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### GRID SUB-STATION, BETTIAH AT GLANCE

Grid sub-station, Bettiah is a 132/33KV grid sub-station.& It is part of transmission - Division Bettiah.

### CAPACITY of GSS

There are total three transformers:-

- 1.T1 - (50MVA) BHARAT BHIJLEE
  - 2.T2 - (50MVA) ECE
  - 3.T3 – (20MVA) LMP CO. LTD
- GRID MAX. T/F CAPACITY 120MVA

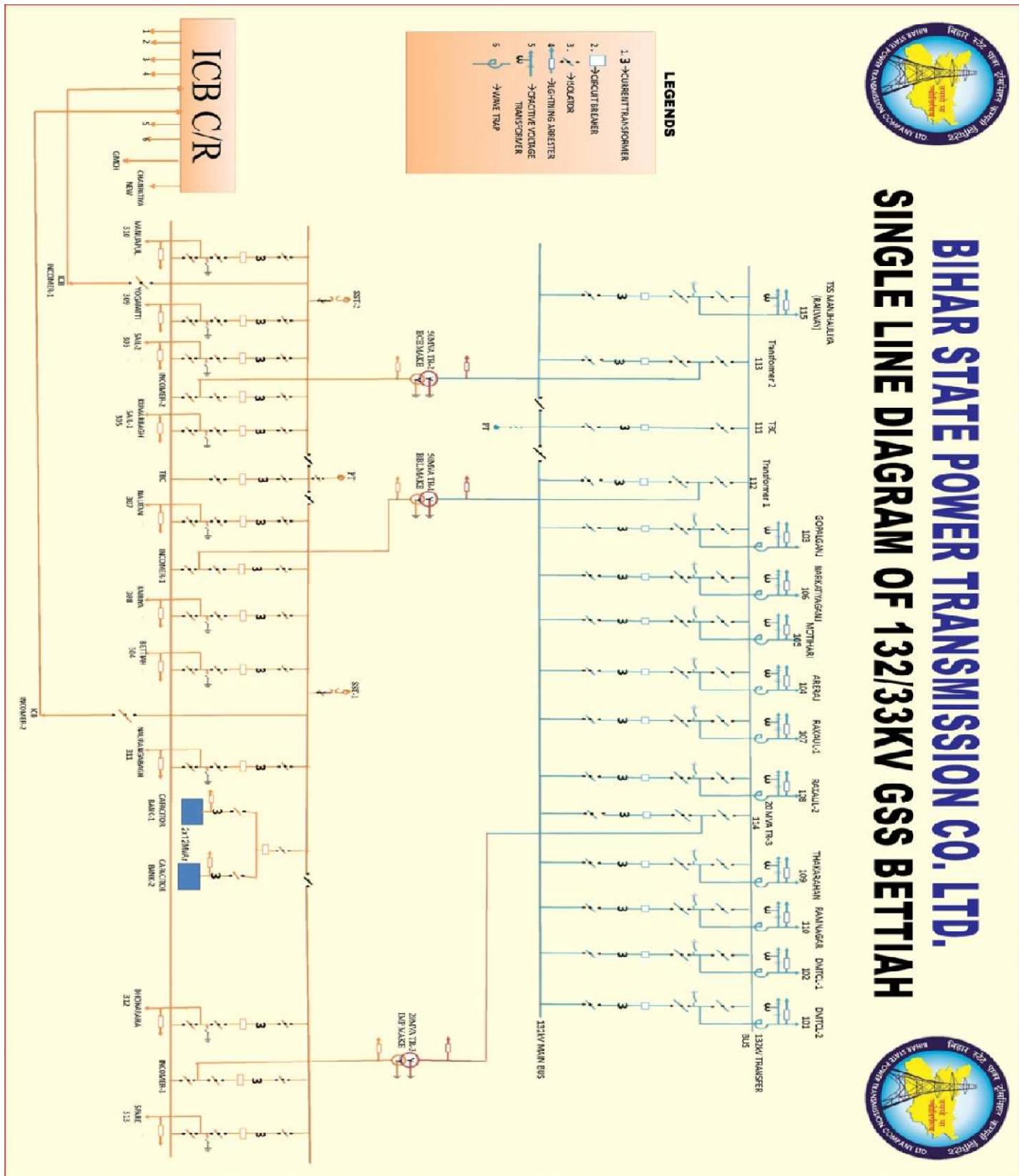
### HIGH VOLTAGE SIDE-132KV

1. DMTCL CKT - 1
2. DMTCL CKT - 2
3. RAMNAGAR
4. THAKARAHAN
5. RAXAUL CKT – 1
6. RAXAUL CKT - 2
7. ARERAJ
8. MOTIHARI
9. NARKATIYAGANJ
- 10.GOPALGANJ
- 11.T.S.S MANJHAULIYA (RAILWAY)

### LOW VOLTAGE SIDE-33KV

1. DHOKARAHA
2. NAURANGABAGH
3. BETTIAH
4. BAIRIYA
5. NAUTAN
6. KUMARBAGH SAIL 1
7. SAIL 2
8. YOGAPATTI
9. MANUAPUL
- 10.CHANPATIA NEW • THROUGH ICB C/R
- 11.GMCH

## SINGLE LINE DIAGRAM



## **INTRODUCTION**

Bihar State Power Transmission Company Limited, a subsidiary company of Bihar State Power (Holding) Company Limited, is a wholly owned corporate entity incorporated under the Companies Act 1956 on 1st Nov, 2012 after restructuring of erstwhile Bihar State Electricity Board. Presently the company is carrying on intra-state transmission and wheeling of electricity under license issued by the Bihar Electricity Regulatory Commission. The company is also discharging the functions of State Load Dispatch Center (SLDC).

BSPTCL operates a transmission network of 8531.382 km of 132 kV lines, 2491.584 km of 220 kV lines and 75 km of 400 kV line as well as 122 no. of EHV sub-stations with 10280 MVA transformation capacity. The company is operating through its two transmission zones i.e. Patna & Muzaffarpur, seven transmission circles and seventeen transmission divisions.

In order to increase the evacuation capacity, BSPTCL is implementing large number of sub-station and transmission line projects. BSPTCL is also working towards installation of Gas Insulated Sub-Station, Sub-Station Automation System and High Capacity Conductors in transmission lines, BSPTCL has also undertaken various projects of augmentation, renovation and modernization of existing Grids and Transmission Lines. To ensure stable and uninterrupted power supply to the people of state, company has taken up projects for connecting its GSS to multiple sources of power and making them N-1 compliant. All the GSSs and Transmission Lines are on GIS map. The State Load Dispatch Center has the latest technology of real time data control and communication.

Besides continual technical up-gradation, the company lays emphasis on imbibing required skills in its people and therefore it has invested in creating training infrastructure. It has recently established a "Power Training Center at Gaurichak, Patna, where employees and students are trained on various power system protection and equipment testing techniques.

"BSPTCL: The Life Line of Bihar" is committed to the goal of Quality Power to all..



## **SUBSTATION**

A substation is a part of an electrical generation, transmission and distribution system. Substations transform voltage from high level to low level or the reverse ,or perform any of the several other important function between generating station and the consumer.

A substation may include transformers to change voltage levels between high transmission voltages and distribution voltages or at interconnection of two different transmission voltages.

### **ELEMENTS OF SUBSTATION**

1. Ground Wire
2. Bus Bar
3. Capacitor Voltage Transformer
4. Wave Trap
5. Disconnecting Switch(Isolators)
6. Circuit Breaker
7. Current Transformer
8. Potential Transformer
9. Lighting Arrester
10. Power Transformer
11. Parts of Transformer
12. SST
13. Capacitor bank
14. Battey storage



## **GROUNDWIRE**

Ground wire is used for protection in electrical equipment. Electrical circuit may be connected to ground for several reason. In mains powered equipment, exposed metal parts are connected to ground so that if, due to any fault conditions, a "line" supply voltage connection occurs to any such conductive parts, the current flow will be such that any protective equipment installed counter overload or "leakage" protection will operate and disconnect the line voltage. This is done to prevent harm resulting to the user from coming in contact with any such dangerous voltage in a situation where the user may, at the same time, also come in contact with an object at ground potential.

## **BUS BAR**

An Bus bar is an essential component of an electrical power grid. It is a rigid conductor, usually made of copper or aluminium, that serves as a common electrical connection point for multiple incoming and outgoing circuits operating at the same voltage level.

In a grid system, the bus bar acts as a central node through which electrical power is Received from transmission lines and then distributed to transformers & feeders.

Bus bars are designed to carry very high currents with minimal losses, Different bus bar arrangements are adopted in grid substations depending on the level of reliability and operational flexibility required. Simple arrangements are used in smaller substations, while complex configurations are implemented in high-voltage and extra-high-voltage substations

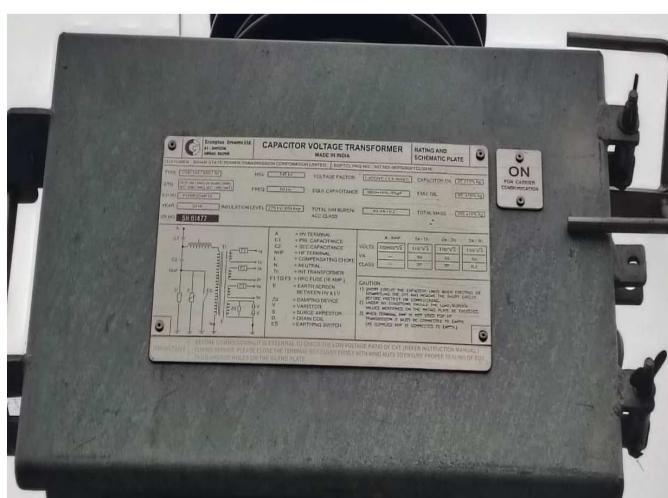
In the 132/33kV **grid sub-station Bettiah**, the main bus bar used in grid sub- station is ACSR double moose Conductor, which receive power from DMTCL & Several 132kV Interconnected grid sub-stations and the ACSR Panther & dog conductor used for feeder

# **CAPACITOR VOLTAGE TRANSFORMER**

- It is a transformer used in power system to step down the extra high voltage signals and provide a low voltage signal, for metering or operating a protective relay.
  - It is always connected in parallel.
  - It has 3 secondary core in which two are used for protection and one is used for metering.
  - The CVT is installed at a point after lightning arrester and before wave trap

### ❖ Difference b/w CVT & PT

- PT is only use for measuring voltage & and for some safety purpose while CVT use for these all work as well as for communication purchase.
  - CVT and wape trap combine make a tuned LC circuit filter that allow a certain frequency range signals. Thats why CVT is only used in interconnecting grid BAY



## WAVETRAP

A wave trap is a maintenance free parallel resonant circuit, mounted in line on high voltage AC transmission power lines to prevent the transmission of high frequency (40KHz to 1000KHz) carrier signals of power lines communication to unwanted destinations. Wave trap are cylinder like structure connected in series with high voltage transmission lines.

- It is an inductor having tuned LC circuit, which is mainly used for power line carrier communication (PLCC) purpose.
- It offer very high impedance to high frequency PLCC signals does not allow them to enter in system and offers very low impedance for frequency current.
- It is connected between buses and transmission lines and allow only 50Hz signal to pass through it.



## **DISCONNECTING SWITCH OR ISOLATOR**

- An Isolator is a mechanical switching device that, in the open position allows for isolation of input and output of the device.
- An Isolator differs from a switch in that it is intended to be opened when the circuit is not carrying current.
- An Isolator is a device used for isolating a circuit or equipment from a source of power.
- Isolator is a device which always operate under no load condition. This is because it has no provision for arc quenching.
- Its function is to isolate the circuit after operation of circuit breaker and discharge the grapes charges to the earth through earth switch.
- It does not have any specified current making or breaking capacity.
- Isolator are used in addition to circuit breaker and are provided on each side of every circuit breaker to provided isolation and enable maintenance.
- It has two parts male contact and female contact when they come in contact Isolator is closed.
- It is very useful in maintenance period.



## **CIRCUITBREAKER**

- A Circuit breaker is a device which makes or breaks a circuit either manually or automatically under normal or abnormal conditions.
- Under normal condition, it is operated manually.
- Under abnormal or faulty conditions, it is operates automatically after getting command from relay.

### **▪ CIRCUIT BREAKER USED IN GRID**

#### **1. Sf<sub>6</sub> Gas circuit Breaker :-**

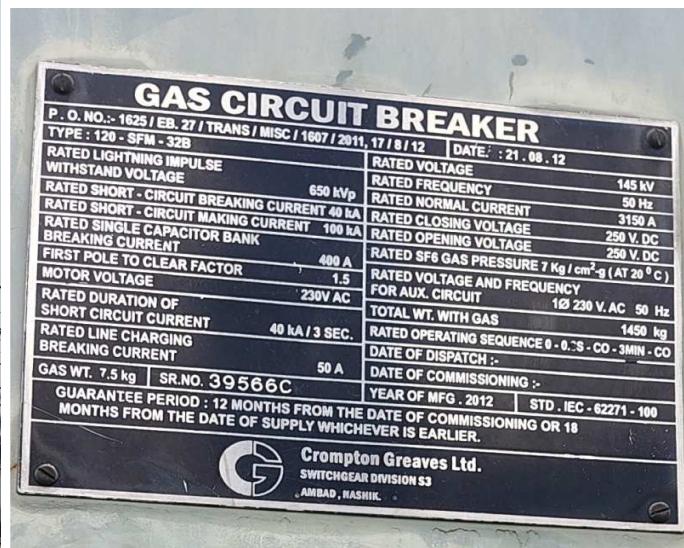
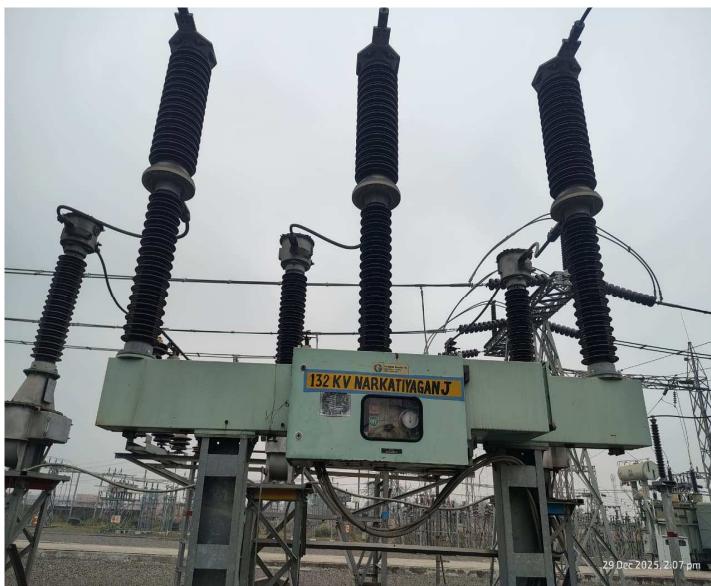
SF<sub>6</sub> circuit breakers are most commonly used at the 132 kV level due to their excellent arc-quenching properties, high dielectric strength, compact size, and low maintenance requirements. Sulphur hexafluoride gas effectively cools and deionizes the arc, allowing quick interruption of high fault currents

#### **2. Vacuum circuit breaker :-**

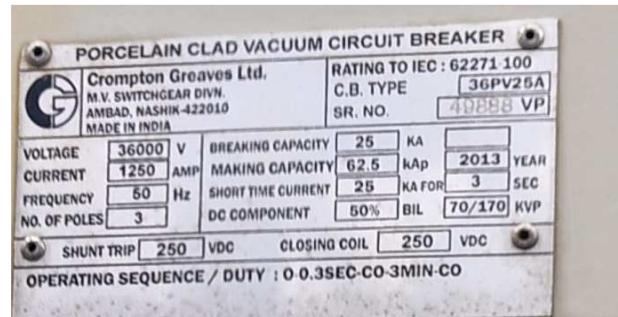
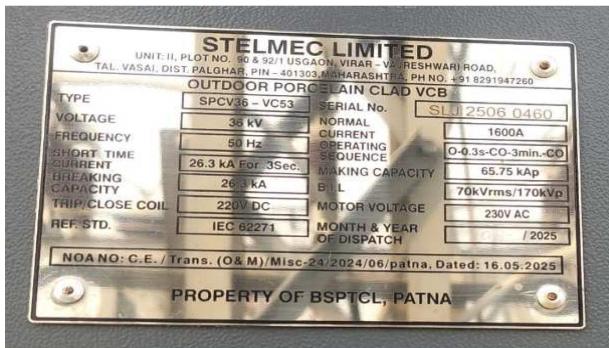
Vacuum circuit breakers (VCBs) are predominantly used. In a VCB, arc extinction occurs in a high vacuum environment, which provides rapid recovery of dielectric strength and long service life. VCBs are known for their reliability, minimal maintenance, and suitability for frequent switching operations, making them ideal for medium-voltage applications like 11kV & 33 kV feeders

### **PARTS OF CIRCUIT BREAKER**

1. **INTERRUPTOR**-It is the main contact of circuit breaker which makes or break the circuit.
2. **PREINSERTION**-It is used in circuit breaker to reduce switchover voltage at the time of closing the circuit.
3. **GRADIENTCAPACITOR**:-
  - ❖ It is used to equalize the restriking voltage across the interrupter at the time of opening or closing of circuit breaker.
  - ❖ In this 132/33kV grid sub-station Bettiah, the circuit breaker used in 132kV side is SF<sub>6</sub> gas circuit breaker and circuit breaker used in 33kV side is vacuum circuit breaker.



▪ SF6 Circuit Breaker & Name plate



▪ Vacuum Circuit Breaker Name plate

## REASON FOR USING SF6 GAS IN CIRCUIT BREAKER

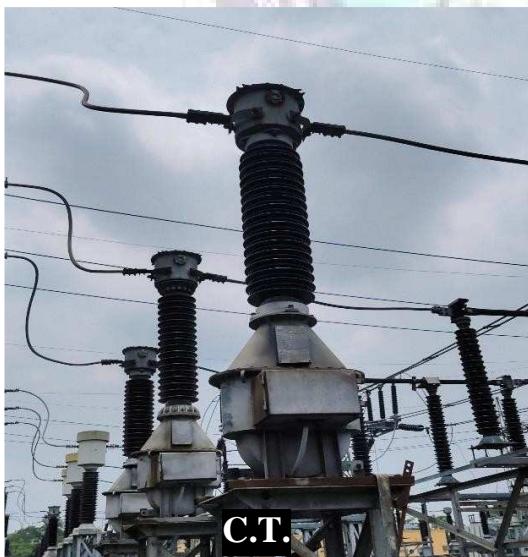
- Due to high dielectric strength.
- Due to high thermal conductivity.
- Thermal and electrical stability.
- Non inflammability.
- Arc extinguishing ability.
- Moderate cost.

## **CURRENT TRANSFORMER**

- A current transformer is used for measurement of alternating electrical current. Since current transformer is used for measurement, so it is known as measuring instrument.
- When current in a circuit is too high to directly apply to measuring instrument, a current transformer produces a reduced accurately proportional to the current in the circuit, which can be connected to measuring and recording instructions.
- A current transformer also isolates measuring instrument from what may be very high voltage in the monitored circuit. Current transformer are commonly used in metering and protective relays in the electrical power industry.
- The current transformer is typically described by its current ratio from primary to secondary. Often, multiple current transformers are installed as a "stack" or various uses. For example, protection devices are revenue metering may use separates current transformers to provide isolation between metering and protection circuits, and allow current transformer with different characteristics to be used for the devices.
- A high voltage current transformer may contain several cores, each with a secondary winding, for different purpose (such as metering circuit, control or protection).

## POTENTIAL TRANSFORMER

- Potential transformer are also called voltage transformer. It is parallel connected type transformer, used for metering and protection in high voltage circuit phasor phase shift isolation. There are designed to present negligible load to supply being measured and to have an accurate voltage ratio to enable accurate metering.
- Some transformer winding (usually high voltage) connection points maybe label ledasH1,H2(sometimeH0 if it is internally designed to be grounded) and X1, X2 and sometimes X3 tap may be present.
- Some time a second isolated winding (Y1, Y2 and Y3) may also be available on the same voltage transformer. The primary may be connected to phase to ground or phase to phase. The secondary is usually grounded on one terminal.



# **LIGHTING ARRESTER**

- A lightning arrester is a device used on electrical power system to protect the isolation and conductors of the system from damaging effects of lightning. The typical lightning arrester has a high voltage terminal and a ground terminal. When a lightning surge travels along power line to the arrester, the current flow from the surge is diverted through the arrester, in most cases to earth.
- It is a protective device which conducts the high voltage surges on the power system to ground.
- Lightning arrester incorporate zinc oxide(ZnO) element with superior linear voltage current non characteristics.
- Lightning arrester works on the principle of non linear resistance under normal operation, the lightning arrester is off the line.
- On the occurrence of over voltage, the air insulation across the gap breaks down an arc is formed, provided a low resistance path for the surge to the ground in this way, the excess charge on the line due to the surge is harmlessly conducted through the arrester to the ground.



# TRANSFORMER

- Transformer are used to increase voltage before transmitting electrical energy over long distances through conductors. Conductor have resistance which losses energy through Joule heating at a rate corresponding to square of the current. By transmission of power to a higher voltage transformer enable economical transmission of power and distribution.
  - Consequently, transformer have shaped the electricity supply industry, permitting generation to be located remotely from point of demand. All but a tiny of the world's electrical power electrical power has passed through a series of transformers by the time it reaches the consumer.
- 
- Transformer are also used extensively in electric products that step down the supply voltage to a level suitable for the low voltage circuit that contain.
  - The transformer also electrically isolates end from contact with supply voltage

## PARTS OF TRANSFORMER

- **Bushing**:-Brushing acts as a connection between overhead conductor and the winding of the transformer.
- **Tank**:-Tank of a transformer consists of core, winding which is immersed in oil. (Oil is basically provided for cooling and insulation purpose).
- **Oil Pump**:-Oil pump is used for circulation of oil in the tank.

- **Radiator**:-Radiator is used for the purpose of cooling, the blades are so arrange that they cut the air and help to make the temperature of oil low.
- **Conservator tank**:-Conservator tank is used for expansion and contraction of oil.
- **Cooling Fan**:-Cooling fan are placed below radiator. it is used to cool down transformer oil, winding & other temperature. In transformers there some types of cooling method like anon, afon, aof etc.
- **Breather**:-Breather is connected in conservator with the help of a pipe and is placed below radiator which suck air from atmosphere.
- **Silica Gel**:- The tank of silica gel is placed below radiator and next to breather which absorbs the moisture from sucked air. Silica gel is blue in color and after few year of long use it gets pink.
- **Buchholz Relay**:- It is the protection part of transformer. As any internal fault occurs in transformer, arc is produced and gases formed in oil. The gas formed in oil being light rise upwards and try to go into the conservator. The Buchholz relay is fitted in pipe connecting tank and conservator. The gas when reach to Buchholz relay makes the contact of relay and thus gives the command to trip.

**Fig.: -50MVA  
Power Transformer  
(ECE)**



**Fig.: -50MVA  
Power Transformer  
(Bharat bijilee)**

**Fig.: -20MVA  
Power Transformer  
(LMP)**



## SUBSTATION SERVICE TRANSFORMER (SST)

- In a grid substation, SST (Station Service Transformer) is an auxiliary transformer used to supply power for the internal operational and control requirements of the substation. It plays a crucial role in ensuring the continuous and reliable functioning of all substation equipment
- The SST typically receives power from the tertiary winding of a power transformer or directly from the 33 kV bus, and steps it down to low voltages such as 415 V or 230 V. This low-voltage supply is used for essential services within the substation, including control and relay panels, circuit breaker operating mechanisms, battery chargers, SCADA systems, cooling fans and oil pumps of power transformers, lighting, air conditioning, and fire protection systems.



### • CAPACITOR BANK

- A capacitor bank is installed to improve the overall power quality and operating efficiency of the power system. The primary purpose of the capacitor bank is to provide reactive power compensation, which helps in maintaining voltage levels within permissible limits and improving the power factor of the system.
- Capacitor banks in a 132/33 kV grid substation are generally connected on the 33 kV bus, as reactive power support is more effective closer to the load. By injecting capacitive load at this voltage level, the capacitor bank helps in stabilizing bus voltage, reducing line current, and minimizing  $I^2R$  losses in conductors.



## **DIGITAL PROTECTIVE RELAY**

- The junctions of electron based protection systems now being replaced by processor based digital protective relays, sometimes called "numeric relays".
- The digital protective relay or numeric relay is a protective relay that uses a microprocessor to analysis power system voltages, current or other process quantities for the purpose of detection of faults in an industrial process system. These converts voltage and currents to digital form and process the resulting measurements using a microprocessor. The digital relay can emulate the functions of many discrete electromechanical relays in one device, simplifying protection design and maintenance.
- ◆ Each digital relay can run self test routines to conform it's readiness and alarm if a fault is detected.
- ◆ Numeric relays can also provide functions such as communication interface, (SCADA) monitoring of contact inputs, metering, waveform analysis and other useful features.
- ◆ Digital relays can store two sets of protection parameters, which allows the behaviour of the relay to be changed during maintenance of attached equipment.
- ◆ Digital relays also can provide protection strategies impossible to synthesis with electromechanical relays and offer benefits in self testing and communication to supervisory control systems.

## STORAGE BATTERY

**Cell** - A cell is a device in which an electrical difference of potential is established between two electrodes as a result of chemical reaction between the electrodes & electrolytes.

The DC battery system in a 132/33 kV grid substation includes the battery bank, charger, DC distribution board, and monitoring equipment. Proper maintenance, periodic inspection, electrolyte level checking, and temperature control are essential to ensure long battery life and dependable operation

There are two type of cell:-

1. Lead Acid Cell
2. Li-Ion battery



## Working Principles-

When the +ve plate of lead per oxide & -ve plates of spongy lead are immersed in dilute  $H_2SO_4$  & connected together by names of external circuit, current flows round the circuit. The cell works until the peroxide is used up & under this condition the cell is said to be discharging.

The cell under fully discharged condition:-

Positive Plate:-  $PbO_2$

Negative Plate:- Pb electrolyte=Dilute  $H_2SO_4$   
(SP. Gravity = 1.25)

**During discharge:**-The chemical action can be represented by the following chemical equation.

At +ve condition:  $PbO_2 + H_2 + H_2SO_4 + 2H_2O$

At -ve condition:  $Pb + SO_4 = PbSO_4$

**During charging :-**When a direct current from an external source is passed through it from positive to negative, the following changes will occur.

At +ve plate:-  $PbSO_4 + SO_2 + 2H_2O = PbSO_4 + 2H_2O$

At -ve plate:-  $PbSO_4 + H_2 = Pb + H_2SO_4$

## Colour at the end of the charge becomes:

Positive plate:- **Dark Brown**

Negative plate:- **State Grey**

- The batteries are connected to the Relays for the tripping the circuit breaker.
- So DC Supply (battery) is hurt of an sub station.

## **CONCLUSION:**

In conclusion to all the mentioned design aspect of 132/33KV Sub-station, BETTIAH. There are several other factor that are needed to be considered. This include socio-economic factor of the surrounding, locality, political development, union of worker and contractor. Economics factors become chief aspect in any project which can take a prolong period to complete. An assumption of price hike to all the materials to a higher precision is needed. to made in order to estimate the budget of project. The mechanical and civil are also an essential part of any electrical sub-station design. Thus a lot of other engineering brains in those fields are also employees for the construction. Experts in the field of commerce and law are also employed to meet the various challenges that may rise up. It is an overall build up that ensure huge employment of people from different field..

**THANK YOU....**



