# CHAPTER 6 Mechanical & Electrical

## PLUMBING SYSTEM

In theory, a plumbing system is very simple: clean water is brought into the house and used water is drained from the house and disposed of. Adequate plumbing systems require a source of clean water, either a private well or cistern, or a complex municipal water system, and an efficient private or municipal disposal or sewage system.

The incoming clean water has to be moved quickly and efficiently through the house, and for some appliances (such as dishwashers) have to perform work, so it must be pressurized. For pressurized water, strong reliable piping and joints are required as well as efficient and easy to maintain faucets. In addition, if problems occur, pressure has to be removed from part or all of the system and therefore a series of shut-off valves are required.

Although a cold water supply is adequate, a hot water supply is much better, and for that a hot water tank is necessary. For hot water the supply system piping has to be doubled with one cold line and one hot line to almost every fixture. Hot water tanks and space heating boilers can create explosive pressures and therefore safety valves are necessary to keep these systems within safe limits.

A complicated water input system requires a disposal system that is equally sophisticated. Drain pipes large enough to cope with waste are required. Special pipe joints that will not clog are used, along with and traps, that prevent sewer gas from entering the dwelling. It must be designed to allow water to flow smoothly. Vent pipes are needed to eliminate pressure build-up in the drainage system and carry odours away from the house.

In case problems occur in the drainage system, the traps installed are designed to be removed easily and clean outs are placed in main drainage lines.

The objective of a plumbing system is to allow people to have clean water, at a desired temperature, when they need it, and to have an efficient disposal system to remove waste from the dwelling.

The plumbing system consists of four distinct but interacting subsystems, each with specific components. These subsystems are:

- water supply and distribution
- drainage
- venting
- fixtures and appliances.

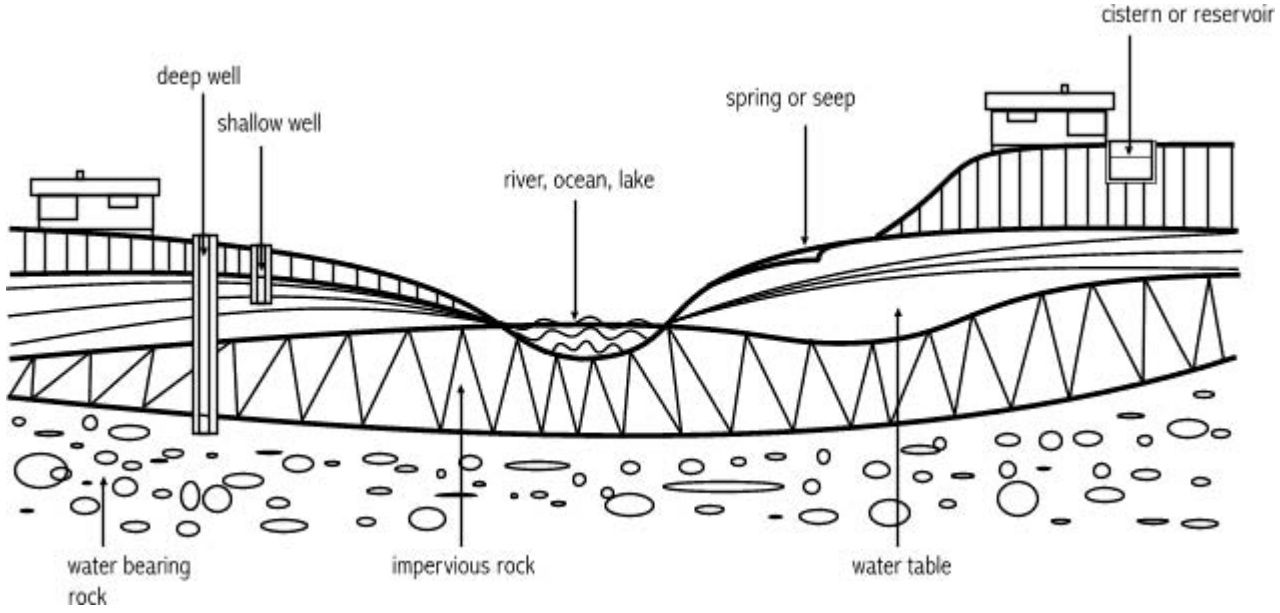
## WATER SUPPLY AND DISTRIBUTION SUBSYSTEM

The water supply subsystem brings potable water into the house. The water can come from wells, cisterns or a municipal system. When water is drawn from a well or cistern the supply system is defined as the entire system up to the main shut-off valve within the house. If the water is from a municipal system the household water service starts at the curb stop on the property, goes through the main shut-off valve, and includes the water meter if there is one.

From the shut-off valve or water meter, the incoming water is in the distribution subsystem. Usually the distribution system terminates in the shut-off valves located just ahead of fixtures or appliances. Hot water heaters and water softeners are exceptions as they are by necessity in the middle of the distribution system.

### Wells and Cisterns

Water from wells and cisterns enters the house directly from the well or buried cistern. Wells may be planned for a convenient location however, the final location depends on the “luck” of the well driller.




### Wells

It is helpful to obtain as much information as possible on the geology and groundwater (hydrogeology) resources of the area before constructing a well. In many areas, the hydrogeology is well known and the information is available to you through a variety of sources.

The following may be useful in determining the availability of groundwater supply:

1. types of wells in the area - collect information from neighbours
2. depths of wells
3. types of bedrock or surficial materials encountered
4. quantity of water available
5. quality of water - whether conditioning is usually necessary
6. groundwater reports and major aquifer maps may be available from Environment and Natural Resources, Yukon Government
7. well problems encountered in the area.

Care should be taken in choosing a site for a well, as drilling is expensive and many failures are indirectly caused by poor site location. For example, a shallow well may become contaminated because it is located too close to a source of pollution.

As a general rule, a well site should be located upslope and as far as possible from potential sources of pollution such as septic tanks, outhouses, barnyards and roads and highways. In addition, surface water bodies such as lakes, streams and reservoirs may also be contaminated and can, under certain circumstances, be a source of pollution. Well pumpage may draw in contaminated water from these sources.

The following minimum distances are recommended for the spacing between any well and a potential pollution source:

| | |
|---|---|
| 10 m (30 ft) | from water tight septic tanks of sewage holding tanks |
| 30 m (100 ft) | from a leaching cesspool or seepage pit or an effluent filter system |
| 15 m (50 ft) | from a subsurface weeping tile effluent disposal field or an evaporation mound |
| 50 m (150 ft) | from a sewage effluent discharge to ground surface (sewage pump out system) |
| 100 m (300 ft) | from a sewage lagoon |

Whenever possible, a well should be located at an elevation higher than that of the immediate surrounding area. This is to prevent surface water, which may be polluted, from ponding (gathering) in the vicinity of the well and subsequently infiltrating, thereby contaminating the groundwater.

The location of existing and planned surface and underground structures on the property, such as buildings and septic systems, should be established before a contractor is hired and drilling started. Such information may eliminate future problems resulting from poor site location.

Property owners often drill or bore wells before construction begins on a house. This is an excellent idea; if a satisfactory water supply cannot be found, they are able to alter the building site. A well should not be located in any area (e.g. basement, below a paved driveway, under power lines, or under the eaves of a building) where it is difficult to maintain the well or the remove the pump for repairs. Contact between a pipe being removed for maintenance and overhead power lines could electrocute the person holding the pipe. Public Safety Branch, Yukon Territorial Government therefore does not allow equipment within 12 m of high voltage lines. This includes drilling rigs.

### Cisterns

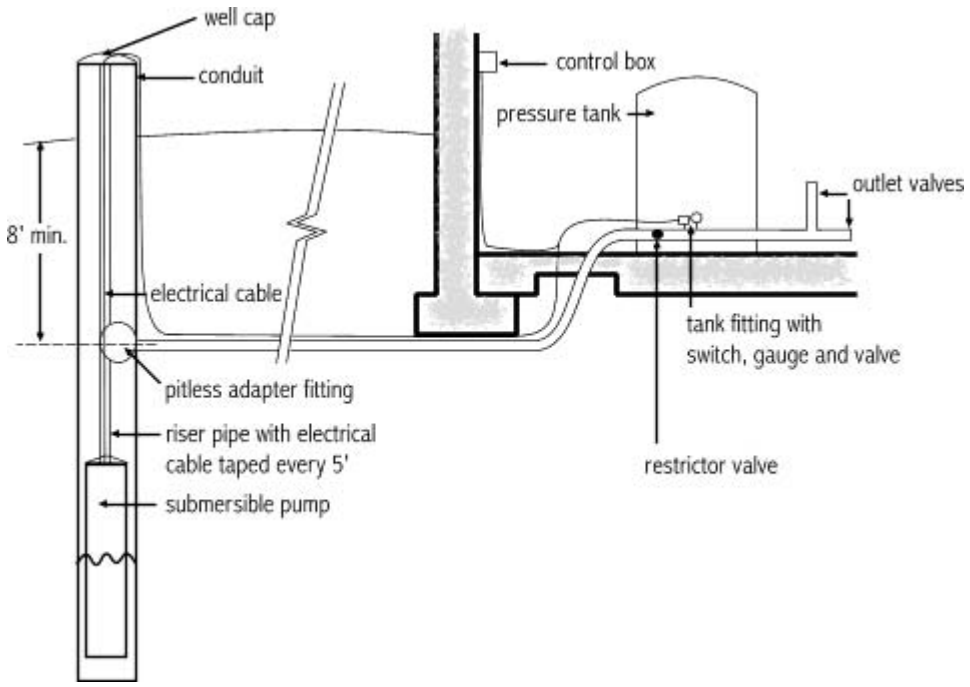
A cistern is a reservoir or tank, often placed underground for the storage and supply of potable water. The cistern can, and often is, placed inside the dwelling. They are used in circumstances where a municipal water supply or a well are not available or financially feasible. In fact, it is usually cheaper over the life of the dwelling, to have water delivered to a cistern rather than paying for the initial cost of the well, periodic servicing, and conditioning of the water.

Occasionally they are used if the quantity of water flow from a well is not sufficient to keep up with household use. In that case, the cistern may be used, in combination with the well, as storage to insure an adequate supply of water is on hand.

### Pressure Systems

The municipal pressure system consists of a water main and a municipal stop leading off toward the dwelling. Municipal systems generally supply water to the house at a pressure of 300 to 450 kPa. (40 lbs. per square inch).

A well requires a pump and pressure system for acceptable water distribution, and



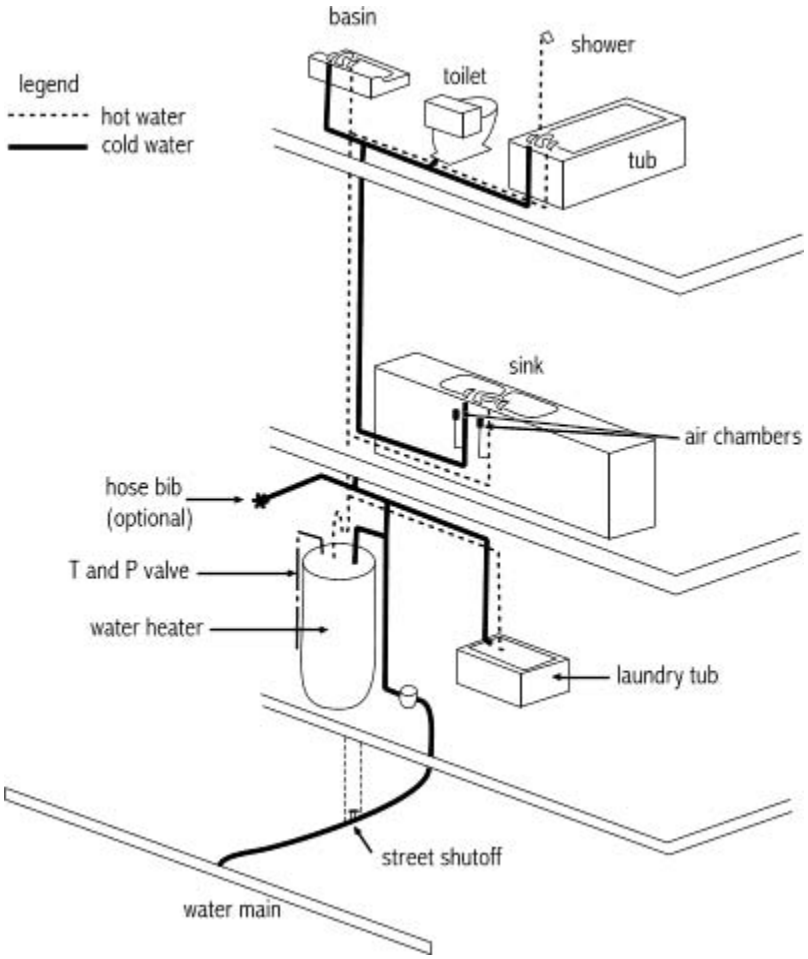

often a water conditioning system as well.
A cistern requires the use of a pump and pressure system as well, although they are smaller and much less expensive than those used with a well.
Water Service:

The main parts of a water service are the curb box located at or near the property line, and the main shut-off valve, located inside the inner face of the exterior foundation wall. A water meter or a meter stop are also considered part of the water service. Municipalities vary in the use of water meters. Check with your Municipal Office or plumbing inspector for the requirements in your area.

Distribution System:

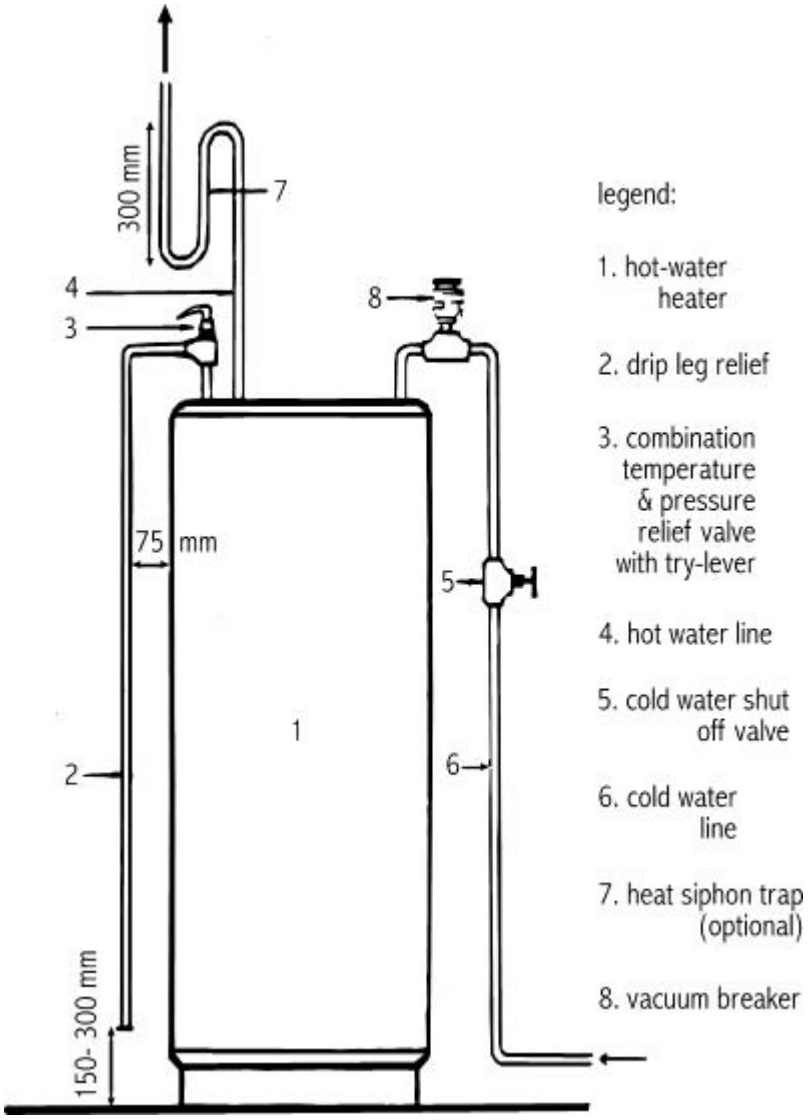
The piping above the meter (or in the absence of a meter, the main shut-off valve) is commonly referred to as distribution piping. It distributes potable water to fixtures, receptacles, appliances, outlets or equipment within the dwelling unit.

### Water distribution in a single family home




### Safety Valves - Temperature and Pressure Relief

The most common safety device is the mandatory temperature and pressure relief valve which is found in domestic hot water tanks. All domestic hot water tanks are a potential safety hazard because they can rupture from excessive pressure or overheating. To overcome the problem, a Temperature and Pressure Relief Valve (T and P Valve) is installed within the top six inches (150 mm) of the tank and must extend a minimal of one inch (25 mm) into the tank. The discharge from the T and P Valve must be able to drain by gravity to avoid rotting the spring in the valve. The valve must have piping attached to it which should terminate a maximum of six inches (150 mm) above the floor level or floor drain, to avoid splash-back or scalding.




## Safety Valves - Backflow Preventers:

Two reasons for backflow of water in a distribution system, either of which could create pollution or contamination problems, are:

1. Back siphoning is the reversal of normal flow in a system caused by a negative pressure (vacuum or partial vacuum) in the supply piping. Back siphonage can result from stoppage of the water supply because of nearby firefighting, repairs or breaks in city mains, breakdown of footvalves in wells, etc. The effect is similar to draining a swimming pool by siphon action with the same hose that had been used to fill the pool.

2. Backpressure backflow is the reversal of normal flow in a system caused by downstream pressure being greater than the supply pressure. This situation can occur in heating systems, elevated tanks and pressure-producing systems. For example, if a hot-water space-heating boiler is operating and under pressure and there is a reduction in the pressure of the incoming water supply below this level, a backpressure backflow condition would be created and the contaminated boiler water would flow into the potable water supply.

Various safety valves can prevent backflow. Current plumbing codes require safety valves on boilers, domestic hot water tanks, sprinkler systems and any other systems where backflow is a potential source of contamination.

**Shutoff Valves**

Shutoff valves control the flow of water to fixtures, receptacles and outlets during emergencies or repairs. As a rule of thumb, control valves should be provided in the following locations of a single-family dwellings:

- domestic hot water tank
- toilet (water closet)
- dishwasher or any appliance including hot water boilers
- outside hose bib - unless a frost free hose bib is used
- in cabinets under sinks (optional)

## DRAINAGE SUBSYSTEM

Two drainage systems can exist in a dwelling, although they are often partially or wholly combined. These are sanitary and storm drainage systems.

Sanitary drainage includes drainage from sanitary fixtures (called soil drainage) and waste from everything else. The sanitary system generally includes fixture drains, traps, soil and waste stacks, clean outs and horizontal (above and below ground) drain piping. It terminates with either the entire private disposal system or the connection to municipal sewage lines.

Storm drainage includes foundation drains and rain water leaders, and is used in areas where high water levels around the foundation occur.

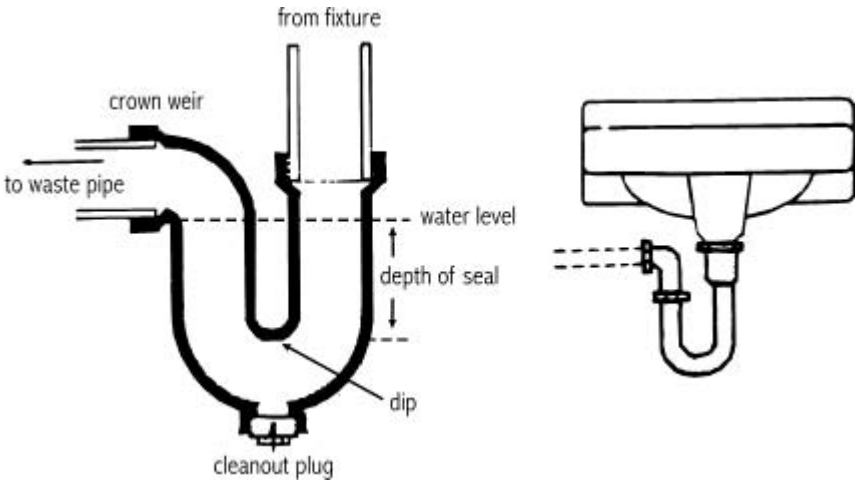
Venting is an integral part of the drainage process but, because it has specific functions, is dealt with separately. Only elements that carry away soils or wastes are considered part of the drainage system .

### Fixture Drains

A fixture drain is the piping from the output of a fixture to the drain stack, and includes standpipes for draining washing machines. A fixture drain must be interrupted by a trap.

### Trap

All plumbing fixtures must be provided with a trap placed as close as possible to the fixture. A trap allows flow of waste water and sewage through a pipe while preventing passage of air or sewer gases in the reverse direction. This is accomplished by means of a water seal which will not materially affect the flow of a liquid. The water in the trap acts as a plug. Consequently, no air or gas from the sewer side can pass back into the fixture.




The trap is normally referred to as a P Trap because its shape resembles that of the letter P.

### Soil Stacks

The soil stack is the largest pipe in the system. All toilets (water closets) are connected to the soil stack and other wastes are often also connected .

### Waste Stacks

A waste stack is any vertical drain stack that does not carry soil (toilet discharge) from a sanitary fixture. Small dwellings may not have a waste stack in addition to the soil stack.

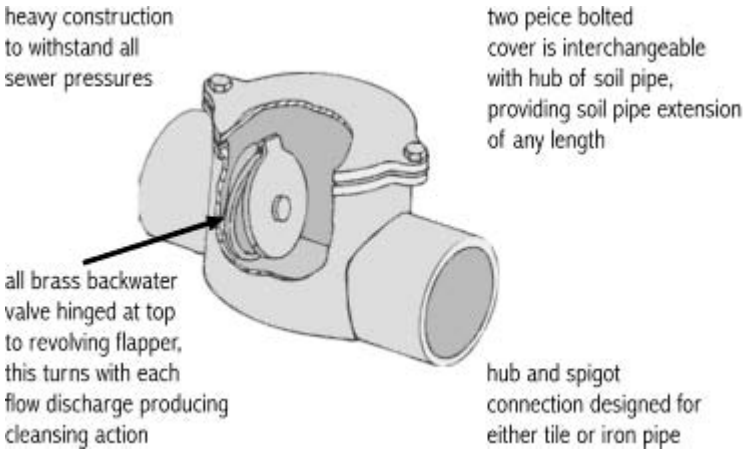
A floor drain is a drain in the basement that is connected to the underground drainage system.

## Clean Outs

Provisions for clean outs should be made in the building drains, in both sewage and waste drains if they are not combined, so that in the event of a blockage, the drain may be cleaned out using mechanical devices (plumbers snake). This usually means at any 90 degree change of direction in the drainage system, as well a clean out should be located where the drain leaves the building.

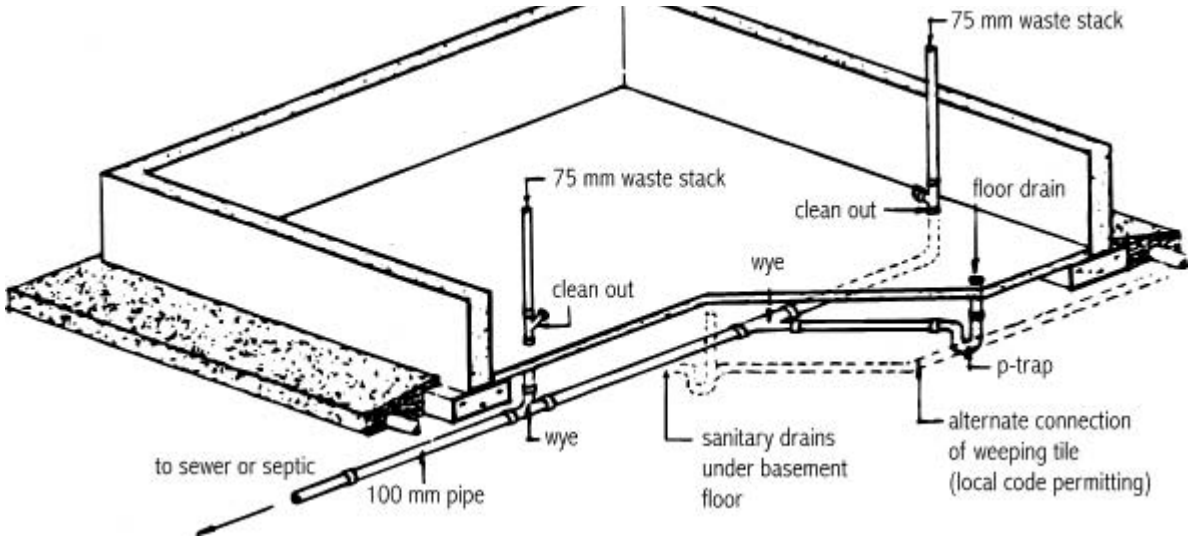
## Backwater Valve

A backwater valve is a check valve permitting sewage to flow out of a building and preventing any backflow. It is used when there is a history of backup from overloaded municipal sewers. It only needs to be installed to protect outlets subject to back flooding. However, note that a backwater valve tends to retard outward flow.




## Building Sewers Line and Building Drain

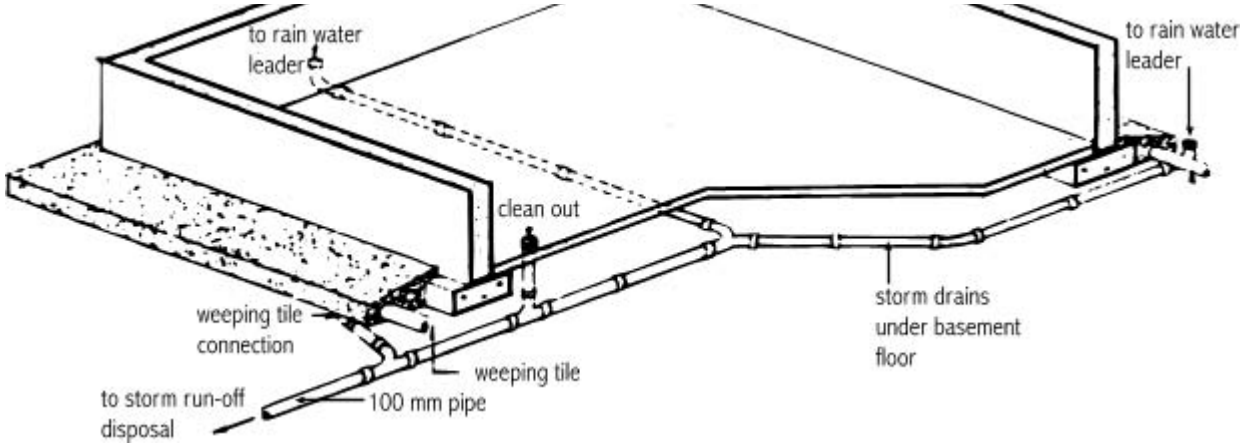
The building sewer line is that part of the drainage system that begins at the street or property line and connects to the building drain at a point 900 mm (3 ft) outside the face of the foundation wall. The building drain is the lowest horizontal piping in the plumbing system and terminates at a point 900 mm outside the building. The building drain connects the soil stacks, waste stacks, floor drains and the foundation drains, below the basement floor. The size of the building drain is determined by the number of fixture units discharging into the system.



The plumber is responsible for the building drain. The sewer and water installer is responsible for the Building Sewer Line. For convenience, the subtrade who completes their job first generally ensures the line runs under the footing of the foundation.

### Storm Drainage

A storm drainage system collects water from Rain Water Leaders (RWL) and down spouts and channels it into a storm sewer or some other runoff, or collection area (sump pit). A sump pump will often be used to pump this water away from the dwelling. Many older houses have no storm drainage system or have a few elements of a complete storm drainage system connected into the sanitary drainage system. This practice is now often restricted by local codes, and should not be used at all with a septic tank and field.




### Foundation Drains

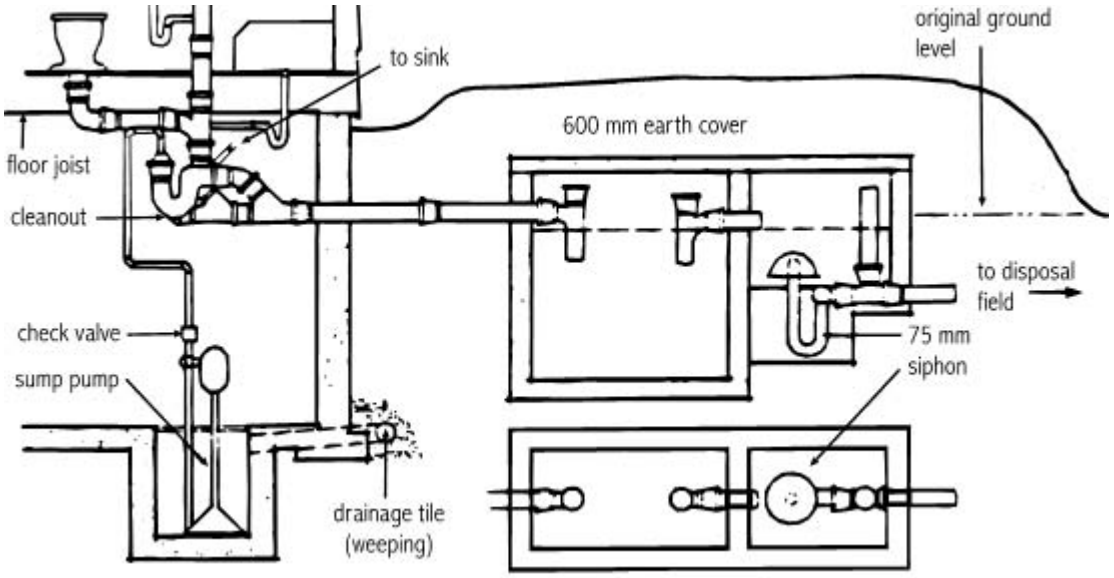
Often called weeping tiles, foundation drains are perforated pipes surrounding the house near the footings. Their purpose is to remove any accumulation of water that would produce water pressure on the underground portion of the house. The foundation drain is connected to the storm drainage system . If there is no storm drainage system, some local codes may permit connecting foundation drains directly to the sanitary system, while other local codes will not permit this type of connection as it places an added burden on the whole disposal system. In the absence of a storm drain system, a local plumbing inspector must determine the approved practice.

Due to generally dry subsoil conditions, it is common practice, in most areas of the Yukon, to not install a foundation drainage system. If there is any chance that subsoil water may occur, a foundation drainage system should be installed, and be connected to a sump so that subsoil can be pumped away.

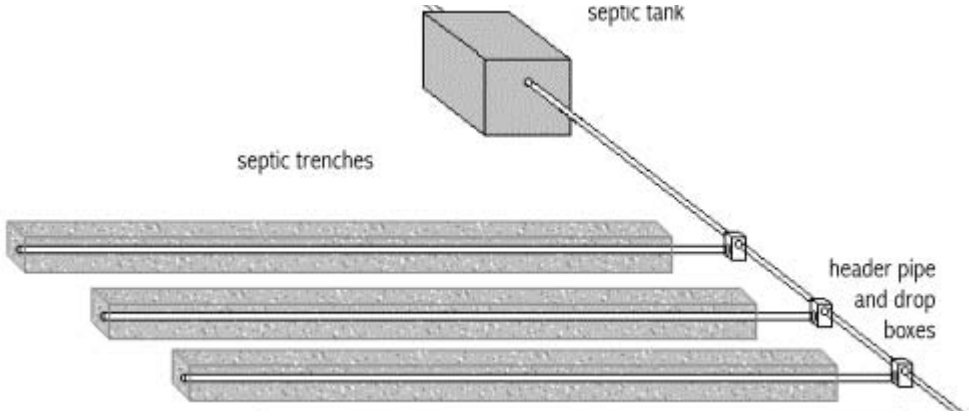
## Septic Tanks and Disposal Fields

Many communicable diseases have been, and are still being, transmitted by food and drinking water contaminated with untreated sewage. Sewage disposal must therefore be controlled to prevent this.

A septic tank receives wastes from the sanitary drain system of the dwelling (not from storm drainage). Bacterial action causes the waste solids to drop to the bottom as sludge, or float on top as scum. Liquid wastes from between the sludge and scum are then drained out to a series of perforated pipes in the absorption field. Septic tanks are vented back through the sewage drain pipe to the existing plumbing vents in the dwelling and out above the roof.




Other types of disposal systems are sometimes used with specific soil conditions. These include evaporation mounds and leeching pits. Local authorities will be able to provide information on the most suitable and approved systems for specific locations.



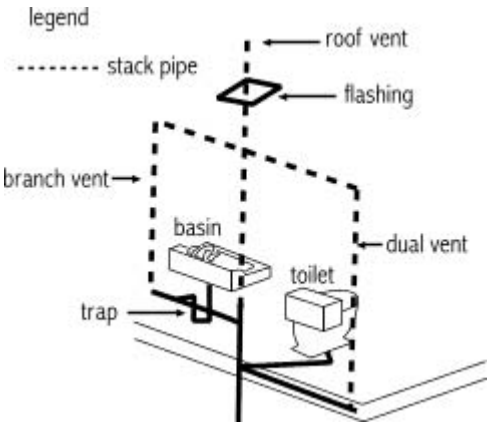
Persons who wish to install a private sewage system should make application for a private sewage disposal system permit to the local plumbing inspector or authority. Local codes on septic tank installation vary considerably. This permit is separate from the permit for installation of the plumbing system inside the building. Before obtaining a septic tank permit, a percolation test is required to enable the proper design of a system for your site. The percolation test is a measure of how much drainage your soil has and therefore how large your septic field has to be to operate properly. Your local plumbing inspector can give you instructions as to how a percolation test is conducted, and who in your area does them.

## VENTING SUBSYSTEM

A venting system is an assembly of pipes and fittings that connects a drainage system to outside air to vent off sewer gases and keep them from bubbling though the water seal in the P Traps. The venting system is connected to the drainage system and often looks no different from the drain piping (such as the stack vent) but generally carries no water. A variety of venting schemes are acceptable, but well defined regulations exist limiting their applications. In general, vents should be neither too close to nor too far from a trap and should be connected to the rest of the system in such a way that there is no risk that water will flow into the vent from above.

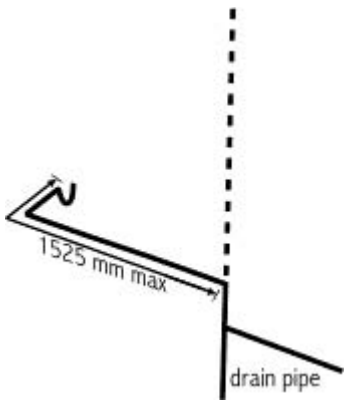
### Stack Venting

A stack vent is a pipe that extends soil or waste stacks up through the roof to the open air. In small single family plumbing systems, this may be the only vent in the entire system. Vent pipes must not terminate inside the attic but must go through the roof and be properly flashed to prevent leaks. Stack vents passing through unheated attic space must be insulated against freezing.



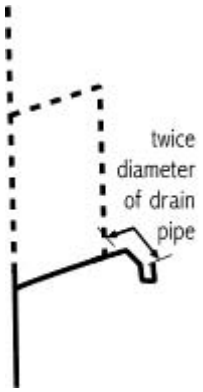

### Continuous or Direct Venting

When a fixture drain is located within 1525 mm (5 ft) of a soil or waste stack, it may, with certain code restrictions, be attached directly to the stack and the stack itself will serve as a vent. The standard restriction is that there be no other fixture above this one draining into the stack. In some localities, a sink may be permitted above a fixture using continuous venting.



## Back Venting

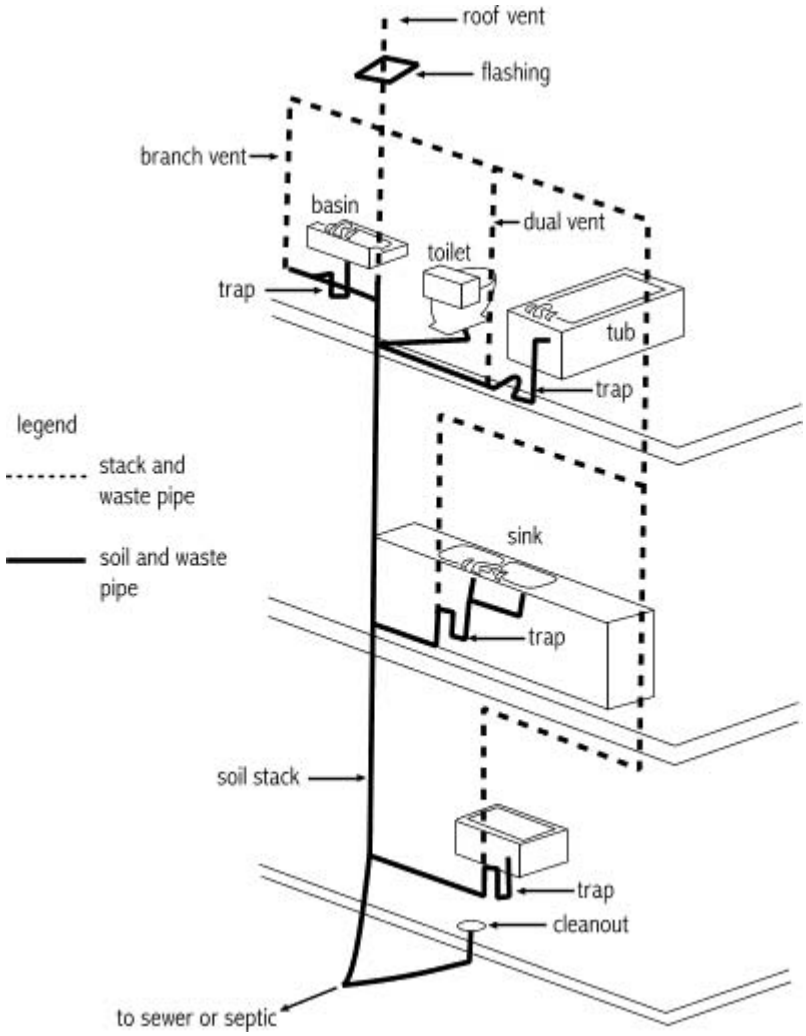
Any vent pipe that returns to the same stack that drains the fixture is called a back vent, which is a specific type of branch vent. When a fixture is more than 5 feet (1525 mm) from its soil or waste stack or there are other fixtures further up the stack, a proper vent pipe can be attached to the drain within the critical distance of 5 feet (1525 mm) and then reattached to the stack higher up. The point at which the back vent may be connected to the stack is limited by building codes.




## The Vent Stack and Main Vent

The vent stack is a pipe connected to the building drain that goes directly from the drain up through the roof. It may have any number of other vents attached to it.

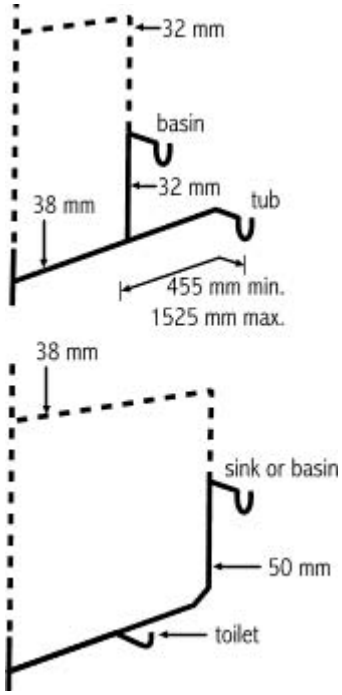
A main vent serves an identical function (venting the building drain, and possibly fixtures along the way) but is usually attached to the lower portion of a soil or waste stack, runs parallel to it and reconnects to the stack vent of that drain stack. A main vent eliminates the need to make another hole through the roof.




## Dual Venting

Dual venting economises on piping by having two fixtures using a common drain vented with a single vent attached near their junction.

### Wet Venting




When a series of fixtures flow into a common horizontal drain, with certain code restrictions, the drain pipe itself may be used for part of the venting requirements. This is called wet venting, as the water and the air share the same pipe. A fixture farthest from the soil or waste stack is back vented by a vent pipe large enough to vent all the fixtures. Venting is based on a size of drain pipe which keeps liquid flow to no more than one-third that of the drain pipe. Thus venting for the fixtures between the stack and the single vent pipe takes place through the branch drain. This method is not permitted in all areas.

## FIXTURES AND APPLIANCES

Generally speaking, fixtures and appliances are those elements of the plumbing system that the occupant actually manipulates, they includes sinks, toilets, washing machines, hot water tank and water softener. These are the links between the distribution and drainage systems. A fixture dumps directly into the drainage system (a sink is a fixture) and an appliance dumps into an indirect waste pipe or into a fixture (a washing machine is an appliance).

Fixtures and appliances should be operational, solidly installed and free from rust or bacteria collecting areas where the finish is worn or chipped away. They are the most visible element of the plumbing system.

Minimum Requirements

Fixtures must include:

- toilet (water closet)
- basin or lavatory
- bathtub or shower
- kitchen sink.

Additional fixtures include:

- laundry tub
- lawn service.

Additional appliances include:

- automatic clothes washer
- automatic dish washer (ensure that there is a proper drain vent or an air gap arrangement if drained through a stand pipe)
- water softener (ensure that there is bypass piping in case the water softener is removed)
- garbage disposal (check local codes for drain arrangements).

## HEATING SYSTEMS

There are many ways to heat a house. Heating systems range from the multi-controlled electric or hot-water systems to the relatively simple single space heating. Three common heating systems are: forced warm air, forced-flow hot water and electric baseboard heating.

Heating systems can be broken down into two types. The first is the central system, which produces heat in one location, usually the basement, and distributes it to the living areas of the house. Air or water may be used to distribute the heat.

The second type is a space heating systems. These appliances produce heat in the room in which they are installed.

Both types may use any of the major heating fuels.

### Fuel Types

Fuel commonly used for home heating includes propane, oil, wood, coal and possibly electricity. It is also possible to use two or more fuels to strike the best balance between economy and convenience; this is known as a HYBRID system (e.g. adding a woodstove or electric heating system or both to a natural gas system).

When considering several alternative fuels, cost and availability may be a decisive factor. Certain regions are blessed with abundant supplies of non-conventional fuels such as wood, coal, etc. These fuels may assure you a secure and inexpensive source of supply. You will have a varying degree of responsibility for obtaining, handling and storing fuel.

### Propane

Propane or LPG (Liquified Petroleum Gas) is generally bottled making storage a necessity. Gas is supplied at low pressure through the burner head of a gas furnace. Gas is generally burned on a multiple jet arrangement of burners. Air intakes located at the ends of the burners allow access for the combustion air. Controls include a valve which limits the amount of gas supplied to the burner and an automatic regulator which controls the pressure. When the thermostat indicates that heat is desired, it opens these valves which allows gas to enter the burner which is ignited by the pilot light. Safety valves are built into the system to prevent gas from entering the burner in the event the pilot light goes out. The burner, in turn, heats a heat exchanger. When the heat exchanger reaches the desired temperature a switch triggers the fan or blower to circulate the return air around the heat exchanger for distribution in the home. The flue gases that heat the heat exchanger are completely separate from the warm air that heats the home.

### Oil

Oil furnaces can be found in many homes in Yukon. They require little space for storage and very little handling. Two grades of oil are available: number one is lighter and more expensive, while number two fuel has a slightly higher heat value per gallon.

There are also two types of burners: vaporizing and atomizing. The vaporizing burner consists of an oil pool or reservoir and an open flame which vaporizes the oil. There are few moving parts and operation is quiet. The atomizing burner uses a pump which forces an oil and air mixture under pressure into a firepot where it is ignited by an electric spark. Because of this electronic ignition, no pilot light is required. The spark is triggered on demand by the pump and no fuel is needlessly burned.

The latter is the most popular of the two types since it achieves the most efficient amount of heat. There should be a minimum quantity of air in the mixture, which will ensure a clean flame. Improper adjustment will cause smoke at the tip of the flame which will result in poor efficiency of the unit. Regular servicing is essential in order to maintain reasonable operating efficiencies.

### Electricity

Electricity is converted into heat with virtually 100% efficiency. However, the process of generating and transporting electricity in Yukon is expensive. Electric resistance heating requires a more expensive electrical service as well as improved insulative values in the building envelope.

Three types of systems are available:

- baseboard heating units
- radiant panels (or wiring embedded in the ceiling or floor)
- forced air furnaces.

Electric heating offers convenience, cleanliness, even distribution of heat, safety and no draft-forming movement of air. Little space is required for the system if baseboard heaters or radiant panels are used, and no chimney is needed. The big disadvantage of using electricity as a heating source at this time is cost.

Electrical forced air furnaces are available which can be used alone or in conjunction with other heating sources (usually wood). They are as expensive to install as any forced air system and the cost to operate is high.

Yukon Electrical is currently discouraging electric heating as it is taxing generating capacity and will force prices higher as new generating facilities have to be built.

**Wood**

Dense woods make the best wood fuel. To get the highest possible efficiency, complete combustion is required. Complete combustion requires adequate oxygen, a high temperature in the combustion chamber and proper mixing of oxygen at certain levels in

the stove. The use of wood requires more labour and storage than the other fuels. A wood furnace could require loading several times a day during the heating season. Wood burning units include fireplaces, wood stoves, circulator heaters and wood burning furnaces. Wood furnaces can be used in a forced warm air or hydronic system. Using wood as a heating source requires certain precautions:

- proper clearances around the units
- burned in an enclosed space
- a proper chimney rated to survive a chimney fire
- chimney cleaning on a regular basis

**Coal**

If a sure supply of coal is available in your area, you may consider a stoker fired furnace. Stokers have automatic controls which feed the furnace as desired. The stoker may be installed at the front, sides or rear of the furnace. Clearances are a requirement for servicing and cleaning.

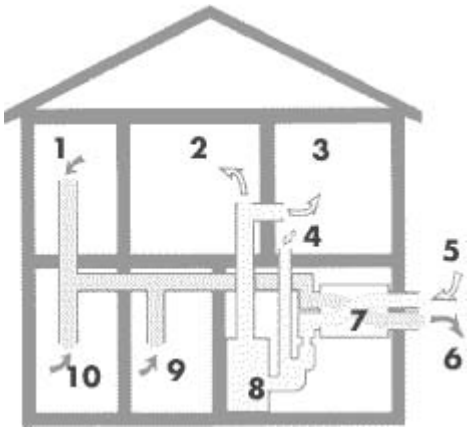
Stoker fired coal air systems are from 55-75% efficient depending on the type of coal used. Two kinds of coal are generally used: anthracite (hard) and bituminous

(soft). Anthracite coal sizes are fairly standardized while bituminous, which is used more often, is not. The heating value of the different sizes vary little but certain sizes are better suited for furnaces with different size firepots (check the manufacturer's recommendations).

## Central Heating Systems

Forced Warm Air Systems

This system consists of a furnace, ducts and registers. A blower in the furnace circulates the warm air to various rooms, through the ducts and registers. Return grills and ducts carry the cooled air back to the furnace where it is reheated and redistributed. This system responds rapidly on demand and heats uniformly.




1) kitchen
2) living room
3) bedroom
4) cold-air return
5) fresh air
6) exhaust air
7) HRV
8) furnace
9) bathroom
10) laundry

The furnace can be installed almost anywhere in the home - basement, crawlspace, closet, attic or attached garage. The location will determine which of the three kinds of furnaces should be used —upflow, downflow or horizontal..

Upflow forced air furnaces are the most common. The fan draws return air in at the bottom through a return air duct. This returned air is forced around the heat exchanger (heated by a fuel) and distributed through the warm air plenum and ducts at the top. Upflow furnaces of this type are generally located in basements where heat is desired above. Often to heat the basement with an upflow furnace, ducts are directed down from the main floor joist space. This, however, is not the best way to get even heat distribution in the lower level. These ducts should be extended out to the exterior wall face and turned down through the studding used to "finish off" the lower level (basement). The registers are then located near floor level for better distribution of heat.

Downflow or counterflow forced air furnaces draw in return air at the top of the furnace. The fan moves the air through the heat exchanger and out the warm air plenum, located at the bottom of the furnace. These units are usually located in basementless homes, mobile homes or lower level spaces, wherever heat is required below the unit. In lower level applications, the main warm air plenum and supply ducts may be installed within the floor construction.

In concrete floors the metal or plastic ducts can be cast within the concrete. On suspended wood floors the warm air could be dumped into the space below the joists with registers placed in the floor where desired. This would eliminate the need for metal ducts, however, insulation and a ground cover are a must. This method would also work in a insulated crawlspace.

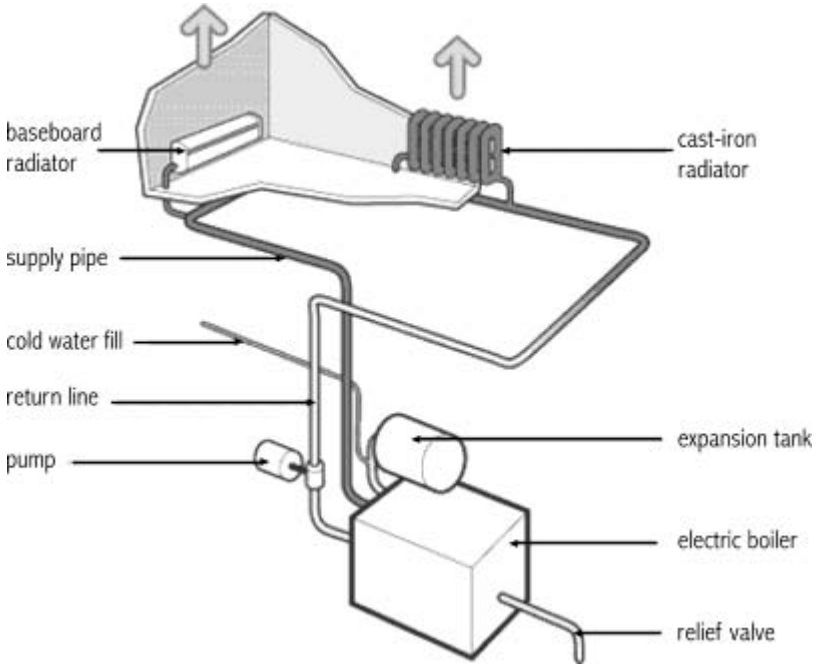
Horizontal forced air furnaces lie on their sides. The cold return air enters at one end, and warm air is discharged from the other. They can be used in an attic space to supply warm air to registers at the ceiling. They can also be installed in a crawlspace with warm air registers in the floor.

The forced warm air system is probably the most versatile of all the heating systems. It can provide heating, cooling, ventilation and air circulation, air cleaning, humidification or dehumidification.

Fuels that can be used in a forced air furnace are wood, oil, coal, natural gas or propane.

**Forced Hot Water Systems**
(Hydronic)

A hydronic system consists of a central water heating system, a circulating pump to move the water, pipes that distribute the water through the home and radiators or convectors in each room to heat the space. A recent development is the use of PVC hot water lines beneath the floor system - both in concrete floors and beneath flooring plywood - to supply even, continuous heating.



The boiler, that part which heats the water, is constructed of either cast iron or steel and designed to burn gas, oil coal or wood/coal. Boilers are generally compact and do not need to be centrally located as does the forced air furnace. Water used within the system is under pressure so that the temperature can be raised from 93( to 120 (without the water boiling. Because water expands when heated, an expansion tank must be provided within the system. The tank allows for any "overflow" as well as a method of maintaining a pressure within the system. A hydronic system under pressure is referred to as a closed system. An open system uses an open tank located at the highest point in the home, possibly in the attic, with an overflow pipe extending out the roof. This system is not used as much as a closed one because of the lower pressure hence a lower heating temperature. Chemicals to fight corrosion are added to the water to prolong the life of both the boiler and the pipes.

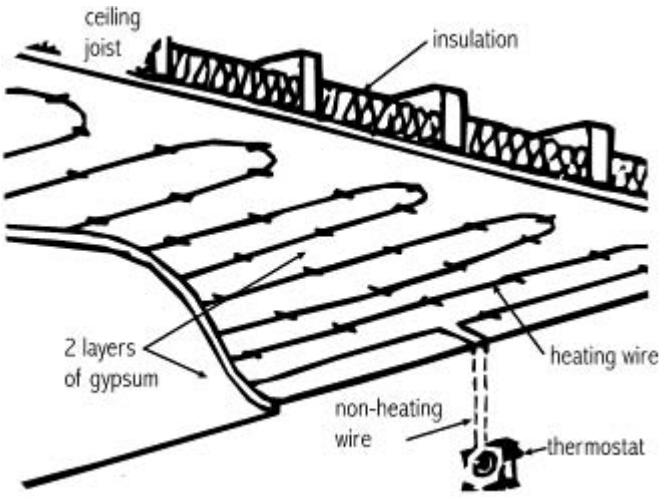
With any Hot Water System, an experienced installer is important. If sufficient space is not allowed for expansion and contraction, the pipes will creak and bang, or there will be insufficient heat.

The length or piping or amount of baseboard radiation is determined by room size, window area, construction, etc. To ensure an adequately sized system, have a heating contractor work out the calculations for your system.

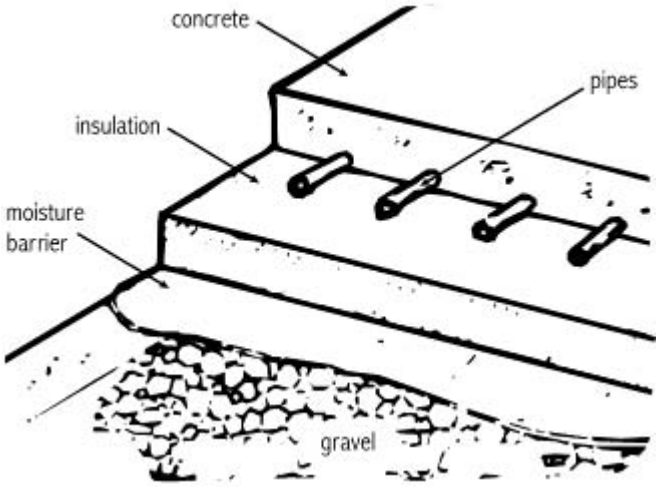
In radiator systems, convectors of copper tubing and aluminum and copper fins have replaced heavy cast iron radiators. Pipes used with the hydronic system are usually copper. The baseboard convectors are constructed of an enclosure over a pipe with radiating fins. A continuous space or slot runs the length of both the top and the bottom, allowing air to flow freely through the fins by natural convection. Dampers are also installed on some units to redirect or shut off air flow.

**Radiant Heat**

The new "in floor" hot water heating systems use PVC piping laid in a concrete floor or fastened in each joist space. The system consists of a series of loops of pipe that begin at the boiler, run out through the floor system, and return to the boiler. These "runs" are just long enough to use all the heat in the hot water before they return to the boiler.



This system permits different areas of the house to be on a separate thermostat (zoned) for more exact heat control. The basement, the main floor and an attached garage could be separate zones on different thermostats.




In summary, the advantages of a hot water heating system include:

- no drafts since air is not forced
- high degree of comfort
- ease of pipe installation and concealment by using a number of thermostats, control valves and circulating pumps, areas of the home may be zoned for different temperatures (depending on the type of system used)
- generally the components have a longer life with lower maintenance as

## Space Heating Systems

In some homes using a central heating system may not be practical, possible or desirable. The alternative is space heaters which are available for use with most of the major heating fuels.

Propane-fired space heaters are available in many styles and sizes. They can be free-standing, wall-mounted or hung from ceilings. Heat is circulated by natural convection or with the aid of a built-in fan.

Oil-fired space heaters are also available in many configurations. Some units are high efficiency which means simple venting. They are clean and dependable.

Electric space heaters, the most common of which are baseboard heaters, are often used. Along with propane heating systems, they provide flexibility of installation and the capability to set different temperatures in different rooms of the house, or provide freeze up protection.

Controlled combustion wood space heaters are a good secondary heat source, reducing the use of the primary furnace.

Consideration must be given to fuel supply lines and venting requirements with space heaters. A number of heaters located throughout the house will require a similar number of supply lines and vents which may increase installation costs and restrict individual room layouts.

**Sizing**

It takes a qualified heating contractor to properly size a heating unit to a house. A heat-loss analysis should be carried out to determine the total required heating capacity, as well as heating requirements for each room or section of the house. Many houses receive heating systems that are too large for the houses they were designed to heat. Correctly sizing a furnace to your needs is important in terms of efficiency. An oversized furnace will cycle on and off frequently and never operate at its best efficiency. As a general rule, a properly sized furnace will be on for almost 90( of the time during the coldest weather, running most of that time at its peak efficiency.

When sizing a heating unit the following points should be taken into account:

- the size of the building
- the insulation level of walls, ceiling and foundation walls the extent of weatherstripping and caulking in the home (air tightness)
- the quality of windows and doors the orientation of windows (to make allowances for passive solar heating effects)
- the number of layers of glazing in the windows.

**Thermostats**

A thermostat is an automatic device used to regulate the temperature of a room. It is basically an electric switch that is activated by changes in temperature, and controls the on-off operation of a heating system .

With central heating systems the thermostat is generally located near the center of the house on the main floor. Space heating and some types of radiant and hot water heating systems allow for thermostats to be located in individual rooms or other areas.

Fuel consumption may be reduced with the use of a setback thermostat. These thermostats can be “programmed” to automatically turn down the house temperature at predetermined times and to predetermined temperatures. A reset feature will also allow the temperature to be raised at a set time. Many different types of automatic setback thermostats with various features are available.

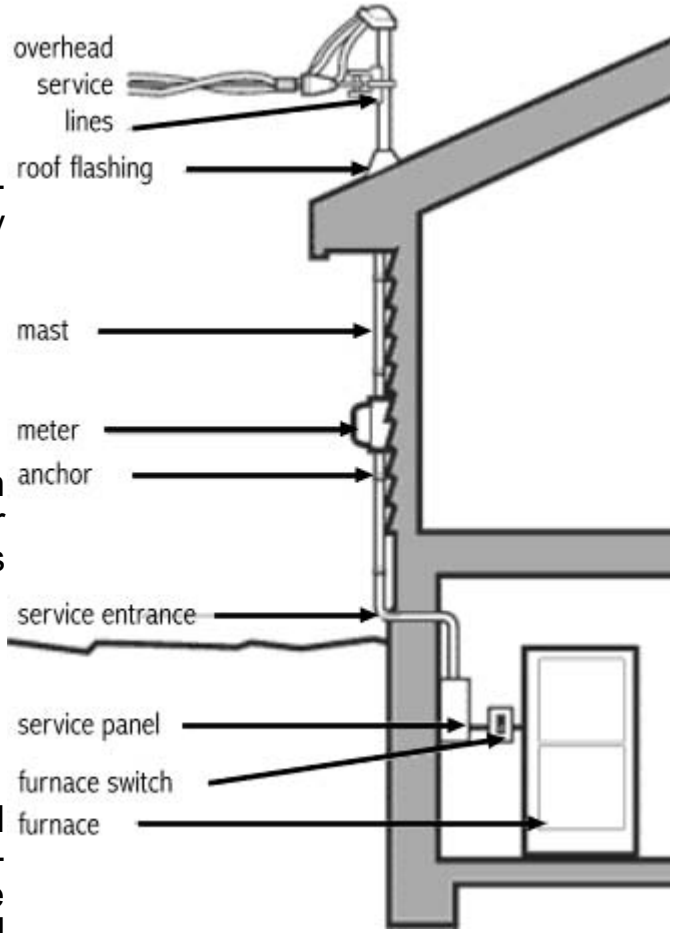
## ELECTRICAL SYSTEM

### Service Entrance

The service entrance is the point at which the electrical supply enters a dwelling and is the collective term for lines and equipment necessary to conduct electricity from the utility wires into the dwelling's distribution box. It consists of the service lines from the utility lines to the house the meter, the main switch and distribution box. The system to attach a wire to ground is an important part of the service entrance.

### Service Lines

Service lines, either overhead or underground, bring the electricity from the supply system to the house.



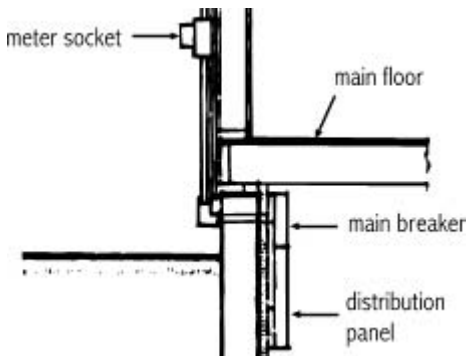

### Meters

The meter measures electrical consumption in the dwelling, and is plugged into a meter socket. All meters installed in new buildings are located on the outside.

### Main Switch

A single switch capable of shutting down all the electricity in the system is always located immediately after the meter, on the inside of the house or at the meter in a rural service.

The main switch usually is the main circuit breaker. This is a switch and fuse built into one unit. Main circuit breakers are usually located by themselves in the upper part of the distribution panel. This type of panel is called a combination panel.



## Ground

It is extremely important that the electrical service equipment is properly grounded to protect users from electric shock. If a live wire comes in contact with a grounded metal enclosure in the system, a fuse will blow and force a repair. If this happens at the same time that a person is in a potential shock position (i.e. touching both the live box and a plumbing fixture), the electricity will follow the path of least resistance which is the ground wire, blow the fuse and protect the person. Without the ground the full force of the electricity would go through the person.

## Distribution Box

The distribution box is the transition point between the service entrance and the distribution system. Usually a metal conduit containing the large service lines enters the box and many smaller circuit wires exit from it. In the distribution box the electricity is divided into branch circuits. The circuit breakers that protect each individual circuit are also in the box.

## Service Entrance Sizing

The minimum service entrance size required in a residence is 100 A (ampere) service with a 24 circuit panel where the living area is 80 m2 (861 sq. ft. ) or more, or 60 A service with a 16 circuit panel where living area is less than 80 m2.

However, to satisfy future development a 100 A service with a 32 circuit panel should be used. This way additional outlets, fixtures or appliances can easily be added without having to upgrade the service entrance at a later date.

Also, if electricity provides the total heat requirements, e.g. electric furnace or electric baseboards, a 200 A service with a 40 circuit panel is required.

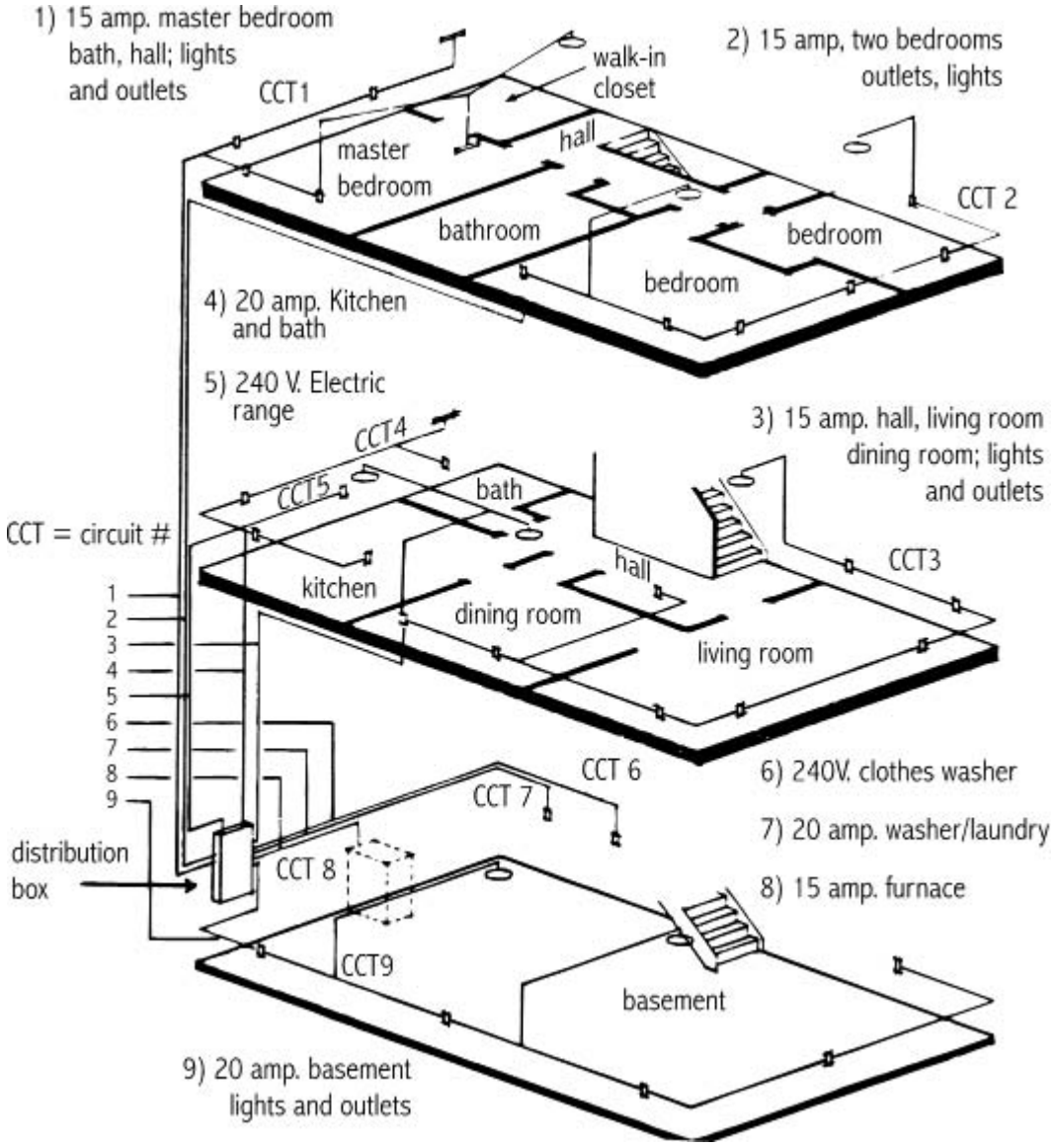
It is important to note that the list of materials required to complete the service entrance differs between a 100 A and 200 A service size.

| Service Size | 100 amp. | 200 amp. |
|---|---|---|
| **Meter base rating** | **100 amp.** | **200 amp.** |
| Main switch | 100 amp. | 200 amp. |
| **Service panel size** | **24-32 circuits** | **32-40 circuits** |
| Service wire size | 2 - #3 AWG | 2 - #3/0 AWG |
| **Service neutral size** | **1 - #3 AWG** | **1 - #3/0 AWG** |
| Ground conductor size | #6 AWG | #3 AWG |
| **Service conduit** | **32 mm (1-1/2 in.)** | **50 mm (2 in.)** |

* AWG is the American Wire Gauge number. The smaller the number, the larger the diameter.

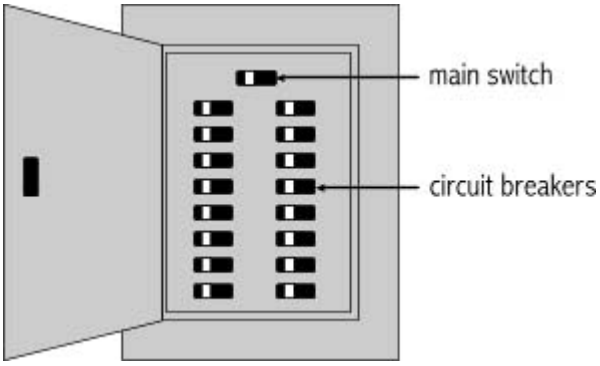
## Distribution

The distribution system carries electricity from the service entrance throughout the dwelling, and provides protection from both electrical shock and fire.



## Distribution Box

The distribution box is the transition point between the service entrance and the household wiring. All branch circuits begin at the box which contains the breakers for those circuits.




The size of the distribution box is measured by the number of circuits it can provide for. This number should match the service entrance capacity.

## Circuit Breakers

Circuit breakers are safety devices designed to open a circuit when the electrical demand (either from a short circuit or from overloading could overheat the wire of that circuit.

A ground fault breaker (a special circuit breaker inside the distribution box) is one form of Ground Fault Interrupter (GFI) that not only trips if a short circuit occurs, but also detects flow of current through an unintended path from the circuit to ground. A very small amount of current to ground will instantly trip the breaker, thereby reducing the possibility of electric shock. Ground fault breakers allow full power outlets to be installed in bathrooms or protect against the high shock potential of outdoor outlets. They are expensive, but the expense should be judged against the value of a life.

## Wires

Wires for domestic electrical systems will usually be copper. The diameter of the wire is designated by an American Wire Gauge Number (AWG #) - the smaller the number, the larger the wire. Domestic wire consists of either two or three wire cables. This designation counts only the current carrying wires and a third or fourth ground wire will always be present. Hence #14-2 wire is a cable with two insulated wires and a bare ground —- the 14 gauge wire being able to carry up to 15 amperes..

Wire gauge for recommendations

- #14-2 for all lights and most outlets (15 A)
- #12-2 for heavy duty outlets and some heaters (20 A)
- #10 3 for 30 A dryers
- #8 - 3 for 40 A stoves

## System Ground

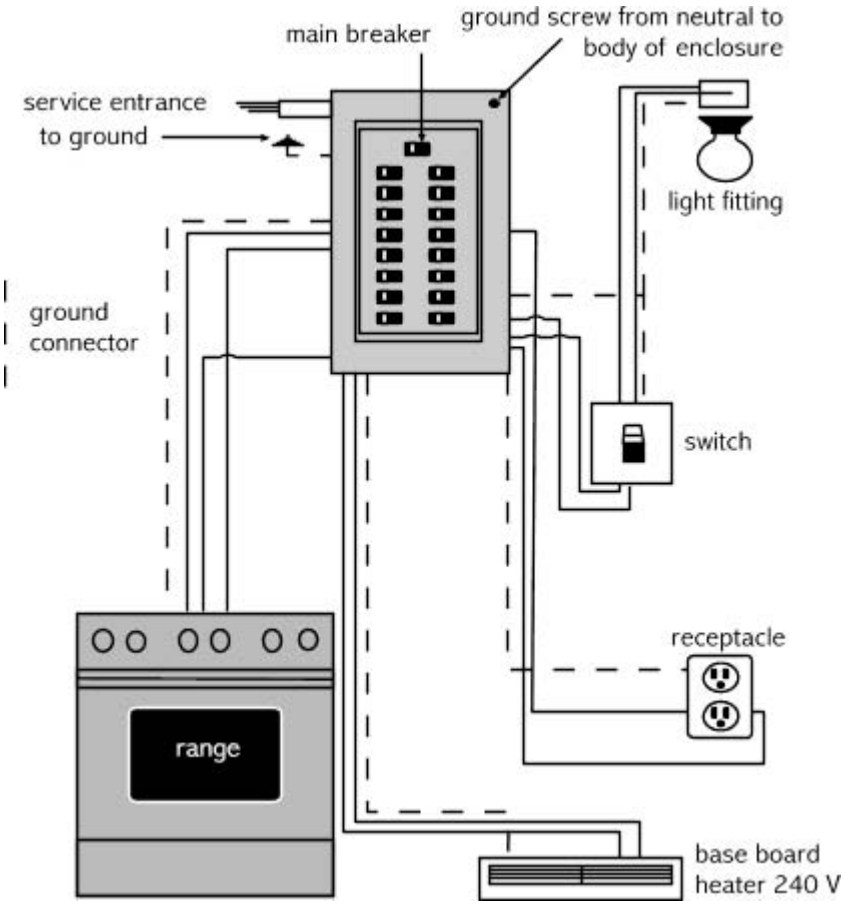
A system ground is the continuous connection of the bare ground wire of a circuit to the distribution box and to each of the outlet or receptacle boxes. Through the service ground, which is also connected to the distribution box, all elements of the electrical system are safely grounded to earth.

## Circuits

A branch is two or more wires that conduct electricity from the source to one or more outlets and back again. A branch circuit can be defined as a set of conductors between the final over current device protecting the circuit and the outlets.

In bathrooms the electrical supply must be protected from the plumbing. A ground fault breaker or a ground fault receptacle (a plug-in with a built in ground fault breaker).

Exterior lines must be on separate circuits and each exterior receptacle must be on a separate circuit and protected with a ground fault breaker.



## Branch Circuits

Branch circuits are the wires that carry electricity from the service panel to the various parts of the home. Each branch circuit carries electricity to one or more plug outlets, lights and/or appliances. Most homes have several branch circuits. Not all branch circuits are alike, however, in the work they perform. They vary according to the type and number of appliances and outlets they serve. There are four main types of branch circuits:

1. ***General Purpose Circui***t

   supplies electricity to most of the lighting and convenience outlets in the home. A total of twelve lighting and convenience outlets may be connected to one general purpose circuit. This type of circuit is protected by a 15 amp circuit breaker or fuse.

2. ***Separate Circuit***

   supplies electricity to only one convenience outlet. It may be connected directly to the appliance such as the furnace, where a separate branch circuit must be used solely for electrical power to operate the furnace equipment. This type of circuit is generally protected by a 15 amp circuit breaker.

   Separate circuits must be provided to supply each of the following:

   - furnace(s)
   - a receptacle in the laundry area or a combination laundry/ utility area
   - split receptacles in each working area of the kitchen counter
   - a refrigerator receptacle
   - receptacle(s) in the eating area of a kitchen
   - outdoor receptacle(s)
   - electric range
   - electric dryer
   - smoke alarms
   - electric hot water heaters
   - electric heating units rated 1500 W (watts) or more
   - electric motors of 1/2 HP or more.

### *3. Major Appliance Circuit*

supplies electricity to one major appliance such as a range, dryer or water heater. The size and type of circuit breaker used to protect this circuit depends on the appliance.

### *4. Split Duplex Receptacle Circuit*

supplies electricity to only one convenience outlet but it differs from the separate circuit (above) in that each half of the convenience outlet is connected to a separate 15 amp circuit. The advantage of this type of outlet is that two high wattage appliances can be plugged into the same convenience outlet without tripping a circuit breaker or blowing a fuse. This type of circuit is generally located in the kitchen and requires a single handle 2 pole breaker.

## Switches

A switch is a device for breaking the flow of electric current.

The main source of light in each room should be controlled by a wall switch located on the latch side of the door or on the traffic side of the archway. Some exceptions to this rule are the control of stairway lights from adjoining areas and the control of lights from outside areas such as closets and storage rooms. Where a room has more than one door there should be a wall switch at each door controlling the main source of light in the room. In a well-planned home, you should be able to turn on a continuous path of light in front of you as you walk through the house and you should be able to turn the lights off behind you without retracing your steps. In most cases wall switches are mounted approximately 48” above the floor line.

A three-way switch is used when a light(s) is/are to be turned on or off from two places. A three way switch must be used at each place .

A four way switch is used when a light is to be turned on or off at more than two places. For three places, two three-way and one four way switches are used: for four places, two three way and two four-way switches are used. An additional four way switch is used for each additional place of control.

## Safety Switches

Gas heating equipment (furnaces or hot water boilers) requires a power cut-off safety switch. The cut-off switch should be located close to the basement entrance and must be clearly marked.

## Outlets, Fixtures and Appliances

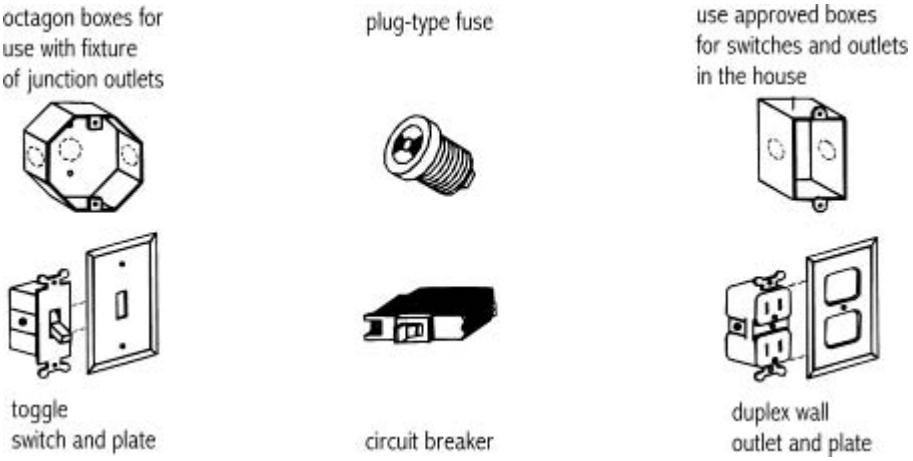
The electricity in the system is used by the occupants to operate fixtures and appliances. All outlets, fixtures and appliances should be properly installed .

### Outlets

An outlet is simply a device that allows electricity to be tapped to operate fixtures or appliances.

Wall plugs or receptacles should be no more than 1800 mm (6 ft) away from any spot on a usable wall in living, dining and recreation rooms, which works out to approximately one receptacle every 3600 mm (12 ft).

Bedrooms of average size should be provided with at least two receptacles per bedroom. Kitchen minimums are usually a two circuit split receptacle for every 900 mm (3 ft) of working counter, which works out to an outlet every 1800 mm (6 ft) (one should never have to reach further than 900 mm (3 ft) for a plug).




Ordinary outlets, light switches and pull chain lights must not be installed within reach of plumbing fixtures or without that circuit being protected with a ground fault breaker.

### Ground Fault Interrupter Outlets (GFI)

A GFI senses the smallest of electrical currents through an unintended path from the circuit to ground (the beginning of a shock or short circuit) and instantly opens the circuit. A GFI is much safer although more expensive than an ordinary breaker. GFI outlets which have self-contained trip and reset buttons can be installed where safety is needed, e.g. bathrooms and exterior receptacles.

Ground fault breakers can be installed in place of GFI outlets to protect an entire circuit for about the same price.

### Fixtures

Most domestic fixtures are simply permanently attached lights. Basement light fixtures have pull-chain light switches with isolating links. These are non-conductive and are placed between the pull-chain and pull-string of the fixture and will not allow the power to flow past the isolating link if a short circuit occurs in the fixture. The isolating link should be installed as close as possible to the point where the chain enters the socket.

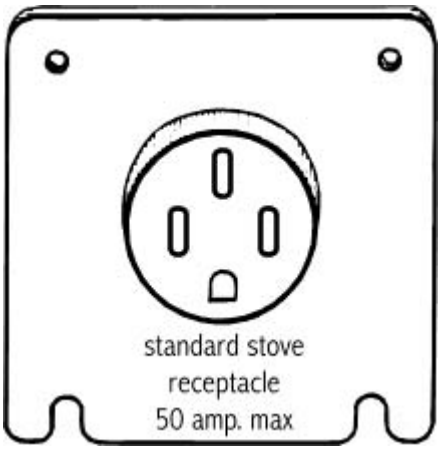
### Appliances

All electrical appliances and equipment are provided with name plates which will list the amperage or wattage and voltage requirements of the appliance. The name plate will also show either a Canadian Standards Association (CSA) or an Underwriters Laboratories of Canada (ULC) approval number, which is mandatory.

All major appliances, including dishwashers and garbage disposal units, must have a separate circuit.

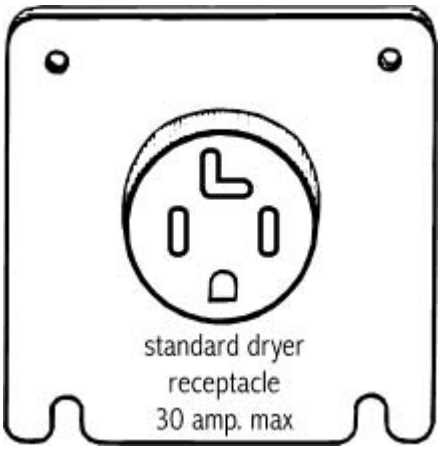
### Stoves and Ranges

Domestic electric ranges should be fused with 40 amp breakers and supplied with three #8 AWG copper conductor wires. Until a few years ago, the electrical code allowed the range feed to be connected directly into the range. However, the code now requires a plug-in cord set. This made it possible for a homeowner to safely connect and disconnect the range.



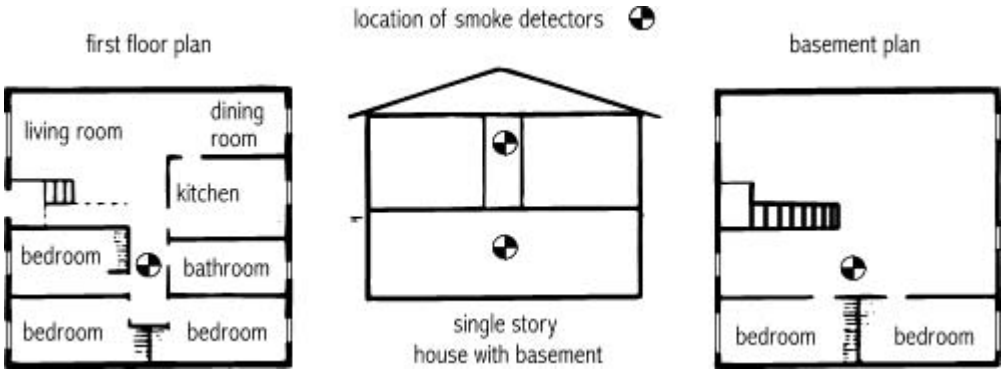

### Electric Clothes Dryer

Most domestic dryers must be protected with 30 amp breakers, with a three wire No. 10 AWG copper conductor feed. Until a few years ago, the electrical code allowed the dryer feed to be connected directly into the dryer. However, the code now requires that a 30 amp receptacle and a plug-in cord set be provided for dryers. With the range, the homeowner could then safely connect and disconnect the dryer.



## Smoke Detector

All new buildings with sleeping accommodation must have smoke alarms or smoke detectors installed as part of the building's electrical system. Smoke detectors that operate on battery power alone are not permitted.




For further information, contact your local Fire Department.

## Special Requirements

If you plan to have any of the following systems installed in your home, you should have the necessary wiring done at the time of construction. It is easier and less expensive to add extra wiring when the home is being built than to do so once the home is completed.

## Entrance Signals

A push button should be installed at each commonly used entrance door and connected to a door bell or chime. A distinctive signal should be given for each entrance. The door chime should be installed in a central location, usually the entrance hall. In larger homes or in homes with a finished basement a second chime is recommended. The entrance signal is not wired to a regular 120 V circuit. It must be equipped with a special transformer.

A voice intercom system that permits conversation without opening the door offers protection as well as convenience. It can be designed for this purpose alone or as part of an overall communication system installed throughout the house.

### Communication

Installation of an intercom system may be desired. It can be arranged for voice communication to the entire house or to selected individual rooms or areas. Provisions for communicating with a caller without opening the door should be included. Music from a radio, stereo or tape recording may be fed into the system. A separate intercom telephone system may also be installed.

### Television and Radio

If you plan to install an outdoor television antenna, outlets should be provided in convenient locations for connecting the master antenna system. A convenience outlet should be provided adjacent to each television outlet. The antenna mast and the shield of the transmission line should be grounded. A lightning arrestor should be provided in accordance with the Canadian Electrical Code.

If cable television is available in your area and you wish to have it installed in your home, outlets should be provided in convenient locations for connecting the cable. The company concerned should be contacted at the time of construction to do the necessary wiring.

Radio receivers used purely for the reception of broadcast communication seldom require antenna and ground connections. If an antenna is desired for FM reception, provisions similar to those for televisions should be included.

### Telephone

Outlets should be located in the kitchen, den, living room, bedrooms and other rooms as desired. The necessary wiring should be installed at the time of construction. The telephone company will run the wiring you need, with a few days notice during construction.

### Central Vacuum Cleaning System

Consideration should be given to installing a central vacuum cleaning system. Hose outlets should be installed in appropriately throughout the house, with the central dust collecting tank being located in a convenient location.

### Time Clocks

For convenience, safety, security and economy, the installation of time clocks is possible. Time clocks should be installed in all areas of the home where the automatic control of lighting and appliances is desired. Both built-in and portable time clocks are available. Built-in models are wired directly into the circuit. Portable time clocks can be plugged into any convenience outlet.

Depending on the model selected, time clocks can be set to turn lights or pieces of electrical equipment on and off automatically at a preset time or times during the day or week . It is recommended that time clocks be installed to control the operation of car block heaters and interior car warmers, all outdoor lighting, baseboard heaters in infrequently used areas (e.g. rumpus room) Select interior lights and radios for security purposes, and any other appliances or lighting you wish to control automatically. Time clocks do not require any special wiring but the rated capacity of the time clock is important. The timer selected must be large enough to handle the total connected electrical load on the circuit it controls.

**Burglar Alarm Systems**

Two basic types of systems are available. One type protects your home while you are away by detecting any movement inside the home. In this case, motion-detecting devices should be installed in strategic locations throughout the home. The other system protects you and your home whether you are at home or away. For this type of protection, burglar alarm equipment should be installed around the perimeter of the home (e.g. on all doors, windows, etc. ) . A combination of the two types of systems may also be used.

If you want the system connected to an alarm that rings locally, a bell or siren should be installed on your property outside the home. The system may also be connected to a telephone communicator. The communicator is installed on your regular telephone and when activated, it dials a pre-selected number (e.g. neighbours, an answering service, a central burglar alarm office, etc.). The most expensive type of system is a direct wire alarm where the home is directly wired to a central burglar alarm station. When activated, the alarm rings in the police station.

## Final Considerations

When planning the electrical system of a new home, you should discuss your present and future needs with your electrical contractor. You should make a list of all your present electrical appliances and any equipment you hope to get in the future. With a plan of the house in front of you, you should go over this list together, deciding in what locations you want to operate this equipment. Consider your electrical needs room by room. The arrangement of your furniture will
dictate the location of some of the outlets. Make allowance for future changes in furniture arrangement. Consider the location of switches. Plan your rooms so that you can switch lights on ahead of you instead of having to stumble down halls and across rooms in the dark, fumbling for the switch. Outlets should be of the duplex or multiple type and some should be switch controlled.

The electrical system installed in your home is most important to the general efficiency of the house. From the point where the current leaves the meter, the rest of

the system within the house is your property. Many building codes and by-laws make frequent reference to the Canadian Electrical Code, one of whose primary objectives is to establish minimum standards for safe wiring. However, it is up to you, as the owner, to see that the system is adequate, and that provision has been made to take care of future demands as the need arises.

### Electrical Plan

The electrical plan, unlike the mechanical or heating plan, is not normally drawn as a separate plan because the information is generally shown on the floor plan. The electrical plan usually shows the following information: the location of fixtures, switches and outlets, location of appliance outlets and special outlets on the exterior.

### The Location of Fixtures, Switches and Outlets

The locating of fixtures, switches and outlets is shown by the use of various symbols. These symbols are usually shown in a legend on the drawing.

### The Connecting Runs (Wires)

The electrical plan will show which switch is controlling each fixture or switched outlet. This is done by connecting the switch to the fixture by a broken line. Stairwell fixtures are switched from two locations. There will be two switches, upstairs and downstairs, connected to one fixture. This is known as 3-way switching. The wire types and gauges are not generally indicated. This is left to the electrician who is more familiar with the Electrical Code.

### The Location of Outlets for Electrical Appliances

These include stoves, baseboard heating and kitchen appliance outlets.

### Outside Weatherproof Outlets

If outside outlets are required, their location is indicated on the drawing.

## Typical Electrical Plan