

INDUSTRIAL VISIT At 220 kV Ichchhapore Substation



The department of Electrical Engineering, Sarvajani college of Engineering and Technology, Surat had organized a one day Industrial visit to 220 kV Ichchhapore Substation, Ichchhapore on 1st February, 2018. There were 31 students from B.E- 4th year morning shift along with two teaching faculties Prof. Naman Bhatt and Prof. Siddhi Patel. We had coordinated with Shri H. A. Patel & Shri Parmar, Executive Engineer, Substation, Ichchhapore. At 10:30 am, we reached at Substation, Ichchhapore. After reaching there, Shri H. A. Patel & Shri Parmar received us with a warm welcome. Shri Parmar sir had explained the working substation in depth. Then we were taken to the control room. In the control room, every quantity of the substation is continuously monitored and we observed the real time data of substation on the panel. Shri H. A. Patel had brought us to battery room & explained its importance in substation. We interacted with H. A. el sir and had a great technical discussion.

➤ GENERAL INFORMATION

Gujarat Energy Transmission Corporation Limited (GETCO) was set up in May 1999 and is registered under the Companies Act, 1956. The Company was promoted by erstwhile Gujarat Electricity Board (GEB) as its wholly owned subsidiary in the context of liberalization and as a part of efforts towards

restructuring of the Power Sector. The company is now a subsidiary of Gujarat Urja Vikas Nigam, the successor company to the GEB. An electrical substation is a subsidiary station of an electricity generation, transmission and distribution system where voltage is transformed from high to low or the reverse using transformers. Electric power may flow through several substations between generating plant and consumer, and may be changed in voltage in several steps. A substation that has a step-up transformer increases the voltage while decreasing the current, while a step-down transformer decreases the voltage while increasing the current for domestic and commercial distribution.



➤ **OBJECTIVE OF VISIT**

Our main purpose for this visit is to be familiar with industrial environment and to get practical knowledge of electrical power transmission and distribution. Being final year students we will get to know about basic industrial functioning of power transmission and distribution. Students will also get familiar with Transformer maintenance, circuit breaker, Transformer isolator, bus bar, Protective relays, Lightning arresters, Load break switches, SCADA system, Current and voltage Transformer and Battery room.

➤ **EQUIPMENT IN A 220KV SUB-STATION**

The equipment required for a transformer Sub-Station depends upon the type of Sub-Station, Service requirement and the degree of protection desired. 220KV EHV Sub-Station has the following major equipments:

- Bus-bar
- Insulators
- Isolating Switches
- Circuit breaker
- Protective relay
- Instrument Transformer

- Current Transformer
- Voltage Transformer
- Metering and Indicating Instrument
- Miscellaneous equipment
- Transformer
- Lightening arrestors
- Line isolator
- Wave trap



Figure 1: Circuit Breaker

Bus-bar: When a no. of lines operating at the same voltage have to be directly connected electrically, bus- bar are used, it is made up of copper or aluminium bars (generally of rectangular X-Section) and operate at constant voltage. The bus is a line in which the incoming feeders come into and get into the instruments for further step up or step down. The first bus is used for putting the incoming feeders in LA single line. There may be double line in the bus so that if any fault occurs in the one the other can still have the current and the supply will not stop. The two lines in the bus are separated by a little distance by a Conductor having a connector between them. This is so that one can work at a time and the other works only if the first is having any fault .

Insulators: The insulator serves two purpose, they support the conductor (or bus bar) and confine the current to the conductor. The most commonly used material for the manufactures of insulators is porcelain. There are several type of insulator (i.e. pine type, suspension type etc.) and there used in Sub-Station will depend upon the service requirement.



Figure 2: Isolator

Isolating Switches: In Sub-Station, it is often desired to disconnect a part of the system for general maintenance and repairs. This is accomplished by an isolating switch or isolator. An isolator is essentially a knife Switch and is design to often open a circuit under no load, in other words, isolator Switches are operate only when the line is which they are connected carry no load. For example, consider that the isolator are connected on both side of a circuit breaker, if the isolators are to be opened, the C.B. must be opened first.

Circuit breaker: A circuit breaker is an equipment, which can open or close a circuit under normal as well as fault condition. These circuit breaker breaks for a fault which can damage other instrument in the station. It is so designed that it can be operated manually (or by remote control) under normal conditions and automatically under fault condition. The use of SF6 circuit breaker is mainly in the substations which are having high input KV input, say above 220KV and more. The gas is put inside the circuit breaker by force i.e. under high pressure. When if the gas gets decreases there is a motor connected to the circuit breaker. The motor starts operating if the gas went lower than 20.8 bar. There is a meter connected to the breaker so that it can be manually seen if the gas goes low. The circuit breaker uses the SF6 gas to reduce the torque produce in it due to any fault in the line. The circuit breaker has a direct link with the instruments in the station, when any fault occur alarm bell rings.

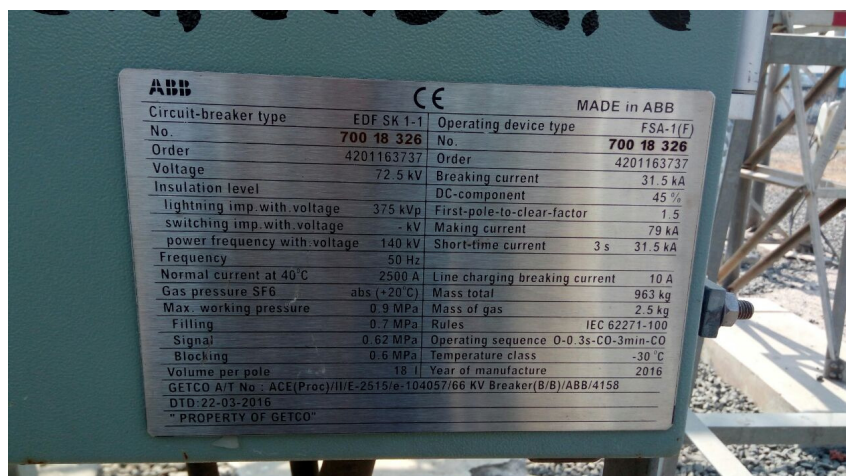


Figure 3: Circuit Breaker Name plate



Figure 4: Circuit Breaker

Protective relay: A protective relay is a device that detects the fault and initiates the operation of the C.B. to isolate the defective element from the rest of the system". The relay detects the abnormal condition in the electrical circuit by constantly measuring the electrical quantities, which are different under normal and fault condition. The electrical quantities which may change under fault condition are voltage, current, frequency and phase angle. Having detected the fault, the relay operates to close the trip circuit of CB.

Instrument Transformer: The line in Sub-station operate at high voltage and carry current of thousands of amperes. The measuring instrument and protective devices are designed for low voltage (generally 110V) and current (about 5A). Therefore, they will not work satisfactory if mounted directly on the power lines. This difficulty is overcome by installing Instrument transformer, on the power lines. There are two types of instrument transformer-

1. **Current Transformer:** A current transformer is essentially a step-down transformer which steps-down the current in a known ratio, the primary of this transformer consist of one or more turn of thick wire connected in series with the line, the secondary consist of thick wire connected in series with line having large number of turn of fine wire and provides for measuring instrument, and relay a current which is a constant fraction of the current in the line. Current transformers are basically used to take the readings of the currents entering the substation. This transformer steps down the current from 800 amps to 1amp. This is done because we have no instrument for measuring of such a large current. The main use of his transformer is: (a) distance protection (b) backup protection (c) measurement.



Figure 5: Current Transformer

2. Potential Transformer: It is essentially a step – down transformer and step down the voltage in known ratio. The primary of these transformer consist of a large number of turn of fine wire connected across the line. The secondary way consist of a few turns and provides for measuring instruments and relay a voltage which is known fraction of the line voltage.

3. C V T: A capacitor voltage transformer (CVT) is a transformer used in power systems to step-down extra high voltage signals and provide low voltage signals either for measurement or to operate a protective relay. In its most basic form the device consists of three parts: two capacitors across which the voltage signal is split, an inductive element used to tune the device to the supply frequency and a transformer used to isolate and further step-down the voltage for the instrumentation or protective relay. The device has at least four terminals, a high-voltage terminal for connection to the high voltage signal, a ground terminal and at least one set of secondary terminals for connection to the instrumentation or protective relay. CVTs are typically single-phase devices used for measuring voltages in excess of one hundred kilovolts where the use of voltage transformers would be uneconomical. In practice the first capacitor, C1, is often replaced by a stack of capacitors connected in series. This results in a large voltage drop across the stack of capacitors that replaced the first capacitor and a comparatively small voltage drop across the second capacitor,C2, and hence the secondary terminals.

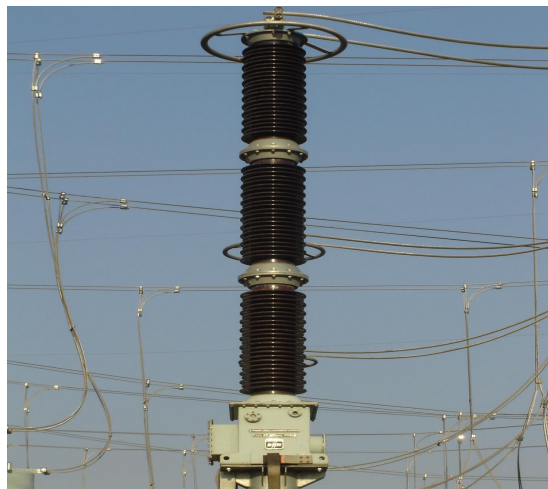


Figure 6: capacitor voltage transformer

Metering and Indicating Instrument: There are several metering and indicating Instrument (e.g. Ammeters, Volt-meters, energy meter etc.) installed in a Substation to maintain which over the circuit quantities. The instrument transformers are invariably used with them for satisfactory operation.

Miscellaneous equipment: In addition to above, there may be following equipment in a Substation :

- i) Fuses
- ii) Carrier-current equipment
- iii) Sub-Station auxiliary supplies

Transformer: There are four transformers in the incoming feeders so that the four lines are step down at the same time. In case of a 220KV or more KV line station auto transformers are used. While

in case of lower KV line such as less than 132KV line double winding transformers are used Auto transformer.

Transformer is static equipment which converts electrical energy from one voltage to another. As the system voltage goes up, the techniques to be used for the Design, Construction, Installation, Operation and Maintenance also become more and more critical. If proper care is exercised in the installation, maintenance and condition monitoring of the transformer, it can give the user trouble free service throughout the expected life of equipment which of the order of 25-35 years. Hence, it is very essential that the personnel associated with the installation, operation or maintenance of the transformer is through with the instructions provided by the manufacture diverted around the protected insulation in most cases to earth.



Figure 7: Power transformer

Auto transformer: Transformer is static equipment which converts electrical energy from one voltage to another. As the system voltage goes up, the techniques to be used for the Design, Construction, Installation, Operation and Maintenance also become more and more critical. If proper care is exercised in the installation, maintenance and condition monitoring of the transformer, it can give the user trouble free service throughout the expected life of equipment which of the order of 25-35 years. Hence, it is very essential that the personnel associated with the installation operation or maintenance of the transformer is through with the instructions provided by the manufacture.

Lightening Arrester: To discharge the switching and lightening voltage surges to earth.

Wave trap: Wave trap is an instrument using for tripping of the wave. The function of this trap is that it traps the unwanted waves. Its function is of trapping wave. Its shape is like a drum. It is connected to the main incoming feeder so that it can trap the waves which may be dangerous to the instruments here in the substation.



Figure 8: Wave Trap

SINGLE LINE DIAGRAM (SLD)

A Single Line Diagram (SLD) of an Electrical System is the Line Diagram of the concerned Electrical System which includes all the required ELECTRICAL EQUIPMENT connection sequence wise from the point of entrance of Power up to the end of the scope of the mentioned Work. As these feeders enter the station they are to pass through various instruments. The instruments have their usual functioning.

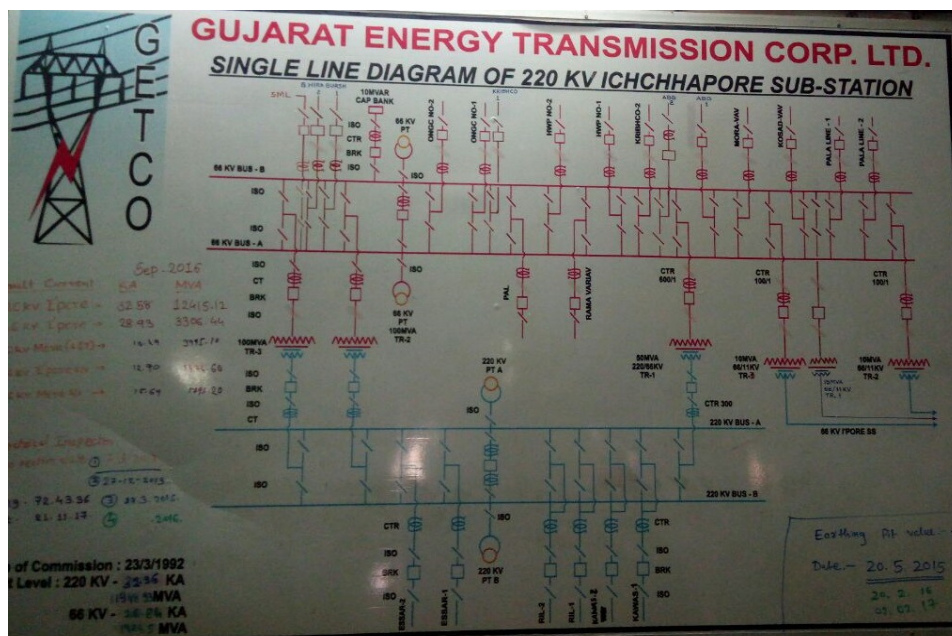


Figure 9: SLD of 220 kV Ichchhapore Substation

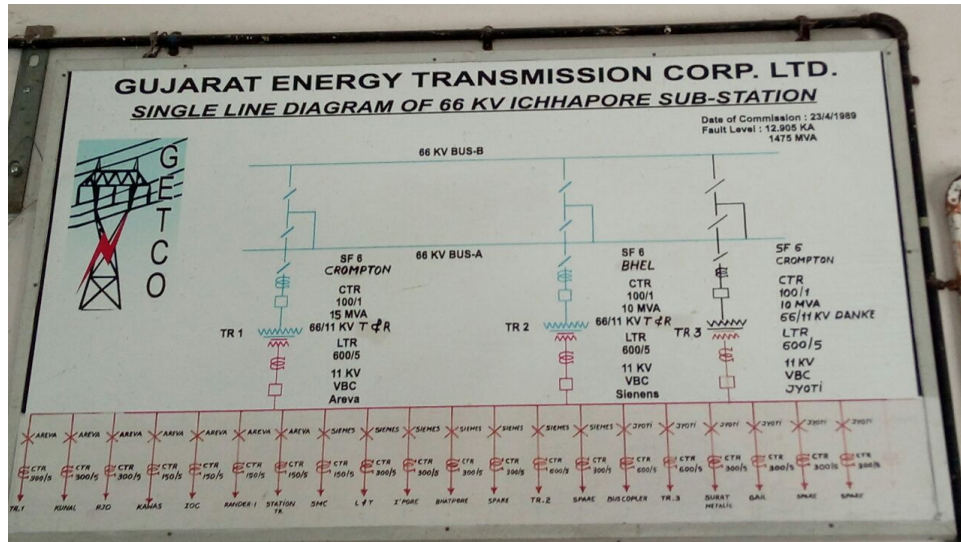


Figure 10: SLD of 66 kV Ichchhapore Substation

CONTROL & RELAY ROOM

The control room has various control panels which shows the information like incoming power, outgoing power, frequency, time common to all sub-stations, status of various lines(healthy, faulted, under outage or maintenance), status of various protective instruments like isolators, circuit breaker, temperature of various instruments, working tap of transformer etc.

The DAS (Data Acquisition System) is used to accumulate the data received from various sources.

The relay room is separate from the control room. The protection system is so fast that it can detect a fault within 30 ms and hence the circuit breaker can be operated within as less as 80 ms. For 400KV side C.B., one time auto re-closure is allowed in order to clear the faults automatically.



Figure 11: Control room of 220 kV Ichchhapore Substation

BATTERY ROOM: The control panels and relays of the sub-station required DC supply of 110 V. The DC supply is made with the help of battery bank reserve normally kept in a separate room called

battery room. The batteries used in this sub-station are Nickel-Cadmium (NI-Cd) batteries. These batteries re-used due to their advantages like low maintenance, longer life (15-20 years) etc.

Batteries at sub-station : Storage battery system is used in emergency situation for the working of electrical equipments. To open and close the switch gear. For indication and control. Emergency lighting Relay and interlocking equipments for working of alarm circuit.



Figure 12: Battery room

➤ CONCLUSION

Now from this report we can conclude that electricity plays an important role in our life. We are made aware of how the transmission the transmission of electricity is done. We too came to know about the various parts of the substation system. The three wings of electrical system viz. generation, transmission and distribution are connected to each other and that too very perfectly. Thus for effective transmission and distribution a substation must:

- Ensure steady state and transient stability
- Effective voltage control
- Prevention of loss of synchronism
- Reliable supply by feeding the network at various points
- Fault analysis improvement in respective field
- Establishment of economic load distribution

We are very grateful to 220 kV Ichchhapore Substation, DGVCL for giving permission for this visit. Students got an opportunity to know regarding practical aspects about what they are learning in theory. We hope that such kind of permission will be given in future also. It was an informative, interesting and a successful visit.