CHAPTER VI

BUILDING PLUMBING

6.1. INTRODUCTION

The chapter covers questions related to water demand, distribution and drainage. The basic principles for planning and installing common plumbing systems are covered.

An understanding of basic aspects of the plumbing code is essential. Every city has adopted a plumbing code to protect the health and safety of its people. Building departments enforce these codes and arrange inspections of plumbing work as it's completed.

Cost of plumbing systems in most homes is about 10% of the total construction cost. Every plumbing system is divided in to three parts:

1) The Drainage and vent system

2) The water service pipes and distributing pipes

3) The plumbing fixture.

6.2. WATER DEMAND

The demand that will be placed on a water supply source is the first step to be calculated when designing it.

The size of water supply pipes will depend on:

1) The type of flush devices to be used on the fixtures

2) The water pressure in pounds per square inch at the source

3) The length of the pipe in the building

4) The number and kinds of fixtures installed

5) The number of fixtures expected to be used at any time.

the average daily water demand for several facilities is shown on Table 6.1.

Table 6.1. Average Daily Water Demand

Type of facility	Water Demand (Gallons/day)
Airport (per passenger)	3-5
Resorts (day and night, with limited plumbing, per camper)	50
Factories (per person per shift)	15-35
Highway rest areas (per person)	5
Hotels with private baths (two persons/room)	60

Multi family dwelling (per resident)	60
Hospitals (per bed)	75-125

A more complete table can be found in [1]

The average hot water demand in the USA is assumed to be 20 gallons per person per day (gppd) for a family of two persons. An additional 15 gppd will have to be added for an increase in the number of family members.

6.3. SIZING THE DISTRIBUTION PIPES

The size of piping in building water supply systems depends on the anticipated demand.

A simple way of sizing the distribution pipes is using tables as shown on Table 6.2 . They can be used for almost one- and two- family dwellings if the minimum water pressure is at least 5 pound per square inch (psi).

Table 6.2. Size of fixture Supply Pipe

Fixture type	Pipe size (inches)
Water closet (WC)	1/2
Shower (SH)	1/2
Bathtub (BT)	1/2
Lavatory (L)	1/2
Kitchen Sink (KS)	1/2
Clothes Washer (CWM)	1/2
Hot water heater (WH)	3/4
Hose bibb (HB)	1/2 or 3/4

The water service pipe is the most important pipe in the distribution system and must be sized first. The following restrictions must be kept in mind when sizing the pipes:

1) The minimum practical size for the water service line is 3/4 inch, and that size can be used only in certain instances

2) The minimum water service pipe size for one-and two- story building is given by Table 6.3.

Table 6.3. Minimum water service pipe

Number Of Bathrooms and Kitchen (Based on Tank-type Water Closets)		Diameter of water service Pipe (inches)
Copper	Galvanized	
1-2	1-2	3/4 or 1
3-4	3-4	1
5-9	5-8	1 1/4

3) The size of the water service pipe must not change when it enters the building to become the building

water main. After the water-distributing branch pipes are connected to the building main, the main can be reduced in size.

4) The water main pressure does not fall below 50 psi at any time.

5) In single - family residential buildings more than two stories high, or where the water main pressure may fall below 50 psi, use the next larger pipe size.

6) Only two fixtures can connect to a ½ inch cold water supply branch.

Example 6.1

Size the cold water piping for the distribution system shown on Figure 6.1.

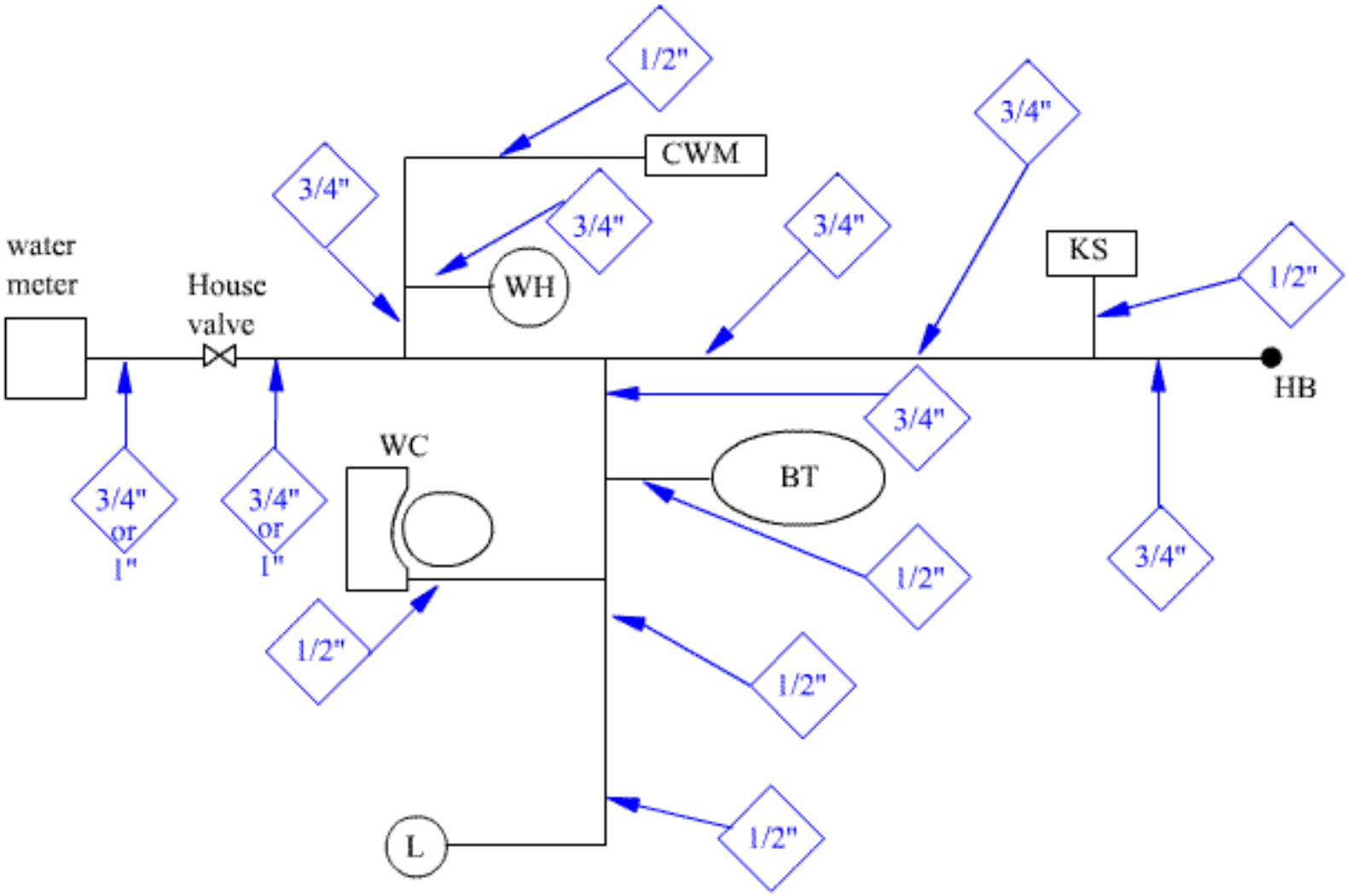

Figure 6.1. Single - bath residence

6.4. WATER, WASTE AND DRAINAGE SYSTEMS

Wastewater generated from buildings has to be transported for treatment and disposal. Almost every

building is provided with both water supply and waste pipes. Drainage in buildings has two major components: sanitary waste and storm water. sanitary waste consists of liquids discharged from plumbing fixtures. Storm water consist of rainwater, surface water or other similar liquid wastes. Sanitary and storm sewers should be separated, because sanitary waste contains a high level of pollutants.

The wastewater from the building can go to a public sewer that carries sanitary waste to a central treatment plant before it is discharged to streams or rivers or the wastewater can be sent to a septic tank. The septic tank is an individual waste system for buildings in areas that are not connected to a municipal treatment system.

Septic tanks are usually constructed underground, divided into two chambers using a baffle wall with an opening 18 inches below the flow line of waste.

In order to calculate the total load carried by a soil or waste pipe, it is defined the Fixture Unit Value (FU).

The FU for continuous flow is computed on the basis that 1 gpm of flow is equivalent to 2 FU. For semi-continuous flow, 1 FU. Table 6.4 shows the Drainage Fixture Units (DFU) for different fixtures:

Table 6.4. Drainage Fixture Units

Fixture Type	DFU
Bathroom group consisting of water closet, lavatory, bidet and bathtub or shower	6
Automatic clothes washer, domestic	2
Kitchen sink, domestic	2
Lavatory	1
Water closet, Flushometer tank, public or private	4

All plumbing fixtures discharge the used water to the drainage system. Sizing the drain and waste pipes can be done following certain rules:

1) According to the Standard Plumbing Code, the maximum number of fixture units (F.U.) to connect to any part of the building drain or horizontal fixture drains (¼ inch fall per foot) is given by Table 6.4.

Table 6.4. Maximum Number of Fixture Units

Pipe Diameter (inches)	Fixture Unit Valve
2	21
2 1/2	24
3	27 (Not over two W.C.)
4	216

2) The minimum size of a building sewer shall not be smaller than 4 inches.

3) For additions to residential buildings, if it is necessary to install the sewer line outside and around an

existing structure, such line shall be considered as a horizontal branch.

4) Always use the minimum sizes required by the code. Using larger waste pipes than required is not recommended.

6.5. TRAPS

Traps provide a water barrier against the infiltration of sewer gases into the building. As shown in Figure 6.2, the water in the trap block the pipe so that gases could not pass.

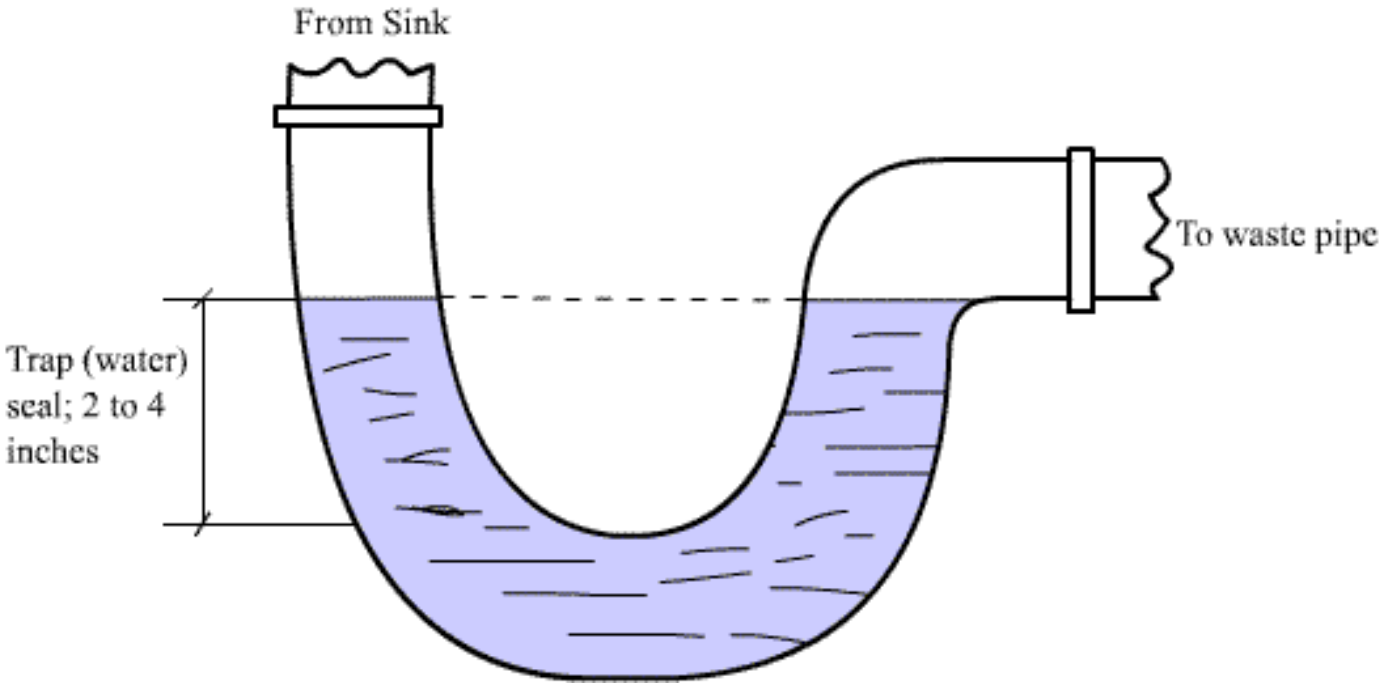

Figure 6.2. Fixture Trap

When water moves into the trap, the mass of water act as a plunger, creating higher pressures in from of it and negative pressures behind. The high pressure might force sewer gas through the water in other traps and the negative pressure could suck the water from the trap, leaving it open to gas passage. These effects a can be eliminated through the proper installation of vents.

All plumbing fixtures must be equipped with a trap. The most common trap is the shown on Figure 6.2 and is called P-trap. When installing fixture traps, the following rules must be observed:

1) Fixture traps shall be self cleaning and can not depend on movable parts to retain the water seal.

2) No trap outlet can be larger than the fixture drain to which it is connected.

3) The water seal shall be between 2 and 4 inches.

4) All traps shall be installed level in relation to their water seal (Figure 6.3)

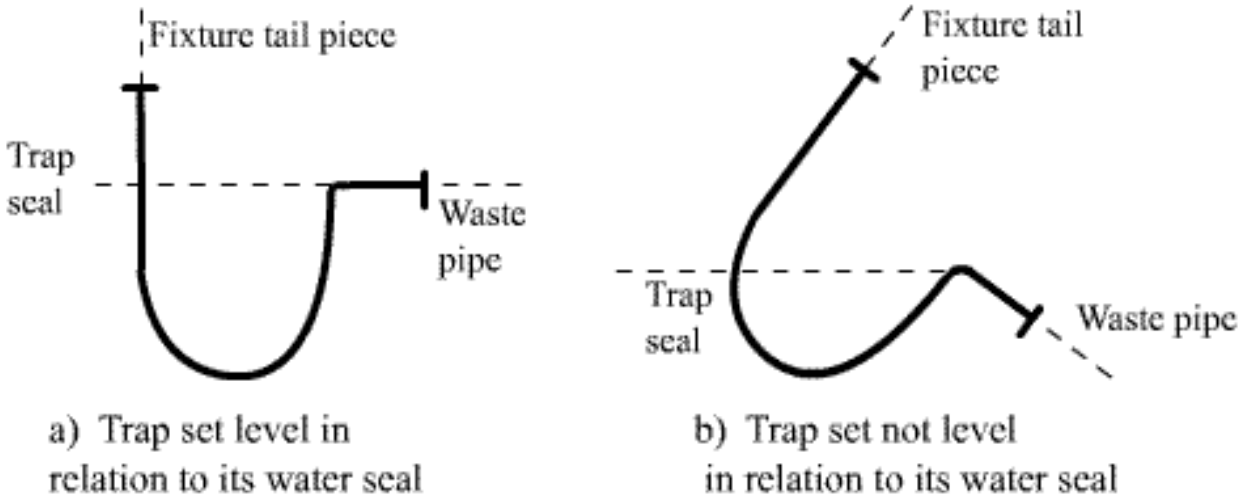

Figure 6.3. Trap installation a) correct b) incorrect

5) No fixture can be double trapped.

6) For sinks, lavatories, showers, bathtubs and similar fixtures, the maximum allowable vertical drop from the fixture waste outlet to the trap water seal can not exceed 24 inches (18 inches in some codes). (Figure 6.4)

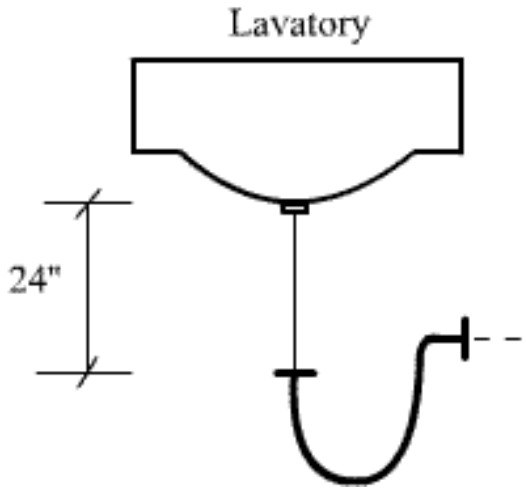

Figure 6.4. Maximum Vertical Drop

7. The vertical drop of the pipe serving fixtures with integral traps, as water closets and similar fixtures shall not exceed 24 inches (Figure 6.5).

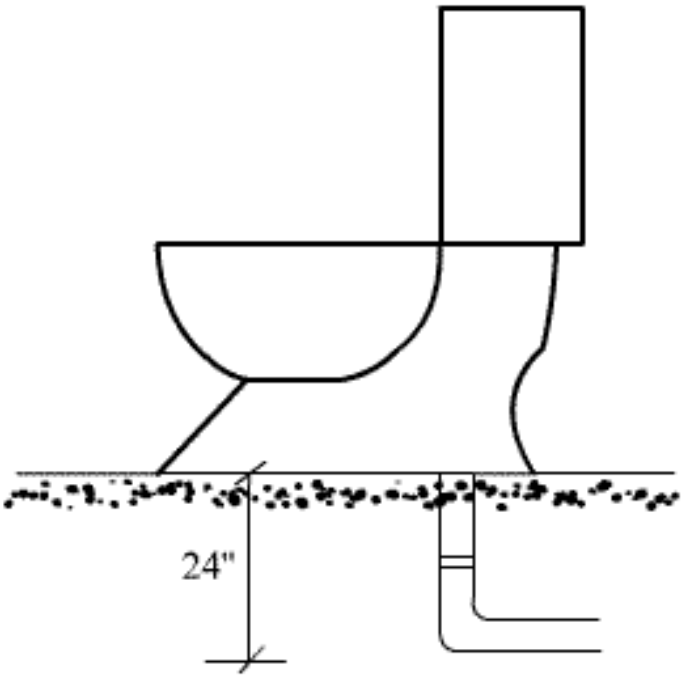

Figure 6.5. Vertical Drop for fixtures with Integral Traps.

6.6. THE VENT SYSTEM

Vents are used to relieve the pressure that builds up as water from plumbing traps is discharged into the sanitary drainage systems. The following problems are presented due to inadequate sizing and arrangement of vent pipes:

1) Water closets need several flushes to remove content from the bowl.

2) Back pressure within the drainage pipes may force sewer gases through the liquid trap seal and into the building .

3) Low pressure in the drains may cause siphoning in the traps. This can occur in plumbing fixtures located farther from a vent pipe than is permitted by the code.

4) Plumbing fixtures drain slowly.

In order to provide efficient ventilation to the drainage system, it is necessary to use individual or continuous vents. However, plumbing codes permit the use of circuit and loop vents, which do not provide an individual vent for every plumbing fixture. The following definitions will be used:

Vent stack: Is a vertical pipe installed to provide circulation to and from the drainage system.

Stack vent: A single main pipe is extended above the highest horizontal drain for a group of fixtures. Each fixture drain must connect independently to the stack. Figure 6.6 shows an example of stack venting.

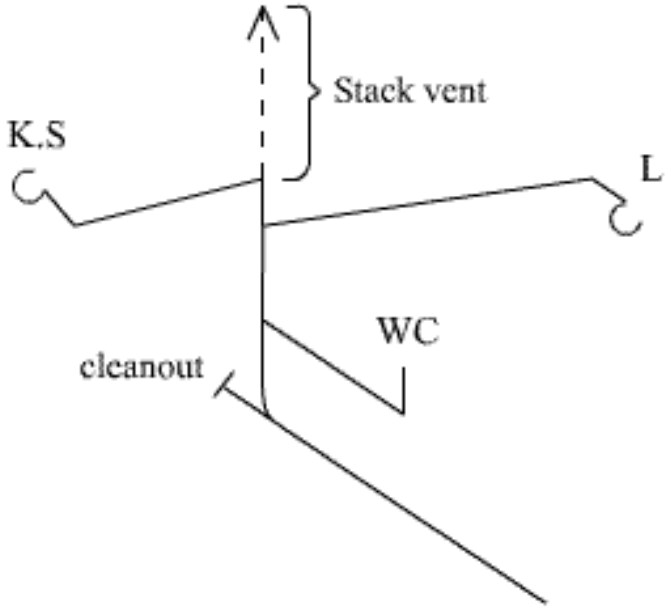

Figure 6.6. Stack Venting.

Soil stack: is the vertical section of pipe in a plumbing system that takes waste from water closets, with or without waste from other fixtures, to the building drain (Figure 6.7)

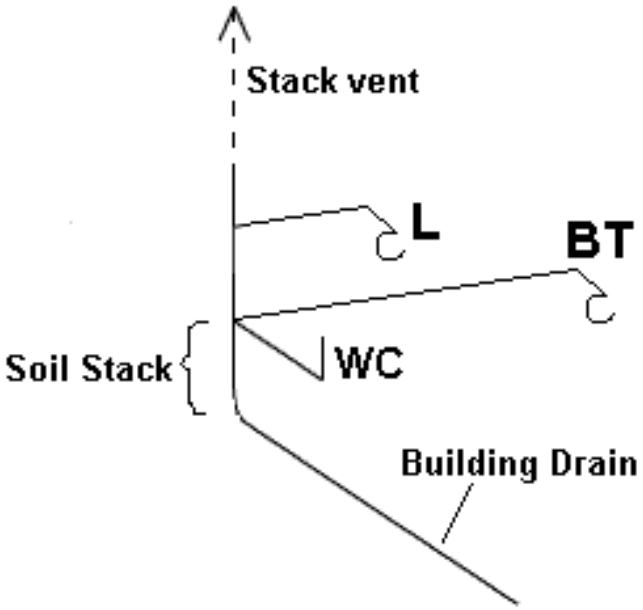

Figure 6.7. Soil Stack.

Common vent: is a vertical vent that serves two fixture drains that are installed at the same level. (Figure 6.8).

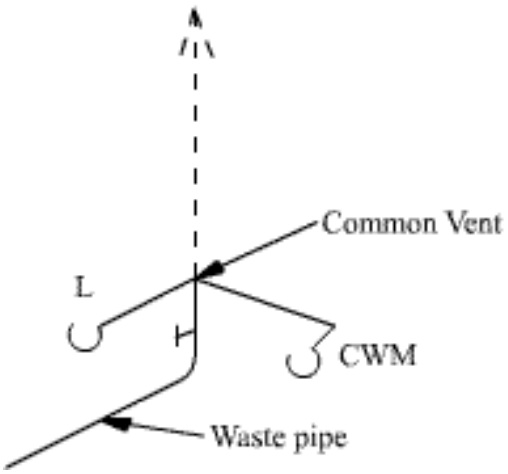

Figure 6.8. Common Vent.

Relief Vent: lets air circulate between the drainage system and the vent of a plumbing system (Figure 6.9).

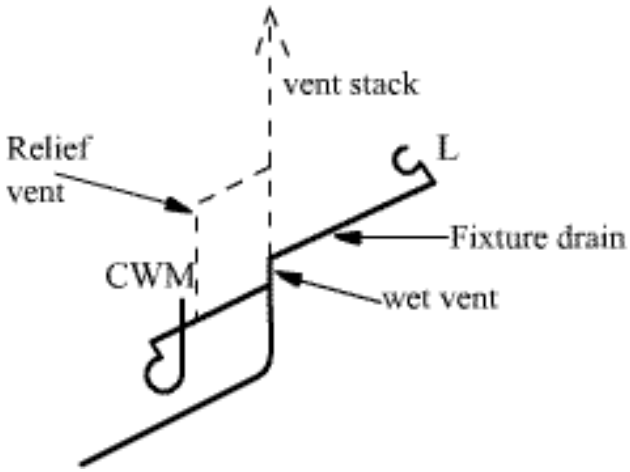

Figure 6.9. Relief Vent.

Circuit Vent: serves more than two fixtures and extends from the front of the last fixture connection of a horizontal branch to the vent stack. (Figure 6.10).

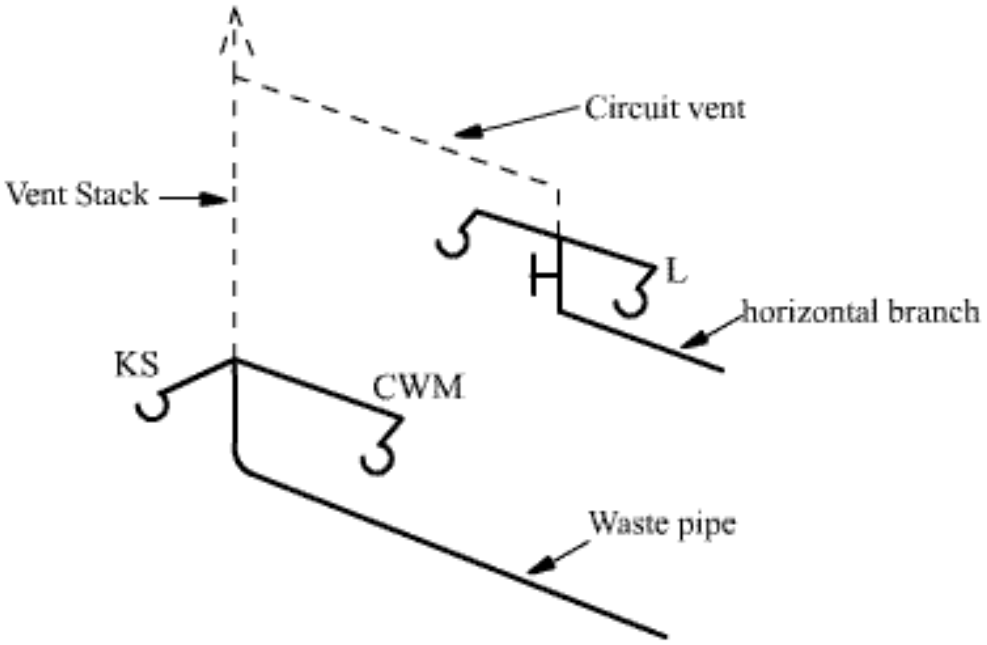

Figure 6.10. Circuit Vent.

The maximum distance of fixture trap from vent for a slope of ¼ inches per foot, is given in Table 6.5 as per the Standard Plumbing Code.

Table 6.5. Distance of Fixture Trap from Vent.

Size of Fixture Drain (inches)	Size of Trap (inches)	Distance (feet)
1 1/4	1 1/4	3 1/2
1 1/2	1 1/4	5
1 1/2	1 1/2	5
2	1 1/2	8
2	2	6

6.7. CLEANOUTS

A cleanout is an accessible opening in a drainage system used for removal of obstructions. They are an essential part of the drainage system.

The Standard Plumbing Code regulates the cleanouts location at:

1) Less than 100 ft apart in horizontal drains within buildings and building sewers.

2) Each change of direction of the building drain or horizontal waste or soil lines greater than 45º.

3) the base of each waste or soil stack.

4) The junction of the building drain and the building sewer.

Cleanout openings can not be utilized for the installation of new fixtures or floor drains and shall be installed to open to allow cleaning in the direction of the flow of the drainage pipe or at right angles thereto.

6.8 REVIEW QUESTIONS

6.1. What are the isometric drawings for?

6.2. What is the stack in a drainage system?

6.3. What is the principal function of a vent stack?

6.4. How many gallons of water flow per minute are equivalent to a fixture unit?

6.5. The minimum size of a building sewer is _____.

6.6. For determining the size of vent pipes, it is necessary to consider:

a)_____
b)_____
c)_____
d)_____

6.7. The smallest vent pipe that can serve any plumbing fixture is _____.

6.8. The maximum distance for a horizontal wet vent is _____.

6.9. Draw the isometric for a vent and drain system for a stack wet vent installation with one shower, one water closet and one lavatory.

6.10. Draw the isometric for an individually vented unit with one kitchen sink, one water closet, one lavatory and one bathtub.

6.11. Name three problems due to inadequate sizing and arrangement of vent pipes.

6.12. The maximum horizontal distance from the trap to the vent depends on the following factors:

6.13. The closer the trap to the vent on a minimum slope the better

a) True b) False

6.14. Draw a common vent for two lavatories.

6.15. Name three restrictions and limitations on the use of P. traps.

6.16. How do the traps protect human health?

6.17. Each fixture trap must have a water seal of not less than _____ inches or more than _____ inches.

6.18. All traps must be installed level in relation to their water seals

a) True b) False

6.19. For sinks, lavatories, bathtubs, showers and other fixtures, the vertical drop can't exceed _____ inches.

6.20. Under certain conditions, fixtures can be double trapped

a) True b) False

6.21. Trap outlets can be larger than the fixture drain to which it is connected

a) True b) False

6.22. It is prohibited by the code to connect more than one lavatory to one trap

a) True b) False