Unit 321PH: Performing plumbing and heating systems installation, commissioning, service and maintenance techniques

# 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 plumbing and 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:

* inspect and pre-commission plumbing and heating systems
* decommission plumbing and heating systems
* install and test plumbing and heating systems
* commission plumbing and heating systems
* service and maintain plumbing and 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:

* How do you inspect and pre-commission plumbing and heating systems?
* How do you decommission plumbing and heating systems?
* How do you install and test plumbing and heating systems?
* How do you commission plumbing and heating systems?
* How do you service and maintain plumbing and heating systems?

Learning outcomes

1. Verify that the job information and documentation are current and relevant and that the plant, instruments, access equipment and tools are fit for purpose
2. Confirm before work starts that the work location and work area can be accessed safely and has been checked for the risk to other personnel on the site, and take appropriate action if a risk is present
3. Select appliances, components and accessories
4. Confirm that the site services and system supply are compatible
5. Produce a risk assessment and method statement for the work to be carried out, including the identification and use of personal protective equipment
6. Comply with industry practices and organisational procedures to ensure the coordination of site services and system supply and the activities of other trades
7. Confirm with the relevant people
8. Implement organisational procedures for the safe transport and/or disposal of waste material, substances and liquids in accordance with suppliers' and manufacturers' instructions
9. Complete relevant documentation in accordance with organisational procedures
10. Confirm appliances, components and accessories installed
11. Determine that the appliances, components and accessories have been fitted
12. Inspect and pre-commission appliances, components and accessories
13. Decommission appliances, components and accessories in accordance with industry practices and organisational procedures
14. Ensure that the plumbing and heating system cannot be accidentally reactivated or become dangerous
15. Determine at the outset, the plans for positioning and fixing the appliances, components and accessories
16. Measure and mark out the locations for fitting and fixing the selected appliances, components and accessories
17. Fit, fix and connect the selected appliances, components and accessories
18. Confirm the integrity of the installed system using appropriate testing procedures
19. Confirm appliances, components and accessories installed
20. Perform visual and manual checks to ensure that the appliances, components and accessories have been fixed, fitted and connected.
21. Confirm the integrity of the installed system using appropriate testing procedures
22. Commission appliances, components and accessories, adjusting safely and effectively the control features
23. Determine at the outset, the plans for servicing and maintaining the appliances, components and accessories
24. Carry out service and maintenance activities and procedures
25. Accurately identify the cause of faults and those parts/components that need to be repaired/replaced
26. Complete repairs/replacements as necessary
27. Complete appropriate testing procedures in-line with industry practices

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

* Institution of Engineering and Technology (IET) (2018*) IET On-Site Guide (BS 7671:2018) (Electrical Regulations)*. London: IET.

ISBN 978-1-7856-1442-2

* 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

British Standards

* BS EN 806. *Specification for installations inside buildings conveying water for human consumption* (Parts 1–5).
* BS EN 12056-2:2000. *Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation*.

Websites

* [Ariston Water Heaters | Homepage](https://www.ariston.com/en-uk/products/electric-gas-water-heaters/)
* [Armitage Shanks | Bathrooms](https://www.armitageshanks-mena.com/homepage.html) [Ideal Standard | Homepage](https://www.idealspec.co.uk/)
* [Baxi Boilers | Homepage](https://www.baxi.co.uk/)
* [Danfoss | Homepage](https://www.danfoss.com/en-gb/)
* [Floplast | Homepage](https://www.floplast.co.uk/)
* [Gas Safe Register | Homepage](https://www.gassaferegister.co.uk/)
* [Grohe | Taps and valves](https://www.grohe.co.uk/en_gb/)
* [Grundfos | Homepage](https://uk.grundfos.com/)
* [Gutter Crest | Homepage](https://www.guttercrest.co.uk/)
* [HETAS | Homepage](https://www.hetas.co.uk/)
* [Honeywell Controls | Homepage](https://heatingcontrols.honeywellhome.com/)
* [Kingspan | Hot Water Cylinders](https://www.kingspan.com/gb/en-gb/products/hot-water-cylinders)
* [Marley Plumbing and Drainage | Homepage](https://www.marleyplumbinganddrainage.com/)
* [McAlpine Plumbing | Homepage](https://mcalpineplumbing.com/)
* [Megaflo | Megaflo Cylinders](http://www.megaflo-unvented.co.uk/megaflo-cylinders.php)
* [Mira Showers | Homepage](https://www.mirashowers.co.uk/)
* [OFTEC | Homepage](https://www.oftec.org/)
* [Pegler Yorkshire | Homepage](https://www.pegleryorkshire.co.uk/)
* [Planning Portal | Homepage](https://www.planningportal.co.uk/)
* [Plasson | Homepage](http://www.plasson.co.uk/)
* [Polypipe | Homepage](https://www.polypipe.com/)
* [Saniflo | Homepage](https://www.saniflo.co.uk/)
* [Toolstation | Taps and valves](https://www.toolstation.com/plumbing/brassware-valves-taps/c183)
* [WRAS | Homepage](https://www.wras.co.uk/)
* [Worcester Bosch | Homepage](https://www.worcester-bosch.co.uk/)

Legislation

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

ISBN 978-1-8594-6508-0

* *Building Regulations 2010 Approved Document H: Drainage and Waste Disposal*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6599-8

* *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

* *Building Regulations 2010 Approved Document M: Access to and Use of Buildings*. Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6747-3

* [GOV.UK | Private Water Supply (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. Verify that the job information and documentation are current and relevant and that the plant, instruments, access equipment and tools are fit for purpose | | * Learners to know how to check that all necessary job information is available before commencing the installation work. * Learners to know how to liaise with other persons to confirm the detail of the installation work to be carried out. * Learners to be able to explain how to obtain details of the customer job requirement by taking details from plans, drawings and specifications. * Learners to be able to demonstrate how to check that all required tools, equipment and materials are available to undertake the installation work. * Learners to demonstrate how to check tools, access equipment and instruments are fit for purpose for the task to be completed. * Learners to know how to use job information to identify the location of the building fabric that requires preparatory work to be carried out. |
| 1. Confirm before work starts that the work location and work area can be accessed safely and has been checked for the risk to other personnel on the site, and take appropriate action if a risk is present | * 1. The access and exit routes | * Learners to be able to explain how to prepare a safe and unobstructed access route to the work areas to carry out the installation work. * Learners to be able to explain how to comply with health and safety requirements when carrying out plumbing and heating work, including: * following safety signs and notices * ensuring emergency exit routes are in place and are free from obstruction * ensuring that lighting is adequate and * ensuring appropriate barriers are used where required. |
| 1. Select appliances, components and accessories and confirm that they are:  * of the right type and size * fit for purpose in accordance with the plumbing and heating system’s design * suitable for the working environment in which they are to be installed | * 1. System design | * Learners to be able to calculate the size and quantities of components and accessories required for cold water systems including: * storage requirements * pipe size * outlet size and type. * Learners to be able to select components and accessories in accordance with calculations from predetermined data including: * storage requirements * pipe size * accumulator * safety device * booster pump. * Learners to be able to calculate the size and quantities of components and accessories required for hot water systems including: * storage requirements * pipe size. * Learners to be able to select components and accessories in accordance with calculations from predetermined data including: * storage vessel * pipe * pump * expansion vessel * safety device * emitter * boiler. * Learners to be able to calculate the size and quantities of components and accessories required for central heating systems including: * total heat load * emitter load * hot water allowance * pipe size * pump size * emitter size * size * expansion. * Learners to be able to calculate the size and quantities of components required for rainwater systems. * Learners to be able to calculate the size and quantities of components required for sanitation systems including: * gradient * diameter * length * material * system type. |
| 1. Confirm that the site services and system supply are compatible with the plumbing and heating system’s design | | * Learners to be able to confirm that the incoming or outgoing main services and supplies meet the requirements of the system or component being installed. |
| 1. Produce a risk assessment and method statement for the work to be carried out, including the identification and use of personal protective equipment, in accordance with the working environment | | * Learners to know the terms ‘likelihood’ (probability that an event will occur) and ‘severity’ (degree of harm which may be caused). * Learners to be able to explain how to calculate risk rating: RISK RATING (RR): Severity x Likelihood. * Learners to be given examples of tasks and allowed to calculate the risk. * Learners to be able to demonstrate how to carry out and complete a risk assessment for work activities by: * identifying hazards * assessing the risks * controlling the risks * recording your findings * reviewing the controls. * Learners to be shown completed examples of risk assessments and to be able to complete one themselves. * Learners to know the purpose of a method statement and to be able to describe its contents. * Learners to be able to detail a step-by-step guide on how to complete a work task in a safe manner. * Learners to be able to provide examples of tasks where method statements are used and to be able to show examples of completed method statements. * Learners to be able to explain the requirements for permits to work. |
| 1. Comply with industry practices and organisational procedures to ensure the coordination of site services and system supply and the activities of other trades | | * Learners to know how to comply with industry practices and organisational procedures to ensure the coordination of site services and system supply and the activities of other trades, including the use of job information to plan the installation work. * Learners to know how to arrange for all tools, equipment and materials to be available to undertake the installation work. |
| 1. Confirm with the relevant people:  * those necessary variations to the planned programme of work * the actions to be taken to ensure that any variations to the planned programme of work will minimise the potential for hazard and risk | | * Learners to be able to confirm with relevant people, such as clerk of works and site supervisors, necessary variations to the planned programme of work and the actions to be taken to ensure that any variations to the planned programme of work will minimise the potential for hazard and risk, including updating of risk assessments and method statements. * Learners to be able to give examples of variation orders and work programmes. |
| 1. Implement organisational procedures for the safe transport and/or disposal of waste material, substances and liquids in accordance with suppliers’ and manufacturers’ instructions | | * Learners to be able to implement organisational procedures for the safe transport and/or disposal of waste material, substances and liquids in accordance with suppliers’ and manufacturers’ instructions. * Learners to be aware of the requirements for the safe disposal of hazardous waste and materials. |
| 1. Complete relevant documentation in accordance with organisational procedures | * 1. Documentation | * Learners to be able to comply with organisational procedures for completing documentation that is required during work operations including: * variation order * timesheets * work programme * requisitions * delivery note. |
| 1. Confirm appliances, components and accessories installed are:  * of the right type and size * fit for purpose in accordance with the plumbing and heating system’s design * suitable for the working environment in which they are installed | | * Learners to be able to confirm that appliances, components and accessories meet the requirements of the system or component being installed using manufacturer instructions and design criteria that are: * of the right type and size * fit for purpose in accordance with the plumbing and heating system’s design * suitable for the working environment in which they are installed. |
| 1. Determine that the appliances, components and accessories have been fitted in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturer instructions | * 1. Preparatory work | * Learners to be able to demonstrate the steps taken during inspection and pre-commission activities to confirm the appliances and components have been fitted in accordance with the plumbing and heating design and manufacturer instructions. * Learners to be able to carry out preparatory work, including: * ensuring there is safe and unobstructed access to work areas * making sure materials, tools and equipment are stored safely * reporting pre-existing damage * protecting the building fabric. * Learners to be able to carry out the following activities safely: * drilling walls or floors * cutting holes and notches in timber floor joists * cutting chases in wall or floor surfaces. * Learners to know that visual checks include checking: * appliances have been installed to the correct height * appliances and components are secure and level * service valves have been fitted as required * drain of valves have been fitted * safety devices have been fitted. * Learners to check the installation conforms to: * the Regulations * the installation section of the manufacturer instructions. |
| 1. Inspect and pre-commission appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * manufacturer instructions | | * Learners to be able to demonstrate the steps taken during inspection and pre-commission activities to confirm the appliances and components are fit for purpose in accordance with the plumbing and heating system’s design, that they are suitable for the work environment and are of the right size and type. * Learners checks to include: * checking that all joints have been made correctly * checking that all pipework is secure * checking the installation conforms to the Regulations * checking pipe size and gradient (sanitary). |
| 1. Decommission appliances, components and accessories in accordance with industry practices and organisational procedures | | * Learners to be able to check that all required tools, equipment and materials are available to undertake the decommissioning work. * Learners to be able to report any pre-existing damage to the building fabric or customer property to other persons before carrying out the decommissioning work. * Learners to know the methods used to provide protection to the building fabric or customer property as the work progresses. * Learners to be able to isolate the system from the supply source or outgoing service as follows: * turn off the electricity and fuel supply to the system * turn off the water supply to the system * prevent the use of sanitary appliances. * Learners to know how to drain and safely dispose of the system contents for: * cold water systems * hot water systems * central heating systems * sanitation. |
| 1. Ensure that the plumbing and heating system cannot be accidentally reactivated or become dangerous | | * Learners to discuss the requirements for each system to record, label and report decommissioned systems to prevent the use of decommissioned appliances including: * informing the responsible person * warning notices * labels * temporary stop ends. * Learners to be able to demonstrate how to safely isolate a range of systems following the recognised electrical safe isolation procedure as follows: * identify * isolate * prove * test * re-prove * lock/label. |
| 1. Determine at the outset, that the plans for positioning and fixing the appliances, components and accessories are in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturer instructions | * 1. Systems | * Learners to use job information to identify the location of the building fabric that requires preparatory work to be carried out. * Learners to be able to determine that the plans for positioning and fixing the appliances and accessories are in accordance with industry requirements for: * cold and hot water systems * central heating systems * sanitation systems * gravity rainwater systems. |
| 1. Measure and mark out the locations for fitting and fixing the selected appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * manufacturer instructions | * 1. Systems | * Learners to be able to demonstrate how to measure and mark out the work location in relation to installation plans, manufacturer’s instruction and approved documents using the correct equipment including: * tape measure * spirit level * pencil * laser level. * Learners to be given time to practice marking out work locations from installation diagrams for the following: * cold and hot water systems * central heating systems * sanitation systems * gravity rainwater systems. |
| * 1. The pipework | * Learners to know how to demonstrate the correct method for installing pipework to industry standards for the range of pipework materials and to practice marking out and installing pipework for a range of materials including: * copper: R220 soft coils, R250 half hard lengths * Low Carbon Steel (LCS) * stainless steel * plastic pipework: Medium Density Polyethylene (MDPE), polybutylene, unplasticized PVC (PVC-u), polypropylene, Modified Unplasticized Polyvinyl Chloride (MUPVC), Acrylonitrile Butadiene Styrene (ABS) * plastic (sanitary) * rainwater systems. |
| 1. Fit, fix and connect the selected appliances, components and accessories in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturer instructions | * 1. Systems | * Learners to be able to discuss the installation requirements and to practice installation on the following systems: * cold water * hot water * central heating * gravity rainwater * sanitation. * Learners to be able to discuss the requirements for installing appliances in compliance with manufacturer instructions and the plumbing and heating system’s design. |
| * 1. The pipework | * Learners to be able to demonstrate the requirements and methods of installing the following pipework materials and to practice their pipework fabrication skills. * Pipework materials include: * copper: R220 soft coils, R250 half hard lengths * LCS (screwed or pressed) * stainless steel * plastic pipework: Medium Density Polyethylene (MDPE), polybutylene, unplasticized PVC (PVC-u), polypropylene, Modified Unplasticized Polyvinyl Chloride (MUPVC), Acrylonitrile Butadiene Styrene (ABS) * plastic (sanitary) * rainwater systems. * Methods of bending pipework include: * 90° bends * sets and offset bends * passover bends. |
| * 1. Jointing methods | * Learners to be able to demonstrate the following methods of jointing pipework: * copper pipe: solder ring and end feed, compression (type A and B) push-fit, press-fit, crimped * LCS pipe: threaded, compression, pressed * plastic pressure pipe: push fit, compression * proprietary: copper and MDPE * plastic soil and waste jointing: ring seal, compression, solvent. * Types of fitting include: * couplers/sockets * elbows and bends * equal tees * reducing tees * reducers * tap connectors * flexible connectors * manifolds * tank connectors * nipples * unions and flanges. * Learners to be given time to practice their pipework fabrication skills using a range of jointing methods and materials. |
| * 1. Components | * Learners to be able to demonstrate how to fit, fix and connect the following appliances, components and accessories: * bath * WC * wash hand basin * sink * shower and tray * cylinder * boiler (connections) * soil stack system * rainwater/guttering system * Feed and Expansion (F&E)/Cold Water Storage Cistern (CWSC) cistern * pump * motorised valves * radiator * water conditioners/filters * urinal * bidet * booster pump/shower pump * accumulators/expansion vessels * fan convector * low loss header * macerator or wastewater lifter/pump * greywater/rainwater station * water softener/filter * refrigerator cold connection * washing machine/dishwasher * underfloor heating circuit and underfloor manifold * outside tap installation * backflow protection components (ea, eb, ec or ed back flow protection). * Learners to be given time to practice the installation of a range of plumbing and heating appliances and components with reference to manufacturer instructions. |
| 1. Confirm the integrity of the installed system using appropriate testing procedures | | * Learners to be able to demonstrate the correct method and to practice how to carry out a soundness test in line with current industry requirements, on installed systems and components. * Soundness test to include: * visual inspection * notify * initial fill * stabilisation * test to required pressure * check for leaks * check pressures after test period * complete documentation and notify as required. * Learners to carry out soundness testing on a range of plumbing and heating systems using air tests and hydraulic pressure tests. |
| 1. Confirm appliances, components and accessories installed are:  * of the right type and size * fit for purpose in accordance with the plumbing and heating system’s design * suitable for the working environment in which they are installed | * 1. A visual inspection of the plumbing and heating system to confirm that it is ready to be soundness tested | * Learners to be to explain the steps taken during a visual inspection to confirm the 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 Regulations * checking any open ends of pipes have been fitted with cap ends. * Learners to be aware that any problems, such as insufficient clipping of pipes and missing or incorrectly installed service valves, should be rectified before testing begins. |
| 1. Perform visual and manual checks to ensure 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 * manufacturers’ instructions | | * Learners to able to explain the steps taken during a visual and manual inspection to confirm the appliances, components and accessories have been fixed, fitted and connected correctly including: * checking that all appliances are secure * checking the installation conforms to the Regulations * checking that the installation has been completed as per manufacturer instructions * checking that appliances and components have been installed as per plans and diagrams. * Learners to be aware that any problems, such as incorrect fixing should be rectified. |
| 1. Confirm the integrity of the installed system using appropriate testing procedures | | * Learners to able to demonstrate the correct method and to practice how to carry out a soundness test in line with current industry requirements, on installed systems and components. * Soundness test to include: * visual inspection * notify * initial fill * stabilisation * test to required pressure * check for leaks * check pressures after test period * complete documentation and notify as required. * Learners to be able to carry out soundness testing on a range of plumbing and heating systems using air tests and hydraulic pressure tests. |
| 1. Commission appliances, components and accessories, adjusting safely and effectively the control features in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturers’ instructions | * 1. Systems | * Learners to know the commissioning requirements and to practice commissioning on the following systems: * cold water * hot water * central heating * gravity rainwater * sanitation. * Learners to be provided with examples of commissioning records and to be given the opportunity to complete them. |
| 1. Determine at the outset, that the plans for servicing and maintaining the appliances, components and accessories are in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturer instructions | | * Learners to be able to use job information to plan the fault diagnosis work. * Learners to be able to discuss maintenance plans and maintenance records. * Learners to know the health and safety requirements when carrying out fault diagnosis work. * Learners to be able to explain how to prepare a safe and unobstructed access route to the work areas to carry out the fault diagnosis work. * Learners to be able to explain how to arrange for all required tools, equipment and materials to be available to undertake the fault diagnosis work. |
| 1. Carry out service and maintenance activities and procedures in accordance with:  * the plumbing and heating system’s design * the working environment * manufacturer instructions | * 1. Systems | * Learners to know the service and maintenance activities requirements and to practice maintenance and service activities on the following systems: * cold water * hot water * central heating * gravity rainwater * sanitation. * Learners to be able to provide examples of service and maintenance activities and to have the opportunity to complete them. |
| 1. Accurately identify the cause of faults and those parts/components that need to be repaired/replaced | | * Learners to know how to obtain information that can be used to identify system faults from the: * end-user * manufacturer instructions * fault diagnosis flow chart * service history. * Learners to be able to explain how to test the component to diagnose the cause of the fault. * Learners to be able to identify parts/components that need to be repaired/replaced using suitable sources of information. |
| 1. Complete repairs/replacements as necessary | * 1. Faults | * Learners to be able to demonstrate how to repair the following common faults: * system debris * pump failure * leakage * trap seal loss * expansion and contraction * cistern failure * pumping over/persistent venting * emitter cold spots * thermostatic radiator valve (TRV)/valve * tap/valve failure. * Learners to be able to demonstrate how to repair the following system faults: * accumulator expansion vessel failure * motorised valves not operating * heat exchanger failure * expansion valve * WC macerators/wastewater lifter * sink waste disposal units * control failure * pressure relief valve * thermostat * programmer * air admittance valves * condensing boiler condensate * component failure. |
| 1. Complete appropriate testing procedures in-line with industry practices | | * Learners to know how to re-commission and handover the repaired system to the client. |