CHAPTER TWO

SUBSTATION AND EQUIPMENTS

2.1 Introduction

The purpose of an electrical power system is to generate and supply electrical energy to consumers. The system should be designed to deliver this energy both reliably and economically.

Substations play an important role in power system at generation, transmission and distribution.

Substation consists of important component such as transformers, bus bar, switchgear, surge arrestor, protection and instruments devices.

2.2 Functions of A Substation:

Recently substation has more jobs to do compared with its historical applications, modern functions include:

1 - Supply of required electrical power.

2 - Maximum possible coverage of the supply network.

3 - Maximum security of supply.

4 - Shortest possible fault duration.

5 - Optimum efficiency of plants and the network.

6 - Supply of electrical power within targeted frequency limits, (49.5 Hz and 50.5 Hz).

7 - Supply of electrical power within specified voltage limits.

8 - Supply of electrical energy to the consumers at the lowest cost.

2.3 Classification of Substations:

The substations may be classified by numerous ways such as on the basis of:

(i) Nature of duties.

(ii) Service rendered.

(iii) Operating voltage.

(iv) Importance of load.

(v) Design

2.3.1 Classification depends on the nature of duties

The substations, on the basis of nature of duties, may be classified into the following three categories:

1-Step-up or primary substations:

2- Primary grid substations

3 - Step-down or distribution substations.

2.3.2 Classification depend on the basis of service rendered

The substations, according to service rendered are:

1 -Transformer substations

2- Switching substations

3-Converting substations.

2.3.3 Classification of Substations on the basis of operating voltage

The substation according to operating voltage, may be categorized as:

1. High voltage substations (HV Substations): involving voltages between 11 KV and 66 kV.

2. Extra High Voltage Substations (EHV Substations): Involving voltages between 132 kV and 400 kV.

3. Ultra High Voltage Substations (UHV Substations): Operating on Voltage above 400 kV.

2.3.4 Classification of substations on the basis of importance

1- Grid substations.

2- Town substations.

2.4 Power Transformer

A transformer is a static electrical device, involving no continuously moving part, used in electric power systems to transfer power between circuits through the use of electromagnetic induction**.**

Transformers are essential elements in any power system. They allow the relatively low voltages from generators to be raised to a very high level for efficient power transmission. At the user end of the system, transformers reduce the voltage to values most suitable for utilization.

The power transformer is used in transmission substations and distribution substations, and there is no different between the transformers used in the two last substations from the side of construction and cooling system, but we can name transformers which have apparent power till 500 KVA distribution transformers, and ones which their apparent power above 500 KVA power transformers.

2.4.1 Construction of power transformer

The construction of the transformer can be classified into two groups:

a. First group:

It consists of the core and windings (primary and secondary). This group is known as active part of the transformer and it contains:

- The core:

It is designed to afford the magnetic field which comes as a result of passing the current through the primary windings and transfers it to cross the secondary windings, then an induced voltage will be generated in secondary windings.

There are two types to collect the core:

Core form construction: In this type there is a single path for the magnetic circuit. For single phase applications, the windings are typically divided on both core legs as shown in Figure 2.1, whereas in three phase applications, the windings of a particular phase are typically on the same core leg

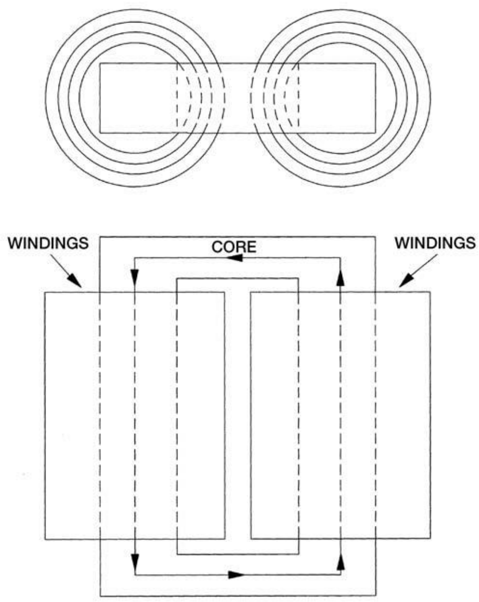

Figure 2.1: Schematic diagram of single phase core type

Shell form construction: In this type the core provides multiple paths for the magnetic circuit. The core is typically stacked directly around the windings, which are usually pancake type windings as shown in Figure 2.2.

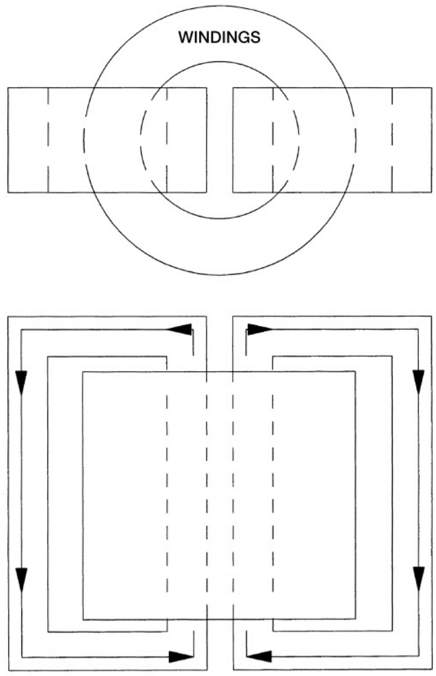

Figure 2.2: Schematic diagram of single phase shell type

- The windings:

Usually it is made of isolated wires from pure red copper. All windings must have an electrical insulation from each other and from the core. The level of insulation and cross sectional area of the windings depend on the values of voltage and currents passing through the windings.

b. Second group:

It consists of the rest parts of the transformer which defined as auxiliaries. This group is known as the passive part and contains:

1. The tank

The main tank is made from un magnetic iron. The main tank has the following advantages:

- Protect the core and windings by containing them.

- Carrying the terminals and existing of connection.
- Saving the transformer's oil which used for cooling and insulation.

2. Conservator tank:

Its job is to intake the expansion and retraction of the oil, and to provide the main tank with oil when it decreases.

The belongings of the conservator tank are:

- Bochdoulze relay: it is a protective relay which can give an alarm when the level of oil decreased, also it can disconnect the transformer if there is dangerous fault.

The bochdolz relay is installed in the tube reached between the main tank and conservator tank, and it has a valve for existing of the excess oil.

- Breather unit: its job is to exist the excess air from the conservator tank to the surrounding, and it contains the material of silicone gel which has capability to absorb any humidity can leak to oil.

3. Bushings:

Its purpose is to connect the three internal terminals of primary windings to the external electrical grid, and to connect the three internal terminals of the secondary windings to the terminals of the load.

4. Cooling tubes and pumping.
5. Raising rings.
6. Oil preservation.

2.4.2 The Equivalent Circuit of Transformer

Equivalent circuit of transformer shown in Figuer2.3

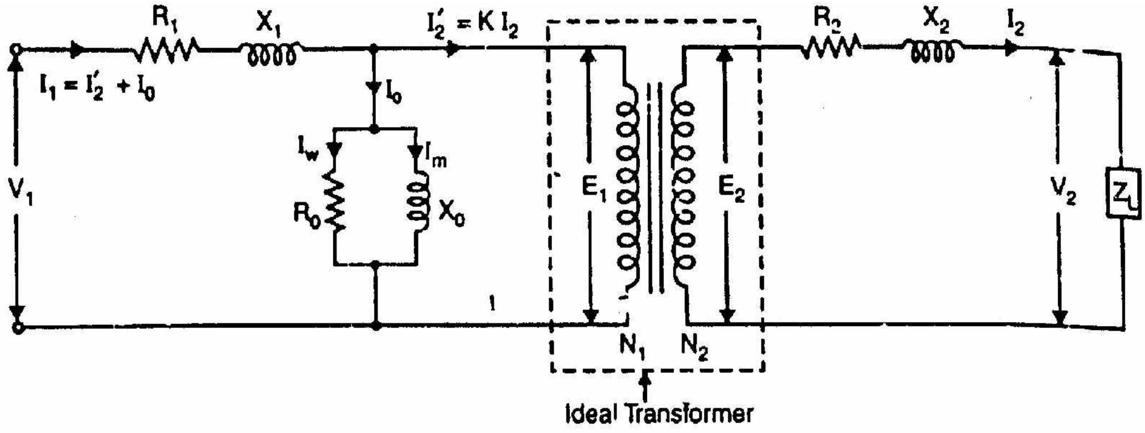

Figure 2.3: Equivalent circuit of transformer

R1: Primary winding resistance.

R2: Secondary winding resistance.

X1: Leakage reactance of primary winding

X2: Leakage reactance of the secondary winding.

R0, X0: the no-load equivalent circuit of the transformer.

2.4.3 Shunt Connection of Transformers:

The demand of load increases with the increase of population and industrial sector. Sometimes it is difficult to meet excess demand of power by existing single unit of transformer. Therefore, there is a need for additional transformer to connect in parallel.

Reasons of shunt connection of transformers:

- Continuity of supply for quality of service.

- Ease of maintenance.

- Ease of structure and transport.

- Capability to disconnect some transformers when there is decrease on the load.

Terms to be considered when connecting transformers in parallel:

- Transformation ratio must be equal for all transformers.
- All transformers should have the same polarity.
- All transformers should have the same percentage impedance.
- The phase sequence of all transformers must be same (In case of three phase transformer).
- All transformers should have the same phase displacement (In case of three phase transformer).

2.4.4 Cooling System of Power Transformer:

The transformers get heated due to iron and copper losses occurring in them. It is necessary to dissipate this heat so that the temperature of the windings is kept below the value at which the insulation begins to deteriorate.

As far as cooling methods are concerned, the transformers are of the following two types:

1- Dry type

This type is used for small transformers up to 25 KVA and have the following cooling arrangements:

- Air Natural: in this method the natural circulation of surrounding air is utilized to carry away the heat generated by losses.
- Air Blast: here, the transformer is cooled by a continuous blast of cool air forced through the core and windings. The blast is produced by a fan and the air supply must be filtered to prevent accumulation of dust in ventilating ducts.

2- Oil immersed type:

Most transformers are of oil immersed type. The oil provides better insulation than the air. Oil immersed cooling transformers are classified as follows:

- Oil Immersed self-cooled transformers**:** In this case the transformer is immersed in oil, and heat generated in the core and windings is passed to oil by conduction. Heated oil is replaced with cool oil from the bottom. The natural oil transfers its heat to the tank walls from where heat is taken away by the ambient air.
- Oil immersed forced air cooled transformers: In this type of cooling, air is directed over the outer surfaces of the tank of the transformer immersed in oil.
- Oil immersed water cooled transformers**:** here, heat is extracted from the oil by means of a stream of water pumped through a metallic coil immersed in the oil just below the top of the tank. The heated water is in turn cooled in spray pond or a cooling tower.
- Oil immersed forced oil cooled transformers: In such transformers, heat is extracted from the oil by pumping the oil itself upward through winding and then back by way of external radiators which may themselves be cooled by fans.

2.4.5 Vector group

Vector group determines the phase displacement between the primary and secondary windings. Depending on the method chosen for the primary and the secondary, a phase shift can take place between the corresponding phases in the primary and secondary voltages of transformer.

Clock face numbers are used to represent phase shift; the highest voltage winding being used as the reference. A 360° shift corresponds to a full 12 h of a clock with each 30° shift being represented by 1 h. For example, 30° corresponds to 1 o’clock position, 150° shift corresponds to 5 o’clock position and 330 (or –30°) shift corresponds to 11 o’clock position.

The vector grouping and phase shift can be expressed using a simple code. The primary winding connection is represented by capital letter while small letter represents the secondary connection. The 'N' means the primary neutral has been brought out.

For example:

YNd1= Primary winding connected in star with neutral brought out.

Secondary winding connected in delta.

Phase shift of secondary 30° from 12 to 1 o'clock compared to primary phase angle.

2.4.6 Three windings transformer

Major of transformers have two groups of windings (primary winding and secondary winding), and these transformers are known as two windings transformers. But there is another type of transformers known as three windings transformer which consist of three groups of windings.

The windings of the additional third group known as tertiary windings which have two basic jobs:

1. Gives different voltage from the voltages of primary and secondary windings, thus, the transformer will give two different voltages from the main voltage.
2. Tertiary windings are used to leakage the zero sequence currents.

2.4.7 Tap changer

There are two types of tap changer can be obtained on power transformer:

- No load tap change

The addition of no load taps in the primary of transformer makes it possible to adapt the transformer to a range of supply voltages. Since no load taps are not capable of interrupting any current including transformer charging current, the transformers have to be de-energized when the manual no load tap position is changed. All taps should have full capacity ratings.

- On load tap changer

On load tap changers are very necessary to maintain a constant voltage on the LV terminals of the transformer for varying load conditions.

This is achieved by providing taps, generally on the HV winding because of the lower current levels. The tap changer changes the turns ratio between primary and secondary, thereby maintaining a nominal LV voltage within a specific tolerance. The tap changer is usually mounted in a separate compartment to the main tank with a barrier board in between.

2.5. Busbar

Various factors affect the reliability of a substation, one of which is the arrangement of the switching devices. Arrangement of the switching devices will impact maintenance, protection, initial substation development, and cost.

There are six types of substation bus commonly used in air insulated substations:

1. Single bus.

2. Double bus, double breaker.

3. Main and transfer (inspection) bus.

4. Double bus, single breaker.

5. Ring bus.

6. Breaker and a half.

2.5.1Single bus configuration

This arrangement involves one main bus with all circuits connected directly to the bus. The reliability of this type of an arrangement is very low. Circuit section between its circuit breaker and the main bus will cause an outage of the entire system. In addition, maintenance of devices on this system requires the de-energizing of the line connected to the device.

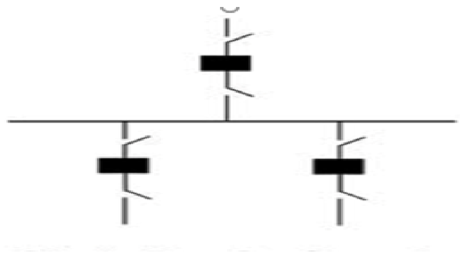

Figure 2.4: Single Bus Configuration

2.5.2 Double Bus, double breaker configuration:

This scheme provides a very high level of reliability by having two separate breakers available to each circuit. In addition, with two separate buses, failure of a single bus will not impact either line. Maintenance of a bus or a circuit breaker in this arrangement can be accomplished without interrupting either of the circuits

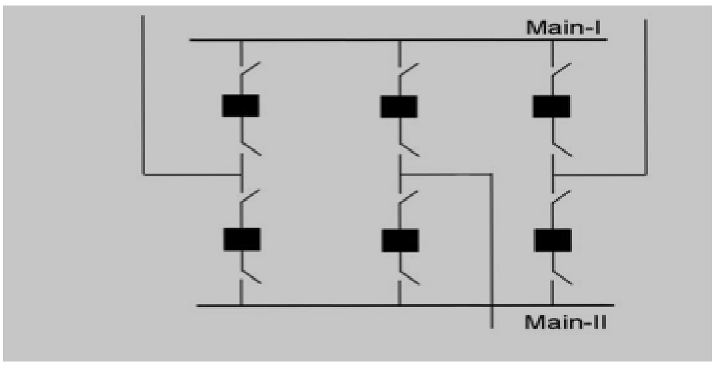

Figure 2.5: Double bus double breaker configuration

2.5.3 Main and transfer bus configuration:

This scheme is arranged with all circuits connected between a main (operating) bus and a transfer bus (also referred to as an inspection bus). Since all circuits are connected to the single, main bus, reliability of this system is not very high. However, with the transfer bus available during maintenance, de-energizing of the circuit can be avoided.

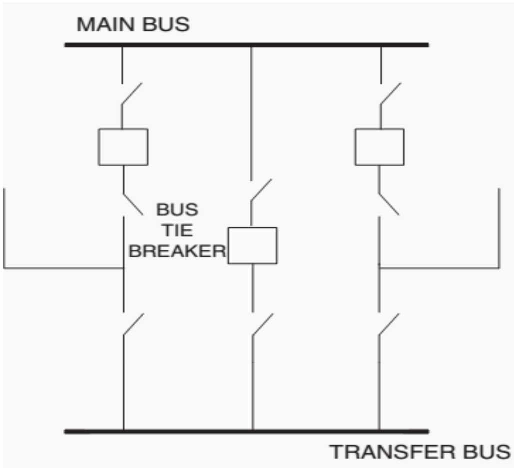

Figure 2.6: Main and transfer bus configuration

2.5.4 Double bus, single breaker configuration:

This scheme has two main buses connected to each line circuit breaker and a bus tie breaker. Utilizing the bus tie breaker in the closed position allows the transfer of line circuits from bus to bus by means of the switches. This arrangement allows the operation of the circuits from either bus. In this arrangement, a failure on one bus will not affect the other bus.

However, a bus tie breaker failure will cause the outage of the entire system. Operating the bus tie breaker in the normally open position defeats the advantages of the two main buses.

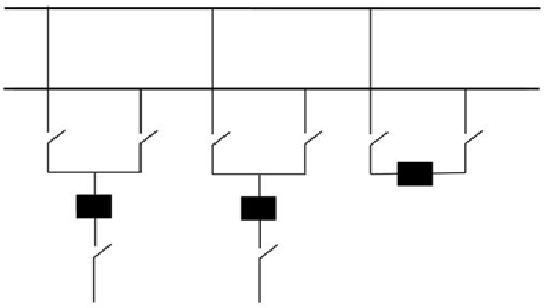

Figure 2.7: Double bus single breaker Configuration

2.5.5 Ring bus configuration:

In this scheme, as indicated by the name, all breakers are arranged in a ring with circuits tapped between breakers. For a failure on a circuit, the two adjacent breakers will trip without affecting the rest of the system. Similarly, a single bus failure will only affect the adjacent breakers and allow the rest of the system to remain energized. However, a breaker failure or breakers that fail to trip will require adjacent breakers to be tripped to isolate the fault.

Maintenance on a circuit breaker in this scheme can be accomplished without interrupting any circuit, including the two circuits adjacent to the breaker being maintained. The breaker to be maintained is taken out of service by tripping the breaker, then opening its isolation switches. Since the other breakers adjacent to the breaker being maintained are in service, they will continue to supply the circuits. In order to gain the highest reliability with a ring bus scheme, load and source circuits should be alternated when connecting to the scheme.

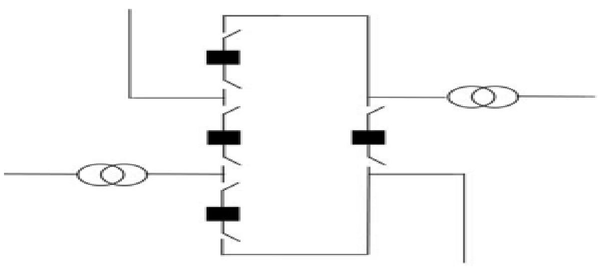

Figure 2.8: Ring bus configuration

2.5.6 Breaker-and-a-half configuration:

The breaker-and-a-half scheme can be developed from a ring bus arrangement as the number of circuit's increases. In this scheme, each circuit is between two circuit breakers, and there are two main buses. The failure of a circuit will trip the two adjacent breakers and not interrupt any other circuit. With the three breaker arrangement for each bay, a center breaker failure will cause the loss of the two adjacent circuits. However, a breaker failure of the breaker adjacent to the bus will only interrupt one circuit.

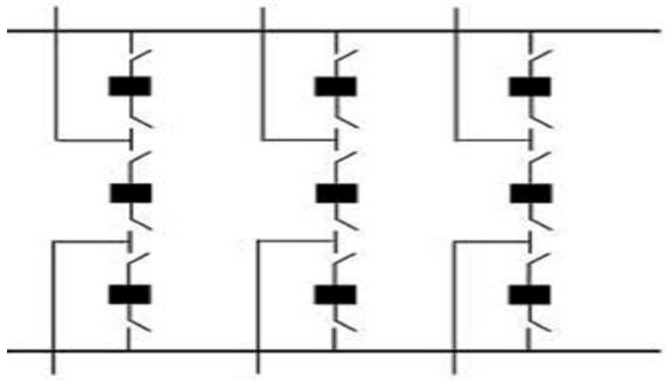

Figure 2.9: Breaker and half configuration

2.6 Surge arrester

Surge arresters are provided to protect equipment from transient overvoltage due to lightning strikes on overhead lines and other exposed connections, and sometimes at the higher system voltages from switching surges. It should be noted that the closer the surge diverter is to the equipment being protected, the better is the protection afforded.

It is normally provided close to the most important and costly items of equipment such as transformers when the earth terminal of the arrester is also directly connected to the transformer tank and, when appropriate, to the transformer neutral.

2.7 Disconnectors

Disconnectors (Isolators) are devices which are generally operated off-load to provide isolation of main plant items for maintenance, or to isolate faulted equipment from other live equipment. Open terminal disconnectors are available in several forms for different applications. At the lower voltages single break types are usual with either 'rocker' type or single end rotating post types being predominant.

At higher voltages, rotating centre post, double end rotating post, vertical break and pantograph type disconnectors are more common.

Disconnectors are usually interlocked with the associated circuit breaker to prevent any attempt being made to interrupt load current. Disconnectors are not designed to break fault current although some designs will make fault current. Most disconnectors are available with either a manual drive mechanism or motor operated drive mechanism and the appropriate drive method must be selected for a particular disconnector in a particular substation, e.g. in a remotely controlled unmanned double busbar substation the busbar selector disconnectors would be motor operated to allow 'on load' busbar changes without a site visit being required.

Disconnector mechanisms incorporate a set of auxiliary switches for remote indication of disconnector position, electrical interlocking and current transformer switching for bus bar protection.

2.8 Earthing Switches

Earthing switches are usually associated and interlocked with disconnectors and mounted on the same base frame. They are driven by a separate, but similar, mechanism to that used for the disconnector. This arrangement avoids the need for separate post insulators for the earth switch and often simplifies interlocking. Normally earth switches are designed to be applied to dead and isolated circuits and do not have a fault making capability, however special designs are available with fault making capability if required.

One practical point worth noting is that line or cable circuit earth switches are normally interlocked with the local line disconnector, but reliance is placed on operating procedures to ensure that the circuit is isolated at the remote end before the earth is applied.

2.9 Circuit breaker

The general function of the circuit breaker (CB) is to close and open the circuit to be able to remove faults and connect, disconnect objects and parts of electricity network.

The circuit breaker is a part of the protection of the main components in the network, transformers and lines. The majority of the switching operations of a CB are normal load operations.

2.9.1 Definition

A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time(maintenance) and breaking currents under specified abnormal circuit conditions either manually or automatically at no load and off load or short circuit.

2.9.2 Operating principle

Two contacts called electrode remain closed under normal operating conditions. When fault occurs on any part of the system, the trip coil of the circuit breaker gets energized and contacts are separated.

2.9.3 Important components of circuit breaker

Circuit breaker has three main components.

- Interrupter Insulating Mediums.
- Extinguishing Chamber.
- Mechanism.

2.9.4 Arc phenomenon

An arc is struck when contacts are separated. The current is thus able to continue. Thus the main duty of a circuit breaker is to distinguish the arc within the shortest possible time.

The arc provides the low resistance path to the current and the current in the circuit remains uninterrupted, the arc resistance depends upon the following factors

- Degree of ionization
- Length of the arc
- Cross Section of the arc

2.9.5 Methods of arc extinction

There are three method of arc extinction

1-High Resistance Method

In high resistance method, the arc resistance is made to increase gradually with the time so that the current force in between the two contacts is insufficient to maintain the arc. Hence the current is interrupted with high resistance, the arc is extinguished without creating any damage to the circuit breaker compartment. The major work is to increase the resistance for the arc current.
The major disadvantage in this method is that a high energy is dissipated across the arc medium where it offers high resistance. So this is method of arc

extinction is generally used in DC circuit breakers and low capacity AC circuit breakers.

2-Low Resistance Method

This method is used in AC power supply only where the voltage and current signals are alternating in their amplitudes (Max, zero, Min). In this method the arc resistance is kept low until the current magnitude becomes zero where the arc extinguishes naturally and is prevented from high restriking voltage by increase the dielectric strength of the contact gap.

3-Artificial Current Zero Interruption

In HVDC systems this method is employed for braking dc current where current is made zero artificially.

2.9.6 Primary application

Circuit breaker used widely in switching, controlling and protection

1-Switching and Controlling

- Transmission overhead lines.
- Transformers and shunt reactors.
- Capacitor banks and harmonic filters.
- Generator switching.
- Bus tie and transfer switching.
- Special applications.

2-Protection

- Fault clearing.
- Protection of the utility assets.
- Protection of personnel and public.

2.9.7 Classification of circuit breaker

Circuit breaker classification depend on different bases

1-Based on Type of Installation:

Classification of circuit break based on type of Installation has two type:

- Indoor

Designed for used only inside building or weather resistant enclosures.

- Outdoor

The only differences between indoor and outdoor circuit breakers are the external structure packaging and the enclosures are used**.**

2-Based on voltage

Table 2.1: Classification of CB based on voltage

Type	Voltage level
Low	Less than 1 KV
Medium	1 KV to 52 KV
High	66 KV to 170 KV
Extra high	220 KV to 765 KV
Ultra high	Above 765 KV

3-Based on External Design

Classification of circuit break based on external design has two type

(i)Dead tank

- Grounded breaking chamber (ground potential).
- Bushing mounted current transformers.

(ii)Live tank:

- Ungrounded breaking chamber (at line potential) and looks like a "T" or candlestick.
- Free standing current transformers.

4-Based on Operating Mechanism

Classification of circuit break based on Operating Mechanism has five type

- Spring.
- Pneumatic.

- Hydraulic.
- Magnetic.
- Motor derive.

5-Based on Interrupting Medium

Classification of circuit break based on Interrupting Medium has four type

(1) Oil Circuit Breaker

- It is inflammable and there is a risk of fire.
- It may form an explosive mixture with air.
- It requires maintenance.
- Absorbs moisture, so dielectric strength reduces.
- Oil leakage problem.
- Oil has to be replaced after some operations because of the carbonization of oil.

(2) Vacuum Circuit Breaker:

- Vacuum is used as an arc quenching medium.
- Have greatest insulating strength.
- 10^{-7} to 10^{-5} pressure is to be maintained.
- Used in 11KV panel in control room of grid station.

Advantages of vacuum circuit breakers:

- Compact, reliable and have longer life.
- No fire hazards.
- No generation of gas during and after operation.
- Can interrupt any fault current.
- No noise is produced while operating.

. Require less power for control operation.

(3) SF6 Circuit Breaker:

1. Sulphur Hexafluoride (SF6) gas is used as an arc quenching medium.
2. SF6 is an electro-negative gas.
3. It has strong tendency to absorb electrons.
4. When contacts are opened in a high pressure flow of SF6 gas, arc produced.
5. Free electron in the arc are captured by the gas.
6. Which build up enough insulation strength to extinguish arc.

It is much effective for high power and high voltages services.

Advantages of SF6 Circuit Breaker:

- Simple construction, less cost.
- SF6 gas is non-flammable, non-toxic& chemical inert gas.
- Same gas is re-circulated in the circuit.
- Maintenance free C.B.
- Ability to interrupt low and high fault current.
- Excellent Arc extinction.

(4) Air blast circuit breaker:

Air blast circuit breakers are used today from 11to1100KV for various applications. They offer several advantages such as faster operations, suitability for related operation, auto-recloser, unit type, multi-break construction, simple, assembly, modest maintenance, etc. Compressor plant is necessary to maintain high air pressure in the receiver. Air –blast circuit breakers operate repeatedly.

Air blast circuit breakers are used for interconnected lines and important lines when rapid operation is desired.

2.9.8 Circuit breaker rating

The main nominal characteristics of circuit breakers are:

(1) Rated voltage

It is a voltage of circuit breaker which refers to higher voltage for which it is designed .it is expressed in KV and the value is R.M.S line to line. A circuit breaker must be assigned two voltage rating one corresponding to maximum nominal system voltage and other maximum designed voltage which indicated to maximum operating voltage which should not be exceeded.

(2) Rated isolation level

The insulation level of a circuit breaker is given by:

- Nominal power-frequency withstand voltage.
- Nominal lightning withstand voltage.
- Nominal switching withstand voltage.

These values characterize the device's insulation regarding its aptitude to withstand over-voltages at power frequency, lightning over-voltages and switching over-voltages of steep wave-front.

(3) Rated current

It is the current assigned by the manufacturer that the device can endure indefinitely (or for a given time) under normal operation conditions, without suffering any heating higher than that fixed by the standards, and without undergo any modification in its functional features.

(4) Rated duration of short circuit

The rated short-time withstand current is the maximum current (expressed in KA R.M.S) which the equipment shall be able to carry in closed position for a specified time duration. The rated short-time withstand current is equal to the rated short circuit breaking capacity.

Standard values for duration are 1 or 3 s.

(5) Rated short-circuit breaking current

The rated short-circuit (breaking) current is the maximum symmetrical short-circuit current in KA R.M.S, which a circuit breaker shall be capable of breaking.

Two values are related to the rated short-circuit current:

- The R.M.S value of the AC component.
- The percentage DC component (depending on the minimum opening time of the circuit breaker and the time constant (τ)).

(6) Rated short-circuit making current

The rated short-circuit making current is the maximum peak value of first current loop of short circuit current which the circuit breaker is capable of making at its rated voltage.

2.9.9 Circuit breaker selection

A circuit breaker selection based on the following factors:

- The voltage class being considered (nominal R.M.S voltage [class] level.
- The continuous load current that the CB must carry under normal or emergency conditions
- The short-circuit current that the breaker must interrupt.
- The speed of short-circuit interruption.

2.10 Protection Equipment Definitions

The definitions that follow are generally used in relation to power system protection:

1. Protection System: a complete arrangement of protection equipments and other devices required to achieve a specified function based on a protection principle (IEC 60255-20).

2. Protection Equipment: a collection of protection devices (relays, fuses, etc.). Excluded are devices such as current transformers (CTs), circuit breakers (CBs) and contactors

3. Protection Scheme: a collection of protection

Protective devices include:

1. Fuses.

2. Automatic Recloser.

3. Sectionalizers.

4. Low-Voltage Breakers.

5. Protective Relay.

2.10.1 Fuses

They are protective devices with a fusible element for an over current, this element melts and an electric arc appear. During a current zero-crossing the fuse extinguishes the arc and interrupts the fault current. We typically apply fuses in low and medium voltage distribution system.

2.10.2 Automatic reclosers

Combine the fault detection, fault current interruption, and line reclosing functions in one piece of equipment. These reclosers are typically pole mounted on overhead distribution lines. Automatic reclosers provide as many as four trips and three reclosers, to give temporary faults the opportunity to disappear.

2.10.3 Sectionalizer

They are pole-mounted devices that count automatic recloser operations and the faulted circuit during a given recloser-open period. Sectionalizers are not intended to interrupt fault current. They sectionalize a faulted lateral, for example, taking advantage of the operation cycle of the recloser installed in the feeder. The recloser resets after an incomplete operation cycle when the sectionalizer disconnects the faulted lateral.

2.10.4 Protective relays

They are intended to detect the fault and issue a tripping signal to a power circuit breaker. We use relays in medium-voltage and high-voltage systems. Protective relaying system reliability depends on all system elements. In the past, electromechanical relays were responsible for a high percentage of protection system operation failures or mal-operations. Present–day digital relays are highly reliable devices.

These relays, besides providing protection, can also monitor the status of protection system elements, further enhancing protection reliability.

2.11 Instrument Transformers

Voltage and current transformers (altogether called instrument transformers) is used to send information to relay in order to detect abnormal conditions as the system voltage and current is extremely high for the relay to handle straight.

2.11.1Current transformer

A current transformer is a device that is used for the transformation of current from a higher value into a proportionate current to a lower value.

The current transformer is used with the AC instrument meters or control apparatus where the current is to be measured of such magnitude that the meter or instrument coil cannot conveniently be made of sufficient current carrying capacity.

2.11.2 Voltage transformers

The potential transformer may be defined as an instrument transformer used for the transformation of voltage from a higher value to the lower value. This transformer steps down the voltage to a safe limit value which can be easily measured by the ordinary low voltage instrument like a voltmeter.

The potential transformer is mainly classified into two types, i.e., the conventional wound types (electromagnetic types) and the capacitor voltage potential transformers.