SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – BUILDING SERVICES – SARA5103

WATER SUPPLY AND SANITARY ENGINEERING

Water supply system - Wastewater system, Pipe sizing – scheme of water supply and waste water - Venting – Plumbing system Inspection and tests. Gas piping - Gas Supply – Gas pipe Sizes - Gas pipe Materials. Components of BAS related to water supply and sanitary system; water pump monitoring and control.

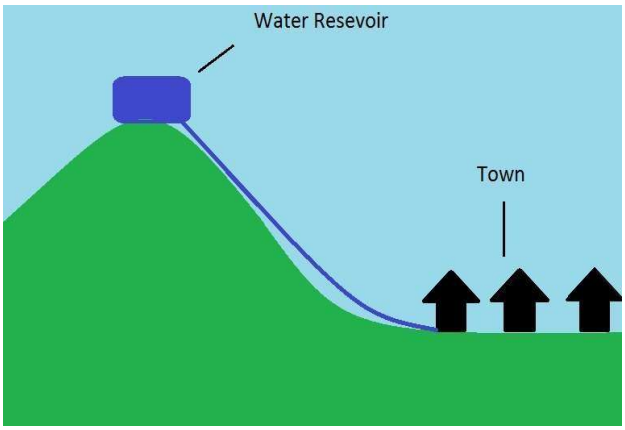
WATER SUPPLY SYSTEM

- The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure.
- Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage.

Methods of water distribution

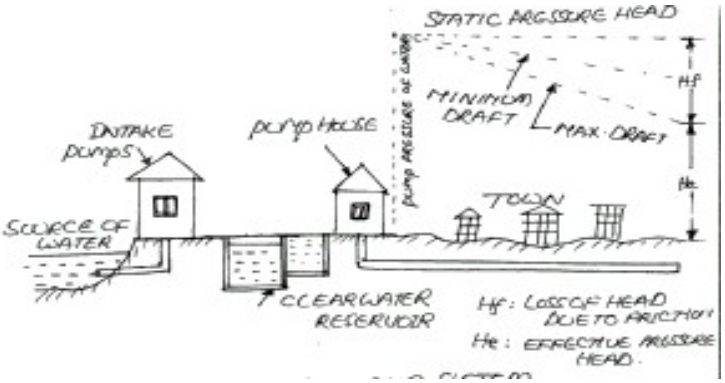
1. **Gravity system**

- 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.



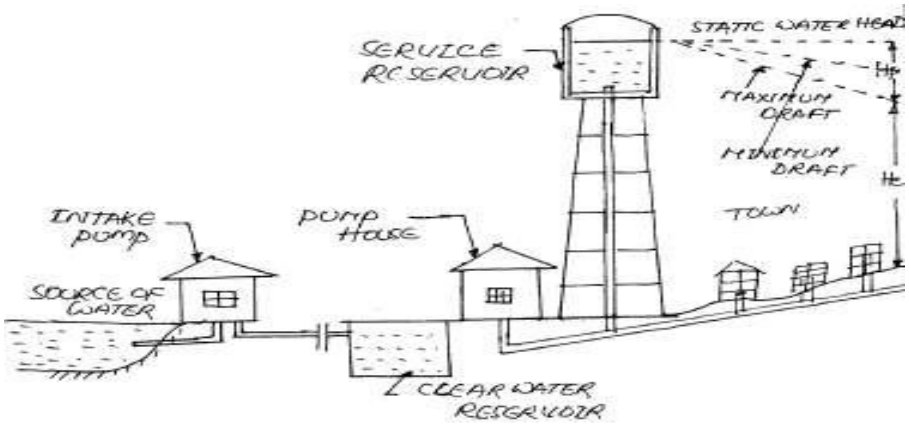
2. **Pumping system**

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



3. **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.



Water supply systems:

1.Cold water system

2. Hot water system

Cold water system

Cold water supply is nothing but an external water supply. However, cold water supply system can also use filter, water softener appliances, or any other fixture. The connection for the cold water system is done in such a way that other appliances could receive it through fixtures and taps. Such appliances include sinks, hot water heaters, faucets, bathtubs, showers etc.

Hot water system

There are certain appliances that can be used to provide hot water, such as water heaters. Cold water supply system supplies a volume of water to such appliances, where they heat the water and provide hot water.

TYPES OF WATER SUPPLY SYSTEM ARE:

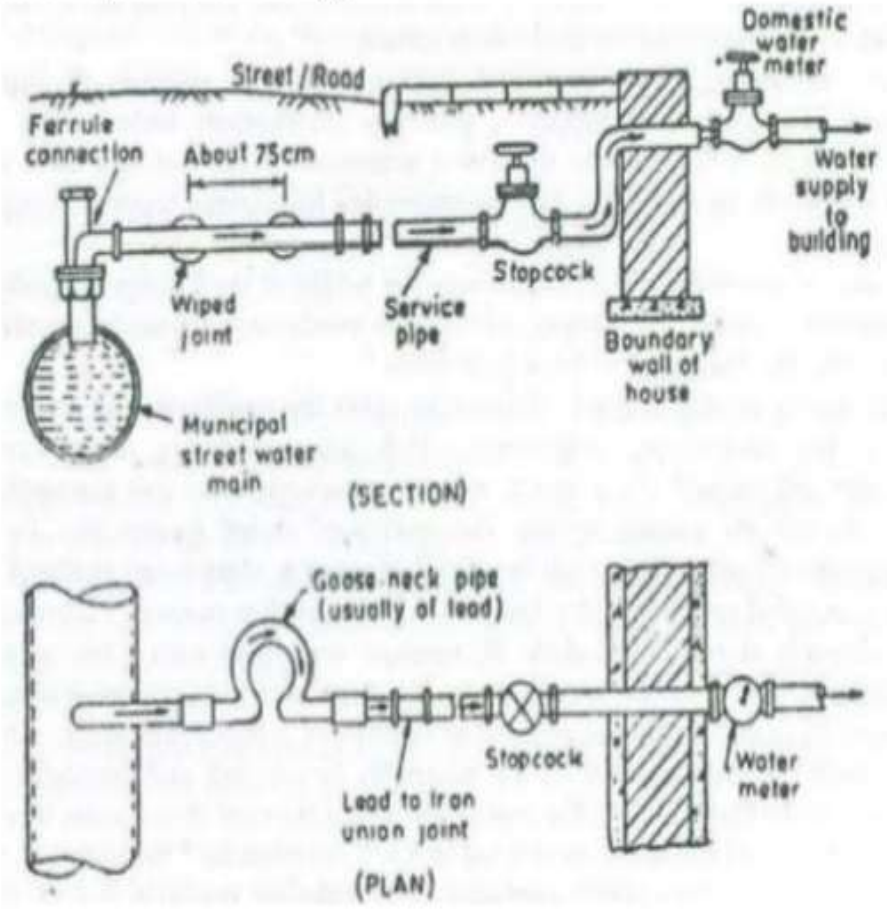
- Direct supply system
- Indirect supply system

Direct systems source water straight from the mains water supply. Indirect water systems require larger storage and more pipe work because they provide water for hot and cold services.

Types of pipes for cool water supply

A water pipe is any pipe or tube designed to transport treated drinking water consumers. The varieties include large diameter main pipes, which supply entire towns, smaller branch lines that supply a street or group of buildings, or small diameter pipes located within individual buildings. Materials commonly used to construct water pipes include cast iron, polyvinyl chloride (PVC), copper, steel or concrete.

Distribution System for a Building:



DISTRIBUTION SYSTEM :

The methods of distribution of water in a multi-storeyed buildings are:

- Direct pumping systems
- Hydro – pneumatic systems
- Overhead tanks distribution

Direct pumping systems :

Water is pumped directly into the distribution system without the aid of any overhead tank, except for flushing purposes**.** The pumps are controlled by a pressure switch installed on the line.

Over-head tank distribution :

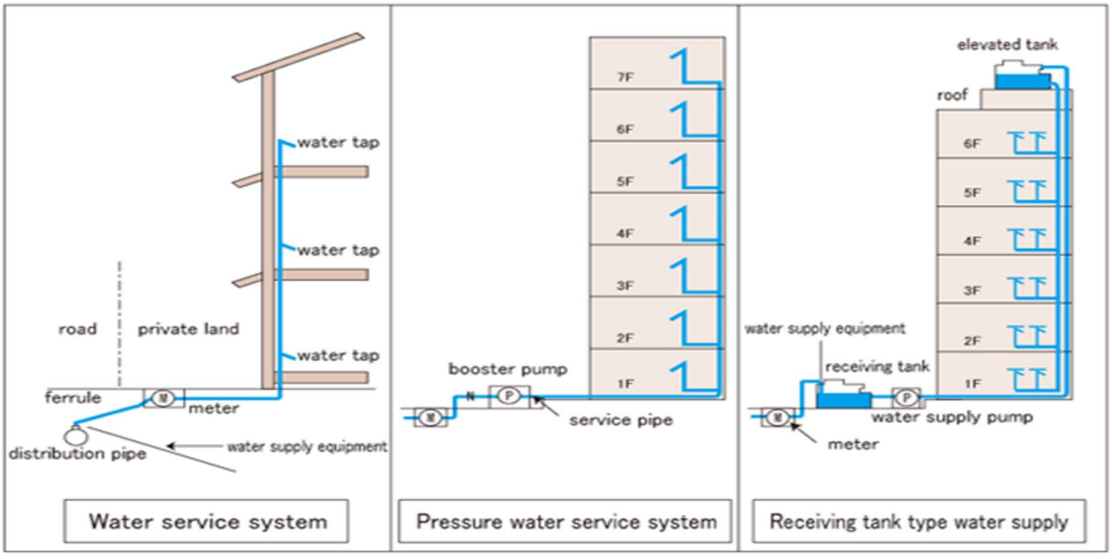
This is the most common of the distribution systems adopted by various type of buildings. The system comprises pumping water to one or more overhead tanks placed at the top most location of the hydraulic zone. Water collected in the overhead tank is distributed to the various parts of the building by a set of pipes located generally on the terrace.

Hydro-pneumatic systems :

Hydro-pneumatic system is a variation of direct pumping system. An air-tight pressure vessel is installed on the line to regulate the operation of the pumps. Hydro-pneumatic system generally eliminates the need for an over head tank and may supply water at a much higher pressure than available from overhead tanks particularly on the upper floors, resulting in even distribution of water at all floors.

Basically the system is configured into 5 types they are :

1. Single booster system
2. Zone- divided system
3. Roof tanks system
4. Series- connected systems with intermediate break tanks
5. Series- connected system



Water supply system design consideration:

The water supply system must be designed to achieve appropriate water pressure and flow, and to avoid contamination to potable water.

- Water pressure
- Water flow rate
- Flow rate and pipe size
- System layout
- Connection to the mains supply
- Backflow
- Mains connection
- Pipe materials and specifications

Water pressure

If water pressure is too low, this will be inconvenient for building users .If pressure is too high, this will lead to wastage of water, as well as high wear and tear on the system.

New buildings in areas with mains water supply will have mains pressure systems. Existing buildings, and buildings that are not connected to mains water, may have low pressure systems or unequal pressure systems (with different pressures for hot and cold water supply).

Mains pressure systems require pressure limiting and pressure reducing valves to control water pressure and temperature. Typically, pressure limiting or pressure reducing valves will be used to control pressure in mains-supplied hot water systems or where high pressure may lead to problems such as burst pipes.

Low pressure systems require few valves or controls. In low or unequal pressure systems, pressure can be increased to adequate levels by storing water in a header tank so that gravity can be used to create water pressure. Pressure can also be raised to adequate levels using a pressurizing pump, in which case it may be necessary to use pressure limiting and pressure reducing valves.

Water flow rate

The Building Code requires that sanitary fixtures and appliances have adequate water supply at an adequate flow rate.

As with water pressure, flow rates are crucial. A flow rate that is too high will result in water being wasted, whereas a flow rate that is too low will mean that sanitary fixtures and appliances don’t work properly.

Flow rate is affected by:

- Water pressure
- Pipe diameters – The smaller the internal diameter of the pipe, the lower the pressure and flow rate.
- Water temperature – higher temperatures will tend to raise pressure and flow rates
- A flow regulator can be used to maintain a constant flow, independent of water pressure.
- Limiting the flow for a tap or appliance to a reasonable rate helps balance the available pressure throughout the system. Regulating flow allows a simpler design and minimum pipe sizes as peak flow rates can be specified accurately and can also reduce noise, splashing taps, and water hammer.
- Flow rate can also be controlled by specifying low-flow outlets.

System layout

In the design process, the layout of the plumbing system will largely follow room layout. Nonetheless, there are many things to consider which relate to Code compliance, building users' comfort, and sustainability.

When planning a water supply layout, the following must be considered:

- Pipe runs and lengths – Keep pipe runs as short as possible. Pass pipes close to fixtures to minimise the number of branches and unnecessary elbows, tees and joints. Having longer pipe runs and more fixtures will reduce flow rate, increase heat losses, and increase use of materials
- Point of entry into the building – This should be into a utility space such as garage/laundry and include an accessible isolating valve, line strainer and pressure limiting valve (if required)
- Water heating system – Locate centrally to reduce the length of pipe runs to fixtures because longer pipe runs require more water to be drawn off before hot water is discharged. Install a separate point-of-use water heater for fixtures that are more than 10 m from the main water heater
- Noise prevention – Avoid running pipes over or near bedrooms and living areas.

Backflow

Backflow is the unplanned reversal of flow of water (or water and contaminants) into the water supply system. The system must be designed and used to prevent contamination from backflow.

Mains connection

Where the water source is a mains supply, the network utility operator is responsible for the water supplied to the property boundary. The property owner is then responsible for providing the pipework to bring the water into the building.

An isolating valve must be fitted at the point of connection to allow for maintenance and repair of the building's water supply system if required.

Pipe materials and specifications

The pipes used in a building must not contaminate potable water supply, and must be suitable for the water pressure, flow rate and temperature of water they will be carrying. This will be influenced by the materials used and also by other factors such as the wall thickness. Other considerations are durability, ease of installation, cost, and sustainability.

Pipe materials and components must not contaminate potable water. They must also be:

- suitable for the expected temperatures and pressures
- compatible with the water supply, to minimise the potential for electrolytic corrosion
- suitable for the ground conditions (if used underground) to minimise the potential for corrosion of the exterior of the pipe
- suitable for the local climate (if used outdoors) such as freezing conditions or atmospheric salt

So, when selecting of materials for water supply pipes, consider water pressure, water temperature, compatibility with water supply, durability, support, ease of installation, and cost.

Piping design considerations The design of the piping must also take into consideration other factors, including expansion and contraction in the piping and the static and dynamic loads of the piping, as they will be reflected in the structural steel framing system of the building; the need for access to expansion joints and the anchors and guides for the piping, which should be subjected to periodic inspection after the building is constructed; the provision of fire stopping between the pipe and the sleeve located at all penetrations of rated slabs, walls, and partitions; and, if required, seismic restraints on the piping systems and the pumps.

WASTE WATER SYSTEM

Wastewater (liquid waste) from flushing the toilet, bathing, washing sinks and general cleaning goes down the drain and into a pipe, which joins a larger sewer pipe under the road. The larger pipe also joins a major pipe that leads to the treatment center.

Methods of treatment

Primary Treatment

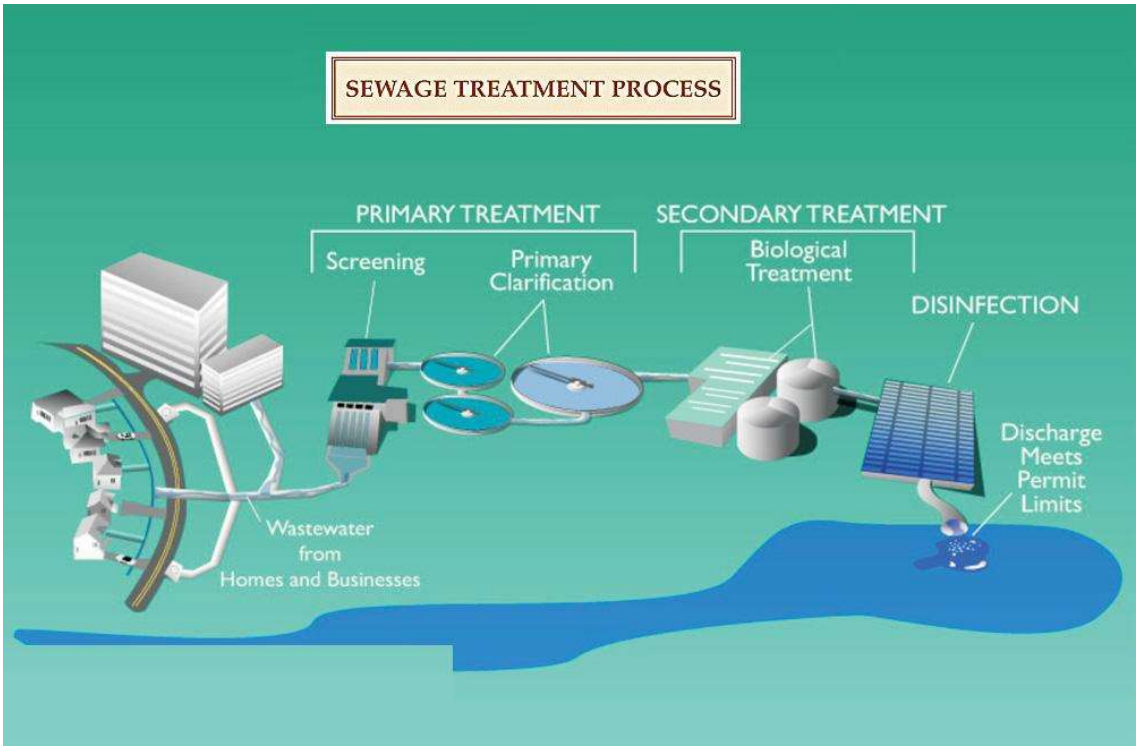
Raw wastewater first passes through screens which extract larger waste materials. The grit tanks remove grit and sand. Primary tanks separate the bulk of the solids from the liquid waste.

Secondary Treatment

Further separating solids and liquid, reactor/clarifiers remove nutrients - in particular nitrogen - which can be harmful to the environment.

Tertiary Treatment

The wastewater is filtered and disinfected using ultraviolet (UV) light, which destroys bacteria and viruses, before it is conveyed to the intertidal storage basin.



System of plumbing

Following are the four principle systems adopted in plumbing work in building

1) Two pipe system.

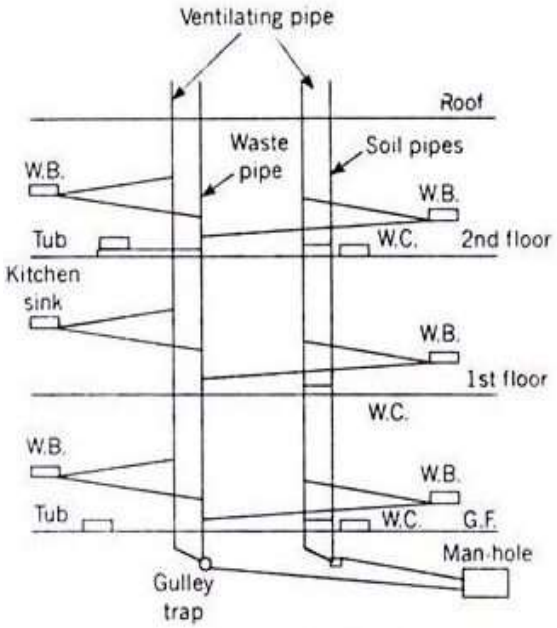
2) One pipe system.

3) Single stack system

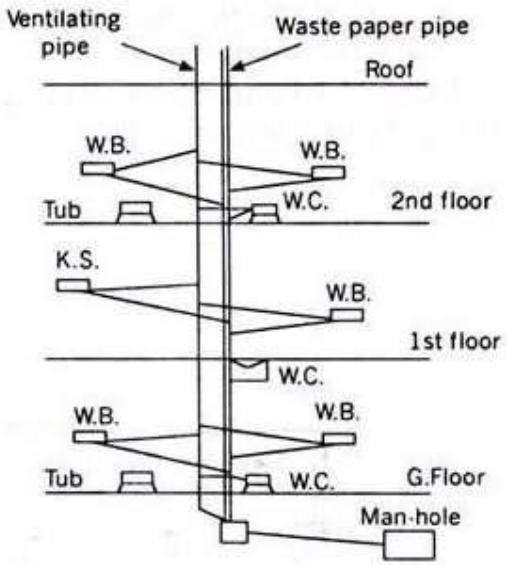
4) Partially ventilated single stack system.

Two pipe system:-

1. This is the best and most improved type of system of plumbing.
2. In this system, two sets of vertical pipes are laid, i.e. one for draining soil and other for draining sullage.
3. The pipe of the first set carrying soil are called soil pipes. and the pipes of the second set carrying sullage from baths etc are called sullage pipe or waste pipe
4. The soil fixtures, such as latrines and urinals are thus all connected through branch pipes to the vertical pipe.
5. Where the sludge fixtures such as baths, sinks, wash-basins, etc are all connected through branch pipes to the vertical waste pipe.
6. The soil pipe as well as the waste pipe are separately ventilated by providing separate vent pipe .



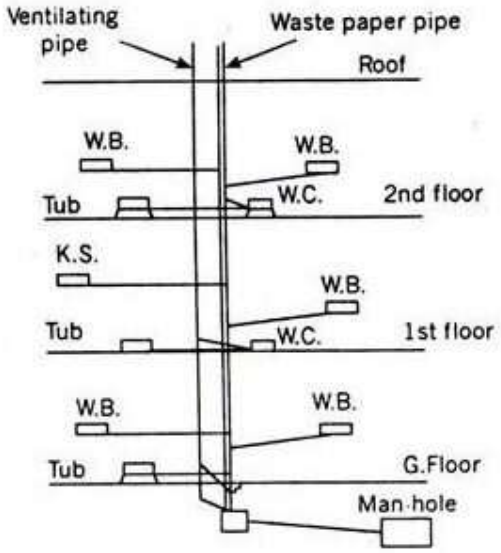
Two-pipe system.



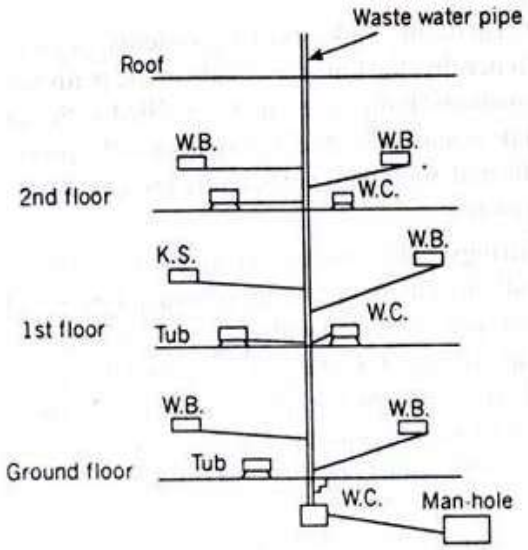
One-pipe system.

One pipe system:-

- In this system, instead of using two separate pipes(for carrying sullage and soil, as it done in the two pipe system), only main vertical pipe is provided which collects the soil as well as the sullage water from their respective fixtures through the branch pipes.
- This main pipe is ventilated in itself by providing cowl at its top and in addition to this, a separate vent pipe is also provided.



One-pipe partially ventilated system



Single stack system.

Single Stack System:-

- This system is a single pipe system without providing any separate ventilation pipe.
- It uses only one pipe which carries the sewage as well as sullage, and is not provided with any separate vent pipe , except that it itself is extended upto about 2m higher than the roof level and provided with a cowl for removal of foul gases as

Partially ventilated single stack:-

- This is an improved form of single stack system in the sense that in this system, the traps of water closets are separately ventilated by a separate vent pipe called relief vent pipe.
- This system uses two pipes as in single pipe system but the cost of branches is considerably reduced compared to single pipe system.

Drainage system considerations

- In the drainage system for a multi-storey building, the drains from the plumbing fixtures are connected to vertical drain stacks that convey the waste and sewage to below the lowest floor of the building.
- The fixture drain traps must be vented to prevent their water trap seal from being siphoned by negative pressure or blown out by positive pressure in the drain piping.
- The fixture vent pipes must extend through the roof to outdoors. They can be run individually or be combined into one or more vents through the roof.
- Where buildings are over 10 storeys high, the drainage stacks require relief vent connections at specified intervals from the top, and connected to a vent stack that terminates above the roof. This relieves and equalizes the pressure in the drainage stack to maintain the water seal in traps serving plumbing fixtures.
- Wherever possible, the sanitary drainage system from a building should discharge to the public sewer by gravity.
- All plumbing fixtures located below ground level should be pumped into the public sewer or the drainage system leading to the sewer. The pump line should be as short as possible and looped up to a point above ground level to prevent back siphonage of sewage.
- The pump discharge rate should be controlled so as not to cause scouring of the internal bore of the pump line or the drainage or sewer system into which it discharges. High-velocity discharge rates may also cause the flooding of adjoining plumbing fixtures or overloading of the sewer itself.

Plumbing inspection

A plumbing inspection is a systematic process of assessing the critical areas of the plumbing system of a property. It is performed by certified plumbers to avoid the risk of pipe corrosion, clogs, leaks, and burst tubes that can cause flooding and property damage.

Importance of Plumbing Inspection

- Conducting regular plumbing inspection keeps the system running smoothly which helps businesses or households prevent costly and unexpected repairs.
- Detect early problems to mitigate the risk of damaged pipelines and plumbing systems;

- Eliminate the hassle of delayed work due to clogs and water leaks;
- Avoid bigger water damage; and
- Prevent a drastic increase in water consumption bill

Defects in Water Supply System

1) Rusting
2) Leakage
3) Dents & Buckles
4) Blockage
5) Cracks

Rusting / Corrosion

- Inspection of main pipeline, distribution pipe or branch pipes.
- Inspect for signs of corrosion and leakage in pipe linkage
- Inspect for the water tank / storage

Leakage

- Inspection of leakage underground pipe
- Inspection of loose joints or fitting in the pipelines
- Inspection of old pipeline

Dents & Buckles

- Inspection of pipe shapes and size; is it normal to the standard size or changes in original size
- Inspection of anomalies that could result to failure of pipes

Blockage

- Inspection for possible causes of blockage such as tree roots, rust, accumulation of sand and stone
- Inspect the water pressure level in the pipeline

Cracks

- Inspect for the weld area is it the causes of crack or not
- Inspect for the sign of crack

GAS PIPING SYSTEM

Recticulated piped gas systems

- Reticulated system is uninterrupted supply of LPG to the consumption point through a pipeline network.
- LPG is sourced from Centralized Cylinder Bank or Bulk LPG storage facility Installed in the premises.

- Drawing uninterrupted piped supply of LPG for the stove is the latest fad, which most of the builders are adding to their portfolio of their value added offerings.

Types

- Vot (vapor off take) system installation
- Lot (liquid off take) system installation
- Bulk system installation

Vot system

- The 'N' no. Of Cylinders are connected to the manifold & the Vaporized LPG is directly drawn from the cylinders with Natural Vaporization Process.
- This LPG VOT facility is normally recommended for Low utility consumption per hour of LPG.
- VOT systems are mostly used in hotels, restaurants, malls.

Lot system

- LOT system is an advance concept in multi cylinder installations which overcomes lots of demerits of Bulk LPG system & conventional Manifold (VOT) systems.
- This system is widely used in commercial & industrial applications only where high pressure is required & not for domestic purpose.
- LOT system withdraws liquid LPG using LOT valves & is converted into vapor using a vaporizer.

Bulk system

- Whenever monthly demand more it is advisable to have bulk storage facility.
- The bulk storage vessels are called bullets.
- There are three types of bulk installations – Above ground, Mounded & Underground.
- Large scale industries where huge consumption is required are the main users of Bulk Installations.
- Tank size required are based on the peak consumption.

To ensure complete safety with continuous supply of LPG to all users, the following equipment is used in the reticulated system:
1) Auto-Changeover Regulator with inbuilt OPSO(PRS - 1)
Besides its function of automatically switching the source of supply from the empty LPG bank to the filled-LPG bank, the auto-changeover regulator is also the FIRST Pressure reducing stage (prs1) due to its in-built pressure regulating feature.
Here, it reduces the LPG pressure to 1.2bar. Also this will have OPSO device in build in case of failure of the PRS 1. The gas supply from manifold to the ring main will stop.

2)PRS 2 : UPSO and OPSO:
The UPSO / OPSO valve with its in built pressure regulator and bleeder arrangement is used for additional safety after the 1st stage pressure reduction. This is the SECOND PRESSURE REDUCING STAGE (PRS2). It automatically stops the supply of LPG if the pressure increases above the desired set limit (1-1.2 bar) downstream of the second pressure reducing stage. Similarly in case the pressure is decreasing below the set limit in the downstream the

UPSO will switch off the gas supply to the risers. In case of this happening, the authorized personnel from the gas company re-start the system after making necessary changes.

3)PRS 3Under-Pressure Shut-Off Valve (UPSO):
The UPSO with its built pressure regulator is installed before the gas meter. It regulates the LPG pressure to 28-mbar pressure. This is the THIRD PRESSURE REDUCING STAGE (PRS3).
It also automatically stops the supply of gas if the flexible hose connected to the appliance ruptures or if it is not connected properly. LPG supply is also stopped downstream of the UPSO if the copper piping after the meter gets punctured. The UPSO has a reset knob on the top, which is pushed to restart the supply of LPG after taking corrective measures.

GAS PIPING MATERIALS: NBC 8.2.1 Piping shall be of wrought iron, steel, copper or cast iron when the gas pressure is less than 7kN/m2 with higher gas pressure use of cast iron shall be prohibited.

Recticulated vot system in an appartment building

Building automation system

A building management system (BMS), otherwise known as a building automation system (BAS), is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. The BAS provides a user interface that allows the end user to adjust the control settings, view the system status, and detect any potential issues related to building system performance.

The main components of a building management system and their basic functionalities are as follows:

- Boiler controls—maintain a constant temperature and switch boilers on/off at certain times.
- HVAC—maintain a specified air state with regard to temperature and humidity; control fans and dampers; control air handling units and fan coil units.
- Lighting control—turn lights on/off according to a specified schedule.

- Electric power control—control and monitor core electrical and mechanical equipment.
- Heating—schedule the system on and off; maintain a set temperature point.
- Ventilation—adjust based on occupancy controls.
- Security and observation—access control; surveillance and intrusion detection.
- Fire alarm system—smoke control system; active alarm locations.
- Elevators—elevator video display; status system.
- Plumbing and water monitoring—detect hydraulic flows; open/close valves automatically; monitor/observe temperature deviations.

Components of BAS

Controller

Field Devices

Mechanical Actuators

Connectivity Systems

User Interface

Controller

The controller is a key component of a building automation system — the overall working of a BAS depends on it. The controller is responsible for collecting data from the sensors for the purpose of monitoring the actual parameters and, based on the taught algorithm, it carries out necessary actions to meet the requirements.

Field Devices

Field devices collect necessary information about an area or particular room so that the building automation system carries out a specific action. Some of these devices include measurement sensors for temperature, airflow, humidity levels, differential pressure, CO2 levels, and smoke detectors.

Mechanical Actuators

Mechanical actuators include damper actuators and control valves. Control valves are used to control the flow of different fluids, such as water. Damper actuators are used to control the open/close mechanism of mechanical dampers installed at various duct positions.

Connectivity System

Building automation systems are of no use if the functions cannot be performed through a central control system. For this purpose, a communication system is an essential part. The communication system consists of a protocol that allows communication and data sharing between different devices at different locations.

User Interface

The user interface allows interaction with the building automation system. Users can monitor the actual climatic conditions of a whole facility or a specific location. The user interface also enables users to input the desired value of a particular climatic parameter.

Function of bms

1. Control of Building Systems and Services
2. Real Time Monitoring of Building Operation and Performance
3. Trending and Logging of Building Operation and Performance
4. Time Scheduling of Building Systems
5. Fault Management and Alarming
6. Control Application Programming
7. User Event Management
8. Energy Management and Reporting

Network architecture

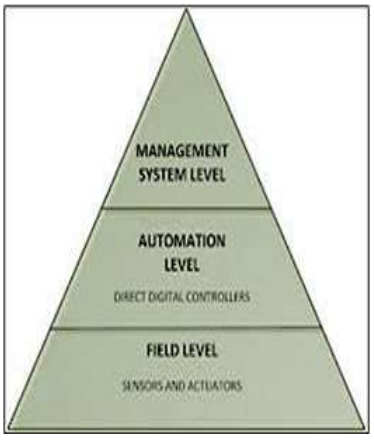
The typical control system network architecture, consists of several network levels:

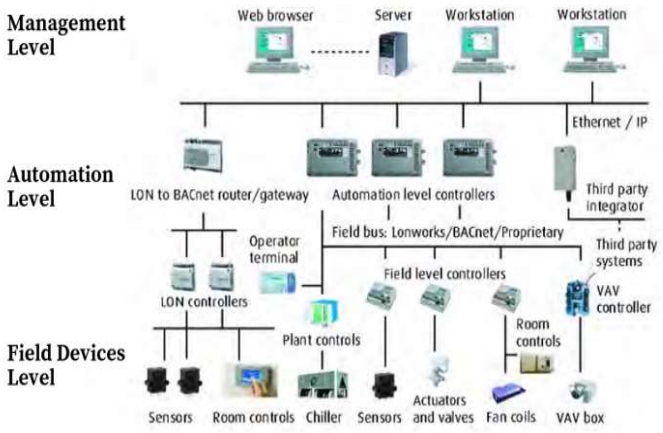
- Management Level
- System-Level or Building-Level Controllers
- Field-Level Controllers

1. Upper level (Management Level). Dispatching and administration as well as work with databases and statistical functions. At this level cooperation between personnel, and system is performed, which is implemented by means of computer devices.

2. Middle level (System-Level). Automated management of functional processes. Basic components of this level are: main controllers, signal input-output units, and various switching equipment.

3. Low level (Field Level). Level of terminals with input/output functions. This level includes sensors, actuating mechanisms, cabling between devices and low-middle levels.





BAS related to water supply and sanitary system

The utilization of DDC and the monitoring of plumbing equipment can save the building owner money.

Some of the money saved could be through:

- Lower maintenance costs.
- Lower energy usage/cost.
- Reduction in repair cost.
- Reduction in occupant complaints and service calls.
- Using Building Controls and sensors, we can:
- Detect various hydraulic flow(s).
- Monitor/observe temperature deviations from set points.
- Valves can be automatically opened and closed.
- Run time can be monitored and adjusted.
- Time and event programs can be scheduled.
- Information from plumbing systems can be incorporated via surface integration, i.e.: standalone systems that provide points information to the BMS or in-depth integration which can utilize system level controllers which can communicate over a common bus system from each plumbing sub-system.
- The cost of integrating plumbing systems into the BMS must be looked at from a first cost basis vs. long term pay back. Smaller and less complex buildings may not prove to be cost effective. Although, large buildings and complex buildings, such as hospitals, labs, etc. the paybacks are more attractive.

The following items could be included in a Building Management System and what to monitor.

- Acid neutralization basin –PH monitoring and alarm on High Water alarm.
- Air compressor – Air Pressure Dryer Dew point remote alarm.
- Water Booster Pump – Alarm annunciation discharge pressure on/off status of pump.
- Emergency showers – Water flow alarm and water temperature.
- Freeze protection heat trace – Low-limit alarm, set point alarm annunciation.
- Fuel Oil Pump sets – Alarm annunciation on/off status of pumps.
- Gas Meters – Alarm annunciation for low gas pressure flow in CFH.
- Irrigation Systems – Water flow or meter monitoring.
- Sump/Sewage Pump – High water alarm, on/off status of pump, moisture sensing probes/alarms.
- Vacuum Pumps – Vacuum pressure (in inches of mercury), remote alarms.
- Water Heaters – Probe (via BMS Installer) to monitor water temperatures, burner failures.
- Water Meters – Alarm annunciation (low flow, flow in gallons per day).

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

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UNIT – II – BUILDING SERVICES – SARA5103

HVAC SYSTEM

HVAC Design – Ventilation system - Heat Losses - Heat Gains - methods of heating and cooling and air conditioning - AC Plant – Refrigeration Cycles, Condensers and Compressors.

Central AC Plant - Zoning - Packaged Air-Conditioning Units – Ducts and Air distribution system - Variable Air Volume (VAV) Systems – Variable Frequency Drive (VFD) Industrial Air Conditioning - Energy efficiency techniques- Air conditioning in office, hospitals, malls, and laboratory etc. Air conditioning for green buildings. Components of BAS related to HVAC, Control of HVAC systems -Direct Digital Control – chiller pumps, BTU monitoring & control.

HVAC Design

HVAC (heating, ventilating, and air conditioning; also heating, ventilation, and air conditioning) is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality.

Shaft size, coordination and location :

Larger shafts reduce pressure loss and lead to lower fan energy. Early coordination with the Architect and Structural engineer can significantly relieve special constraints and the resulting system effects at the duct transitions into and out of the shaft.

Air handler size :

Larger face area for coils and filters reduces pressure loss. Adequate space at the fan outlet improves efficiency and may allow the use of housed fans, which are usually more efficient than plenum fans.

Ceiling height at tight locations :

Coordinate early with the architect and structural engineer for space at duct mains and access to equipment.

Return air path : Plenum returns are more efficient than ducted returns, but they require fire rated construction.

Outside air intake:

Sizing and location of outdoor air dampers are especially important in California due to the savings available from air-side economizer operation. See the chapter Outside Air/Return Air/Exhaust Air Control .

Acoustics :

Coordinate with the architect, acoustical engineer and owner early to determine acoustic criteria and acoustically sensitive spaces. To avoid sound traps in the design.

Window shading:

Reduction or elimination of direct sun on the windows offers several benefits in addition to the direct cooling load reduction. Ducts and VAV boxes serving perimeter zones can be smaller and less expensive due to lower peak air flow requirements. Perhaps more importantly, the glass will stay cooler, improving the comfort of occupants near the windows .

Window orientation :

Favorable orientation can be the most cost effective solar control measure. Avoid east or west-facing windows in favour of north facing windows and south facing windows with overhangs.

Glass type :

Where exterior shades and/or good orientation are not feasible, use spectrally selective glazing with low solar heat gain coefficient (SHGC).

Zoning Grouping :

spaces with similar ventilation requirements, cooling loads and occupancy schedules can provide first cost savings and energy savings (due to opportunities to shut off portions of the system).

Ventilation system

Ventilation (the "V" in HVAC) is the process of exchanging or replacing air in any space to provide high indoor air quality which involves temperature control, oxygen replenishment, and removal of moisture, odors, smoke, heat, dust, airborne bacteria, carbon dioxide, and other gases. Ventilation removes unpleasant smells and excessive moisture, introduces outside air, keeps interior building air circulating, and prevents stagnation of the interior air.

Methods for ventilating a building are divided into mechanical/forced and natural types.

Mechanical or forced ventilation

Mechanical or Forced ventilation "Mechanical" or "Forced" ventilation may be used to control humidity or odors. Heat recovery ventilation systems employ heat exchangers to bring the fresh air temperature to room temperature. Ceiling fans and table/floor fans are very effective in circulating the air in the room. Mechanical, or forced, ventilation is provided by an air handler (AHU) and used to control indoor air quality. Excess humidity, odors, and contaminants can often be controlled via dilution or replacement with outside air. However, in humid climates more energy is required to remove excess moisture from ventilation air.

1.In mechanical Ventilation the air is moved by motor driven fans which may be
a)propellor type or axial flow fans.
b)Impeller type, centrifugal or tangential flow fans.

2.The installations can take the following forms:
a)An exhaust system – removing the used air & letting fresh air find its way through grilles & openings (room under reduced pressure)
b)A plenum system – supplying air into the space & forcing out used air through grilles (slight overpressure in room)
c)A balanced system – both supplying & removing air. The most dependable, but most expensive, system used when combined with warm air heating as it permits partial recirculation.

Natural ventilation

Natural ventilation is the ventilation of a building with outside air without using fans or other mechanical systems. It can be via operable windows, louvers, or trickle vents when spaces are small and the architecture permits. ASHRAE defined Natural ventilation as the flow of air through open windows, doors, grilles, and other planned building envelope penetrations, and as being driven by natural and/or artificially produced pressure differentials.An important component of natural ventilation is air change rate or air changes per hour: the hourly rate of ventilation divided by the volume of the space.

FUNCTIONS OF NATURAL VENTILATION

1.supply of fresh air -

2. movement of air

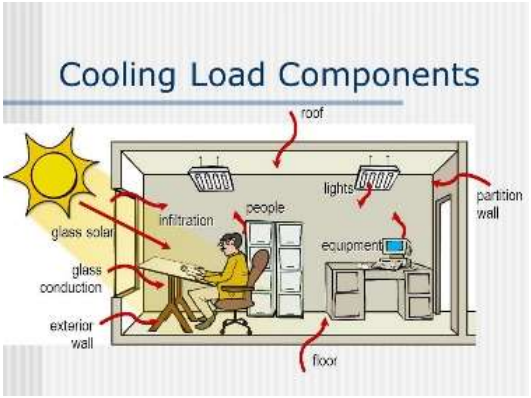
Heat Loss or Heat Gain

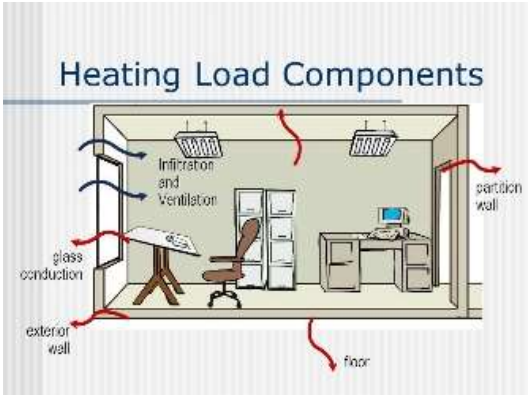
The building can be similarly considered as a defined unit and its heat exchange processes with the outdoor environment can be examined. Heat energy tends to distribute itself evenly until a perfectly diffused uniform thermal field is achieved.

Heat tends to flow from higher temperatures to lower temperature zones by conduction, convection and radiation. The rate of heat flow by any of these three forms is determined by the temperature difference between the two zones or areas considered. The greater the temperature difference, the faster the rate of heat flow.

The equations and the calculations methods given below are valid only when both the out-door and indoor temperature are constant. Such static conditions do not occur in the nature, and hence the assumption of the steady state conditions is a simplification. Calculations based on steady state assumptions are useful to determine the maximum rate of heat loss or gain and also for establishing the cooling or heating load for mechanical installations.

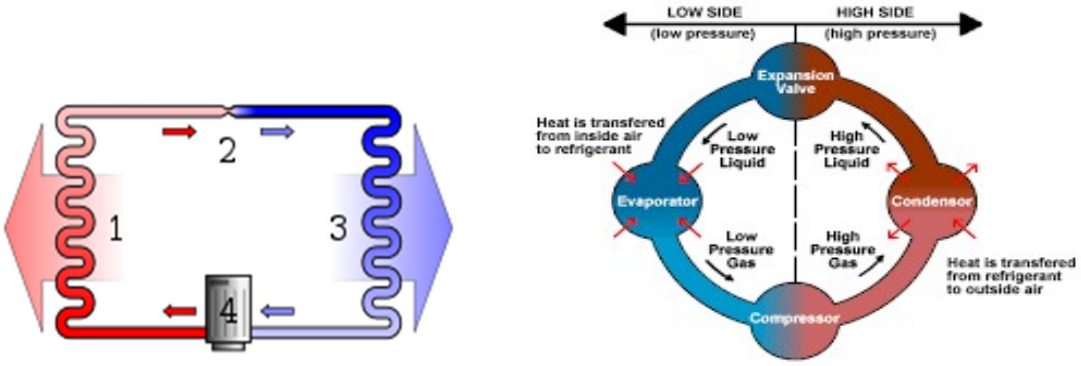
Figure illustrates the following: Qi + Qs +- Qc +- Qv +- Qm -Qe = 0





Refrigeration cycle
The refrigeration cycle uses four essential elements to cool, which are compressor, condenser, metering device and evaporator.

- At the inlet of a compressor, the refrigerant inside the system is in a low pressure, low temperature, gaseous state. The compressor pumps the refrigerant gas up to a high pressure and temperature.
- From there it enters a heat exchanger (sometimes called a condensing coil or condenser) where it loses heat to the outside, cools, and condenses into its liquid phase.
- An expansion valve (also called metering device) regulates the refrigerant liquid to flow at the proper rate.
- The liquid refrigerant is returned to another heat exchanger where it is allowed to evapourate, hence the heat exchanger is often called an evapourating coil or evapourator. As the liquid refrigerant evapourates it absorbs heat from the inside air, returns to the compressor, and repeats the cycle. In the process, heat is absorbed from indoors and transferred outdoors, resulting in cooling of the building.



A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evapourator coil, 4) compressor

Compressor

The compressor is the heart of the system. The compressor pumps the refrigerant through the air conditioning system at a designed flow rate and pressure.

When the refrigerant enters the compressor it is in a vapour state. It enters the compressor because it is literally being sucked into it. That is why the side of the compressor where refrigerant enters is called the suction side or low pressure side. The compressor compresses the vapour as it is being pumped through it. When a vapour is compressed both the pressure and temperature of that vapour increases. The vapour leaving the compressor is very hot.

Condenser

The high temperature refrigerant passes into a condenser coil. As the vapour refrigerant travels through the coil, air from a fan passes over the coil to cool the vapour refrigerant. As the vapour cools it condenses and becomes a liquid, which is referred to as a change of state. This change of state from vapour to liquid is essential. High temperature vapour refrigerant enters the unit

as the heat energy in the vapour is removed by blowing air across the condenser coil. While this is happening, the vapour changes to a liquid.

CENTRAL PLANT SYSTEM

Central systems are defined as those in which the cooling is generated in a chiller and distributed to air-handling units or fan-coil units with a chilled water system.

HVAC system components may be grouped into three functional categories: source components, distribution components, and delivery components.

1. Source components provide or remove heat or moisture. This includes refrigeration chiller for cooling and boiler or hot water generator for heating.

2. Distribution components convey a heating or cooling medium from a source location to portions of a building that require conditioning. This includes air-handling units (AHU), fan coil units, radiators etc.

3. Delivery components serve as an interface between the distribution system and occupied spaces. This includes diffusers, grilles, registers etc.

The components of a central system fall into two broad categories:

1. PRIMARY COMPONENTS
2. SECONDARY COMPONENTS

Primary components

Primary components, often called "central plant" equipment, convert energy from fuel or electricity into heating and cooling energy in the form of hot water, steam, chilled water.

Secondary components

Secondary components, sometimes called "system" equipment, deliver heating and cooling to occupied spaces:

- Air handling equipment may be centrally located or several air handlers may be distributed throughout a facility.
- Most facilities use modular air handlers, but built-up air

handlers may be found in larger facilities. All air handlers adjust air temperature and humidity and remove dust and other particles from air before distributing it to occupied spaces.

- This is accomplished through a series of coils, filters, humidifiers, fans, and dampers.

AIR HANDLING UNIT(AHU)

1. Large metal box containing a blower, heating or cooling elements, filter, and sound attenuators.
2. Connects to ductwork that distributes the conditioned air through the building and returns it to the AHU

- Ducts, plenums and shafts distribute air. Plenums above suspended ceilings are frequently used for return air. Large multi-story facilities often use shafts built into the structure for supply air return air and outside air.
- Terminal units are devices at the end of a duct or pipe that transfer desired heating or cooling to the conditioned space. Some types commonly used with central HVAC systems include fan-coil units, induction units, and convectors.
- Controls are used to make components work together efficiently.
- They turn equipment on/off, adjust energy outputs (chillers, boilers), adjust flow rates (fans, pumps, coils), adjust temperatures (air, water, thermostats in conditioned spaces), and adjust pressures (ducts, pipes, conditioned space).

CENTRALIZED CHILLED WATER SYSTEMS

It serve multiple spaces from one base location and it's divided into two types namely:

- Water cooled system and
- Air cooled system.

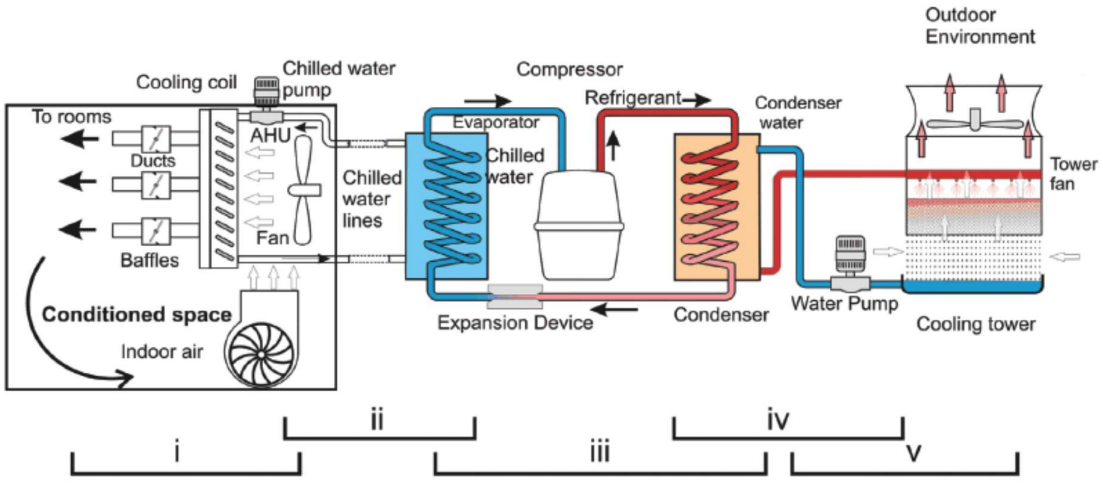
Water cooled system

These system includes a chilled water pump which circulates the chilled water through the chiller's evaporator section and through the cooling coils of the AHUs.

Air cooled system

An air cooled system transfers heat taken from the space to the air. This heated air is then released or expelled. The cooling unit must be located outside the space, the hot air may be released into the air surrounding the unit.

- The chilled water types of central air conditioning plants are installed in the place where whole large buildings, shopping mall, airport, hotel, etc., comprising of several floors are to be air conditioned.
- While in the direct expansion type of central air conditioning plants, refrigerant is directly used to cool the room air; in the chilled water plants the refrigerant first chills the water, which in turn chills the room air.
- In chilled water plants, the ordinary water or brine solution is chilled to very low temperatures of about 6 to 8 degree Celsius by the refrigeration plant.
- This chilled water is pumped to various floors of the building and its different parts.
- In each of these parts the air handling units are installed, which comprise of the cooling coil, blower and the ducts. The chilled water flows through the cooling coil.
- The blower absorbs return air from the air conditioned rooms that are to be cooled via the ducts.
- This air passes over the cooling coil and gets cooled and is then passed to the air conditioned space.



Packaged Air-Conditioning Units

Package units are unique, all-in-one self contained systems that supply both cooling and heating equipment in one "package". These units can be situated in a mechanical room, at grade adjacent to the condition space or on the rooftop.

Types :

Water cooled condenser :

In this system condenser is cooled by water. Water has to be supplied continuously in these systems to maintain functioning of the air conditioning system. The water cooled condenser is used as a function to reject the heat that was absorbed by the refrigerant in the evaporator. Water which is used for the purpose is transferred to a drain line after using in the condenser.

Air cooled condenser :

This system is called as air cooled condenser because in this system atmospheric air is used for cooling the condenser.

Duct design

Ducts are classified with respect to the velocity or the pressure of the air inside the ducts. They are as under:

A) Velocity: They are further classified in to two types as given under:

LOW VELOCITY: Air velocity does not exceed 2500 fpm in the ducts.

HIGH VELOCITY: Air velocity exceeding 2500 fpm in the ducts.

B) Pressure: They are further classified in to three types as given under:

Low pressure: Up to 100mm of water gauge.

Medium pressure: From 100mm to 170mm water gauge.

High pressure: From 170mm to 312mm water gauge.

Purpose of a duct

The major purpose of a duct is to carry the air from one point to the other without bringing it in contact with the outside atmosphere. This can be either Supply Air or Return Air.

SUPPLY AIR: It is defined as the conditioned air being supplied from the air conditioner outlet. This air is treated air & contains all the desired qualities as provided by the air conditioning system.

RETURN DUCT:It is defined as the air being supplied back to the air conditioner from the air conditioned area. This air is returned back to the air conditioner after being circulated in the conditioned area .Return air path should be 1.25 to 1.5 times the Supply air path.

FRESH AIR DUCT: It is defined as the ambient air being supplied to the air conditioner inlet from the outside atmosphere. This air is supplied to the air conditioner inlet from the outside atmosphere after being initially treated.

Aspect Ratio = Long Side / Short Side

= Width of the duct / Height of the duct

Best Aspect Ratio is 1 : 1

Maximum permissible aspect ratio is 4 : 1

CONSIDERATIONS FOR DUCT DESIGN

- Available space
- Even distribution in all parts of room
- Sound level - quiet
- No drafts / suffocation
- Appearance
- Adjustable
- No moisture condensation / dripping
- Heat gain and leakage losses
- Friction loss

Variable-air-volume (VAV)

A variable-air-volume (VAV) air conditioning system varies the volume of constant temperature air that is supplied to meet the changing load conditions of the space.

Vav terminal unit:

• It is a sheet-metal assembly installed upstream of its respective space diffusers. The unit consists of an air-modulation device, control hardware and, depending on the system application, possibly a heating coil, a filter.

VAV box perform better due to:

1.Air flow measuring – Velocity sensor more accurate to measure the air flow = better control = less temperature variation = less energy consumption not easy to maintain accuracy when flow rate is lower

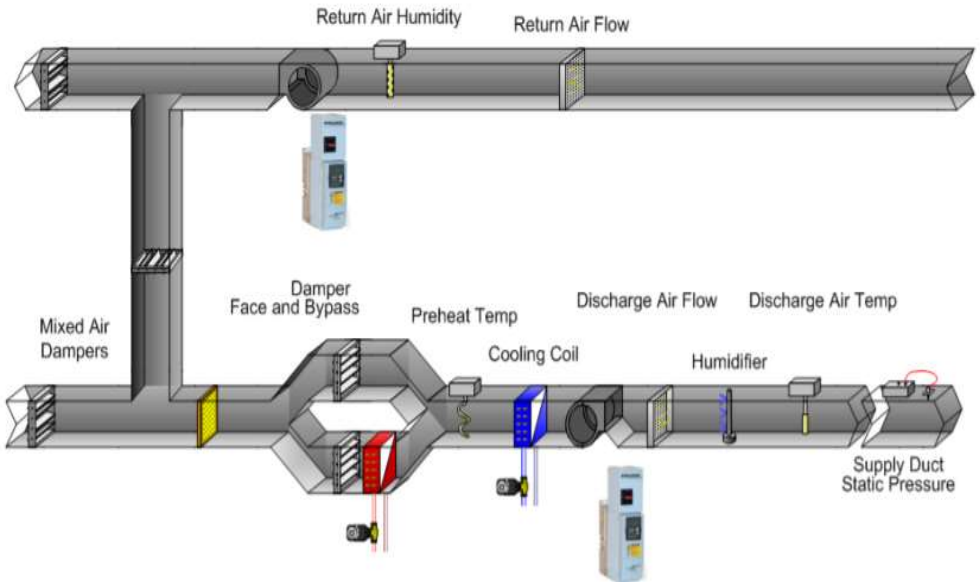
2. Air flow controlling – Flow damper

Pressure drop across the VAV box

Less the pressure drop = less fan energy consumption

3. Noise level – Mixing box

Lower dB rating = quieter the box = more comfortable Controller

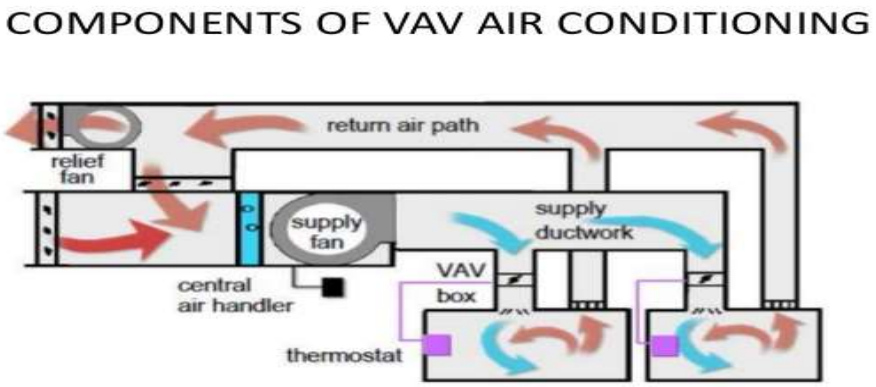


Advantages :

There are two primary advantages of this system. In modern applications it has a fan capacity control, where there are variable speed options, which is a substantial part of the total cooling energy requirements of a building. Dehumidification is greater than with any other system, therefore makes this system be a most comfortable cooling or heating for the specific application.

Disadvantages:

- Imbalance of Building Pressures
- Partial Load Comfort Problems
- Reduction in Outdoor Air
- Supply Air Dumping



Variable Frequency Drive (VFD)

A Variable Frequency Drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage supplied to the electric motor. A basic VFD system generally consists of an AC motor, a controller, and an operator interface.

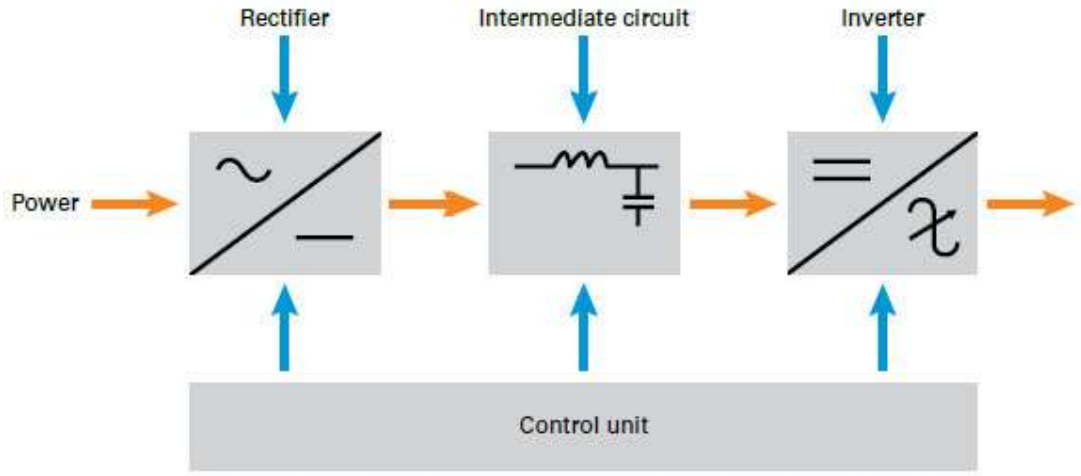
A typical VFD can be divided into three major sections:

- the power-conversion section
- the microprocessor control section (CPU) and the control section that includes the external switches an signals to control the VFD operations
- the power section where AC voltage is converted to DC and then DC is inverted back to 3-phase AC voltage

There basic design consists of four elements:

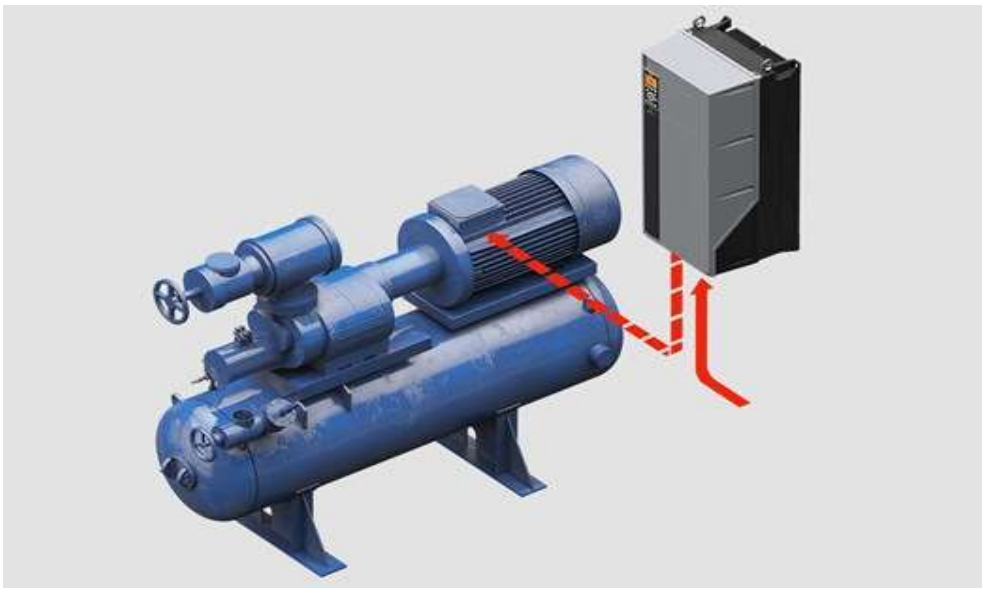
- Rectifier: the working principle of rectifier is changing the incoming alternating current (AC) supply to direct current (DC). Different designs are available and these are selected according to the performance required of the variable frequency drive. The rectifier design will influence the extent to which electrical harmonics are induced on the incoming supply. It can also control the direction of power flow.
- Intermediate circuit: the rectified DC supply is then conditioned in the intermediate circuit, normally by a combination of inductors and capacitors. The majority of VFDs currently in the marketplace use a fixed-voltage DC link.
- Inverter: the inverter converts the rectified and conditioned DC back into an AC supply of variable frequency and voltage. This is normally achieved by generating a high frequency pulse width modulated signal of variable frequency and effective voltage. Semiconductor switches are used to create the output; different types are available, the most common being the Insulated Gate Bipolar Transistor (IGBT).
- Control unit: the control unit controls the whole operation of the variable frequency drive; it monitors and controls the rectifier, the intermediate circuit and the inverter to deliver the correct output in response to an external control signal.

Variable frequency drives are typically 92-98% efficient with 2-8% losses being due to additional heat dissipation caused by the high-frequency electrical switching and the additional power required by the electronic components.



There are many reasons why we may want to adjust this motor speed.
For example, to

- Save energy and improve system efficiency
- Convert power in hybridization applications
- Match the speed of the drive to the process requirements
- Match the torque or power of a drive to the process requirements
  Improve the working environment
  Lower noise levels, for example from fans and pumps
- Reduce mechanical stress on machines to extend their lifetime
  Shave peak consumption to avoid peak-demand prices and reduce the motor size required



Variable frequency drives

Advantage :

- A variable frequency drive can vary the power supplied to match the energy requirement of the driven equipment, and this is how it saves energy or optimizes energy consumption.
- The drive can dramatically reduce energy consumption when compared to direct-on-line (DOL) operation, where the motor runs at full speed regardless of the demand.
- Using a drive, power or fuel savings of 40% are common.
- The roll-on effect means that use of drives also the reduces NOx emissions and CO2 footprint of the systems in which it's installed.

Energy efficiency techniques:

1. **Selection of Chiller**
2. **Variable Speed Drives for Pumps, Fans and Compressors:** Pump and fan capacities can be reduced and energy saved by using variable speed drives to control their speed. Reductions in both peak and off-peak energy costs can be obtained by using variable speed drives on pumps, fans and compressors that operate at varying loads.
3. **Dedicated Outdoor Air Systems:** A DOAS uses a separate air handler to condition the outdoor air before delivering it directly to the occupied spaces. While a DOAS can be applied in any design, it is the most beneficial in a facility with multiple spaces with differing ventilation needs. It reduces a building's energy use when compared to mixed air systems that requires over ventilation of some spaces. It allows the designer to decouple the latent load from the sensible load, hence providing more accurate space humidity control.
4. **Supply Air System Control:** Using Variable Air Volume boxes and dedicated individual control for 50 per cent of the occupied people or all closed cabins in the occupied area will become mandatory to ensure human comfort and energy saving benefit.
5. **Demand Control Ventilation:** In order to maintain the IAQ of the occupied area, it is required to install a fresh air system which controls, measures, monitors continuously the flow of fresh air (Outdoor air) supplied to the occupied area. CO_2 sensor can be used to measure or control the per person ventilation rate and, in turn, allow the designer to introduce a ventilation demand control strategy.
6. **Heat Recovery System:** A heat exchange enthalpy wheels can be used in comfort application, where energy in the exhaust stream would otherwise be wasted.
7. **Chilled Beams:** Chilled beams do not require a secondary fan so they are inherently more energy efficient than fan coil units, their main air terminal device rivals.
8. **Thermal Storage System for Cooling:** Consider a thermal storage system when designing chiller plant. With a thermal storage system, the idea is to run chiller equipment off-peak and store cooled water or ice, then draw on this cooling during the peak times of the day.

Air conditioning in office, hospitals, malls, and laboratory:

❖ HVAC system design strategies for better comfort in office space

The following are essential strategies that must be taken into consideration :

1. Design the space to reduce HVAC cooling loads for energy efficiency

The HVAC system consumes more energy than any other part of office space. Adding more daylight is a design consideration that's great for workplace health and wellbeing, and also for reducing heating loads in the winter.

However, to avoid solar gain and increased cooling loads in the summer, consider using tinted low-e glass. Another energy-saving idea is lighting systems that dim or turn off when there is sufficient daylight for working in the space. This strategy combined with cooler types of lighting produce less heat waste and reduce the cooling load on HVAC system.

2. HVAC system design and sizing

Calculating loads for HVAC system design must take into consideration all energy efficiency design features in order to avoid installing an oversized HVAC system.Installing air conditioning equipment that's oversized for the required load of your space will produce inadequate comfort conditions. Here's what happens: the system is constantly turning on and off, and never runs long enough to remove humidity. So space is clammy and riddled with hot and cold spots.

3. Create zones

For better energy efficiency as well as comfort, your HVAC system design should include multiple independently-controlled zones within the space. That's because, even in an open office, different areas have different requirements to remain consistently comfortable. For example:

- Perimeter spaces are more affected by weather than interior areas and should be controlled separately
- Some spaces have special needs for temperature and/or humidity control, such as computer rooms from comfort zones, and these must be controlled independently.
- Areas where large numbers of people are gathering, such as big conference rooms, will need more cooling when in use, and less when unoccupied.

4. Take advantage of sensors

Sensor technology for smart buildings has come a long way in recent years. Two types of sensors are useful for saving energy by integrating with HVAC system design:

LIGHT SENSORS : they can sense the amount of daylight available in the space, and adjust the lighting as needed. These sensors can be tied into HVAC system design to adjust the heating and cooling accordingly as well.

OCCUPANCY SENSORS track how many people are using the space at any given time, and can send messages to HVAC controls. For example, when sensors detect that a large meeting space is in use, cooling can be increased to accommodate the increased load in the area.

5. Consider under floor air distribution

Traditionally, office spaces have been cooled with overhead air distribution. However, this HVAC system design can be less than effective (and less energy efficient) in open, modern office spaces with high ceilings.

Instead, many office spaces with an open plan are using under floor air distribution systems. These systems use diffusers installed under a raised floor to deliver conditioned air to different areas within the space. The systems then take advantage of stratification that moved warm air up toward the ceiling to be replaced by the cooler conditioned air at workers' feet. Under floor air is great for providing consistent comfort levels as well as maintaining indoor air quality.

6. Address indoor air quality with ventilation

Maintaining proper indoor air quality levels is critically important for workforce wellbeing and productivity.That means addressing the "V" in HVAC: ventilation. HVAC system design must provide for adequate intake and distribution of outside air within the space, as well as well-controlled distribution of conditioned air.

❖ **HVAC system design strategies for Hospitals**

Operating theatres in which air is filtered to high levels to reduce **infection** risk and the humidity controlled to limit patient dehydration. Although temperatures are often in the comfort range, some specialist procedures such as **open heart surgery** require low temperatures and others such as **neonatal** relatively high temperatures .

HVAC system in a hospital assumes high significance due to its sensitive relationship with the health of the patients, caregivers and visitors. HVAC system is also important as the cost of its operations affects the cost of healthcare in a significant way. focuses on Three important issues in hospital HVAC design**: Indoor Air Quality (IAQ), energy recovery and system reliability.**

Seven categories of areas:
1. Surgery and critical care (operating room, delivery room, etc.)
2. Nursing (patient rooms, intensive care unit, etc.)
3. Ancillary (radiology, laboratories, etc.)
4. Administration (offices)

5. Diagnostic and treatment (examination room, therapy room, etc.)
6. Sterilisation and supply (steriliser room, equipment storage, etc.)
7. Service (kitchen, laundry, etc.)

The functional requirements dictate the HVAC requirements.
- Temperature and humidity
- Ventilation
- Pressure relationship with surrounding spaces
- Air cleanliness level
- Air distribution
- Operating hours
- System reliability

Proper understanding of both functional and HVAC views of each and every space is the foundation for a successful HVAC design.

Design of an Operating Theatre
HVAC system design for an operating theatre starts with a reminder of the following key objectives: – To control the concentration of harmful bacteria; – To prevent infiltration of less clean air into the operating theatre; – To create an air flow pattern that carries contaminated air away from the operating table; – To provide a comfortable environment for the patient and operating team; – To ensure uninterrupted operations; – To save energy.

❖ **HVAC system design strategies for Malls:**

HVAC consideration for shopping malls:

System efficiency – Electrical consumption versus how much cooling and heating the system can provide.

- **Building application** – What the intentional use of the building will be.
- **Capital cost versus payback period** – How much the client will end up paying for the air-conditioning system today and how long it will take them to recover these extra costs of a more efficient system from the resultant energy savings.
- **System longevity** – The serviceable life expectancy of the system before product quality and system performance deterioration.
- **System flexibility** – Will the system be able to cope with any alterations, variations and possible additions to the building's initial application?
- **Location** – How far are the nearest sub-contractors located the site and what are their capabilities.
- **Plant room space available** – Are there space restrictions from the architect and is the HVAC plant to be constricted to a specific area has to be considered.

Energy Conservation Measure (ECM) Strategies in HVAC System for green buildings:

❖ Demand Control Ventilation (DCV) using CO2 Sensors
❖ Dedicated Outdoor Air Systems (DOAS)
❖ Heat Recovery System
❖ Night Pre Cooling
❖ Displacement Ventilation

- ❖ Control Cooling Tower Fans by Sensing Ambient Wet Bulb Temperature
- ❖ Chilled Beams
- ❖ Consider Variable Speed Drives for Pumps, Fans & Compressors

The following strategies in the construction improves the overall energy performance of the building :

Providing High Performance Glass Façades by going for SHGC < 0.19

Providing adequate insulation on building Wall & Roof to beat ECBC & ASHRAE Standard.

Adopting Lower Power Density (LPD) for lighting as compared to the recommendation from ECBC & ASHRAE standard.

Efficient Lighting system & using Solar Energy System - Photovoltaic

Optimizing the orientation of building

Providing external & internal Solar shading devices.

Restricting the Glass Facades to meet the Window to Wall Ratio (WWR) not exceeding 60%

Water conserving plumbing fixtures

Grey water Systems Rainwater Harvesting Daylight harvesting

COMPONENTS OF BAS RELATED TO HVAC

The most common primary function of the BMS is the control of the building HVAC system including;

- Chilled Water Plant
- Cooling Towers
- Tenant Condenser Water
- Heating Water Plant
- Exhaust Systems

Building Control Applications

- Zone temperature monitoring and control
- Zone Variable Air Volume (VAV)
- CO2 monitoring and control (Air Quality)
- Air handling unit • Air flow/pressure control
- Toilet, car park, kitchen and general exhaust fan control
- After Hours Building Control Management of intelligent Buildings

System Monitoring and Alarm

1. Software alarms shall be generated at the operator workstation whenever the run status of the supply fan (with differential pressure switch) does not match the current command state.
2. A failure alarm shall occur when the run status of the load shows no operation, and the load has been commanded to be on.
3. An advisory alarm shall occur when the run status of the load shows operation and the load has been commanded to be off. All alarms shall be recorded in an alarm log for future review. Provide 15 seconds (adjustable) time delays before generating an alarm.

Equipment controllers are typically DDC but can be the equipment manufacturer's controls where DDC is integrated. All controllers have various functions in their programs for the equipment. The controller also has various levels of operation. The levels of operation include:

- Occupied Mode
- Unoccupied Mode
- Morning Warm-up Mode
- Setback Mode for Night

The sequence of Operation

a. Auto Mode:

When the AHU start is in AUTO mode (i.e. selector switch installed in the MCC must be in Auto Position), the unit is started and stopped from the BMS via a time schedule or BMS override command. When the start for the AHU is initiated, the control program residing in the controller follows the following sequence

Start-Up:

The following sequence follows with a preset time interval per interlock equipment start-up:

1) Check Supply fan trip signal – Normal State

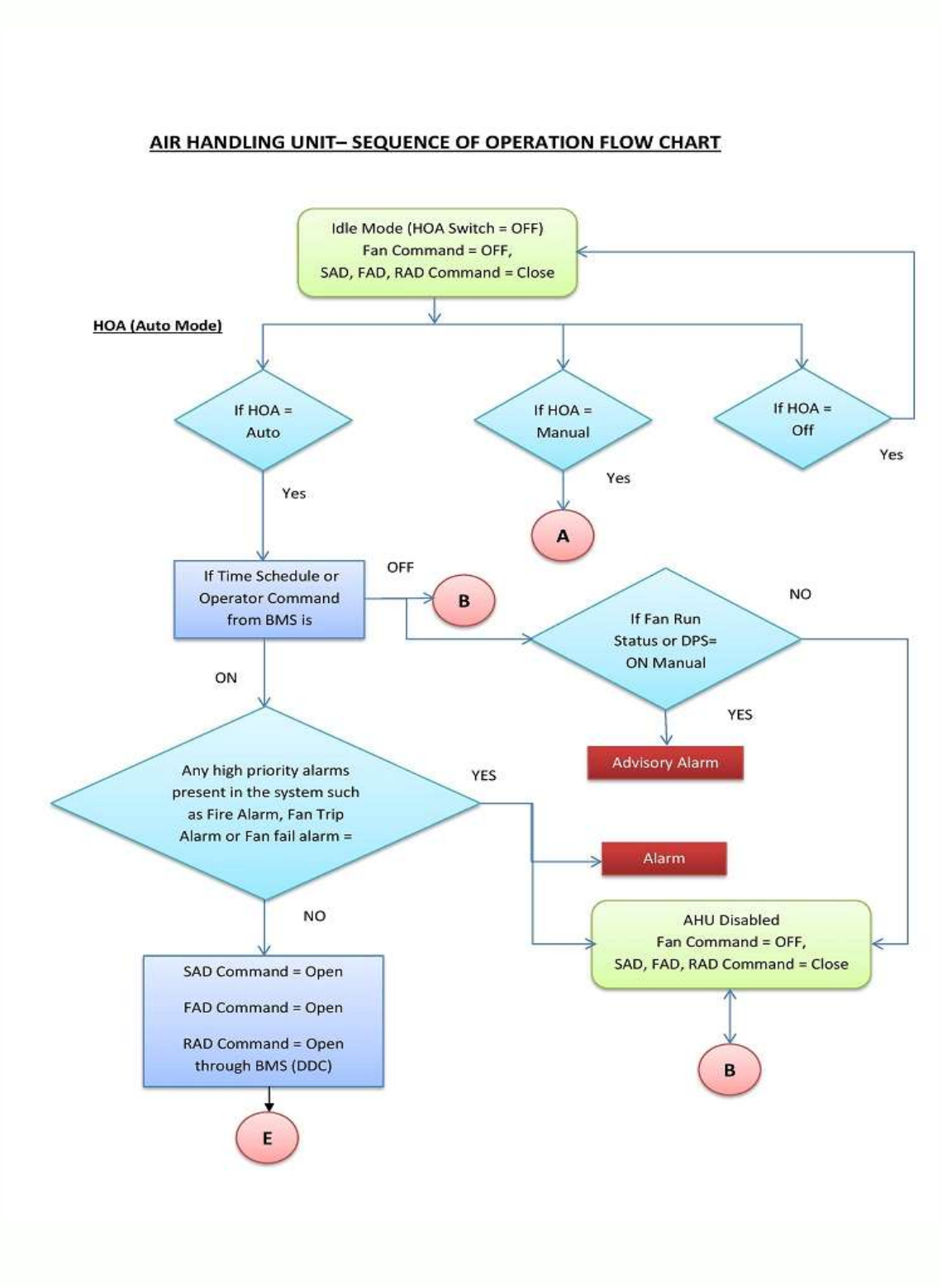
2) Supply Air Damper –Open Position

3) Outdoor Air Damper –Open Position

4) Return Air Damper – Open Position

5) Once the above conditions are satisfied, AHU is enabled to start in Auto mode or using a plant enable button on the graphics in manual mode by the operator. Once enabled, BMS will automatically command the supply fan to start.

6) Supply Fan shall start, and it's associated Interlock equipment in sequence. Through the signal from the Diff. Airflow Switch, if airflow is detected, the System will continuously run, if No airflow is detected by the DP Switch, the Supply Fan will de-activated and send an Alarm to the DDC – for "No Airflow" and shut down the whole system including its associated interlocks. If the Airflow switch signal is proved 'ON' then BMS will enable control loops.



b. Shutdown Mode:

When the shutdown command for the AHU is initiated, the control program residing in the controller follows the following sequence.

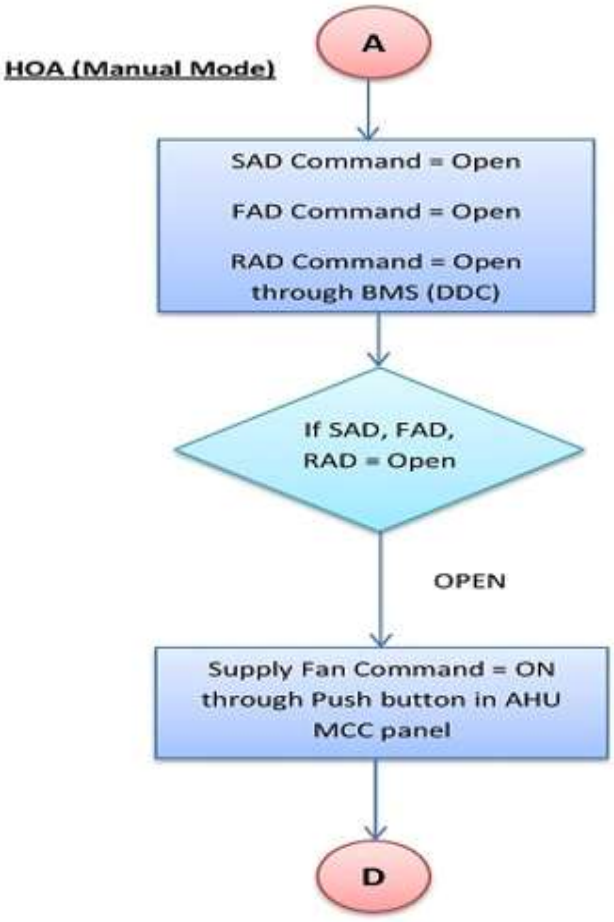
1) Send Stop command to stop the supply fan

2) The outdoor air, return and supply air damper move to close

3) Move chilled water valve to close position

c. Manual (Hand) Mode:

When the AHU is the manual mode, the fans are started and stopped from the AHU control panel. Other control except for fan on/off control shall function as per the Auto mode.



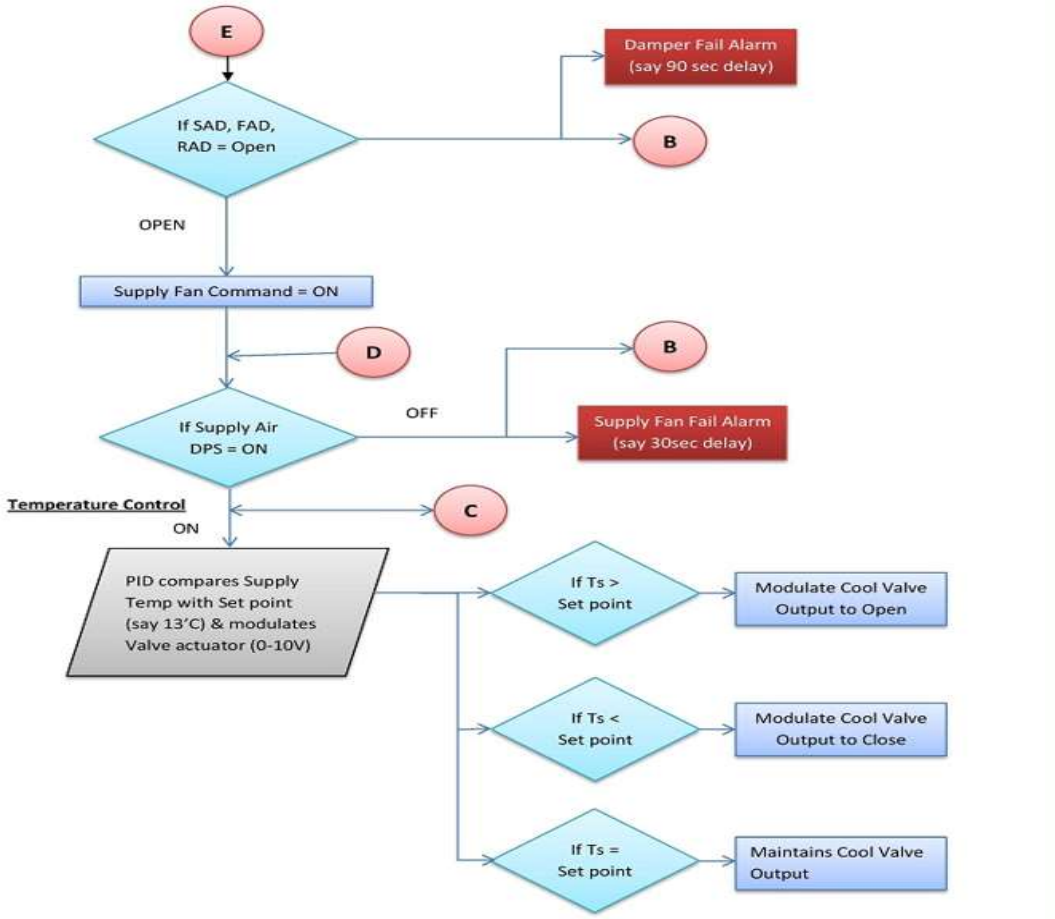
d. Fire / Smoke Mode:Fire condition is determined by the Fire Alarm Control Panel. AHU will automatically shutdowns the whole system with associated interlocks.

4. AHU Control:

The control program, on the feedback of air handling unit operation, initiates the control algorithm. This algorithm consists of three controls. Each temperature, pressure and ventilation control has its own control loop. The pressure control loop is used to modulate the speed of the supply air fan hence supply airflow. The control loops design to function as per the following explanation:

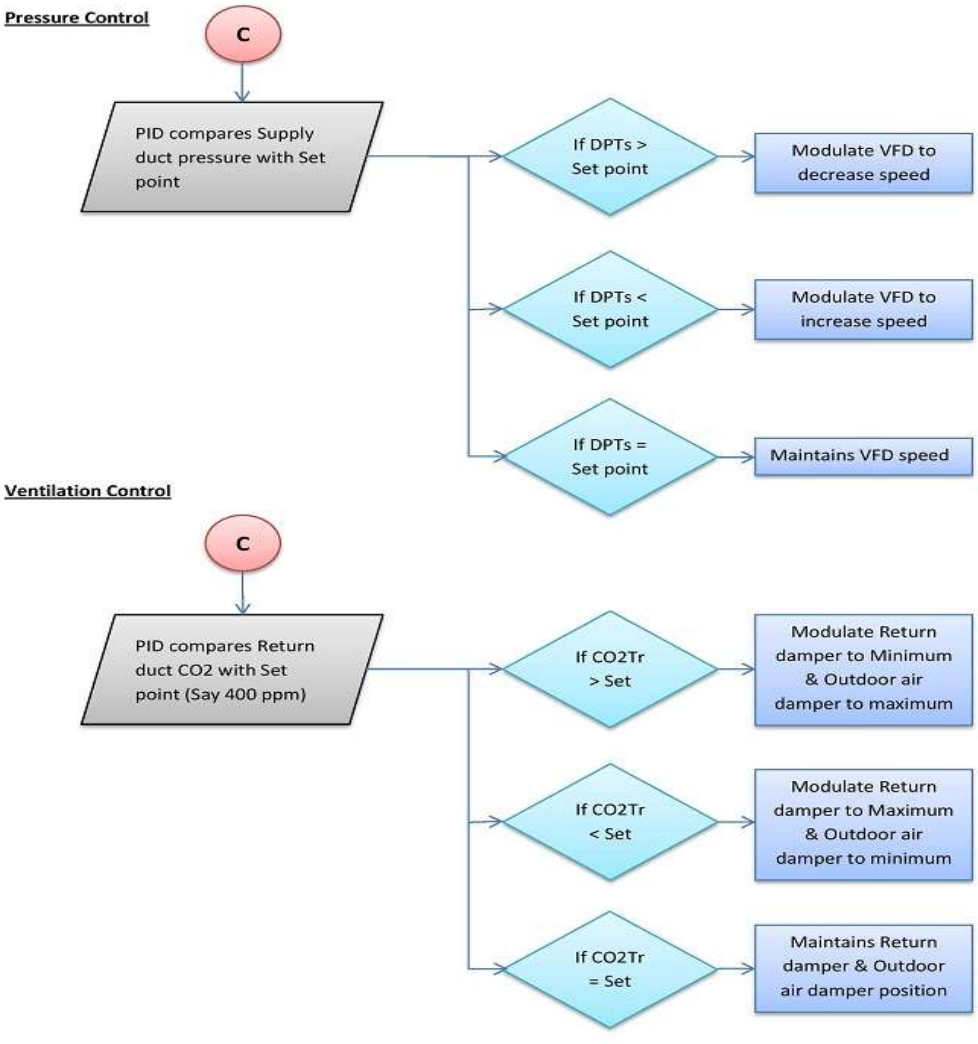
a. Temperature Control loop:

The supply air temperature installed in the duct will relay the measured signal(temperature) to the DDC controller, the DDC controller compares this signal with set-point (adjustable by the operator from BMS central) and generates an analog output to the 2-way modulating cooling valve. Based on the difference between the two values, a proportional-integral program will determine the percentage of the cooling coil valves opening to achieve the desired condition. The default set-point value for the supply air temperature is Adjustable.



b. Pressure Control loop:

The supply air pressure sensor shall be installed in the duct will relay the measured signal (static pressure) to the DDC controller, the DDC controller compares this signal with the set-point (adjustable by the operator from BMS central) and generates an analog output to the variable frequency drive (VFD) of the supply air fan. Based on the difference between the two values, a Proportional-Integral program will determine the percentage of the fan speed to achieve the desired pressure. The set-point value for the supply air pressure for each AHU shall be adjusted.



c. Ventilation Control loop:

Demand control ventilation employs return air carbon dioxide controlling strategy.A single carbon dioxide sensor sense carbon dioxide concentration in the return air duct and sent to the DDC controller, the DDC controller compares the signals with return air carbon dioxide concentration.Then DDC controller generates an analogue output to the outside air dampers and returns air damper to modulate, based on the difference between the values, the Proportional integral program will determine the percentage of the modulation of outdoor and return air dampers.

Minimum outdoor air quantity shall be governed either by building pressurisation requirement (Input from Building differential pressure sensor) or 20% of the Maximum outdoor demand of the AHU.

5. Alarms:

The following minimum alarms shall be generated on BMS

1) Filter Dirty Alarm: This is generated when pressure drop on each filter exceeds the set value to indicate dirt accumulate at filters.

2) Fan Trip Alarm: A normally open “NO” volt free contact at the MCC panel when closed will generate an alarm at the BMS indicating that the fan is tripped

3) Fan Fail: In case the supply air fan fails to start or if the differential pressure switch across

supply fan is not giving the signal according to the command due to any reason then alarm shall be generated. In case of a fan fail alarm on the BMS, due to abnormal behaviour, the DDC controller will latch the alarm. The operator has to acknowledge (reset) the alarm on the BMS once the trouble has been checked and removed. The operator shall not be able to start the AHU until the alarm s acknowledged and reset.

4) Temperature High & Low: Temperature HIGH and LOW alarms shall be generated if the supply/return air temperature rises above or falls below the supply /return air temperature alarm limit.

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – III – BUILDING SERVICES – SARA5103

ELECTRICAL & FIRE FIGHTING SERVICES

Electrical system, electrical load and emergency power – electrical conductors– Substations – power distribution system – standby and alternate power supply system. Lighting– methods of lighting– system design of lighting. Measuring Light and Illumination – Electrical power metering / monitoring.

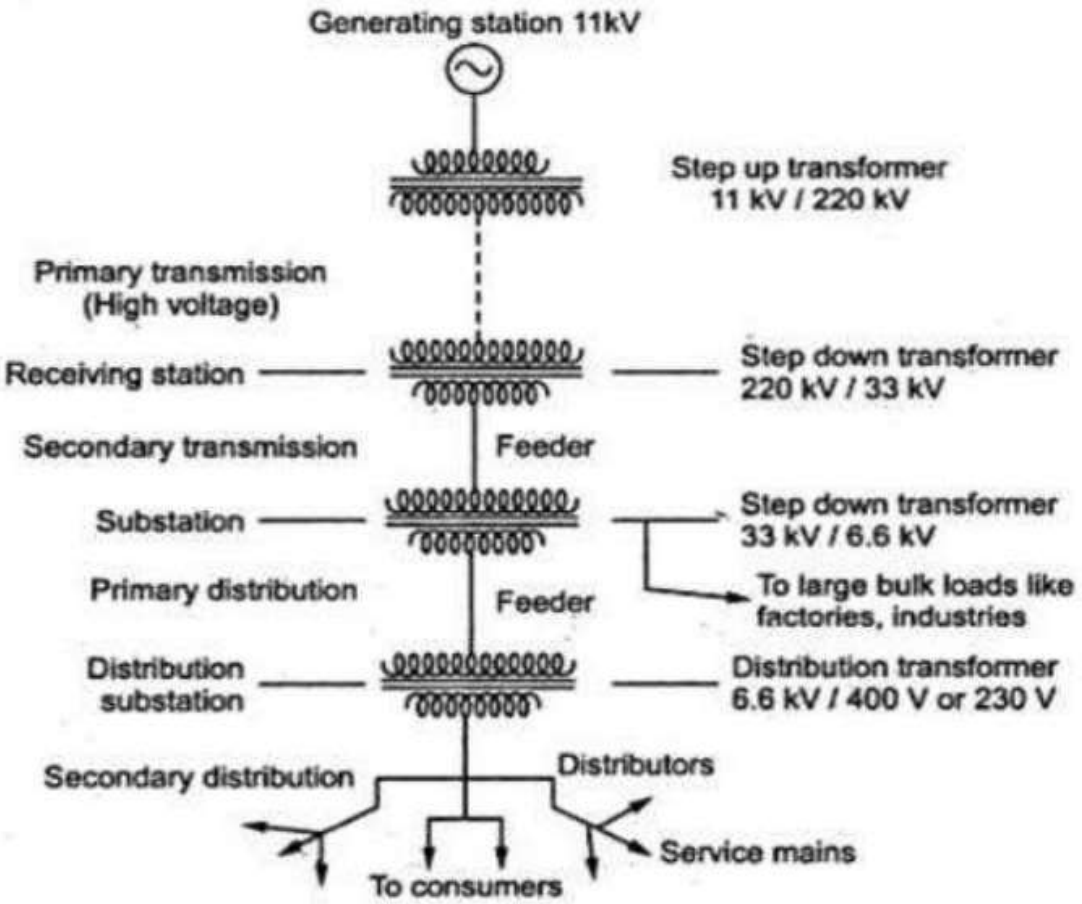
Fire detection, alarm system – fire protections and fighting systems and monitoring – sprinkler system –Public Address system– access control system - CCTV surveillance system. Components of BAS related to Electrical and fire safety, security – communication and automation system.

Electrical system

Distribution system is a part of power system, existing between distribution substations and consumers.

It is further classified on the basis of voltage

- Primary distribution system- 11 KV or 6.6 KV or 3.3 KV
- Secondary distribution system- 415 V or 230 V



Classification Of Distribution System: It can be classified under different considerations as;

1. Type Of Current:

a) AC Distribution System

b) DC Distribution System

2. Type Of Construction:

a) Overhead System

b) Underground System

3. Number Of Wires:

a) Two Wire

b) Three Wire

c) Four Wire

4. Scheme Of Connection:

a) Radial Distribution System

b) Ring or Loop Distribution System

c) Interconnected Distribution System

Ac distribution :

A.c. distribution system is the electrical system between the step-down substation fed by the transmission system and the consumers' meters. The a.c. distribution system is classified into (i) primary distribution system and (ii) secondary distribution system.

Primary distribution system:

- voltages somewhat higher than general utilisation and handles large blocks of electrical energy than the average low-voltage consumer uses.
- Commonly used primary distribution voltage 11KV, 6.6 KV,3.3 KV.
- Electric power from the generating station is transmitted at high voltage to the substation located in or near the city.
- At this substation, voltage is stepped down to 11 kV with the help of step-down transformer.
- Power is supplied to various substations for distribution or to big consumers at this voltage.
- This forms the high voltage distribution or primary distribution.

Secondary distribution system:

 It is that part of a.c. distribution system which includes the range of voltages at which the ultimate consumer utilizes the electrical energy delivered to him.

 The secondary distribution employs 400/230 V, 3-phase, 4-wire system.

D.C. Distribution :

 D.c. supply is required for the operation of variable speed machinery (i.e., d.c. motors), for electro-chemical work and for congested areas where storage battery reserves are necessary.
 For this purpose, a.c. power is converted into d.c. power at the substation by using converting machinery e.g., mercury arc rectifiers, and motor-generator sets.

Type of DC distributor:

The dc supply from the substation may be obtained in form of

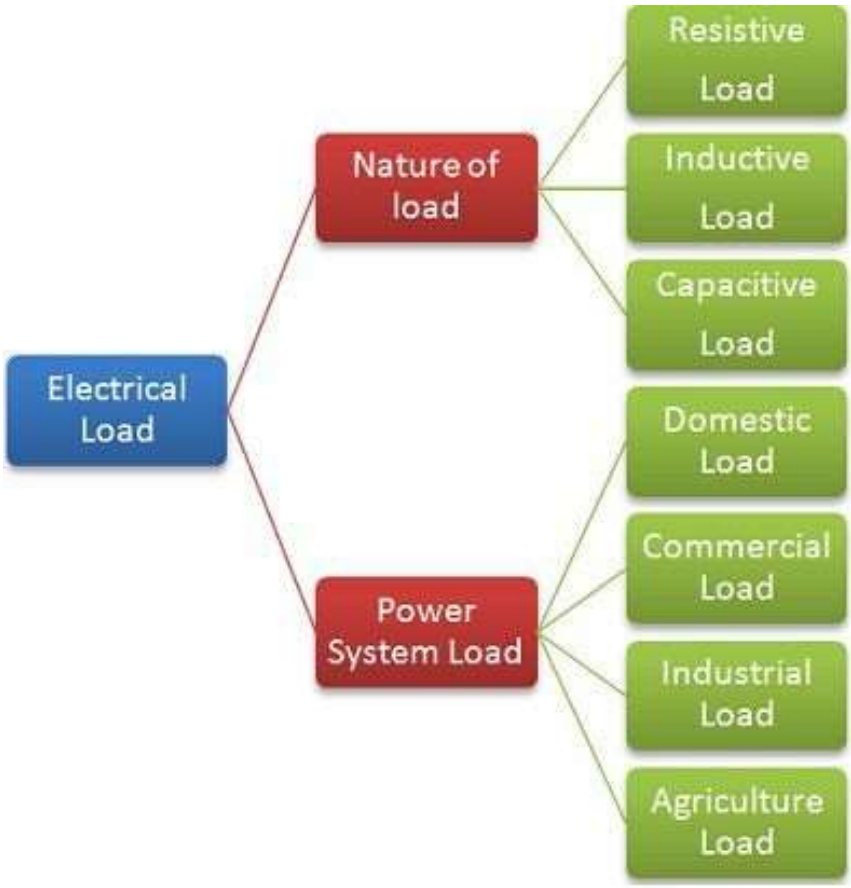
(i) 2-wire or

(ii) 3-wire for distribution.

Electrical load

The electrical load is a device that consumes electrical energy in the form of the current and transforms it into other forms like heat, light, work, etc. The electrical load may be resistive, inductive, capacitive or some combination between them.

- To indicates a device or a collection of the equipment which use electrical energy.
- For showing the power requires from a given supply circuit.
- The electrical load indicates the current or power passing through the line or machine.



Electrical conductors

- A conductor is an object or type of material that allows the flow of charge (electrical current) in one or more directions.
- Materials made of metal are common electrical conductors.

Electrical current is generated by the flow of negatively charged electrons, positively charged holes, and positive or negative ions in some cases.

- Materials include metals, electrolytes, superconductors, semiconductors, plasmas and some nonmetallic conductors such as graphite and Conductive polymers.
- Copper has a high conductivity. Copper, Silver, Gold, Aluminum are the examples of good conductor.

Diesel generator :

o Electric power generators can be grouped into one of three different types depending on their style of operation (ISO 8528)

1. Continuous
2. Prime
3. Standby

STANDBY :

- o Supply emergency power for a limited duration during a power outage.
- o Designed to operate at a maximum 200 hours per year.
- o No overload capabilities built into the units.
- o Variable load factor is 70 % of standby rating.
- o Not for maintained utility paralleling applications.

PRIME :

- o Can accommodate varying loads on an unlimited basis throughout the year.
- o The average power factor cannot exceed 70 percent of the prime rating.
- o Designed to operate at a maximum 750 hours per year.
- o 10% overload available, but limited to 1 in 12 hours and not to exceed 25 hours per year.

CONTINUOUS :

- o Unlimited hours of usage.
- o The average output of a continuous power gen set is 70 to 100 percent of the rating and is designed to provide 100-percent power load for every hour during the year.
- o Used in situations where a limited amount of power load fluctuation occurs.

Diesel generator

Substations:

According to service requirements it is classified in to transformer substations, switching substations and converting substations.

(1) Transformer substations: majority of the substations in the power system are in the type. they are used to transform power from one voltage level to another voltage level. transformer is the main component in such substations. transformer substations are further classified into step-up substations, primary grid substations, secondary substations and distribution substations.

(a) step-up substations: these substations are usually located at the generating stations. generating voltage of the order of 11kv needs to be stepped up to a primary transmission voltage level of the order of 220kv or 400kv.

(b) primary grid substations: these substations are located at the end of primary transmission lines and the primary voltage is stepped down to suitable secondary voltages of the order of 66kv or 33kv.

(c) secondary substations: the voltage is further stepped down to 11kv. large consumers are supplied power at 11kv.

(d) distribution substations: these substations are located near the consumer localities to supply power at 400v, three phase or 230v, single phase to the consumers.

(2) Switching substations: these substations are meant for switching operations of power lines without transforming the voltage. different connections are made between the various transmission lines.

(3) Converting substation: such substations are meant for either converting ac to dc or vice versa. some are used to change the frequency from higher to lower or vice versa for industry utilisations.

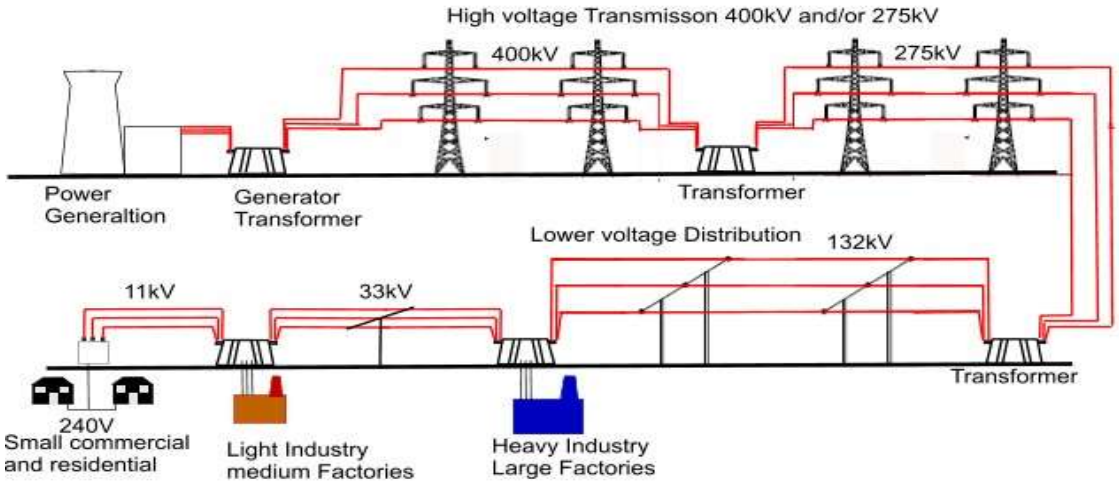
According to constructional features substations are classified into indoor substations, outdoor substations, underground substations and pole mounted substations.

(1) Indoor substations: all equipments of the substation are installed within the station buildings.

(2) Outdoor substations: all equipments such as transformers, circuit breakers, isolators, etc., are installed outdoors.

(3) underground substations: in thickly populated areas where the space is the major constraint, and cost of land is higher, under such situation the substations are laid underground.

(4) pole mounted substations: this is an outdoor substation with equipments installed overhead on a h pole or 4 pole structure.



Location and requirement of substation

- The substation should preferably be located in separate building and could be adjacent to the generator room, if any. location of substation in the basement floors should be avoided, as far as possible.
- The ideal location for an electrical substation for a group of buildings would be at the electrical load centre on the ground floor.
- The floor level of the substation or switch room shall be above the highest flood level of the locality.
- Generally the load centre would be somewhere between the geometrical centre and the air conditioning plant room, as air conditioning plant room would normally be the largest chunk of load, if the building is air conditioned.

- Oil filled transformers may be used only in substations located in separate single or two storeyed service buildings outside the main building structure and there shall atleast 6 meter clear distance between the adjoining buildings and substation such that fire tender is able to pass between the two structures.
- If dry type transformer is used, it may be located adjacent to medium voltage switchgear in the form of unit type substation. no separate room or fire barrier for the transformer is required, in a substation with oil free equipment. in such a case the room size will decrease. layout of equipment has to keep the requirement that any one piece of equipment or sub-assembly can be taken out of service and out of the installed location, while keeping the remaining system in service.

Layout of substation:

The flow of electric power is from supply company's room to hv room, then to transformer and finally to the medium voltage switchgear room. the layout of the room shall be in accordance with this flow, so as to optimise the cables, bus-trunking etc.

High voltage switch room — in case of substation having one transformer and one source of supply, the owner is required to provide one high voltage switch. in case of single point supply

with two or more transformers the number of switch required will be one for incoming supply and one for each transformer.

Power distribution system:

Distribution configurations :

1. single-end fed
2. double-end fed
3. closed ring network

Single-end fed

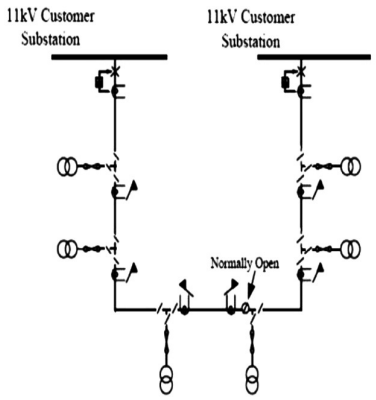
- The power is supplied through a single source
- The supply security is the lowest as any single point failure will result in the loss of supply to the customer substation

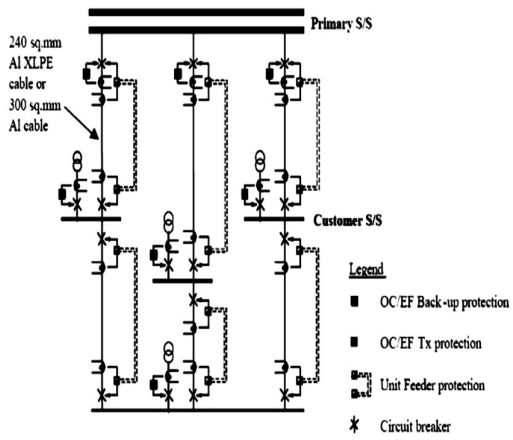
Double- end fed with an no point

- To provide a higher supply security, the customer substations can be fed from two sources.
- the customer substation is normally supplied from a single end and in the case of loss of supply from the one source end, for example due to a component failure, the no (normally open) point can be closed to restore supply after the faulty portion of the component is isolated.

Ringed network configuration

- Atypical customer substation in a ring-configured network contains two feeders and one transformer feeder.
- The former have cb"s and cable connecting to other substations while the later has cb's and cable connecting to transformer.





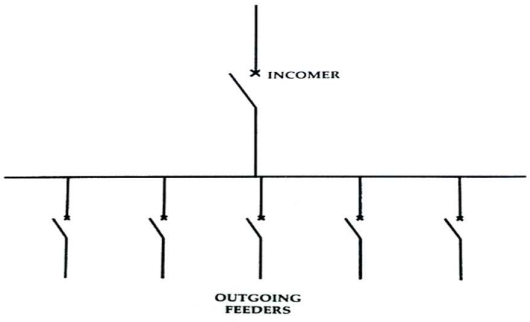
Schemes of distribution system:

The various scheme of distribution system in power control center are as follows.

1) single bus-bar
2) sectionalized bus-bar
3) sectionalized ring bus-bar scheme
4) duplicate bus-bar scheme
5) tie bus system

1) Single bus scheme

- simple and economical
- only one bus bar – incoming and outgoing feeders are connected to this bus.
- if fault takes place on the bus, total system has to be shut down and power supply cannot be restored quickly
- non flexible
- go for it when – economic is main consideration and load is of non critical nature.
- this type of arrangement is used in small substation with single feeder.



2) Sectionalized bus

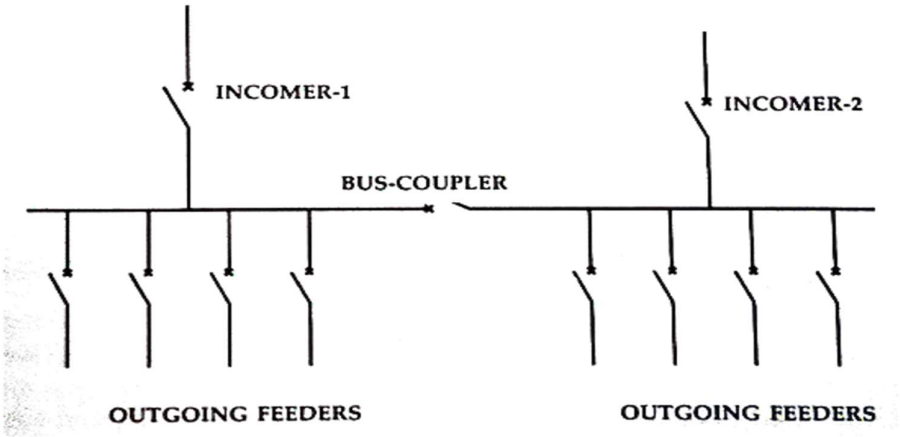
- A simple system has two incomers with one bus coupler
- In normal condition, the bus-coupler remains open while the two bus bars are fed independently by two incoming feeders.
- Each feeder is capable of feeding the entire load of the PCC in case of failure of power supply of either of the incoming feeder
- The bus coupler is used to connect the two buses when the system is fed by one source
- To prevent synchronization of the two incomers, the bus-coupler is electrically

interlocked with the two incomers, so that at a time all the three circuit breakers could not be closed.

- Used in projects situation 100% redundancy of power need – manufacturing plant,

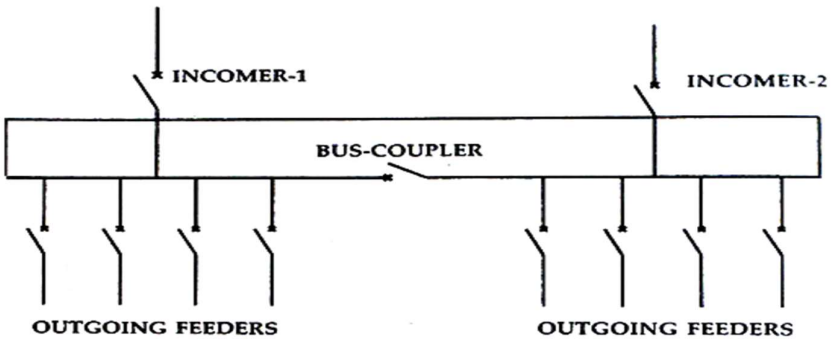
service industry, commercial area.

- More flexible



3) Sectionalized ring bus – bar scheme

- In sectionalized ring bus-bar system, both the open ends of the bus-bars are joined through another bus bar.
- It has more flexibility and each section of the bus can feed power to another section



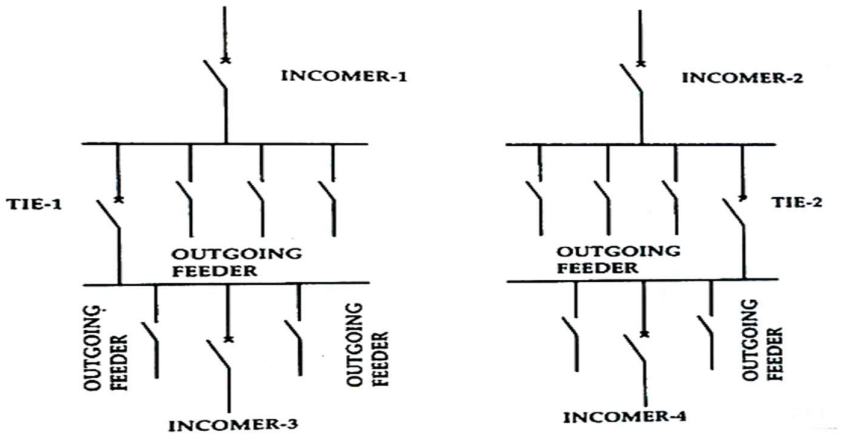
4) Duplicate bus-bar scheme

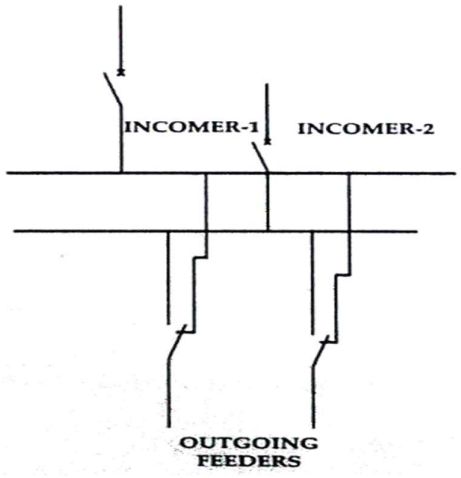
- Two bus bars are provided
- The bus bars are supplied with separate sources of power supply.
- The load is connected to the bus-bars by the on-load changeover switch, so that in case of failure of one source or fault on one bus, the power to the load can be fed through another bus.

5) Tie bus system

- Sometimes it is needed to join two PCC through the tie bus.
- For example, the DG PCC and grid PCC could be joined through two tie bus bars to
- increase the flexibility of the system.

Tie bus system





Duplicate bus-bar scheme

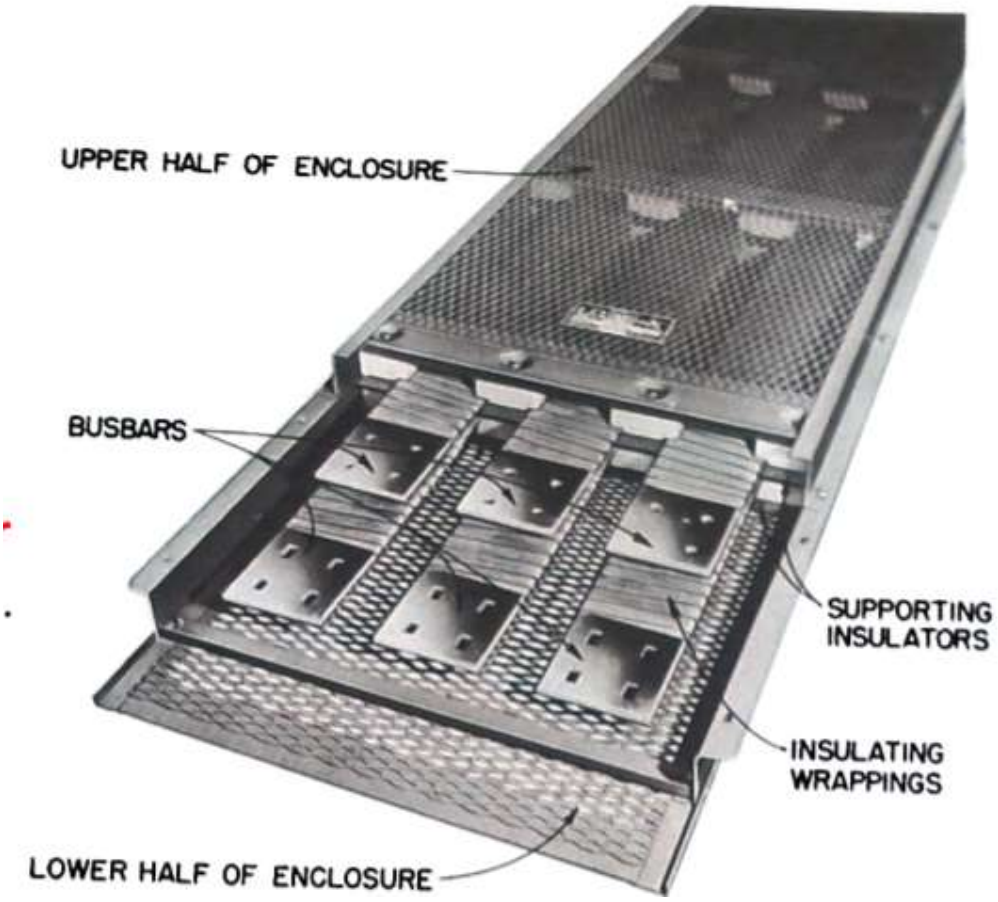
Busway

o Cable and conduit assemblies are costly and time consuming to install and needs more space. Once installed, they are difficult to change. To eliminate these shortcomings, power is often distributed using enclosed bus bars.

o A major advantage of busway is the ease with which busway sections are connected.

o Electrical power can be supplied to any area of a building by connecting standard lengths of busway.

o It typically takes up to 35% fewer man – hours to install or change a busway system that cable and conduit assemblies.



Busway solutions include these core elements:

Conductor : Also known as busbars, these are solid bars of either copper or aluminum that conduct electrical current .

Housing : This is a metal enclosure, typically made of aluminum, that contains the conductors.

Insulation: This key components electrical faults by separating conductors from one another and from the units housing. Most busway products feature either air-insulated or epoxy-insulated designs.

Types of bus systems :

o Bus system can be one of the following types, depending upon its application :

1) Non – segregated

2) Segregated

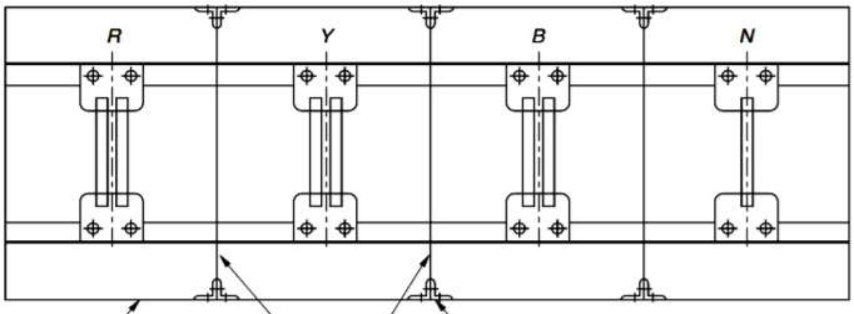
3) Isolated phase bus (IPB)

4) Rising Mains (Vertical bus systems)

5) Overhead Bus (Horizontal bus system)

6) Non-conventional bus systems

- Compact and sandwich type
- Partially isolated phase bus (PIPB) type
- Gas (SF6) insulated bus bars (GIB)



A SEGREGATED PHASE BUS SYSTEM

BMS- DG SETS MONITORING – RS 485 MODBUS INTEGRATION :

HT AND LT PANEL :

BMS is incorporated in the substation for

1. Monitoring Incoming HT voltage, Frequency, MW, MVA, PF, KWH
2. Monitor outgoing LT voltage, current, KW, KWH
3. Monitor Breaker status (ON/OFF/TRIP)
4. Monitor Transformer Fault status
5. MCC feeder monitoring
6. Energy monitoring and recording of individual feeder at MPCC

H.T. PANEL VCB MONITORING – MODBUS RS485 INTEGRATION :

- HT panel VCB monitoring device Checks Voltage of Incoming EB supply and the status of VCB and sends the information to IBMS server as analog signal.

M.V. PANEL ACB MONITORING – MODBUS RS485 INTEGRATION :

- If ACB is ON, supply is through
- If ACB is OFF, supply is OFF – Then Generator Takes Over
- Panel shows readings of Voltage, Shutting off power zone– wise can be done

APFCR PANEL – RS 485 MODBUS INTEGRATION :

- For maintaining a constant power factor of 0.95 for electrical supply by capacitor bank.
- The IBMS server shows power factors and switches on Capacitors. Adds or removes Capacitor load based on the power consumption and optimizes the system.

DG SETS MONITORING – RS 485 MODBUS INTEGRATION :

BMS is incorporated in the dg for

1. Monitors the status of DG set and log number of run hours
2. Monitor DG Battery charger
3. Control start/stop of each pump and link it to start/stop DG sets.
4. Monitor MW, MVA, frequency and PF of each DG
5. Diesel tank level monitoring.
6. Monitoring of breaker status available in the DG control panel

DG test mode :

- To check the generator if it works for a changeover
- It is set as per client requirement for every week or a particular no. of days.
- The generator automatically switches on at the set time for a set duration even if there is no power failure

Setpoints :

Overload current: The generator trips automatically when the current generated is more than the setpoint (due to faults in the generator).

High voltage & over frequency : If there is a generation of High Voltage or Frequency , the Generator trips Automatically

Engine safety dripping : If the water temperature exceeds 90 deg C (before water boils) there is tripping

Oil pressure:If oil pressure < 2kg/cm sq. engine shuts off automatically

LIGHTING DESIGN

Light defines space, enhances color and reveals the intricacies of texture and form.

The lighting design should take into consideration the following aspects:

1. ILLUMINATION LEVEL (right quantity of light)

2. PROPER PLACEMENT OF LUMINAIRE (proper location)

3. WITH EFFICIENT INTEGRATED CONTROLS

Lighting design can be governed on the basis of following criteria's:

1. Light distribution:

A. Task and ambient lighting B. Day lighting integration C. Light pollution and light trespass.

2. Lighting quality and quantity:

A. Illumination levels B. Adaptation levels

3. Lighting on people and object :

A. Modeling faces and objects B. Surface characteristics C. Points of interest D. Sparkle

4. Space and workplace considerations:

A. Flexibility B. Appearance of the space and luminaires C. Color appearance D. Luminance of room surfaces E. Flickering of light F. Direct and reflective glare

Lighting systems:

Lighting systems can be divided into six generic types. In many applications, a combination of these basic systems is used.

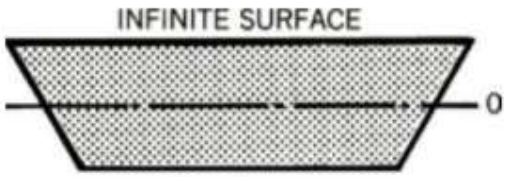
1.General Lighting 2. Localized Lighting 3. Ambient Lighting 4. Task Lighting 5. Accent Lighting 6. Decorative Lighting

Visualizing light distribution

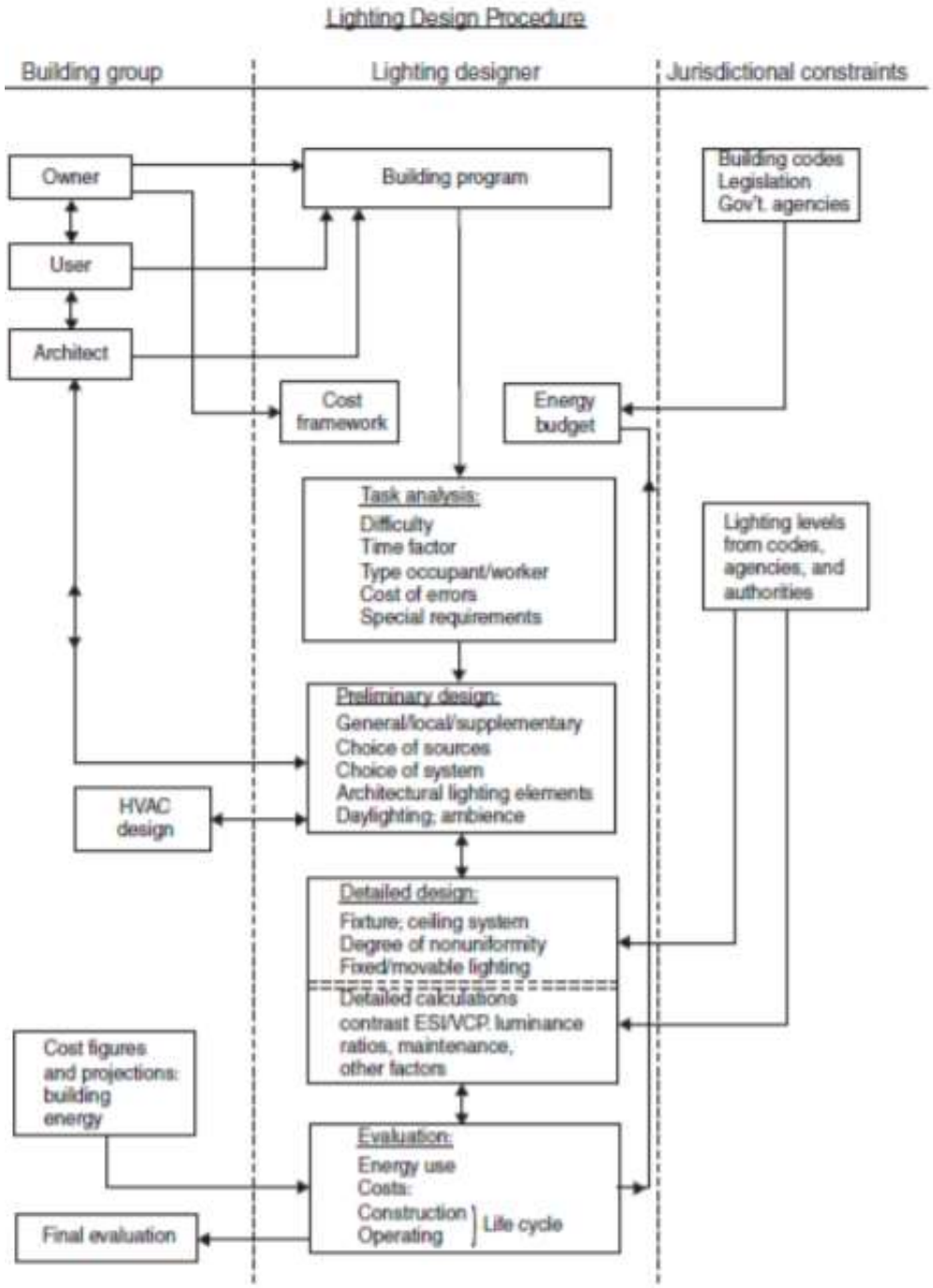
I. For a point light source, the illumination (foot candles [lux]) is inversely proportional to the square of the distance.

II. Infinite line source: The illumination from a line source of infinite length is inversely proportional to the distance.

III. Infinite surface: The illumination from a surface of infinite area is constant with distance. A typical example of this kind of light source would be well-distributed indirect lighting in a large room. only direct sunlight acts as a beam of parallel light.(luminaire optics also will)



LIGHTING DESIGN PROCEDURE CHART



LIGHTING CONTROL:

1. Dimming 2. Occupancy sensing 3. Scheduling 4. Daylight harvesting 5. task/ambient lighting 6. Personal (manual) control of workstations

Some rules for the design of efficient electric lighting :

1. Use light-colored surfaces for ceilings, walls, floors, and furniture.

2. Use local or task lighting to prevent the unnecessary high illumination of non-work areas.

3. Use task/ambient lighting for most work areas.

4. Use electric lighting to complement daylighting.

5. Use the lowest recommended light level for electric lighting.

6. Carefully control the direction of the light source to prevent glare and veiling reflections.

7. Use high-efficacy lamps (e.g., metal halide, fluorescent, and LED).

8. Use the full potential of manual and automatic switching and dimming to save energy and the environment. Use occupancy sensors, photo sensors, timers, and central energy management systems whenever possible.

9. Use Energy Star–labeled lamps.

Illuminance: glare

• Light Level or Illuminance, is the total luminous flux incident on a work plane, per unit area. The work plane is where the most important tasks in the room or space are performed. • There are recommended minimum illuminance for each place or task that must be followed, Standards.

LUMINAIRES- TYPE

Illustration	Distribution of Light (% directed up/ % directed down)	Type
	0–10 90–100	*Direct:* Direct lighting fixtures send most of the light down to the workplane. Since little light is absorbed by the ceiling or walls, this is an efficient way to achieve high illumination on the work-plane. Direct glare and veiling reflections are often a problem, however. Also, shadows on the task are a problem when the fixture-to-fixture spacing is too large.
	10–40 60–90	*Semidirect:* Semidirect fixtures are very similar to direct luminaires except that a small amount of light is sent up to reflect off the ceiling. Since this creates some diffused light as well as a brighter ceiling, both shadows and the apparent brightness of the fixtures are reduced. Veiling reflections can still be a problem, however.
	40–60 40–60	*General diffuse:* This type of fixture distributes the light more or less equally in all directions. The horizontal component can cause severe direct glare unless the diffusing element is large and a low-wattage lamp is used.
	40–60 40–60	*Direct–indirect:* This luminaire distributes the light about equally up and down. Since there is little light in the horizontal direction, direct glare is not a severe problem. The large indirect component also minimizes shadows and veiling reflections.
	60–90 10–40	*Semi-indirect:* This fixture type reflects much of the light off the ceiling and, thus, yields high-quality lighting. The efficiency is reduced, however, especially when the ceiling and walls are not of a high-reflectance white.
	90–100 0–10	*Indirect:* Almost all of the light is directed up to the ceiling in this fixture type. Therefore, ceiling and wall reflectance factors must be as high as possible. The very diffused lighting eliminates almost all direct glare, veiling reflections, and shadows. The resultant condition is often used for ambient lighting.

The following describes the various techniques used to improve the types of luminaires: Lenses, prisms, diffusers, baffles, and reflectors are all used in fixtures to control the manner in which light is distributed from the lamps.

Lighting design consideration criteria are as follows:

- The analysis of quality and quantity of light
- Consider colour appearance, colour rendering
- Consider lamp life and luminaire efficiency
- Consider light distribution
- Consider luminaire position and maintenance
- Consider controls and use of daylight

Electrical power metering

A device that measure the amount of **electrical energy** consumed by electrically Powered devices.There are two types of EM which works on different mechanism .

 Electromechanical induction type meter
 Electronic meter or solid state meter

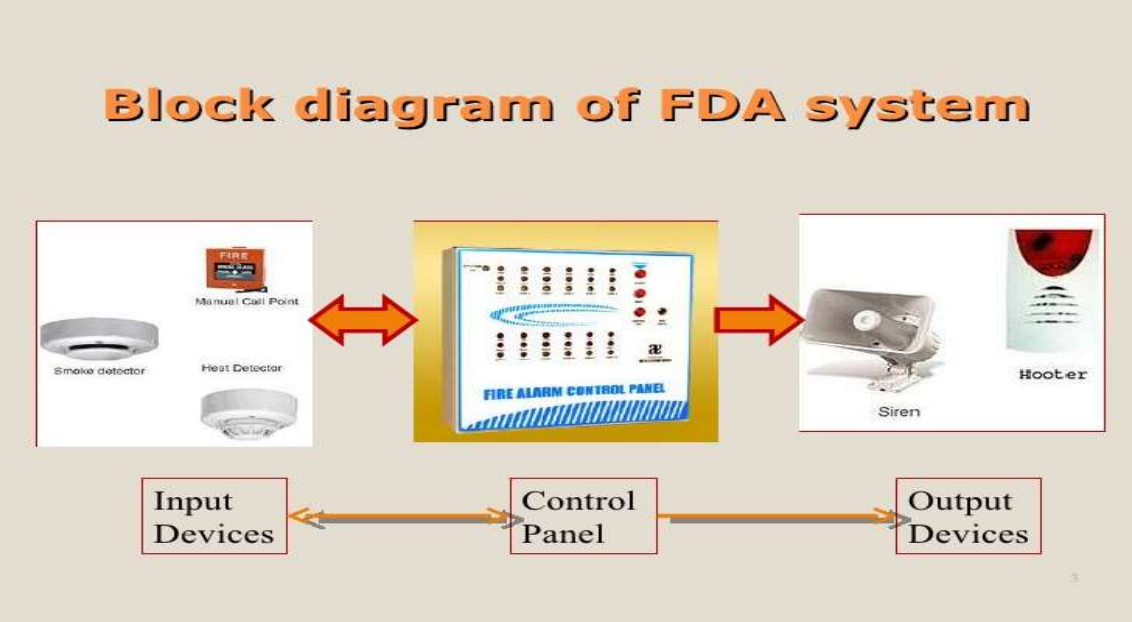
Electromechanical induction type meter:
Measure energy by counting revolution of a rotating disk.
 The metal disk is non-magnetic, but electrically conductive.
 The number of revolutions is proportional to the energy usage
1) Voltage coil - many turns of fine wire encased in plastic, connected in parallel with load.
2) Current coil - three turns of thick wire, connected in series with load.
3) Stator - concentrates and confines magnetic field.
4) Aluminium rotor disc.
5) rotor brake magnets.
6) spindle with worm gear.
7) display dials.

Electronic Energy Meter (EEM):
Electronic Energy Meter is based on Digital Micro Technology (DMT).
 Functions are controlled by a specially designed IC called ASIC (Application Specified Integrated Circuit).
 Analogue circuits are also present in EEM to “Sample” current and voltage.
 The ‘Input Data’ (Voltage) is compared with a programmed ‘Reference Data’ (Voltage) and a ‘Voltage Rate’ is given to the output.
 This output is then converted into ‘Digital Data’ which is converted into average value.
 Average Value / Mean Value is the measuring unit of power.
 The output of ASIC indicated by the LED as “Pulses”. These pulses are equal to Average Kilo Watt Hour (kWh / unit).

This type of meter has various features
 Display in LCD LED monitors
 Calculate real power, reactive power , apparent power
 Calculate bill in specified tariff plan .
 Send billing information to remote wirelessly .
 Report and record important parameter.

Fire detection

Fire detectors sense one or more of the products or phenomena resulting from fire, such as smoke heat, infrared and/or ultraviolet light radiation, or gas. In dwellings, smoke detectors are often stand-alone devices. In non-domestic buildings, fire detection will typically take the form of a fire alarm system, incorporating one or more of the following automatic devices.



Smoke detectors

• It initiate an alarm much quicker than a heat detector because it responds to smoke

generated very early in a fire's development (incipient stage)

Basic types of smoke detectors:

– Ionization, spot type

– Photoelectric, spot type

– Projected beam detector

– Air- sampling smoke detector

List of factors to be considered for smoke detector placement in section:

• The design should account for the contribution of the following factors in predicting detector response to the anticipated fires to which the system is intended to respond:

1. Ceiling shape and surface 2. Ceiling height 3. Configuration of contents in the protected area 4. Combustion characteristics and probable equivalence ratio of the anticipated fires involving the fuel loads within the protected area 5. Compartment ventilation 6. Ambient temperature, pressure, altitude, humidity, and atmosphere 7. The easiest configuration to address for spot type smoke detectors is the standard 10-ft smooth ceiling with normal ambient temperatures.

SMOKE DETECTORS	
Ionization, spot-type	Early warning or life safety. This detector is most efficient when flaming fires are expected.
Photoelectric, spot-type	Most efficient when smoldering fires are expected or where the smoke has to travel a distance before reaching the detector ("aged" smoke).
Photoelectric, beam-type	Used in high ceiling environments such as churches, atriums and warehouses.
Photoelectric, air sampling-type	Used in high value applications, such as computer rooms; also used air sampling-type in high airflow areas and some rack storage application Notification of occupants or others of potentially dangerous conditions, such as the presence of fuel gases or toxic gases such as carbon monoxide shall be permitted.

Heat detectors

A heat alarm is designed to detect heat instead of smoke, the alarm contains a thermostat which is set to respond to temperatures above 58°C. When a fire breaks out hot air from the fire will rise and enter the sensor chamber. When temperature inside the chamber reaches 58°C a signal is sent to the integrated circuit which causes the alarm to sound alerting the occupants to the fire.

Detector Description	Application
HEAT DETECTORS	
Fixed temperature, spot-type	Enclosed Areas (rooms, closets, etc.), primarily for property protection. Not considered an early warning device.
Rate of rise, spot-type	Enclosed areas (rooms, closets, etc.); primarily used for property protection where design goals require more sensitive heat detection and response to developing fires. Avoid use in areas of fluctuating ambient temperature. Not considered an early warning device.
Rate compensation	Same as for fixed temperature, spot-type heat detectors. Because of sealed design, may be used in dusty and moist areas. Spacing ratings are better due to reduced thermal lag.
Fixed temperature, line-type	Application is similar to spot-type. Used in severe environments, cable trays, wharf applications, and historic buildings.

Choosing a suitable detector system Which detectors need to be specified, where, depends :on the ► Monitoring category or the general monitoring objectives of the fire detection system.

► Room height.

► Environmental conditions, including deceptive phenomena.

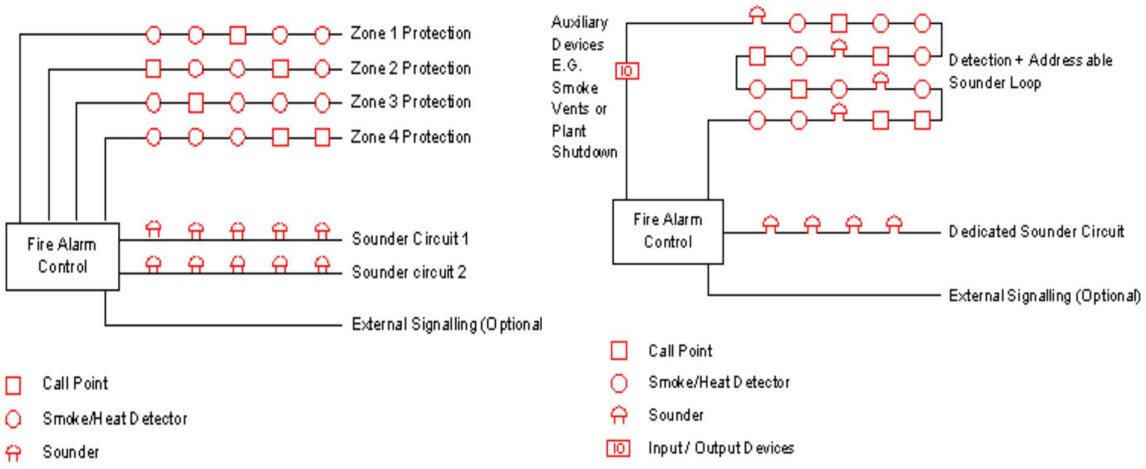
Fire alarm

An automatic fire alarm system is designed to detect the unwanted presence of fire by monitoring environmental changes associated with combustion . In general, a fire alarm system is either classified as automatic, manually activated, or both. Automatic fire alarm systems can be used to notify people to evacuate in the event of a fire or other emergency, to summon emergency forces aid, and to prepare the structure and associated systems to control the spread of fire and smoke.

- Conventional fire alarm system
- Addressable fire Alarm System

Conventional Fire Alarm System the 'intelligence' of the system resides solely within the Fire Alarm Control Panel which receives a trigger signal from a Conventional Detector or Call Point and in turn, signals the condition to other devices such as alarm sounders and remote signaling equipment.Conventional detectors are normally connected to the Fire Control Panel via dedicated circuits, each circuit protecting a designated 'Zone‘ or 'Area' of the building. Detectors have two states, Normal healthy and Alarm.

Addressable fire alarm systems offer benefits in speed of detection, identification of the location of a fire and easier maintenance. Addressable fire alarm systems also offer tolerance to faults in the system wiring, which allows a single pair of wires to be used to connect up to 200 devices to the system, allowing cost savings in the wiring of large systems



The selection of a fire alarm system should take into consideration the following:

• The purpose of the system

• The fire protection goals of the owner

• The type of occupancy to be protected

• The type and quantity of the contents to be protected

• The required response time of the system; i.e. how fast must it operate?

• The basic function of the system

• The applicable fire alarm system codes and standards

• The other fire protection systems that must be interfaced

• The response time of the fire department

• The available water supply

Basic components of a fire alarm system:

The following is a list of the basic components that can be installed together to make up a typical fire alarm system:

Alarm Initiation Devices

•Manual Fire Alarm Boxes

•Water flow Initiating Devices

•Heat Detectors

•Smoke Detectors

•Radiant Energy Sensing Fire Detectors

•Other Fire Detectors

Notification Appliances

•Bells

•Horns

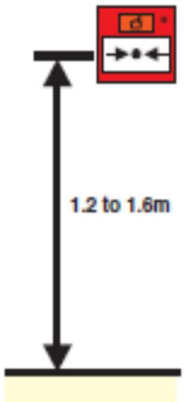
•Speakers

•Sirens

•Strobes

Fire Alarm Control Units

1. Conventional fire alarm systems
2. Addressable fire alarm systems
3. Analog-addressable fire alarm systems



Remote On-Site Annunciation

Point Lighted

Alphanumeric

Liquid Crystal Displays (LCD's)

Graphic

Batteries

•Standby Power

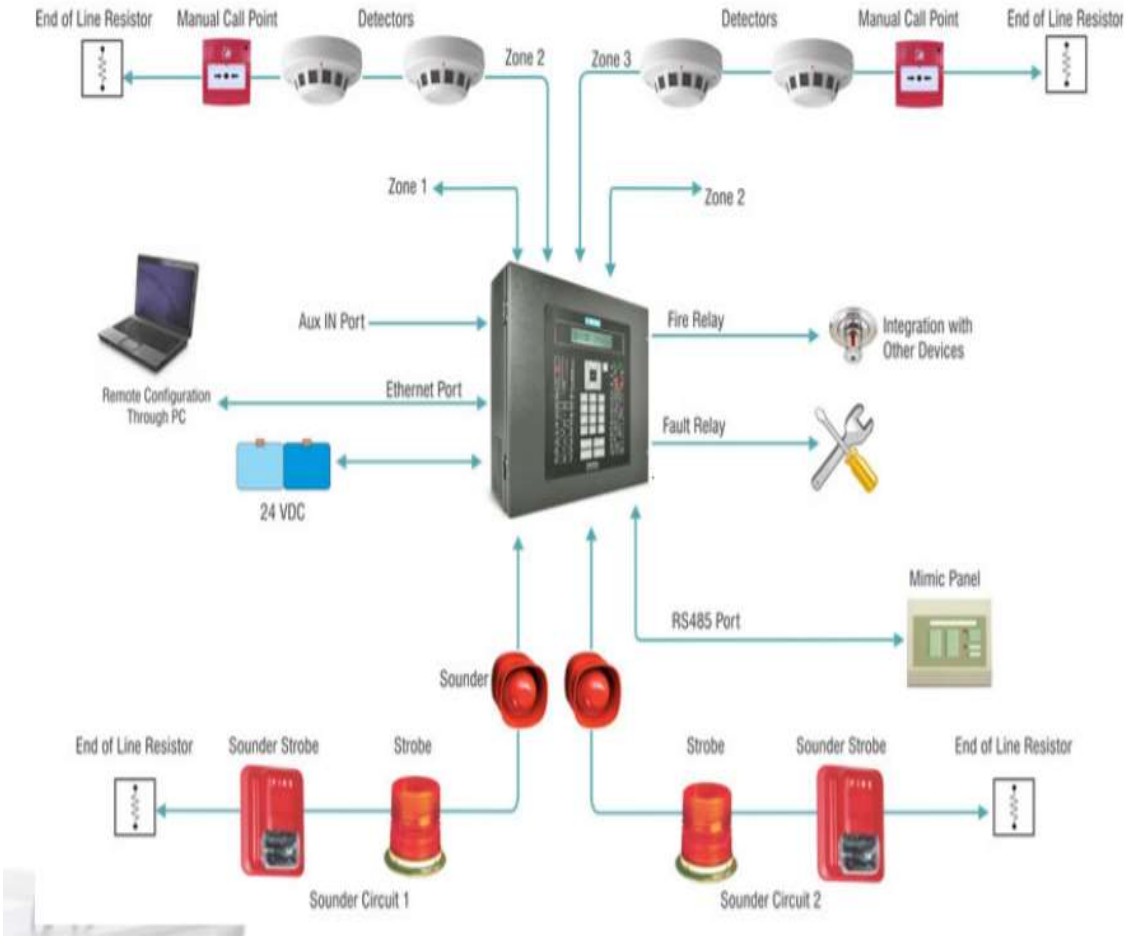
Loops & Zones:

Addressable Fire Alarm Control Panels employ one or more Signaling Line Circuits, usually referred to as loops or SLC loops -ranging between one and thirty. Depending on the protocol used, a Signaling Line Circuit can monitor and control several hundred devices. Some protocols permit any mix of detectors and input/output modules, while other protocols have 50% of channel capacity restricted to detectors/sensors and 50% restricted to input/output modules. Each device on a SLC has its own address, and so the panel knows the state of each individual device connected to it.

Common addressable input (initiating) devices include Smoke detectors ,Heat Detectors (Rate of Rise and Fixed Temperature) Manual call points or manual pull stations ,Notification appliances (Simplex systems with TrueAlert signals only) ,Responders .Addressable output devices are known as relays and include (Warning System/Bell) Relays ,Door Holder Relays

Zones:

Zones are usually made by dividing a building, or area into different sections. Then depending on the specific zone, a certain amount and type of device is added to the zone to perform its given job.



FIRE PROTECTION

Fire protection is the study and practice of mitigating the unwanted effects of potentially destructive fires. It involves the study of the behavior, compartmentalization, suppression and investigation of fire and its related emergencies, as well as the research and development, production, testing and application of mitigating systems.

Fire safety aspects are of two types:

•Passive fire prevention/protective means

•Active fire prevention/protective means

Passive fire protection (PFP):

Passive protection are those which are taken care –off during designing of a building structure and does not need any energy consumption. They directly

affect the architecture and construction value of a building. Such means envisage the methods of assembling the components of the building in such a

way as to achieve a structure in which spread of fire is limited to barest minimum. Following passive fire safety aspects are to be taken care of:

1)Internal hazard

i. The fire resistance of building structure.

ii. Fire integration of building

iii. Compartmentation

iv. Fire and smoke venting for smoke extraction.

2) Personal hazard the internal means of evacuation

3) Exposure hazard

i. Isolation from neighboring structures.

ii. Access for outside emergency services

iii. site planning

Active fire protection (AFP):

Systems which require a certain amount of motion/or action in order to work properly. Some of these actions could be slowing the progress of the fire, putting out the fire, or notifying of the fire and smoke conditions.

Fire suppression systems and fire detection systems together forms active fire protection system.

The active fire security methods can be in general divided in following heads:

•Portable fire extinguishes

•Fixed first-aid fire fighting equipment like hose-reels

•Fire hydrant installations like wet risers and yard hydrant

•Manual/automatic fire detection and alarm systems

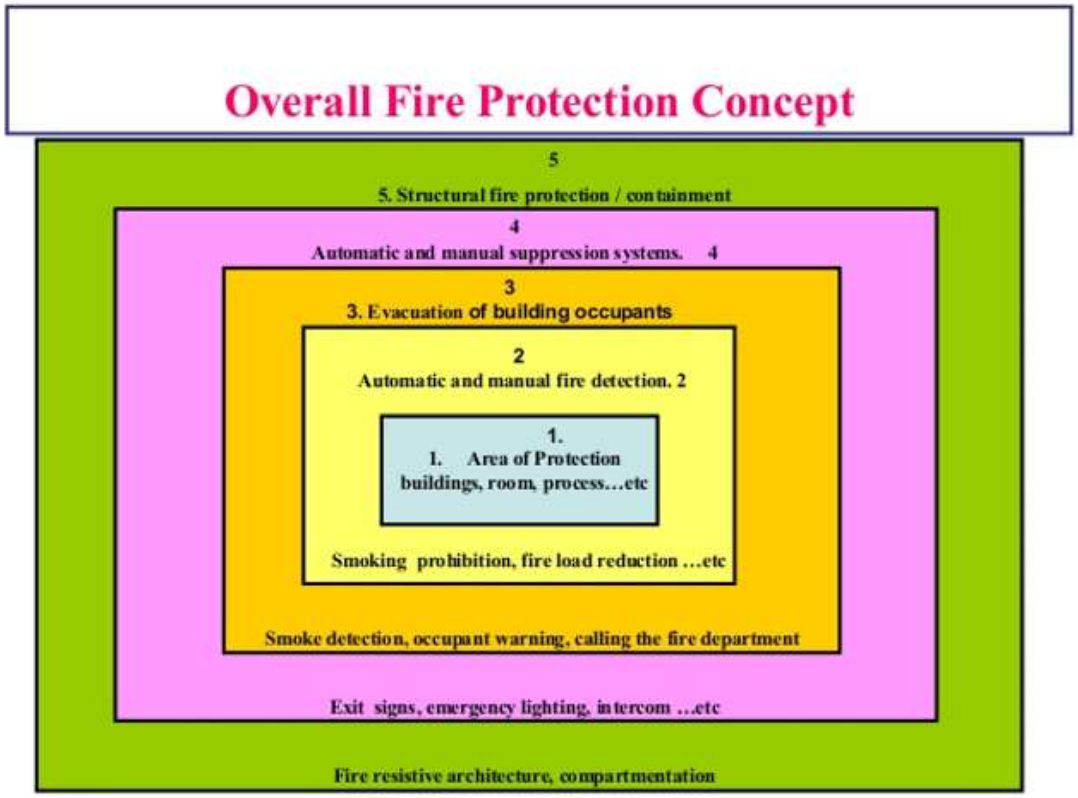
•Fixed automatic fie fighting systems

- Water sprinklers and emulsifier systems
- Co2 fire fighting system
- Halon fire fighting systems

•Mobile fire fighting systems and fire brigades

•Dry chemical and foam installations

•Fire salvage corps



CLASSIFICATION OF FIRE SUPPRESSION SYSTEM:

The classification can be done based on the medium(water, gas ,foam etc),

equipment (sprinkler, extinguisher etc),arrangement(fixed, portable).They are:

1.Fire Extinguishers 2.Sprinklers 3. Hose reels 4.Hydrants 5. Foam systems

Fire hydrant installation for buildings:

•Internal wet/dry risers

•Yard hydrant for public premises /private properties

The primary objective of hydrant installation is to make the water supply

available all the times under pressure at strategic points in a building , both inside and outside.

Any hydrant system essentially consists of:

1. reliable water supply source and its storage.
2. A piping network connecting the various fire fighting hydrant outlets with the storage tank.
3. Fire fighting hydrant outlets with their control valves.
4. Hose pipes with nozzle for spraying water jet at pressures.

HYDRANTS

Fire hydrants are used to supply a large flow of water to fight fires .They are positioned in public roads and within large building complexes.

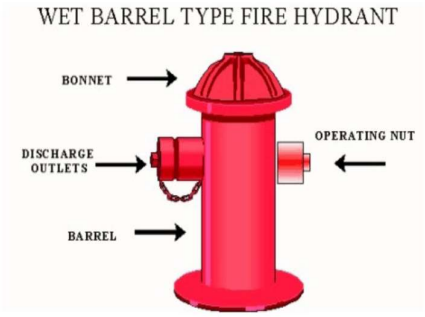
The fire brigade uses the hydrant as a quick and easy method of obtaining water from the mains water system, instead of having to rely solely on water tanks in tenders.

TYPES OF FIRE HYDRANT

- Wet-barrel type
- Dry-barrel type

Wet-barrel type

- The wet barrel hydrant is used in areas where freezing does not occur. The parts of
- wet-barrel hydrant are:
- • Operating nut - turns hydrant on and off
- • Bonnet - top of the hydrant
- • Barrel - main body of hydrant, contains
- operating stem
- • Discharge outlet - where fire hose is hooked
- up to allow water to flow from hydrant



Dry-Barrel Type

The dry-barrel hydrant is used in areas where freezing temperatures occur.

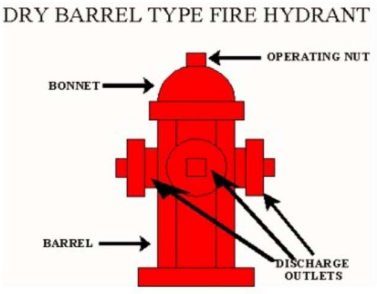
The parts of dry-barrel hydrant are:

• Operating nut - turns hydrant on and off

• Bonnet - top of the hydrant

• Barrel - main body of hydrant, contains operating stem

• Discharge outlet - where fire hose is hooked up to allow water to flow from hydrant



Fire sprinkler systems :

A fire sprinkler system is an active fire protection measure, consisting of a water supply system, providing adequate pressure and flow rate to a water distribution piping system, onto which fire sprinkler are connected. A sprinkler is a device that when activated will automatically douse a fire with water. A glass bulb breaks with heat build up at between 60degC and 260degC depending on the risk and location. A fire is doused with water below the sprinkler

Types:

Wet pipe systems

Dry pipe systems

Deluge systems

Pre-Action Systems

Foam water sprinkler systems

Foam system

Water Mist systems

Inspection, Testing, & Maintenance of Sprinkler Systems:

- Maintaining adequate fire protection systems is as critical as the original decision to install these systems
- Because fire suppression, detection, and alarm systems are generally not used on a routine basis, their state of readiness is not immediately apparent
- The periodic inspection, testing, and maintenance of fire detection and suppression systems are essential to ensure successful performance when these systems are needed

Fire protection and means of exit requirements

1) General Exit Requirements :-

• may be a doorway, corridor, passageway to an internal or external staircase or to a verandah or roof which have access to the street or to the roof of the building or a refuge area. May include horizontal exit leading to the adjoining building at same level.

• Shall be continuously maintained free of all obstructions or impediments in case of use in an emergency and shall provide continuous means of egress to exterior.

2) Fire Access Stair Cases :-

• Buildings having an area of more than 500 sq.m. per floor shall have a minimum of two staircases.

3) Doorways:-

• Shall open into an enclosed stairways or a horizontal exit of a corridor providing protected means of egress.

• Shall not be less than 1000mm in width, except in assembly buildings where it should not be less than 2000mm in width. Shall not be less than 2000mm in height.

4) Corridors and Passageways:-

• Width shall not be less than the width of the exit doorways leading out from them .

• Height shall not be less than 2400mm.

• Shall be adequately ventilated.

5) Internal Staircases:-

• Shall be composed of non-combustible materials throughout.

• External wall of building shall constitute one of its sides.

• Shall not be arranged around a lift shaft.

• Minimum flight width=1000mm, Maximum flight width=2000mm.

• Minimum tread = 250mm, Maximum riser=190mm, Minimum Head Room=2200mm.

(varying slightly based on classification of buildings).

6) External Staircases:-

•An external staircase is desirable to be provided for high rise buildings.

•Shall be kept in sound operable condition.

•Shall be directly connected to the ground.

•Entrance shall be separate and remote from the internal staircase.

•No wall opening or window opens on to or close to the external stairs.

•Route to the external stairs shall be free of obstruction at all times.

•Shall be constructed of non-combustible materials and any doorway

leading to it shall have the required fire resistance.

•Shall have straight flight not less than 1250mm wide with 250mm

treads and risers not more than 190mm. The number of risers shall be

restricted to 15 per flight.

•Handrails shall be of a height not less than 1000mm and not exceeding

1200mm. Provision of balusters with maximum gap of 150mm.

•The use of spiral staircase shall not be less than 1500mm in

diameter and shall be designed to give adequate headroom.

•Unprotected steel frame will not be accepted as a means of escape .However steel staircase in an enclosed fire rated compartment of 2h will be accepted as a means of escape.

7.) Horizontal Exits:-

• The width of horizontal exit shall be same as that for the exit doorways.

•A horizontal exit shall be equipped with at least one fire / smoke door of minimum 1h fire resistance, of self closing type.

•Where there is a difference in level between connected areas for horizontal exits, ramps not more than 1 in 10 slope shall be provided, steps shall not be used.

•Doors in horizontal exits shall be operable at all times from both sides.

8) Refuge Areas:-

•Shall be provided on the periphery of the floor or preferably on a cantilever projection and open to air at least on one side protected with suitable railing.

•For floors above 24 m and up to 39m- one refuge area on the floor immediately above 24m.

•For floors above 39m – one refuge area on the floor immediately above 39 m and so on after every 15m.

•Residential flats in multi storied buildings with balcony need not be provided with refuge area, flats without balcony shall provide refuge area.

9) Fire Towers:-

•Preferred and safest type of escape route for storied buildings.

•In high rise buildings with over 8 storeys or 24m in height, at least one required means of egress shall preferably be a fire tower.

•Shall be constructed of walls with a 2h fire resistance without openings other than the exit doorway.

Components of BAS related to fire safety, security – communication and automation system.

Some applications where a fire alarm system communicates with other building subsystems include the following:

Environmental monitoring

Door monitoring

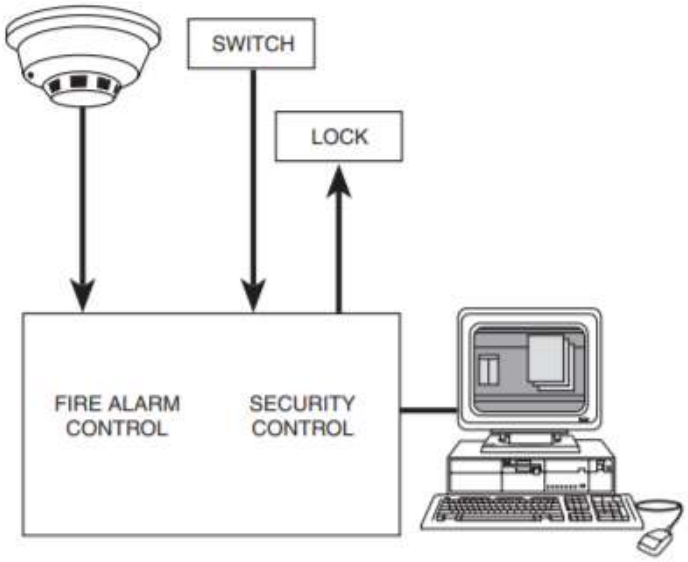
Selective door unlocking

Motion detection

Fire alarm/CCTV interface: Fire alarm systems can integrate with the closed circuit television subsystems (CCTV) of the IBSS to automatically switch on cameras at the actual location of the origin of a fire alarm signal. These cameras can then provide fire fighters with a realtime view of conditions in the area of the fire.

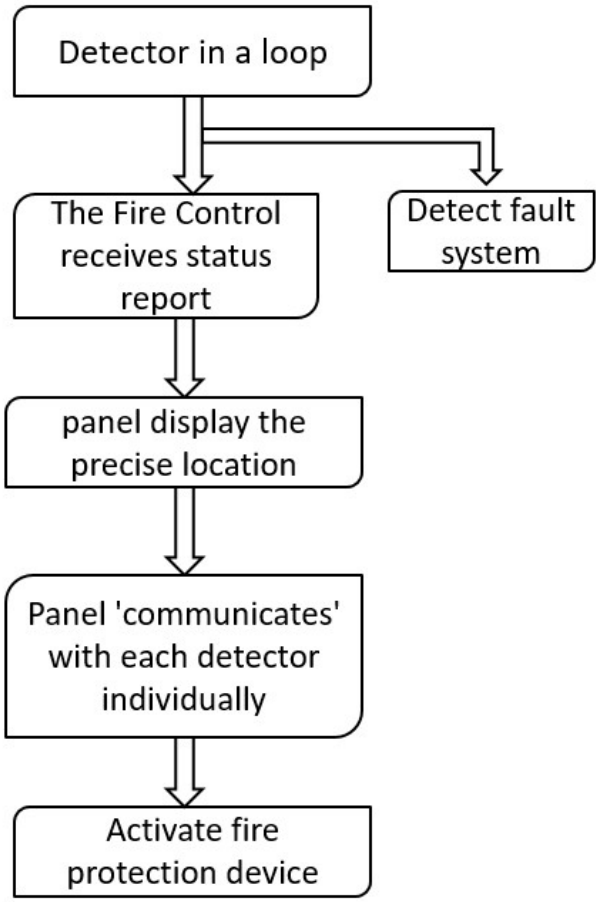
Elevator control: The building codes and the Safety Code for Elevators and Escalators require that elevators be ‘‘captured and recalled’’ by the fire alarm subsystem of the IBSS when smoke detectors sense smoke in an elevator lobby or elevator machine room. Many elevators also interface with a security/access control subsystem of the IBSS to manage access to specific floors at predetermined times.

HVAC override by fire alarm systems and security systems: security/access control subsystems of bms often interact t with HVAC control subsystems to place spaces into an unoccupied mode on nights and weekends. The fire alarm subsystem of the bms frequently interfaces with HVAC subsystem to open and close dampers and turn fans on and off for smoke control.



Single Control Unit Performing Fire Alarm and Security Functions.

BMS – Fire Alarm System -Working



BMS – Lighting System :

BMS can help in controlling the individual lighting circuits (Internal) based on lux levels and/or on schedules and substantially save on energy.

- Lighting can be turned on, off, or dimmed with a building automation or lighting control system based on
    - Chronological time (time of day)
    - Astronomical time (sunrise/sunset)
    - Occupancy using occupancy sensors
    - Daylight availability using photocells
    - Alarm conditions
    - Program logic (combination of events)

There are two types of lighting control systems which are:

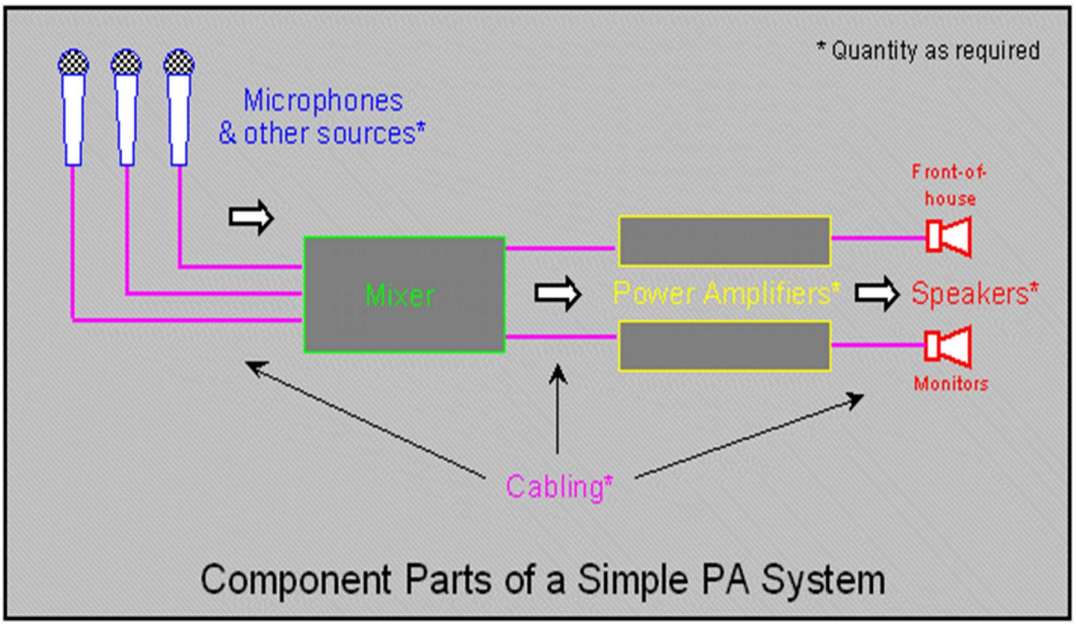
- ❑ Analogue lighting control
- ❑ Digital lighting control

Those are all wired lighting control system.

There is also a wireless lighting control system that is based on some standard protocols.

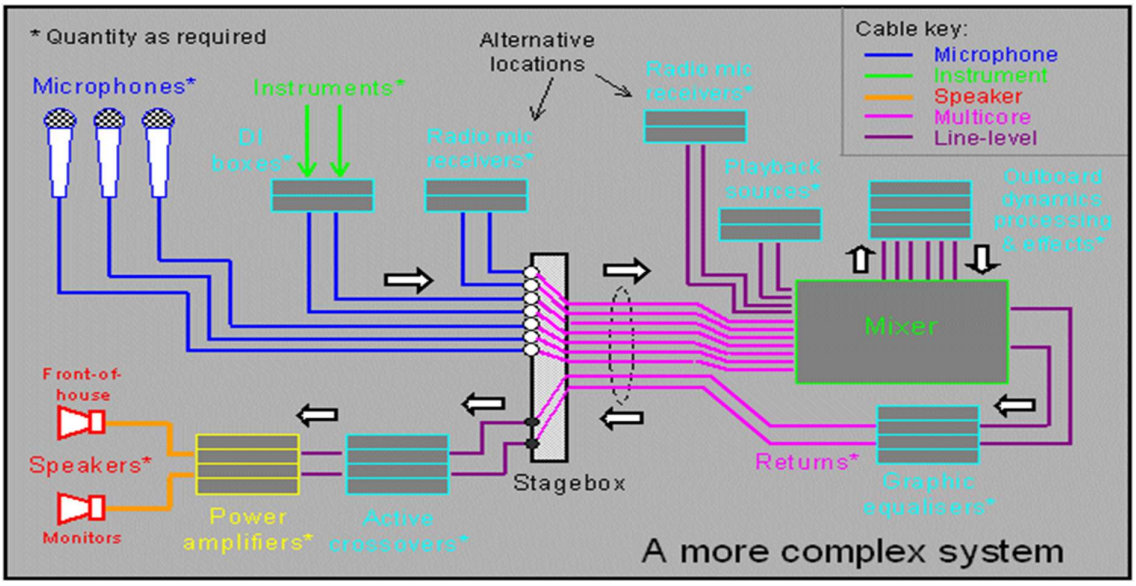
<u>Public Address System</u>

- Public Address System for announcements and emergency voice evacuation as per the requirement of the installation.
- Public address components are provided with graduated priority. The system is integrated with the Fire Alarm System through necessary interfaces.
- Each floor constitutes a zone with selective floor-wise isolation facility.



The main parts of a PA system :

1. Microphones, DI boxes and other sources
2. A mixer
3. Power amplifiers
4. Speakers
5. An arrangement of cables to interconnect the equipment.



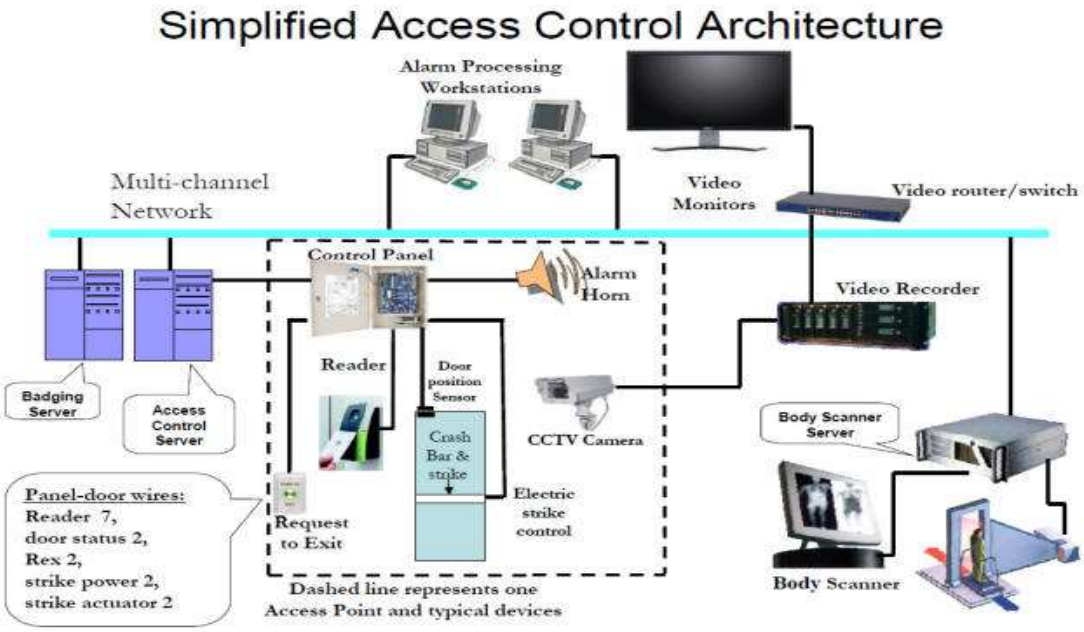
Access Control System :

Security Access Control System

- Physical Security and Access Control Systems have become necessary for most companies.
- Large or small, companies need to protect their facilities, data, and personnel.
- A door may be unlocked with a swipe card, an RFID keyfob, or through biometric means.
- Laboratories and other facilities with areas requiring high security may also use a card control system, making the cards double as personnel identification.

Automatic time and attendance sub-systems

- Time & attendance
- Standalone
- Bio-metric
- IP based
- Door Interlocking
- Visitor management

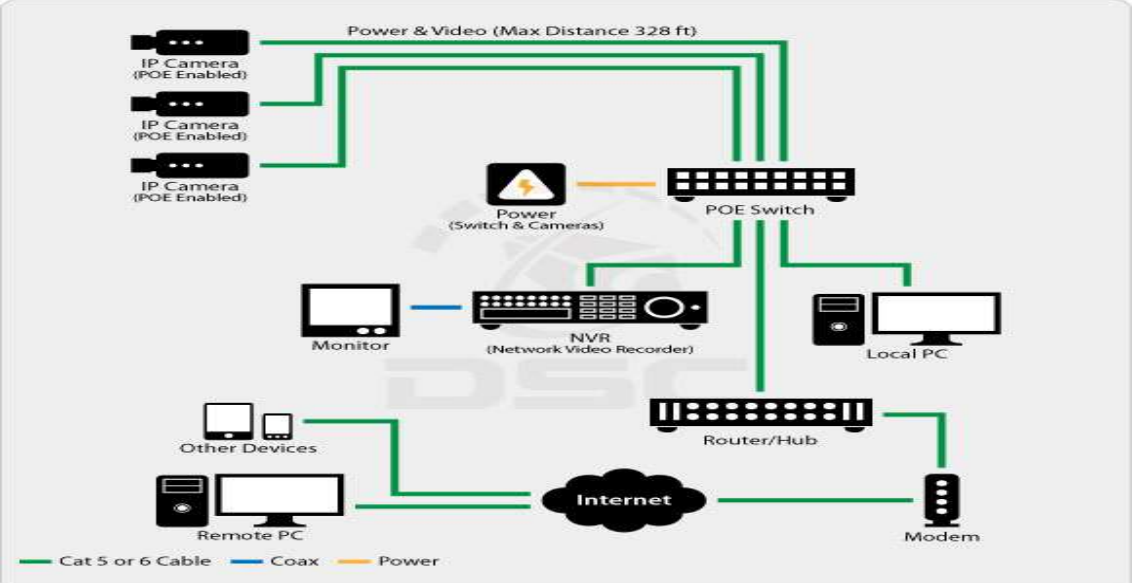


IP Based CCTV Systems :

- For Electronic Surveillance purposes, indoor/outdoor type cameras are located at strategic points as per the challenges of the design and to maintain discreet positioning as required.
- These cameras are connected to either DVR or a server based system .

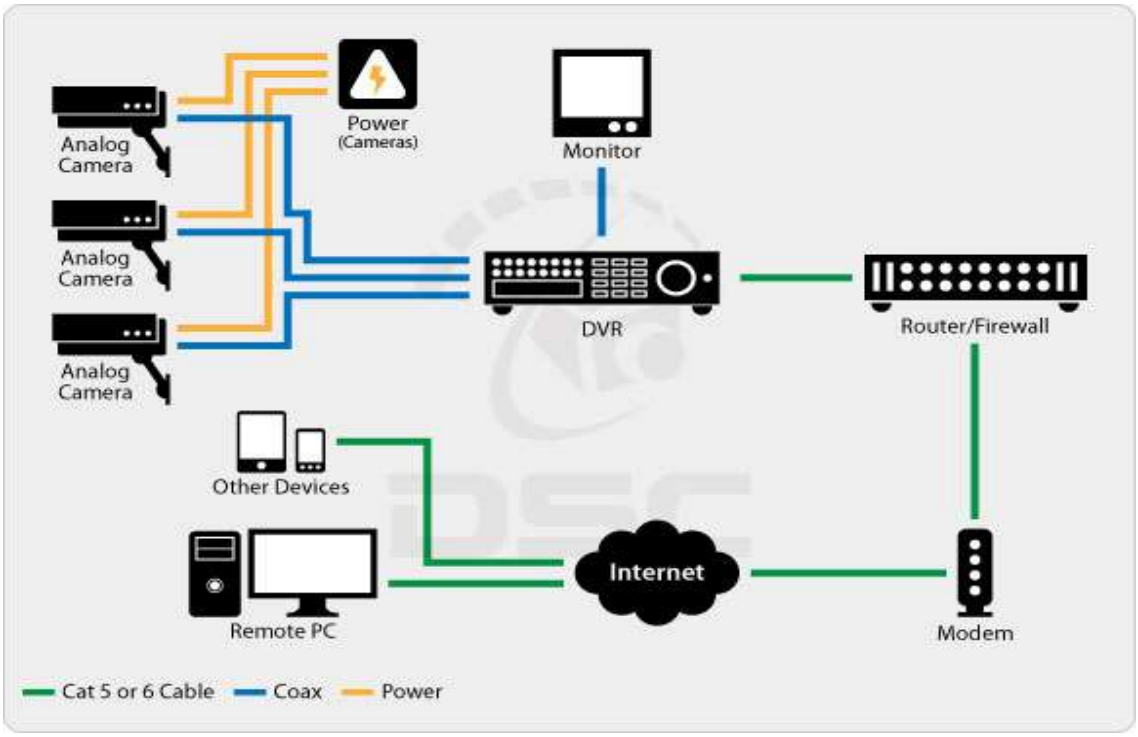
Video analytics solutions

- Video analytics is the practice of using computers to automatically identify things of interest without an operator having to view the video.
- The most commonly used types of video analytics professionally deployed are perimeter violation, people counting.



Analog CCTV system:

- The security cameras capture an analog video signal and transfer that signal over coax cable to the Digital Video Recorder (DVR).
- DVR converts the analog signal to digital, compresses it, and then stores it on a hard drive for later retrieval. Intelligence is built into the DVR to handle such things as scheduling, motion detection, and digital zoom.
- Monitors for viewing the video are connected to the DVR, or it can be set up to publish over an internal network for viewing on PCs.
- The DVR can also be set up to broadcast over the Internet and can add password protection and other features.



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Escalators - Elevator Installations - Electric Elevators - Hydraulic Elevators –MRL type elevators - Planning for Passenger Elevators – Elevator systems in high-rise buildings - Planning and design of elevator lobby areas, recent development in elevator technology.

External infrastructure services for residential and institutional complexes – planning, design, construction aspects of water supply, sewerage, solid wastes, roads and storm water drainage and RW harvesting. Telecommunications, Structured Cabling Systems - Blown Optical Fibre Technology (BOFT)-Components of BAS related to vertical transportation & external infrastructure.

Escalator

- An escalator is a moving staircase – a conveyer transport device for carrying people between floors of a building.
- The benefits of escalators are many. They have the capacity to move large numbers of people.
- Escalators are used around the world to move pedestrian traffic in places where elevators would be impractical.
- An escalator is a power-driven, continuous moving stairway designed to transport passengers up and down short vertical distances.
- Escalators are used around the world to move pedestrian traffic in places where elevators would be impractical

Type of escalator

- parallel.
- crisscross.
- multiple parallel
- Curved escalators

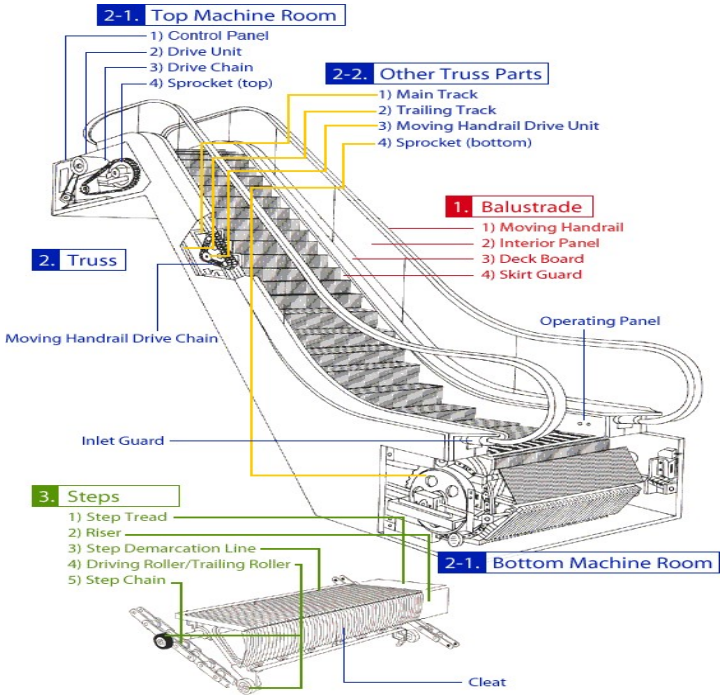
Components of escalator

- Landing platforms
- Truss
- Tracks
- Steps
- Handrail

Landing platforms

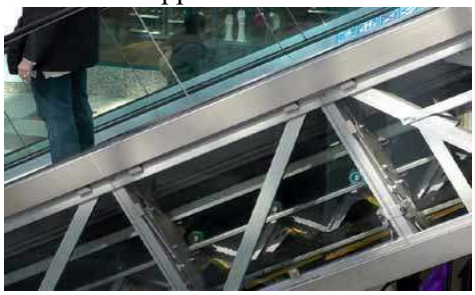
- These two platforms house the curved sections of the tracks, as well as the gears and motors that drive the stairs.
- The top platform contains the motor assembly and the main drive gear, while the bottom holds the step return idler sprockets

Landing platforms



Truss

- The truss is a hollow metal structure that bridges the lower and upper landings.
- It is composed of two side sections joined together with cross braces across the bottom and just below the top .The ends of the truss are attached to the top and bottom landing platforms via steel or concrete supports.



Tracks

- The track system is built into the truss to guide the step chain, which continuously pulls the steps from the bottom platform and back to the top in an endless loop.
- There are actually two tracks: one for the front wheels of the steps (called the step-wheel track) and one for the back wheels of the steps (called the trailer- wheel track).

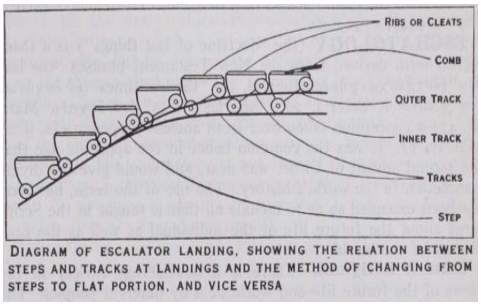
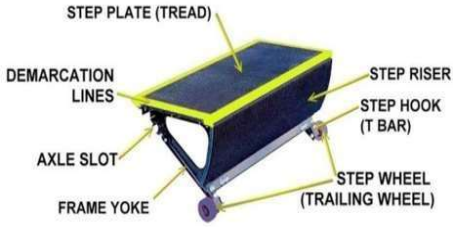


DIAGRAM OF ESCALATOR LANDING, SHOWING THE RELATION BETWEEN STEPS AND TRACKS AT LANDINGS AND THE METHOD OF CHANGING FROM STEPS TO FLAT PORTION, AND VICE VERSA

Steps

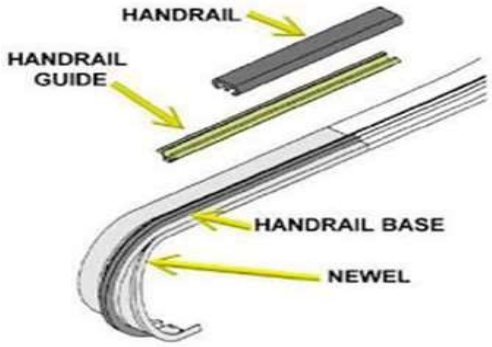
- The steps are solid, one piece, die-cast aluminum or steel. Yellow demarcation lines may be added to clearly indicate their edges.

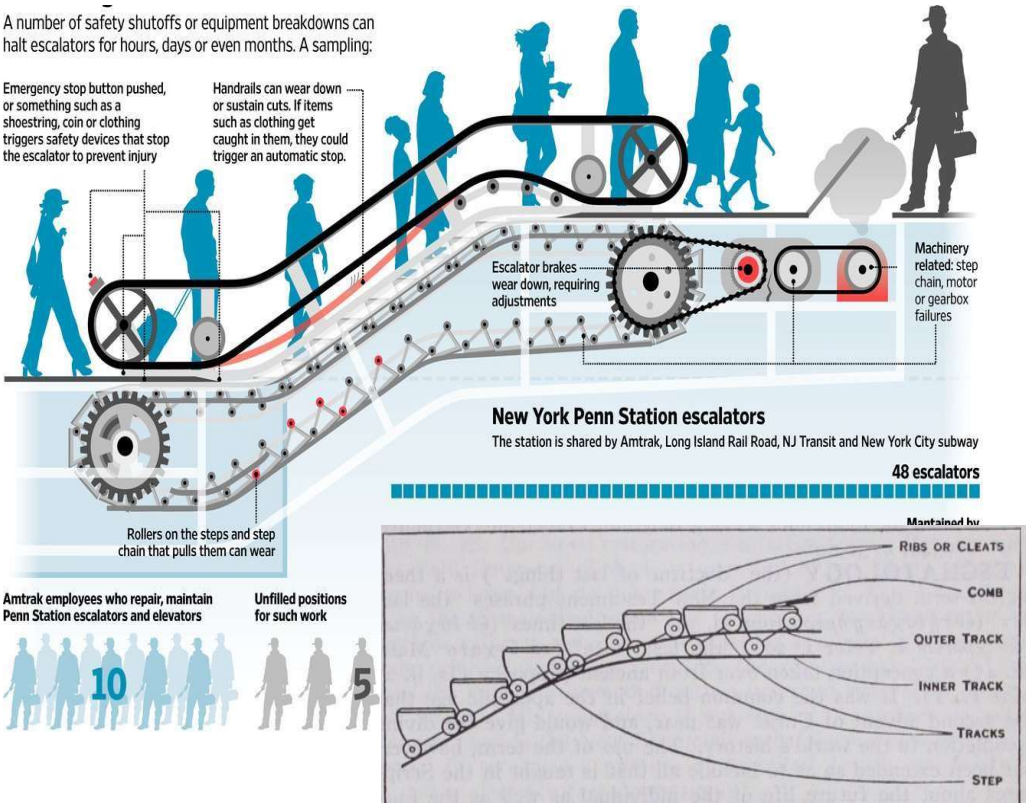


ESCALATOR STEP

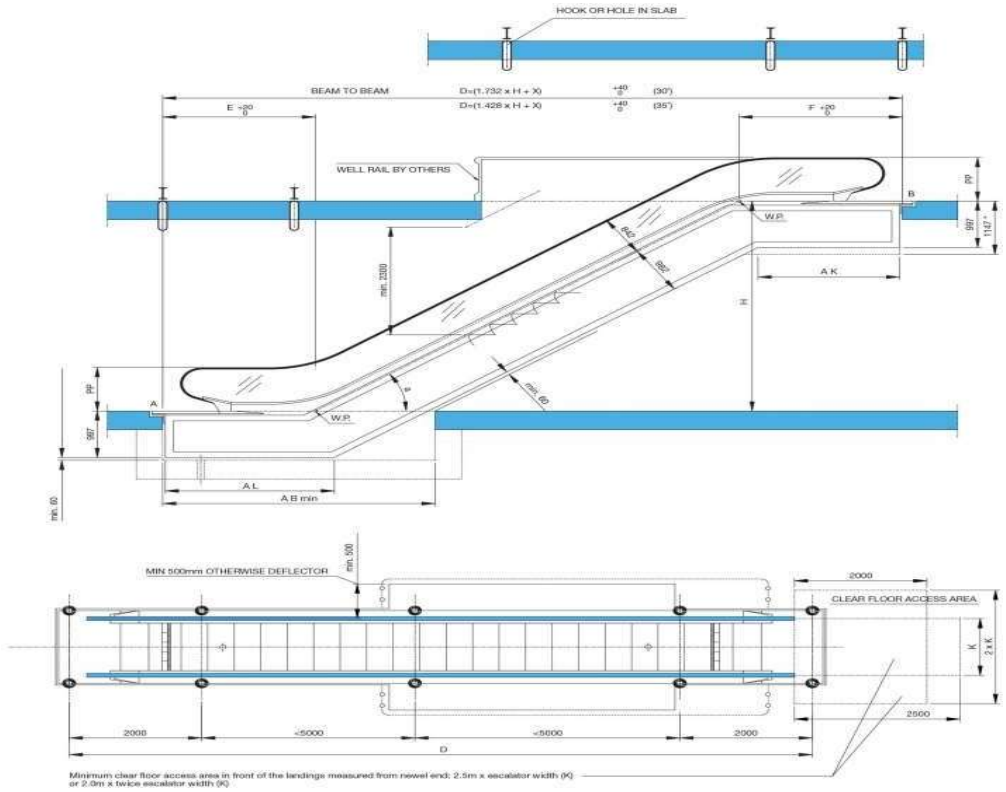
Handrail

- The handrail provides a convenient handhold for passengers while they are riding the escalator.





Standard dimension



Escalator design

Physical factors

- Physical factors like the vertical and horizontal distance to be spanned must be considered.
- These factors will determine the pitch of the escalator and its
- actual length.

Location

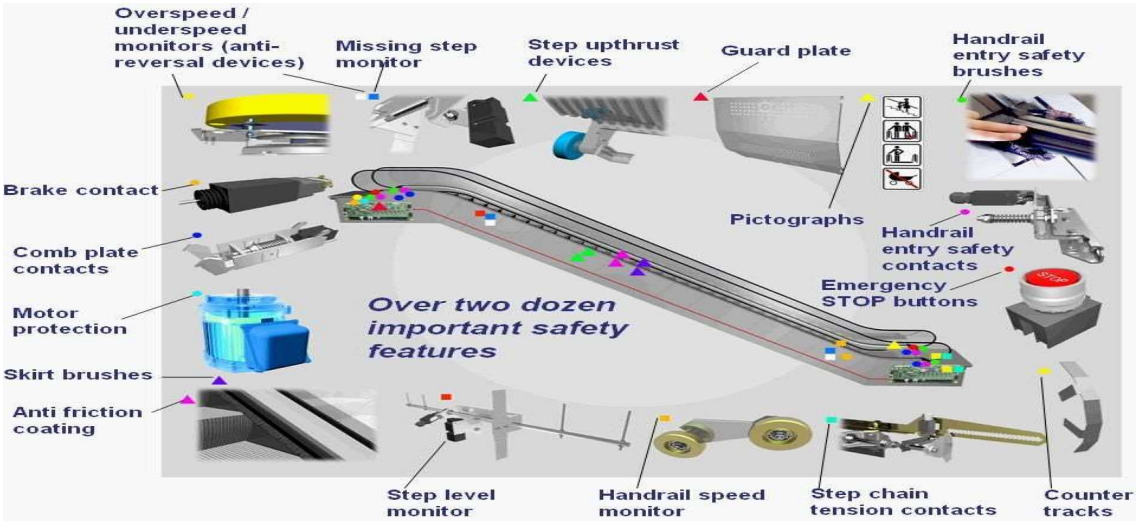
- Escalators should be situated where they can be easily seen by the general public.
- Furthermore, up and down escalator traffic should be physically separated and should not lead into confined spaces.

Traffic patterns

- Traffic patterns must also be anticipated in escalator design.
- In some buildings the objective is simply to move people from one floor to another, but in others there may be a more specific requirement, such as funneling visitors towards a main exit or exhibit.
- The number of passengers is important because escalators are designed to carry a certain maximum number of people.

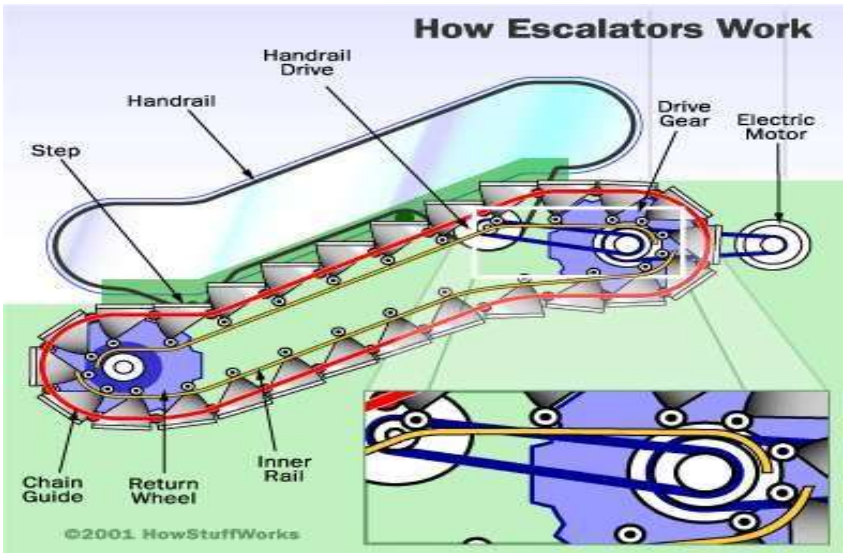
Safety

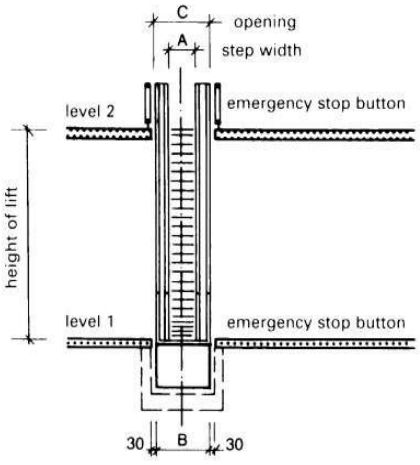
- Safety is also major concern in escalator design.
- Fire protection of an escalator floor-opening may be provided by adding automatic sprinklers or fireproof shutters to the opening, or by installing the escalator in an enclosed fire-protected hall.
- To limit the danger of overheating, adequate ventilation for the spaces that contain the motors and gears must be provided.
- It is preferred that a traditional staircase be located adjacent to the escalator if the escalator is the primary means of transport between floors



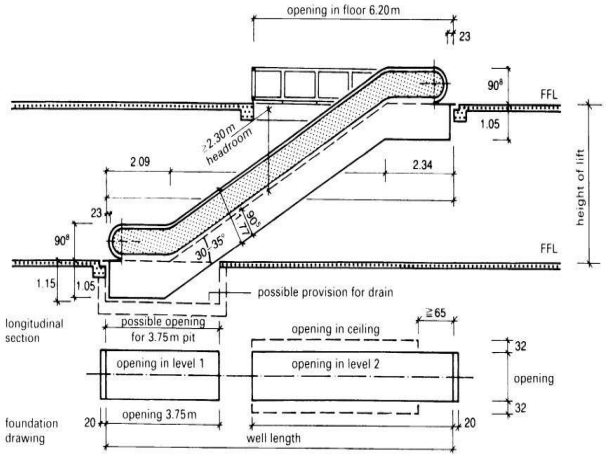
Working

An escalator is a continuously moving staircase. Each stair has a pair of wheels on each side, one at the front of the step and one at the rear. The wheels run on two rails. At the top and bottom of the escalator, the inner rail dips beneath the outer rail, so that the bottom of the stair flattens, making it easier for riders to get on and off.





Width of the escalator



cross section of an escalator

step width	600	800	1000
A	605–620	805–820	1005–1020
B	1170–1220	1320–1420	1570–1620
C	1280	1480	1680
transportation capacity/h	5000–6000 persons	7000–8000 persons	8000–10000 persons

Advantage of escalator

- It helps a large no. of people in moving from one place to another at the same time and they reduce the need of elevator because people would not have to wait for elevator and escalator can carry a large no. of people at the same time.
- It is helpful for the people that have pain in their legs and joints i.e it provide comfort to the people
- Escalators are effective when used as a mean of guidance and circulation.
- Their speed can be adjusted which is helpful in managing the crowd.
- When turned off they can be used a staircase.

Disadvantages of escalators

- Waste of energy when not in use.
- Possible injuries when stopped suddenly
- Source of fear for small children

Electric elevators

- Common type used today.
- Use electric lift cable to lift the elevator car with the weight and movement is the catalyst action.
- Use the traction with the motor.
- Used in most building > 60ft.
- Motor room on top of lift shaft will increase the load of building structure.
- Possibility of noise structure
- Need a lift wells and maintenance room near the engine room.

Hydraulic elevators

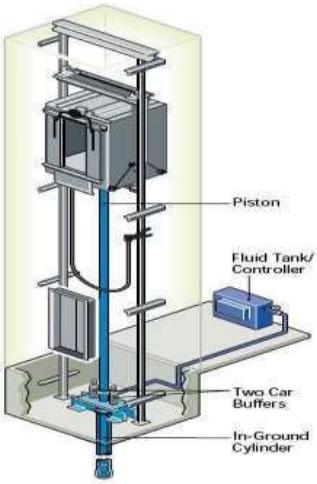
These are powered by piston that travels inside a cylinder. An electric motor pumps hydraulic oil into the cylinder to move the piston. The piston smoothly lifts the elevator cab.

- Hydraulic elevators have become widely popular in the commercial setting. They are ideally suited for buildings with up to 6 stories. There is no need for lots of overhead hoisting equipment compared to other systems. This is because the system is shaped like a cylinder. These lifts use metal piston under the car.

Some of the key points about hydraulic lifts are as follows:

- Perfect for up to mid-rise buildings
- Flexible in terms of design
- Can accommodate both passengers and freight
- Openings can be created on any side

The elevator shaft features space under the car for housing the piston. Some models can have telescoping piston that can collapse and don't require a big pit or eliminates the need for it.



Types of hydraulic elevators:

Conventional Hydraulic Elevators have a sheave that extends below the floor of the elevator pit, which accepts the retracting piston as the elevator descends. Some configurations have a telescoping piston that collapses and requires a shallower hole below the pit. Max travel distance is approximately 60 feet.

Hole-less Hydraulic Elevators have a piston on either side of the cab. In this configuration, the telescoping pistons are fixed at the base of the pit and do not require a sheave or hole below the pit. Telescoping pistons allow up to 50 feet of travel distance. Non-telescoping pistons only allow about 20 feet of travel distance.

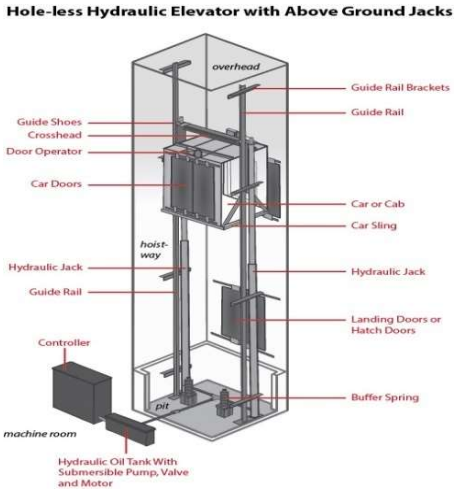
Roped Hydraulic Elevators use a combination of ropes and a piston to move the elevator. Maximum travel distance is about 60 feet.

Hydraulic elevators have a low initial cost and their ongoing maintenance costs are lower compared to the other elevator types. However, hydraulic elevators use more energy than other types of elevators because the electric motor works against gravity as it forces hydraulic fluid into the piston. A major drawback of hydraulic elevators is that the hydraulic fluid can sometimes leak, which can cause a serious environmental hazard. The environmental risk and high energy use are two main reasons that hydraulic elevators are not being installed as often as in the past.

Benefits of Installing Hydraulic Lifts

- The key benefits of choosing hydraulic elevators for your building are as follows:
- It doesn't require to make a pit.
- There is no need for a machine room and head room.
- can install the machine close to the shaft.
- There is high level of customization option based on the size. can also have a wall-mounted design.
- It requires power only when moving up, not when moving down.
- Due to the cantilever cabin frame, entry and exit can be made from 3 sides.
- The passenger capacity can range from 2 to 25.
- A hydraulic elevator can move down to the ground floor even when there is power outage. This is made possible because it comes down with the help of gravity. It is

also found that these systems require lesser amount of maintenance compared to their electric counterparts.



Machine room-less (MRL) elevators

• Machine room-less elevators are designed so that most of the components fit within the shaft containing the elevator car; and a small cabinet houses the elevator controller. Other than the machinery being in the hoistway, the equipment is similar to a normal traction elevator.

Benefits

- creates more usable space
- use less energy (70-80% less than hydraulic elevators)
- uses no oil
- slightly lower cost than other elevators

Passenger elevators

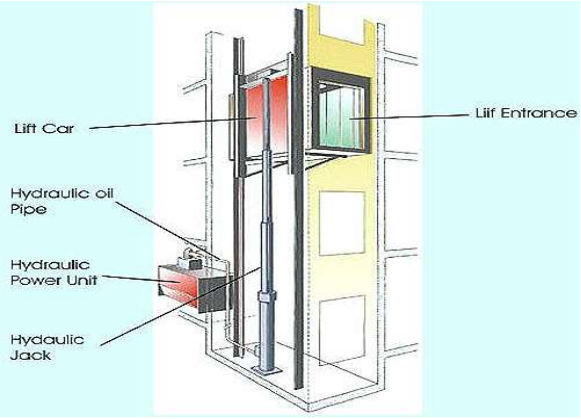
Passenger lifts are designed to carry people and can come in a variety of forms. As these lifts carry passengers, they should meet specific requirements and standards to ensure that they are safe. They can come in a range of sizes, transporting different numbers of passengers.

These lifts can be customised with different designs, both inside and outside of the cabin, so they can fit in with the design and style of the space around it. These lifts appear in a variety of settings, from shopping centres to private residences. They also tend to travel faster than other lift types as they are often used in high-rise buildings where passengers may be travelling through multiple floors

Passenger elevators should be located at the circulation core of the building and be grouped into banks when this is necessary and desirable.

The required umber of elevators is determined by:

- Building type
- Building height
- Number of stops
- Floor use
- Passenger volume



Two primary criteria: quantitative, or the number of persons who can be moved by the system within a defined peak traffic period, and qualitative, which expresses the calculated time between departing elevators during the same heavy traffic period.

Number of Elevators Required

The number of passenger elevators required for a particular building depends on the number of persons expected to work or live in the building. Traffic is measured by the number of persons requiring service during a peak 5-min period. For proposed buildings, a population estimate is generated on the basis of occupancy trends for that specific building type. Peak-traffic projections are based on the type of tenancy expected for the building.

Handling Capacity & RTT :The handling capacity is calculated by the formula:

H = (300 x Q x 100)/T x P

Where ,H = Handling capacity as the percentage of the peak population handled during 5min.

Q = Average number of passengers carried

Another factor affecting passenger-transfer time is the shape of the car. The narrower and deeper a car, the greater is the time required for passenger entry and exit during peak-traffic conditions

Elevator planning

Several factors combine to influence the cost of an elevator installation, including the passenger handling capacity, waiting interval, speed, location, finishes, intelligent group control safety, and reliability.

Parameters in design of elevators include:

Characteristic of the premises

• Type and use of building;

• Floor plate size and height of the building;

• Size of population and its distribution in the premises;

• Fire safety and regulations;

• The house keeping of the premises.

Circulation Efficiency

• Number of cars and their capacity;

• Location and configuration of elevators in entrance lobby;

• Travel length, number of stops and maximum acceptable waiting time;

• Arrangement with the combination of elevator, escalator and emergency stairs.

Characteristic of the equipment

• Type of transportation systems;

• Rated load and car dimensions;

• The speed of the lift/escalator system;

• The type of motor drive control system of the machine;

• Mode of group supervisory control and safety features;

• Cab enclosure and hoist way door finishes;

• Emergency power supplies and fire protection systems;

• Requirements of the local regulations on vertical transport system.

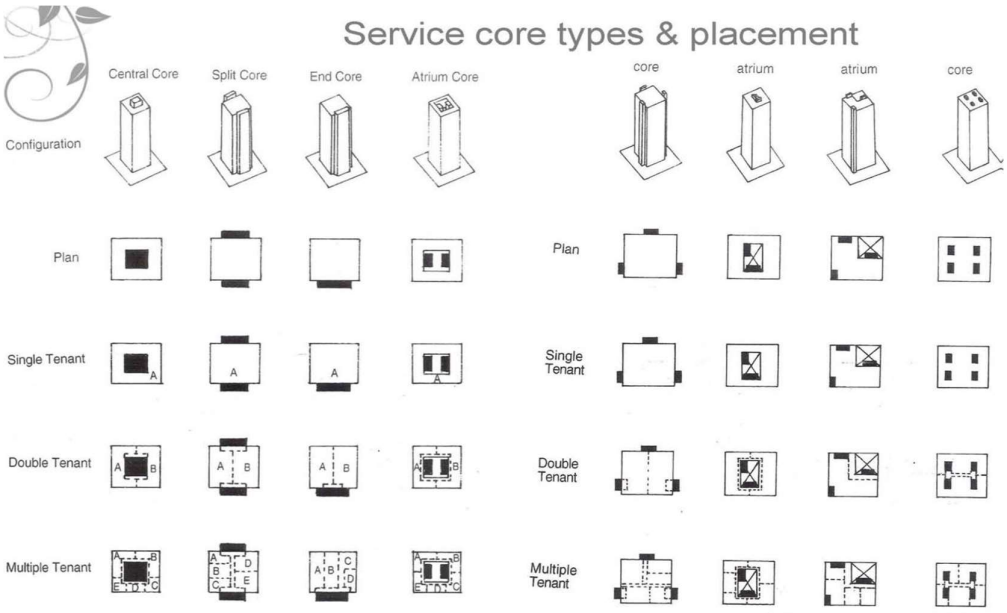
Service core

A service core is defined as those parts of a building that consist of the elevators, the elevator shafts, the elevator lobby, staircases, toilets, M&E service, riser ducts and, in some cases, the M&E plant rooms. Its structure can also contribute to the structural stability of the building.

Service cores can typically contain the following elements:

- Elevator shafts (inclusive of the elevator cars and equipment inside them)
- Elevator lobby (into which the elevator shafts open)
- Staircases (usually consisting of a main staircase and an escape staircase)
- Fire-protected lobbies (where these are required, depending on the configuration and level of fire protection, building type and size)
- Toilets (which usually consist of male and female toilets, disabled persons toilets, and executive toilets, where provided)
- Ancillary rooms such as pantry, space for cleaning materials, where these are provided.
- Mechanical vertical services riser-ducts, e.g. for electrical power and lighting distribution, water distribution (including both riser and dropper pipes),
- Sewage pipes, rainwater downpipes, system-medium piping, hot water piping, firefighting pipes and equipment, exhaust ducts, etc
- Structural bracing and stability, achieved in the elevator shaft and staircase design (if applicable), mechanical vertical fire-protection risers for sprinklers, hose reels, wet and dry risers
- Electrical vertical service riser for power
- Electrical vertical service risers for telecommunications and data systems
- M&E services plant rooms (where required for air handling units, telecommunications distribution equipment, etc
- Walls (to the service core) which can contribute to the structural stiffness of the building

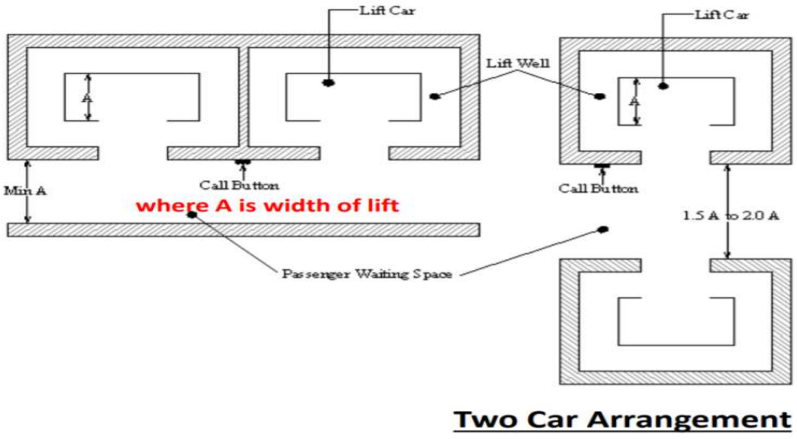
- The placement of the service core stems from four generic types which are used to design floor plates that meet the spatial requirements of the brief. They are known as
- the central core
- the split core
- the end core
- the atrium core



Design of elevator lobby areas

Two-car grouping

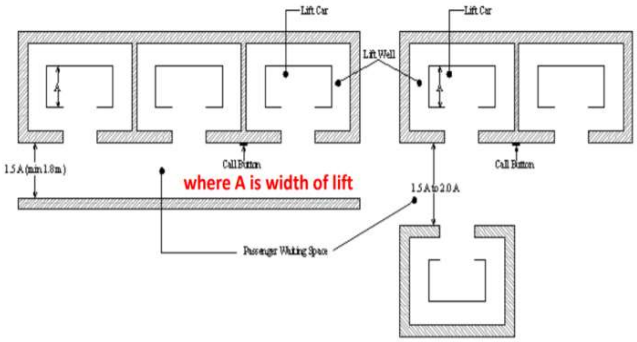
- Side by side arrangement is best.
- Passenger face both cars and can react immediately.
- Avoid separation of elevators .
- Excessive separation is not needed.
- Advantages of group operation.



Two Car Arrangement

Three-car grouping

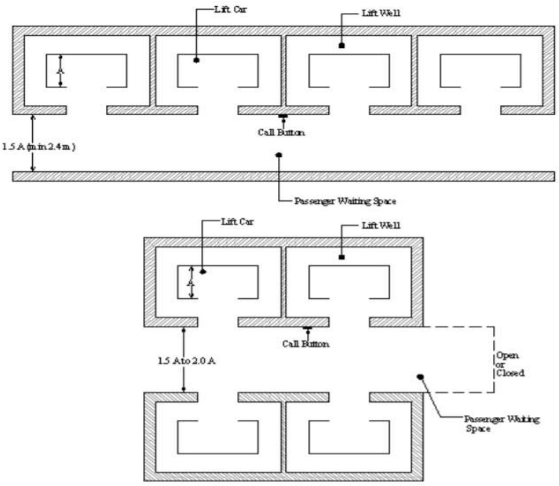
- 3 cars in a row is preferable.
- 2 cars opposite ,and 1 in same row is acceptable.
- Location of elevator call button is a problem.



Three Car Arrangement

Four-car grouping

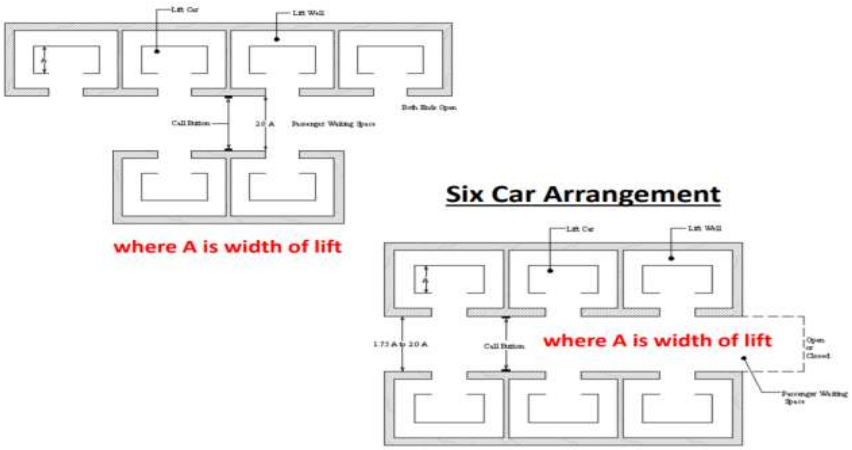
- Commonly in large busier buildings.
- 2 cars opposite ,and 2 in same row is most efficient .



Four Car Arrangement

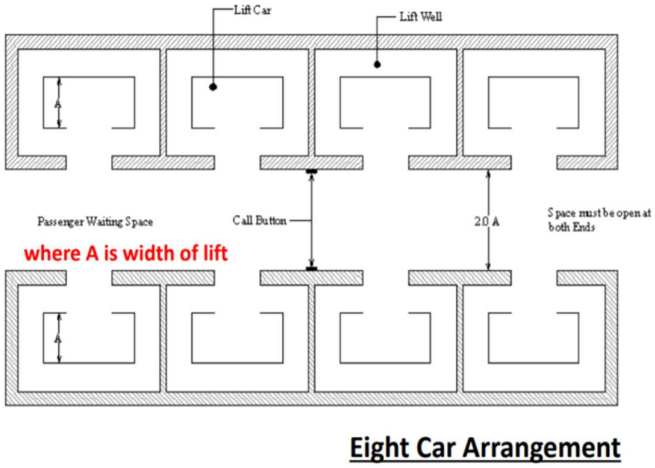
Six-car grouping

- Commonly used in large buildings.
- 3 cars opposite ,and 3 in same row is preferred.
- Dimension of the lobby must not be less than 3m or 3.6m if function as a passageway.



Eight-car grouping

- Commonly used in large busier buildings.
- 4 cars opposite ,and 4 in same row is most efficient .



Recent development in elevator technology

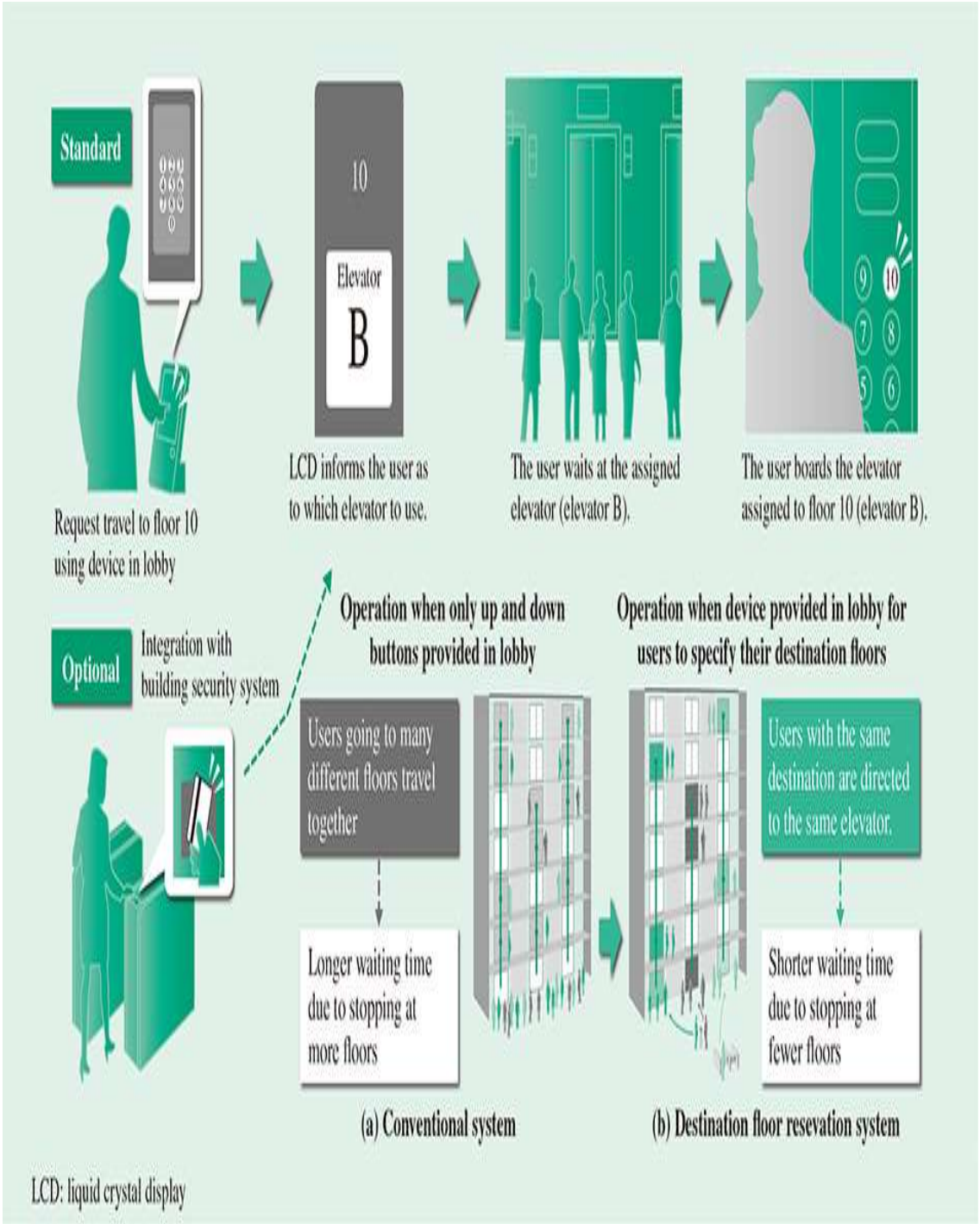
Destination controls:

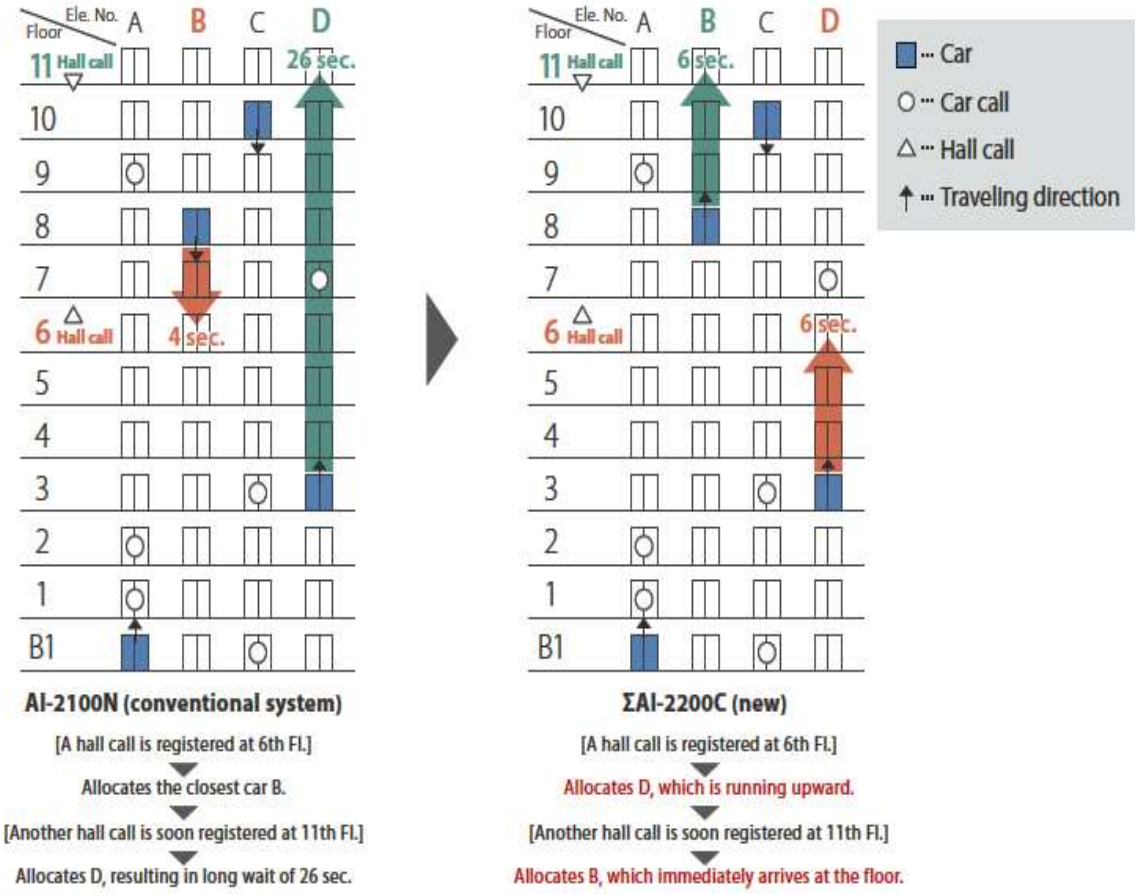
- Calling an elevator is no longer simply pressing a button and waiting for it to arrive. New, high-tech features "allow building managers to more intelligently group and assign passengers to elevators, move people more rapidly to their destination, adjust passenger flow in real-time and personalize touch screens and kiosks."

- Elevators can be dedicated to high-traffic areas to more adequately answer passenger demands. Building managers will be able to control everything remotely from anywhere in the building.

- The group control system offers the best operating schedule based on destination information entered.

- The optimum elevator operating system provides a stress-free environment for all elevator passengers.
- Device Description of FLOOR
- FULL DCS type and a HYBRID DCS type of DCS(s)
- Security System Linkage Function





External infrastructure services:

- Site preparation works.
- Roads, paths, pavings and surfacings.
- Soft landscaping, planting and irrigation systems.
- Fencing, railings and walls.
- External fixtures.
- External drainage.
- External services.

Site preparation works:

Before construction works can begin, site clearance and preparatory groundworks are generally necessary. This might include.

- Removal of any vegetation including roots.
- Levelling the site to a roughly even gradient, or modelling the site to create the desired form.
- Setting out and trench lines.
- Establishing site offices, welfare facilities, storage, access routes, and so on.

Roads, paths, pavings and surfacings

It is common for the external areas around buildings to require hard standing areas and surfacing features for use by workers, pedestrians and vehicles. These might include:

- Paving, kerbs, and edging.
- Asphalt or block surfacing to driveways, footpaths, car parks and roads.
- Timber decking, handrails and balustrades.
- Patios, platforms and so on.

Soft landscaping, planting and irrigation systems

Softscape or soft landscape includes all types of plant life, from flowers and trees to shrubs and groundcover. It naturally changes and evolves over time, driven by the climate, time of year and other conditions. Careful consideration should be given to the amount of maintenance that these elements will require to stay in good order.

Irrigation systems for gardens and external areas can be used to automate the process of watering. The most common forms are a drip irrigation systems that precisely releases water to the roots of plants, and a micro spray system that delivers a fine spray of water over a defined area. The benefit of installing such systems is their efficiency, delivering a water-use reduction of up to 90% compared to a traditional garden hose.

External fixtures

These are fixtures that may be installed for functional or aesthetic purposes outside the building. The most common examples include:

- Bollards: Used as an alternative to fencing to restrict vehicular access and as segregation between pedestrians roads.
- Street furniture: This includes benches, bins, cycle stands, tree guards, lighting, signage, and so on. Within a town or city environment the layout and manufacture of these features may be used to create a period theme.
- Shelters: These may be required to provide protection from the elements. Bespoke shelters are often supplied by manufacturers for a range of purposes, from smoking shelters for office buildings, to cycle shelters, bus shelters, sports shelters, and so on.

External drainage

This might include:

- Foul drainage: Above-ground pipework is referred to as sanitary pipework, whilst underground pipework is referred to as foul drainage and sewers. Both carry used water from toilets, sinks, basins, baths, showers, bidets, dishwashers and washing machines.

- Surface water drainage: This carries water from rain, condensation and melted snow/ice from structures. The above-ground guttering and rainwater pipes are referred to collectively as roof drainage.
- Sustainable urban drainage systems: SUDS provide an alternative to, or addition to, traditional drainage systems and may include; filter strips and drains, swales, permeable surfaces, basins and ponds, underground storage, wetlands, and so on.

External services

This might include:

- Water mains supply.
- Electricity mains supply and distribution.
- External transformation devices (wind turbines, solar panels, satellite dishes).
- Gas mains supply.
- Telecommunications and other communication system connections.
- Fuel storage and piped distribution systems.
- External security systems.
- Site/street lighting systems.
- Irrigation systems.
- Local/district heating installations.

Ensuring that utilities are supplied to developments is vitally important, not just for the completed development, but also for the construction process itself. Developers will need to ensure that existing site information is obtained, and surveys carried out to determine the position, extent and capacity of existing services. They will need to agree with the provider, the design of any new infrastructure that is required, who will provide it, who will adopt it, and any charges, as well as the appropriate testing, inspection, certification, connection (or disconnection), installation of meters, and so on.

The costs associated with utilities can be significant, both in terms of the initial capital cost of installation (particularly if there is no existing supply or if the existing supply is inadequate) and ongoing bills during operation.

During mobilisation for construction, the contractor will need to arrange for the necessary water, power and telecommunications services to enable the site to function.

Telecommunications Systems

Telecommunications systems include wired and wireless local and wide area networks and hardware and software providing the capabilities for systems to communicate with each other or with users.

Structured cabling system

Structured Cabling is defined as building or campus telecommunications cabling infrastructure that consists of a number of standardized smaller elements (structured).

A properly designed and installed structure cabling system provides a cabling infrastructure that delivers predictable performance as well as has the flexibility to accommodate moves, additions, and changes; maximizes system availability; provides redundancy; and future proofs the usability of the cabling system.

This infrastructure serves a wide range of uses, such as to provide telephone service or transmit data through a computer network. It should not be device dependent.

Every structured cabling system is unique. This is due to variations in:

- The architectural structure of the building, which houses the cabling installation;
- The cable and connection products;
- The function of the cabling installation;
- The types of equipment the cabling installation will support -- present and future;
- The configuration of an already installed system (upgrades and retrofits);
- Customer requirements;

Structured cabling installations typically include: entrance facilities; vertical and horizontal backbone pathways; vertical and horizontal backbone cables; horizontal pathways; horizontal cables; work area outlets; equipment rooms; telecommunications closets; cross-connect facilities; multi-user telecommunications outlet assemblies (MUTOA); transition points; and consolidation points.

Blown optical fiber technology

Blown optical fiber technology is an exciting method of delivering a fiber solution that provides unmatched flexibility and significant cost savings when compared to conventional fiber cables. In a blown optical fiber system, the fiber route is “plumbed” with small tubes.

These tubes, known as microduct, come in 5- and 8 mm diameters and are approved for riser, plenum, or outside-plant applications.They are currently available as a single microduct, or with two, four, or seven microducts bundled (straight, not twisted) and covered with an outer sheath,called multiducts.

They are lightweight and easy to handle. Splicing along the route is accomplished through simple push-pull connectors. These microducts are empty during installation, thereby eliminating the possibility of damaging the fibers during installation.

Fiber is then installed, or “blown,” into the microduct.The fiber is fed into the microduct and rides on a current of compressed air. Carried by viscous drag, the fibers are lifted into the airstream and away from the wall of the microduct, thereby eliminating friction even around tight bends.

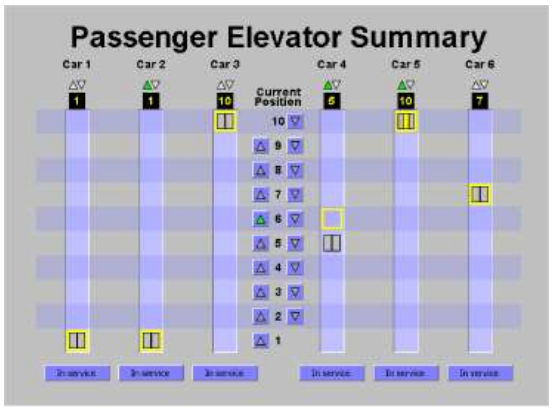
Vertical transporation bms

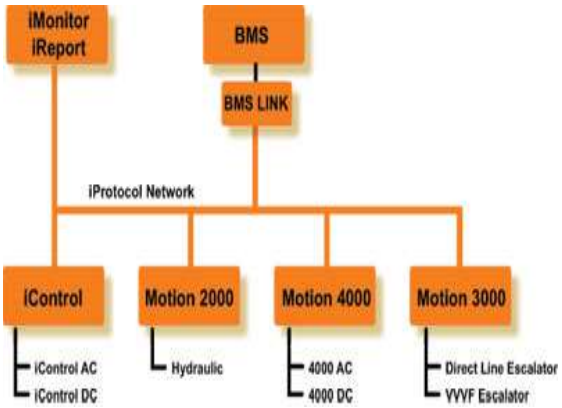
Vertical transportation systems are open to the Building Management System that already allows effective control and energy management for all other building systems. When connected to an elevator group, the management system page provides

- realtime car position,
- current and intended floor information, door position,
- direction of travel,
- active floor calls and selected direction,
- current car mode/service status.

Through BMS-LINK, management system can place up or down direction hall calls and even tune elevator energy usage . Cars may be placed out of service with doors open or doors closed. Out of service cars may be returned to service at any time.

Demand response is an intelligent reaction to real-time energy pricing in which energy consumers, primarily large building operators, shed load and adjust building conditions to reduce energy use during peak demand/expense. Demand response allows building owners to reduce energy expense.





Transportation Demand Response

Elevator groups can contribute to Demand Response benefits.

As an example, a six-car elevator group might respond to a first level signal from the building management system by removing one car from service, to a second level signal by removing two additional cars from service, and to a third level signal by removing all but one car from service.

The building management system would signal different levels after making energy cost calculations coordinated with current elevator traffic demand. As energy costs declined, or as building traffic increased, the building management system would return individual cars to service as needed.