BUILDING SERVICES

SEMESTER - III
(ARCH. ASSTT.)

1. WATER SUPPLY

WATER DISTRIBUTION SYSTEM

The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity & pressure

Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage

Requirement of good distribution system

- Water quality should not get deteriorated in the distribution pipes.
- It should be capable of supplying water at all the intended places with sufficient pressure.
- It should be capable of supplying the requisite amount of water during fire fighting.
- The layout should be such that no consumer would be without water supply, during the repair of any section of the system.
- All the distribution pipes should be preferably laid one meter away or above the sever line.
- It should be fairly water tight as to keep losses due to leakage to the minimum.

LAYOUT DISTRIBUTION NETWORK

- The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads.
- There are general, four different types of pipe networks; any one of which either single or in combinations, can be used for a particular place.

1.2 System of water supply:

1. Continuous

2. Intermittent

Advantages and Disadvantages

CONTINUOUS SYSTEM OF WATER SUPPLY :

Continuous system of water supply 24x7 is achieved when water is delivered continuously to every consumer of the service 24 hours a day, every day of the year, through a transmission

and distribution system. More wastage of that is continuously full and under positive pressure. More wastage of water due to lack of civic sense.

INTERMITTENT SYSTEM OF WATER SUPPLY :

Intermittent water supply is a piped water supply service delivering water to users for less than 24 hours in one day, and is used when the available supply and/or the hydraulic capacities of the water supply system are too weak.

Advantages and disadvantages of continuous system of water supply :

Advantages:

- Reduces pipe works and cost of same as pipes to and from tank for cold water are omitted.
- Potable good quality drinking water is available at all taps.
- Energy is saved as pumps are not required to pump water to cistern/tanks.
- In this system water is not stagnant in pipe at any instant & hence fresh water is always available.
- Lesser pipe sizes are required.
- Fire hazards can be met within time.

Disadvantages :

- If there are some minor leakages etc in the system, great volume of water is wasted because of long duration of flow.
- More water is required at the source which is difficult in tropical countries like India, which get rains only during a particular season.

Advantages and disadvantages of Intermittent system of water supply :

Advantages:

- For older distribution systems having weaker joints and more leakage, restrained supply hours can limit leakage
- Reduced pressure also helps lowering leakage
- Overall scarcity may sometimes be managed by interrupting the water supply and equally balancing the resources (controversial)
- Time is available for repair and maintenance out of supply hours

Disadvantages :

- Systems do not operate as designed: components are underused, others are overexploited and damaged
- Inconvenience to consumers, mostly the poor (often, one person per household is devoted to storing the water at supply times)
- Pipelines are subjected to vacuum condition after supply hours, which can cause groundwater infiltration into the pipelines with contamination of the supply or pipes deformation

- Frequent contamination requires household-level water treatment, as well as higher doses of residual chlorine by the supplier
- Consumers need to store water between supplies and tend to throw away remnant store. This causes water wastage and storage costs

1.3 METHODS OF STORAGE WATER DISTRIBUTION

For efficient distribution system adequate water pressure required at various points.

Depending upon the level of source, topography of the area and other local conditions, the water may be forced into distribution system by following ways –

- Gravity System
- Pumping System
- Combined gravity and pumping system

GRAVITY SYSTEM-

- Suitable when source of supply is at sufficient height.
- Most reliable and economical distribution system.
- The water head available at the consumer is just minimum required.
- The remaining head is consumed in the frictional and other losses.

PUMPING SYSTEM-

- Treated water is directly supplied into the distribution main out storing.
- Also called pumping without storage system.
- High lifts pumps are required.
- If power supply fails, complete stoppage of water supply.
- The method is not generally used.

COMBINED GRAVITY and PUMPING SYSTEM

- Most common system
- Treated water is pumped and stored in an elevated distribution reservoir.
- Then supplies to consumer by action of gravity.

- The excess water during low demand periods get stored in reservoir and get supplied during high demand period.
- Economical, efficient and reliable system.

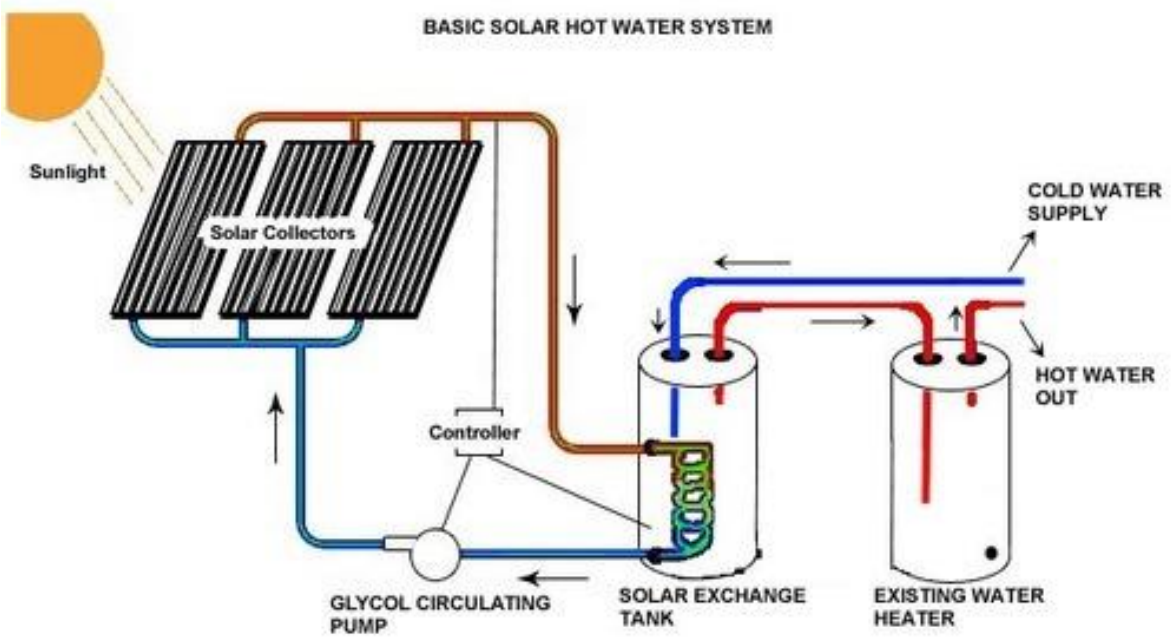
1.4 Hot water supply for buildings including solar water heating.

Hot water supply systems :

Hot water supply systems consist of heat sources, water treatment apparatus, water heaters, pipelines to transport the water, and devices to regulate and control the water's temperature. The heat is transmitted to consumers through heating system pipelines.

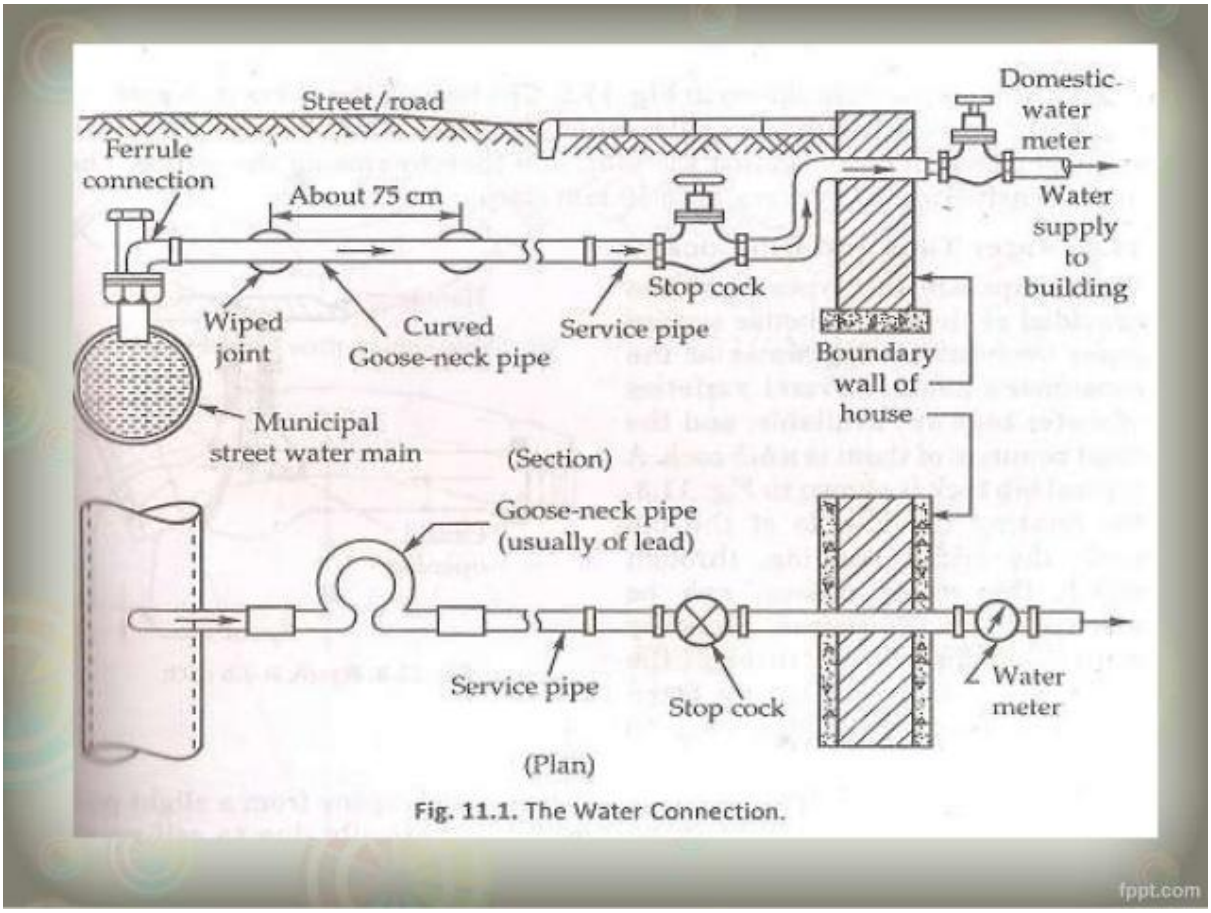
Solar water heating:

Solar water heating (SWH) is the conversion of sunlight into heat for water heating using a solar thermal collector. A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive (convection-driven).



1.5 Service connections, types and sizes of pipes, water supply fixture and installations

Service connections means any utility facility installed overhead or underground between a distribution main, pipelines, or other sources of supply and the premises of the individual customer.



TYPES OF PIPES

PVC PIPES-

PVC stand for Polyvinyl Chloride. This type of pipe has a wide variety of plumbing uses from drainage pipe to water mains. It is most commonly used for irrigation piping, home, and building supply piping. PVC is also very common in pool and spa systems. PVC is often white but it can also come in a wide variety of colours.

CPVC PIPES-

CPVC stands for Chlorinated Polyvinyl Chloride. This type of pipe can stand temperatures up to about 180 degrees (this depends on the schedule) or so and can be used for hot and cold water inside of a house or mobile home. CPVC is the same outside diameter as copper and PEX so push fit fitting that fit PEX and copper, such as Shark Bite, will fit the CPVC piping. Like with PVC you should use primer and a glue when making a CPVC joint

PEX PIPES-

PEX stands for Cross-linked polyethylene but, PEX is much easier to remember and say. PEX is commonly used for hot and cold water in homes and as hedonic heating due to its resistance to hot and cold temperatures. PEX is widely used now for its competitive pricing, ease of use, and the long rolls of piping that it can come in.

Copper Pipe –

This type of pipe is mostly used for hot and cold water distribution as well as being regularly used in HVAC systems for refrigerant lines. Copper piping works in both underground and aboveground applications, but copper can be affected by some soils and should be sleeved if used underground. Due to the price of copper and longer labor needed to install many builders are switching to alternative water distributions piping like PEX. Copper comes in different thicknesses which are labeled M, L, and K. M is the thinnest grade of copper. Copper is connected by soldering pipe into the fittings.

SIZES OF WATER SUPPLY PIPES:

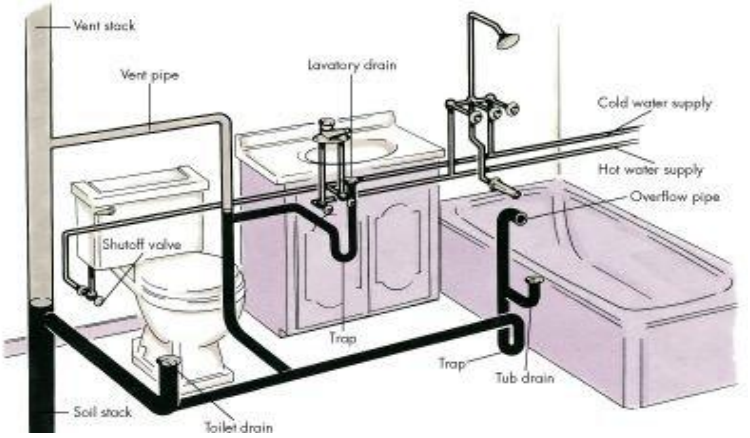
In most cases, the main pipeline from the street to your home is either 3/4 or 1 inch in diameter, supply branches use 3/4-inch-diameter pipe, and pipes for individual components are 1/2 inch. Remember that water pressure decreases by a half-pound per square inch for every foot pipes extend above your water supply.

MINIMUM SIZES OF FIXTURE WATER SUPPLY PIPES

FIXTURE	MINIMUM PIPE SIZE (inch)
Bathtubs[a] (60″ × 32″ and smaller)	1/2
Bathtubs[a] (larger than 60″ × 32″)	1/2
Bidet	3/8
Combination sink and tray	1/2
Dishwasher, domestic[a]	1/2
Drinking fountain	3/8
Hose bibbs	1/2
Kitchen sink[a]	1/2
Laundry, 1, 2 or 3 compartments[a]	1/2
Lavatory	3/8
Shower, single head[a]	1/2
Sinks, flushing rim	3/4

Water supply fixture and installations:

Plumbing fittings and fixtures are the homeowner's tools for using water in the home. These are the valves, faucets, toilets, shower heads, drain stoppers and basins of your plumbing system. Fittings and fixture can wear out so they are usually made to be replaceable.

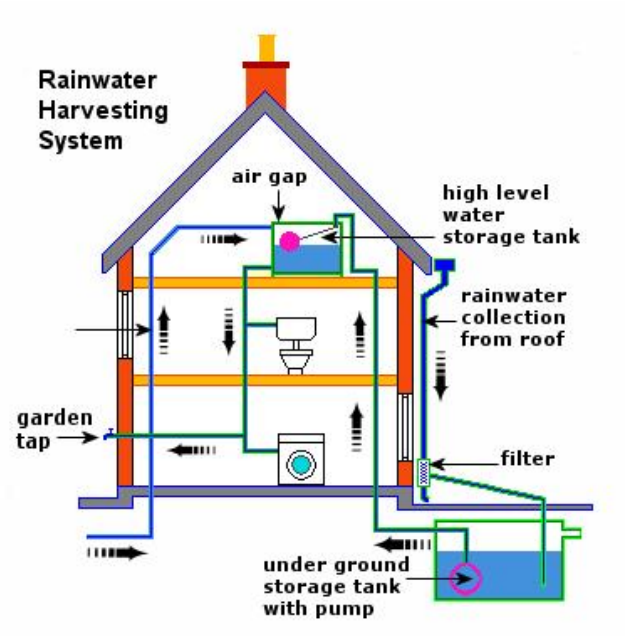


1.6 CONCEPT OF RAIN WATER HARVESTING

The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally water is collected from the roofs of buildings and stored in rainwater tanks.

Importance of rainwater harvesting

The importance of rainwater harvesting lies in the fact that it can be stored for future use. Just as it can be used directly so also the stored water can be utilized to revitalize the ground level water and improve its quality. ... Harvesting rainwater checks surface run off of water and reduces soil erosion.



2. DRAINAGE:

Principles of Drainage system: House Drainage should be preferable laid by side of the building to facilitate easy repair and better maintenance. The sewage or sullage should flow under the force of gravity. *The house sewer should always be straight.

Combined sewerage carries both surface run-off and wastewater, while separate sewerage carries surface run-off and wastewater separately. ... By replacing the combined sewer systems with separate sewer systems, sewage and surface run-off can be managed in two separate systems.

In a separate system, the flow of water will look very much like the illustration above. ... Rain water is carried away into stormwater drains that eventually lead the water into a nearby river.

Drainage is the natural or artificial removal of a surface's water and sub-surface water from an area. The internal drainage of most agricultural soils is good enough to prevent severe water logging (anaerobic conditions th, but many soils need artificial drainage to improve production or to manage water supplies

Subsoil water

This is water collected from the earth to lower the subsoil's water table.

Surface water

This is collected from surfaces such as roofs and paved areas.

Foul and soil water

This is effluent contaminated by domestic or trade waste. Foul (or waste) water relates to effluent from sinks and basins which does not contain excreta. Soil water relates to effluent from water closets, toilets and urinals which does.

Subsoil and surface water are considered to be clean and can be discharged into an approved watercourse (e.g. river or lake), or soakaway without treatment. Permission is required from the relevant authority or owner before discharging. Foul and soil water must be conveyed by sewer to a treatment plant before being discharged into a watercourse.

Subsoil drainage :

Subsoil drainage can be used to improve ground stability, to lower the moisture content of a site, to enhance horticultural properties for landscaping and so on. It can be required to drain the whole site or to protect a particular part.

Surface water drainage

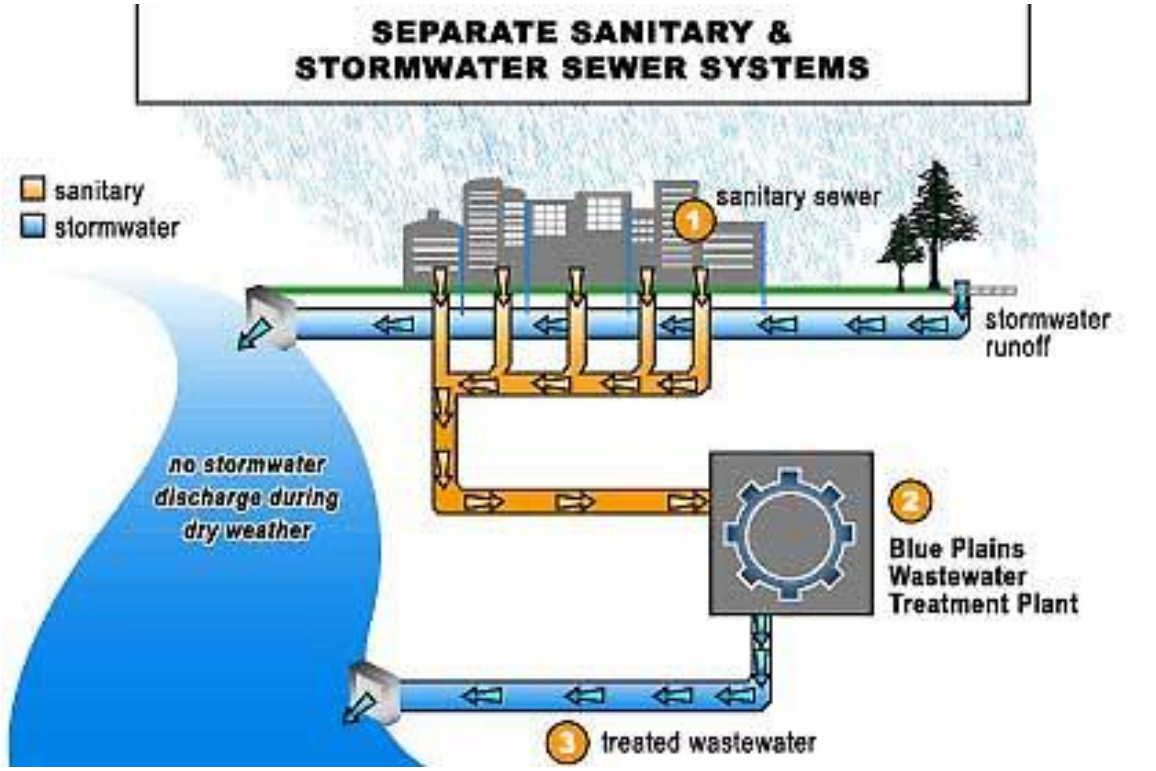
Roofing

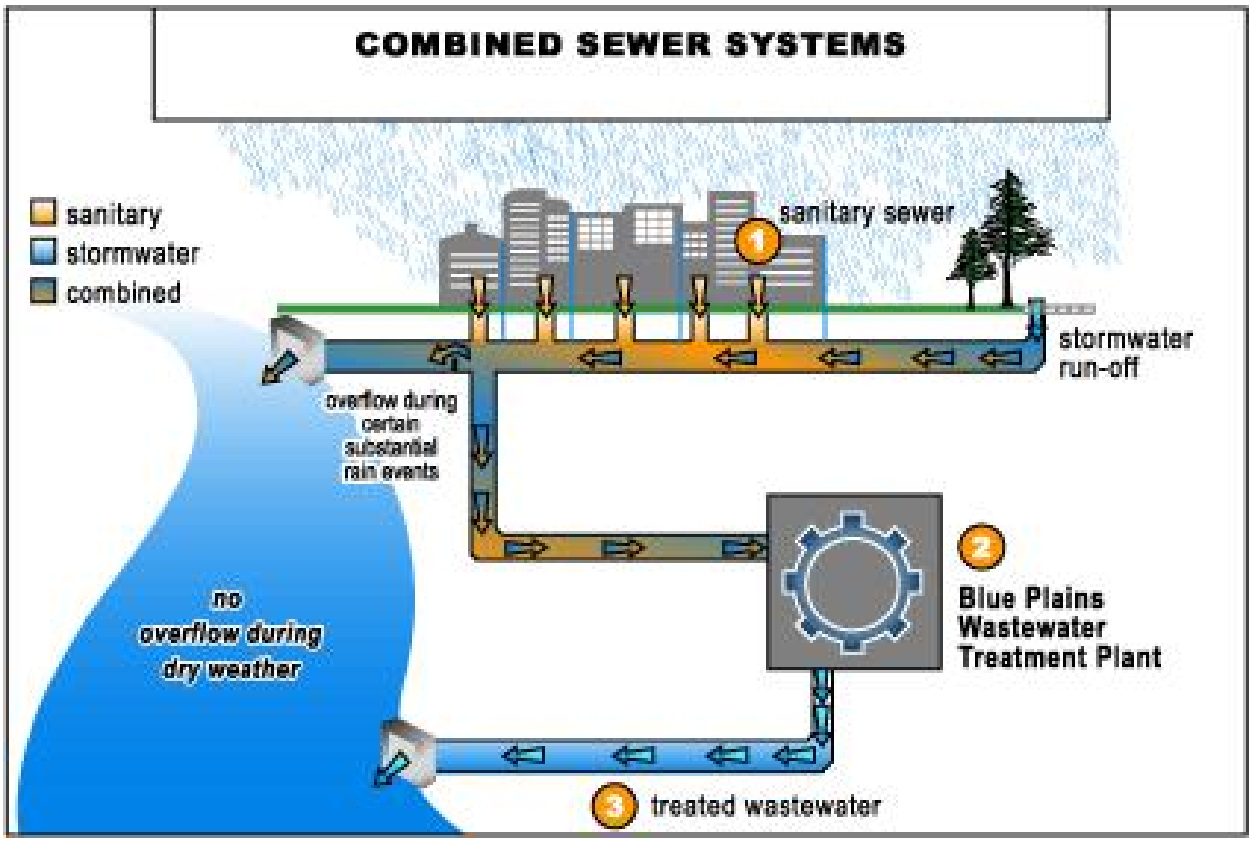
It is a requirement of Building Regulation's Approved Document H that adequate provision is made for rainwater to be carried from the roof of buildings. To achieve this, roofs must be designed with a suitable fall towards either a surface water collection channel or gutter that conveys surface water to vertical rainwater pipes, which in turn connect the discharge to the drainage system.

COMBINED AND SEPARATE SYSTEMS-

SEPERATE SYSTEM VS COMBINED SYSTEM

1) In seperate system rainwater is kept seperate form sewage while in combined system rain and sewage passes from a single set of pipe.
2) The storm/natural water is not polluted in seperate system while it gets polluted in combined system.
3) The storm water can be discharged into river without treatment while it should be treated before mixing into the river.
4) The sewers are small in size while sewers are large in diameters in combined system.
5) The cleaning of sewers is hard in separete system due to small size while it is easy to clean the sewares due to large diameters.
6) The maintainance cost is high in seperate system while it is reasonable in combined system.
7) Loads on treatment untis becomes less in seperate system while the load on treatment units are high in combined system.
8) Seperate system requires two sets of sewers ends which might be costly while in combined system one set of sewers is required which is economical.
9) Self cleaning velocity is not easily achieved in seperate system while it is achieved easily in combined system.
10) Over flow problem in seperate system is reduced while in monsoon season the combined sewers may overflow and puts danger to the public health.
11) Seperate system is economical if pumping is required to lift the sewage while it is uneconomical if pumping is required to lift the sewage.


SEPARATE SANITARY &
STORMWATER SEWER SYSTEMS
sanitary
stormwater
sanitary sewer
1
stormwater
runoff
no stormwater
discharge during
dry weather
2
Blue Plains
Wastewater
Treatment Plant
3
treated wastewater


COMBINED SEWER SYSTEMS
sanitary
stormwater
combined
sanitary sewer
1
stormwater
run-off
overflow during
certain
substantial
rain events
no
overflow during
dry weather
2
Blue Plains
Wastewater
Treatment Plant
3
treated wastewater

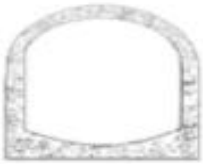
SHAPES AND SIZES OF DRAINS AND SEWERS,STORM WATER OVER FLOW CHAMBER

- The sewage should flow under gravity with 0.5 to 0.8 full at designed discharge, i.e. at the maximum estimated discharge.
- The sewage is conveyed to the point usually located at low-lying area, where the treatment plant is located.
- Treatment plant should be designed taking into consideration the quality of raw sewage expected and to meet the discharge standards.

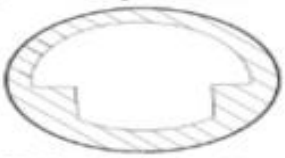
(e) Semi-elliptical section

(f) Rectangular Sewer

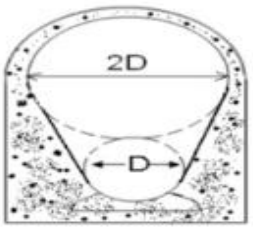
(g) U-shaped section



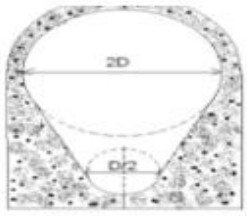
(h) Semi-circular Section



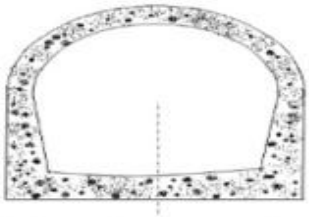
(i) Basket-Handle Section



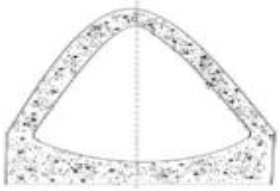
(a) Standard Egg Shaped Sewer



(b) New/ Modified Egg shaped Sewer



(c) Horse shoe sewer section



(d) Parabolic section

- Semi-circular shaped sewer
- Basket handled shape sewer
- Standard egg-shaped sewers, also called as ovoid shaped sewer, and new or modified egg-shaped sewers are used in combined sewers. These sewers can generate self cleansing velocity during dry weather flow. Horse shoe shaped sewers and semi-circular sections are used for large sewers with heavy discharge such as trunk and outfall sewers. Rectangular section is used for conveying storm water. U-shaped section is used for larger sewers and especially in open cuts. Other sections of the sewers have become absolute due to difficulty in construction on site and non availability of these shapes readily in market.

Shapes of Sewer Pipes

- Sewers are generally circular pipes laid below ground level, slopping continuously towards the outfall. These are designed to flow under gravity. Shapes other than circular are also used.
- Other Shapes used for sewers are :
- Standard Egg-shaped sewer
- New egg-shaped sewer
- Horse shoe shaped sewer
- Parabolic shaped sewer
- Semi-elliptical section
- Rectangular shape section
- U-shaped section

- **Plastic sewers (PVC pipes)**
- Plastic is recent material used for sewer pipes. These are used for internal drainage works in house. These are available in sizes 75 to 315 mm external diameter and used in drainage works. They offer smooth internal surface. The additional advantages they offer are resistant to corrosion, light weight of pipe, economical in laying, jointing and maintenance, the pipe is tough and rigid, and ease in fabrication and transport of these pipes.
- **High Density Polyethylene (HDPE) Pipes**
- Use of these pipes for sewers is recent development. They are not brittle like AC pipes and other pipes and hence hard fall during loading, unloading and handling do not cause any damage to the pipes. They can be joined by welding or can be jointed with detachable joints up to 630 mm diameter. These are commonly used for conveyance of industrial wastewater. They offer all the advantages offered by PVC pipes.

Steel Pipes

- These are used under the situations such as pressure main sewers, under water crossing, bridge crossing, necessary connections for pumping stations, laying pipes over self supporting spans, railway crossings, etc. They can withstand internal pressure, impact load and vibrations much better than CI pipes.
- They are more ductile and can withstand water hammer pressure better. These pipes cannot withstand high external load and these pipes may collapse when negative pressure is developed in pipes. They are susceptible to corrosion and are not generally used for partially flowing sewers. They are protected internally and externally against the action of corrosion.

Cast Iron Sewers

- These pipes are stronger and capable to withstand greater tensile, compressive, as well as bending stresses. However, these are costly. Cast iron pipes are used for outfall sewers, rising mains of pumping stations, and inverted siphons, where pipes are running under pressure. These are also suitable for sewers under heavy traffic load, such as sewers below railways and highways. They are used for carried over piers in case of low lying areas. They form 100% leak proof sewer line to avoid ground water contamination. They are less resistant to corrosion; hence, generally lined from inside with cement concrete, coal tar paint, epoxy, etc. These are joined together by bell and spigot joint.

Brick Sewers

- This material is used for construction of large size combined sewer or particularly for storm water drains. The pipes are plastered from outside to avoid entry of tree roots and ground water through brick joints. These are lined from inside with stone ware or ceramic block to make them smooth and hydraulically efficient. Lining also make the pipe resistant to corrosion.

- ***Disadvantages***
- Heavy, bulky and brittle and hence, difficult to transport.
- These pipes cannot be used as pressure pipes, because they are weak in tension.
- These require large number of joints as the individual pipe length is small.

- ***Advantages*** of concrete pipes
- Strong in tension as well as compression.
- Resistant to erosion and abrasion.
- They can be made of any desired strength.
- Easily moulded, and can be in situ or precast pipes.
- Economical for medium and large sizes.
- These pipes are available in wide range of size and the trench can be opened and backfilled rapidly during maintenance of sewers.

- These pipes can be easily assembled without skilled labor with the help of special coupling, called 'Ring Tie Coupling' or Simplex joint.
- The pipe and joints are resistant to corrosion and the joints are flexible to permit 12° deflection for curved laying.
- These pipes are used for vertical transport of water. For example, transport of rainwater from roofs in multistoried buildings, for transport of sewage to grounds, and for transport of less foul sullage i.e., wastewater from kitchen and bathroom.

Storm Water Drains

- Storm water drains are provided with nominal freeboard, above their designed full supply line because the overflow from storm water drains is not much harmful. Minimum of 0.3 m free board is generally provided in storm water drains.

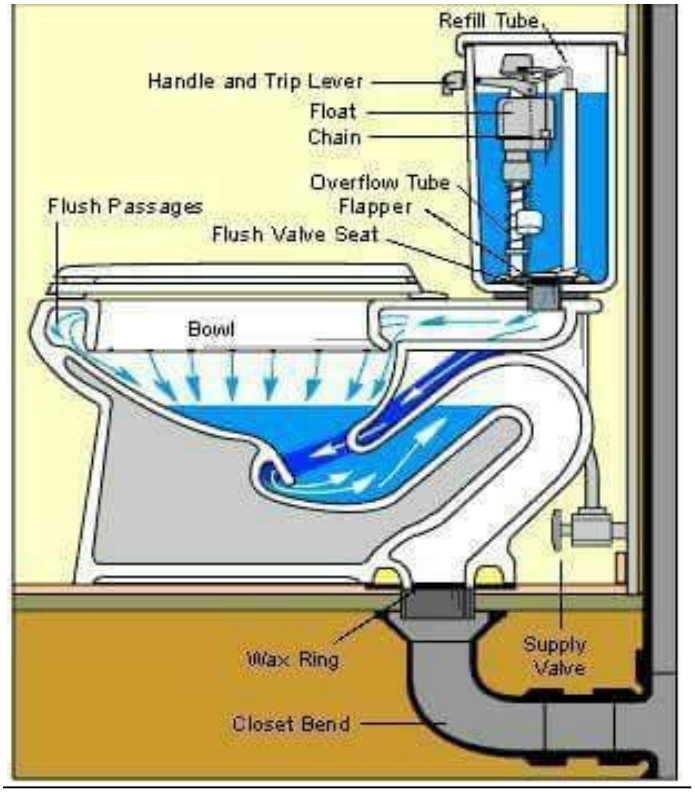
ANTI SIPHONAGE PIPE

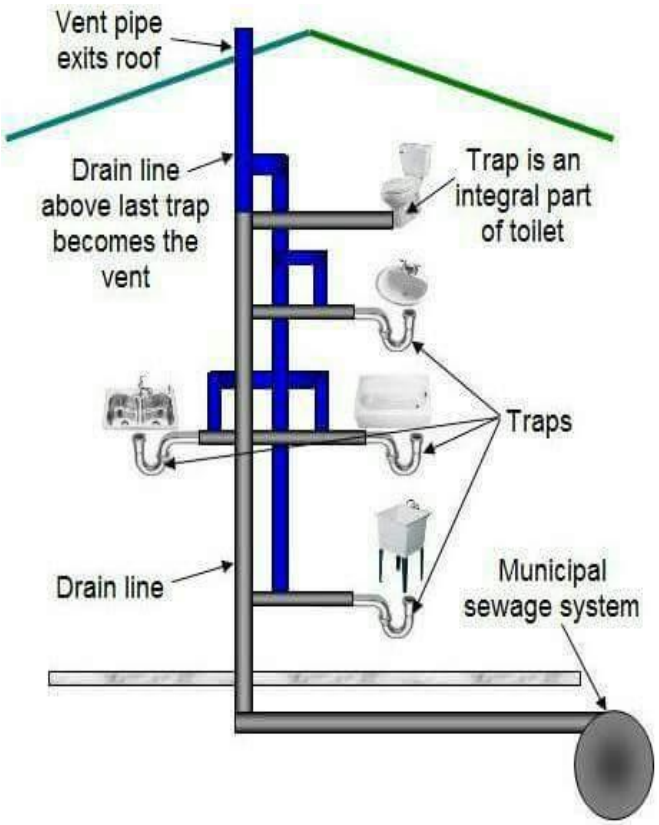
Rain A vent is open at top and bottom, to facilitate exit of foul gases. It is carried at least one meter higher than the roof level. water pipe: it is a pipe which carries only the rain water. Anti-siphonage pipe: it is pipe which is installed in the house drainage to preserve the water seal of traps

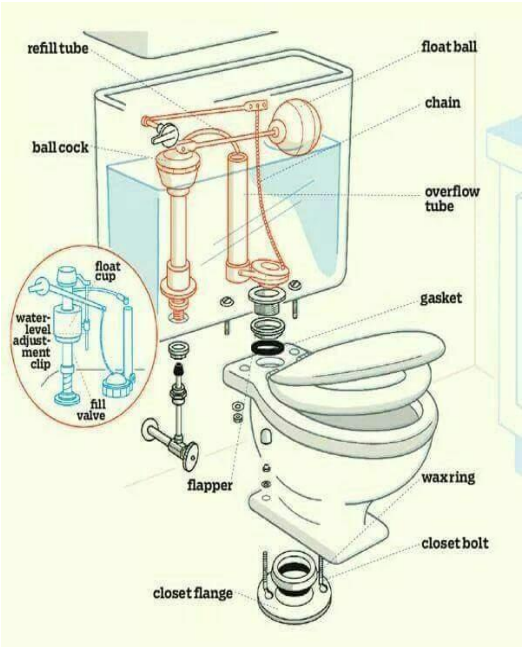
System	Types of Pipes	Advantages	Disadvantages
Dual Pipe	1. Waste single stack pipe 2. Soil single stack pipe	1. More effective drainage	1.Require two types of pipe 2. Complicated installation work
Single Pipe	1. Waste and soil single stack pipe 2. Vent pipe	1. Require only one main pipe 2. Easier to install	1. Vent pipe installation is complicated 2. Require more pipelines for vent pipe
Single Stack	1. Waste and soil single stack pipe	1. Require only one single stack pipe	1. Ventilation is less efficient

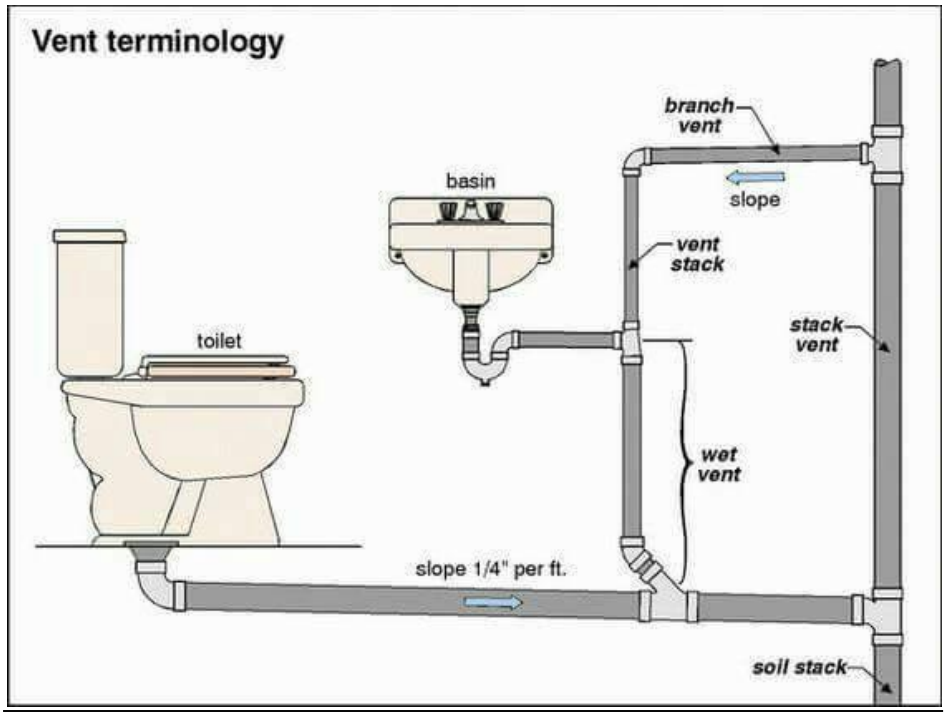
BUILDING SANITARY DRAINAGE SYSTEMS

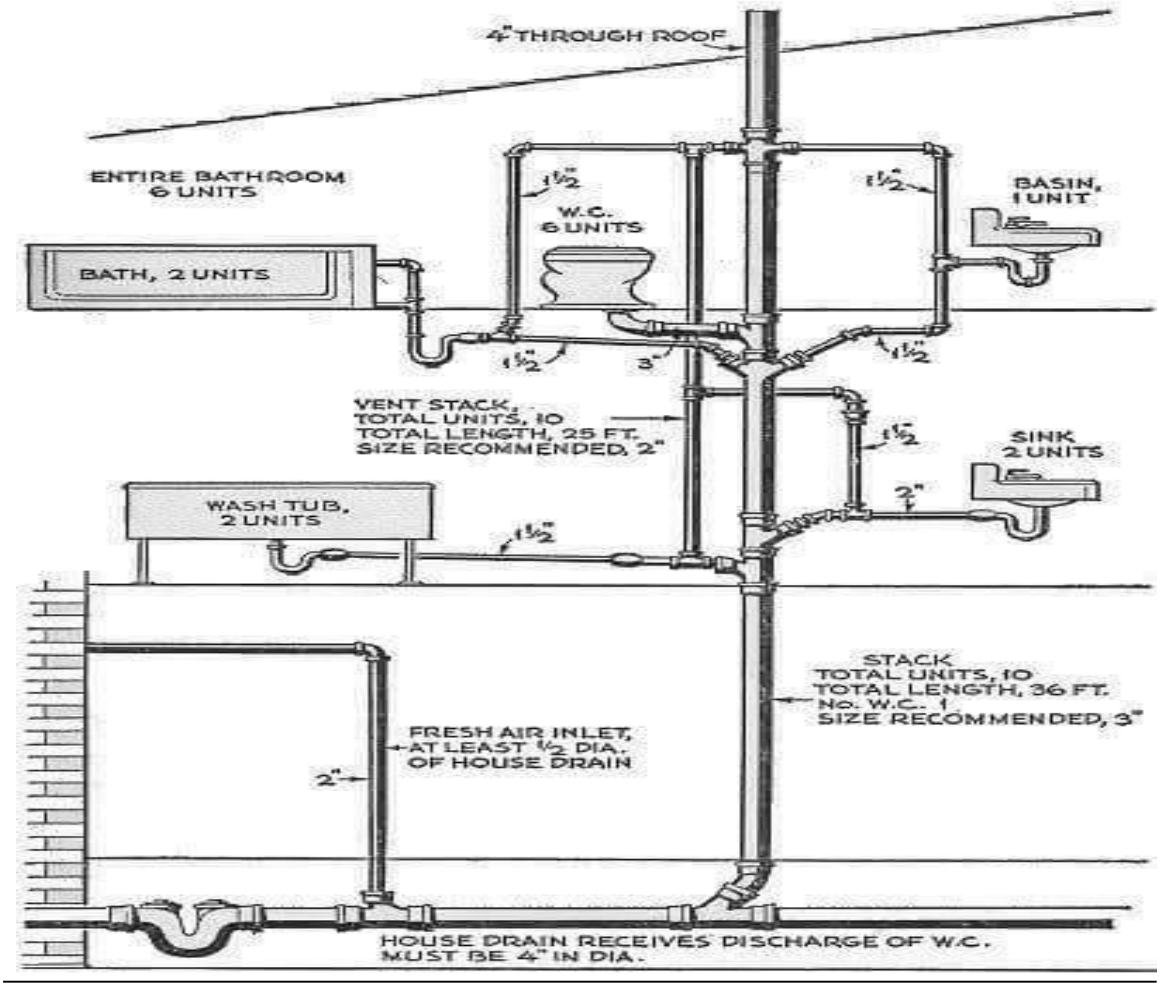
- **TWO-PIPE SYSTEM -** INDPENDENT STACKS FOR SOIL AND WASTE WATER WITH ASP.
- **ONE-PIPE SYSTEM-** COMBINED STACK FOR SOIL AND WASTE WATER WITH ANTI SIPHONAGE PIPE.
- **SINGLE STACK SYSTEM-** COMBINED STACK FOR SOIL AND WASTE WATER WITH OUT ANTI SIPHONAGE PIPE.
- **SINGLE STACK(PARTIALLY VENTILATED) SYSTEM-** VIA MEDIA BETWEEN ONE PIPE AND SINGLE STACK. ONLY SOIL TRAPS ARE VENTILATED.

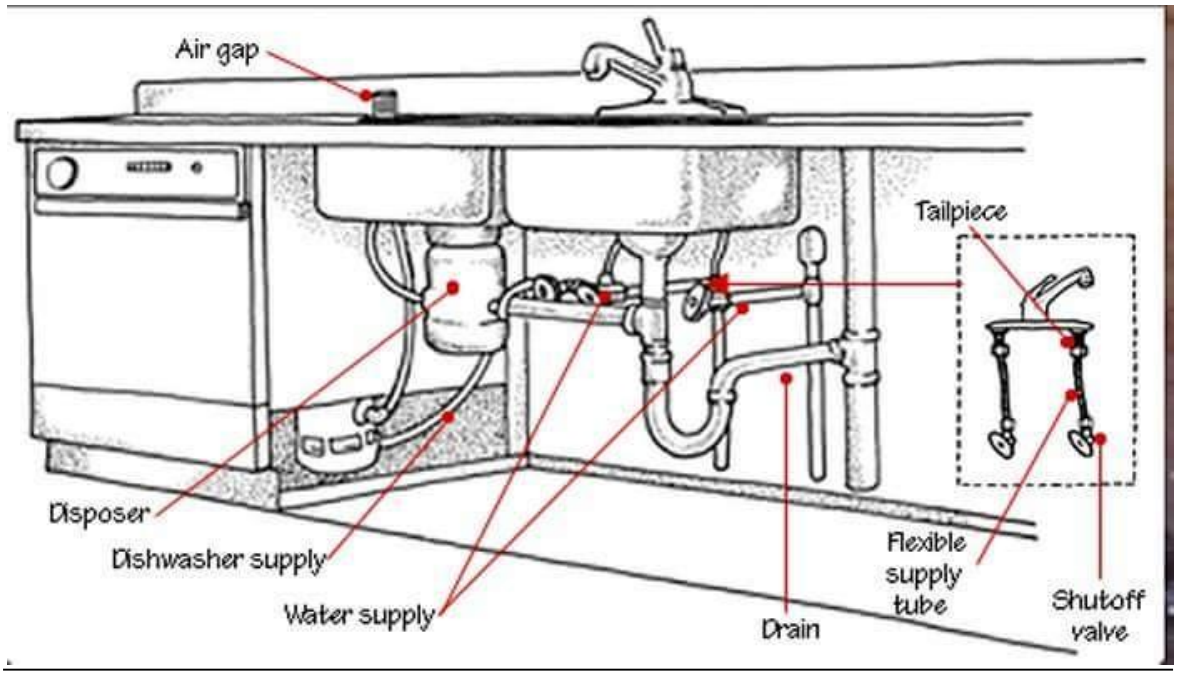


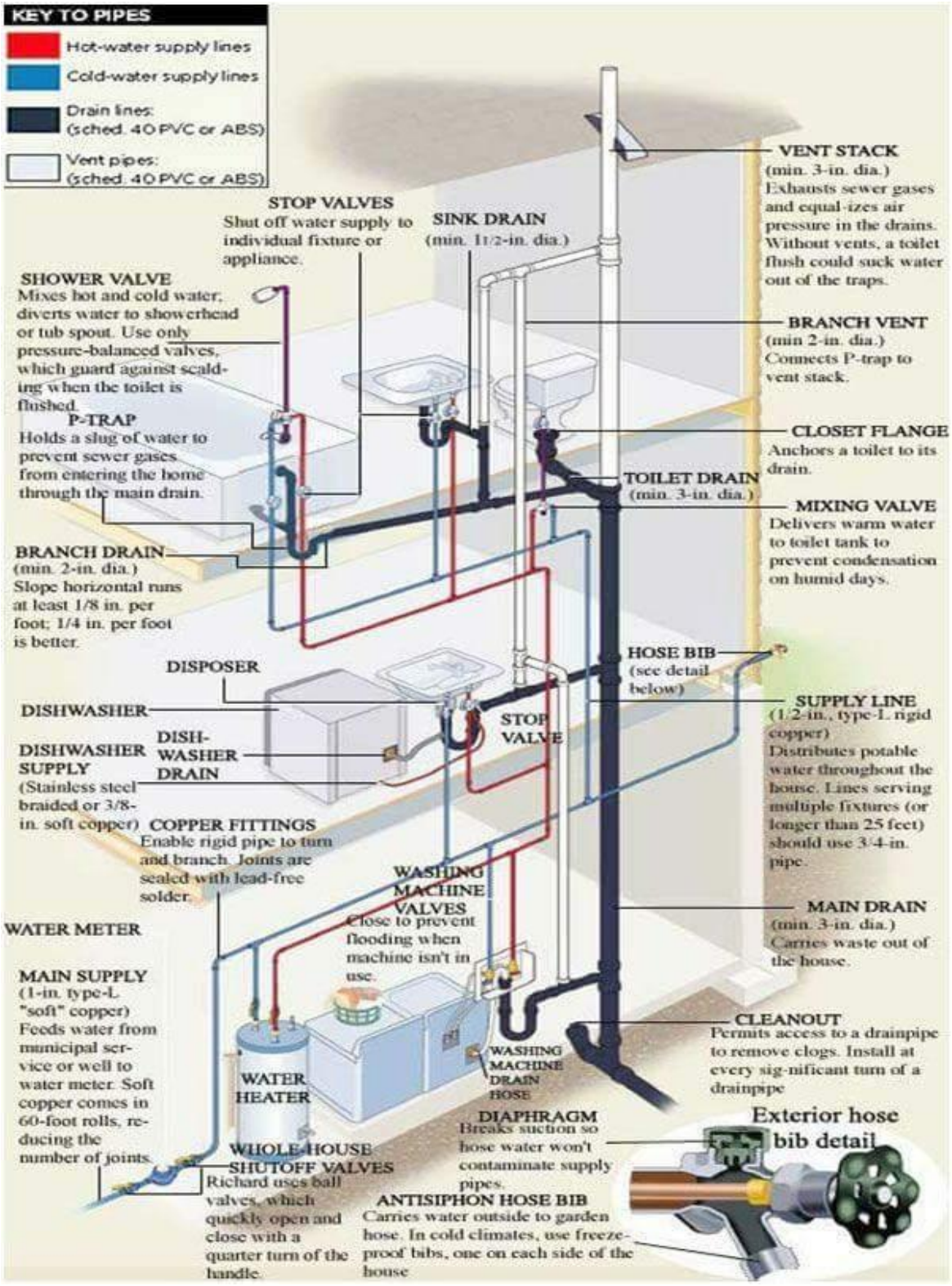

Vent pipe exits roof
Drain line above last trap becomes the vent
Trap is an integral part of toilet
Traps
Drain line
Municipal sewage system


refill tube
float ball
chain
ball cock
overflow tube
float cup
water-level adjust-ment clip
fill valve
gasket
flapper
wax ring
closet bolt
closet flange


Vent terminology
branch vent
basin
slope
vent stack
stack vent
toilet
wet vent
slope 1/4" per ft.
soil stack


4" THROUGH ROOF
ENTIRE BATHROOM
6 UNITS
1½"
W.C.
6 UNITS
1½"
BASIN,
1 UNIT
BATH, 2 UNITS
1½"
3"
1½"
VENT STACK,
TOTAL UNITS, 10
TOTAL LENGTH, 25 FT.
SIZE RECOMMENDED, 2"
1½"
SINK
2 UNITS
2"
WASH TUB,
2 UNITS
1½"
STACK
TOTAL UNITS, 10
TOTAL LENGTH, 36 FT.
No. W.C. 1
SIZE RECOMMENDED, 3"
FRESH AIR INLET,
AT LEAST ½ DIA.
OF HOUSE DRAIN
2"
HOUSE DRAIN RECEIVES DISCHARGE OF W.C.
MUST BE 4" IN DIA.


Air gap
Tailpiece
Disposer
Dishwasher supply
Water supply
Drain
Flexible
supply
tube
Shutoff
valve


KEY TO PIPES
Hot-water supply lines
Cold-water supply lines
Drain lines: (sched. 40 PVC or ABS)
Vent pipes: (sched. 40 PVC or ABS)
STOP VALVES
Shut off water supply to individual fixture or appliance.
SINK DRAIN
(min. 1 1/2-in. dia.)
VENT STACK
(min. 3-in. dia.)
Exhausts sewer gases and equal-izes air pressure in the drains. Without vents, a toilet flush could suck water out of the traps.
SHOWER VALVE
Mixes hot and cold water; diverts water to showerhead or tub spout. Use only pressure-balanced valves, which guard against scald-ing when the toilet is flushed.
BRANCH VENT
(min 2-in. dia.)
Connects P-trap to vent stack.
P-TRAP
Holds a slug of water to prevent sewer gases from entering the home through the main drain.
CLOSET FLANGE
Anchors a toilet to its drain.
TOILET DRAIN
(min. 3-in. dia.)
MIXING VALVE
Delivers warm water to toilet tank to prevent condensation on humid days.
BRANCH DRAIN
(min. 2-in. dia.)
Slope horizontal runs at least 1/8 in. per foot; 1/4 in. per foot is better.
DISPOSER
HOSE BIB
(see detail below)
DISHWASHER
STOP VALVE
SUPPLY LINE
(1/2-in., type-L rigid copper)
Distributes potable water throughout the house. Lines serving multiple fixtures (or longer than 25 feet) should use 3/4-in. pipe.
DISH-WASHER DRAIN
DISHWASHER SUPPLY
(Stainless steel braided or 3/8-in. soft copper)
COPPER FITTINGS
Enable rigid pipe to turn and branch. Joints are sealed with lead-free solder.
WASHING MACHINE VALVES
Close to prevent flooding when machine isn't in use.
MAIN DRAIN
(min. 3-in. dia.)
Carries waste out of the house.
WATER METER
MAIN SUPPLY
(1-in. type-L "soft" copper)
Feeds water from municipal ser-vice or well to water meter. Soft copper comes in 60-foot rolls, re-ducing the number of joints.
CLEANOUT
Permits access to a drainpipe to remove clogs. Install at every sig-nificant turn of a drainpipe
WASHING MACHINE DRAIN HOSE
WATER HEATER
DIAPHRAGM
Breaks suction so hose water won't contaminate supply pipes.
Exterior hose bib detail
WHOLE-HOUSE SHUTOFF VALVES
Richard uses ball valves, which quickly open and close with a quarter turn of the handle.
ANTISIPHON HOSE BIB
Carries water outside to garden hose. In cold climates, use freeze-proof bibs, one on each side of the house

3. Sound Insulation

Sound may be defined as vibrations or pressure changes in an 'elastic' medium which are capable of being detected by the ear.
Elastic means that the particles of the medium return to their original position after disturbance by the vibrational wave.
These vibrations travel through solids, liquids and gases but the normal process of hearing depends on their ultimate transmission through air so that the ear drum is set in vibration and a sequence of events we call hearing begins.

Propagation of sound : Sound is a sequence of waves of pressure which propagates through compressible media such as air or water. (Sound can propagate through solids as well, but there are additional modes of propagation). During their propagation, waves can be reflected, refracted, or attentuated by the medium.

Acoustics in building: **Building acoustics** is the science of controlling noise in **buildings**. This includes the minimisation of noise transmission from one space to another and the control of the characteristics of sound within spaces themselves

Source of Sound.

Acoustical Defects:

Echoes: Echos mainly produced due to the reflection of **sound** waves (mainly from the surface of walls , roofs , ceilings etc.)
Reverberation: Reverberation means the prolonged reflection of **sound** from wall floor or roof of a hall.
Sound Foci: The spots of unusual loudness is called sound foci. ... Due to the high concentration of reflected sound at sound foci, there is deficiency of reflected sound rays at some other points. In this areas low sound intensity may result in unsatisfactory hearing for the audience called as dead spots .

Acoustical Material: Acoustical Material are used to block noise from transmitting from one area to another. These acoustical materials are typically made of flexible mass-loaded vinyl or other engineered materials. Acoustical materials are a variety of foams, fabrics, metals, etc. used to quiet workplaces, homes, automobiles, and so forth to increase the comfort and safety of their inhabitants by reducing noise generated both inside and outside of those spaces.

The origin of sound is usually the vibrations of a solid body such as a rotating machine causing vibrations in its associated parts.
A pump motor for example rotates inside a casing and this rotates the impeller also inside a casing.
These two rotating items run on bearings which transfer vibrations to the whole pump unit which in turn vibrates the pump mounting bracket(s).
If part of the rotating machine is out of balance or damaged it is quite likely that the noise will be increased as the intensity of vibration increases.

Sound waves can also be caused by air turbulence, by an explosive expansion of air or by a combination of vibration and air turbulence.

Reverberation Time

If sound in a room is reflected from several surfaces it will reach the receiver at different times and in the worst cases an echo is set up.

The reverberation time is a standard to indicate the time taken for a sound to decay by 60 decibels.

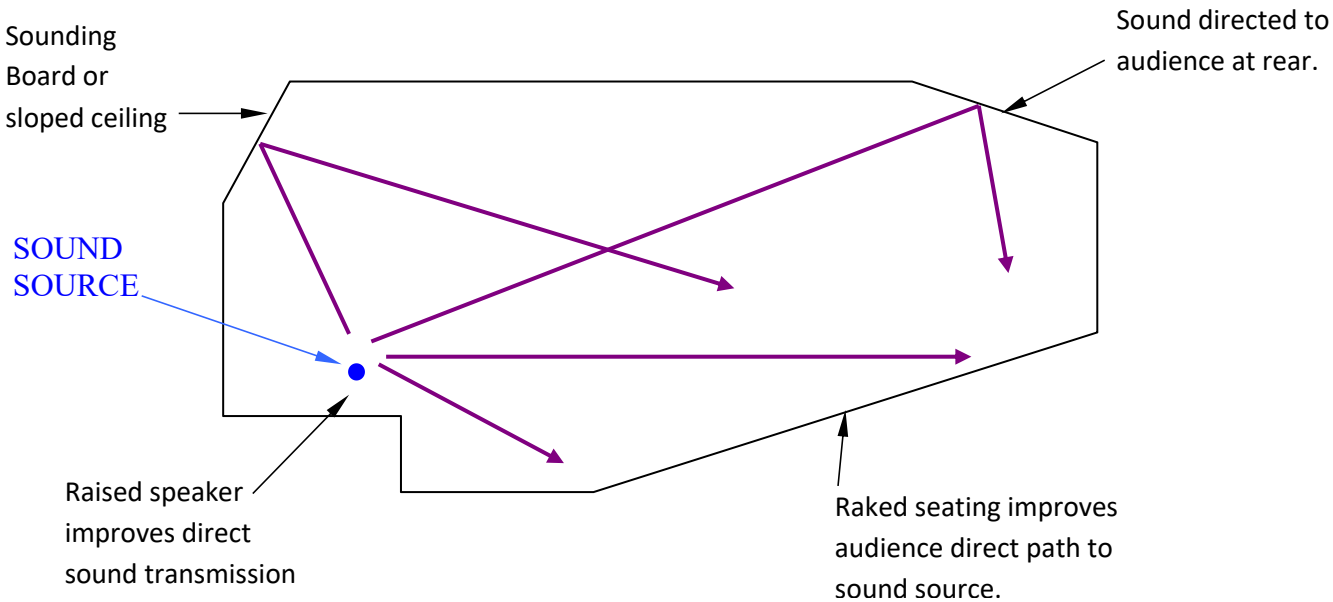
It is also the time taken for the sound intensity to die away to one millionth of its original intensity, the symbol is 't' and the units are in seconds.

The table below shows some typical reverberation times

Use	Small Rooms 750 m^3	Medium Rooms 750 –7500 m^3	Large Rooms Over 7500 m^3
Speech	0.75	0.75 - 1.00	1.00
Multi-purpose	1.00	1.00 - 1.25	1.00 - 2.00
Music	1.50	1.50 - 2.00	2.00 or more

Room Acoustics

In some areas such as lecture theatres, concert halls and conference rooms the acoustics are important.
The shape of an auditorium is significant since sound may be directly or indirectly transmitted to the audience. The diagram below shows an elevation of an auditorium with a shape to give improved room acoustics.



4. Lighting and Electrical Fittings

Electrical Power Systems in Buildings
CURRENT: The unit of current is the ampere (A).
1 ampere = 1 coulomb/second
Prefer to current as being either direct (dc) or alternating (ac).

SINGLE PHASE AND THREE PHASE SUPPLY Difference between single phase and three phase supply: –Three-phase current offers a steadier source of power.
Magnetic force which, causes motor rotation is strongest when current flow is at its peak in the cycle
Single-phase current peaks twice during one cycle, whereas, three-phase current peaks six times during one cycle.
A balanced three-phase, three-wire circuit with equal voltages uses 75% of the copper required for conductors

A three-phase system is usually more economical than an equivalent single-phase or two-phase system at the same voltage because it uses less conductor material to transmit electrical power.
The main advantage of 3 phase is that it is more efficient for running AC motors than one or two phase.
Properties of three phase supply.

Three-phase has properties that make it very desirable in electric power systems:
1) The phase currents tend to cancel out one another, summing to zero in the case of a linear balanced load. This makes it possible to eliminate or reduce the size of the neutral conductor; all the phase conductors carry the same current and so can be the same size, for a balanced load.
2) Power transfer into a linear balanced load is constant, which helps to reduce generator and motor vibrations.
3) Three-phase systems can produce a magnetic field that rotates in a specified direction,

INTRODUCTION TO PROTECTIVE DEVICES IN ELECTRICAL INSTALLATION

Advantage and disadvantages of different protective devices

1. Need for Earthing
2. Types of earthing
3. Electricity is the most common form of energy that is used by man in his premises .
4. It is beneficial to us as a source of lighting and power
5. Electricity could be dangerous through misuse and handling as it could cause harm to the consumer .
6. If the electricity passes through a human body, the person will suffer electric shock and burns It could also cost damage to properties

CAUSES OF ELECTRICAL ACCIDENTS

The main causes of electrical accidents are : –
A) Lack of maintenance

B) Failure or lack of earthing
C) Unsafe and carelessness operating procedures
D) Electrical wiring and equipment's physical form could have been damaged
E) Incorrectly connected wires and other mistakes are usually caused by ignorance or negligence

ELECTRIC SHOCK
There are two possible ways one can get electric shock.
They are –direct contact – indirect contact .
The severity of an electric shock is determined by the amount of current flowing through the body .

NEED FOR THE PROTECTIVE DEVICES
All electrical wiring systems and all electrical apparatus associated with wiring must be protected to: –
(a) prevent damage by fire or shock
(b) maintain continuity of the supply
(c) disconnect faulty apparatus from the remainder of the system
(d) prevent damage to wiring and equipment
(e) minimize the system interruptions under fault conditions.

PROTECTIVE DEVICES
All electrical circuits must be protected against over current therefore a protective device has to be installed in order to isolate the fault from the supply so as to protect the equipment and appliances from being damaged over current is caused

FEATURES OF PROTECTIVE DEVICES
Protective equipment must possess the following features:
(a) Certainty and reliability of operation under fault conditions and non-operation under normal conditions.
(b) Discrimination
(c) Rapidity of operation
(d) Simplicity, low initial and maintenance cost
(e) Easy adjustment and testing.

POPULAR METHODS OF PROTECTION
The most popular methods of protection are
(i) use of fuses or circuit breakers (such as the Miniature Circuit Breaker – MCB)
(ii) Surgé Protection Device (SPD)
(iii) earthing or grounding of equipment

FUSE :
Fuses are the earliest means of protection against over currents in circuits. Basically, the fuse consists of a short length of suitable material (often a thin wire). When the current flow is greater than the fusing current of the fuse, it will get hot and burn (melt), thus interrupting the fault current before damage could be caused.

CIRCUIT BREAKER:
The circuit breaker is a device for making and breaking a circuit (under normal and abnormal conditions).

A circuit breaker is selected for a particular duty taking the following into consideration:
(a) the normal current it will have to carry
(b) the amount of current which the supply system will feed into the circuit under a fault (which current the circuit breaker will have to interrupt without damage to itself) -MCB -ISOLATOR -RESIDUAL CURRENT OPERATED CIRCUIT BREAKER (RCCB)

Miniature circuit breaker (MCB) You can find the miniature circuit breaker (MCB) in consumer units (CU)

The advantages of a miniature circuit breaker (MCB) are
1) Shorter tripping time
2) Can be reused
3) Easy to reset
4) Has a switch that can isolate the equipment

The disadvantages of a miniature circuit breaker (MCB) are
1) The most expensive protection device for home use
2) Slow tripping time due to aging
3) Surrounding temperature may affect the MCB

DISTRIBUTION BOARD
A distribution board (or panel board) is a component of an electricity supply system which divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit, in a common enclosure. Distribution Inside Large Buildings In large buildings the type of distribution depends on the building type, dimension, the length of supply cables, and the loads.
The distribution system can be divided in to:
The vertical supply system (rising mains).
The horizontal supply
ELECTRICAL INSTALLATIONS IN BUILDINGS

TYPES OF WIRES
Wiring systems and their choice
planning electrical wiring for building
Main and distribution boards An electrical installation is a combination of electrical equipment installed to fulfil a specific purpose and having coordinated characteristics.
In dealing with the electrical installation, it is necessary to ensure the safety of personnel as well as the protection of equipment from electrical faults

STANDARD WIRING REGULATIONS
The Regulations are designed to protect persons, property and livestock from electric shock, fire, burns and injury from mechanical movement of electrically actuated equipment. Prevention of electric shock is carried out by Insulation of live parts, formation of barriers or enclosures, keeping obstacles and making the place out of reach, etc.

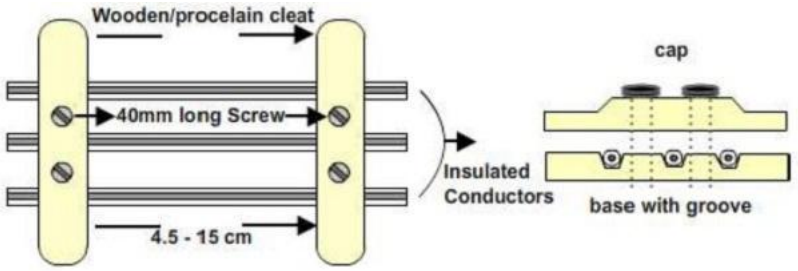
Fundamental requirements for safety require the use good workmanship, approved materials and equipment to ensure that the correct type, size and current-carrying capacity of cables is chosen.
The regulations also ensure that the equipment is suitable for the maximum power demanded of it and make sure that the conductors are insulated, and sheathed or protected if necessary, or are placed in a position to prevent danger.

TYPES OF WIRING

1. Cleat wiring
2. CTS wiring or TRS wiring or batten wiring
3. Metal sheathed wiring or lead sheathed wiring
4. Casing and capping
5. Conduit wiring

CLEAT WIRING

In this type of wiring, insulated conductors (usually VIR, Vulcanized Indian Rubber) are supported on porcelain or wooden cleats. • The cleats have two halves one base and the other cap.
The cables are placed in the grooves provided in the base and then the cap is placed. Both are fixed securely on the walls by 40mm long screws.
The cleats are easy to erect and are fixed 4.5 – 15 cms apart.
This wiring is suitable for temporary installations where cost is the main criteria but not the appearance



Advantages:

1. Easy installation
2. Materials can be retrieved for reuse
3. Flexibility provided for inspection, modifications and expansion.
4. Relatively economical

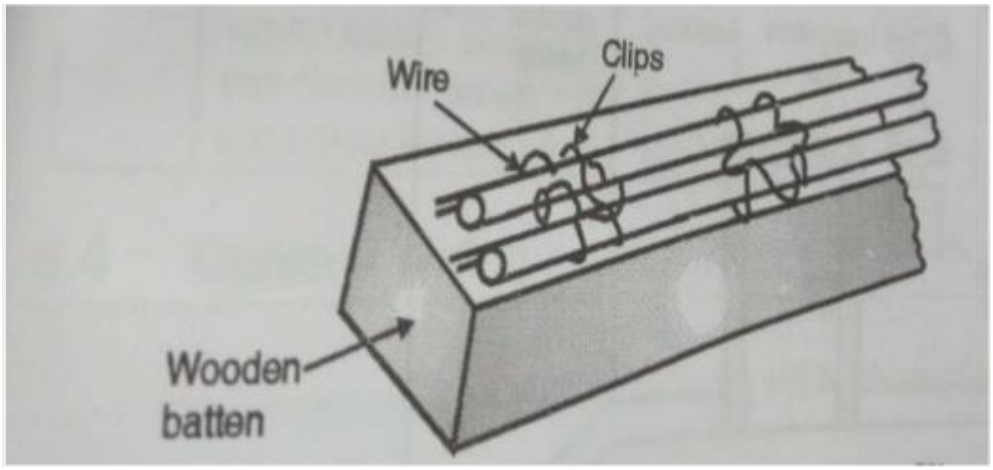
5. Skilled manpower not required.

Disadvantages:

1. Appearance is not good
2. Open system of wiring requiring regular cleaning
3. Higher risk of mechanical injury

CTS WIRING OR TRS WIRING OR BATTEN WIRING

In this wiring system, wires sheathed in tough rubber are used which are quite flexible.
They are clipped on wooden battens with brass clips (link or joint) and fixed on to the walls or ceilings by flat head screws.
These cables are moisture and chemical proof. They are suitable for damp climate but not suitable for outdoor use in sunlight.
TRS wiring is suitable for lighting in low voltage installations



Advantages:

1. Easy installation and is durable
2. Lower risk of short circuit.
3. Cheaper than casing and capping system of wiring
4. Gives a good appearance if properly erected.

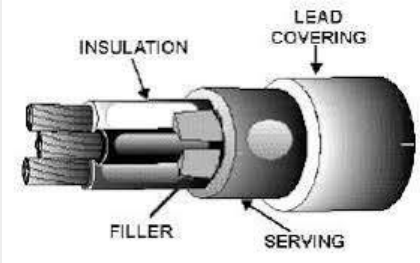
Disadvantages:

1. Danger of mechanical injury.
2. Danger of fire hazard.
3. Should not be exposed to direct sunlight.
4. Skilled workmen are required.

METAL SHEATHED OR LEAD SHEATHED WIRING

1. The wiring is similar to that of CTS but the conductors (two or three) are individually insulated and covered with a common outer lead-aluminum alloy sheath.
2. The sheath protects the cable against dampness, atmospheric extremities and mechanical damages.
3. The sheath is earthed at every junction to provide a path to ground for the leakage current. They are fixed by means of metal clips on wooden battens.

4. The wiring system is very expensive. It is suitable for low voltage installations Precautions to be taken during installation
5. The clips used to fix the cables on battens should not react with the sheath.
6. Lead sheath should be properly earthed to prevent shocks due to leakage currents.
7. Cables should not be run in damp places and in areas where chemicals (may react with the lead) are used.



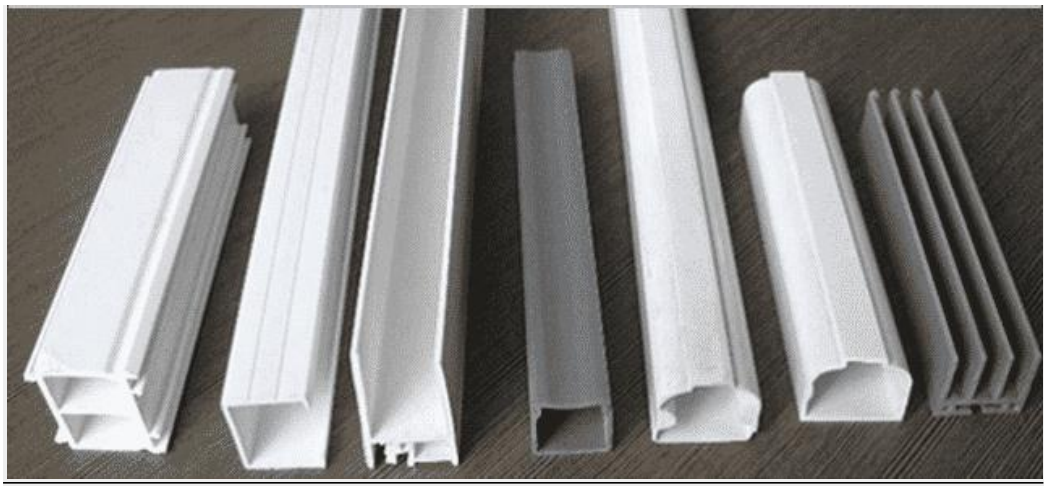
Advantages:

1. Easy installation and is aesthetic in appearance
2. Highly durable
3. Suitable in adverse climatic conditions provided the joints are not exposed

Disadvantages:

1. Requires skilled labor
2. Very expensive
3. Unsuitable for chemical industries Casing and Capping
4. It consists of insulated conductors laid inside rectangular, teakwood or PVC boxes having grooves inside it.
5. A rectangular strip of wood called capping having same width as that of casing is fixed over it. Both the casing and the capping are screwed together at every 15 cms.
6. Casing is attached to the wall. Two or more wires of same polarity are drawn through different grooves.
7. The system is suitable for indoor and domestic installations

CASING AND CAPPING



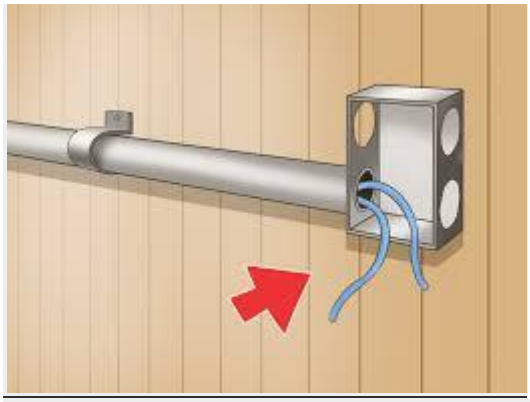
Advantages:

1. Cheaper than lead sheathed and conduit wiring.
2. Provides good isolation as the conductors are placed apart reducing the risk of short circuit.
3. Easily accessible for inspection and repairs.
4. Since the wires are not exposed to atmosphere, insulation is less affected by dust, dirt and climatic variations.

Disadvantages:

1. Highly inflammable.
2. Usage of unseasoned wood gets damaged by termites.
3. Skilled workmanship required

CONDUIT WIRING



In this system PVC (polyvinyl chloride) or VIR cables are run through metallic or PVC pipes providing good protection against mechanical injury and fire due to short circuit.
They are either embedded inside the walls or supported over the walls, and are known as concealed wiring or surface conduit wiring (open conduit) respectively.
The conduits are buried inside the walls on wooden gutties and the wires are drawn through them with fish (steel) wires.
The system is best suited for public buildings, industries and workshops

Advantages:

1. No risk of fire and good protection against mechanical injury.
2. The lead and return wires can be carried in the same tube.
3. Earthing and continuity is assured.
4. Waterproof and trouble shooting is easy.
5. Shock- proof with proper earthing and bonding
6. Durable and maintenance free
7. Aesthetic in appearance

Disadvantages:
Very expensive system of wiring.
Requires good skilled workmanship.
Erection is quiet complicated and is time consuming.
Risk of short circuit under wet conditions (due to condensation of water in tubes)

Factors Affecting The Choice Of Wiring System

1.Durability: Type of wiring selected should conform to standard specifications, so that it is durable i.e. without being affected by the weather conditions, fumes etc.
2.Safety: The wiring must provide safety against leakage, shock and fire hazards for the operating personnel.
3.Appearance: Electrical wiring should give an aesthetic appeal to the interiors.
4.Cost: It should not be prohibitively expensive.
5.Accessibility: The switches and plug points provided should be easily accessible. There must be provision for further extension of the wiring system, if necessary.
6.Maintenance Cost: The maintenance cost should be a minimum
7.Mechanical safety: The wiring must be protected against any mechanical damage

TYPES OF WIRES

There are mainly 6 types of wires:

1. Vulcanised Indian rubber wire (V.I.R)
2. Tough rubber sheathed wire (T.R.S)
3. Poly vinyl chloride wire (P.V.C.)
4. LEAD alloy sheathed wire
5. Weather proof wires

VULCANISED INDIAN RUBBER WIRE (V.I.R)

Nowadays these wires are not used since a better quality wires are available at a cheaper rate.¬
Finally the wire is finished with wax for cleanliness. ¬
A cotton bradding is done over the rubber insulations to protect the conductor against the moisture. ¬
Thickness of rubber mainly depends on the operating voltage to which wire is designed. ¬
Tinning of conductor prevents the sticking of rubber to the conductor. ¬A VIR wire mainly consists of a tinned conductor having rubber coating.

T.R.S. (TOUGH RUBBER SHEATHED) WIRES

These wires are generally available in single conductor, two conductors or three conductors.¬This layer provides better protection against moisture and wear and tear. Also it provides an extra insulation. ¬This type of wire is a modification of V.I.R. wire. It consist of the ordinary rubber coated conductors with an additional sheath of tough rubber.

P.V.C. (POLY VINYL CHLORIDE) WIRES

it softens at high temperatures therefore not suitable for connection to heating appliances ¬4.Chemically inert. ¬3.Durable. ¬2.Tough. ¬1. Moisture proof. ¬P.V.S. has following properties: ¬Conductor is insulated by poly vinyl chloride (insulating material). ¬This is the most commonly used wire for wiring purpose

LEAD ALLOY SHEATHED WIRES

The ordinary wires can be used only at dry places but for damp places these wires are covered with continuous lead sheaths
The layer of lead covering is very thin like 0.12 cm thick.
These wires provides little mechanical protections to the wires.

WEATHER PROOF WIRES

These types of wires are used outdoor i.e. providing a service connection from overhead line to building etc

In this type of wire the conductor is not tinned and the conductor is covered with three braids of fibrous yarn and saturated with water proof compound.

These wires consists of number of strands instead of a single conductor. (Strand is a very thin conductor).

The conductor is insulated with P.V.C. material.

These wires are very useful for household portable appliances where flexibility of wire is more important

55/.01mm(55 strands of 0.1mm diameter), maximum current 6A,used for household purposes. Flexible wires.¬Typical specifications

LAMPS

The oldest source of artificial light is the flame from fires, from candles and from oil lamps where light is produced as one of the products of chemical combustion. Modern sources of artificial light convert electrical energy light energy and are of two general types: incandescent sources and discharge sources.

Incandescent Lamps

Incandescent sources produce light by heating substances to a temperature at which they glow and are luminous. lncandescence can be achieved by heating with a flame but in an electric lamp, such as the light bulb, a metal wire is heated by an electric current.

- Discharge Lamps

Discharge lamps produce light by passing an electric current through a gas or vapour that has become ionised and hence able to conduct electricity. At low gas pressures, a luminous arc or discharge is formed between the electrodes and useful quantities of light are given off. Discharge lamps need special control gear in their circuits and the colour quality of their light is often poor. The fluorescent tube is one type of discharge lamp.

The characteristics of the electric lamps used in modern lighting are summarised in the table at the end of this section.

Further details of these lamps and their properties are given in the following sections.

INCANDESCENT LAMPS

1. Tungsten Filament Lamps

Electric incandescent lamps work by passing an electric current through a filament of metal and raising the temperature to white heat. When the metal is incandescent, at around 2800 K, useful quantities of light are given off. Tungsten is usually used because it has a high melting point and low rate of evaporation.

To prevent oxidation (burning) of the metal the tungsten coil is sealed inside a glass envelope and surrounded by an inert atmosphere of uncreative gases such as argon and nitrogen. During the operation of the lamp tungsten is evaporated from the filament and deposited on

the glass causing it to blacken. The filament therefore thins and weakens and must eventually break.

The simple tungsten lamp, such as a light bulb, is the oldest, shortest-lived and least efficient type of electrical light source and is being replaced by more efficient lamps. But the properties of filament lamps have been greatly improved by using halogen gases and lower voltages, as described below, and these lamps are useful in modern lighting design.

2. General Lighting Service Lamp

The general lighting service (GLS) lamp, or common light bulb, has a coiled filament contained within an envelope (bulb) of glass which may be clear or frosted. inside the lamp is a fuse and typical construction is shown in
figure 1.2.

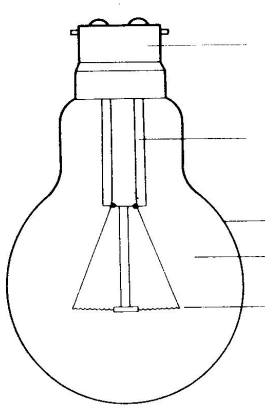


FIG. 1.2
TUNGSTEN FILAMENT LAMP

The filament lamp produces a spectral distribution of light which is continuous but deficient in blue. This quality of light is seen as 'warm' and is considered generally suitable for social and domestic applications.

The cost of a tungsten filament lamp is low and its installation is simple, but the relatively short life (1000 hours) of the lamp can cause the labour costs of replacement to be high. The low luminous efficacy of the lamp produces high electrical running costs. Only about 5 per cent of the electrical energy is converted to visible light and most of the energy consumed is given of as heat, especially radiant (infra-red) heat.

Incandescent lamps come in a variety of shapes and sizes and have a number of different fittings: Bayonet cap (BC), Small Bayonet cap (SBC), Edison screw (ES or E27) and Small Edison Screw (SES or E14). The Edison screw types are becoming more popular in the UK. Several different coatings are also available with the following properties: Pearl is an all over frosting which diffuses the light and is best used in a light fitting with shades. Clear bulbs are more attractive when used in fittings where the bulb is visible or a sparkle is required such as crystal chandeliers.

3. Reflecting Lamps

The relatively large size of the standard tungsten filament lamp makes it difficult to control the direction of the light.
Spot lamps (PAR) are filament lamps with the glass bulb silvered inside and shaped to form a parabola with the filament at the focus. This arrangement gives a directional beam of light which is available in different widths of beam. Sealed beam lamps use similar techniques.
Crown-silvered lamps (CSL) are standard filament lamps where the glass bulb is silvered in front. When this lamp is used with a special external reflector it also gives narrow beams of light.

4. Tungsten-Halogen Lamps

Halogen bulbs produce a very attractive light which closely resembles sunlight. They are more efficient than incandescent bulbs using only half the energy to produce the same light output and last twice as long. Generally they are small lamps which generate a lot of heat so they can only be used in light fittings designed to cope with the higher temperatures. There are two main types of halogen lamp available in the domestic market:

Low voltage (12 volts) with transformer and Mains voltage.

Tungsten-halogen lamps have filaments which run at higher temperatures with the presence of a small quantity of a halogen gas, such as iodine or bromine. When tungsten evaporates from the filament it is deposited on the hot wall of the lamp where it combines with the iodine. This new compound is a vapour which carries the tungsten back onto the lamp and re-deposits it on the hot filament, while the iodine is also re-cycled.

In order to run at higher temperatures the envelope of the tungsten-halogen lamp is made of quartz instead of plain glass. The heat-resistance of the quartz allows the construction of a very small bulb for applications such as spot lamps, projectors and car headlamps where directional control of light is important. Tungsten-halogen lamps also have the general advantages over simple tungsten lamps of increased efficiency and longer life.

5. Low Voltage Systems

Tungsten halogen techniques have allowed the development of low-voltage bulbs where, because a lower resistance is needed, the filaments can be shorter, thicker and stronger. A common system uses 12 volt lamps fed from the mains by a transformer.

The small size of these lamps gives them good directional qualities which make them popular in shops for the display of goods. The relatively low heat output of low-voltage systems is also an important property in stores where high levels of illumination can cause overheating.

DISCHARGE LAMPS

Apart from the well-known tubular fluorescent lamp, gas discharge lamps have in the past been restricted to outdoor lighting, such as for roadways where their generally poor colour

qualities have not been important. Modern types of discharge lamp have a colour rendering that is good enough for large-scale lighting inside buildings such as factories and warehouses. Continuing technical advances are producing more discharge lamps suitable for interior lighting and the high efficacy of such lamps can give significant savings in the energy use of buildings.

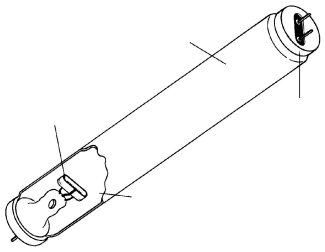
1. Fluorescent Lamps

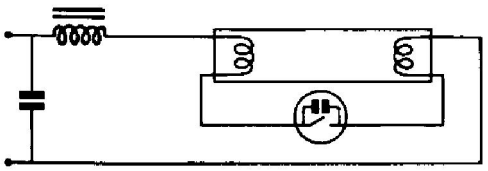
Fluorescent gas discharge lamps work by passing an electric current through a gas or vapour so that a luminous arc is established within a glass container.
The energised gas atoms emit ultra-violet (UV) radiation and some blue green light. A coating of fluorescent powders on the inside of the glass absorbs the UV radiation and re-radiates this energy in the visible part of the spectrum. The fluorescent coating therefore increases the efficiency of the system and allows the colour quality of the light to be controlled.

1.1 Tubular Fluorescent Lamps

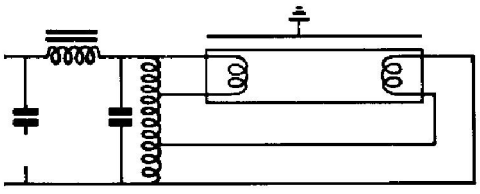
The common tubular fluorescent (MCF) lamp is a form of gas discharge lamp using mercury vapour at low pressure. Figure 2.1 illustrates the construction of a typical lamp and an example of the electrical control gear that it requires. This gear is needed to provide a starting pulse of high voltage, to control the discharge current, and to improve the electrical power factor.

Modern types of control gear use electronic circuits instead of wire-wound components.



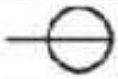
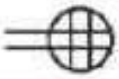
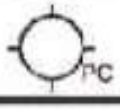


SWITCH-START CIRCUIT
When the main switch is closed, the mains is developed across the electrodes, and because they are close together, a glow discharge takes place between them.
This warms them up and they bend towards each other until they make contact, allowing current to flow through the lamp electrodes.



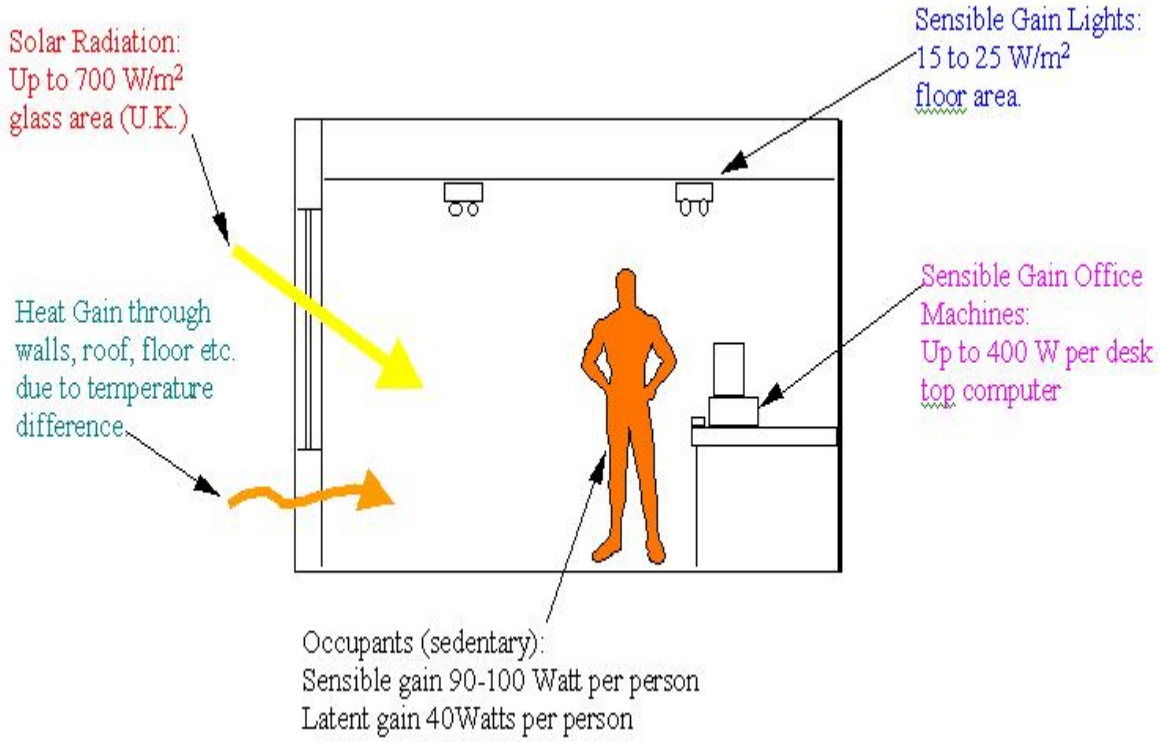
QUICK-START CIRCUIT
In this system the cathodes are heated by a small transformer and the arc will not strike until the preheating period is completed.

SYMBOLIC REPRESENTATION:

	Electrical switchbox	S	Single Pole Switch
S_3	Three-Way Switch		SinglePlex Receptacle
	Duplex Receptacle	 WP	Duplex Receptacle WP= Waterproof
 GFCI	GFCI Duplex Receptacle	 *	Isolated Ground Receptacle
	Switched Receptacle		FourPlex Four Gang Receptacle
	240-Volt Receptacle	 PC	Ceiling Mounted Light Fixture PC= Pullchain
	Wall-Mounted Light Fixture	R	Recessed Light Fixture
 WP	Weatherproof Light Fixture		Fluorescent Light Fixture
 CF	Ceiling Fan		Combination Light & Fan
 VF	Power Vent Fan	 2	Electric Motor Number=HP
SD	Smoke Detector		Circuit Breaker
	Telephone Jack	T	Doorbell Transformer
	Doorbell Pushbutton		Ground

5.HEAT,VENTILATION,AIR CONDITIONING

Air conditioning may be required in buildings which have a high heat gain and as a result a high internal temperature.
The heat gain may be from solar radiation and/or internal gains such as people, lights and business machines.
The diagram below shows some typical heat gains in a room.



If the inside temperature of a space rises to about 25°C then air conditioning will probably be necessary to maintain comfort levels.

This internal temperature (around 25°C) may change depending on some variables such as:

type of building
location of building
duration of high internal temperature
expected comfort conditions.
degree of air movement
percentage saturation

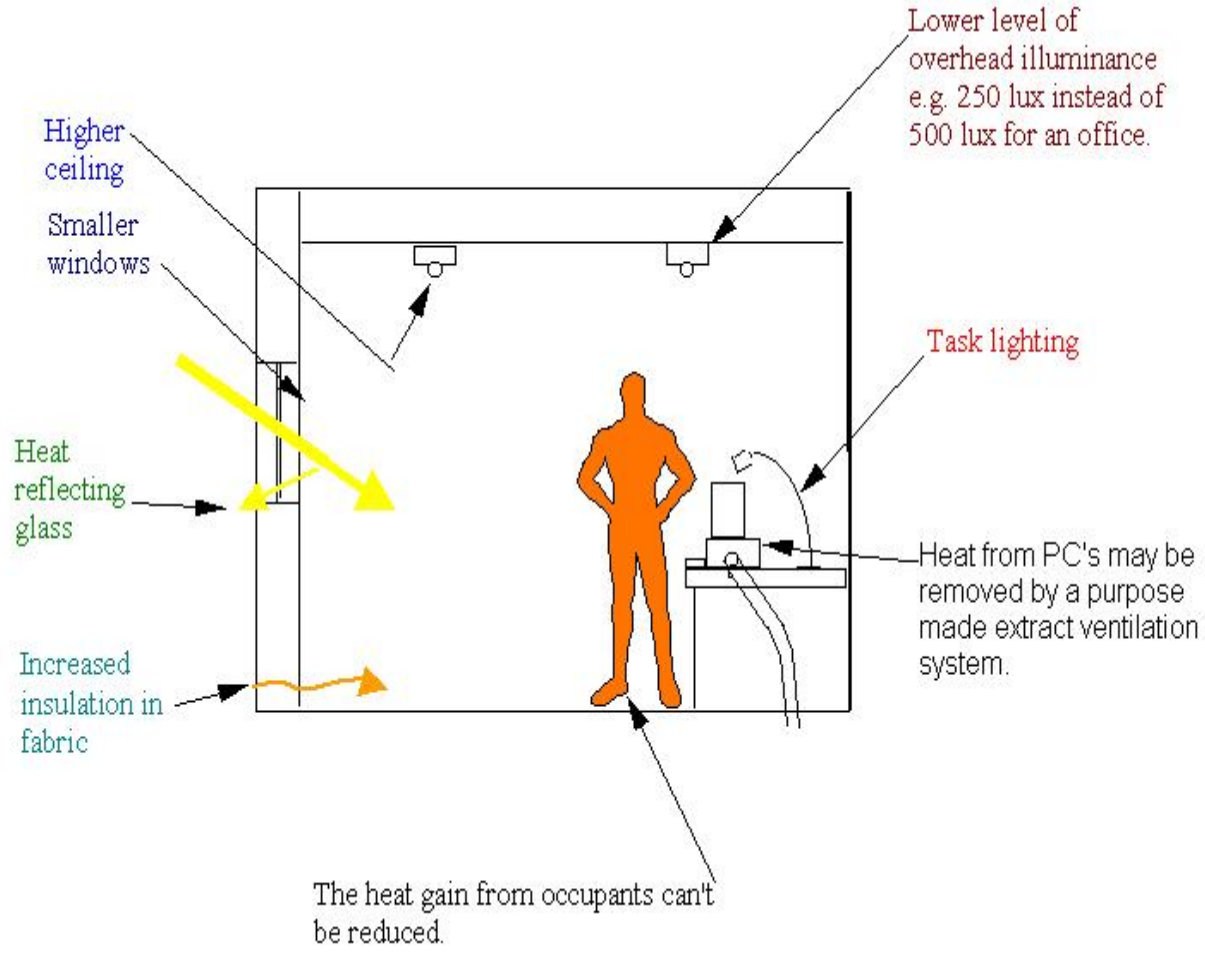
In some buildings it may be possible to maintain a comfortable environment with mechanical ventilation but the air change rate will tend to be high (above about 8 air changes per hour) which can in itself cause air distribution problems.

Since air conditioning is both expensive to install and maintain, it is best avoided if possible.

This may possibly be achieved by careful building design and by utilising methods such as:

- window blinds or shading methods
- heat absorbing glass
- heat reflecting glass
- openable windows
- higher ceilings
- smaller windows on south facing facades
- alternative lighting schemes.

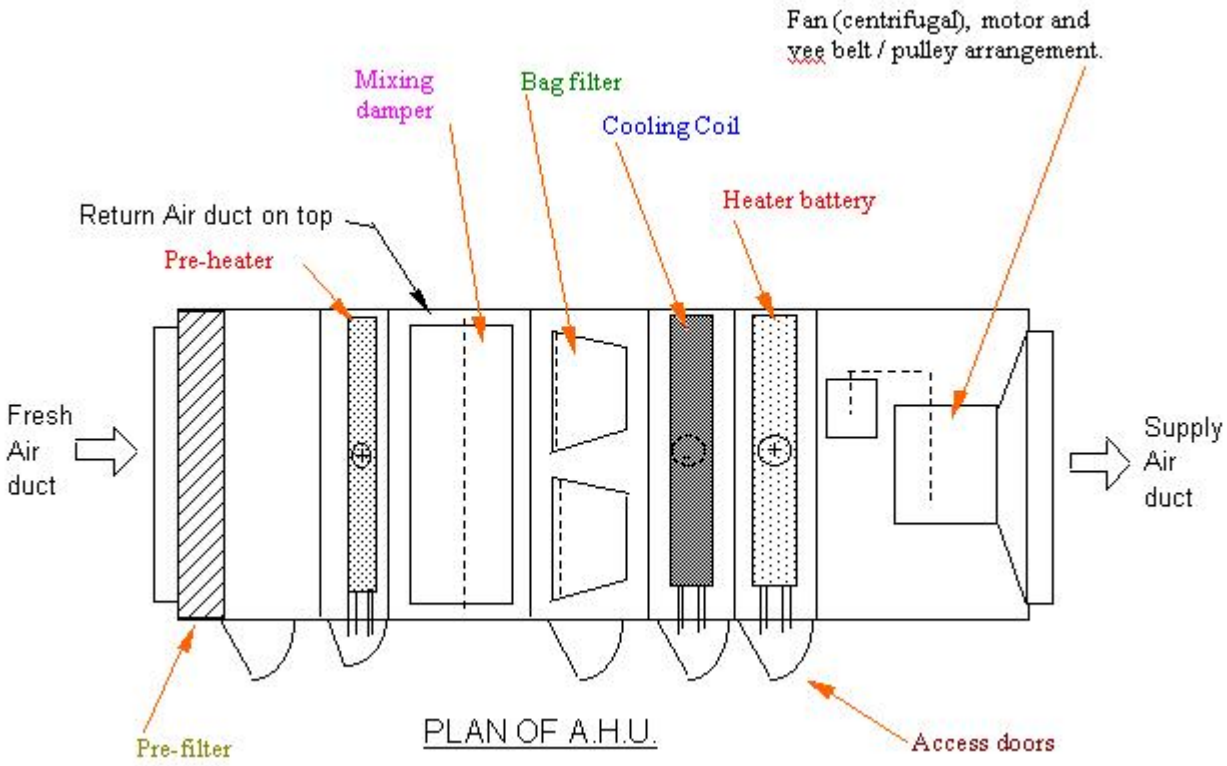
The diagram below shows some of these methods.



Air Handling Units

Air handling units (A.H.U.) are widely used as a package unit which incorporates all the main plant items as shown below.

Pipework, ductwork and electrical connections are made after the unit is set in place on site.
Since air conditioning plant rooms tend to be at roof level, the larger A.H.U.'s are lifted into place by crane before the roof is fixed.

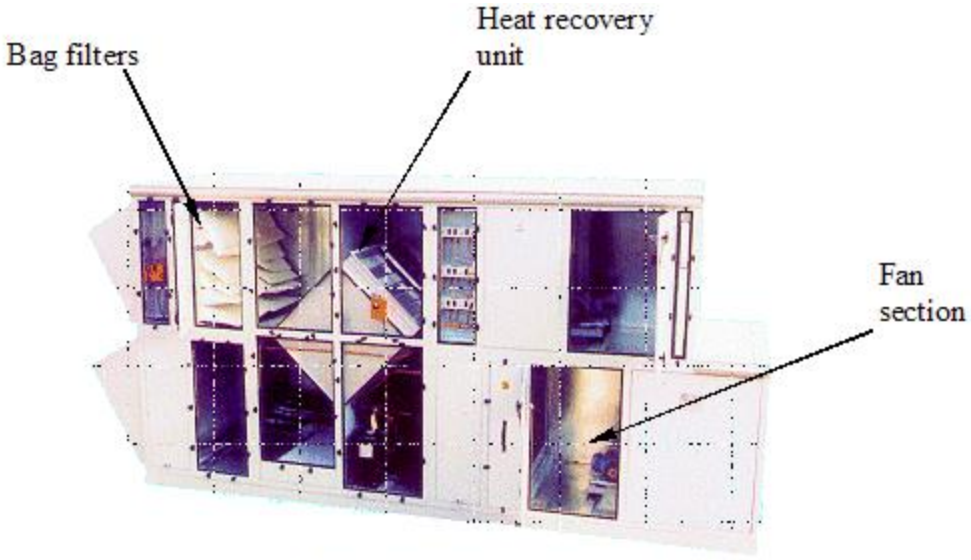


PLAN OF A.H.U.

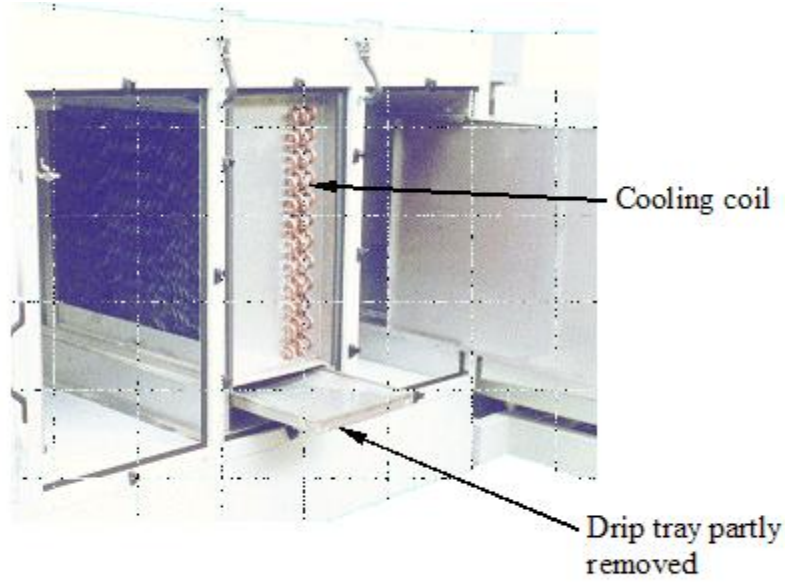
In some cases it is usual to place the fan in front of (that is upstream of) the heater battery and cooling coil.
This is because fans operate best if the system resistance is at the outlet rather than the inlet of the impeller.
This is shown on the schematic diagrams above.

The photograph below shows a typical air handling unit with handles on the doors for access to equipment.


TYPICAL AIR HANDLING UNIT



AIR HANDLING UNIT WITH DOORS REMOVED



AIR HANDLING UNIT COOLING COIL SECTION

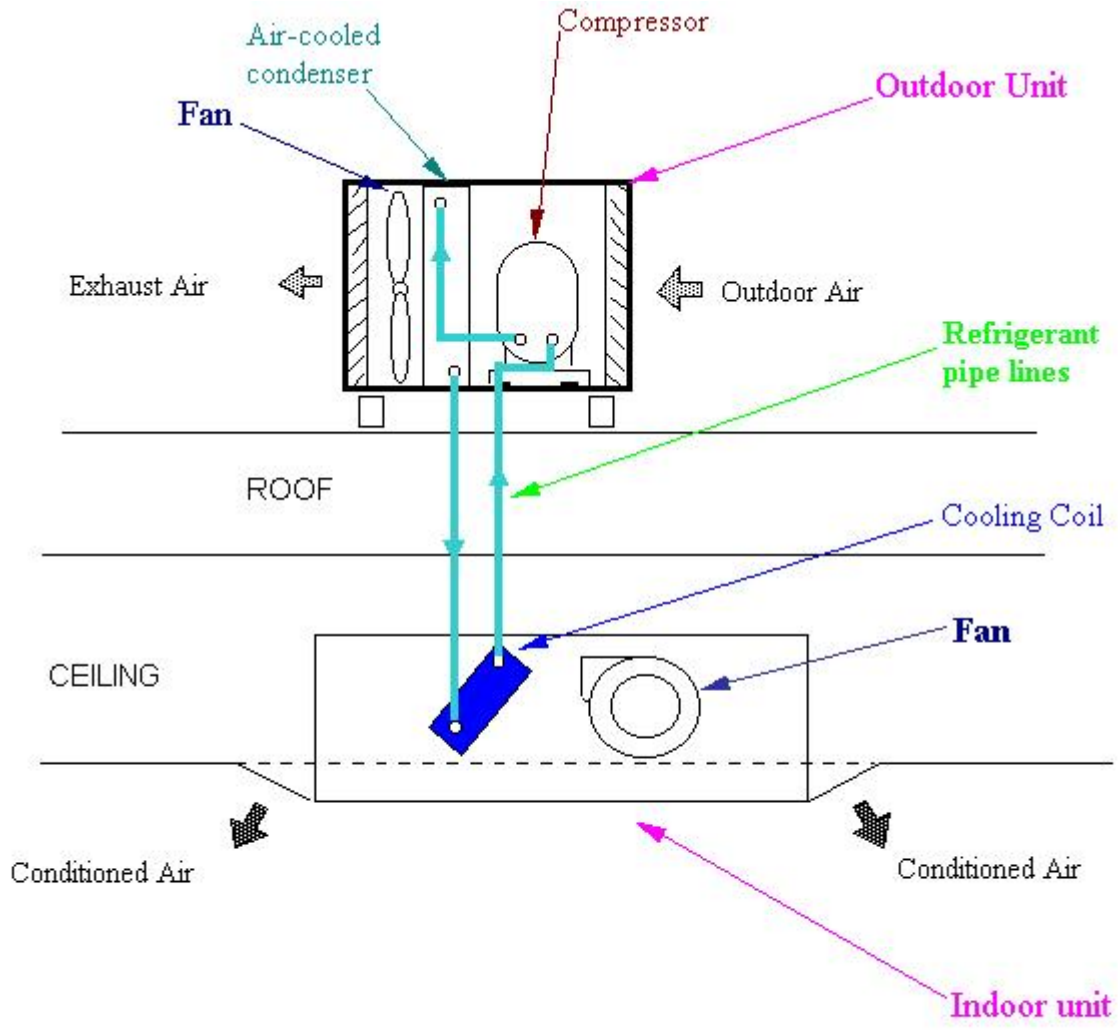
2. Room Air Conditioning Units

These units use refrigerant to transfer cooling effect into rooms.
Room air conditioning units fall into two main categories:

1. Split type
2. Window/wall units.

Split Air Conditioners

Split air conditioners have two main parts, the outdoor unit is the section which generates the cold refrigerant gas and the indoor unit uses this cold refrigerant to cool the air in a space.
The outdoor unit uses a compressor and air cooled condenser to provide cold refrigerant to a cooling coil in the indoor unit.
A fan then blows air across the cooling coil and into the room.
The indoor unit can either be ceiling mounted (cassette unit), floor mounted or duct type.
The drawing below shows a ceiling mounted (cassette unit).

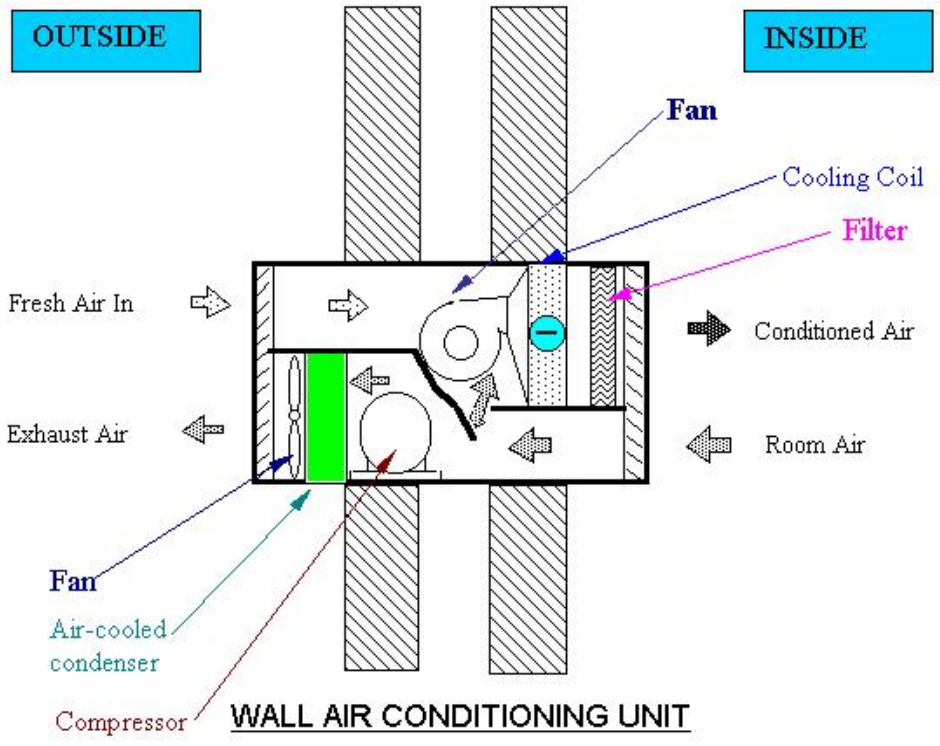


SPLIT AIR CONDITIOING UNIT

The photographs below show a ceiling mounted cassette and an outdoor unit.

Window AC / Wall Units

Window or wall units are more compact than split units since all the plant items are contained in one box.
Window units are installed into an appropriate hole in the window and supported from a metal frame.
Wall units like the one shown below are built into an external wall and contain all the necessary items of equipment to provide cool air in summer and some may even provide heating in winter.



A small hermetically sealed compressor is used to provide refrigerant gas at the pressure required to operate the refrigeration cycle.
The condenser is used to condense the refrigerant to a liquid which is then reduced in pressure and piped to the cooling coil.

VARIOUS TYPES OF ROOM AIR CONDITIONERS – INDOOR UNITS

Central Plant Systems - Advantages:

1. Noise in rooms is usually reduced if plant room is away from occupied spaces.
2. The whole building can be controlled from a central control station.
   This means that optimum start and stop can be used and a weather compensator can be utilised.
   Also time clocks can bring air conditioning on and off at appropriate times.
3. Maintenance is centralised in the plant room. Plant is easier to access.

Central Plant Systems - Disadvantages:

1. Expensive to install a complete full comfort air-conditioning system throughout a building.
2. Space is required for plant and to run ductwork both vertically in shafts and horizontally in ceiling spaces.
3. Individual room control is difficult with central plant.
   Many systems have been tried such as Variable Air Volume (VAV), dual duct systems and zone re-heaters.
   Zone re-heaters are probably more successful than the rest.

Room Air Conditioning Units - Advantages:

1. Cheaper to install.
2. Individual room control.
3. Works well where rooms have individual requirements.
4. No long runs of ductwork.
5. Can be used to heat as well as cool if a reversing valve is fitted.

Room Air Conditioning Units - Disadvantages:

1. Sometimes the indoor unit fan becomes noisy.
2. Noisy compressor in outdoor unit.
3. Each unit or group of units has a filter, compressor and refrigeration pipework that
   needs periodic maintenance and possible re-charging.
   Units have course filters therefore filtration is not as good as with AHU's.
4. The installation may require long runs of refrigerant pipework which, if it leaks into the building, can be difficult to remedy.
5. Not at robust as central plant.
6. The majority of room air conditioners just recirculate air in a room
   with no fresh air supply although most manufacturers make units with fresh air capability.
7. Cooling output is limited to about 9 kW maximum per unit;
   therefore many units would be required to cool rooms with high heat gains.

Fan coil units are similar is some respects to Room Air Conditioners.

Fan Coil Units - Advantages:

1. Cheaper to install than all air central plant system.

2. Individual room control.
3. Works well where rooms have individual requirements.
4. No long runs of ductwork.
5. Can be used to heat as well as cool if 3 or 4-pipe system is used.

Fan Coil Units - Disadvantages:

1. Sometimes the indoor unit fan becomes noisy, especially when the speed is changing
   with in-built controls.
2. Each unit requires maintenance.
3. Long runs of pipework are required.
4. A chiller is still required to produce chilled water therefore they do not save as much in plant
   and plant room space as room air conditioners.
   Also boilers will be required if heating mode is installed.
5. Fresh air facility may not be installed.
6. Cooling output is limited to about 5 kW.