CHHATTISGARH STATE POWER TRANSMISSION COMPANY LIMITED

YEAR 2018

SUBSTATION KACHNA (132/33 KV), RAIPUR

COLLEGE :- KRUTI INSTITUTE OF TECHNOLOGY & ENGINEERING,RAIPUR

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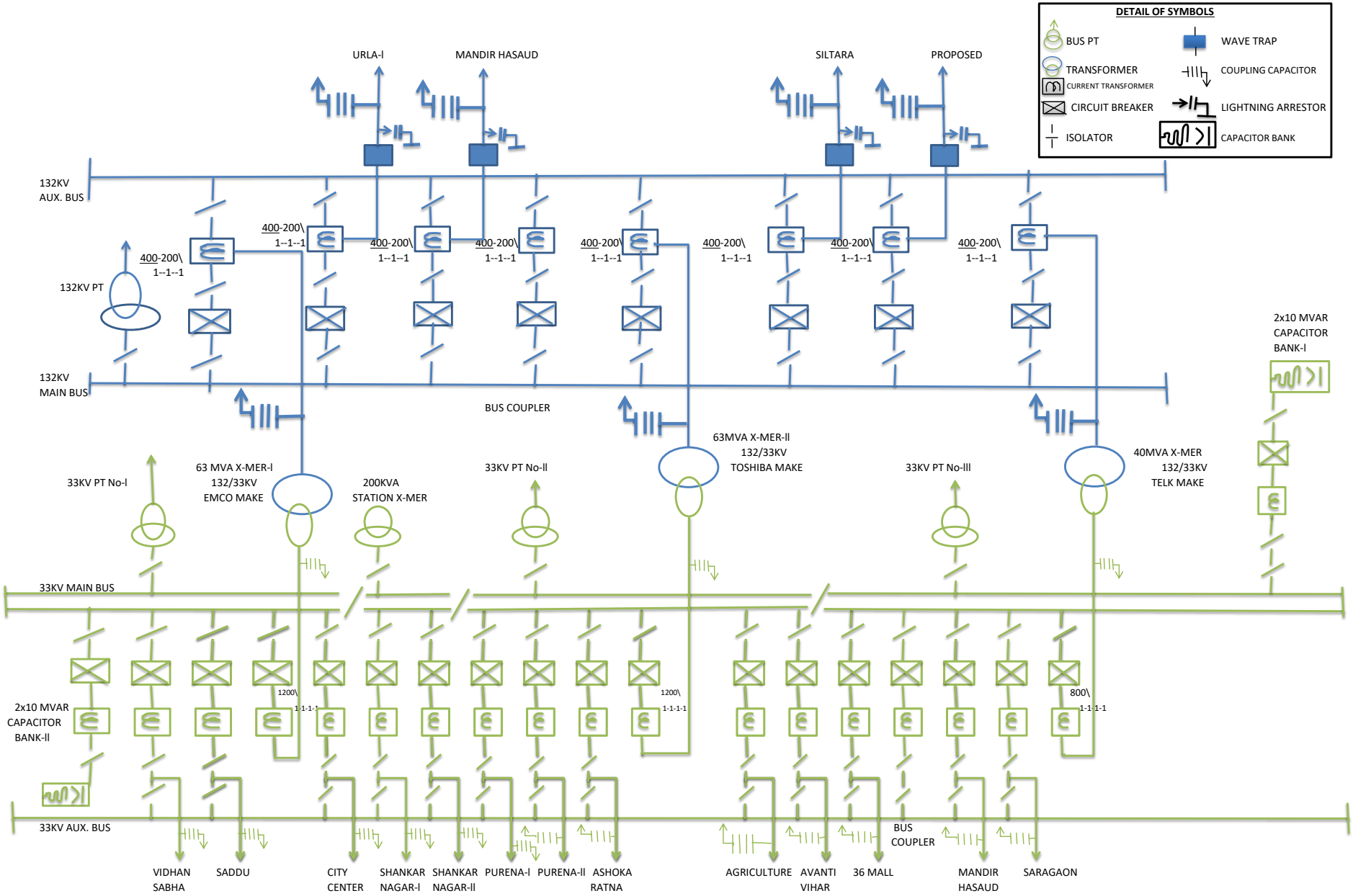
SINGLE LINE DIAGRAM OF 132/33KV SUB-STATION ,CSPTCL,KACHNA



1. INTRODUCTION

Electrical power is generated at different generating stations. These generating stations are not necessarily situated at the load centre. During construction of generating station number of factors are to be considered from economical point of view. These all factors may not be easily available at load centre; hence generating stations are not normally situated very nearer to load centre. Load centre is the place where maximum power is consumed. Hence there must be some means by which the generated power must be transmitted to the load centre. Electrical transmission system is the means of transmitting power from generating station to different load centres.

Factor to be considered for constructing a generating station

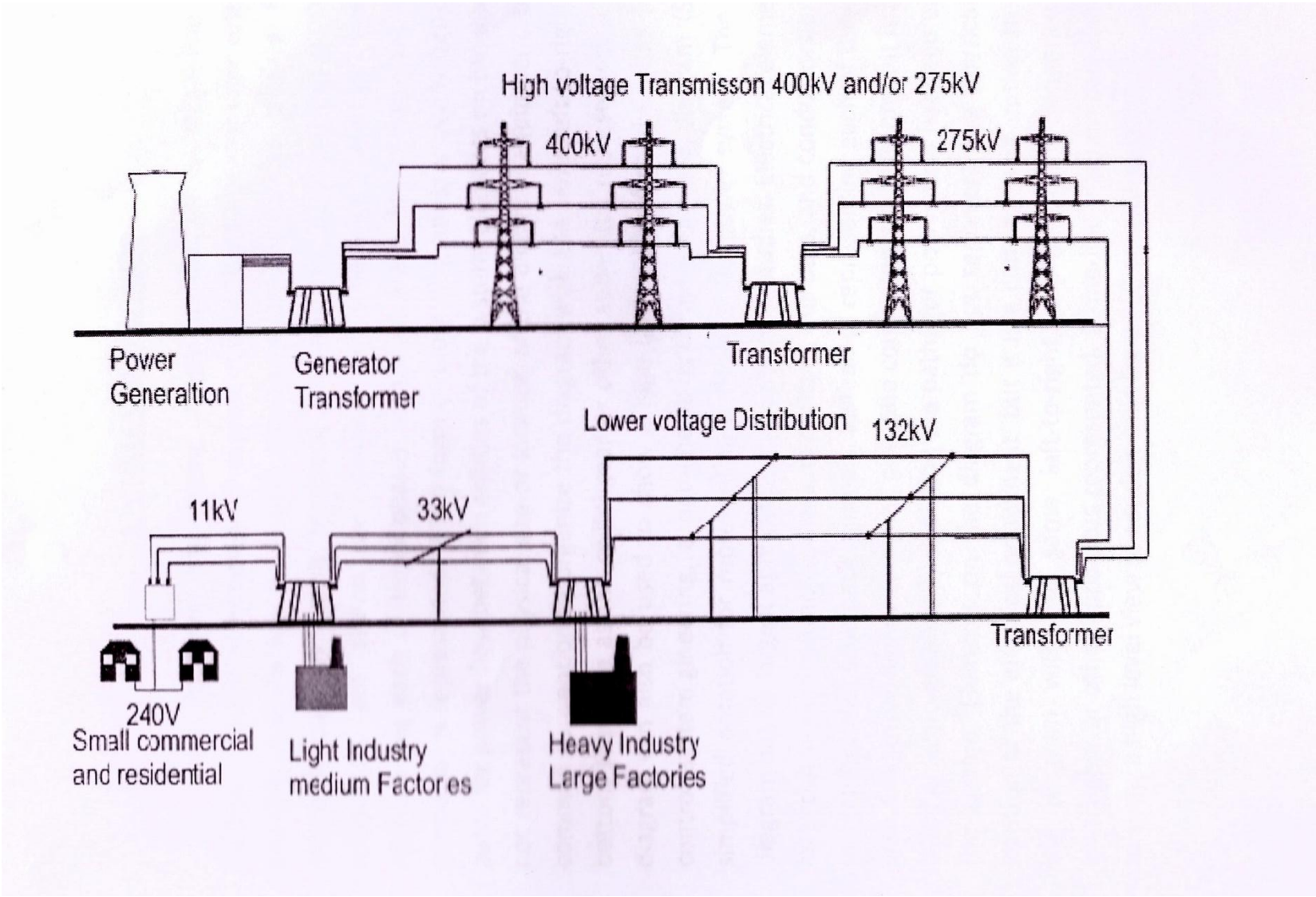
During planning of construction of generating station the following factors to be considered for economical generation of electrical power.

Easy availability of water for thermal power generating station.

Easy availability of land for construction of power station including it's staff township.

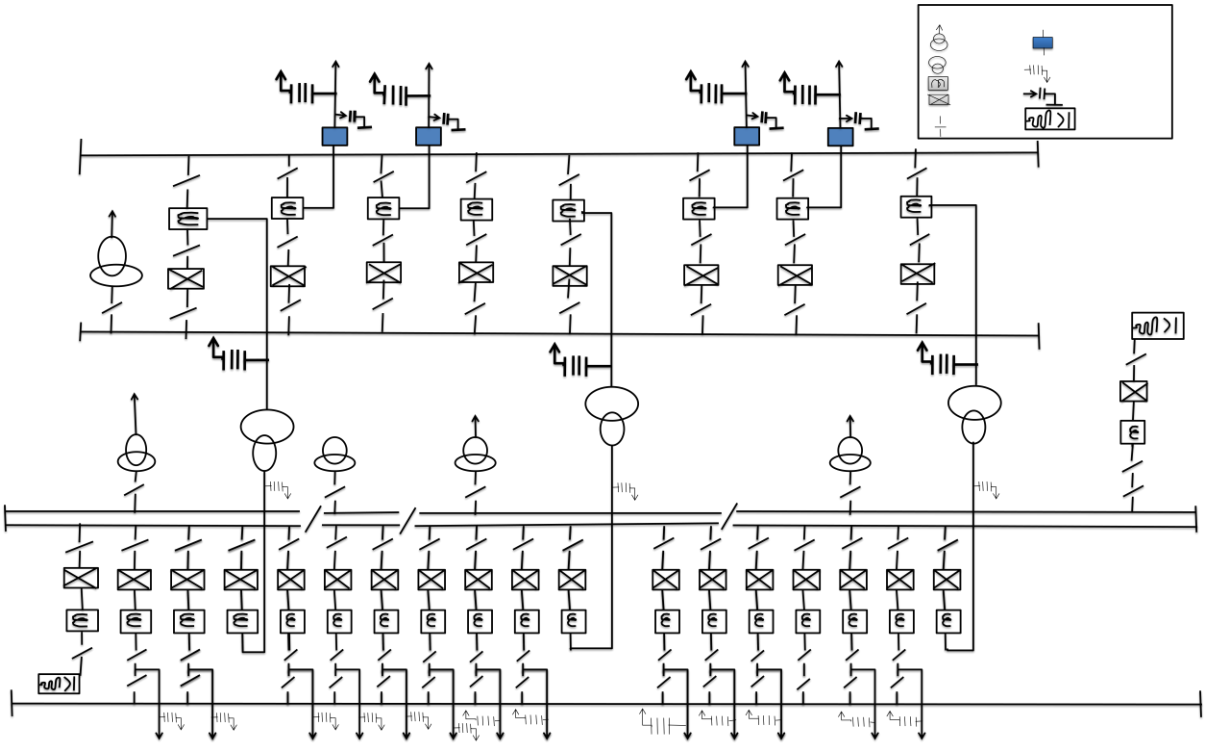
For hydro power station there must be a dam on river. So proper place on the river must be chosen in such a way that the construction of the dam can be done in most optimum way.

For thermal power station easy availability of fuel is one of the most important factors to be considered.

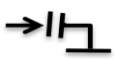
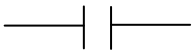
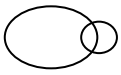

High voltage Transmisson 400kV and/or 275kV
400kV
275kV
Power
Generation
Generator
Transformer
Transformer
Lower voltage Distribution
132kV
11kV
33kV
Transformer
240V
Small commercial
and residential
Light Industry
medium Factories
Heavy Industry
Large Factories

2. SINGLE LINE DIAGRAM

In power engineering, a one-line diagram or single line diagram (SLD) is a simplified notation for representing a three-phase power system. The one-line diagram has its largest application in power flow studies. Electrical elements such as circuit breakers, transformers, capacitors, bus bars, and conductors are shown by standardized schematic symbols. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented. It is a form of block diagram graphically depicting the paths for power flow between entities of the system. Elements on the diagram do not represent the physical size or location of the electrical equipment, but it is a common convention to organize the diagram with the same left-to-right, top-to-bottom sequence as the switchgear or other apparatus represented. A one-line diagram can also be used to show a high level view of conduit runs for a PLC control system engineering, a one-line diagram or single line diagram (SLD) is a simplified notation for representing a three-phase power system. The one-line diagram has its largest application in power flow studies. Electrical elements such as circuit breakers, transformers, capacitors, bus bars and conductors are shown by standardized schematic symbols. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented. It is a form of block diagram graphically depicting the paths for power flow between entities of the system. Elements on the diagram do not represent the physical size or location of the electrical equipment, but it is a common convention to organize the diagram with the same left-to-right, top-to-bottom sequence as the switchgear or other apparatus represented. A one-line diagram can also be used to show a high level view of conduit runs for a PLC control system.



2.1 SYMBOLS USED IN SINGLE LINE DIAGRAM

EQUIPMENTS	SYMBOL
LIGHTNING ARRESTOR	
WAVE TRACKER	
CURRENT TRANSFORMER	
ISOLATOR	
CIRCUIT BREAKER	
POTENTIAL TRANSFORMER	
DROP OUT FUSE	
CAPACITOR	
POWER TRANSFORMER	

3. BATTERY CHARGER

In sub stations there are many equipments and all this equipments we are controlling according to our needs. For this we use control circuits for every equipments which are in Sub-station and this control circuit is runs on DC. That have own advantage suppose a blackout occur and sub-station can't give power from power plant then DC source take wide and very important role in sub stations there are many equipments. And all this equipments we are controlling according to our need. So for this we use control circuit for every equipments which are in sub-station and this control circuit is runs on DC. That have own advantage suppose a blackout occur and sub-station can't give power from power plant then DC source take wide and very important role. So we design a control circuits basis on DC power supply because if blackout occur we start the sub-stations for restoring. So in sub-stations a special battery room is provided and specially maintenance also done.

Battery

4. CONTROL PANEL

Control and Relay panel is most important most important equipment of the substation as it work as shield guard for all substation equipments and electrical network. Moreover, these panels are useful to control the flow of electricity as per the voltage class and detect the faults in transmission lines. Designing and manufacturing of control and relay panel depend on the requirement of utilities and these can broadly be classified as follows;

- Line Protection
- Transformer Protection
- Bus Bar Protection
- Tie Breaker
- Bus Coupler
- Reactor

In this panel, varieties of numerical and electromechanical relays are installed to provide damage protection to equipments. Meters, semaphore indicators, Control switches, Indicating lamps, Push Buttons, Annunciation, Test Blocks and Test Plugs are among of major equipments installed as per designing requirements. The control and relay panels are designed and manufactured as per voltage class of substations like 11KV, 33KV, 66KV, 132KV, 220KV and 400KV etc. However DC voltage or supply voltage may differ according to the panel requirement such as 30V DC, 110VDC, 220V DC etc. Use of control & relay panel is not only limited in substations owned and operated by electrical utilities, but also essential in industrial and commercial sector where power consumption is very high.

5. **ISOLATOR**

Circuit breaker always trip the circuit but open contacts of breaker cannot be visible physically from outside of the breaker and that is why it is recommended not to touch any electrical circuit just by switching off the circuit breaker. So for better safety there must be some arrangement so that one can see open condition of the section of the circuit before touching it. Isolator is a mechanical switch which isolates a part of circuit from system as when required. Electrical isolators separate a part of the system from rest for safe maintenance works. So definition of isolator can be rewritten as isolator is a manually operated mechanical switch which separates a part of the electrical power. Isolators are used to open a circuit under no load. Its main purpose is to isolate one portion of the circuit from the other and is not intended to be opened while current is flowing in the line. Isolators are generally used on both ends of the breaker in order that repair or replacement of circuit breaker can be done without and danger. There are different types of isolators are available depending upon system requirement such as :-

- Double Break Isolator
- Single Break Isolator
- Pantograph type Isolator
- Depending upon the position in power system, the isolators can be categorized as
- Bus side isolator – the isolator is directly connected with main bus
- Line side isolator – the isolator is situated at line side of any feeder
- Transfer bus side isolator – the isolator is directly connected with transfer bus.

6. LIGHTNING ARRESTOR

Over voltage may cause burning of insulation of sub-station equipment if not well protected. Lightning is one of the most serious causes of over voltages. Lightning arrestors/ surge arrestors are connected to protect the equipments from lightning and switching surge. Various types of lightning arrestor construction are Rod gap, Expulsion type, Valve type, Horn gap, Pellet type, Thirties type etc.

An ideal LA should posses the following characteristics.

1) It must not take any current at normal system voltage.
2) Any transient wave with voltage peak exceeding the spark over voltage must cause it to break down.
3) After break down it must be capable of carrying the resulting discharge current without any damage to itself and without voltage across it exceeding the break down voltage.
4) The power frequency current following the breakdown must be interrupted as soon as the transient voltage has fallen below the breakdown value.
5) The lightning arrestor should be capable of bear the high voltage lightning from sky.
6) The lightning arrestor is situated at the top of the substation. Due to this position of the lightning arrestor we can protect our equipments of our substation from lightning.

7. CAPACITOR BANK

The demand of active power is expressing Kilo Watt (KW) or mega watt (MW). This power should be supplied from electrical generating station. All the arrangements in electrical pomes system are done to meet up this basic requirement. Although in alternating power system, reactive power always comes in to picture. This reactive power is expressed in kilo VAR or Mega VAR. The demand of this reactive power is mainly originated from inductive load connected to the system. These inductive loads are generally electromagnetic circuit of electric motors, electrical transformers, inductance of transmission and distribution networks, induction furnaces, fluorescent lightings etc. This reactive power should be properly compensated otherwise, the ratio of actual power consumed by the load, to the total power i.e. vector sum of active and reactive power, of the system becomes quite less. Let's explain in details, we know that active power is expressed = vlcosθ where, cosθ is the power factor of the system. Hence, if this power factor has got less value, the corresponding current (I) increase for same active power P. As the current of the system increases, the Ohmic loss of the system increases. The equipments used to compensate reactive power. There are mainly two equipments used for this purpose.

1) Synchronous condensors
2) Static capacitors or Capacitor bank.

8. CIRCUIT BREAKER

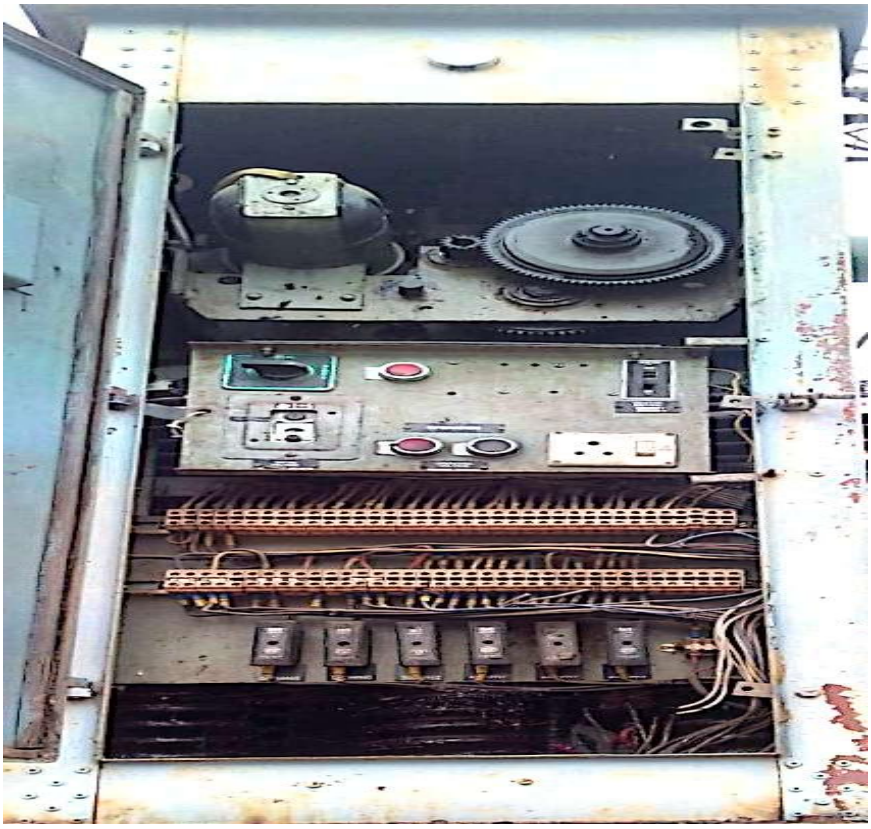
Electrical power transmission networks are protected and controlled by High Voltage Circuit Breaker inside electrical grid substation. In substations the protection relay scheme can be complex, protecting equipment and busses from various types of overload or ground/earth fault. Electrical protection should be provided against the following abnormal conditions:

Overloading (excessive currents not due to faults) transformer faults, short-circuit faults between phases, short-circuit faults to earth. Classification of High Voltage Circuit Breaker:

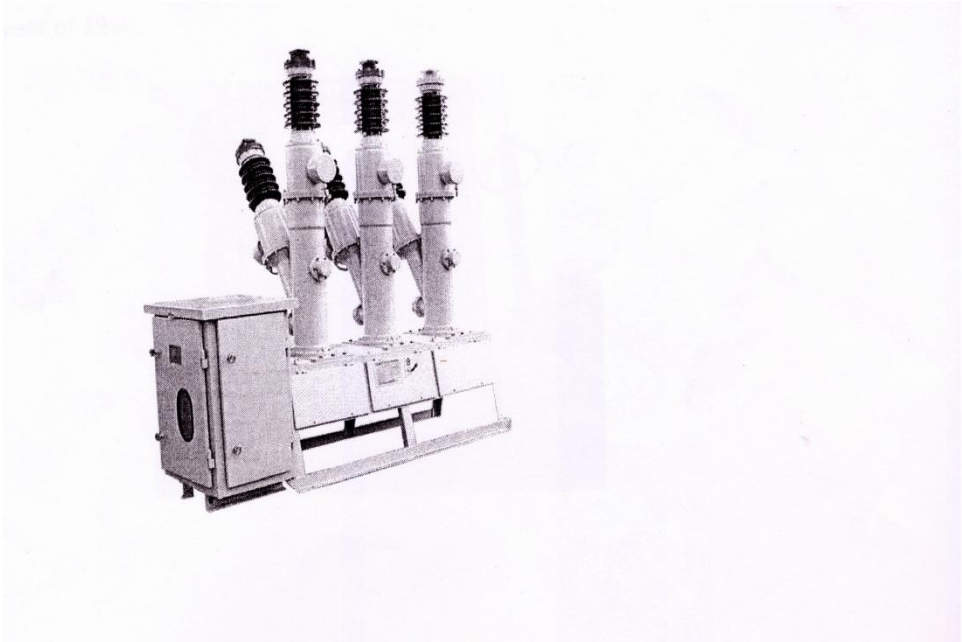
These High Voltage Circuit Breaker are available for indoor or outdoor applications and High Voltage breakers are broadly classified by as follows.

- **Oil circuit breaker (OCBs)**

❖ Vacuum circuit breaker (VCB)



❖ SF6 Circuit Breakers



9. POWER TRANSFORMER

A transformer is a static machine used for transforming power from one circuit to another without changing frequency. This is a very basic definition of transformer. Since there is no rotating or moving part so transformer is a static device. Transformer operates on ac supply. Transformer works on the principle of mutual induction.

9.1 History of Transformer

If we want to know the history of transformer we have go back long in the 1880s. Around 50 years before that in 1830 property of induction which is the working principle of transformer was discovered. Later the transformer design was improved resulting in more efficiency and lesser size. Gradually the large capacity of transformers in the range of several KVA, MVA came into existence. In the year 1950, 400KV electrical power transformer was introduced in high voltage electrical power system. In the early 1970s, unit rating as large as 1100 MVA was produced and 800KV and higher KV class transformers were manufactured in year of 1980.

9.2 Use of Power Transformer and ratings

Generation of electrical power in low voltage level is very much cost effective. Theoretically, this low voltage level power can be transmitted to the receiving end. This low voltage power if transmitted results in greater line current which indeed causes more line losses. But if the voltage level of a power is increased, the current of the power is reduced which causes reduction in ohmic or I^2R losses in the system, reduction in cross sectional area of the conductor i.e. reduction in capital cost of the system and it also improves the voltage regulation of the system. Because of these, low level power must be stepped up for efficient electrical power transmission. This is done by step up transformer at the sending side of the power system network. As this high voltage power may not be distributed to the consumers directly, this must be stepped down to the desired level at the receiving end with the help of step down transformer. Electrical power transformer thus plays a vital role in power transmission. Two winding transformers are generally used where ratio of high voltage and low voltage is greater than 2. It is cost effective to use autotransformer where the ratio between high voltage and low voltage is less than 2. Again a single unit three phase transformer is more cost effective than a bank of three phase transformers unit in a three phase system. But a single three phase transformer units is a bit difficult to transport and have to be removed from service entirely if one of the phase winding breaks down.

9.3 Types of Transformers

Transformers can be categorized in different ways, depending upon their purpose, use, construction etc. The types of transformer are as follows:

9.3.1 Step Up Transformer and Step Down Transformer – Generally used for stepping up and down the voltage level of power in transmission and distribution power system network.

9.3.2 Three Phase Transformer and Single Phase Transformer – former is generally used in three phase power system as it is cost effective than later. But when size matters, it is preferable to use a bank of three single phase transformer as it is easier to transport than one single three phase transformer unit.

9.3.3 Electrical Power Transformer, Distribution Transformer and Instrument Transformer – Power transformers are generally used in transmission network for stepping up or down the voltage level. It operates mainly during high or peak loads and has maximum efficiency at or near full load. Distribution transformer steps down the voltage for distribution purpose to domestic or commercial users. It has good voltage regulation and operates 24 hrs a day with maximum efficiency at 50% of full load. Instrument transformers include CT and PT which can be measured by conventional instruments.

9.3.4 Two Winding Transformer and Auto Transformer – Former is generally used where ratio between high voltage and low voltage is greater.

For providing long service life to the transformer, different transformer accessories get fitted with it. These transformer accessories should also be included in our study for better understanding transformer operation and maintenance.

9.4 Breather of Transformer

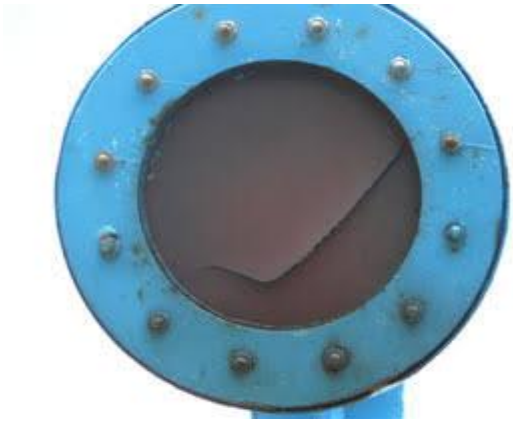
When the temperature changes occur in transformer insulating oil, the oil expands or contracts and there an exchange of air also occurs when transformer is fully loaded. When transformer gets cooled, the oil level goes down and air gets absorbed within. This process is called breathing and the apparatus that pass through the air is called breather. Actually, silica gel breathers control the level of moisture, entering electrical equipment during the change in volume of the cooling medium and / or airspace caused by temperature increasing.

9.5 Conservator Tank of a Transformer

This is a cylindrical tank mounted on supporting structure on the roof of the transformers main tank. When transformer is loaded, the temperature of oil increases and consequently the volume of oil in the transformer gets increased. Again; when ambient temperature is increased, the volume of oil is also increased. The conservator tank of a transformer provides adequate apace for expansion of oil. Conservator tank of transformer also acts as a reservoir of oil.

9.6 Explosion Vent of Transformer

The purpose of the explosion vent in a transformer is to prevent damage of the transformer tank be releasing any excessive pressure generated inside the transformer.



9.6.1 Construction of Explosion Vent of transformer

This is nothing but a bent pipe with thin aluminium diaphragms at both ends. A wire mesh is provided at lower end of the explosion vent to prevent the pieces of rutted diaphragm from entering the tank. A wire mesh is also provided at upper end of vent pipe to protect mechanical damages of upper diaphragm.

Near the lower end, a small oil level indicator is provided to lower diaphragm ruptures; transformer oil rises in the vent pipe and is visible through the indicator indicating the failure of the diaphragm. If even after brushing the lower diaphragm, there is enough pressure and is not reduced, the upper diaphragm then bursts out oil and gases. In this way, explosion vent of transformer prevents mechanical damage to the transformer tank. Sometimes, upper portion of conservator tank is connected with explosion vent with an equalizer pipe with or without a valve.

9.7 Radiator of Transformer

Oil immersed transformer is always provided with radiator. In case of electrical power transformer, the radiators are detachable and transported separately to the site. The upper and lower portions of the radiator unit is connected with the transformer tank via valves. These valves are provided to prevent draining of oil during detaching a radiator unit from the transformer for cleaning and maintenance purposes.

9.7.1 Operation and Purpose of Radiator in Transformer – When

Transformer is in the loaded condition, the hot oil comes up in the main tank, and enters into the radiator tank through upper valve. As the heat transfer surface of the radiator is quite large, the oil gets cooled and enters into the transformer tank via lower value of radiator units. The convectional flow of oil in the tank and radiator of transformer continues.

10. ELECTRIC CABLE

Electric power can be transmitted or distributed either by overhead system or by underground cable. Cables are mainly designed as per requirement. Power cables are mainly used for power transmission and distribution purpose. It is an assembly of one or more individually insulated electrical conductors, usually held together with an overall sheath. The assembly is used for transmission and distribution of electrical power. Electrical power cables may be installed as permanent wiring within buildings, buried in the ground and run overhead or exposed. Flexible power cables are used for portable devices, mobile tools and machinery. These are designed and manufactured as per voltage, current to be carried, operating maximum temperature and purpose of applications desired by customer. For wind power plant customers generally require flexible and UV protected cable with mechanical tough sheath so we design as per their requirement. The underground cables have several advantages such as less liable to damage through storms, lightning, low maintenance cost, less chances of faults, smaller voltage drop and better general appearance.

10.1 Short Circuit Rating –

It happens frequently that the conductor size necessary for an installation is dictated by its ability to carry short-circuit current rather than sustained current. During a short-circuit, there is a sudden inrush of current for a few cycles followed by a steadier flow of current for a short period until the protection switchgear operations, normally between 0.1-0.3 seconds.

10.2 Current Carrying Capacity –

Current carrying capacity is an important aspect is the selection of the optimum size of conductor. Voltage drop and short rating is also very important aspect to select the economical and optimum size of conductor. The safe current carrying capacity of an underground cable is determined by the maximum permissible temperature rise.

11. RELAY

A relay is automatic device which senses an abnormal condition of electrical circuit and closes its contacts. These contacts in turns close and complete the circuit breaker trip coil circuit hence make the circuit breaker tripped for disconnecting the faulty portion of the electrical circuit from rest of the healthy circuit. Now let's have a discussion on some terms related to protective relay.

11.1 Pickup Level of Actuating Signal:

The value of actuating quantity (voltage or current) which is on threshold above which the relay initiates to be operated.

If the value of actuating quantity is increased, the electromagnetic effect of the relay coil is increased and above a certain level of actuating quantity the moving mechanism of the relay just starts to move.

11.2 Reset Level:

The value of current or voltage below which a relay opens its contacts and comes in original position.

11.3 Operating Time of Relay:

Just after exceeding pickup level of actuating quantity the moving mechanism (for example rotating disc) of relay starts moving and it ultimately close the relay contacts at the end of its journey. The time which elapses between the instant when actuating quantity exceeds the pickup value to the instant when the relay contacts close.

11.4 Reset Time of Relay:

The time which elapses between the instant when the actuating quantity becomes less than the reset value to the instant when the relay contacts returns to its normal position.

11.5 Reach Time of Relay:

A distance relay operates whenever the distance seen by the relay is less than the pre-specified impedance. The actuating impedance is the relay is the function of distance in a distance protection relay. This impedance or corresponding distance is called reach of the relay. Power system protection relays can be categorized into different types of relays.

12. EQUIPMENT USED FOR SAFETY

Power system protection is a branch of electrical power engineering that deals with the protection of electrical power systems from faults through the isolation of faulted parts from the rest of the electrical network. The objective of a protection scheme is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation. Thus, protection schemes must apply with very pragmatic and pessimistic approach to clearing system faults. The devices that are used to protect the power systems from faults are called protection devices.

12.1 Components

Protection systems usually comprise five components:

- Current and voltage transformers to step down the high voltages and currents of the electrical power system to convenient levels for the relays to deal with;
- Protective relays to sense the fault and initiate a trip or disconnection, order;
- Circuit breakers to open/close the system based on relay and autorecloser commands;
- Batteries to provide power in case of power disconnection in the system.
- Communication channels to allow analysis of current and voltage at remote terminals of a line and to allow remote tripping of equipment.

For parts of a distribution system, fuses are capable of both sensing and disconnecting faults. Failures may occur in each part, such as insulation failure, fallen or broken transmission lines, incorrect operation of circuit breakers, short circuits and open circuits. Protection devices are installed with the aims of protection of assets, and ensure continued supply of energy. Switchgear is a combination of electrical disconnect switches, fuses or circuit breakers used to control, protect or isolate electrical equipment. Switches are safe to open under normal load current, while protective devices are safe to open under fault current.

13. CONCLUSION

- We have to use the electronic control panels in the operator room.
- The wireless transmission system is very efficient then wire transmission system.
- The transmission network has good power factor in the wireless transmission system.

14. REFERENCE

- WWW.electrical4u.com
- Book of electrical machine " p.s.bhimrah "
- Asfaq husain