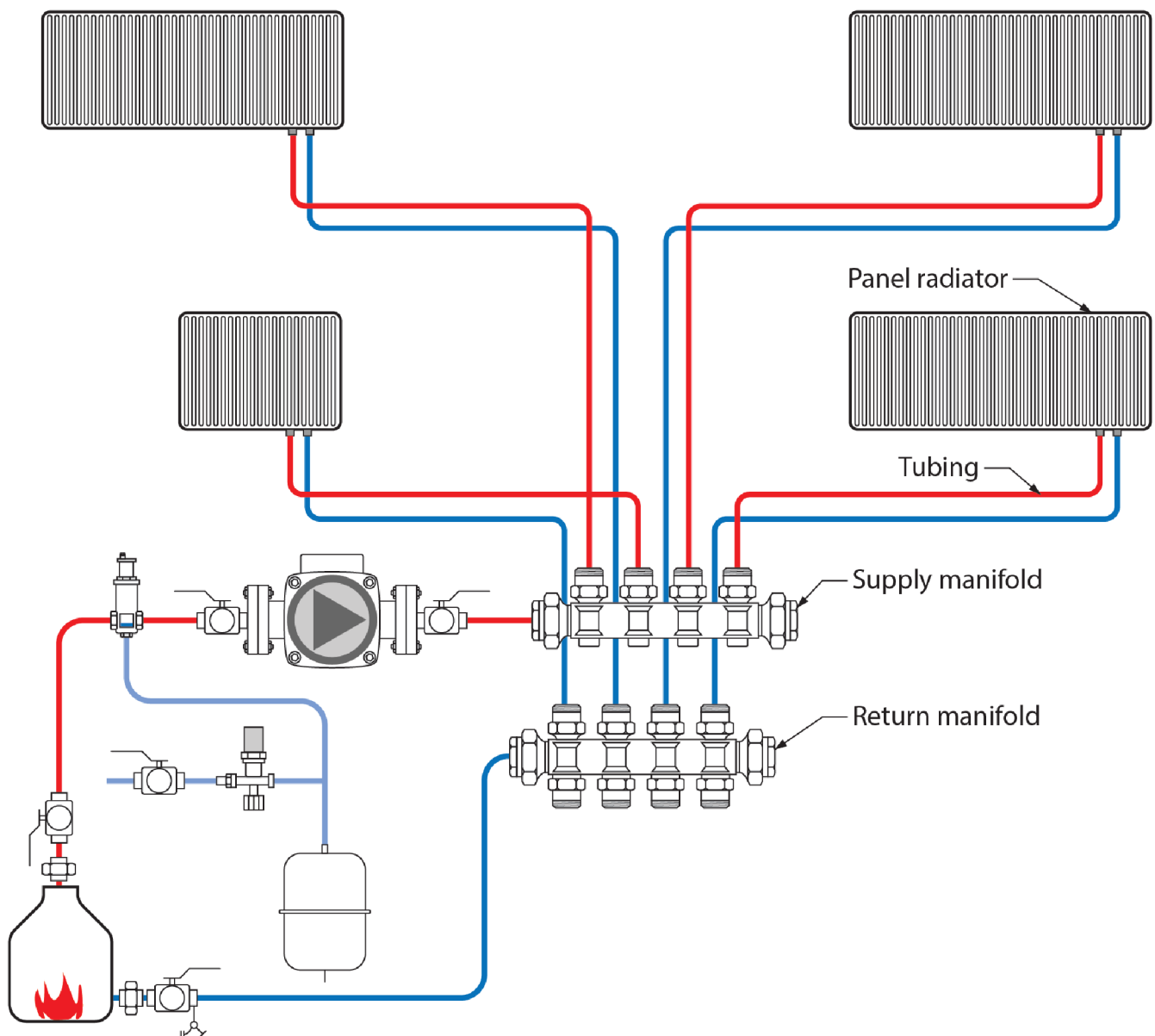


Block B: Heating & Cooling Systems



Block B: Heating & Cooling Systems

BC Plumbing Apprenticeship, Level 2

SKILLED TRADES BC

*BC PIPING ARTICULATION AND CURRICULUM SUBCOMMITTEE; ROD
LIDSTONE; AUDREY CURRAN; AND PAUL SIMPSON*

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Suggested citation (APA style, 7th Edition):

Block B: Skilled Training BC. (2025). Block B: Heating & Cooling Systems (Rev. ed.; adapted by Rod Lidstone, the BC Articulation Curriculum Subcommittee, & TRU Open Press). TRU Open Press, Thompson Rivers University.
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Block B: Heating & Cooling Introduction

In the field, there are many similarities or overlaps with the work of plumbers and gas fitters. Many plumbing and heating contractors employ both plumbers and gas fitters as well as tradespeople with dual certifications.

Upon completion of a Plumbing Apprenticeship, a plumber can receive cross-program credit for a portion of the Gas fitter apprenticeship. As such, training in fuel gas has been incorporated into all levels of the Plumbing Apprenticeship.

Block B of the **Plumbing Apprenticeship Program Level 2 Series** focuses on the fundamentals of heating and cooling systems, providing apprentices with a thorough understanding of various system types and their components. This section is designed to equip apprentices with the knowledge needed to install, maintain, and troubleshoot complex heating and cooling systems, with an emphasis on hydronic technology.

Plumbing Apprenticeship Program Level 2 Series

The *Plumbing Apprenticeship Program Level 2 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Fuel Gas Systems (<https://a-fuelgas-bcplumbingapprl2.pressbooks.tru.ca/>)

- A-1: Gas Fired Appliances
- A-2: Gas Codes Regulations and Standards
- A-3: Gas Appliance and Building Air Requirements
- A-4: Technical Instruments and Testers

Block B: Heating and Cooling Systems (<https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/>)

- B-1: Types of Heating and Cooling Systems
- B-2: Hydronic Heating and Cooling Generating Equipment
- B-3: Hydronic Heat Transfer Units
- B-4: Hydronic Heating Piping and Components

Block C: Install Fixtures and Appliances

(<https://c-plumbfixappliance-bcplumbingapprlz.pressbooks.tru.ca/>)

C-1: Plumbing Fixtures and Trim

C-2: Plumbing Appliances

Block D: Drainage Systems

(<https://d-drainagesystems-bcplumbingapprlz.pressbooks.tru.ca/>)

D-1: Sanitary Drain, Waste and Vent Systems

D-2: Planning and Installation of DWV Systems

D-3: Storm Drainage Systems

D-4: Test and Drainage Systems

D-5: Drainage System Maintenance and Repairs

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** is coming soon to TRU Open Press in 2025–2026!
- **Plumbing Apprenticeship Program Level 3 Series** (<https://collection.bccampus.ca/search/?q=%22pl3%22>) can be found in the BCCampus Open Collection (<https://collection.bccampus.ca/>).
- **Plumbing Apprenticeship Program Level 4 Series** (<https://bccampus.ca/projects/archives/zed-cred-z-degrees/ztc-open-educational-resources-for-trades/>) can be found in the BCCampus Open Collection. (<https://collection.bccampus.ca/>) (Block F: Commission and Service will be available soon.)

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The current Standards and Regulation in BC can be obtained at the WorkSafeBC (<http://www.worksafebc.com>) website:
<http://www.worksafebc.com>

Please note that it is always the responsibility of any person using these materials to inform themselves about the Occupational Health and Safety Regulation pertaining to their areas of work.

Symbol Legend



Important Information



Potentially Toxic/ Poisonous Situation



Required or Optional Resources



Potentially Flammable Situation



Complete a Self-Test



Possibly Explosive Situation



Use Protective Equipment



Potential Electric Shock

Acknowledgments

The development of the *Piping Trades Learning Guides* was a collaborative effort driven by a commitment to excellence in trades education. These guides were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose leadership and guidance have been instrumental in shaping high-quality training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.



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The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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Glossary - Block B: Heating and Cooling Systems

active (solar watering heating) systems

These use electric pumps, valves, and controllers to circulate water or other heat-transfer fluids through the collectors. There are three types: direct, indirect/ closed-loop, and drainback. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

adjustable louver

A type of window or vent with slats that can be moved or tilted. These slats can be adjusted to control the amount of light, air, and noise that comes through, making them useful for ventilation and privacy. (Section B-3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

air elimination

The process of removing trapped air from a hydronic heating system to ensure efficient operation. Usually accomplished using air vents placed at high points in the piping. (Section B-3.2 (#chapter-b-3-2-heat-transfer-units-installation))

air purger

(Also called air separators or air scoops); A device used in heating and cooling systems to remove larger air pockets and air bubbles from water, which can cause problems like noisy pipes or reduced efficiency. The device helps to keep the system running smoothly by ensuring that the water is free from air. Also see **microbubble resorber**. (Section (#chapter-b-4-1-system-components)B-4.1 (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

air vents

Steam cannot circulate nor can radiators emit heat until air has been vented from the system. Thermostatic air vents are installed on each radiator and at the end of each steam main. Thermostatic steam traps also act as air vents. (Section B-1.1 (#chapter-b-1-1-heat-and-heat-transfer), Section B-3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units) and Section B-3.2) (#chapter-b-3-2-heat-transfer-units-installation)

aquastat

A device used in heating systems to control the temperature of the water. It works like a thermostat but specifically for water, turning the boiler on or off to keep the water at the desired temperature. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

Authority Having Jurisdiction (AHJ)

An organization or person responsible for enforcing safety and building codes. They make sure that buildings and structures follow the law and safety standards, such as proper electrical wiring and fire safety measures. (Section B-2.2 (#chapter-b-2-2-installation-of-heating-and-cooling-sources-2))

backflow preventer

A device that stops water from flowing backward into the water supply. It ensures that water doesn't get

contaminated by preventing dirty or used water from flowing back into clean water lines. (Section B-4.2 (#chapter-b-4-2-valves))

balancing valve

A valve used in a piping system to control and balance the flow of fluid to ensure that each part of the system gets the right amount of flow. It also helps to make sure that all sections of the system work efficiently and evenly. (Section (#chapter-b-4-3-types-of-distribution-systems)B- (#chapter-b-2-1-heat-and-cooling-sources)4.3) (#chapter-b-4-3-types-of-distribution-systems)

ball valve

A valve that controls the flow of liquid using a ball with a hole through the center. When the ball is turned so that the hole lines up with the pipe, liquid flows through. When the ball is turned so that the hole is perpendicular to the pipe, the flow is blocked. Ball valves are known for their quick and easy on-off operation. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

baseboard wallfin units

Heating devices installed along the baseboards of rooms. They use electricity or hot water to produce heat, which is then radiated into the room. These units are effective for heating spaces efficiently and are often controlled by thermostats to maintain desired temperatures. (Section B-3.1) (#chapter-b-3-1-types-of-hydronic-transfer-units)

bypass valve (quick fill valve)

A valve that allows water to quickly flow around a system or component. It is used to quickly fill up or bypass parts of the system, making it easier to manage and maintain. (Section B-4.2 (#chapter-b-4-2-valves))

cast-iron sectional boiler

Water is contained in tanks called sections, with hot flue gases passing around the sections. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

cavitation

The process where tiny bubbles or vapor pockets form in a liquid when the pressure drops below the liquid's vapor pressure. These bubbles can collapse suddenly, creating strong shockwaves and high temperatures. Cavitation can occur in pumps, propellers, and other machinery, and while it can be useful in some processes (like cleaning or mixing), it can also cause damage to equipment over time. See also **cavitator**. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

cavitator

A device used to create cavitation in a liquid. Cavitation happens when rapid changes in pressure cause tiny bubbles to form and then collapse. These collapsing bubbles can generate powerful forces that help mix, stir, or break down materials. Cavitators are used in various applications like cleaning, chemical processing, and in some industrial processes to improve efficiency. See also **cavitation**. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

centrifugal pump

A device that moves liquids by using a rotating impeller. The impeller spins the liquid outward through centrifugal force, pushing it through the pump and into the pipes of a system. Centrifugal pumps are commonly used in water

supply, heating, and cooling systems to efficiently move fluids. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

check valve

A valve that allows liquid to flow in only one direction. It automatically closes when the liquid starts to flow backward, preventing backflow. Check valves are used to keep liquids from flowing the wrong way in a pipe system. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2) (#chapter-b-4-2-valves)

circulating pump (or circulator)

A device that moves water through a heating or cooling system. It helps distribute hot or cold water to different parts of a building, ensuring even temperature control. Circulating pumps are essential for systems like radiators and underfloor heating. (Section B-4.1 (#chapter-b-4-1-system-components))

component isolation

The process of shutting off or separating a specific part of a system, like a pipe or valve, from the rest of the system. This is done to allow for repairs or maintenance without affecting the entire system. It ensures that only the isolated part is affected while the rest continues to operate normally. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2) (#chapter-b-4-2-valves)

conduction

The transfer of heat through direct contact between materials. Heat travels from warmer to cooler areas within an object or between two objects in contact. (Section B-1.1 (#chapter-b-1-1-heat-and-heat-transfer))

convection

The transfer of heat through the movement of liquids or gases. Warmer particles rise, while cooler particles sink, creating a circular flow that distributes heat. (Section B-1.1 (#chapter-b-1-1-heat-and-heat-transfer))

convector

A heating device that warms up a room by circulating air over a heated surface. The warm air rises and spreads through the room, while cooler air is drawn in to be heated. This process creates a continuous flow of warm air, making the room comfortable. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-2-1-heat-and-cooling-sources)3.1) (#chapter-b-3-1-types-of-hydronic-transfer-units)

counterflow

A term used to describe a situation where two substances, such as fluids or gases, flow in opposite directions relative to each other. This arrangement maximizes the efficiency of heat or mass transfer between the substances by allowing the greatest temperature or concentration difference across the exchange interface. (Section (#chapter-b-1-2-low-pressure-steam-heating-systems)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

dedicated branch circuit

An electrical circuit that supplies power to only one specific piece of equipment or appliance, without sharing the circuit with other devices. (Section B-2.2 (#chapter-b-2-2-installation-of-heating-and-cooling-sources-2))

direct systems

In active systems, use pumps to circulate water through the collectors. These systems are appropriate in areas that do not freeze for long periods and do not have hard or acidic water. Systems that are installed in hard or acidic water conditions may not survive the “payback period” if care is not taken to address water chemistry. In off-grid situations where solar energy may be the only option, water chemistry must be considered. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

direct-return

A piping system design where the water or fluid returns directly to the source or starting point after passing through each section of the system. This means that each section gets the same temperature fluid and helps in balancing the system evenly. (Section B-4.3 (#chapter-b-4-3-types-of-distribution-systems))

diversion tee

A pipe fitting that splits the flow of a fluid into two separate paths. It looks like a "T" shape and allows part of the fluid to be redirected or sent to a different part of the system while the rest continues along the original path. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2) (#chapter-b-4-2-valves)

drainback systems

In active systems, are direct systems that use pumps to circulate water through the collectors, then drain themselves automatically to prevent freezing. Because the water in the collector loop drains into a reservoir tank when the pumps stop, this is still a good system for colder climates and does not require antifreeze and a heat exchanger. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

dry return

The dry return is the portion of the return main located above the boiler water level. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

equalizer line

The vertical piping at the end of the header going back to the boiler return connection. Its job is to return any water that slips out of the boiler with the steam, and to balance the pressure between the supply and the return sides of the boiler. Without a properly-sized equalizer, water can back out of the boiler. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems) and Section B-4.2 (#chapter-b-4-2-valves))

expansion tank

A special tank in a heating or cooling system that helps manage the pressure caused by changes in temperature. When the water heats up and expands, the expansion tank provides extra space for the water to go, so the system doesn't get too much pressure. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

feedwater valve (pressure-reducing valve)

A valve that controls the amount of water that enters a system and lowers the pressure to a safe level. It helps keep the water pressure steady and safe for the system. (Section B-4.2 (#chapter-b-4-2-valves))

fire-tube boiler

Heated flue gases travel through tubes that are surrounded by the water in the boiler. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-2-low-pressure-steam-heating-systems)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

flat-plate (or transpired air collectors)

Solar energy systems that consist of dark metal plates mounted on building walls or roofs. These plates absorb solar radiation, heating the air which is then circulated for heating purposes inside the building. They are a passive method of harnessing solar energy for space heating and ventilation. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-1-heat-and-heat-transfer)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

floor drain

A plumbing fixture installed in the floor of a building, typically found in areas like basements, bathrooms, or utility rooms. Its purpose is to remove excess water and prevent flooding by directing water into the building's drainage system. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-1-heat-and-heat-transfer)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

flow regulation

The control of how much fluid flows through a pipe or system. It involves adjusting valves or other devices to manage the flow rate, pressure, or speed of the fluid. This helps ensure that the system works efficiently and that different parts of the system receive the correct amount of fluid. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

forced circulating convectors

Heating units that use a fan or pump to circulate air or water through the convector. They are more powerful than gravity systems and can distribute heat more evenly throughout a room. These systems are often used in larger buildings or where rapid heating is required. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-2-1-heat-and-cooling-sources)3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

friction loop

Part of a system where friction losses occur due to the flow of fluid through pipes or other components. In systems where friction loops are managed, the aim is to reduce friction losses and improve efficiency. (Section (#chapter-b-4-3-types-of-distribution-systems)B- (#chapter-b-2-1-heat-and-cooling-sources)4.3 (#chapter-b-4-3-types-of-distribution-systems))

gate valve

A type of valve that controls the flow of liquid by raising or lowering a gate or barrier inside the valve. When the gate is fully open, the flow of liquid is unimpeded. When the gate is closed, it blocks the flow completely. Gate valves are good for stopping or allowing flow but are not ideal for regulating flow. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2) (#chapter-b-4-2-valves)

gauge glass

Used to identify the water level in the boiler. Expect to see some minor movement in the water line when the boiler is operating. When the boiler is off, the “normal” water line is the centre of the gauge glass. When the system

is running, the “normal” water line is near the bottom of the gauge glass. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

globe valve

A valve that controls the flow of liquid by moving a disc up and down inside the valve. This movement allows for precise control of the flow rate. Globe valves are often used when it's important to adjust or regulate the flow of liquid rather than just stopping or allowing it. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

gravity circulating convectors

Heating units that use natural convection to circulate warm air. They are typically placed near windows and walls where cold air enters. As the air near the heater warms, it rises, creating a convection current that circulates throughout the room. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-2-1-heat-and-cooling-sources)3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

Hartford loop

A piping arrangement designed to prevent complete drainage of the boiler if a leak develops in the wet return. The wet return is connected to an equalizing line between the supply and return opening of the boiler. This connection is made about 2” below the normal water level of the boiler. This connection between the loop and the equalizer must be made with a close nipple to prevent water hammer. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

header

Boilers, depending upon their size, have one or more outlet tappings. The vertical steam piping from the tapped outlet joins a horizontal pipe called a header. The steam supply mains are connected to this header. If the boiler has more than one outlet, it is important to remember to pipe the headers with swing joints. This will help alleviate any stress on the boiler when the header heats up and expands. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems) and Section B-4.2 (#chapter-b-4-2-valves))

heat emitters (units)

Steam heating systems use convectors, cast-iron radiators, wall fin tubes, and similar heat-emitting units. (Section B-1.4 (#chapter-b-1-4-hydronic-heating-and-cooling-systems) and Section B-3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

heat exchanger

A device used to transfer heat between two fluids (liquids or gases) without them coming into direct contact. It facilitates the efficient exchange of thermal energy, commonly found in HVAC systems, refrigeration units, and industrial processes. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-1-heat-and-heat-transfer)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

heat exchangers

Devices designed to transfer heat between two fluids or between a fluid and a solid surface. They facilitate the exchange of thermal energy without the fluids coming into direct contact with each other. They work by maximizing surface area contact between the fluids to efficiently transfer heat from a warmer fluid to a cooler one, or vice

versa, depending on the application's requirements. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)3.1) (#chapter-b-3-1-types-of-hydronic-transfer-units))

hot flue gases

The exhaust gases produced from combustion processes, such as those in furnaces, boilers, or industrial equipment. These gases are typically very hot and contain by-products of combustion such as carbon dioxide, water vapor, carbon monoxide, and other pollutants. Hot flue gases are often directed through flues or exhaust pipes to safely remove them from the combustion chamber or heating system. They may also be used in heat exchangers to recover some of their thermal energy before being vented to the atmosphere. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)3.1) (#chapter-b-3-1-types-of-hydronic-transfer-units))

housekeeping pads

A raised concrete platform on which mechanical equipment, such as a boiler, is mounted. (Section B-2.2 (#chapter-b-2-2-installation-of-heating-and-cooling-sources-2))

hydronic fan coil

A unit that uses circulating water to heat or cool air by passing it over coils, adjusting the room temperature efficiently. (Section B-3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

hydronic heating

A system that uses water to heat a building. Water is heated in a boiler and then pumped through pipes to radiators or underfloor tubing. As the hot water moves through these pipes, it releases heat into the rooms, keeping them warm. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)3.1) (#chapter-b-3-1-types-of-hydronic-transfer-units))

impeller

A rotating part of a pump or other machine that moves fluid by spinning. It has blades that push the fluid outward from the center, creating flow and increasing pressure. Impellers are commonly found in devices like centrifugal pumps and are essential for moving liquids efficiently. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1) (#chapter-b-4-1-system-components))

impeller "eye"

The center part of an impeller where liquid or gas enters before being pushed out by the spinning blades. It's like the entrance point that leads the fluid into the impeller. (Section B-4.1 (#chapter-b-4-1-system-components))

indirect/closed-loop systems

In active systems, these pump heat-transfer fluids, such as a mixture of glycol and water, through collectors. Heat exchangers then transfer the heat from the fluid to the water within the heating system. These systems are used in climates subject to freezing. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

input (boilers)

The amount of energy the boiler consumes in order to produce heat. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

insulation

A material that reduces the transfer of heat. It traps air or uses materials like foam or fiberglass to slow down heat loss or gain, helping to maintain comfortable temperatures in buildings. (Section (#chapter-b-1-1-heat-and-heat-transfer)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)1.1 (#chapter-b-1-1-heat-and-heat-transfer))

integral collector storage (ICS) systems

This type of passive solar watering heating system consists of one or more storage tanks placed in an insulated box with a glazed side facing the sun. During the winter, the connecting piping must be drained or protected from freezing. (Section 2.1 (#chapter-b-2-1-heat-and-cooling-sources))

low-water cut-off

The job of the low-water cut-off is to shut off the burner should the water level fall to an unsafe level. The boiler manufacturer determines this level, but it is usually within one-half inch of the bottom of the gauge glass. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems) and Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

main stop valve

A valve that controls the flow of water or other fluids into or out of a system. It can completely stop the flow when needed, allowing you to turn off the entire system or isolate it for repairs or maintenance. (Section B-4.2 (#chapter-b-4-2-valves))

microbubble resorber

A device used in heating and cooling systems to remove very tiny air bubbles (microbubbles) from water that may not be captured by standard air purgers. By getting rid of the bubbles, the microbubble resorber may more efficiently help the system work better and more quietly. See also **air purgers**. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1) (#chapter-b-4-1-system-components)

outlet tapping

An outlet tapping is when a hole is made in a pipe to add another pipe or valve. This lets water or gas flow from the main pipe to a new area, like a faucet or another system. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

output (boilers)

The amount of energy that is actually transferred to the medium being heated (water, heating fluid, glycol, etc.). (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

parallel flow

A situation where two substances, such as fluids or gases, flow in the same direction relative to each other. In heat exchangers, parallel flow occurs when both the hot and cold fluids move in the same direction through adjacent channels or tubes. This configuration typically results in a lower temperature difference between the two fluids compared to counterflow, but it is simpler to construct and often more compact. (Section (#chapter-b-1-2-low-pressure-steam-heating-systems)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

passive (solar water heating) systems

Solar water heating systems that move water or heat-transfer fluid without pumps. There are two types of passive systems: Integral collector storage (ICS) and thermosiphon systems. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

potable water system

A water supply system that provides water safe for drinking and other domestic uses, free from harmful contaminants. (Section B-2.2 (#chapter-b-2-2-installation-of-heating-and-cooling-sources-2))

pump curve

A graph that shows how well a pump can move water at different speeds. It helps us see how much water the pump can push out at different pressures or flows. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

push nipples

Small connectors used in boilers and heating systems to join sections of piping together securely. They allow for easy assembly and disassembly when maintaining or repairing the system. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-1-heat-and-heat-transfer)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

radiant panels

Heating devices that are installed in ceilings, walls, or floors of buildings. They emit infrared radiation, which directly heats objects and people in the room without heating the air. This method of heating is efficient and provides comfortable warmth evenly throughout the space. (Section B-3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

radiation

The transfer of heat through electromagnetic waves. Unlike conduction and convection, radiation does not require a medium and can travel through vacuum, transferring heat from the Sun to Earth and between objects. (Section (#chapter-b-1-1-heat-and-heat-transfer)B- (#chapter-b-3-1-types-of-hydronic-transfer-units)1.1 (#chapter-b-1-1-heat-and-heat-transfer))

radiator valves

Radiator valves control the steam supply to the system radiators. Each radiator is equipped with an angle pattern radiator supply valve. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems) and Section 4.2 (#chapter-b-4-2-valves))

radiators

Heating devices that use hot water or steam to warm a room. They consist of metal panels or pipes that emit heat through radiation and convection. Radiators are commonly found under windows or along walls and are controlled by thermostats to maintain desired temperatures. (Section (#chapter-b-3-1-types-of-hydronic-transfer-units)B- (#chapter-b-2-1-heat-and-cooling-sources)3.1 (#chapter-b-3-1-types-of-hydronic-transfer-units))

relief valves

These valves protect the boiler against a runaway fire. On space-heating steam boilers, the relief valve is set to pop

open and relieve pressure at 15 psi. This is the limit for any low-pressure boiler. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems), Section B-4.1 (#chapter-b-4-1-system-components), and Section B-4.2 (#chapter-b-4-2-valves))

residual heat

The leftover warmth retained by an object or substance after the source of heat has been removed. It can be useful in conserving energy or maintaining temperatures in systems like engines or household appliances. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-1-heat-and-heat-transfer)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

reverse-return

A piping system design where the fluid flows in a way that the return path is the opposite of the supply path. This means that the last section to receive the fluid is the first to return it, helping to balance the system and ensure even heating or cooling throughout. (Section (#chapter-b-4-3-types-of-distribution-systems)B- (#chapter-b-2-1-heat-and-cooling-sources)4.3 (#chapter-b-4-3-types-of-distribution-systems))

riser

A vertical pipe or duct that carries water, steam, air, or other fluids up through different floors of a building. It's used to move fluids between different levels or stories in a building. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems), Section B-4.1 (#chapter-b-4-1-system-components), and Section B-4.4 (#chapter-b-4-4-distribution-system-installation))

runout

A horizontal pipe or section of piping that extends from a riser to other parts of a system. It helps direct the flow of fluids from the vertical riser to different areas or equipment. (Section (#chapter-b-4-4-distribution-system-installation)B- (#chapter-b-2-1-heat-and-cooling-sources)4.4 (#chapter-b-4-4-distribution-system-installation))

series loop

A type of piping arrangement where the water or other fluid flows through one section of the system, then directly into the next section, like a chain. In a series loop, all the sections are connected in a single path, so the fluid passes through each one in order. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

solution tank

A container where a mix of substances, like water and chemicals, is stored. It's used to hold and sometimes mix these substances before they are used in a process or system. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

spring piece

A type of pipe or fitting that includes a spring to allow for movement or adjustment. It helps accommodate changes in temperature, pressure, or alignment in the piping system, reducing stress and preventing damage. (Section (#chapter-b-4-4-distribution-system-installation)B- (#chapter-b-2-1-heat-and-cooling-sources)4.4) (#chapter-b-4-4-distribution-system-installation)

standpipe

A vertical pipe used to carry liquids or gases from one place to another. It's often found in systems where a pipe needs to reach a higher level or where it helps manage the flow of liquids. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1 (#chapter-b-4-1-system-components))

steam boiler

A steam boiler is a device that heats water until it turns into steam. This steam is then used to provide heat or power. It works by burning fuel like coal, oil, or gas, or by using electricity to generate heat. The steam produced can be used for various purposes, such as heating buildings, running engines, or powering machines. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

Note: Steam boilers differ from hot water boilers because they are only partially filled with water. They have a sight glass for checking the water level and a relief valve to prevent damage from excessive pressure. A pressure switch, or pressuretrol, controls the burner and determines the boiler's operating pressure. When heat is needed, the boiler runs until it reaches the pressuretrol's cut-out setting, then the pressuretrol shuts off the burner. Commercial boilers also have a manual-reset high-limit pressuretrol to turn off the burner if the pressure gets too high.

steam supply main

The steam supply main carries steam from the header to the radiators connected along its length. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

steam traps

Steam traps prevent steam from getting into the condensate returns, because they close in the presence of steam, creating a separation from the return piping of the system. The steam trap has three jobs: to let air pass through the radiators, to close when steam reaches it, and to open when condensate accumulates. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

swing connection

A type of flexible pipe fitting that allows for movement and adjustment. It helps connect pipes or equipment while accommodating changes in position or alignment, making it easier to install and maintain the system. (Section (#chapter-b-4-4-distribution-system-installation)B- (#chapter-b-2-1-heat-and-cooling-sources)4.4 (#chapter-b-4-4-distribution-system-installation))

thermosiphon systems

This type of passive solar watering heating system relies on convection created between the fluids in the tank and in the collector. The fluid in the collector becomes less dense and rises into the tank above, while the denser fluid in the bottom of the tank falls through piping into the bottom of the collector to be reheated. The fluid to be heated is circulated through a separate path within the tank (heat exchanger) where it absorbs the heat created and returns to the building for use. (Section (#chapter-b-2-1-heat-and-cooling-sources)B- (#chapter-b-1-2-low-pressure-steam-heating-systems)2.1 (#chapter-b-2-1-heat-and-cooling-sources))

thermosiphoning

A process where a liquid moves naturally without the need for a pump, because of temperature differences. When a liquid gets heated, it becomes less dense and rises. Cooler, denser liquid then moves in to take its place. This

creates a natural circulation of the liquid. It's often used in heating systems and solar water heaters. (Section B-4.3 (#chapter-b-4-3-types-of-distribution-systems))

throttling

The process of controlling the flow of a fluid (liquid or gas) by partially obstructing or restricting the passage through a valve or other device. This adjustment allows for precise control over the flow rate, pressure, or speed of the fluid. Throttling is commonly used in various systems, like heating and cooling systems, engines, and pipelines, to manage the performance and efficiency of the system. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

tridicator

A device that measures and displays three different things at once: pressure, temperature, and altitude (or level) of a liquid in a system. It's commonly used in heating systems to monitor these conditions and ensure everything is working properly. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

upfed system

A way of moving water in a building where the water comes in from the bottom and gets pumped up to higher floors. This is often used in places where the water pressure isn't strong enough to reach the top on its own. (Section B-4.3 (#chapter-b-4-3-types-of-distribution-systems))

venturi

A device that controls the flow of fluid through a pipe by narrowing the pipe at a certain point. This narrowing causes the fluid to speed up and the pressure to drop. Venturis are often used to measure flow rates or to mix fluids. (Section (#chapter-b-4-3-types-of-distribution-systems)B- (#chapter-b-2-1-heat-and-cooling-sources)4.3 (#chapter-b-4-3-types-of-distribution-systems))

volute

A spiral-shaped casing in a pump that surrounds the impeller. It helps direct the flow of liquid as it leaves the impeller, converting the high-velocity flow into a more controlled, higher-pressure flow. The volute design ensures efficient movement and pressure management of the liquid within the pump system. (Section (#chapter-b-4-1-system-components)B- (#chapter-b-2-1-heat-and-cooling-sources)4.1) (#chapter-b-4-1-system-components)

waste heat (or waste energy)

Energy that is produced but not used efficiently, often escaping as heat during processes like running machines or producing electricity. Instead of being used, this energy is usually lost to the environment. (Section 2.1 (#chapter-b-2-1-heat-and-cooling-sources))

water makeup

The process of adding water to a system to replace water that has been lost due to evaporation, leakage, or other reasons. This is commonly done in systems like boilers, cooling towers, and HVAC systems to maintain the proper water levels and ensure the system operates efficiently. The added water is often treated or conditioned to match the quality and chemistry requirements of the system. The term "water makeup" is used to indicate the piping and accessories connected to the system that not only fills it but keeps a constant pressure within it. (Section (#chapter-b-4-2-valves)B- (#chapter-b-2-1-heat-and-cooling-sources)4.2 (#chapter-b-4-2-valves))

water-tube boiler

Water travels through tubes that are surrounded by the hot flue gases within the fire chamber. (Section B-2.1 (#chapter-b-2-1-heat-and-cooling-sources))

wet return

The portion of the return main, located below the boiler water level. It is always completely filled with water and does not carry air or steam in the same way the dry return does. (Section B-1.2 (#chapter-b-1-2-low-pressure-steam-heating-systems))

zone valve

A valve used in heating or cooling systems to control the flow of fluid to different areas or zones of a building. It allows you to control the temperature in each zone separately, so you can heat or cool only the areas that need it. (Section (#chapter-b-4-4-distribution-system-installation)B- (#chapter-b-2-1-heat-and-cooling-sources)4.4 (#chapter-b-4-4-distribution-system-installation))

Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship** (<https://skilledtradesbc.ca/plumber>) – Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber** (<https://www.red-seal.ca/eng/trades/plumbers/overview.shtml>) – National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards** (<https://www.bccodes.ca/>) – Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC** (<https://www.worksafebc.com/en>) – Essential safety resources for plumbers, including:
 - Health & Safety – WorkSafeBC (<https://www.worksafebc.com/en/health-safety>)
 - Report Unsafe Working Conditions (<https://www.worksafebc.com/en/contact-us/departments-and-services/health-safety-prevention>)
 - Report a Workplace Injury or Disease (<https://www.worksafebc.com/en/claims/report-workplace-injury-illness>)
 - Submit a Notice of Project Form (<https://www.worksafebc.com/en/for-employers/just-for-you/submit-notice-project>)
 - Get Health and Safety Resources (Videos, Posters, Publications, and More) (<https://www.worksafebc.com/en/resources-health-safety>)
 - Search the OHS Regulations (and Related Materials) (<https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation>)
 - Conduct an Incident Investigation (<https://www.worksafebc.com/en/health-safety/create-manage/incident-investigations/conducting-employer-investigation>)
- **CCOHS: OHS Answers Fact Sheets – Plumber** (https://www.ccohs.ca/oshanswers/occup_workplace/plumber.html) – Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** (<https://skilledtradesbc.ca/financial-support>) – Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training

(ISET) program.

- **StudentAidBC** (<https://studentaidbc.ca/>) – Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** (<https://www.workbc.ca/find-loans-and-grants/students-and-adult-learners/services-apprentices-and-employers>) – Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** (<https://www.healthlinkbc.ca/mental-health-and-substance-use>) – HealthLink BC resources for mental health and wellness support.
- **Here2Talk** (<https://here2talk.ca/>) – Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** (<https://helpstartshere.gov.bc.ca/>) – A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** (<https://www.hopeforwellness.ca/>) – 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
 - First Nations Health Authority Mental Health Supports Info Sheet [PDF] (<https://www.fnha.ca/Documents/FNHA-mental-health-and-wellness-supports-for-indigenous-people.pdf>) by First Nations health Authority – List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** (<https://www.heretohelp.bc.ca/>) – Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** (<https://www.constructionrehabplan.com/>) – Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** (<https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports>) – Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** – Call 1-888-353-2273 (tel:+1-888-353-2273) for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** (<https://talksuicide.ca/>) – An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** – Call 250-310-6789 (tel:+1-250-310-6789) for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** – Call 1-800-784-2433 (tel:+1-800-784-2433) if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** – Call 1-833-804-8111 (tel:+1-833-804-8111) between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** – Call 1-800-588-8717 (tel:+1-800-588-8717) for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** – Call 1-800-663-1441 (tel:+1-800-663-1441) to find resources and support.



Emergency Services — For life-threatening situations, call 911 or visit your nearest emergency department.

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 2, Block B (<https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/>). Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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Version	Date	Change	Details
1.0	September, 2025	Plumbing Apprenticeship Level 2 Block B learning resource from STBC content converted to open and freely accessible digital platform and published at TRU.	