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132 KV/ 33 KV Substation

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Abstract: *This Paper presents designing of 132/11 kV substation. For healthy operation of the system, the system should be balanced. The single line diagram is used for the substation to understand it's electrical system. The electrical equipment are represented by the symbols in a one-line diagram. The single line diagram is required so that we can understand the electrical system of the substation. The designing of single line diagram is necessary as it displays the right power distribution route from entering power source to each downstream load including the rating of each electrical apparatus. The single line diagram is a diagram in which the single line represents the three-phase power system. For maintaining and controlling, the power supply Substation apparatus are required. Reliability of the system is also dependent on Substation equipment sizing. By calculating the equipment sizing, we are able to find the rating of the equipment used in the substation. By doing equipment sizing the reliability of the system also, increases. The sizing of equipment is done so that the rating of equipment used in the substation can be selected. For different rating like 132kv, 11kv, The sizing of equipment like Lightning arrester, Wave trap, CVT, Current transformer, Isolator, Circuit breaker, Transformer etc. have been calculated.*

Keywords: Single Line Diagram, Lightning arrester, Wave trap, CVT, Current transformer, Isolator, Circuit breaker, Transformer

I. INTRODUCTION

Any sub-station which handles power at over 33KV is termed as extra High Voltage sub-station by the rules implemented by Indian government. The design process of an EHV sub-station begins with very elemental work of selection of site and estimation of requirements which includes capital and material. It is also needed to keep in mind, the civil aspects of a substation design. In India about 75% of electric power used is generated in thermal and nuclear plants, 23% from mostly hydro station and 2% comes from renewable and other resources. The distribution system supplies power to the end consumer, while the transmission system connects between the generating stations and distribution system through transmission line. The entire network forms a power grid and each power grid across the country is interconnected which facilitates uninterrupted supply. While designing a power grid the following aspects must be taken into consideration: ⎪ Low capital cost. ⎪ Reliability of the supply power. ⎪ Low operating cost ⎪ High efficiency ⎪ Low cost of energy generation. ⎪ Simplicity of design. ⎪ Reserve capacity to meet future requirements Starting from the generating stations to the end users, voltage is needed to be stepped up and down several times in various substations. This ensures efficient transmission of power, minimizing the power losses. Our project is to design a 132KV/33KV EHV sub-station where the incoming power is received at 132 KV from a generating station. The power factor is corrected here and the voltage is stepped down to 33KV and power is then transferred to distribution system of the grid to meet the requirements of the end consumers at their suitable voltage.

II. SINGLE LINE DIAGRAM OF 132/33 KV SUBSTATION

2.1 Earthing

Earthing means that, making a connection to the general mass of the earth. The use earthing is so widespread in an electrical system that at particular every point in the system, from the generators to the consumer equipment, earth connections are made.

The subject of earthing may be divided into

a. Neutral Earthing
b. General Earthing

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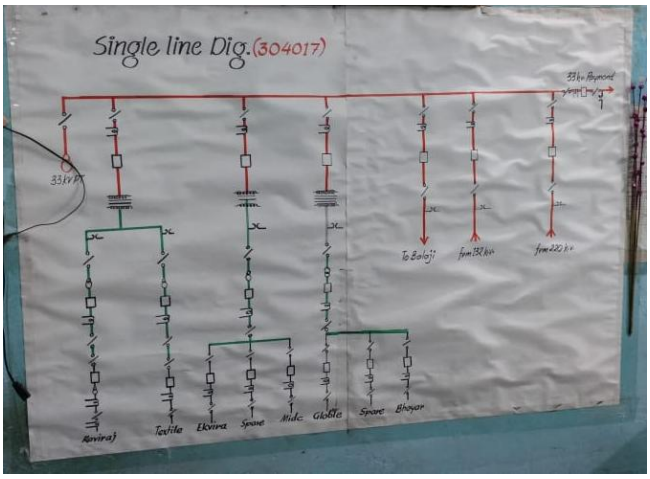

III. INSULATION COORDINATION

Insulation co-ordination is the process of determining the proper insulation levels of various components in a power system as well as their arrangements. It is the selection of an insulation structure that will withstand voltage stresses to which the system or equipment will be subjected to, together with the proper surge arrester. The process is determined from the known characteristics of voltage surges and the characteristics of surge arrester. Its final objective is to ensure safe, optimized distribution of electric power.

IV. DESIGN OF BUS BARS

Bus bars are Cu/Al rods of thin-walled tubes and operate at constant voltage. The bus-bars are designed to carry normal current continuously. The cross section of conductors is designed on the basis of rated normal current and the following factors: System voltage, position of sub-station. Flexibility, reliability of supply and cost. Our design must ensure easy and uninterrupted maintenance, avoiding any danger to the operating of operating personnel. It must be simple in design and must possess provision for future extension. Any fluctuation of load must not hinder its mechanical characters. The sub-station bus bars are broadly classified in the following three categories:

1. Outdoor rigid tubular bus-bars.
2. Outdoor flexible ACSR or Al alloy bus-bars.
3. Indoor bus bars.

V. INSULATORS

The insulators serve two purposes. They support the conductors (or bus-bars) and confine the current to the conductors. The most commonly used material for the manufacture of insulator is porcelain. There are several types of insulators, and their use in the sub-station will depend upon the service requirement. The main four types of insulators are as follows:

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1. Pin Type Insulators
2. Suspension Type Insulators
3. Strain Insulators
4. Shackle Insulators

VI. CIRCUIT BREAKER

Circuit breakers are a piece of electrical device that
1) Make or break a circuit either manually or by remote control under normal conditions.
2) Break a circuit automatically under fault conditions.
3) Make a circuit either manually or by remote control under fault conditions.
Classification of Circuit Breakers:
The most common method of classification of circuit breakers is on the basis of medium used for arc extinction. Accordingly they are classified as:
1. Oil circuit-breaker.
2. Air-blast circuit breaker.
3. Sulphur hexafluoride circuit breakers.
4. Vacuum circuit breakers.

6.1 Relays

A protective relay is a device that detects the fault and initiates the operation of the circuit breaker to isolate the defective element from the rest of the system. The relay constantly measures the electrical quantities which are different under normal and fault condition. Having detected the fault the relay operates to close the trip circuit of the breaker. The trip circuit is operated by a direct voltage. A relay must be highly selective to the normal and fault conditions to avoid unwanted tripping. It must operate with suitable speed so that fault is eliminated before it can cause any damage. A relay must also be sensitive to work with low values of currents.

6.2 Functional Relay Types

1. Induction type over-current relay
2. Induction type reverse power relay
3. Distance or Impedance relay
4. Differential relay
5. Translay scheme

VII. CURRENT TRANSFORMER

CT has a primary winding one or more turns of thick wire connected in series with the line carrying the current to be measure. The secondary consist of a large no of turns of fine wire and feeds a standard 5 amp. ammeter. It is used for the measuring and protection purpose. The secondary of current transformer should never be left open under any circumstances.

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VIII. POTENTIAL TRANSFORMER

These transformers are extremely accurate ratio step down transformer s and are used in conjunction with standard low range voltmeter (100-120V) whose deflection when divided by transformation ratio, gives the true voltage on primary side. In general, they are shell type. Their rating is extremely small for safety operation secondary is completely insulated from high voltage primary. Its primary current is determined by the load on secondary

8.1 Lightning Arrester

An electric discharge between clouds and earth, between clouds or between the charge centers of the same cloud is known as lightning. It is a huge spark and takes place when the clouds are charged to such high potential with respect to earth or a neighboring cloud that the dielectric strength of neighboring medium is destroyed. A lightning may strike the power system (e.g. overhead lines, towers or sub-stations) directly and the current path may be over the insulators down to pole to the ground or it may strike indirectly, resulting from electrostatically induced charges on the conductors due to the presence of charged clouds.

IX. SWITCHGEAR

Switchgear Panel

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The term switchgear, used in association with the electric power system, or grid, refers to the combination of electrical disconnects, fuses and/or circuit breakers used to isolate electrical equipment. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream. Switchgear is already a plural, much like the software term code/codes, and is never used as switchgears. The very earliest central power stations used simple open knife switches, mounted on insulating panels of marble or asbestos. Power levels and voltages rapidly escalated, making open manually-operated switches too dangerous to use for anything other than isolation of a de-energized circuit. Oil-filled equipment allowed arc energy to be contained and safely controlled. By the early 20th century, a switchgear line-up would be a metalenclosed structure with electrically-operated switching elements, using oil circuit breakers. Today, oil-filled equipment has largely been replaced by air-blast, vacuum, or SF6 equipment, allowing large currents and power levels to be safely controlled by automatic equipment incorporating digital controls, protection, metering and communications.

9.1 Power Transformer

This is the most important component of a sub-station. The main work of a sub-station is to distribute power at a low voltage, by stepping down the voltage that it receives in its incoming lines. Power is generally transmitted over long distances at very high voltages, generally in the range of 400 KV, 200 KV or 132 KV to the sub-stations. However consumer requires power at rather low voltages, 11 KV for industries and 440 V or 220 V for domestic consumers. The sub-stations use step-down transformers to attain this voltage and then distribute this power. All the other equipment in a sub-station works only to facilitate the smooth working of the power transformer.

9.2 Control Cable

Control cables are used in substations for connecting control systems, measurements, signaling devices, protection circuits etc. rated below 1000volts. They have a copper conductor. They may have another rubber insulation or PVC insulation. Control cables have several cores, each having independent insulation. To avoid interference due to stray magnetic fields, the control cables should be properly laid and their sheath should be properly earthed.

9.3 Annunciation Scheme

Other trip and non trip alarm scheme. Fascia annunciation system has to be provided in each control panel by means of visual and audible alarm to draw attention of operator. The annunciation can be divided into the following categories:-

9.4 Trip annunciation

Warning annunciation

Incoming DC fail and annunciation bus DC fail alarm scheme. Bus coupler panel shall have an “incoming DC fail and annunciation bus DC fail alarm scheme” common to the entire C&R board and operate from 230V AC supply for audible and visual alarm through lamp and bell arrangement. The scheme comprises of DC supervision relay with push buttons for incoming DC supply and annunciation bus DC system, one AC operated alarm accept relays, one indication lamp, one AC operated hooter and one push button for cancellation of audible alarm.Alarm inscriptions are engraved in facial window and the same should be prominently visible when fascia light is ON.Accept reset and lamp test push buttons for acknowledgement of alarm, reset of visual indicator and checking correctness of lamps are provided below each fascia.The annunciation scheme should be such that momentary closing of any fault contacts shall cause operation of annunciation.

Isolators

When carrying out inspection or repair in a substation installation, it is essential to disconnect reliably the unit or section on which the work is to be done, from all other live parts on the installation in order to ensure complete safety of the working staff. To guard against mistakes it is desirable that this is done by an apparatus which makes a visible break in the circuit. Such an apparatus is the isolating switch or ISOLATOR.Isolators used in power systems are generally three pole isolator. The three pole isolators have three identical poles. Each pole consists of two or three isolator posts mounted on fabricated supports. The conducting parts are supported on insulator posts. The conducting

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part consists of conducting copper or aluminum rod, fixed and moving contacts. During the opening operation the conducting rod swings apart and isolation is obtained.

The simultaneous operation of 3 poles is obtained by mechanical interlocking of 3 poles. For all 3 poles there is a common operating mechanism. The operating mechanism is manual plus one of the following

- Pneumatic mechanism
- Electric motor mechanism

X. CONCLUSION

In conclusion to all the mentioned design aspects of the 132/33KV sub-station there are several other factors that are needed to be considered. This includes socio-economic factor of the surrounding locality, political developments, union of workers and contractors. Economic factors become chief aspect in any project which can take a prolonged period to complete. An assumption of price hike of all the materials to a higher precision is needed to be made in order to estimate the budget of this project.The mechanical and civil designs are also an essential part of any electrical substation design. Thus a lot of other engineering brains in those fields are also employed for the construction. Experts in the field of commerce and law are also employed to meet the various challenges that may rise up. It's an overall build up that ensures huge employment of people from different fields.

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