

Design and Construction of 33/11 KV Line & Substation

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ABSTRACT - The thesis deals with the analysis of Construction of Power Lines and Substation Switchyard of 33/11 KV. In today's life electricity plays a very vital role. The demand of electricity is being increased day by day. Therefore many new projects are being introduced not only in town as well as in remote areas also to provide the facilities of electricity by Constructing new transmission lines and Switchyard.

1. INTRODUCTION

Before construction of any line, survey is done. The Line route should be so selected that the maintenance is easy and the line does not cause Obstruction to vehicular traffic and should be shortest, as well, consistent with engineering and economic principles. The transmission lines shall be routed, where ever possible to avoid difficult terrain and natural obstacles such as steep hills, dense forests, landslides, lakes, rivers, highly developed areas, etc. Transmission lines should not also cross school-yards. The correct and accurate Survey results in speedy construction and saving of unnecessary alignment and realignment at the time of carrying out actual construction work. All measurements should be taken with utmost accuracy and similarly the line charts and the profiles should be prepared with great care and precaution.

Where the lines are constructed over farm-land, structures and anchors shall be so located as to interfere as little as possible with farming operation. Wherever such structures and anchors become necessary, the same shall be located along fencing or in any uncultivated areas.

While aligning for poles or for underground cabling, care should be exercised to determine the location of all underground services such as water mains, sewers, telephone cables, power cables, land drainage tiles, gas, and oil pipe lines etc. and adequate clearance should be provided to avoid damage.

The Transmission lines shall be routed to avoid buildings and build up areas wherever possible. The clearances of the various conductors from the ground and buildings should be taken well as per latest INDIAN ELECTRICITY RULES.

Where Switchyard means collection of equipment where high voltage electricity is switched using of various components. Electrical Switchyard is usually a part of Substation where electricity is transferred from one Voltage to another for the Transmission and Distribution purpose.

2. CONFIGURATION

2.1 Lines

The transmission lines shall be routed to avoid length of parallelism between power and Communication circuits as far as possible. Minimum separation distance between power and Communication Circuits should be kept as 61 metres (200 ft.) for 33 KV line provided length of parallelism does not exceed 1.6 Km. For greater distances minimum "separation distance will be governed" by given formula as:-

$$\text{Minimum Spacing} = 0.25 \times \sqrt{EL} \text{Metres}$$

Where,

E = Voltage between Phases in Volts

L = Length of Parallelism in Km

After the survey and stacking out have been done, the construction of line should be started. The holes for cross-arm, F- bracket and other fitting should be drilled in the supports before these are transmitted to site. The sequence of operation in construction of the transmission line is given as:-

- Pit digging and Pole erection
- Concreting of Poles.
- Staying of Supports.
- Running and tensioning of conductors.
- Clamping up.
- Fitting of Armour rods and Binding of Conductors.
- Fixing of Danger and number Plates and Anti-Climbing device.

After the line is erected, pole to pole inspection is done to ensure the following:-

- Jumpering has been done neatly at all the section Points.
- Danger and number Plates and Anti-Climbing devices has been provided on the supports.
- Stays provided at angle and section points have been tightened and are taking up the load.
- All the cross-arms and poles are painted.
- All the poles are in vertical position.
- No loose conductor, binding wire or earth wire is hanging at any location and short circuiting the line.
- All the trees in the danger zone have been felled.

After inspection, the line is meggered by 1000 volt megger and insulation resistance between phases and, between phase and earth is noted.

2.2 Switchyard

Switchyard means collection of equipment where high voltage electricity is switched using of various components. Electrical Switchyard is usually a part of Substation where electricity is transferred from one Voltage to another for the Transmission and Distribution purpose.-

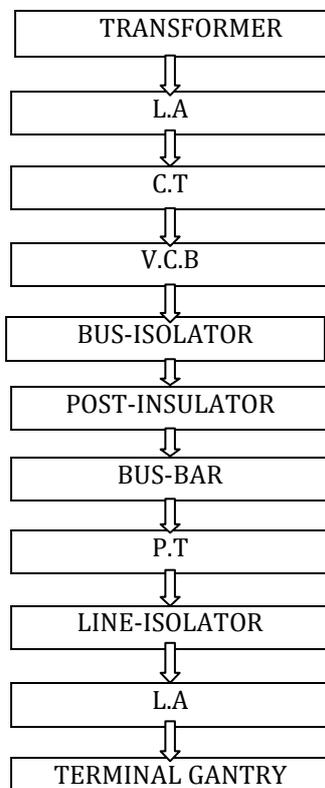


Fig-1: Switchyard Equipments

Switchyard is constructed with assembling of much electrical equipment. The various main structures used in construction of switchyard are configurations of equipments are:- Transformer, L.A, CT, VCB, Bus Isolator, Post Insulator, Bus-bar, P.T, Line Isolator and Terminal Gantry. The sequence of Equipments used in switchyard from starting point of transformer to the end point of terminal gantry is given as:-

3. PRINCIPLE OF EQUIPMENTS

Transformer -

A static electrical machine used for transforming power from one circuit to another circuit without changing frequency is termed as power transformer. The transformers are generally used to step down or step up the voltage levels of a system for transmission and generation purpose. These transformers are classified into different types based on their design, utilization purpose, installation methods, and so on.

Lightning Arrester-

The substation equipments such as conductors, transformers, etc., are always erected outdoor. Whenever light surges occur then, a high-voltage pass through these electrical components causing damage to them (either temporary or permanent damage based on the amount of voltage surge). Therefore, to avoid this difficulty, lightening arresters are placed to pass the entire lightening surges to earth. There are other arresters which are used to ground the switching surges called as surge arresters.

Current Transformer -

It is used for the measurement of the alternating current by taking samples of the higher currents of the system. These reduced samples are in accurate proportions with the actual high currents of the system. These are used for installation and maintenance of the current relays in substations for protection purpose which are normally has low-current ratings for their operation.

Vacuum Circuit Breaker -

For the protection of substation and its components from the over currents or over load due to short circuit or any other fault the faulty section is disconnected from the healthy section either manually or automatically. If once the fault is rectified, then again the original circuit can be rebuilt by manually or automatically. Different types of circuit breakers are designed based on different criteria and usage. But in general mostly used circuit breakers are Oil circuit breaker, Air circuit breaker, SF6 circuit breaker, Vacuum Circuit Breaker, and so on.

Bus Isolator -

These have three stacks of post insulators. The central post insulator carries a tubular or flat male contact which can be rotated horizontally with rotation of central post insulator. This rod type contact is also called moving contact.

The female type contacts are fixed on the top of the other post insulators which fitted at both sides of the central post insulator. The female contacts are generally in the form of spring loaded figure contacts. The rotational movement of male contact causes to come itself into female contacts and isolators becomes closed. The rotation of male contact in opposite direction make to it out from female contacts and isolators becomes open. Rotation of the central post insulator is done by a driving lever mechanism at the base of the post insulator and it connected to operating handle (in case of hand operation) or motor (in case of motorized operation) of the isolator through a mechanical tie rod.

Post Insulator -

It is more or less similar to Pin insulator but former is suitable for higher voltage application. Post insulator has higher numbers of petticoats and has greater height. This type of insulator can be mounted on supporting structure horizontally as well as vertically. The insulator is made of one piece of porcelain but has fixing clamp arrangement are in both top and bottom end.

Post Type insulators are usually used in substations. These insulators are constructed in the form of a cylinder. The circular surface of the cylinder is corrugated to increase the leakage distance. They are mounted on pedestals. These insulators exhibit high resistance to puncture.

Bus-Bar -

The conductor carrying current and having multiple numbers of incoming and outgoing line connections can be called as bus bar, which is commonly used in substations. These are classified into different types like single bus, double bus and ring bus.

Potential Transformer -

It is quite similar to the current transformer, but it is used for taking samples of high voltages of a system for providing low-voltage to the relays of protection system and also to the low-rating meters for voltage measurement. From this low-voltage measurement, the actual system's high voltage can be calculated without measuring high voltages directly to avoid the cost of the measurement system.

Line Isolator -

In Power systems an isolator is a switch which is used to completely open a circuit which has been rendered dead by means of opening a circuit breaker for maintenance of equipment. It can be visually seen that an isolator is open and hence service man are assured that it is safe to work on the isolated equipment. The equipment to be worked on is further earthed mostly on either side so that electrical energy that could be in the equipment is completely discharged to earth further enhancing safety of the service man. An isolator is also used for sectionalising power lines during fault location.

Isolators are always opened in no load condition (after opening of circuit breakers) because it lags the mechanism of operating in high voltage.

Terminal Gantry -

Gantry tower is a structure commonly found in electrical substation or transmission line. It is a combination of two or more legs (towers) and an overhead beam. To the overhead beam a lifting device is connected. Gantries can be constructed to meet the specific requirements of the location. As they can only lift vertically, versatility is limited and they need to be built over the foundation.

Conductor -

The material or object that obeys the electrical property conductance (mostly made of metals such as aluminium and copper) and that allows the flow of electric charge is called conductor. Conductors permit free movement of the flow of electrons through them. These are used for the transmission of power or electrical energy from one place (generating station) to another place (consumer point where power is consumed by the loads) through substations. Conductors are of different types and mostly aluminium conductors are preferred in practical power systems.

Relays -

Relays are used for disconnecting the circuits by manual or automatic operation. Relay consists of the coil which is excited or energized and such that making the contacts of relay closed activates the relay to break or make the circuit connection. There are different types of relays such as over current relays, definite time over current relays, voltage relays, auxiliary relays, reclosing relays, solid state relays, directional relays, and inverse time over current relays, microcontroller relays, etc

Capacitor Bank -

A Capacitor bank is a set of many identical capacitors connected in series or parallel within a enclosure and is used for the maintaining power factor correction and basic protection of substation. These capacitor banks are acts as a source of reactive power, and thus, the phase difference between voltage and current can be reduced by the capacitor banks. They will increase the ripple current capacity of the supply. It avoids undesirable characteristics in the power system. It is the most economical method for maintaining power factor and of correction of the power lag problems.

4. RESULT

While working and making analysis on this project, I have Observed many Technical Implementation on it. While erecting pole for the line of 11 KV and 33 KV Line, we use 11m STP Pole for 11 KV and 13m STP Pole for 33 KV.

Watching future scope, here I would like to replace the 11 m STP Pole by 13 m STP Pole because in Present Scenario, many new lines are being constructed either of 33 KV or 11 KV line. In future also many such lines will be constructed. For convenient purpose, we will use 13 m Pole for both 11 KV and 33 KV Lines. So that if any new line being constructed in future then Composite lines can be made on 13 m STP Poles for 11 KV Lines.

By making above changes, the result obtained will be as below:-

- Space can be minimised for the other lines that can be constructed in future.
- Expenses of Poles for new lines will be decreased.
- Labour cost is reduced.
- Work can be carried easier.
- Minimum time is required for completion of work.

In Distribution or L.T side, Load Fluctuation always occurs, generally in Summer Season, load is increased. Due to this increase in load, heating effects occur and current flowing in the conductors increases above the rated current carrying capacity of the conductors.

Due to above undesired conditions fault occurs in the line and the Conductor breakdown Occurs.

This Serious problem of fault Occurring and breakdown of Conductors can be removed to a great extent by replacing RABBIT Conductor by RACCOON or DOG Conductors, because DOG and RABBIT Conductor have high Current Carrying Capacity of approx. 350 Amp and 300 Amp respectively rather than RABBIT Conductors which have the current carrying capacity of approx. 240 Amp.

5. CONCLUSION

While making this Project on Design and constructed of 33/11 KV Lines and switch yard, I conclude that in this overall project and report for electrical engineering I put my great effort to understand and explore more and more about the Construction of lines and switch yard designing for substation. But Construction of Lines and Substation Switchyard designing is such a complex which has so many functions, systems and components which need so much time to understand. But I try my best to utilize this short span of time to bring out the valuable knowledge about the Construction of 33/11 KV Lines and switch yard designing for substation.

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While making this thesis report on Design and Construction of 33/11 KV lines and Substation Switchyard I referred the following books and websites.

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