# IV a Substations

## Air Insulated Substations:

⇒ **Substation:** Substation is a link between the transmission system and distribution system. Substation receives electrical energy at higher level and distributes it to the consumers at lower level.

* In a substation the voltage can be stepped up or stepped down or it can be converted from A.C to D.C or vice versa.
* Successful operation of substation provides continuity of supply to the consumers without any interruption.

The following points must be kept in view while designing and building a substation.

* A substation should be located near to the load centre to reduce transmission losses and cost of distribution system.
* It should be easily operated and maintained.
* Fire proof switch room and cable room should be provided in order to avoid fire hazards.
* It should involve minimum capital cost.
* It should provide safe and reliable arrangement.

⇒ **classification of substation:**

Substations are classified in a number of ways as follows.

1) According to service Requirements
2) According to constructional features
3) on the basis of importance
4) Depending upon the operating voltages.

1) According to service requirements:

According to service requirements, substations may be classified into

a) Transformer substations: Those substations which change the voltage level of electric supply are called transformer substations. These substations receive power at some voltage and deliver it at some other voltage. transformer will be the main component in such substations. most of the substations in the power system are of this type.

b) Switching substations: these substations do not change the voltage level. However they simply perform the switching operations of power lines.

c) power factor correction substations:

Those substations which improve the power factor of the system are called power factor correction substations.

Such substations are generally located at the receiving end of transmission lines.

these substations generally use synchronous condensers as the power factor improvement equipment.



d) freq changer substations:

Those substations which change the supply freq are known as freq changer substations. such a freq change may be required for industrial utilisation.

e) Converting substations:

Those substations which change a.c power into d.c power are called converting substations. These substations receive a.c power and convert it into d.c power used for traction, electroplating and electric welding etc.

2) According to constructional features

According to constructional features, the substations are classified into (i

i) indoor substation ii) outdoor substation

iii) underground substation iv) pole mounted substation,

i) Indoor substations: For voltages upto 11 kV, the equipment of the substation is installed indoor because of economic considerations.

ii) Outdoor Substations: For voltages beyond 66kV, equipment is invariably installed outdoor.

iii) Underground substations: In thickly populated areas, the space available for equipment and building is limited and cost of land is high. Under such situations the substation is created underground.

iv) pole mounted substations: This is an outdoor substation with equipment installed over head on H-pole or 4 pole structure. It is cheaptest form of substation for voltages not exceeding 11 kV (or 33 kV in some cases)

3) On the Basis of importance:

i) Town Substation: This type of substations are used for steping down the voltage at 33/11 kV for further distribution in the towns.

ii) grid substations: This type of substation are used to transmit huge amount of power from one point to other point in the grid.

4) Depending upon the operating voltage.

The substations depending upon the operating voltage are divided into three types. they are

i) High voltage substation:

This type of substations are also known as HV substation. In these substations the operating voltage ranges between 11kV to 66 kV.

ii) Extra high voltage substation:

This type of substations are also known as EHV substations. in these substations the operating voltage ranges between 132 kV to 400 kV.

iii) Ultra high voltage substation:

This type of substation are also known as UHV substations, the operating voltage ranges is above 400 kV.

⇒ Comparision between outdoor and indoor substations

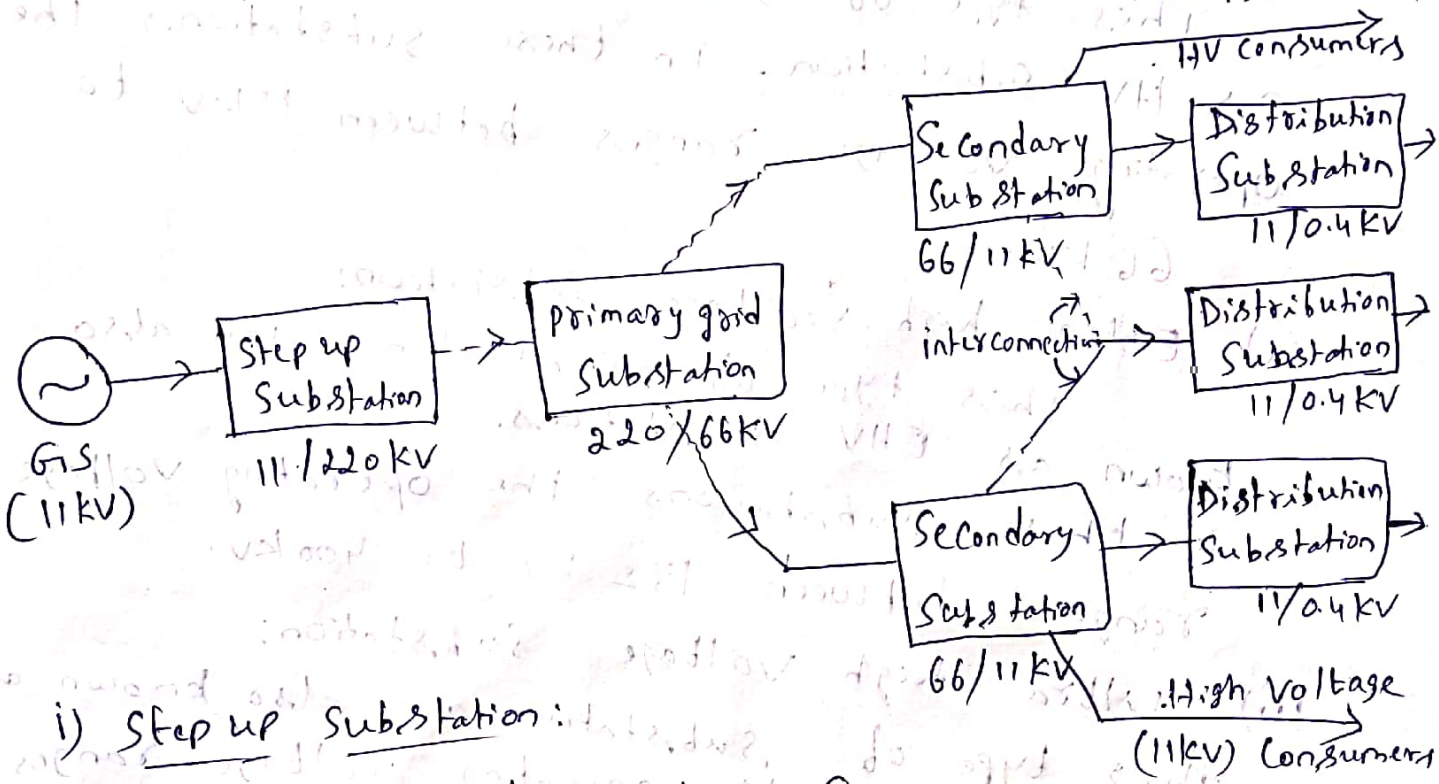
| S.no | Particular | outdoor substation | indoor substation |
|---|---|---|---|
| 1. | Space required | more | less |
| 2. | Time require for erection | less | more |
| 3. | Future extension | Easy | difficult |
| 4. | Fault location | Easier because the equipment is in full view | Difficult because it is enclosed |
| 5. | Capital cost | low | High |
| 6. | Operation | Difficult | Easier. |

## ⇒ Transformer Substations:

Depending upon the purpose served transformer substations may be classified into

i) Step up substation ii) primary grid substation

iii) Secondary substation iv) Distribution substation.




### i) Step up Substation:

The generation voltage (11kV) is stepped up to high voltage (220kV) in transmission of electric power. These are generally located in the power houses and are of outdoor type.

### ii) primary grid substation:

From the step up substation, electric power at 220kV is transmitted by 3 ϕ, 3 wire overhead system to the outskirts of the city. Here electric power is received by the primary grid substation which reduces the voltage level

to 66kV for secondary transmission.
The primary grid substation is generally of outdoor type.

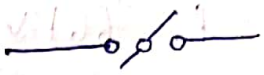
iii) Secondary Substation: From the primary grid substation, electric power is transmitted at 66kV by 3 phase, 3 wire system to various secondary substations. At a secondary substation, the voltage is further stepped down to 11kV.

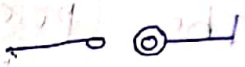
iv) Distribution Substation:
The electric power from 11 kV lines is delivered to distribution substations. These substations are located near the consumers localities and step down the voltage to 400V, 3$\phi$, 4 wire for supplying to the consumers.
The voltage between any two phases is 400V and between any phase and neutral it is 230V.

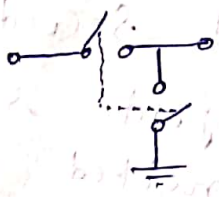
⇒ Symbols for equipment in substations

Symbols of important equipment in substation are given below.

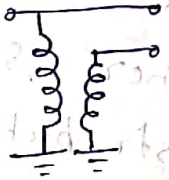
| S.No | Circuit element | Symbol |
|---|---|---|
| 1. | Busbar | |
| 2. | Single break isolating switch | |

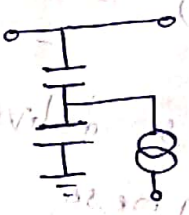
3. Double break isolating switch 

4. On load isolating switch 

5. Isolating switch with earth blade 

6. Current transformer 

7. potential transformer 

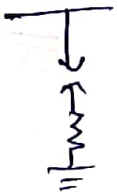
8. Capacitive voltage transformer 

9. Oil circuit breaker 

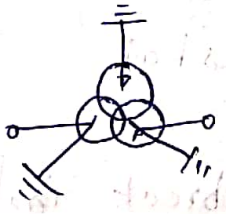
10. Air circuit breaker with overcurrent tripping device 

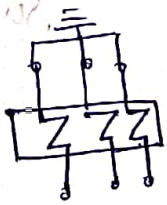
11. Air blast circuit breaker 

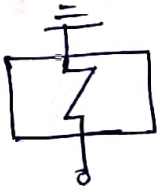
12. Lighting Arrester 

13. Lighting Arrester (valve type) 

14. Arcing horn 

15. 3$\phi$ power transformer 

16. overcurrent relay 

17. Earth fault relay 

## ⇒ Equipment in a transformer substation

1. **Busbar**: when a number of lines operating at the same voltage have to be directly connected electrically, busbars are used as a common electrical component. this having aluminium and copper bars and operates at constant voltage.
   * the incoming and outgoing lines connected to Busbars in a substation.
2. **Insulators**: these are support to busbars and provide insulation to busbars. these made with the porcelain and fiber glass.
3. **Isolating Switches**: these can be used in a substation to disconnect a part of the system for general maintainance and repair.
4. **Circuit Breaker**: A circuit Breaker is an equipment which can open or close a circuit under normal as well as fault condition. It is so designed that it can be operated manually (or by remote control) under normal condition and automatically under fault condition.
5. **power transformers**: A power transformer is used in a substation to step up or step down the voltage
6. **Instrument transformers**: The function of these Instrument transformers is to transfer voltages or currents in the power lines to values which

are convenient for the operation of measuring Instruments and relays.

7. Control house: The substation control house contain control panels, batteries, meters, battery charger supervisory control and relays. It provides protection and security for the control equipments.

8. Control panels: It contains meters, control switches and recorders. these are used to control substation equipment to send power from one circuit to another ckt. and open or closed the ckt under normal and abnormal conditions.

9. Control wires: these are installed for connecting the control house and control panels to all the equipment in the substation.

10. High voltage fuses: these are used to protect the electrical system in a substation from power transformer faults.

11. Batteries: these are used in the substation control house as a back up to power the automatic control circuits.

12. Circuit switchers: these will provide protection for the equipments such as cables, transformers, lines and capacitor banks.

13. Lightning arrester: It is a device used in power systems and tele communication systems to protect the insulation and conductor of the system from the damaging effects of lighting. (6)

⇒ the considerations for the selection of site for an outdoor substation.

Sol: while locating site for substation, the following factors must be considered.

1. Substation type: Depending on the type of substation, the proper site for the substation is selected. Different substations are located at different sites based on its requirements such as the a step up substation is to be located close to the generating stations to reduce the transmission losses whereas the stepdown substation is to be located close to the load centre to minimize transmission losses to achieve better reliability of supply.

2. Availability of Land:
The land opted for a substation must fulfill the following things.

i) The land must be level and open from all sides

ii) The land must be free from water logged specially in rainy season.

iii) The land or area required for the substation must be enough and according to the substation type.

3. Transportation facilities: If the site is selected on road side then the transportation will be very much easier and expenditure incurred will also be very less.

4. Atmospheric pollution: The site selected should be free from atmospheric pollution. The places near factories, sea coasts should not be selected as the air around factories produces harmful gases which is not suitable for proper functioning of power system.

5. Availability of Basic facilities: The basic facilities like school, hospital, housing, water etc should be available for the staff.

6. Expenditure and cost: The site selected for substation should be of low cost and it should involve minimum expenditure for its construction.

⇒ Draw the key diagram of a typical 33/11 kV substation showing the location of all the substation equipment.

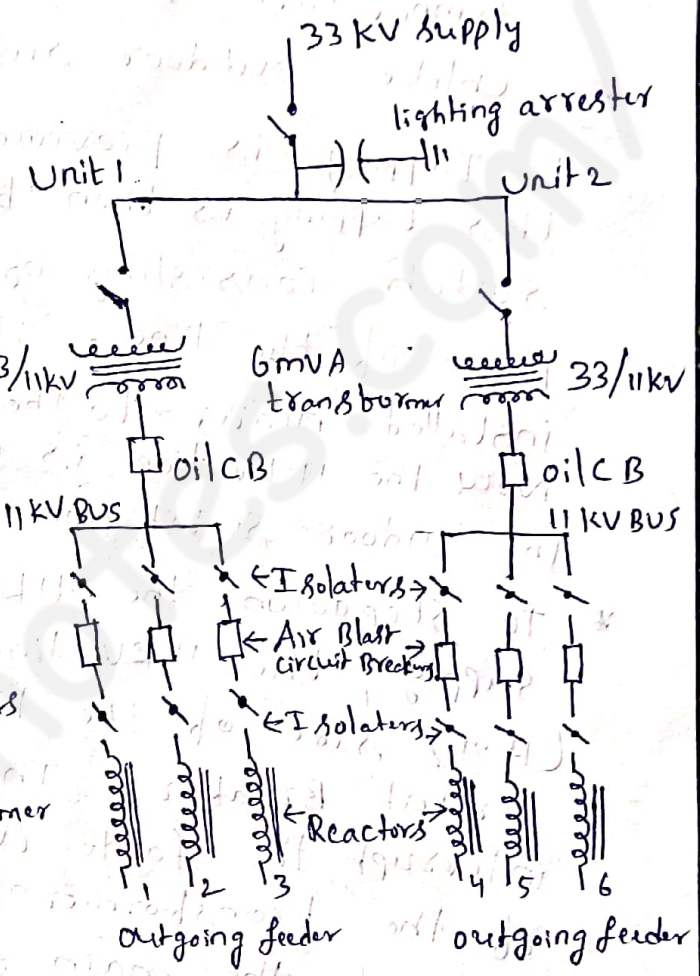
* A 33/11 kV substation basically is an outdoor substation and located at the distribution side or load centre. It is generally called distribution substation. The term 33/11 kV implies that the primary or the incoming feeders of the substation carries 33 kV potential and the secondary of the outgoing feeders carry 11 kV potential.

* there are many outgoing feeders to cater the needs of either industrial load or domestic load. The line diagram clearly indicates the sequence of arrangement of all the equipments inside the substation.



* The line diagram of a 33/11 kV substation is shown in big.

* In the line diagram It is shown that there are two separate transformers each rated 6MVA in 33 kV at the primary side. The voltage is stepped down to 11 kV at the secondary side. An oil circuit breakers are placed in between the secondaries of each transformer and their respective 11 kV buses, which isolates the circuit during fault conditions.




big Key diagram of 33/11 kV substation.

⇒ Draw and explain key diagram of a typical 11 kV/400V indoor substation showing location of all equipments.

Sol: The substation for which the equipments are installed within the substation building is known as indoor substation.

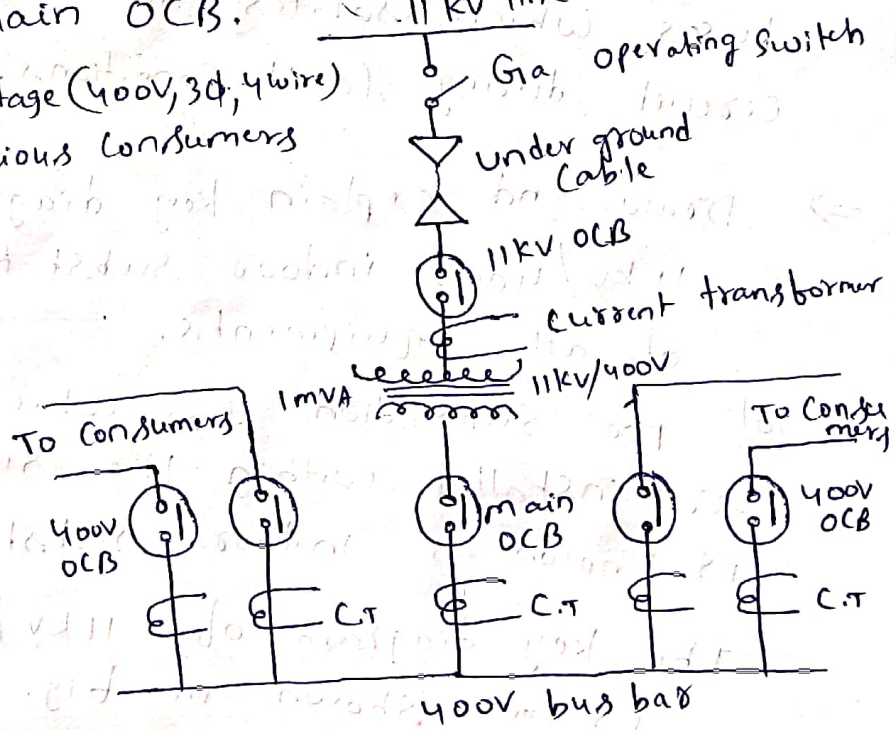
The key diagram of 11 kV/400V indoor substation is as shown in big.

* The space required for it is less and are easier to operate. There is no need for installing any protection devices for protecting the equipments against lighting surges, rapid temperature changes and dust or dirt deposits unlike outdoor substation.

* Tapping is provided to the 3ϕ, 3wire 11 kV line. this tapping is then brought to the gas operating switch consisting of isolaters connected in each phase of the line. The gas operating switch is installed nearer to the substation.
Now the 11 kV line is undergrounded and brough to the indoor substation from the G.o switch.

* To stepdown the 11kV supply to 400V, 3ϕ, 3wire supply, the 11 kV line is fed to the High Tension (H.T) side of the transformer through 11 kV oil circuit Breaker. The purpose of OCB is to interrupt the fault current, the secondary winding of the transformer is fed to the 400V busbar through the main OCB.

* Now the stepdown voltage (400V, 3ϕ, 4wire) is supplied to the various consumers through 400V OCB.



* The voltage between any of the two phases is 400V, whereas the voltage between any phase and neutral is 230V. For a domestic consumers the load is connected between any phase and neutral, whereas the industrial consumers the load is connected across 3 phase line directly.

The purpose of the current transformer is to supply for the metering and indicating instruments and relay circuits.

⇒ What are the different types of bus bar arrangments ?

Busbar is a conductor made up of copper or aluminium of large cross sectional area compared to the conventional conductors, which carry higher amount of currents in a limited space and the incoming and outgoing feeders are connected to Busbars in a substation.

* The selection of a particular bus bar arrangement is done depending upon the factors such as voltage level, simplicity, reliability, safety, cost of installation and maintainance etc.

Different types of busbar arrangements available

i) Single bus bar system
ii) Single busbar with sectionalisation.
iii) Double busbar system
iv) main and transfer busbar system.

i) Single busbar system: Single busbar arrangement consists of a single busbar, to which all the

incoming and outgoing feeders are connected.
The Single busbar system has the simplest design.

ii) Single busbar with Sectionalisation:

Single busbar with sectionalisation consists of two or more sections of the busbar where the sections are connected by a circuit breaker and isolator.

iv) main and transfer busbar system:

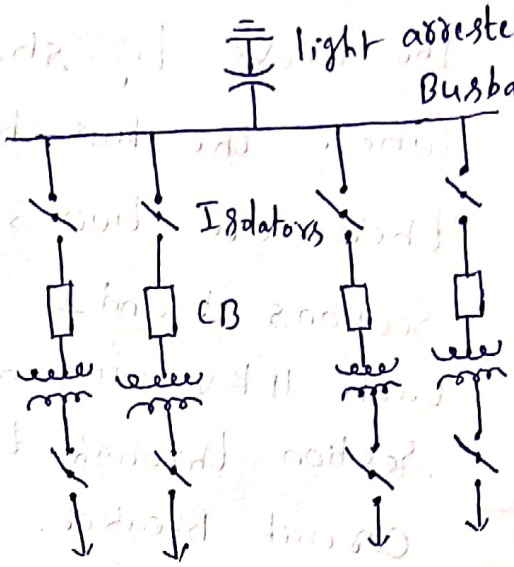
The system consists of two busbars i.e a main busbar and a transfer busbar, the generator and feeder can be connected to any of the busbar and the continuity of supply can be maintained.

⇒ Draw and explain the single bus bar system and mention its advantages and Disadvantages.

Sol: Single busbar system is the simplest and cheapest arrangement of busbars.
It consists of a single busbar to which all the electrical equipments viz., generators, transformers, isolators etc.

* Single busbar system is used for voltages below 33 kV. Usually it is employed for 11 kV indoor substation.
* All the incoming and outgoing lines are connected to the single bus bar only.
* The incoming lines at a voltages of 11 kV are connected to the busbar through isolator and circuit breakers.

In the outgoing line, the voltage is stepped down to 400V using 11KV/400V transformer, thereby making the voltage at outgoing lines to 400V as shown in fig.




Advantages: Due to Simplicity and low initial cost, Single busbar systems are used frequently in small substations.

* Since the connections of single busbar system are simple, it is easy to operate.

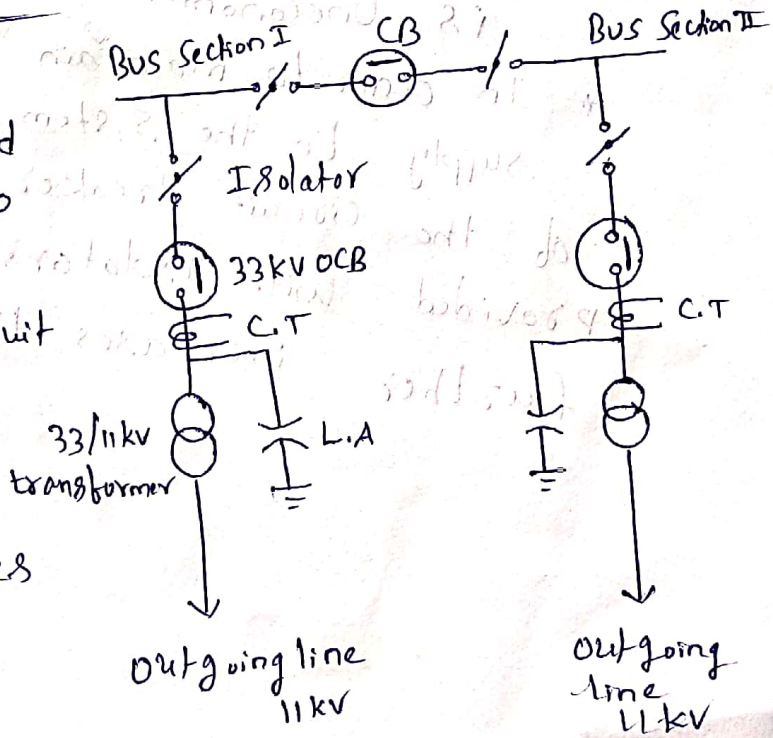
Disadvantages:

* In case of fault on the busbars, the supply to the whole system is to be interrupted.

⇒ Explain the Single busbar system with Sectionalisation and what are its merits and Demerits.

Sol:

* The Bus bar is divided into sections. Any two sections of the busbar are connected by a circuit Breaker and Isolator.
* this arrangement is used for voltages upto 33kV.



The above fig shows bus bar with Sectionalisation where the bus has been divided into two sections. There are two 33 kV incoming lines connected to Sections I and II through CB and Isolator. Each 11 kV outgoing line is connected to one section through transformer (33/11 kV) and Circuit Breaker.

Advantages:

* Flexiable operation Can be achieved using Single bus bar with Sectionalisation.
* more reliable than Single bus bar scheme.
* The maintenance or repair of one section is possible as it is shut downed, without affecting other section supply.

Disadvantages:

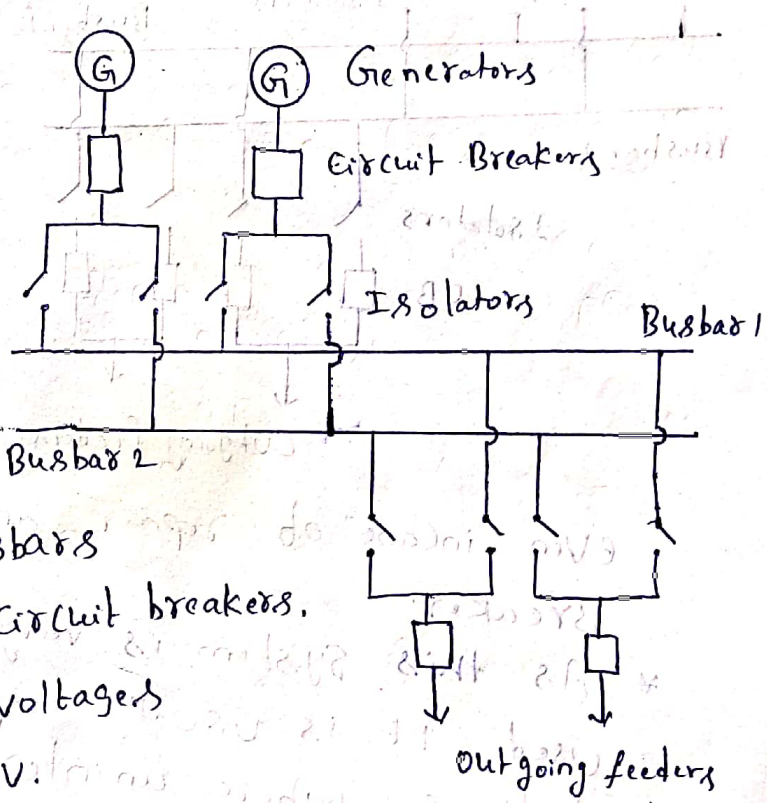
* Single bus bar system with Sectionalisation is uneconomical for small substations.
* In order to maintain the Continuity of supply to the system, during the maintenance of the Circuit Breaker, the CB must be provided with Isolators on both sides, which further increases the cost of the system.

⇒ Explain about double bus bar system with one and two circuit Breakers. (10)

Sol: Based on the number of circuit breakers used, a double bus bar system is classified as

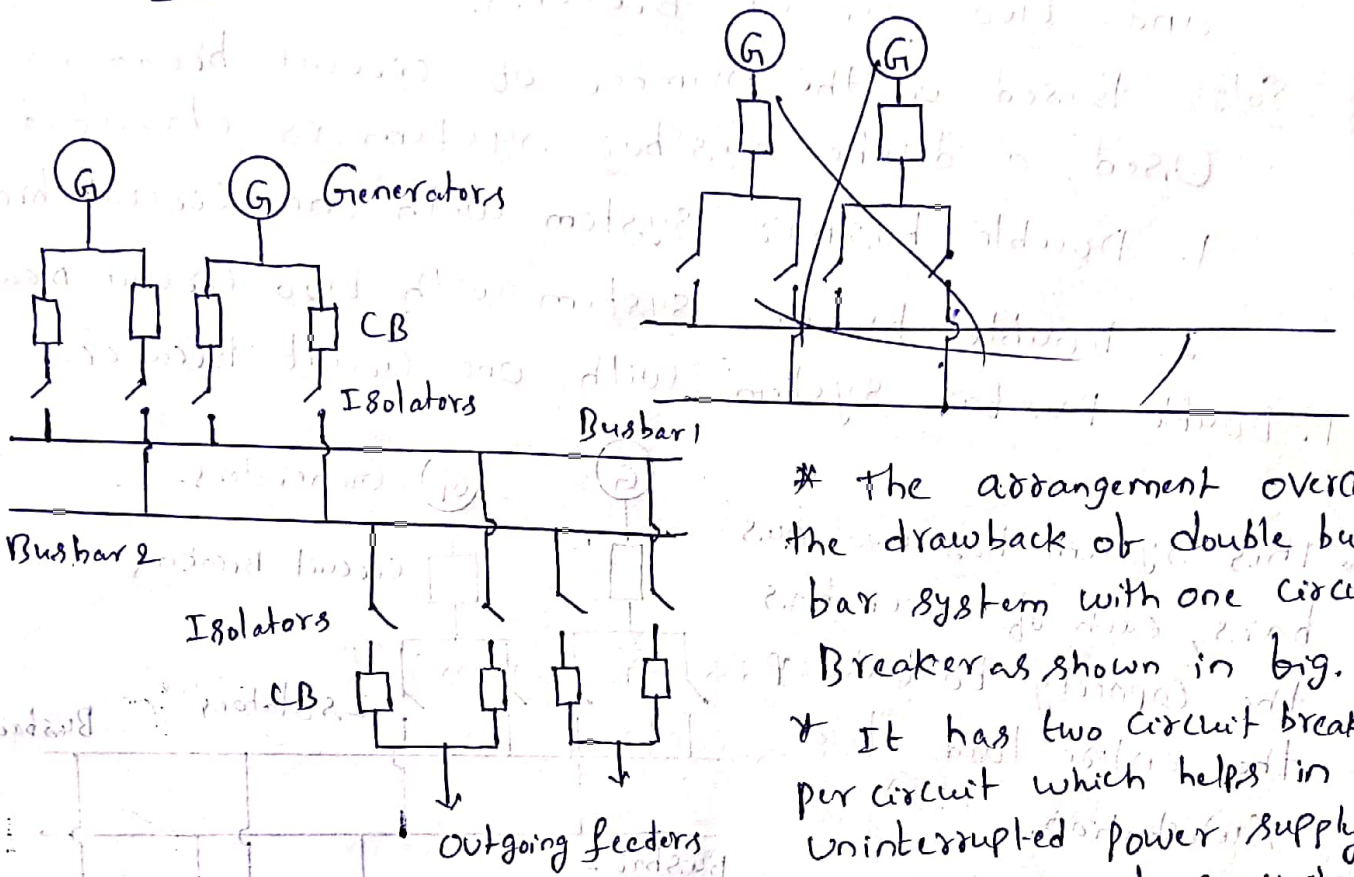
1. Double busbar system with one circuit breaker
2. Double busbar system with two circuit breakers

1. Double Busbar System with one Circuit Breaker:




* This system has two bus bars, each of which has the capacity to take up the entire load of a substation.
* Load is fed from any one of the two busbars through Isolators and circuit breakers.
* Generally used for voltages greater than 33 KV.
* this system facilitates easy repair and maintenance of bus bars without interruption in supply.
* However, supply is interrupted when circuit breakers in the circuit needs repair or maintenance.

## 2. Double busbar system with two circuit Breakers.

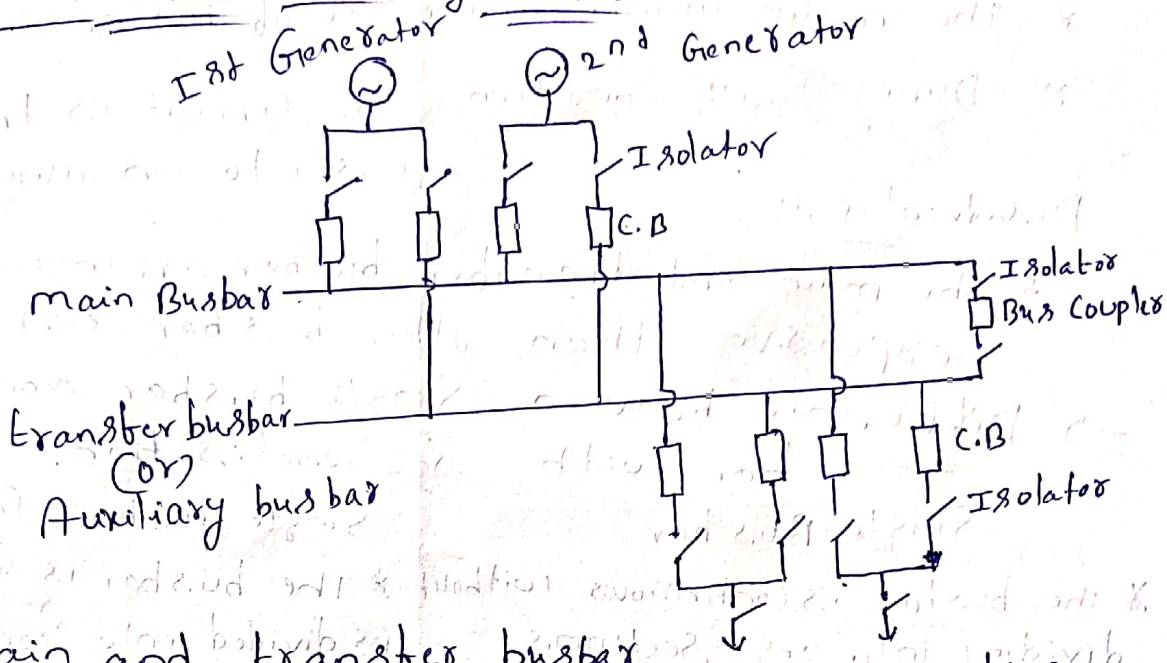



* the arrangement overcomes the drawback of double bus bar system with one circuit Breaker as shown in fig.
* It has two circuit breakers per circuit which helps in uninterrupted power supply even incase of repair and maintenance of circuit Breaker.
* As this system is very expensive, it is rarely used. It is usually employed in large generating stations where uninterrupted supply is more important than cost considerations.

⇒ with suitable diagrams explain the main and transfer bus bar arrangements.

* Busbars are the copper rods, that are used to collect electrical energy at one place. The generators and feeders that are operating at same voltage are connected directly to these Busbars

⇒ With suitable diagrams, explain the main and transfer busbar arrangements. (11)




* the main and transfer busbar arrangement uses two buses, one as main bus and other as transfer (or) auxiliary bus. The generators and feeders are connected to both main bus as well as transfer bus.
* Under normal conditions the generator and feeder are connected to main bus. Suppose Assume that the fault has occurred in any breaker or main bus then the power flow gets interrupted. For Avoiding this, the entire equipment that are connected to main bus is shifted (or) transferred to a transfer bus without any interruption of power flow by using a bus coupler, which use double Isolating switches.
* Thus the generators and feeders are transferred from main bus to auxiliary bus without any interruption of power.

Advantages: There is no interruption of power supply i.e the power supply is continuous even under fault condition.

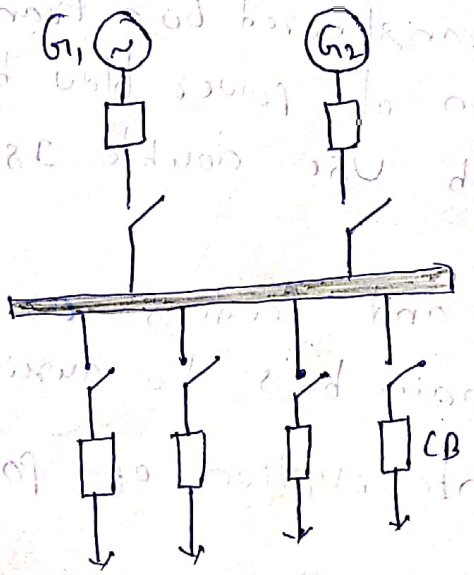
* The maintainance and repair of bus or circuit breaker is easy,
* During fault conditions, the circuit is transferred to easily to an auxiliary bus

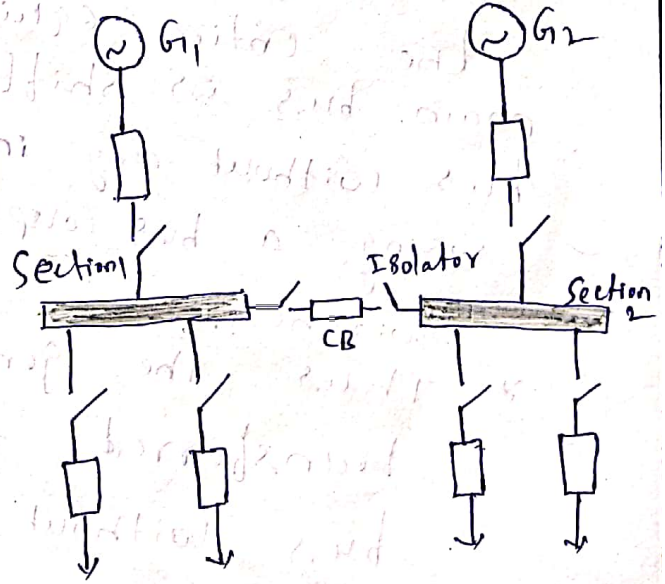
Disadvantages:

* The main and transfer busbar arrangement is very expensive than other busbar arrangements.

⇒ Difference between Single busbar and Single bus bar with Sectionalisation.

| Single Bus bar | Single Bus bar Sectionalisation |
|---|---|
| * The busbar is continuous without dividing into any sections. | * The busbar is discontinuous and is divided into 2 or 3 sections. |
| * As there are no sections on the busbar, no bus coupler (CB) is required. | * Each of the two sections of the busbar is connected by a bus coupler. |
| * In order to test or repair or clean the busbar, the whole system has to be de-energized. | * The repair or maintanance of any section can be carried by de-energizing the concerned section only. |
| * when a fault occurs on the busbar, it results in very large fault current | * this having lower fault current. |
| * The b circuit for Single Busbar | * the circuit for Single Busbar with Sectionalisation. |



# 4 b) Gas Insulated Substation (1)

⇒ What is a gas insulated substation?

Gas insulated substation is a small multi component assembly which is enclosed in a ground metallic room and uses sulphur Hexa fluoride ($SF_6$) gas as an insulating medium.

* Because of reliability, easy control and maintainance the GIS are preferred rather than other substations like Air Insulated substation etc.
* A GIS consists of two transformers that are arranged side by side and gas insulated switching apparatus like disconnecting switches at higher levels than the transformers.
* The main bus bars are interconnected to the transformers through branch busbars, which are further connected to circuit breakers.

⇒ List out the merits and demerits of GIS substation.

Advantages:

* The GIS system is eco-friendly i.e it is free from the pollution.
* Easy to maintain and control.
* Requires less space for installation.
* As $SF_6$ is non-inflammable, the
* It has longer life and periodical inspection is not required.
* GIS are more reliable than other substation.
* the time required for erection is less compared to other substations.

Disadvantages:

* Earth faults may cause server problems
* Installation of gas insulated substation is expensive.

⟹ Classification of Gas Insulated Substation:

GIS are classified according to the type of configurations or modules as,

1. Isolated phase module.
2. Three phase common modules
3. Hybrid modules
4. Compact modules
5. Highly integrated systems

1. Isolated Phase GIS module:

The individual circuit elements such as a pole of circuit breaker, a single pole isolator, one phase assembly of a current transformer etc., connected together forms a isolated phase GIS module.

2. Three phase common module:

In this type of module a three phase bay is assembled using the desired no of three phase elements. this reduces the total no of enclosures to one-third. The control of bay width is done by the dimension of the largest three phase module.

3. Hybrid module: In hybrid GIS systems, a suitable combination of isolated phase and three phase common elements is used to achieve an optimal techno Commercial solution.

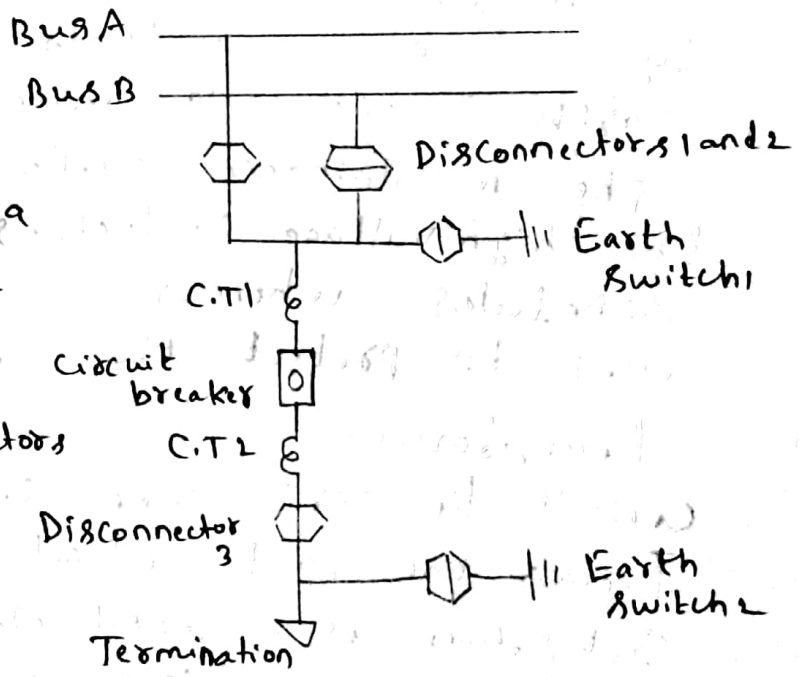
Hybrid GIS technology has gained popularity, specially in the medium and low voltage range.

Compact module: Compact GIS Systems are essentially three phase common systems in which the elements such as three phase circuit breaker, current transformer and earth switches are placed in a single enclosure which supports the busbar and other feeder elements.

Highly Integrated System:

Highly integrated ~~Substation~~ Systems provides a total substation solution for outdoor substations.

⇒ Draw the single line diagram GIS insulated substation and explain its working.




big ① Single line diagram of double bus section.

A Substation consists of many sections. The main equipments in a section or bay consists of

1. circuit breakers
2. Isolators (or) disconnectors
3. current transformers
4. Earth switches
5. Surge arresters.

the Gas Insulated Substation contains the same components as that of a conventional outdoor substation. All the line parts in these substation, are housed in separate

metal enclosed modules filled with gas of high dielectric strength such as $SF_6$.

Isolators or Disconnectors:

Disconnectors designed for the interruption of small currents are always placed in series with the circuit breaker in order to provide additional protection and physical isolation. Generally two isolators are used in a circuit one on the line side and other on the feeder side. These Isolators are driven manually or can be motorised. In gas insulated systems, motorised isolators are preferred.

Earth Switches:

In gas insulated Substation systems the two types of earth switches used are fast earth switch and maintenance earth switch. The maintainance earth switch used for grounding the high voltage conductors during maintenance schedules whereas a fast earth switch is used to protect the circuit Connected Current transformer

Circuit breaker: The circuit breaker which forms the most critical part in a gas insulated Substation is a metal clad and uses Sulphur hexafluoride gas ($SF_6$) for the purpose of insulation and fault interruption.

* The circuit breaker is directly connected to either current transformers or the isolators in gas.

Current transformers:

In gas insulated systems, the current transformers employed are essentially in line current transformers.

These consists of following parts.

i) The tabular primary conductor
ii) Electrostatic shield
iii) Ribbon wound toroidal core
iv) Gas tight enclosure.

⇒ Briefly discuss the installation and maintenance of GIS?

The dimensions, weight and floor loading for the three voltage classes of the gas insulated substation

| S.No | | Voltage classes | | |
|---|---|---|---|---|
| | | 145 kV | 170 kV | 245 kV |
| 1 | Bay width, m | 1.5 | 2.0 | 2.0 |
| 2 | Bay depth, m | 3.3 | 3.35 | 3.4 |
| 3 | Bay height, m | 3.2 | 3.4 | 3.4 |
| 4 | floor area Sq.m | 4.95 | 6.7 | 6.8 |
| 5. | Volume, m3 | 15.84 | 22.78 | 23.12 |
| 6. | weight, kg | 3800 | 5,000 | 5700 |
| 7 | floor loading kg/Sq.m | 765 | 750 | 840 |

The GIS equipment has identical floor area occupied by the bays for the three voltage classes and the floor loading of less than 1000 kg/Sq.m

GIS is a maintenance free installation. Good GIS installation over a period of time requires better dielectric properties. maintaining gas pressure and periodic cleaning of the particle traps is a good maintenance practice for the equipment.

⇒ Comparision between Air insulated substation and Gas insulated substation.

| AIS | GIS |
|---|---|
| i) These substations are generally constructed as outdoor substations but, can also be constructed as indoor substation provided with good ventilation. | i) It is a type of indoor substation. |
| ii) The equipments in AIS are large in size | ii) The equipments in GIS are smaller in size. |
| iii) it requires more time for site preparation and planning for installation | iii) Time required for site preparation and planning for installation is small. |
| iv) Requires large area of land for installation | iv) Requires minimum land for installation. |
| v) The equipments in these sub-stations are not housed in separate metal enclosure but all the equipments are under atmospheric conditions. | v) The equipments in these substations are housed in separate metal enclosed modules filled with gas of high dielectric strength ($SF_6$) |
| vi) It is suitable, at the places where, the cost of land is less and in places where large area of lange is available | vi) It is suitable at the places where the cost of land is high and in areas where there is scarcity of land. |

⇒ classification of Gas Insulated Substation:

Gas insulated substations are classified according to the type of configurations or modules as



1. Isolated phase module
2. Three phase common module
3. Hybrid module
4. Compact modules
5. Highly integrated systems.

1. Isolated phase GIS module:

The individual circuit elements such as a pole of a circuit breaker, a single pole isolator, one phase assembly of a current transformer etc, connected together forms an isolated phase GIS module.

2. Three phase common module:

In this type of module a three phase bay is assembled using the desired no of three phase elements. this reduces the total no of enclosures to one third.

3. Hybrid modules:

In hybrid GIS systems, a suitable combination of isolated phase and three phase common elements is used to achieve an optimal techno commertial solution. Hybrid GIS technology has gained popularity, specially in the medium and low voltage range.

4. Compact module:

Compact GIS systems are essentially three phase common systems in which the elements such as a three phase circuit breaker, current transformer and earth switches are placed in.

a single enclosure which supports the busbar and other feeder elements.

Highly integrated system: Highly integrated systems provides a total substation solution for outdoor substations. Highly integrated substation ready to install substation with predefined circuit elements housed, sealed and pressurised in a single enclosure.

⇒ Explain the constructional aspects of GIS: (5)

The main parts of GIS system are

1. Gas circuit
2. Seals and Gaskets
3. Current transformer and plug-in Joints
4. Expansion Joints
5. Enclosure
6. Support structure.

1. Gas Circuit: Gas Circuit is the heart of GIS since it has to maintain the dual purpose SF6. The operating pressure in GIS ranges from 0.1 to 0.8 MPa.

* In medium voltage system, the pressure of Vaccum circuit breaker is 0.1 MPa and that of SF6 circuit breaker ranges between 0.25 to 0.45 MPa. In high voltage system, the working pressure of SF6 circuit breaker ranges from 0.65 to 0.8 MPa.

2. Seals and Gaskets:

* In GIS seals and gaskets are used to capture the SF6 gas leakages In practice, O-rings and rectangular gaskets are used for sealing. Generally Nitrile rubber and viton are used as seal material as they are resistant to strain, oil, decomposed SF6 etc.

3. Current transformer and plug in Joints:

The plug in Joints are of three types.

they are i) Static Joints: They are the plug-in Joints which are connected permanently to the GIS systemwith high insertion force at the time of manufacturing itself.

ii) Quasi-static Joints: They are the plug-in Joints which can be removed and fitted. These Joints are formed by plugging the spring loaded strongly held copper elements.

iii) Dynamic Joints: These are the plug-in Joints associated with the dynamic operation of the equipment like circuit breaker contacts.

4) Expansion Joints: these are preferred over ordinary copper and steel ones in GIS with more no of sections. Use of expansion Joints also helps in adding new sections (or removing old) in the substation and hence improves flexibility.

5) Enclosure: The material used for the construction of enclosure are carbon steel and alloy steel or cast aluminium. In order to remove the loosely held metal particles on the inner surface, a blast of corrosive sand is passed through the enclosure. Smooth finishing is provided for the inner surface using electro polishing or anodising process. Sometimes power coating is applied for the purpose.

6) Support Structure: The support structure is required to maintain the mechanical stability of the equipment. For isolated GIS systems, the supporting units are attached in horizontal fashion to the vertical mounted circuit breakers.