A

TRAINING

REPORT ON

SOUTHERN POWER DISTRIBUTION COMPANY OF A.P.LTD

33/11 KV SUBSTATION SURYARAOPET,

VIJAYAWADA (ANDHRA PRADESH).

Submitted by

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Training has an important role in exposing the real life situation in an industry. It was a great experience for me to work on training at **<u>Southern Power Distribution Company of A.P.Ltd</u>** through which I could learn how to work in a professional environment.

Now, we would like to thank the people who guided us and have been a constant source of inspiration throughout the tenure of my summer training.

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1. INTRODUCTION

The creation of **Southern Power Distribution Company of A.P.Ltd** on **April 1, 2000** is the result of power sector reforms and restructuring in Krishna, Guntur, Prakasam, Nellore, Chittor, Ananthapur, Kurnool and Kadappa districts of AP which is the focal point of the Power Sector, responsible for planning and managing the sector through its **distribution** and **supply of electricity.**

APSPDCL is a professionally managed utility supplying reliable and cost efficient electricity to every citizen of the state through highly motivated employees and state of art technologies, providing an economic return and maintaining leadership in the country.

We shall achieve this being a dynamic, forward looking, reliable, safe and trustworthy organization, sensitive to our customers' interests, profitable and sustainable in the long run, providing uninterrupted supply of quality power, with transparency and integrity in operation

1.1 ABOUT 33/11KV SUBSTATION Suryaraopet

Figure 1.1 33/11KV Substation Suryaraopet

The main bus 33KV is connected to grid located at **Suryaraopet, VIJAYAWADA.** Now the transmission line first parallel connected with lightning arrester to diverge surge, followed by PT connected parallel. PT measures voltage and steps down at 110V. A.C. for control panel.

A current transformer is connected in series with line which measure current and step down current at ratio 400:1 for control panel.

Switchgear equipment is provided, which is the combination of a circuit breaker having an isolator at each end. A transformer is connected to main bus though a bus coupler. The main bus has total capability of 16 MVA for 33 KV, which is subdivided into two transformers of capacity of 8 MVA each.

At both ends of transformer lightning arrester current transformer and switchgear equipment provided. Transformer step downs voltage from **33KV to 11KV**. The main bus is provided with switchgear equipment, a current transformer and a potential transformer. This gives way to four feeders transmitting power to **Visalandra, Seetharampuram, Chuttugunta, SRR.** A step down transformer of 11KV/440V also known as station transformer is connected to output busbar to provide supply to the substation.

1.1 Single Line Diagram of 33/11KV Substation Suryaraopet

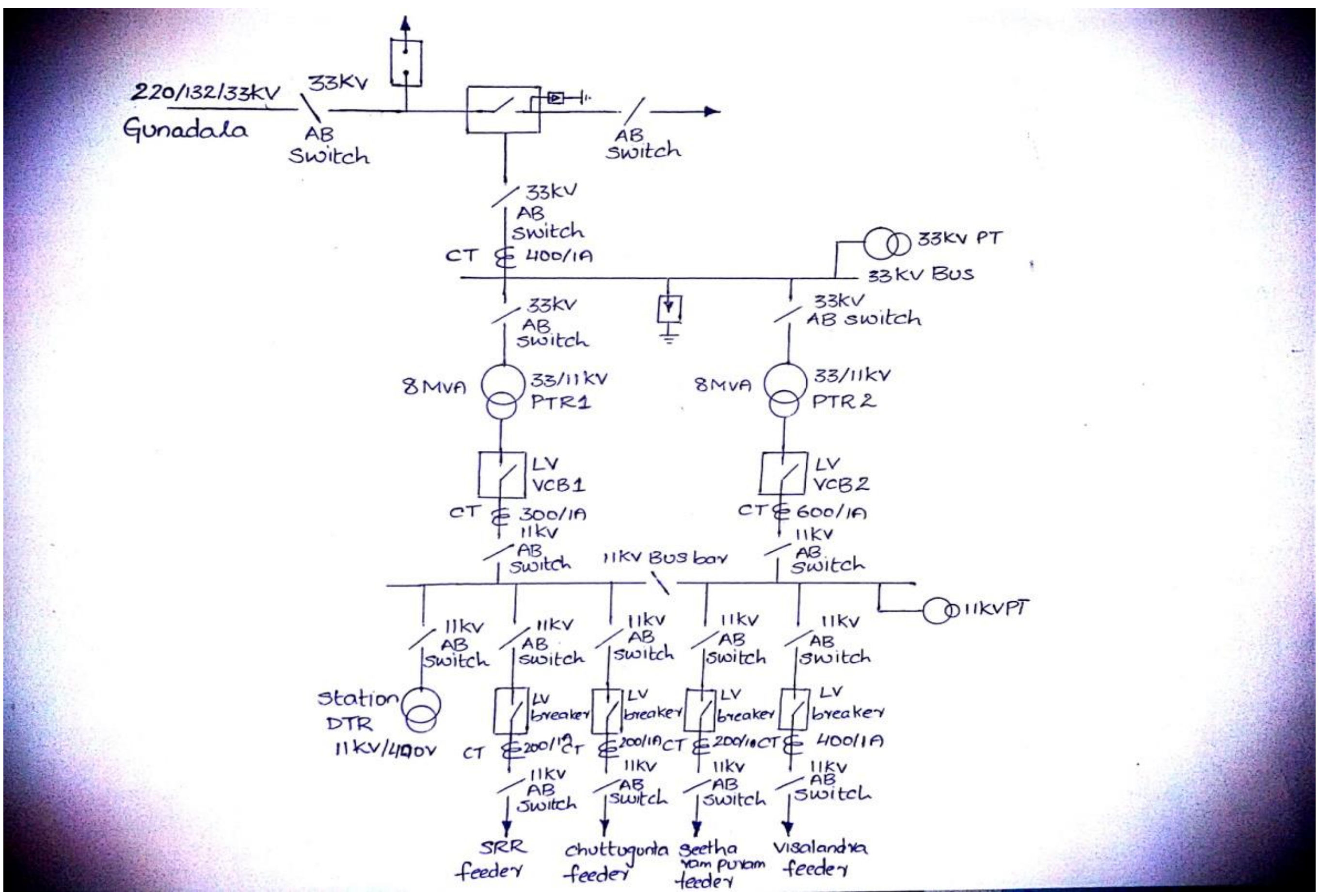

Figure 1.2 Single line diagram of Suryaraopet SS

2. TRANSFORMERS

Figure: 2.1 Transformer

Transformer is a static machine, which transforms the potential of alternating current at same frequency. It means the transformer transforms the low voltage into high voltage & high voltage to low voltage at same frequency. It works on the principle of static induction principle.

When the energy is transformed into a higher voltage, the transformer is called step up transformer but in case of other is known as step down transformer.

2.1 TYPES OF TRANSFORMER

2.1.1 Power transformer

2.1.2 Instrument transformer

2.1.3 Auto transformer

2.1.4 On the basis of working

2.1.5 On the basis of structure

2.1.1 POWER TRANSFORMER:

Figure 2.2 Power Transformers

Types of power transformer:

2.1.1.1 Single phase transformer

2.1.1.2 Three phase transformer

2.1.2 INSTRUMENT TRANSFORMER:

Fig: 2.3 Instrument Transformers

a) Current transformer

b) Potential transformer

2.1.3 AUTO TRANSFORMER:

Fig 2.4 Auto Transformer

a) Single phase transformer

b) Three phase transformer

2.1.4 ON THE BASIS OF WORKING

2.1.4.1 Step down: Converts high voltage into low voltage.

2.1.4.2 Step up : Converts low voltage into high voltage.

2.1.5 ON THE BASIS OF STRUCTURE

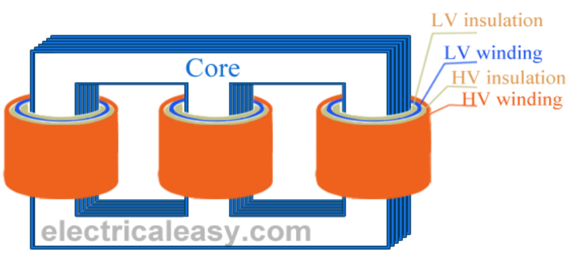

Figure 2.5 core type

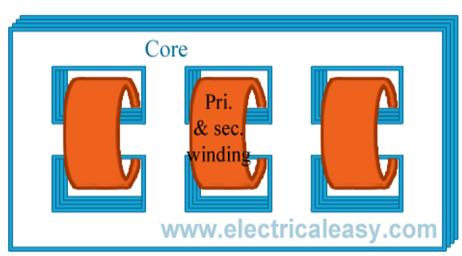

Figure 2.6 Shell type

3. SUBSTATIONS

Figure 3.1View of substation

The present day electrical power system is A.C. i.e. electrical power is generated, transmitted & distributed in the form of the alternating current. The electric power is produced at power plant stations which are located at favorable places generally quite away from the consumers. It is delivered to the consumers through a large network of transmission and distribution.

At many places in the power system, it may be desirable and necessary to change some characteristics e.g. voltage, ac to dc, frequency, power factor etc. of electric supply. This accomplished by suitable apparatus called substation. For example; generation voltage (11 KV or 33 KV) at the power station is set up to high voltage (say 220 KV or 132 KV) for transmission of electric power. The assembly of apparatus (e.g. transformer etc.) used for this purpose in the substation. Similarly near the consumer's localities, the voltage may have to be step down to utilization level. This job is again accomplished by suitable apparatus called substation.

The assembly of apparatus to change some characteristic of electric power supply is called substation.

The two most ways to classify substation are:-

3.1 TYPES OF SUBSTATION

3.1.1 According to the service requirement:

4.1.1.1 Transformer substation

4.1.1.2 Switch substation

4.1.1.3 Power factor correction substation

4.1.1.4 Frequency change substation

4.1.1.5 Converting substation

4.1.1.6 Industrial substation

3.1.2 According to the constructional features:

3.1.2.1 Indoor substation

3.1.2.3 Outdoor substation

3.1.2.4 Underground substation

3.1.2.5 Pole mounted substation

3.1.1.1 TRANSFORMER SUBSTATION

Figure 3.2 Transformer substation

They are known as transformer substations as because transformer is the main component employed to change the voltage level, depending upon the purposed served transformer substations may be classified into:

3.1.1.1.1 STEP UP SUBSTATION

The generation voltage is steeped up to high voltage to affect economy in transmission of electric power. These are generally located in the power houses and are of outdoor type.

3.1.1.1.2 PRIMARY GRID SUBSTATION

Here, electric power is received by primary substation which reduces the voltage level to 33KV for secondary transmission. The primary grid substation is generally of outdoor type.

3.1.1.1.3 SECONDARY SUBSTATIONS

At a secondary substation, the voltage is further steeped down to 11KV. The 11KV lines runs along the important road of the city. The secondary substations are also of outdoor type.

3.1.1.1.4 DISTRIBUTION SUBSTATION

These substations are located near the consumer’s localities and step down to 400V, 3-phase, 4-wire for supplying to the consumers. The voltage between any two phases is 400V and between phase and neutral it is 230V.

3.2 SUBSTATION CHARACTERISTICS:

- Each circuit is protected by its own circuit breaker and hence plant outage does not necessarily result in loss of supply.

- A fault on the feeder or transformer circuit breaker causes loss of the transformer and feeder circuit, one of which may be restored after isolating the faulty circuit breaker.
- A fault on the bus section circuit breaker causes complete shutdown of the substation. All circuits may be restored after isolating the faulty circuit breaker.
- Maintenance of a feeder or transformer circuit breaker involves loss of the circuit.
- Introduction of bypass isolators between bus bar and circuit isolator allows circuit breaker maintenance facilities without loss of that circuit.

3.3 STEPS IN DESIGNING SUBSTATION:

The First Step in designing a Substation is to design an Earthing and Bonding System**.**

3.3.1 Earthing and Bonding:

The function of an earthing and bonding system is to provide an earthing system connection to which transformer neutrals or earthing impedances may be connected in order to pass the maximum fault current. The earthing system also ensures that no thermal or mechanical damage occurs on the equipment within the substation, thereby resulting in safety to operation and maintenance personnel. The earthing system also guarantees equipotent bonding such that there are no dangerous potential gradients developed in the substation.
In designing the substation, three voltages have to be considered these are:

3.3.1.1 Touch Voltage:

This is the difference in potential between the surface potential and the potential at earthed equipment whilst a man is standing and touching the earthed structure.

3.3.1.2 Step Voltage:

This is the potential difference developed when a man bridges a distance of 1m with his feet while not touching any other earthed equipment.

3.3.1.3 Mesh Voltage:

This is the maximum touch voltage that is developed in the mesh of the earthing grid.

3.3.2 Substation Earthing Calculation Methodology

Calculations for earth impedances, touch and step potentials are based on site measurements of ground resistivity and system fault levels. A grid layout with particular conductors is then analyzed to determine the effective substation earthing resistance, from which the earthing voltage is calculated.

In practice, it is normal to take the highest fault level for substation earth grid calculation purposes. Additionally, it is necessary to ensure a sufficient margin such that expansion of the system is catered for.

To determine the earth resistivity, probe tests are carried out on the site. These tests are best performed in dry weather such that conservative resistivity readings are obtained.

3.3.3 Earthing Materials

3.3.3.4 Conductors:

Bare copper conductor is usually used for the substation earthing grid. The copper bars themselves usually have a cross-sectional area of 95 square millimeters, and they are laid at a shallow depth of 0.25-0.5m, in 3-7m squares. In addition to the buried potential earth grid, a separate above ground earthing ring is usually provided, to which all metallic substation plant is bonded.

3.3.3.4 Connections:

Connections to the grid and other earthing joints should not be soldered because the heat generated during fault conditions could cause a soldered joint to fail. Joints are usually bolted.

3.3.3.5 Earthing Rods:

The earthing grid must be supplemented by earthing rods to assist in the dissipation of earth fault currents and further reduce the overall substation earthing resistance. These rods are usually made of solid copper, or copper clad steel.

3.3.4 Switchyard Fence Earthing:

The switchyard fence earthing practices are possible and are used by different utilities. These are:

- Extend the substation earth grid 0.5m-1.5m beyond the fence perimeter. The fence is then bonded to the grid at regular intervals.
- Place the fence beyond the perimeter of the switchyard earthing grid and bond the fence to its own earthing rod system. This earthing rod system is not coupled to the main substation earthing grid.

3.4 CONDUCTORS USED IN SUBSTATION DESIGN:

An ideal conductor should fulfill the following requirements:

- Should be capable of carrying the specified load currents and short time currents.
- Should be able to withstand forces on it due to its situation. These forces comprise self weight, and weight of other conductors and equipment, short circuit forces and atmospheric forces such as wind and ice loading.
- Should be corona free at rated voltage.
- Should have the minimum number of joints.
- Should need the minimum number of supporting insulators.
- Should be economical.

The most suitable material for the conductor system is copper or aluminums. Steel may be used but has limitations of poor conductivity and high susceptibility to corrosion.

In an effort to make the conductor ideal, three different types have been utilized, and these include: Flat surfaced Conductors, Stranded Conductors, and Tubular Conductors

3.5Overhead Line Terminations

Two methods are used to terminate overhead lines at a substation.

3.5.1 Tensioning conductors to substation structures or buildings

3.5.2 Tensioning conductors to ground winches.

The choice is influenced by the height of towers and the proximity to the substation.The following clearances should be observed:

VOLTAGE LEVEL	MINIMUM GROUND CLEARANCE
less than 11kV	6.1m
11kV - 20kV	6.4m
20kV - 30kV	6.7m
greater than 30kV	7.0m

Table 1 Clearance in accordance with voltage value

4. BUSBARS

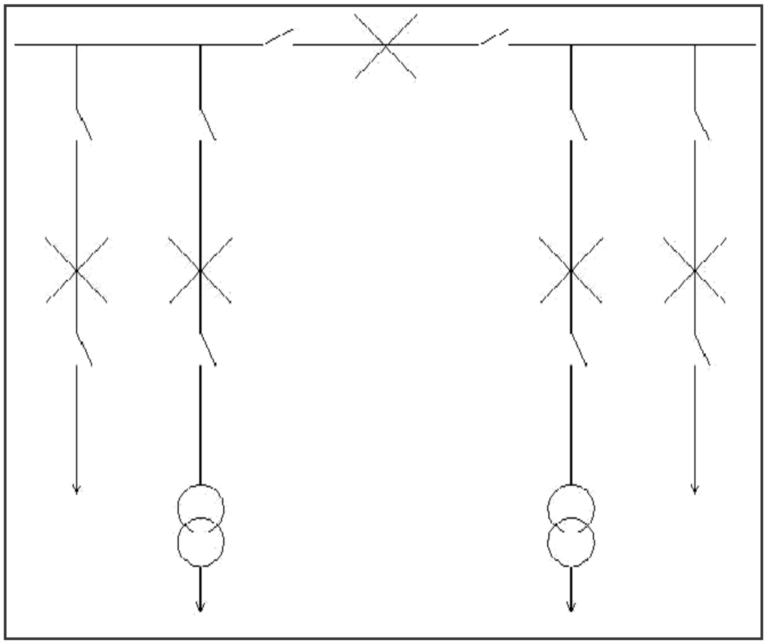

Figure 4.1 Typical representation of bus bars

When numbers of generators or feeders operating at the same voltage have to be directly connected electrically, bus bar is used as the common electrical component. Bus bars are made up of copper or aluminum rods operate at constant voltage. For 33KV, 11KV and 66KV system the size of rod is 42mm/35mm where 42mm is external diameter and 32mm is internal diameter of rod. The following are the important bus bars arrangements used at substations:

- Single bus bar system
- Single bus bar system with section sectionalization.
- Duplicate bus bar system

In large stations it is important that break downs and maintenance should interfere as little as possible with continuity of supply to achieve this, duplicate bus bar system is used. Such a system consists of two bus bars, a main bus bar and a spare bus bar with the help of bus coupler, which consist of the circuit breaker and isolator.

In substations, it is often desired to disconnect a part of the system for general maintenance and repairs. An isolating switch or isolator accomplishes this. Isolator operates under no load condition. It does not have any specified current breaking capacity or current making capacity. In some cases isolators are used to breaking charging currents or transmission lines.

While opening a circuit, the circuit breaker is opened first then isolator while closing a circuit the isolator is closed first, then circuit breakers. Isolators are necessary on supply side of circuit breakers, in order to ensure isolation of the circuit breaker from live parts for the purpose of maintenance.

A transfer isolator is used to transfer main supply from main bus to transfer bus by using bus coupler (combination of a circuit breaker with two isolators), if repairing or maintenance of any section is required.

5. INSULATORS

The insulator serves two purposes. They support the conductors (bus bar) and confine the current to the conductors. The most common used material for the manufacture of insulator is porcelain. There are several types of insulators (e.g. pin type, suspension type, post insulator etc.) and their use in substation will depend upon the service requirement. For example, post insulator is used for bus bars. A post insulator consists of a porcelain body, cast iron cap and flanged cast iron base. The hole in the cap is threaded so that bus bars can be directly bolted to the cap.

Figure 5.1 Insulators used in substations

With the advantage of power system, the lines and other equipment operate at very high voltage and carry high current.

The arrangements of switching along with switches cannot serve the desired function of switchgear in such high capacity circuits. This necessitates employing a more dependable means of control such as is obtain by the use of the circuit breakers. A circuit breaker can make or break a circuit either manually or automatically under all condition as no load, full load and short circuit condition.

A circuit breaker essentially consists of fixed and moving contacts. These contacts can be opened manually or by remote control whenever desired. When a fault occurs on any part of the system, the trip coils of breaker get energized and the moving contacts are pulled apart by some mechanism, thus opening the circuit.

When contacts of a circuit breaker are separated, an arc is struck; the current is thus able to continue. The production of arcs are not only delays the current interruption, but is also generates the heat. Therefore, the main problem is to distinguish the arc within the shortest possible time so that it may not reach a dangerous value.

The general way of classification is on the basis of the medium used for arc extinction.

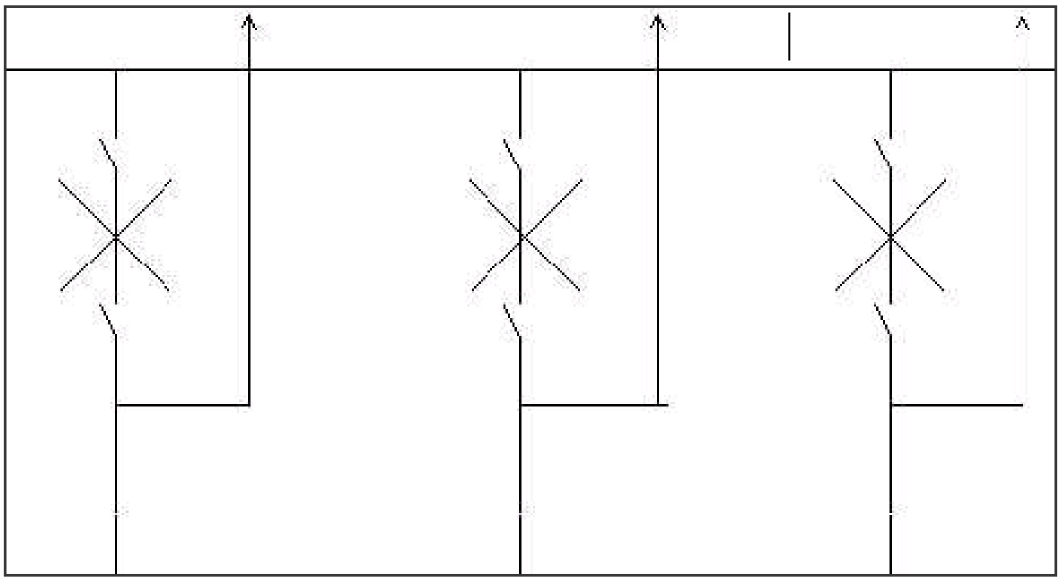

Figure 5.2 Circuit breaker arrangements

5.1. Circuit breakers

They can be classified into:

5.1.1 Oil circuit breaker

5.1.2 Air-blast circuit breaker

5.1.3 Sulfur hexafluoride circuit breaker (SF_6)

5.1.4 Vacuum circuit breakers

Note: SF_6 and Vacuum circuit breaker are being used in 33KV distribution substation.

5.2 Oil Circuit Breaker

Figure 5.3 Oil circuit breaker

A high-voltage circuit breaker in which the arc is drawn in oil to dissipate the heat and extinguish the arc; the intense heat of the arc decomposes the oil, generating a gas whose high pressure produces a flow of fresh fluid through the arc that furnishes the necessary insulation to prevent a restrike of the arc.

The arc is then extinguished, both because of its elongation upon parting of contacts and because of intensive cooling by the gases and oil vapor.

5.3 Air blast circuit breaker

Fast operations, suitability for repeated operation, auto reclosure, unit type multi break constructions, simple assembly, modest maintenance are some of the main features of air blast circuit breakers. A compressors plant necessary to maintain high air pressure in the air receiver. The air blast circuit breakers are especially suitable for railways and arc furnaces, where the breaker operates repeatedly. Air blast circuit breakers is used for interconnected lines and important lines where rapid operation is desired.

Figure 5.4 Air blast circuit breaker

High pressure air at a pressure between 20 to 30 kg/ cm2 stored in the air reservoir. Air is taken from the compressed air system. Three hollow insulator columns are mounted on the reservoir with valves at their basis. The double arc extinguished chambers are mounted on the top of the hollow insulator chambers. The current carrying parts connect the three arc extinction chambers to each other in series and the pole to the neighboring equipment. Since there exists a very high voltage between the conductor and the air reservoir, the entire arc extinction chambers assembly is mounted on insulators.

5.4 SF_6 CIRCUIT BREAKER:

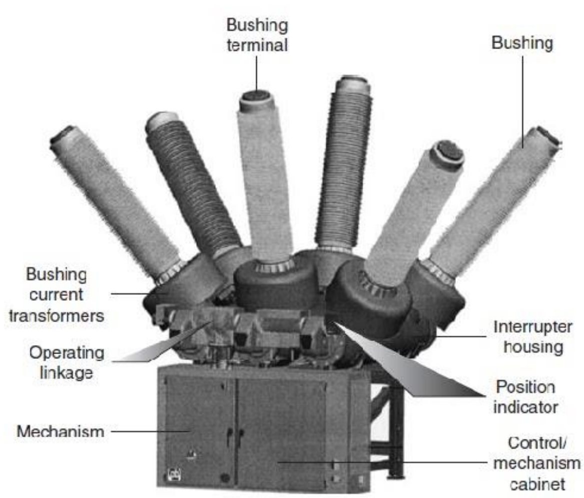

Figure 5.5 SF_6 Circuit breaker

In such circuit breaker, sulfur hexafluoride (SF_6) gas is used as the arc quenching medium. The SF_6 is an electronegative gas and has a strong tendency to absorb free electrons. The SF_6 circuit breaker have been found to a very effective for high power and high voltage service. SF_6 circuit breakers have been developed for voltage 115 KV to 230 KV, power rating 10 MVA.

It consists of fixed and moving contacts. It has chamber, contains SF_6 gas. When the contacts are opened, the mechanism permits a high pressure SF_6 gas from reservoir to flow towards the arc interruption chamber. The moving contact permits the SF_6 gas to let through these holes.

5.5 Vacuum Circuit Breaker

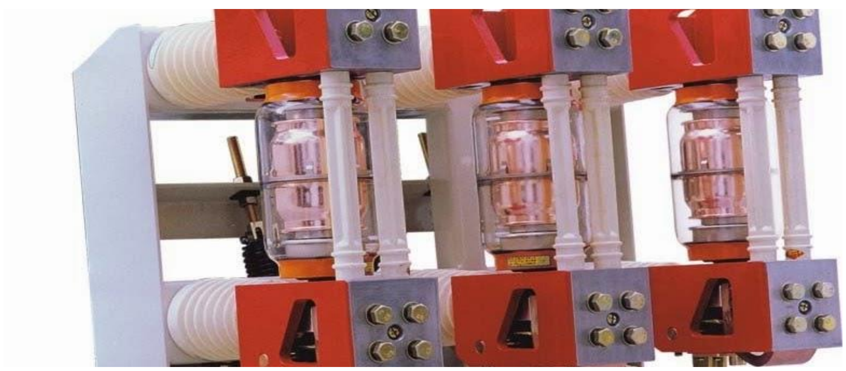

Figure 5.6 Vacuum circuit breaker

Vacuum circuit breakers are circuit breakers which are used to protect medium and high voltage circuits from dangerous electrical situations. Like other types of circuit breakers, vacuum circuit breakers literally break the circuit so that energy cannot continue flowing through it, thereby preventing fires, power surges, and other problems which may emerge. These devices have been utilized since the 1920s, and several companies have introduced refinements to make them even safer and more effective.

6. METERING AND INDICATION EQUIPMENT

6.1 RELAY:

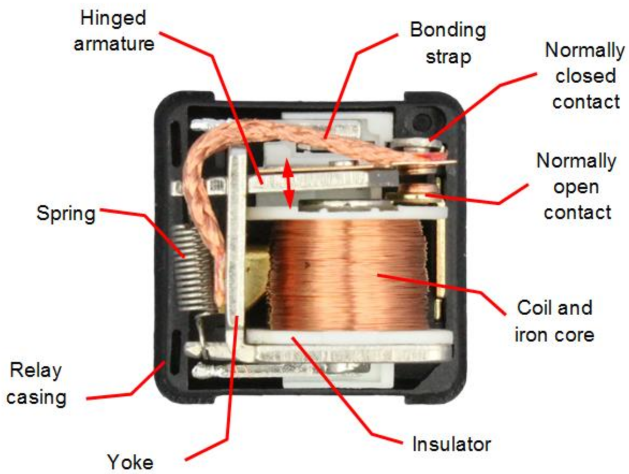

Figure 6.1 Relay

In a power system it is inevitable that immediately or later some failure does occur somewhere in the system. When a failure occurs on any part of the system, it must be quickly detected and disconnected from the system. Rapid disconnection of faulted apparatus limits the amount of damage to it and prevents the effects of fault from spreading into the system. For high voltage circuits relays are employed to serve the desired function of automatic protective gear. The relays detect the fault and supply the information to the circuit breaker.

The electrical quantities which may change under fault condition are voltage, frequency, current, phase angle. When a short circuit occurs at any point on the transmission line the current flowing in the line increases to the enormous value.This result in a heavy current flow through the relay coil, causing the relay to operate by closing its contacts. This in turn closes the trip circuit of the breaker making the circuit breaker open and isolating the faulty section from the rest of the system. In this way, the relay ensures the safety of the circuit equipment from the damage and normal working of the healthy portion of the system. Basically relay work on the following two main operating principles:

6.1.1 Electromagnetic attraction relay

6.1.2 Electromagnetic induction relay

6.2 Relays used in control panel of the substation:

6.2.1DIFFERENTIAL RELAY:

Figure 6.2 Differential Relay

A differential relay is one that operates when vector difference of the two or more electrical quantities exceeds a predetermined value. If this differential quantity is equal or greater than the pickup value, the relay will operate and open the circuit breaker to isolate the faulty section.

6.2.2 OVER CURRENT RELAY:

Figure 6.3 Over current Relay

This type of relay works when current in the circuit exceeds the predetermined value. The actuating source is the current in the circuit supplied to the relay from a current transformer. These relay are used on A.C. circuit only and can operate for fault flow in the either direction. This relay operates when phase to phase fault occurs.

6.2.3 DIRECTIONAL RELAY:

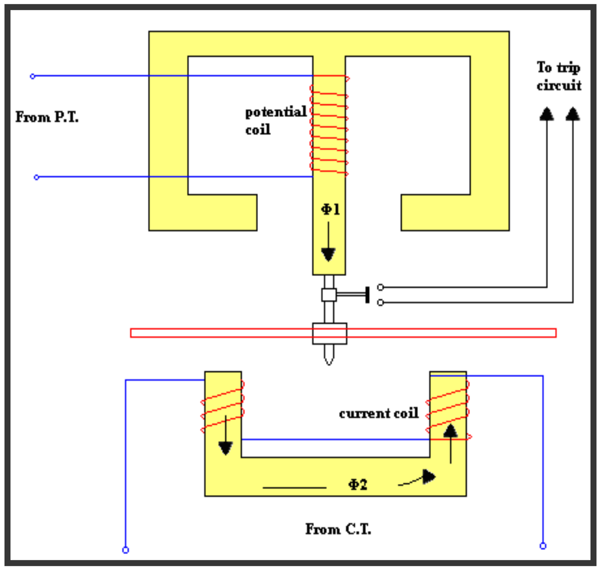

Figure6.4 Directional Relay

This relay operates during earth faults. If one phase touch the earth due to any fault. A **directional power relay** is so designed that it obtains its operating torque by the interaction of magnetic field derived from both voltage and current source of the circuit it protects. The direction of torque depends upon the current relative to voltage.

6.2.4 TRIPPING RELAY:

Figure 6.5 Tripping Relay

This type of relay is in the conjunction with main relay. When main relay sense any fault in the system, it immediately operates the trip relay to disconnect the faulty section from the section

6.2.5 AUXILIARY RELAY:

Figure 6.6 Auxiliary Relay

An auxiliary relay is used to indicate the fault by glowing bulb alert the employee.

6.3 ELECTRICITY METERS:

An **electricity meter**, **electric meter**, **electrical meter**, or **energy meter** is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device.

Electric utilities use electric meters installed at customers' premises to measure electric energy delivered to their customers for billing purposes. They are typically calibrated in billing units, the most common one being the kilowatt hour [*kWh*]. They are usually read once each billing period.

7.3.1 Types of meters:

7.3.1.1 ELECTROMECHANICAL METERS:

The electromechanical induction meter operates by counting the revolutions of a non-magnetic, but electrically conductive, metal disc which is made to rotate at a speed proportional to the power passing through the meter. The number of revolutions is thus proportional to the energy usage. The voltage coil consumes a small and relatively constant amount of power which is not registered on the meter. The current coil similarly consumes a small amount of power in proportion to the square of the current flowing through it which is registered on the meter.

The amount of energy represented by one revolution of the disc is denoted by the symbol Kh which is given in units of watt-hours per revolution. Using the value of Kh one can determine their power consumption at any given time by timing the disc with a stopwatch.

$$P = \frac{3600 \cdot Kh}{t}$$

Figure 6.7 Electromechanical meter

7.3.1.2 ELECTRONIC METERS:

Electronic meters display the energy used on an LCD or LED display, and some can also transmit readings to remote places. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as instantaneous and maximum rate of usage demands, voltages, power factor and reactive power used etc. They can also support time-of-day billing, for example, recording the amount of energy used during on-peak and off-peak hours.

As in the block diagram, the meter has a power supply, a metering engine, a processing and communication engine (i.e. a microcontroller), and other add-on modules such as RTC, LCD, communication ports/modules and so on.

The metering engine is given the voltage and current inputs and has a voltage reference, samplers and quantisers followed by an ADC section to yield the digitised equivalents of all the inputs. These inputs are then processed using a digital signal processor to calculate the various metering parameters.

Figure 6.8 Electronic meters

7. MISCELLANOUS EQUIPMENT

7.1 CAPACITOR BANK:

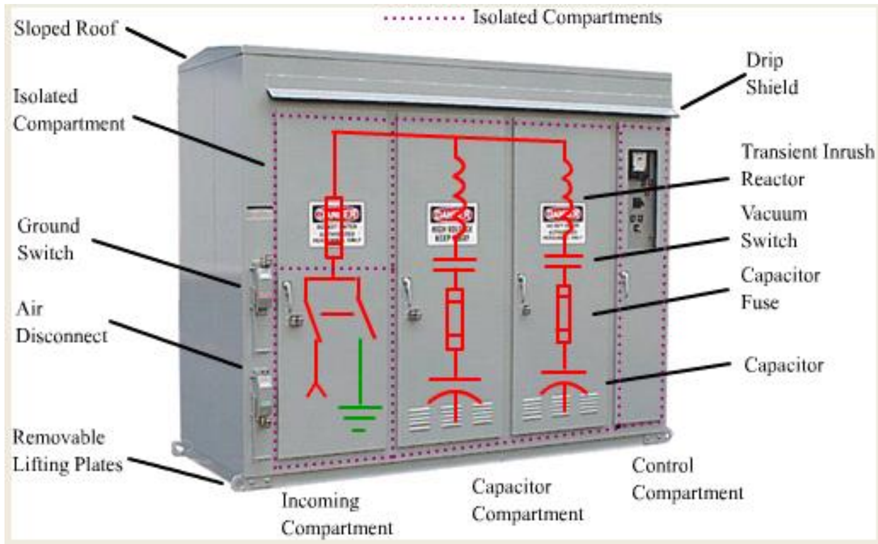

Figure 7.1 Capacitor bank

The load on the power system is varying being high during morning and evening which increases the magnetization current. This result in the decreased power factor. The low power factor is mainly due to the fact most of the power loads are inductive and therefore take lagging currents. The low power factor is highly undesirable as it causes increases in current, resulting in additional losses. So in order to ensure most favorable conditions for a supply system from engineering and economical stand point it is important to have power factor as close to unity as possible. In order to improve the power factor come device taking leading power should be connected in parallel with the load. One of the such device can be **capacitor bank**. The capacitor draws a leading current and partly or completely neutralize the lagging reactive component of load current.

Capacitor bank accomplishes following operations:

- Supply reactive power
- Increases terminal voltage
- Improve power factor

7.2 FUSE:

Figure 7.2 Substation Fuse

A fuse is a short piece of wire or thin strip which melts when excessive current through it for sufficient time. It is inserted in series with the circuit under normal operating conditions; the fuse element is at a nature below its melting point. Therefore it carries the normal load current overheating. It is worthwhile to note that a fuse performs both detection and interruption functions.

7.3 BUS COUPLER:

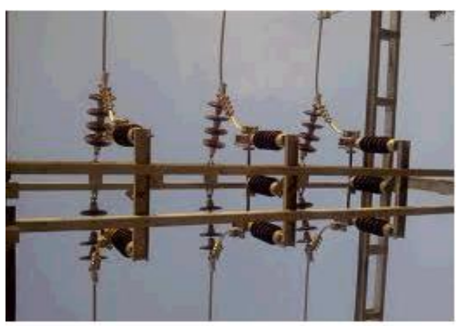

Figure 7.3 bus coupler

The bus coupler consists of circuit breaker and isolator. Each generator and feeder may be connected to either main bus bar or spar bus bar with the help of bus coupler. Repairing, maintenance and testing of feeder circuit or other section can be done by putting them on spar bus bar, thus keeping the main bus bar undisturbed.

8. PROTECTION OF SUBSTATION

8.1 Transformer protection:

Transformers are totally enclosed static devices and generally oil immersed. Therefore chances of fault occurring on them are very easy rare, however the consequences of even a rare fault may be very serious unless the transformer is quickly disconnected from the system. This provides adequate automatic protection for transformers against possible faults.

8.2 Conservator and Breather:

When the oil expands or contacts by the change in the temperature, the oil level goes either up or down in main tank. A conservator is used to maintain the oil level up to predetermined value in the transformer main tank by placing it above the level of the top of the tank.

Breather is connected to conservator tank for the purpose of extracting moisture as it spoils the insulating properties of the oil. During the contraction and expansion of oil air is drawn in or out through breather silica gel crystals impregnated with cobalt chloride. Silica gel is checked regularly and dried and replaced when necessary.

Figure 8.1 Conservator and breather

8.3 Marshalling box:

It has two meter which indicate the temperature of the oil and winding of main tank. If temperature of oil or winding exceeds than specified value, relay operates to sound an alarm. If there is further increase in temperature then relay completes the trip circuit to open the circuit breaker controlling the transformer.

8.4 Transformer cooling:

When the transformer is in operation heat is generated due to iron losses the removal of heat is called cooling.

There are several **types of cooling methods**, they are as follows:

8.4.1 Air natural cooling:

In a dry type of self cooled transformers, the natural circulation of surrounding air is used for its cooling. This type of cooling is satisfactory for low voltage small transformers.

8.4.2 Air blast cooling:

It is similar to that of dry type self cooled transformers with to addition that continuous blast of filtered cool air is forced through the core and winding for better cooling. A fan produces the blast.

8.4.3 Oil natural cooling:

Medium and large rating have their winding and core immersed in oil, which act both as a cooling medium and an insulating medium. The heat produce in the cores and winding is passed to the oil becomes lighter and rises to the top and place is taken by cool oil from the bottom of the cooling tank.

8.4.4 Oil blast cooling:

In this type of cooling, forced air is directed over cooling elements of transformers immersed in oil.

8.4.5 Forced oil and forced air flow (OFB) cooling:

Oil is circulated from the top of the transformers tank to a cooling tank to a cooling plant. Oil is then returned to the bottom of the tank.

8.4.6 Forced oil and water (OWF) cooling:

In this type of cooling oil flow with water cooling of the oil in external water heat exchanger takes place. The water is circulated in cooling tubes in the heat exchanger.

8.5 Lightning arrester:

If lightning strikes the electrical system introduces thousands of kilovolts that may damage the transmission lines, and can also cause severe damage to transformers and other electrical or electronic devices. Lightning-produced extreme voltage spikes in incoming power lines can damage electrical home appliances or even produce death. So in order to protect from thunders lightning arresters are used.

A **lightning arrester** is a device used on electrical power systems and systems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrester, the current from the surge is diverted through the arrestor, in most cases to earth.

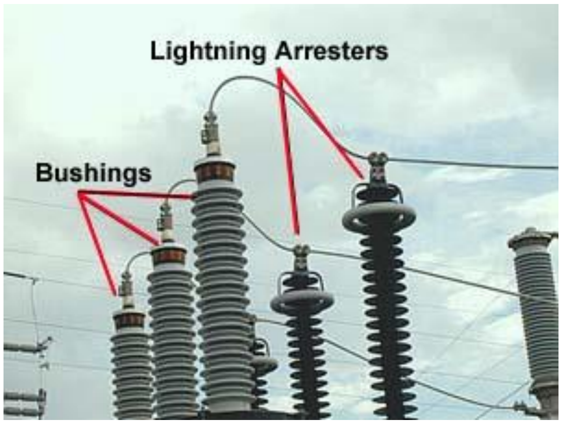

Figure 8.2 Lightning arresters

9. SUBSTATION AUTOMATION USING SCADA

9.1 Introduction:

Nowadays, computer control is one of the most cost effective solutions for improving reliability, optimum operation, intelligent control and protection of a power system network. Having advanced data collection capabilities, **SCADA system** plays a significant role in power system operation. Typically, at distribution side SCADA does more than simply collecting data by automating entire distribution network and facilitating remote monitoring, coordinate, control and operating distribution components just like in Smart Grid System.

Supervisory Control and Data Acquisition or simply **SCADA** is one of the solutions available for data acquisition, monitor and control systems covering large geographical areas. It refers to the combination of data acquisition and telemetry. In this system, measurements are made under field or process level in a plant by number of remote terminal units and then data are transferred to the SCADA central host computer so that more complete information can be provided remotely.

9.2 COMPONENTS OF TYPICAL SCADA SYSTEM:

The major components in SCADA system are:

9.2.1 Remote Terminal Units (RTUs):

A remote terminal unit (RTU) is a microprocessor-controlled electronic device which is responsible for properly converting remote station information to digital form for modem to transmit the data and also converts the received signals from master unit in order to control the process equipment through actuators and switchboxes.

9.2.2 Master Terminal Units (MTUs):

A central host servers or server is called Master Terminal Unit, sometimes it is also called as SCADA center. It communicates with several RTUs by performing reading and writing operations during scheduled scanning. In addition, it performs control, alarming, networking with other nodes, etc.

9.2.3 Communications System:

The communication network transfers data among central host computer servers and the field data interface devices & control units. The medium of transfer can be cable, radio, telephone, satellite, etc. or any combination of these.

9.2.4 Operator Workstations:

These are the computer terminals consisting of standard HMI (Human Machine Interface) software and are networked with a central host computer. These workstations are operator terminals that request and send the information to host client computer in order to monitor and control the remote field parameters.

9.3 AUTOMATION OF ELECTRICAL DISTRIBUTION SYSTEM:

SCADA improves the reliability of supply by reducing duration of outages and also gives the cost-effective operation of distribution system. Therefore, distribution SCADA supervises the entire electrical distribution system. The major functions of SCADA can be categorized into following types

9.3.1 Substation control

9.3.2 Feeder control

9.3.1 Substation control:

SCADA system continuously monitors the status of various equipments in substation and accordingly sends control signals to the remote control equipments. Also, it collects the historical data of the substation and generates the alarms in the event of electrical accidents or faults. The central control or master unit receives and logs the information, displays on HMI and generate the control actions based on received data. This central controller also responsible for generating trend analysis, centralized alarming, and reporting.

9.3.2 Feeder control:

In this system, **SCADA architecture** continuously checks the faults and their location by using wireless fault detector units deployed at various feeding stations. In addition, it facilitates the remote circuit switching and historical data collection of feeder parameters and their status. In the above typical ***SCADA* network**, different feeders are automated with modular and integrated devices in order to decrease the number and duration of outages. Underground and overhead fault detection devices provide accurate information about transient and permanent faults so that at the remote side preventive and corrective measures can be performed in order to reduce the fault repeatability.

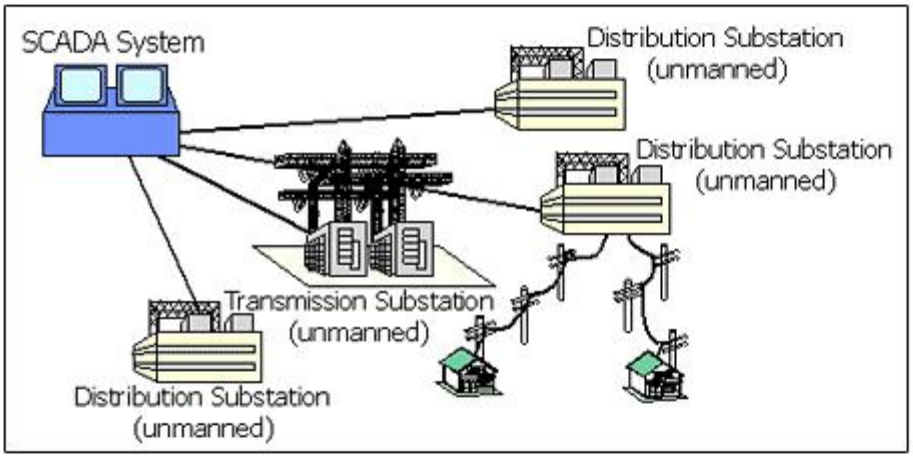

Figure 8.2 SCADA technology

9.4 ADVANTAGES OF IMPLEMENTING SCADA FOR ELECTRICAL DISTRIBUTION SYSTEM:

- Due to timely recognition of faults, equipment damage can be avoided
- Continuous monitoring and control of distribution network is performed from remote locations
- Saves labor cost by eliminating manual operation of distribution equipment
- Reduce the outage time by a system-wide monitoring and generating alarms so as to address problems quickly
- Improves the continuity of service by restoring service after the occurrence of faults (temporary)
- Automatically improves the voltage profile by power factor correction and VAR control
- Facilitates the view of historian data in various ways
- Reduces the labor cost by reducing the staff required for meter reading

10. 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 of electricity is done. We too came to know about the various parts of the Substation system.

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