reverse circulation * methods of balancing circuits. * Learners to be able to explain how trace heating can be used as an alternative to a secondary circulation system including the operating principles of trace heating. |
| * 1. The operating principles of solar thermal | * Learners to be able to describe the basic layout and operating principles of solar thermal hot water systems. * Learners to be able to describe the purpose of components used within solar thermal hot water systems including: * differential temperature controller * circulating pump * hot water storage cylinder * solar collector circuit * auxiliary heat source * flat plate collectors and evacuated tube collectors. |
| 1. Understand the appropriate industry standards and regulations relevant to  * decommissioning * installing and testing * commissioning * service and maintenance   of hot water systems | * 1. The backflow risk and required methods of prevention | * Learners to be able to explain backflow risk on hot water systems and the required methods of prevention as laid down in the Water Regulations including basic mechanical and non-mechanical methods: * air gaps: AA, AB, AD, AG, AUK1, AUK2, AUK3, DC * mechanical: BA, CA, DB, EA/EB, EC/EDHA, HUK1, HC. * Learners to be able to specify the backflow prevention requirements referring to the Water Regulations. |
| * 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 hot water systems including: * The Water Supply (Water Fittings) Regulations 1999 * BS EN 806. Specifications for installations inside buildings conveying water for human consumption * manufacturers’ technical instructions. |
| 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 know what procedures need to be followed prior to undertaking work and any actions that should be followed to ensure there is no risk to themselves or others. * 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 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 including: * verbal communication * written communication * emails * text messages. * Learners to be able to communicate with the building services engineer to confirm insulation requirements. |
| * 1. The importance of complying with company policies and procedures | * Learners to know 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 know the impact when materials are not delivered on time: * 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 which affect working time allocation to work activities including: * material availability * labour requirements * staff experience * delivery requirements * labour availability * weather * environmental * client requirements/deadlines. |
| 1. Understand the appropriate testing procedures for confirming the systems’ integrity | * 1. How to fill and vent hot water systems | * Learners to know the methods of filling and venting a hot water system including: * opening the service valve to the hot water cylinder/heater or boiler * turning on the kitchen hot tap * allowing the water to flow into the kitchen sink to clear any debris that may have collected in the pipework * closing the hot tap on the kitchen sink and allowing the system to fill to full standing pressure * opening any taps and terminal fittings fed from the system and clearing any air in the system. * Learners to be able to provide example of filling and venting hot water systems in a variety of settings. * Learners to be given the opportunity to simulate filling and venting a system. |
| * 1. A soundness test to industry requirements on hot water systems pipework and components | * Learners to know the method of applying a soundness test using pressure testing equipment on metallic pipework systems and on plastic pipework systems. * Learners to be able to describe a soundness test to industry requirements on hot water systems 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 understand that any leaks must be rectified and re-tested before a test certificate is issued. * Learners to be made of aware the equipment used and the types of tests for both rigid and plastic pipework, including test pressure and test durations as laid down in the Water Regulations. * Learners to be shown how to use hydraulic test equipment and to be given the opportunity to practice using it. * Learners to be able to state the reason for a timed stabilisation period prior to carrying out a soundness test. * Learners to know how to fill and vent the system after a successful 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 * discharge point pressure readings * temperatures * materials used * test information including soundness test results. * Learners to be provided with examples of commissioning, installation and maintenance records and to know the additional information that should be contained within a maintenance record. * Learners to understand how to comply with Approved Document Part G: Notification requirements and the procedure for notifying relevant authorities of work carried out on hot water systems. * Learners to be able to give the appropriate advice on the safe use of a hot water system to the customer and to understand that component manufacturer’s instructions are to be left and explained to the customer during 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 that affect the selection of hot water systems for dwellings | * Learners to be aware of the factors that affect the selection of hot water systems for dwellings including: * customer needs * size of household * affordability/cost * type of property * building layout and features * energy efficiency * environmental impact * occupancy and purpose * appliance location * storage type/location * current legislation. |
| * 1. The information sources required to size and select hot water systems and components | * Learners to know that the following information sources are required to size and select hot water system components: * Approved Document G – Sanitation, hot water safety and water efficiency * Approved Document L – Conservation of fuel and power (L1A and L1B) * The Water Supply (Water Fittings) Regulations 1999 * BS EN 806. Specifications for installations inside buildings conveying water for human consumption * Approved Code of Practice (ACOP) L8 – The Control of Legionella Bacteria in Water Systems * the domestic building services compliance guide * manufacturers’ technical instructions * plans and drawings * pre-determined data * specifications * industry standards * verbal and written feedback from the customer. |
| * 1. The recommended design temperatures within hot water systems | * Learners to know that, when selecting, positioning and designing hot water systems and components, the required design temperatures should be considered: * hot water to be stored at no less than 60°C * hot water to be distributed at no less than 55°C * secondary circulation return pipework to be no less than 50°C * hot water at appliance outlets to be no less than 50°C. |
| * 1. How to calculate hot water system requirements used in dwellings | * Learners to be provided with system requirements and different sources of information to calculate system components including: * capacity of a storage vessel/cistern * sizes of pipework using demand units suitable to meet the system design * the required head pressure and mass flow rate of booster pumps (shower and full system) * secondary circulation pump. * Learners to be able to determine how to make the required selection of components based on their calculations. |
| * 1. How to select hot water 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: * hot water cylinder * pipework * booster pumps * secondary circulation pump * expansion vessels * safety devices. * Learners to determine how to make the required selection of components. |
| 1. Understand how to interpret diagrams and drawings for the hot water system to identify the planned location of the appliances, components and accessories | * 1. Interpret information to complete a detailed materials list | * Learners to be aware of how to interpret information from a range of sources including diagrams and drawings to complete a detailed material list. * Learners to know that material lists should include quantities, colours/grades/sizes of: * pipework * consumables * fittings * components * appliances. * Learners to know that when ordering from a plumber’s merchant, product codes should also be included. * Learners to know 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 and 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 * technology and bespoke computer programmes, 3D drawings and artist impressions are produced to show what the installation will look like when completed * spreadsheets can be used to present design calculations and functions can also be added to automatically calculate data * 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 how to prepare a quotation from design information and calculations and 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 hot water systems | * Learners to know how to install the following components, appliances and accessories in compliance with the manufacturer instructions, industry requirements and current regulations and standards: * cylinder (open vented) * cylinder (unvented) * bath * wash hand basin (WHB) * shower * plastic and copper pipework. * Learners to be aware of how to connect hot water pipework to components using 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 hot water 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 and what is required on a visual inspection. * Learners to know the steps taken during a visual inspection to confirm the hot water system is ready to be soundness tested including checking: * that all joints have been made correctly * that all pipework is secure * the installation conforms to the regulations * any open ends of pipes have been fitted with cap ends * any cisterns/cylinders are supported * service valves have been fitted correctly * drain off valves have been closed off * tap and cylinder connections are fully tightened. * Learners to know the procedure for inspecting pipework supports and how to check the back or underside of soldered fittings in awkward positions on hot water systems. * Learners to understand the procedure to follow if they identify installation faults on hot water systems whilst carrying out a visual inspection. * Learners to know that any problems, such as insufficient clipping of pipes and missing or incorrectly installed service valves, should be rectified before testing begins. |
| 1. Understand the methods and techniques for commissioning the hot water 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 hot water systems | * Learners to be informed of the requirements for flushing a hot water system before putting it to work following soundness testing. * Learners to be aware of the flushing requirements including the use of system additives for new and existing hot water systems as detailed in the Water Regulations. These include: * flushing requirements: cold, disinfection * system additives: neutralisers, cleanser, water softener (salt). * Learners to know the procedures for dealing with suspected infestations of micro-biological contamination in hot water systems. |
| * 1. The operational checks required during commissioning | * Learners to be able to describe the operational checks required during commissioning of hot water systems including: * temperature * flow rate * pressures * operation of controls. * Learners to be provided with the opportunity to undertake the commissioning procedure and to carry out operational checks, including: * how to take and record flow rates and pressure reading from discharge points * how to check the temperature and alter to align to manufacturer and industry standards * how to check the correct operation of controls. |
| * 1. The commissioning procedures for hot water systems | * Learners to be aware of the commissioning procedure for vented and unvented hot 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 Water Supply (Water Fittings) Regulations 1999 and industry guidance. * Learners to know how to balance a secondary circulation 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 hot water systems. * Learners to know how to deal with systems that do not meet correct installation requirements, including insulation requirements. * Learners to know the remedial work associated with: * defective pipe work bracketing * leakage from pipe work 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. This process involves: * 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 components and accessories using design data, pre-installed systems and manufacturer information. * Learners to be provided with examples and asked to determine the type of size of replacement components and accessories on existing and replacement systems. |
| 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 the use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of hot water system components. * Learners to be able to provide examples of manufacturer instructions and job maintenance schedules. |
| * 1. The routine checks required on hot water system components and pipework as part of a periodic maintenance programme | * Learners to know 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 storage cistern * unvented cylinder and controls * effective operation of thermostatic control devices * temperature and pressure relief valve * expansion vessel * composite valve * pumps * timing devices. * Learners to know how to check for correct operation of system safety valves including: * temperature relief * expansion relief. * 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 hot water 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. The requirements for Legionella and bacterial growth control measures | * Learners to have an overview of the Legionella and bacterial growth control measures and the procedures for dealing with suspected infestations of micro-biological contamination in hot water systems. * Learners to be introduced to Approved Code of Practice (ACOP) L8 – The Control of Legionella Bacteria in Water Systems HSE documentation. |
| 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 understand the methods and techniques for replacing/repairing the components and accessories in hot water systems. * Learner to be given the opportunity to replace/replace appliances, components and accessories on hot water systems. |
| 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: * diagnose * notify client * safely isolate * decommission * rectify * re-commission * handover. |
| * 1. The methods of obtaining information on system faults | * Learners to know the types of instruments and measuring devices used in fault diagnosis techniques, the method of checking system components for correct operation and the methods of repairing faults in hot water system components. * Learners to be aware of how information on system faults can be obtained: * 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 can 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 * manufacturer instructions contain a maintenance section which will detail common system/component faults. This section may be a flow chart detailing symptoms and checks/repairs * manufacturer technical instructions will detail replacement part numbers. * Learners to know that faults to discuss and rectify include: * motorised valves not operating * incorrect pressures * expansion vessel failure * heat exchanger * blockages * system debris * pump failure * thermostat * programmer * expansion valve * pressure relief valve * stratification of cylinders * incorrect support to hot water system pipework and storage cisterns * excessive noise in pipework systems * cistern failure * hot water storage cylinder/heater failure * leakage or ineffective operation of; terminal fittings, float operated valves, stop and service valves, mixer showers, thermostatic mixing valves. |