Unit 319HV: Understand hydronic heating systems for industrial and commercial buildings

# Delivery guide

Unit information

This unit covers the knowledge and understanding of the principles for hydronic heating systems and related components. Learners will gain an understanding of the system layouts, circuits, components, controls, heat generating equipment, heat emitters and the regulations, guidance and standards available to assist the learner to install these system components.

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

* How do hydronic heating systems work?
* What are the installation requirements for hydronic heating systems?
* What are the different types of heat emitters, and how are they applied?
* What industry standards and regulations are relevant to the installation of hydronic heating systems in industrial and commercial buildings?

Learning outcomes

1. Understand the operation, applications, advantages, and limitations of hydronic heating systems
2. Understand the applications, advantages and limitations of industrial and commercial hydronic heating systems components, controls, and accessories in relation to the working environment
3. Understand the types and applications of heat emitters used within industrial and commercial hydronic heating systems
4. Understand the appropriate industry standards and regulations relevant to the installation of industrial and commercial hydronic heating systems

Suggested resources

Textbooks

* Bleicher, D. (2017) *BSRIA Illustrated Guide to Mechanical Building Services (BG/31/2017)*. Berkshire: BSRIA.

ISBN 978-0-8602-2758-8

* Brown, R. (2015) *BSRIA Heat Interface Units (BG 62/2015)*. Berkshire: BSRIA.

ISBN 978-0-8602-2747-2

* Chadderton, D. (2012) *Building Services Engineering*. London: Taylor & Francis.

ISBN 978-0-4156-9932-7

* Oughton, D., Hodkinson, S. and Brailsford, R. M. (2015) *Faber and Kell’s Heating and Air-Conditioning of Buildings.* London: Routledge.

ISBN 987-0-4155-2265-6

Websites

* [Grundfos | Homepage](http://www.grundfos.co.uk/)
* [Hamworthy Heating | Homepage](http://www.hamworthy-heating.com/)
* [Spirax Sarco | Homepage](http://www.spiraxsarco.com/)
* [Stelrad | Homepage](http://www.stelrad.co.uk/)
* [The Engineering Mindset | Homepage](http://www.theengineeringmindset.com/)

British Standards

* BS 1710:2014. *Specification for identification of pipelines and services.*

Legislation

* *Building Regulations 2010 Approved Document L2B: Conservation of fuel and power in existing buildings other than dwellings. 2010 edition (incorporating 2010, 2011, 2013 and 2016 amendments).* Newcastle upon Tyne: NBS.

ISBN 978-1-8594-6746-6

| **Learning outcomes** | **Criteria** | **Delivery guidance** |
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| 1. Understand the operation, applications, advantages, and limitations of industrial and commercial hydronic heating systems | * 1. The working principles of a hydronic heating system | * Learners to know the underpinning principles of hydronic heating systems and how water is used to distribute heat to emitters. * Learners to be able to explain how the boiling point of water is affected by pressure and how this relates to open vented systems and closed systems. * Learners to understand the open vent and how this prevents water exceeding 100°C and the comparison between the components within open and sealed systems. * Learners to know the differences between one pipe, two pipe and reversed return systems and the flow of water within each. * Learners to be shown examples of commercial system layouts and to know the differences relating to pressure and temperature within low, medium and high temperature systems. * Learners to be able to identify and recognise system circuit layouts such as: * one pipe system * two pipe parallel system * two pipe reversed return * up feed system * down feed system * ladder systems * open vented systems * sealed heating systems * Low Temperature Hot Water (LTHW) * Medium Temperature Hot Water (MTHW) * High Temperature Hot Water (HTHW). * Learners to know the basic layout of steam systems including heat exchangers to generate lower temperatures. * Learners to know the advantages and limitations of district heating projects and, where possible, use trips and visits to see examples. * Learners to understand the difference between Variable Temperature (VT) and Constant Temperature (CT) circuits and the valve arrangements that allow this to be controlled (mixing and diverting valves). * Learners to be shown layouts of underfloor heating and how manifolds are used. |
| * 1. The application of hydronic heating systems relevant to building layout and use | * Learners to know the system principles including the operating temperatures of low, medium and high temperature hot water systems and the application of CT and VT systems. * Learners to know how the following building layouts could be provided with hydronic heating: * commercial * industrial * agricultural * horticultural * leisure and entertainment * residential medical and care facilities * public services establishments and * pre-1919 traditional/historic buildings. * Learners to be able to state why certain systems suit certain building types. For example, high temperature or steam systems may be used to distribute heat over longer distances within hospitals. * Learners to consider set scenarios such as what type of system would be suitable for schools or nurseries. * Learners to be aware of different considerations such as prevention of burns on high temperature pipework or exposed heat emitters. |
| * 1. The operating temperatures of hydronic heating systems | * Learners to be able to state the operating temperatures ranges of LTHW, MTHW and HTHW systems. * Learners to know the pressures required to achieve these temperatures and to be able to describe how this is achieved within the system. * Learners to be able to explain anti-flash margins used to protect high temperature systems from flashing to steam and how pressure and temperature relief valves are essential. |
| * 1. The advantages and limitations of various hydronic heating system types | * Learners to be able to explain the advantages and limitations of the systems discussed. * Learners to list these and to be able to show practical examples of radiator circuits and how temperatures reduce as heat emitters move further away from the heat source. * Learners to know that this may lead to the issues with one pipe systems mixing water and to know how reversed return systems can reduce the need for balancing due to equal pipe length and resistances. |
| * 1. The methods to protect, insulate and identify hydronic heating system pipework | * Learners to be able to list reasons why heated pipework may become damaged. * Learners to use the centre/facility to discuss why pipework is positioned in certain positions and to be able to identify areas of issue within installations, which could lead to damage or corrosion. * Learners to know ways in which it could be protected such as: * painting * galvanising * water treatment * insulation types * BS 1710:2014. Specification for identification of pipelines and services * pipe bandings * wrapping pipework. * Learners to be shown videos of water treatment processes and manufacturer’s literature and be able to explain the benefits of inhibitors. * Learners to be told about the benefits of inhibitors by visiting water treatment companies where possible. * Learners to be able to explain the purpose of dosing pots and dirt/air separators. * Learners to be able to recognise the colour bandings for the various hydronic systems. |
| * 1. The installation requirements specific to hydronic heating system pipework within the building | * Learners to know the methods of pipework installation relevant to heating systems. * Learners to be shown presentations and visual examples of requirements such as: * pipework types * clipping and bracketry * routes and positions and * typical sizes. * Learners to understand how flow rates dictate pipe diameters. * Learners to know the importance of pipework routes and correct fitting choice to ensure air is not trapped and water is able to flow suitably whilst allowing water to drain from low points where required without trapping water. * Learners to be shown intumescent collars and fire stopping and sleeving methods. * Learners to know how pipe material, size and orientation affect clipping distances. * Learners to be able to plan basic pipe routes to avoid crossing of pipes and set correct centres. * Learners to be familiar with set scenarios and to discuss this as a class. |
| * 1. Types of boilers and heat generating equipment installed within industrial and commercial hydronic heating systems | * Learners to be shown presentations and examples of industrial and commercial heat generating equipment and to be able to explain how a range of boilers and heat exchangers differ and operate including: * modular * high efficiency * cast iron sectional * steel shell * water tube * low water content * plate heat exchangers * non-storage calorifiers * wall hung * cascade system. * Learners to be shown how these appliances are physically connected to pipework, manifolds and headers. * Learners to be given examples of the different burners and flues relevant to the different appliances. * Learners to know how plate heat exchangers fit into systems, in particular within district heating systems and higher temperature systems. |
| * 1. The methods used to install boilers in position | * Learners to know how sectional boilers are built and positioned using videos and, where suitable, practical examples. * Learners to know how modular wall hung boilers are hung and to be able to give examples of cascades and framed systems. * Learners to be shown diagrams and videos to show larger boilers and how steel shell boilers are moved using lifting equipment. * Learners to have opportunities to make final connections to boilers. |
| * 1. The application and operating principles of renewable energy sources for hydronic heating systems | * Learners to be shown diagrams, drawings and images of system layouts to show how renewable systems are used to couple in with heating systems to reduce energy consumption. * Learners to be able to sketch system layouts relevant to: * solar thermal hot water systems * ground source heat pumps * air source heat pump. * Learners to know how energy consumption is reduced using these technologies. * Learners to be shown videos and diagrams to explain the basic operating principles of the refrigerant cycle so that they know how the heat is generated. |
| * 1. The advantages and limitations of renewable energy sources for hot water generation | * Learners to be shown the advantages and limitations of the various renewable energy sources using presentations and videos. * Learners to work in small groups to summarise these advantages and limitations relative to given scenarios before discussing as a class. |
| 1. Understand the applications, advantages and limitations of industrial and commercial hydronic heating system components, controls, and accessories in relation to the working environment | * 1. The basic operating principles and positions of components and accessories used within industrial and commercial hydronic heating systems | * Learners to be shown site drawings, schematics and presentations and to be able to explain where a range of components and accessories fit within the system. * Learners to be able to state the principles of each and describe the effect of these components within a system. * Learners to be shown systems installed within the centre to offer physical examples and distribute components for them to examine and discuss including: * expansion vessels * low loss headers * expansion bellows * expansion loops * dosing pots * air and dirt separators * pressurisation unit * feed and expansion cisterns * open vent pipe * manifold * temperature and pressure relief * motorised * gate * lockshield * Double Regulating Valve (DRV) * Non-return Valve (NRV) * test/metering station * 3 port diverting * 3 port mixing valve * 2 port valve * Thermostatic Radiator Valve (TRV) * differential pressure controls. * Learners to know the positional relationship between low loss headers and expansion vessels, dosing pots, pressurisation units, air dirt separators and 3 port valves. * Learners to be able to state the need for expansion vessels and Feed & Expansion (F&E) cisterns and to know why open vent pipes are needed. * Learners to be able to label and complete incomplete drawings to add these components and take breakout sessions within the workshop or centre facilities to identify physical components. |
| * 1. The basic operating principles and positions of control devices used within industrial and commercial hydronic heating systems | * Learners to understand the basic control principles involved within industrial and commercial systems to maintain safe, functional and efficient operation. * Learners to know how time, temperature and comfort conditions are maintained including: * time controls * optimum start controllers * compensators * thermostats * Building Management Systems (BMS). * Learners to be shown diagrams to explain how compensators affect the position of 3 port mixing valves. * Learners to be shown images and examples of ‘front end’ systems connected to BMS so that they can see the functionality and depth of control available using BMS operating systems. * Learners to be able to explain and discuss how optimising time controls save energy and how thermostats are used and positioned. |
| * 1. The basic operating principles of circulating pumps for hydronic heating systems | * Learners to know the purpose of the range of circulating pumps within industrial and commercial heating systems and the position of each. * Learners to be able to explain the effect of a pump on the system flow and how pressures are affected by positive and negative sides of the pump. * Learners to be shown examples of actual pumps and their construction including: * centrifugal pumps * direct driven pump * belt driven pump. * Learners to be shown diagrams to explain how a neutral point is created and how this affects the system pressure. * Learners to be able to look at system schematics to identify where the range of pumps are positioned including: * shunt pump * variable temperature pump * constant temperature pump * primary pump. |
| * 1. The installation methods and positioning of circulating pumps within hydronic heating systems | * Learners to know how pumps should be orientated dependant on manufacturer’s instructions and how pumps should pump upwards as opposed to downwards to prevent air locking. * Learners to be shown examples of anti-vibration mountings and connections and connections for differential pressure switches. * Learners to be able to draw basic system layouts and identify within how pressure is affected within the system. |
| 1. Understand the types and applications of heat emitters used within industrial and commercial hydronic heating systems | * 1. The types and positioning of heat emitters used in industrial and commercial hydronic heating systems | * Learners to be able to use manufacturer’s literature, physical examples and presentations to explain the types, principles and positioning of heat emitters. * Learners to know the installation requirements, connections and suitable locations for each type including: * radiators * convector heaters * fan convectors * fan coil units * perimeter heating coils * radiant panels * Low Surface Temperature (LST) radiators. |
| * 1. The applications of heat emitters relevant to building use and layout | * Learners to know that different heat emitters have different advantages and limitations and to be able to conclude which type is best suited to a given building and use including: * commercial * industrial * agricultural * horticultural * leisure and entertainment * residential medical and care facilities * public services establishments and pre-1919 traditional/historic buildings * maximum recommended surface temperatures for at risk occupants. * Learners to work in groups and be given a set of scenarios. Students to offer suitable solutions and examine heat emitters within the centre to generate discussion on their application relevant to that environment, including connection arrangements, fixing and measurements. |
| * 1. The advantages and limitations of various heat emitter types relevant to building type and use | * Learners to create lists as a class or in groups to generate discussions regarding the limitations and advantages of various heat emitters relevant to building types and use. * Learners to be able to select heat emitters for a range of building types and scenarios. |
| * 1. The installation requirements specific to heat emitter type | * Learners to be familiar with manufacturer’s literature regarding heat emitter installation processes. * Learners to be able to discuss heights and clearances for each type. * Learners to know how ceiling mounted emitters are fixed and suspended and to be shown the process for hanging radiators. * Learners to practice the installation processes for: * marking and measuring for radiators and wall mounted heat emitters * heights * final connection types * connection orientation. |
| 1. Understand the appropriate industry standards and regulations relevant to the installation of industrial and commercial hydronic heating systems | * 1. Current regulations and standards relevant to hydronic heating systems | * Learners to be familiar with all legislation and regulations specific to the installation of heating systems where possible, however some of this content will be discussed throughout the unit in relevant criteria. * Learners to know the legal stance of each document and to know the difference between British Standards and legislation. * Learners to know where to find and to be familiar with a range of relevant documentation including: * The Building Regulations 2010 Approved Document L2A – Conservation of fuel and power in new buildings other than dwellings * The Building Regulations 2010 Approved Document L2B – Conservation of fuel and power in existing buildings other than dwellings * BS EN 14511:2018. Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors (Parts 1–4) * BS EN 303-5:2012. Heating boilers – Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW. Terminology, requirements, testing and marking * BS EN 15316-4-1: 2017 Energy performance of buildings * BS EN 378-3:2016+A1:2020. Refrigerating systems and heat pumps. Safety and environmental requirements – Installation site and personal protection * BSRIA Illustrated Guide to Renewable Technologies * BESA TR/20 Installation and Testing of Pipework Systems. * Learners to know how each of these documents is used, the main points within them and the information that can be gathered from each. * Learners to be introduced to these documents first and to be told how to use them when discussing the individual content of the criteria as relevant. |