Block B: Heating & Cooling Systems

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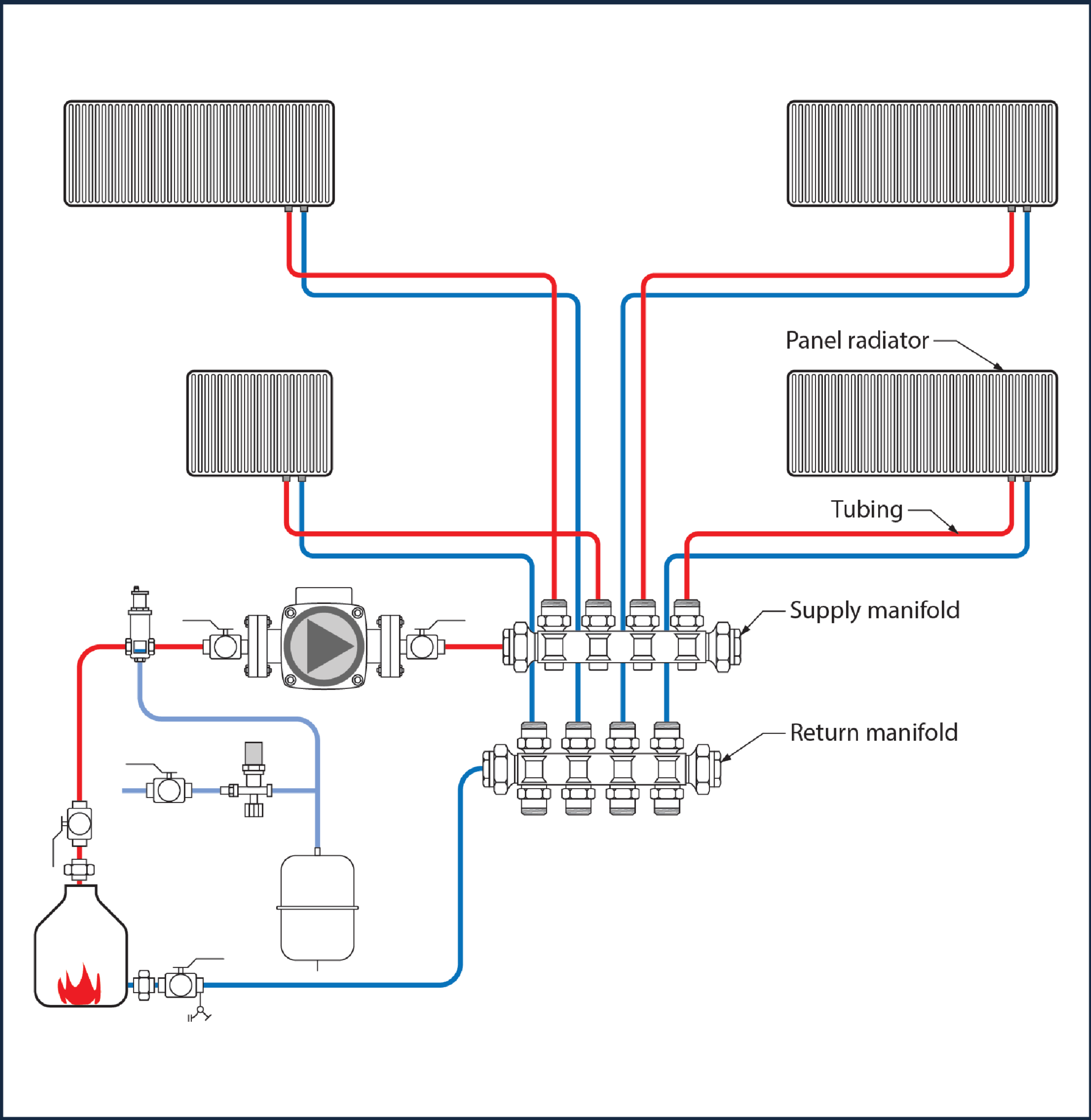

Plumbing Apprenticeship Program Level 2 Series

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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Contents

Block B: Heating & Cooling Introduction vii
Acknowledgments xi
Accessibility xvi

B-3 Hydronic Transfer Units

B-3 Hydronic Transfer Units Introduction 119
B-3.1 Hydronic Heat Transfer Units 122
B-3.2 Heat Transfer Units Installation 142
Self-Test B-3.1 Hydronic Heat Transfer Units 152
Answer Key: Self-Test B-3.1 154
Self-Test B-3.2 Heat Transfer Units Installation 155
Answer Key: Self-Test B-3.2 156

Plumbing Apprenticeship & Trade Resources in BC 298
Version History 301

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-bcplumbingapprl2.pressbooks.tru.ca/)

C-1: Plumbing Fixtures and Trim
C-2: Plumbing Appliances

Block D: Drainage Systems (https://d-drainagesystems-bcplumbingapprl2.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

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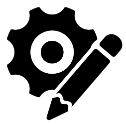
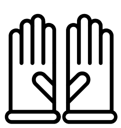
 Required or Optional Resources

 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.

The Open Press

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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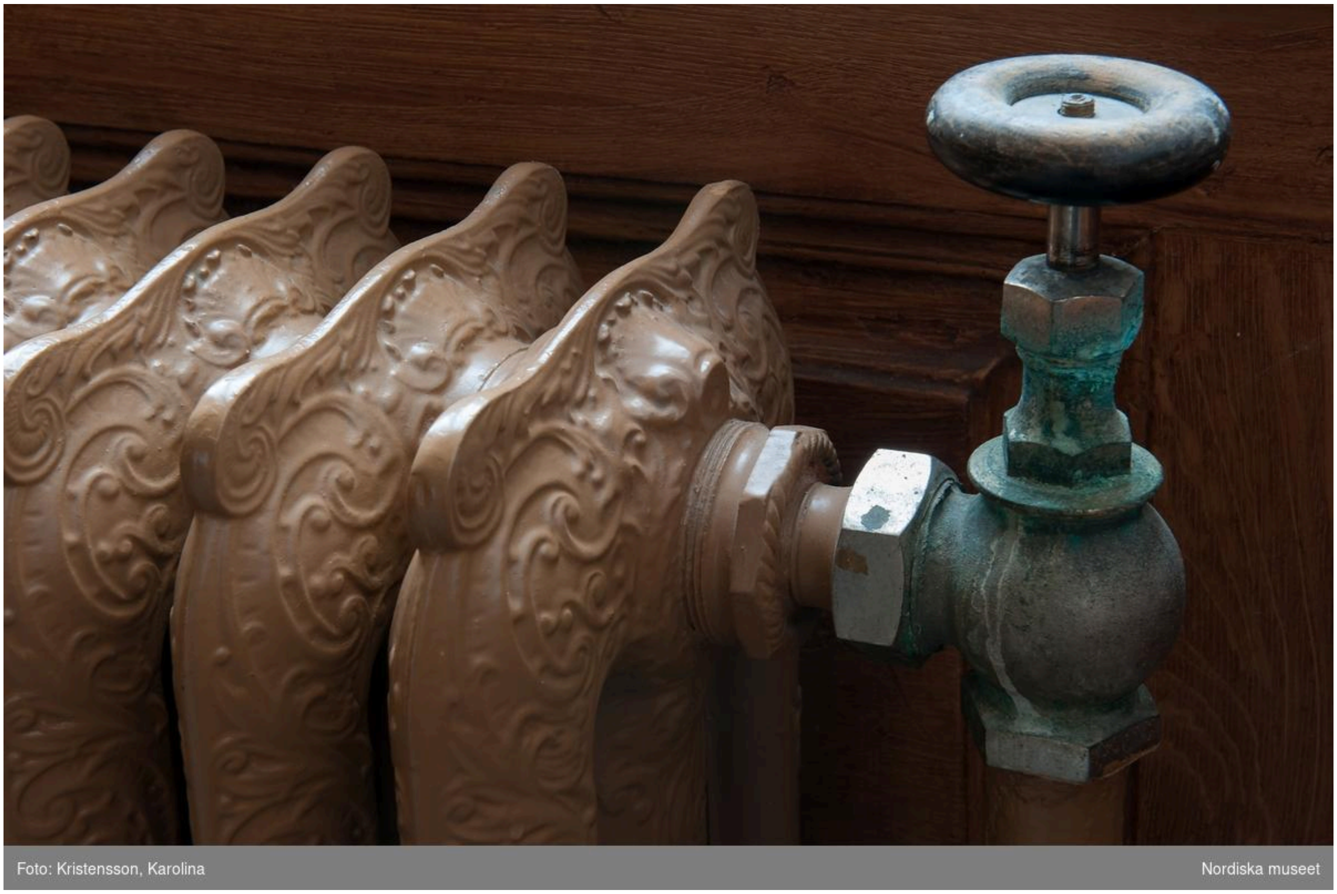
B-3 HYDRONIC TRANSFER UNITS

Plumber Apprenticeship Program – Level 2



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B-3 Hydronic Transfer Units Introduction

Because heat always moves from an area of higher temperature to an area of lower temperature, all buildings either gain or lose heat depending on their surrounding environment. Buildings must have their rate of heat transfer estimated before a means of adding or removing that heat can be specified.

The rate of heat transfer depends on two factors. One is the temperature difference between two bodies or areas. The greater the temperature difference (ΔT or "Delta T"), the faster the rate of heat transfer or flow.

The second factor is the material through which the heat moves. For instance, heat moves through a well-insulated wall much more slowly than through an uninsulated wall. Copper is generally used in the hydronic heating industry because it is a good conductor of heat. This means that heat moves through copper quite easily and has a high rate of heat transfer. By comparison, plastic is more of an insulator, and less heat is lost through the walls of plastic tubing than through copper.

Heat in buildings can only be transferred by three means: conduction, convection, and radiation. Heat transfer units are designed to operate using these three methods.

Heat transfer units are also referred to as heat emitters. In this section we will look at the different types of **heat emitters** and some general installation guidelines for each type. Although the installation of site constructed in floor wall and ceiling radiant panels will be covered in Level 3 studies.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Name types of heat transfer units.
- Describe heat transfer units, including the following:
    - In-floor heating
    - Radiant panels
    - Heat exchangers
    - Force flow units
    - Unit heaters
- Explain considerations for selecting and installing heat transfer units.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **adjustable louvre:** 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)
- **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-3.1 and Section B-3.2)
- **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)
- **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 B-3.1)
- **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 B–3.1)
- **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 B-3.1)
- **heat emitters (units):** Steam heating systems use convectors, cast-iron radiators, wall fin tubes, and similar heat-emitting units. (Section B-1.4 and Section B-3.1)
- **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 B-3.1)
- **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 B-3.1)
- **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)
- **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 3.1)

- **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)
- **radiators:** Heating devices that use hot water or steam to warm a room. They consist of metal panels, electrical coils, or hot water 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 B-3.1)

B-3.1 Hydronic Heat Transfer Units

Heat in a hydronic heating system is generated at the heat source. Consider a boiler as an example. A boiler heats water to temperatures as high as 88°C (190°F), then the distribution piping system carries this heated water throughout the building. At some point along the way, a portion of that heat is released into the space that requires it. This is the point where heat transfer units, aka **heat emitters**, are installed. They take the heat out of the water and transfer it into the room.

Hydronic heating has the advantage of offering many options to choose from when selecting heat transfer units. Small **baseboard wallfin units** operating at high temperatures can do the same job as low-temperature **radiant panels** that use a large surface area. Designers take into account variables such as comfort, aesthetics, and control when designing systems and choose transfer units accordingly. Because of the wide variety of heat transfer units available, designers are also able to choose transfer units that meet the architectural requirements of a building. The ductwork involved with forced-air heating systems may require dropped ceilings in the room below, whereas a radiant panel in-floor heating system requires no additional space to be used.

Although there are many classifications of heat emitters, this section will group them into four categories:

- **Gravity circulating convectors**
- **Forced circulating convectors**
- **Radiators**
- **Radiant panels (in-floor heating)**

Gravity Circulating Convectors

Convectors are so named because they operate on the principle that when air is heated, its density decreases, and colder, denser air will force the heated air upward. Gravity or "passive" convectors (Figure 1) use natural air currents to move heated air through them. The coldest air in a room is near the floor, so the cabinet of a gravity circulation convector is open at the bottom to allow cold air to enter. Hot water flowing through the tube heats the fins by conduction.

The large surface area of the fins transfers the heat to the air in contact with them, also via conduction. The now-warmed air rises due to its buoyancy and mixes with the rest of the room air. The design of the gravity circulation convector is such that the cabinet does not become hot, so it will transfer very little heat through radiant means.

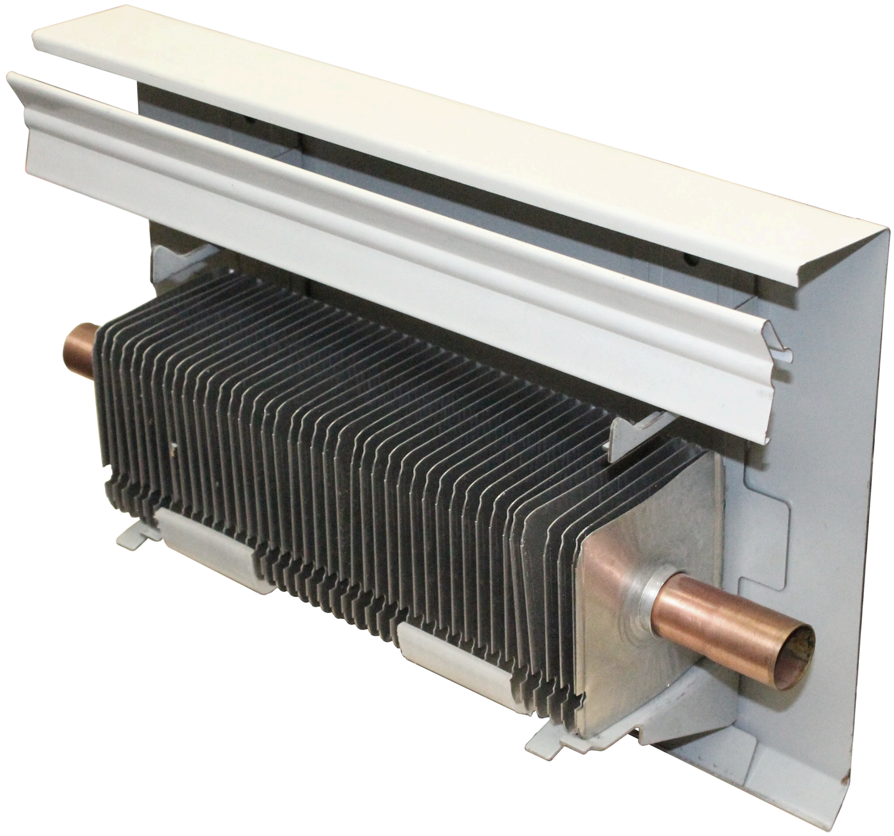

Figure 1 *Residential gravity circulating convector. (Skilled Trades BC, 2021) Used with permission.*

Gravity circulation convectors are either surface-mounted or recessed into the wall. Insulation behind the back of the cabinet prevents heat loss through the wall. Brackets attached to the back of the cabinet support the finned tube. The front panel of the cabinet can be removed for access to the tube and air vent, and the pivoting damper can be adjusted to allow more or less air to flow across the fins

Residential circulating convectors are mounted at baseboard level, beneath windows. Commercial-grade convectors are normally found in stairwells and common areas.

Finned Tube Baseboard Convectors

The finned tube baseboard convector (also known as “baseboard wallfin”) has historically been the most common hydronic heat emitter used in residential and small commercial applications. Figure 2 shows two views of a typical finned tube convector (with a back panel or cabinet).

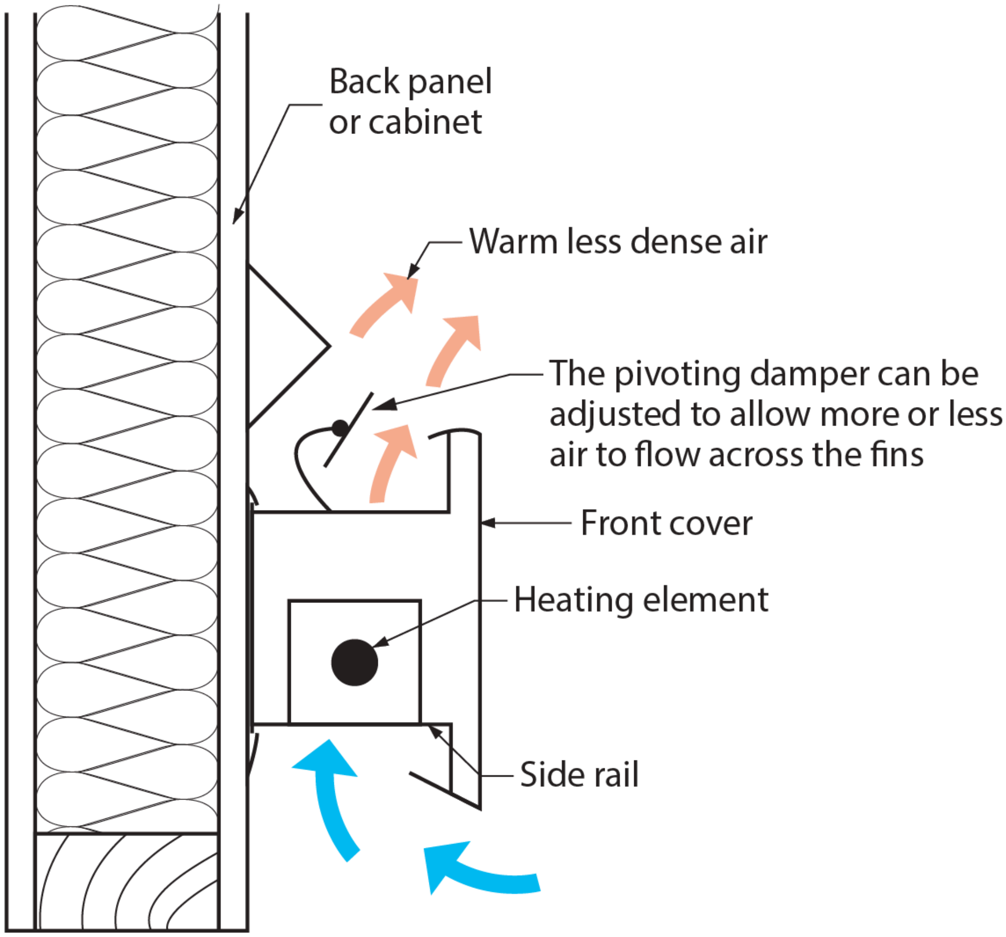

Figure 2 *Finned tube baseboard convector. (Skilled Trades BC, 2021) Used with permission.*

The heating element is a single copper tube with aluminum fins. When heated water is moved through the copper tube, heat is transferred by conduction to the aluminum fins. The cold air that has been trapped between the fins begins to warm through contact with the fins, and eventually this warm, less dense air rises. Colder, denser air displaces the warm air and thus begins the convection currents that warm the room. Because the heat is quickly moved away from the convector, there is not enough time for the convector to warm up and create radiant heat, so almost all of the heat created for the room is through air convection. As well, the white cabinet tends to reflect the heat back into itself rather than absorb the heat, so it emits very little radiant heat.

The finned tube baseboard convector is encased in a housing, also known as a cabinet, designed to allow for airflow in and out of the unit. Movable brackets attached to the back panel of the cabinet support the heating element or finned tube, the front panel, and the **adjustable louvre**. The adjustable louvre regulates airflow. Closing the louvre slows or stops the flow of air and eventually stops or slows down the flow of heat. Figure 3 shows how the heat is transferred from the water into the convector and then into the room.

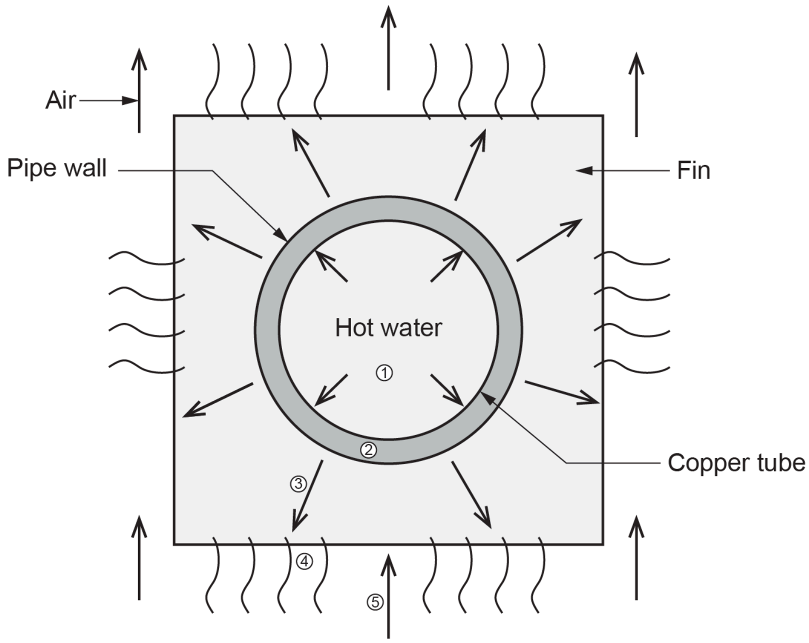

Figure 3 *Finned tube baseboard convector. (Skilled Trades BC, 2021) Used with permission.*

Baseboard convectors for residential use are typically 230 mm (9 in.) high and extend less than 100 mm (4 in.) from the wall. However, they do come in various sizes. Convectors should be mounted below windows to balance the cold drafts from the windows. When the air in contact with the window is cooled by heat loss through the glass, it moves downward. If a convector is mounted below the window, the cool downdraft will mix with the warm air that is rising from the convector. Together these drafts produce a more even room temperature. To allow the convector to function as designed, nothing should obstruct the movement of air through the unit and the room. Homeowners must keep this in mind when placing furniture and drapery near the baseboard wallfin.

Commercial-Grade Wall-Mounted Convectors

Commercial wall-mounted convectors are the modern counterpart of the cast-iron radiator. A wall-mounted convector is not nearly as heavy as a cast-iron radiator and typically extends only about 125 mm (5 in.) from the wall, however, the sizes may vary. Wall-mounted convectors are used in commercial applications and large buildings, such as schools. They are normally installed below windows, in stairwells, and in stairway landings.

The heating element of the wall-mounted convector has a manifold and several tubes running through the fins.

Figure 4 shows a multi-tube wall-mounted convector. A wall-mounted convector works in the same manner as a finned tube baseboard. Cool air enters the bottom opening and gets trapped between the aluminum fins. As this air is warmed, it rises and exits through the top of the unit. Cool air replaces this warm air, establishing convection currents.

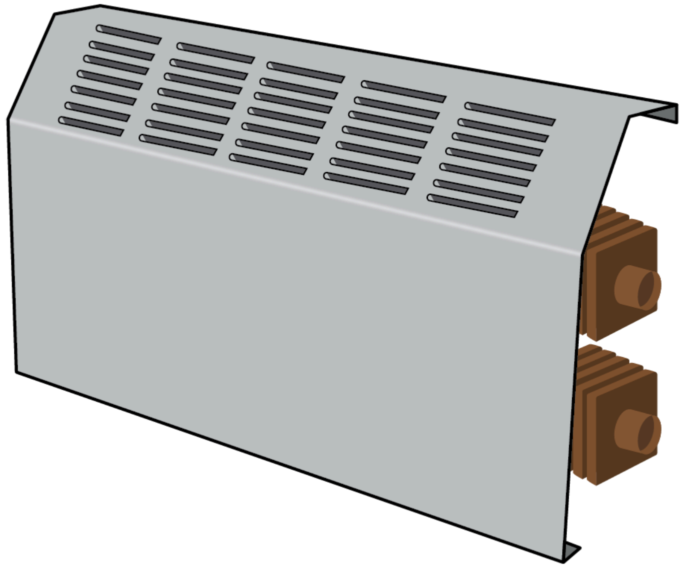

Figure 4 *Wall-mounted convector and finned tube. (Skilled Trades BC, 2021) Used with permission.*

Forced Flow Systems or Fan Coils

Gravity convectors rely on the differences in temperature and density of the air to create convection air currents that move the heat. Forced flow systems combine a heating element, which is a finned tube heat exchanger, similar to those in the gravity convectors, and a fan or blower to move the air. The concept is similar to that of a forced-air furnace — in both cases, warm air is circulated using a fan, but the heat sources differ. A furnace uses **hot flue gases** on the inside of its heat exchanger, whereas, in a forced flow convector, the hot water inside the tubing is the heating medium.

A **hydronic fan coil** (Figure 5) is a type of forced flow convector that can best be compared to a radiator in a car. It consists of small-diameter tubing with a large surface area of aluminum fins attached to it and uses a fan to push air through it. The principle of heat transfer is similar to that of the baseboard wallfin, except the fan coil has more tubing of smaller diameter that the water has to push through. Rather than relying on air currents, the air is forced over the finned tubes using a fan. This increases the heat transfer rate but also increases the resistance to flow that the circulator has to overcome.

Consequently, stronger pumps may be required on fan coils than on baseboard wallfin or convectors. When heating is required, a fan on the upstream side of the coil pushes air across the coil. The air picks up heat and is pushed out directly into the room or into ductwork. Other names used to describe particular types of fan coils are unit heaters, duct heaters, and kickspace heaters. The different names generally relate to their location, but essentially, they all work on the same principle.

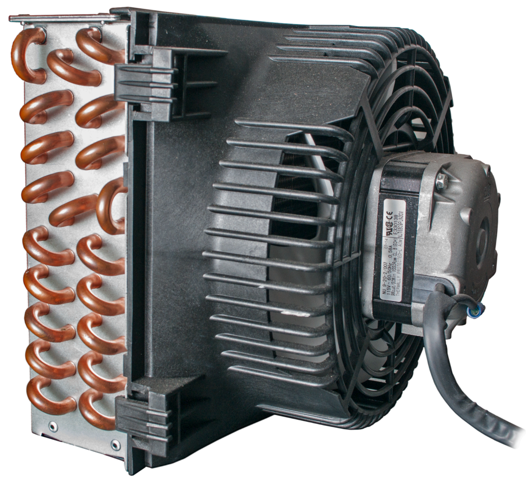

Figure 5 *Fan coil heater. (Skilled Trades BC, 2021) Used with permission.*

Because forced flow systems use a fan to transfer heat from the coil surface to a room, these systems are much more responsive than gravity convection systems. They generally have little thermal mass and low water content, which allows them to respond to a call for heat quickly.

Forced-air heating can cause more dust movement and more noise from the fan than a gravity system. An installer must also consider the fact that as forced flow systems are equipped with a fan, a source of line voltage, wiring, and other electrical controls associated with the fan are required.

Unit Heaters and Overhead Fan Coils

Unit heaters and overhead fan coils are mainly used in commercial buildings, where it may be advantageous to deliver heat from above. This allows the hydronic piping to be kept close to the ceiling and avoids having to run piping down to the floor level in areas where that might be difficult. An example of this would be a large open space, such as a warehouse. Machine shops, service garages, and supermarkets are all areas that would benefit from the installation of unit heaters.

Unit heaters have closely spaced fins on their tubing, much the same as fan coils. The fan forces air between the fins, allowing unit heaters to transfer great quantities of heat, making them suitable for large commercial and industrial applications.

Unit heaters are installed high above the floor. The warmed air is directed downward by a series of louvres attached to the discharge side of the unit. Because they are mounted high in a room, they do not produce uncomfortable drafts at head level. The heat from one unit heater can be circulated through a large area by the action of a few well-placed ceiling fans.

Unit heaters can be either vertical or horizontal. Horizontal units are less expensive, but vertical units will heat a larger area. Smaller units are less expensive than larger ones, although smaller units require higher water flow rates, larger pipes, and a stronger pump to achieve the same level of heat transfer.

Vertical Unit Heaters

Vertical unit heaters, also called projection unit heaters, push air downwards and are mounted near the ceiling. The vertical unit heater has a circular heating element. This element has a manifold tube running through the vertical fins that allows air to flow through the unit (Figure 6). The fan draws the air in through the heating element then forces the heated air toward the floor. Deflecting louvres below the fan can be adjusted to direct the air, or a diffuser cone can be used to decrease drafts.

Figure 6 *Vertical unit heater. (Skilled Trades BC, 2021) Used with permission.*

Vertical unit heaters create downdrafts and updrafts; however, they can often produce warmer and cooler spots within a room. Warm downdrafts occur directly under the unit, and updrafts occur in other areas. Well-positioned vertical unit heaters can mix the air to give even temperatures throughout, and will not create excessive drafts near the floor.

Horizontal Unit Heaters

Horizontal unit heaters (Figure 7) move air at a lower velocity than vertical unit heaters. In situations where unit heaters must be installed at lower levels, horizontal units provide more comfort due to their ability to direct airflow via adjustable discharge deflectors. Horizontal unit heaters should be used in areas less than 4.5 m (15 ft) high, where there is no permanent obstruction to airflow.

Figure 7 *Horizontal unit heater. (Skilled Trades BC, 2021) Used with permission.*

Because of their lower velocity, horizontal unit heaters are used in groups to circulate air throughout a large area. Normally, a fan is mounted behind the heating element, and adjustable air deflectors are mounted in front of the heating element.

Kickspace Heaters or Under-Cabinet Fan Coils

Kickspace heaters (Figure 8) are also referred to as under-cabinet fan coils. These transfer units are designed to be installed in kitchens or bathrooms in the "kickspace" below cabinets. They heat a room in which wall space is limited, and serve as supplementary heat for a radiant floor system. They operate similarly to a unit heater in that hot water is circulated through a finned tube coil. A fan draws air into the kickspace heater and across the coil and moves the heated air out into the room.

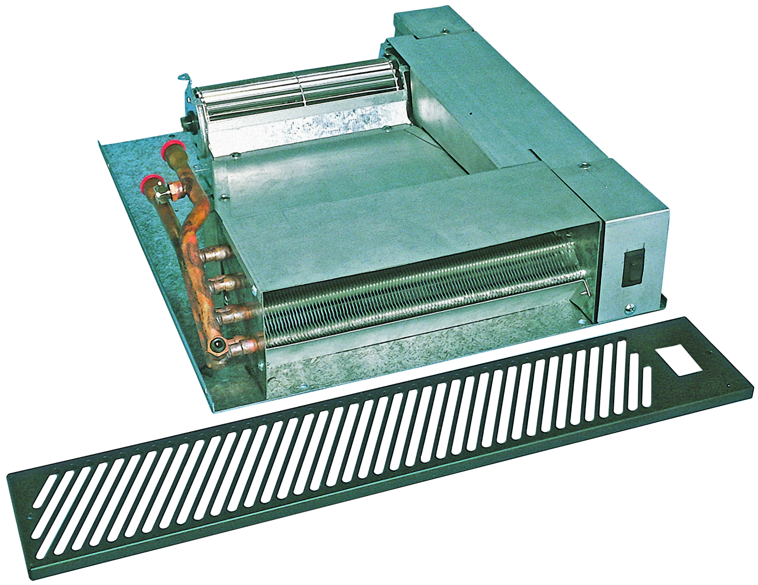

Figure 8 *Kickspace heater. (Skilled Trades BC, 2021) Used with permission.*

Forced-Flow Wall-Mounted Convectors

Forced-flow wall-mounted convector units can also be called wall-mounted fan coils. They are identical to a wall-mounted gravity convector except for the addition of a fan that draws air in through the bottom and moves heated air out through the top. Another version of the convector is recessed into the wall (Figure 9).

Figure 9 *Forced-flow wall convector. (Skilled Trades BC, 2021) Used with permission.*

Using Fan Coils for Cooling

Some hydronic systems can supply heating and chilled water to fan coils in ductwork, but these installations are normally limited to commercial buildings with more sophisticated control systems. Residential and smaller commercial buildings will often install a heat/cool device, such as a heat pump, which is an air conditioner with a reversible function for heating. These units use a single coil in order to provide both heating and cooling.

A hydronic cooling fan coil operates the same as a heating coil, except that chilled water is circulated through the coil rather than warm water. A fan then pushes air past the coil and sends cool air into the room.

Most of the heat transfer units discussed in this section are heat-only, and any unit designated for heating and cooling must also install a drip pan and piping to collect and drain away any condensate (Figure 10) that will form on the coil while in the cooling cycle.

Figure 10 *Condensate drain for a cooling fan coil.*

Radiators

Radiators are so named because of the main way that they emit heat. The term radiator traditionally refers to both freestanding cast-iron radiators and baseboard radiators. The hot water inside the radiator warms its outside surface via conduction, then the warm outer surface of the radiator emits heat to objects in the room via radiation. The warmed objects then emit heat via radiation as well, heating the air in contact with their surface by conduction. As the water temperature inside a radiator increases, the amount of heat it can transfer increases as well. The amount of heat transmitted is also proportional to the overall surface area of the radiator.

Freestanding Cast-Iron Radiators

Cast-iron radiators are highly effective due to their rough, black material. However, they are unpopular today mainly because they are heavy, costly, intrusive, often unsightly, and slow to respond to heating needs.

A freestanding cast-iron radiator (Figure 11) emits about 60% of its heat by radiation and the remaining 40% by convection currents. Other types of radiators may heat more by convection than by radiation. Depending on the location, colour, texture, and temperature of a radiator, the transfer of heat from it may be almost entirely by convection, with only a small amount by radiation.

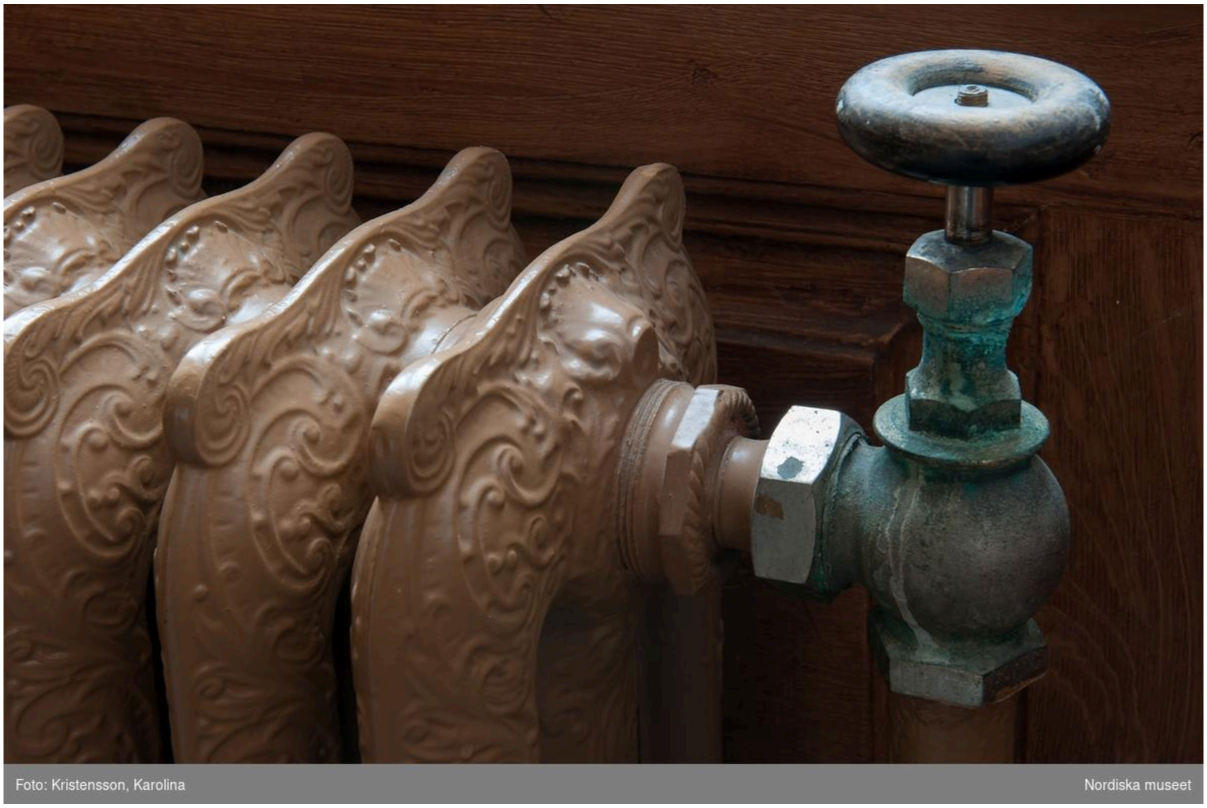

Figure 11 *Freestanding cast iron radiator. (Karolina Kristensson/DigitaltMuseum)* CC BY-NC-ND 4.0 *(https://creativecommons.org/licenses/by-nc-nd/4.0/deed.en)*

Freestanding cast-iron radiators for hot water heating have vertical sections that are interconnected at the top and at the bottom. These interconnections allow water to flow from one section to the next. Cast-iron radiators used for steam systems do not need to be interconnected at the tops, so they will not work if used for hot water heating. Older units have only two large tubes to carry the water from the top to the bottom of the section. In newer units, a section can have many small vertical pipes to perform this function. More pipes increase the surface area from which heat can be radiated.

Generally, the surface area of a section ranges from 0.09 m^2 (1.2 ft) to 0.36 m^2 (4.2 ft). Sections may be connected together by push nipples and bolts in a manner similar to cast-iron sectional boilers. Alternatively, the sections may be connected together by left- and right-hand nipples that have left- and right-hand threads at opposite ends. Left- and right-hand nipples can be tightened by turning them with a bar placed against the lugs within the nipple. This will pull the two sections together simultaneously. Gaskets are used as seals between the sections.

Freestanding radiators are typically 1 m (3 ft) high, 1 m (3 ft) or more long, and 125 mm to 200 mm (5–8 in.) wide; however, sizes may vary. They are well suited for window locations. In most cases, they are constructed to be no wider than a window in order to maximize the use of convection currents within the room.

Freestanding radiators take up a large amount of space. In addition, care must be taken to avoid obstructing these radiators with furniture. Also, because the radiators can be very hot, skin can burn on contact.

Radiant Baseboards

The large amount of space required for freestanding radiators prompted the innovation of cast-iron baseboard radiators. In a cast iron baseboard radiator (Figure 12), each section has a hollow core and is typically 0.3 or 0.6 m (1 or 2 ft) long and about 0.2 m (9 in.) high. Sizes may vary.

The sections are joined together by bolts and push nipples. Baseboard radiators are mounted on the outside walls, in the same manner as baseboard convectors. The end sections of a baseboard radiator have tappings (female threaded connections) for connecting supply and return piping.

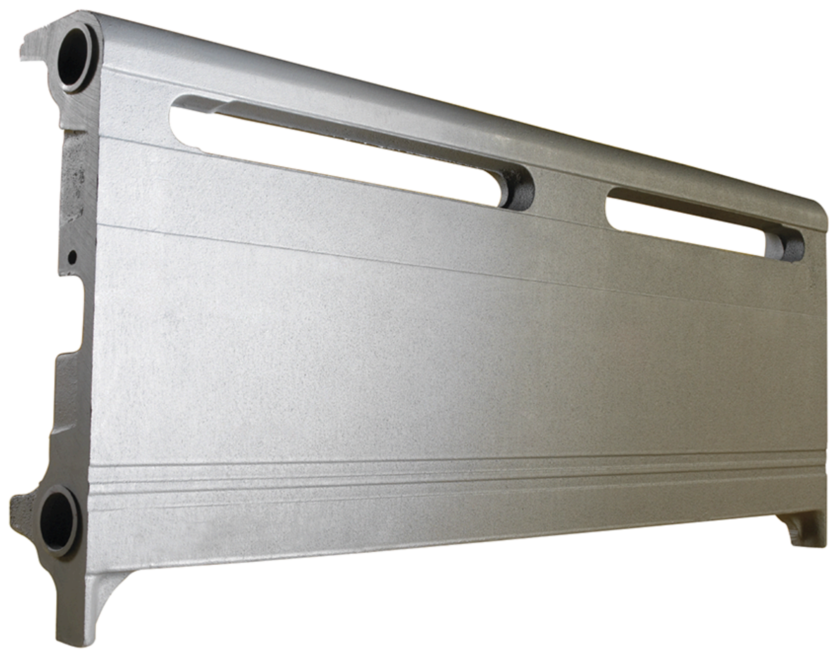

Figure 12 *Section of radiant baseboard. (Skilled Trades BC, 2021) Used with permission.*

The main difference between a radiant baseboard and a finned tube baseboard is that a radiant baseboard contains no fins. Hot water runs through a copper tube within the housing, but rather than heating the air between the fins, it heats the front panel of the housing itself. This heat is then radiated to the objects in the room. Whereas, finned tube convectors do not radiate much heat because the front panel of the housing does not get hot. All the heat within it is trapped between the fins then moved out through convection currents.

Because baseboard units are long, they often extend beyond the dimensions of a window. As a result, there is warmth emitted along more of the cold outdoor wall. This brings a better balance of temperatures to all the cold surfaces of the room. The radiator-convector has air passages that promote some convection.

Panel Radiators vs. Radiant Panels

Although the names sound similar (in fact, there are many similarities between them), panel radiators are very different from radiant panels. Much literature has been written regarding both, and many times the words are used interchangeably. This text will differentiate between the two forms of transfer units.

Panel Radiators

Panel radiators (Figure 13) are factory-made in all shapes and sizes. Panel radiators are mostly constructed from steel, but some are made from aluminum. They contain tubing that circulates hot water, with the tubing pressed into channels in the back side of the panel. The tubing's contact with the panel heats the panel via conduction, which, in turn, emits radiant heat outward into the room. Panel radiators are generally built to project their heat through radiation, but some are built to transfer their heat through convection as well. In that case, the radiator is manufactured to include fins, like a finned tube baseboard, which captures the heat then creates convection currents.

Figure 13 *Wall-mounted panel radiator. (Skilled Trades BC, 2021) Used with permission.*

One of the benefits of panel radiators is the relatively small amount of wall or ceiling space they require. They are available in all shapes and sizes; a situation that could not fit a wallfin baseboard heater due to lack of space will likely accommodate a panel radiator. A good example would be in a kitchen, where wall space is limited.

Panel radiators generally do not contain much water or metal, so they have a low thermal mass. Thermal mass is the ability of a material to absorb and store heat. Heat transfer units with a low thermal mass are less likely to subject the occupants of a room to temperature overshoot.

Radiant Panels

The phrase radiant panel most often refers to heating using the floor as a thermal mass, although there are also situations where either the ceiling or a wall can be used (Figure 14). There are a number of different methods of heating floors through radiant means, and the popularity of these types of systems is growing rapidly in North America.

Figure 14 *Radiant floor panel. (H. Raab (User:Vesta)/Wikimedia Commons)* CC BY-SA 3.0 *(https://creativecommons.org/licenses/by-sa/3.0/deed.en)*

The practice of using the floor as a thermal mass has been around for thousands of years. Ancient Romans built hypocausts (Figure 15), which took combustion gases from wood fires and ran them underneath a stone floor. Many years later, with advances in technology, hot water was run through piping in the floor. The first piping material used for radiant floors was steel and wrought iron, but in the 1940s, the use of copper became popular. This continued until polybutylene was introduced in the mid-1970s. Polybutylene has since been replaced by cross-linked polyethylene, which is now the material of choice for radiant floor tubing.

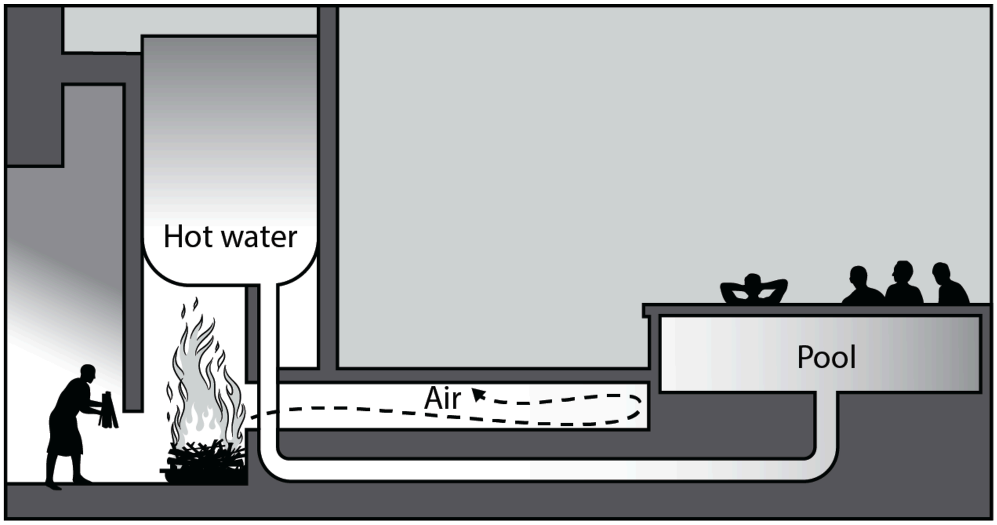

Figure 15 *Roman hypocaust. (Skilled Trades BC, 2021) Used with permission.*

Benefits of Radiant Panels

The main benefit of radiant floor panels is an increased level of comfort. A comfortable room is one in which the temperature "bands" in the room in a way that matches the human body's requirements as closely as possible (Figure 16).

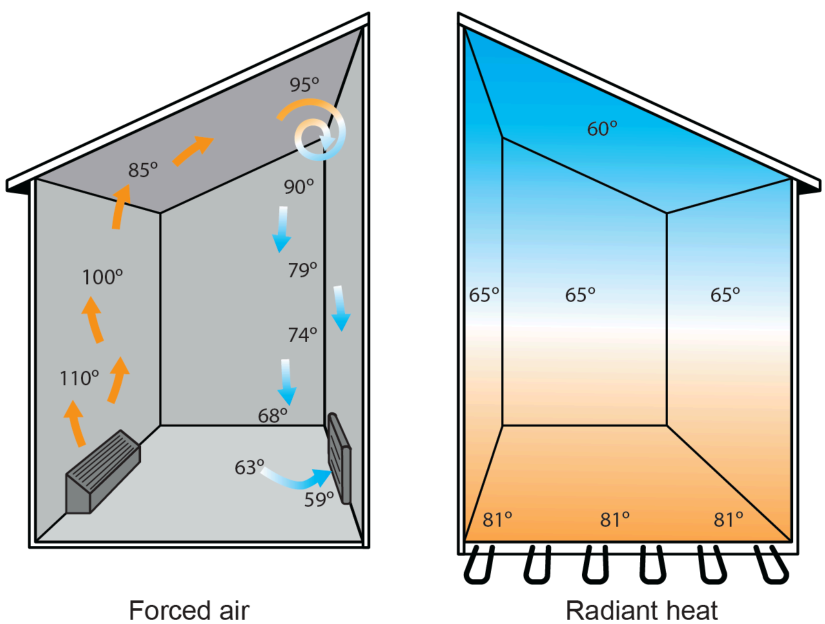

Figure 16 *Forced-air and radiant floor temperatures. (Skilled Trades BC, 2021) Used with permission.*

This is commonly referred to as the ideal heating curve (Figure 17). A room with this curve would be warmest at floor level (where you have contact with the surface), "comfortable" at eye level, and coolest near the ceiling (where not much heat is needed, in any case). The temperature of a "comfortable" room should be approximately 20°C to 22°C (68°F to 72°F) at eye level (approx. 1.5 m or 5 ft above the floor). A radiant floor panel system can deliver this.

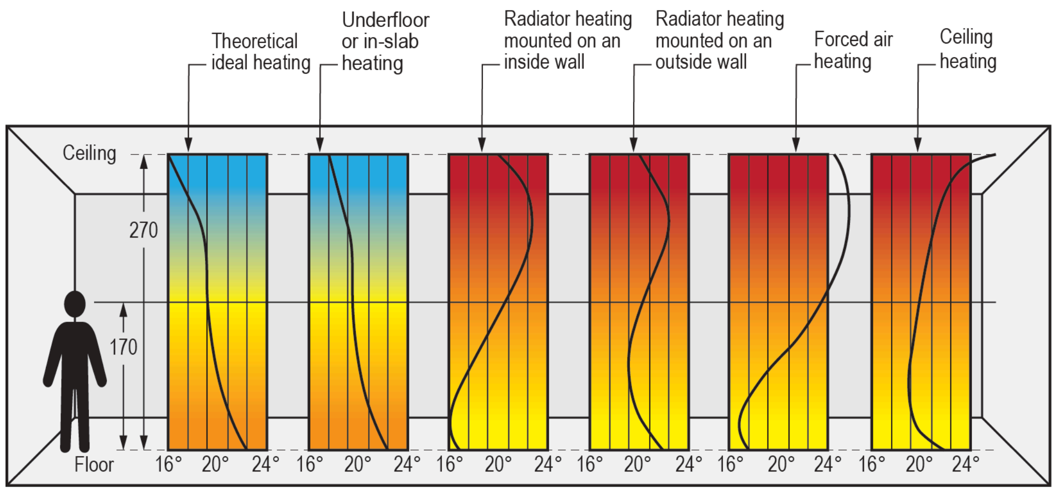

Figure 17 *Heat curves. (Skilled Trades BC, 2021) Used with permission.*

It is important to note that the curve representing forced-air heating is actually in direct conflict with or opposite to what the human body needs to feel comfortable.

Other benefits of radiant floor heating include:

- Does not use or waste interior space.
- Is durable and out of sight.
- Creates minimal drafts.
- Can be used with low-temperature heat sources.
- Can be used to dry floors in an area such as an airplane hangar or truck bay.
- Has a large thermal mass.
- Responds quickly to a loss of heated air such as when a door is opened.
- Has the ability to be "zoned."
- Is the quietest of all heating systems.

Radiant panels can also provide hydronic cooling, but this application is limited to radiant ceiling panels. Circulating chilled water through tubing embedded in a floor would result in people becoming uncomfortable when walking on the floor. Again, hydronic cooling requires more elaborate control strategies to prevent condensation from forming on cool surfaces.

There are many methods of providing radiant heating, some of which include:

- Radiant floor panels
    - Slab-on grade
    - Gypsum thin slab
    - Concrete thin slab
    - Above floor and tube
    - Below floor and tube
    - Suspended tube

- Radiant walls
    - Wall panel radiators
    - Prefabricated radiant wall panels
    - Site-constructed radiant wall panels
- Radiant ceilings
    - Prefabricated radiant ceiling panels
    - Site-constructed radiant ceiling panels

The choice of radiant system depends on many factors, not the least of which is installation cost. Other considerations include:

- Available floor space
- Intended floor coverings
- Amount of glass/doors in outside walls
- Building structural integrity
- Zoning preferences
- Heat source preferences
- Available height

The basics of radiant panel installations are all similar, regardless of which system is chosen. Heated boiler water is pumped through pipes installed on, in, or under the floor. The piping used in most of today's installations is cross-linked polyethylene (PEX). The heat absorbed by the water is released through the walls of the PEX pipe as it travels through the radiant panel and then back to the boiler. It is important to note that the temperature of boiler water used in radiant floor systems is typically no higher than 49°C (120°F). This prevents both the floor and occupants from becoming too warm. Higher-temperature water is used in wall or ceiling panels to increase heat transfer rates, since these areas are usually out of reach and can be hotter.

Some radiant panel systems have the PEX tubing laid in concrete or gypsum (Figure 18). This is known as a "wet system." The concrete or gypsum provides a thermal mass that acts like a big storage tank for heat, absorbing and retaining it. High thermal mass heat transfer units are generally slow to react to a change in temperature, but will hold their heat longer than low-mass units.

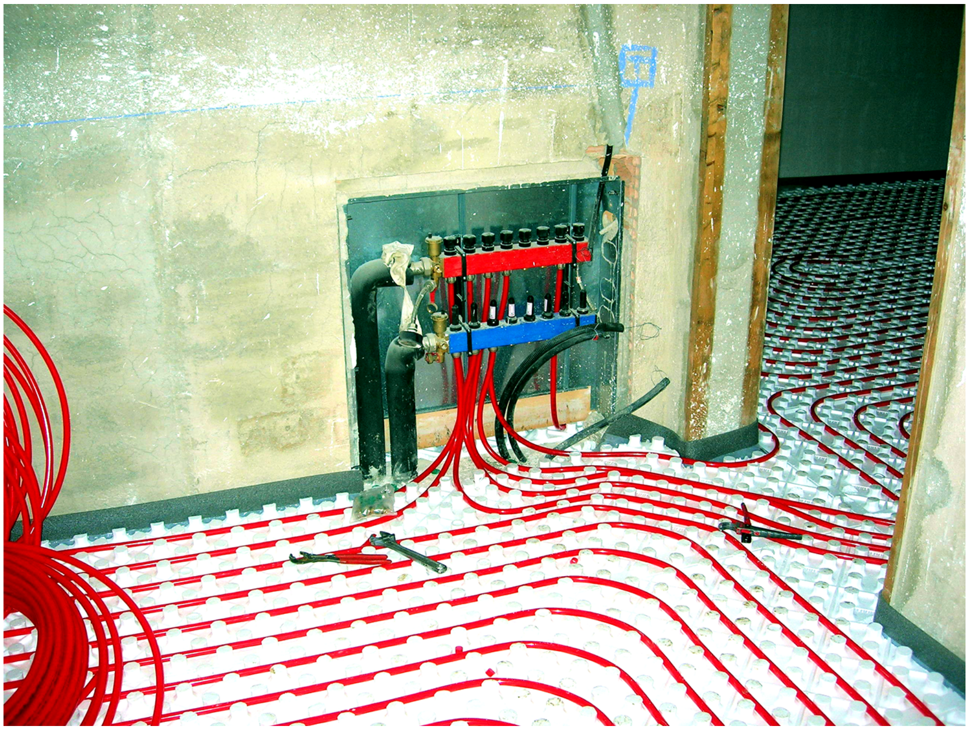

Figure 18 *In-floor radiant tubing connected to manifold. (Chixoy/ Wikimedia Commons)* CC BY-SA 3.0 (*https://creativecommons.org/licenses/by-sa/3.0/deed.en*)

Self-Test B-3.1: Hydronic Heat Transfer Units

Complete the chapter Self-Test B-3.1 and check your answers.

If you are using a printed copy, please find Self-Test B-3.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/?p=54#h5p-7 (https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/?p=54#h5p-7)

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B-3.2 Heat Transfer Units Installation

A distinct advantage of hydronic heating is the wide variety of heat transfer units available to suit almost any job requirement.

Selecting Heat Transfer Units

The heat transfer units for a given project must be selected and sized so that comfort and control are achieved in all areas of the building. Economic considerations can greatly expand or restrict heat emitter options. Since most heating systems are designed after the floor plan of the building has been established, the heating design is often a case of making the system fit the plan.

When selecting heat transfer units, the following must be considered:

- Floor and wall finishes
- Blockage of heat movement
- Effects of drafts
- Movement of dust
- Economy
- Design water temperature
- Water temperature drop
- Balancing of heat distribution
- Air elimination

Floor and Wall Finishes

Only radiant panel systems allow complete flexibility in the decoration of the room. All other systems may limit how the room can be arranged or furnished.

All heat transfer units that are baseboard- or wall-mounted are best placed under windows. High units, such as wall-mounted convectors, may be too high and could interfere with the window.

Ideally, heat transfer units should not extend beyond the dimensions of a window because of drapes. When opened, drapes normally hang beside the window. This mass of material above a heat transfer unit would interfere with convection and radiation. Baseboard wallfin convectors are usually used in conjunction with drapery because of their low profile.

There are usually enough exterior walls in a room to fit heat transfer units of sufficient capacity to warm the room. In some situations, it may be necessary to place heat transfer units on an interior wall. This situation occurs in colder climates or if the window location is unsuitable for other reasons.

Consult the owner or architect about where the furniture will be located. They will probably not want the largest clear wall space to be taken up by a heat transfer unit. A larger number of small units on shorter walls may be the better choice.

Manufactured panels have many options for installation location. Ceiling or wall mount locations are used by institutions, such as hospitals and schools, to keep the panels away from contact, avoiding burns and vandalism.

Blockage of Heat Movement

The transfer of heat from a convector is reduced by anything that hinders the movement of air. The transfer of heat from a radiator is blocked by anything that faces the radiator. Instead of heating the intended objects, the object blocking the radiator will absorb the heat.

Because most heat transfer units heat by radiation and convection, it is important to prevent anything from blocking the movement of air or radiated heat. Furniture should not be placed against heat transfer units, nor should the planned placement of heat transfer units ignore possible furnishing intentions.

Radiant panels provide a small amount of heat over a large area, so there is little concern about blockage of heat movement. However, if a significant portion of the floor is covered, the effectiveness of the heat transfer will be reduced. For example, in a warehouse that stacks inventory on the ground, there is little exposed floor space to use as a heat transfer surface. In a home, carpets cover many floors. The radiant panel will warm the carpet through conduction and the carpet will warm the room through radiation. The design of the radiant panels' heat output must take into account the insulating properties of the finished floor covering (carpet, tile, hardwood, etc.).

Effects of Drafts

The installation of heat transfer units must take into account where drafts (infiltration) will take place. The placement of convectors should take into account the movement of cold-air drafts in order to give optimum performance.

Movement of Dust

All heat transfer units that create convection currents will spread dust and other particles. If the movement of dust is a concern, do not use convectors. Radiators that are designed to function with minimum convection are better than those that encourage convection. Manufactured panel radiators and radiant panels cause almost no air and are, therefore, a good choice for dust prevention.

Economy

Radiant systems have advantages in every aspect of installation except initial cost. It is expensive to install a radiant panel and particularly expensive to retrofit them. On the other hand, radiant panels are the least expensive to operate

Design Water Temperature

Hotter water translates into less area of transfer unit needed, and possibly easier placement. For example, running hotter water through baseboard wallfin increases the output in BTU/h per lineal foot, so less wallfin needed.

Alternately, designing a system with a greater area of transfer units will enable the use of lower-temperature heat sources, such as heat pumps and condensing boilers.

Water Temperature Drop

Water temperature drop is also known as a "design temperature difference" or "ΔT." Most systems are designed to release 20°F (11°C) from the water. If a system is designed for a larger ΔT, the area or length of heat transfer units required will be less.

Balancing of Heat Distribution

If one room has a heat transfer unit that has a higher capacity than necessary, the other rooms may receive less heat than required. Choosing heat transfer units that are suited for the heat demands of the room is an important first step in achieving a well-balanced system.

Air Elimination and Access to Air Vents

The primary function of **air vents** is to rid the system of trapped air. Air vents must be placed at all the high points in a piping arrangement and be accessible for servicing. This will typically be at the return end of every up-fed heat transfer unit. Either manual or automatic air vents can be used.

Installing Heat Transfer Units

The following includes general installation information regarding different types of heat transfer units. In order to ensure their proper operation, it is important to follow the manufacturer's installation instructions.

Installing Baseboard Units

Locate baseboard heat transfer units beneath or as close as possible to windows. Baseboard units will often extend beyond the dimensions of the window due to the possible length of wallfin needed.

If a baseboard unit is recessed, it must stay within the dimension of the window. There is little weight carried under a window. The studs on either side of a window will be weight-bearing and will have been strengthened to support the weight that is above the window. The structural integrity of the wall studs cannot be compromised in any way by the installation of heat transfer units.

Because baseboard units can be long, thermal expansion must be considered. Baseboard units will expand 5 mm per 3 m ($\frac{3}{16}$ in. per 10 ft) as they warm from 4°C to 93°C (from 40°F to 200°F).

Drill larger holes through the floor for the piping to allow for this movement. If this is not done, the pipes will rub against the floor and creak loudly. When baseboard units are installed on three adjacent walls, install expansion loops in the piping below the floor at the corners.

The length of the baseboard units required depends on the design's water temperature difference, the heat loss of the room, and the heat output rating of the heat transfer unit. Manufacturer's information will provide the heat output rating based on those criteria. Baseboard units are sold in lengths that are multiples of 2 ft (60 cm). When ordering cabinet and wallfin, use the next longer length available if the length needed falls between two values. The length of wallfin installed inside the cabinet can be shortened so as to not overheat the room.

Do not mix convectors and cast-iron radiators on the same circuit. These heat transfer units heat up and cool down at widely different rates, so the controls will be out of step. If mixing these the two kinds of heat transfer units cannot be avoided, they must be installed on separate piping loops, and each loop must have individual and proper controls.

The baseboard units' location will be mapped out once the building is framed but before it is insulated or drywalled. At that time, make sure that any holes drilled through flooring for pipe penetrations are adequately oversized and that the supply and return piping to the wallfin will end up inside the confines of the cabinets when installed. Testing the installed wallfin will be done through its filling and purging operations.

The installation details for baseboard heat transfer units will vary with the manufacturer's design; however, the following procedures generally apply:

1. Attach the supplied self-adhesive foam strip to the back of the back panel.
2. Attach the back panel to the wall.
3. Attach brackets to the back panel.
4. Attach the fin to the brackets. If using more than one length of fin, connect them together.
5. Install eccentric connectors, valves, and an air vent between the fin pipe and the system piping.
6. Attach the damper assembly.
7. Attach the front cover and the end caps.

The foam strip blocks convection currents from passing through gaps between the panel and the wall. Dust streaks on the wall above the cabinet will be the result of not blocking that air path. If a thermostatic control is being used at the convector, ensure that air can pass freely around the control. If this is not possible (e.g., because of drapes), a thermostatic valve with a remote sensor must be used.

Installing Freestanding Cast-Iron Radiators

Freestanding cast-iron radiators should also be installed under or in front of a window. When installing radiators, they can extend to just under the window sill but never above it. The best place for the unit is at least 100 mm (4 in.) below the sill height. Figure 1 shows the installation of a freestanding cast-iron radiator. If air cannot continuously pass freely over the operator of the thermostatic radiator valve because of curtains or a shelf over the radiator, a thermostatic valve with a remote sensor must be used.

Figure 1 *An installed freestanding cast-iron radiator. (Karolina Kristensson/ DigitaltMuseum)* CC BY-NC-ND 4.0 (*https://creativecommons.org/licenses/ by-nc-nd/4.0/deed.en*)

Cast-iron radiators are designated by the square feet of radiation they possess. Radiators are selected from manufacturers' catalogues and specifications.

Installing Panel Radiators

Panel radiators can be installed in a wide variety of ways and be custom built for special situations. Panel radiators come in many configurations. Their selection and installation requirements can differ greatly from those of other heat transfer units, and manufacturers' specific literature must always be consulted.

Figure 2 *An installed panel radiator. (Skilled Trades BC, 2021) Used with permission.*

Installing Unit Heaters

Unit heaters should be selected so that they work at full capacity under design conditions and should not be selected on the basis of floor coverage. Doing so will result in having more heating output than required. In that situation, some units would operate for short periods, while others may not perform as expected, resulting in inconsistent heating.

Horizontal-flow unit heaters are usually suspended from the ceiling by two or four threaded rods, known as "redi-rod" in the industry. Always follow manufacturers' installation guidelines in order to conform to safety and warranty considerations. Normally, unit heaters have attachment points for rods near each of the four corners. The rods should be double-nutted at each connection to ensure that vibration will not loosen the nuts. They may also need to be seismically restrained (see the information later in this section for suspended heating or cooling coils).

Unit heaters can be installed equally well on a direct return or a reverse return piping system. In either case, connect the supply water to the bottom connection on the unit heater and the return to the top connection. This allows air to be vented from the piping and the unit heater in the direction of water flow. Furthermore, counterflow piping direction is promoted for most heat exchangers, and isolation valves should be installed on both supply and return piping connections.

Locate the units in areas of the greatest heat loss, such as by doors and windows. For efficiency and ease of operation, unit heaters should be placed so that they assist each other in stirring the air. Cross-currents of air and fans that oppose one another are counterproductive. The size and discharge capacity of the unit heaters must also be taken into consideration when spacing them for efficient airflow. Consult the manufacturer's guide for placement when designing a system.

On large buildings with open areas, unit heaters can be arranged along the perimeter without being concerned about the building's central area, where heat loss will be minimal. Figure 3 shows a circular installation pattern (or parallel arrangement) used for a perimeter installation. The fans set up a circular flow around the room near the ceiling. Smaller air currents will circle from the front to the back of the fan, producing vertical and horizontal currents that will dampen or de-intensify the main air current.

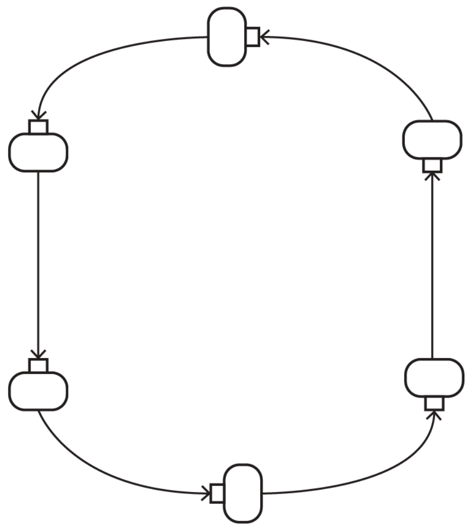

Figure 3 *Circular airflow of unit heaters.*
(Skilled Trades BC, 2021) Used with permission.

Figure 4 shows an installation pattern for a building that has high heat loss on all walls and large doors at either end. The units are installed along two lines down the middle of the building but blowing in opposite directions. Also, the units nearest the doors are positioned to blow air toward the doors.

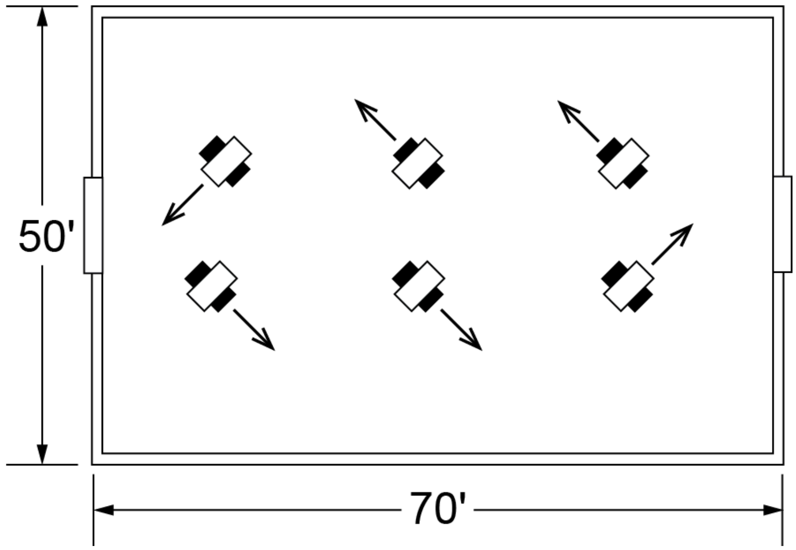

Figure 4 *Horizontal unit heaters arranged for four high heat loss walls. (Skilled Trades BC, 2021) Used with permission.*

Unit heaters are well suited for locations where there is need for quick heat recovery, such as in a service station or other buildings with large and frequently opened doors. Figure 5 shows the installation of three horizontal unit heaters in a service station. In the automobile areas, the units blow air through the entire space toward the door. The office has the third unit. To prevent the air from the service areas from coming into the office, this unit should have a return air plenum or duct. A return air plenum is constructed on-site to move cooler air from the bottom of the room that the unit is installed in to the unit.

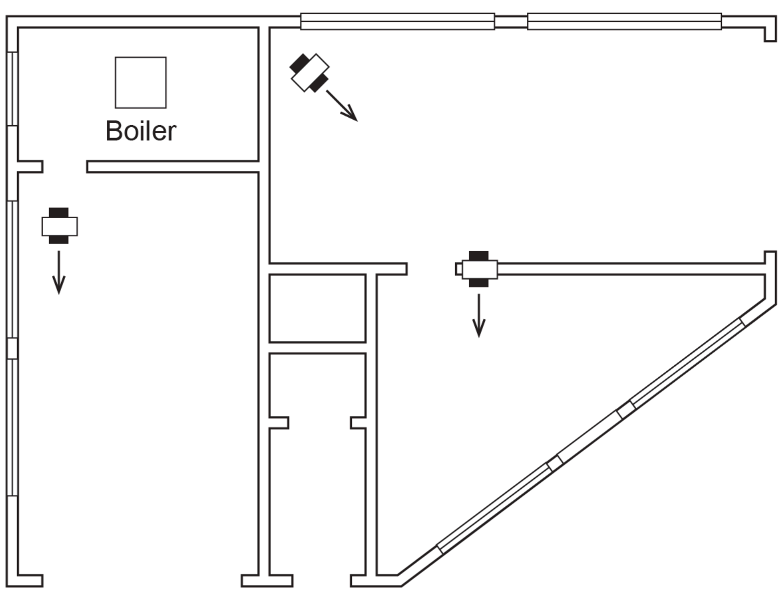

Figure 5 *Horizontal unit heaters in a service station. (Skilled Trades BC, 2021) Used with permission.*

Vertical Unit Heaters

Vertical unit heaters should be installed 17 m (50 ft) apart for best performance. They should be installed high enough that dampers directing airflow cannot be tampered with once they are positioned properly.

Self-Test B-3.2: Heat Transfer Units Installation

Complete the chapter Self-Test B-3.2 and check your answers.

If you are using a printed copy, please find Self-Test B-3.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/?p=56#h5p-8 (https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/?p=56#h5p-8)

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Skilled Trades BC. (2021). Book 1: Fuel gas systems, Heating and cooling Systems. Plumber apprenticeship program level 2 book 1 Harmonized. Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). B-3: Install hydronic transfer units. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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- **Figure 1** Tyresö slott, interiör, detaljer (https://digitaltmuseum.se/021016859452/tyreso-slott-interior-detaljer) by Karolina Kristensson, via DigitaltMuseum, is used under a CC BY-NC-ND 4.0 (https://creativecommons.org/licenses/by-nc-nd/4.0/deed.en) license.

Self-Test B-3.1 Hydronic Heat Transfer Units

Complete Self Test B-3.1 and check your answers.

1. How does a convector heat a room?
    a. Heats the air
    b. Heats the objects in the room
    c. Heats the floor
    d. Heats the walls

2. What are convectors that have fans called?
    a. Fan heaters
    b. Baseboard heaters
    c. Unit heaters
    d. Gravity convectors

3. What does a convector that does not depend on gravity for circulation use?
    a. Fan
    b. Baseboard convector
    c. Unit heater
    d. Circulation pump

4. What are convector cabinets usually made of?
    a. Aluminum
    b. Wood
    c. Steel
    d. Plastic

5. Convectors should be installed under windows.
    a. True
    b. False

6. What type of pipe is the heating element of a convector usually made of?
    a. Plastic
    b. Louvred
    c. Finned
    d. Slotted

7. Complete the following statement: “The amount of heat given off by a hot gravity circulation convector is usually regulated by an adjustable _____________ .”

a. Louvre
b. Fin
c. Dial
d. Fan

8. What are the two types of unit heaters?

a. Water and air
b. Forward and reverse
c. Gravity circulation and forced circulation
d. Vertical and horizontal

9. In which of these heat transfer units is steel **not** used?

a. Baseboard convector
b. Wall-mounted convector
c. Freestanding cast iron radiator
d. Baseboard radiator

10. What is the most common type of tubing used today in radiant floor installations?

a. Polybutylene
b. Polyethylene
c. Copper
d. PEX

Answer Key: Self-Test B-3.1 (#chapter-answer-key-self-test-b-3-1) is on the next page.

Answer Key: Self-Test B-3.1

1. a. Heats the air
2. c. Unit heaters
3. a. Fan
4. c. Steel
5. a. True
6. c. Finned
7. a. Louvre
8. d. Vertical and horizontal
9. c. Freestanding cast iron radiator
10. d. PEX

Self-Test B-3.2 Heat Transfer Units Installation

Complete Self Test B-3.2 and check your answers.

1. Which type of heat transfer unit is not normally installed under a window?
   a. Wall-mounted convectors
   b. Unit heaters
   c. Baseboard radiators
   d. Freestanding radiators

2. Complete the following statement: "On the same circuit, do not mix convectors with _____________ ."
   a. Manufactured panels
   b. Unit heaters
   c. Baseboard radiators
   d. Freestanding cast-iron radiators

3. Complete the following statement: "If a baseboard heat transfer unit is to be recessed, it must not _____________ ."
   a. Extend beyond the dimensions of the window
   b. Be installed on an inside wall
   c. Be installed on an outside wall
   d. Be mixed with convectors

4. As the maximum cold temperature drops, what is the effect on the amount of glycol that would be needed for the water/glycol solution?
   a. Becomes unimportant
   b. Becomes less
   c. Stays the same
   d. Becomes greater

Answer Key: Self-Test B-3.2 (#chapter-answer-key-self-test-b-3-2) is on the next page.

Answer Key: Self-Test B-3.2

1. b. Unit heaters
2. d. Freestanding cast iron radiators
3. a. Extend beyond the dimensions of the window.
4. d. Becomes greater.

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.	