A STUDY ON DISTRIBUTION SYSTEM AND EQUIPMENT OF NARAYANGANJ PALLI BIDYUT SAMITI 1, 33/11 KV SUB-STATION

This report presented in partial contentment of the requirements for the Degree of Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this project and thesis entitled **A STUDY ON DISTRIBUTION SYSTEM AND EQUIPMENTS OF NARAYANGANJ PALLI BIDYUT SAMITI 1, 33/11 KV SUB-STATION is** done by the following students through my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in fractional fulfillment of the wants for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 29 September 2018.

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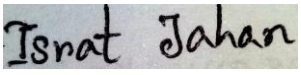

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The project and thesis entitled **"A STUDY ON DISTRIBUTION SYSTEM, PROTECTION AND EQUIPMENTS OF JESSORE 33/11KV GRID SUB-STATION'** "submitted by **Shariful Islam** ID No: 143-33-2254 and **Pulak Mandal**, ID No: 143-33-2092 Session: Fall 2014 has been accepted as satisfactory in partial fulfillment of the wants for the degree of **Bachelor of Science in Electrical and Electronic Engineering**.

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Dedicated to

Our Parents

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LIST OF ABBREVIATIONS

ACB	Air-Blast Circuit Breaker
AVR	Automatic Voltage Regulator
CT	Current Transformer
OCR	Oil Circuit Re-closer
PFI	Power Factor Improvement
PT	Potential Transformer
VCB	Vacuum Circuit Breaker

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ABSTRACT

Narayanganj Palli Bidyut Samity-1 service area consists of Rupgonj (Tarabo Pourshova), Bandar and Sonargaon Thana. The objective of the PBS is to provide electric power and energy to each village positioned within its geographical service area for irrigation pumping, food processing, cottage industries and other small or big industries, commercial centers, health and social services and family homes. This objective is to be accomplished through the Area Coverage Rural Electrification (ACRE) concept by constructing, operating and maintaining lines up to 33 kv, extending lines from existing distribution system. Each potential customer within the PBS service area may become a member of the PBS, the membership being achieved by application and payment of minimal subscription fee. Providing electric power and energy to its user members at the lowest cost possible consistent with sound economy and good management is a prime requirement of the PBS.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Electricity is the power that drives the whole world. Now-a-days we cannot think even a moment without electricity. Without electricity the civilization will go back to the thousands of epochs. In every step of our modern life we are totally depend on electricity. From Narrayanganj PBS-1 we have gathered practical experience over equipment's protection and power distribution system. This electric power comes to us by three steps, these are:

- Generation
- Transmission
- Distribution

In our country Bangladesh Power Development Board (BPDB) is the mother of organization in electric power sector.

1.2 Company Profile

Company Name: Narrayanganj Palli Bidyut Samity-1, chengain, Sonargaon

Head office: Nikunja-2, Khilkhet, Dhaka-1229

Date of start: 1st July 2005

Built line: 2165.243 km

Connected subscriber number: 243090

System loss: 5.88%

Power Purchase: Money / kWh (This Month) 835,96,36,691.00 / 143,11,93,845

Electricity sales money / kWh (this month) 911,61,98,669.00 / 11,08,18,813

1.3 Objective of the Internship

The first objective is to complete EEE400 course which is an essential part of completing Bachelor in EEE at DIU. Before doing this internship we had only theoretical knowledge over these topics but on completion of internship in Narrayanganj PBS-1 we have earned practical knowledge also. The following list summarizes our internship goals.

- Understanding official management
- Acquiring practical knowledge about power Distribution System.
- Acquiring practical knowledge about various protection.
- Acquiring knowledge about safety.

1.4 Scope

This report is based on the internship program where we reviewed the basic process of power distribution and substation of Narrayanganj PBS-1. It also contains descriptions of various electrical equipment's which are used to distribute power in Narrayanganj PBS-1. The report contains other relevant information about the Narrayanganj PBS-1 which we observed during the internship program.

1.5 Methodology:

Both primary and secondary data are collected for this report. This report is concentrated of 33/11 KV sub-station of Narrayanganj PBS-1, Chengain, Sonargaon, Narrayanganj.

- **Primary information:** The information is gathered by personal observation and working with the sub-station engineers at Narrayanganj PBS-1.
- **Secondary information:** The company website and various single line diagrams provided by the engineers whom we worked with.

1.6 Vision and Mission

1.6.1 Vision

The Rural Electrification Board of Bangladesh has been providing facility to rural member customers for over 40 years. Continued support from the Govt. of Bangladesh, the contributor community, consulting partners, and member consumers will help this program continue to enlarge, providing the gift of electricity to millions more Bangladeshi households, businesses, and industries.

1.6.2 Mission

- To supply excellence electricity at reasonable and affordable prices with outstanding professional services.
- To take the people of the country into electrical service by 2021.

CHAPTER-2

ELECTRIC SUB-STATION

2.1 Sub-Station

The assembly of apparatus utilized to change some characteristic for example voltage, a.c to d.c, frequency, power factor etc. of electric supply is named a sub-station. The principle of sub-station is to take power at high voltages from the transmission or sub-transmission level, reduce its voltage and supply it to a number of primary voltage feeders for distribution area.

Sub-stations are essential part of power system. The continuity of supply depends to a substantial range upon the successful operation of sub-stations. It performs operational and emergency switch and protection responsibilities at both the transmission and feeder lines.

2.2 Classification of Sub-Station

There are the two most important ways of classifying sub-stations are according to Service requirement and Constructional features.

2.2.1 According to Service Requirement

A sub-station can be called upon to change voltage level or recover factor or convert ac power into dc power etc. According to the service requirement, sub-station may be classified into:

- **Transformer Sub-Station:** Those sub-station that change the voltage level of electric supply are known as transformer sub-station.

- **Switching Sub-Station:** A switching sub-station is a sub-stations that doesn't contain transformer and works only at a single voltage level. Switching sub-stations are sometimes used as collector and distribution station.
- **Power Factor Correction Sub-Station**: This sub-stations that improves the power factor of the system are known as power factor correction sub-station.
- **Changer Sub-Station:** This sub-stations that change the supply frequency are named frequency changer sub-station.
- **Converting Sub-Station:** Those sub-stations that change the alternating current into direct current are named converting sub-station.
- **Industrial Sub-Station:** This sub-stations that supply power to individual industrial concern are named industrial sub-station.

2.2.2 According to Constructional Features

- **Indoor Sub-Station:** For voltage up to 11kv, the equipment of the sub-station is installed indoor as a result of economic concern.
- **Outdoor Sub-Station:** For voltage beyond 33kv, equipment is inflexible installed outdoor. It's just because for such voltages, the clearness in the middle of conductors and the space required for switches, circuit breakers and the other equipment come to be so great.
- **Underground Sub-Station:** In densely populated areas, the space available for equipment and construction is limited and the cost land is high. This type of sub-station is made in underground.
- **Pole-mounted sub-stations:** This is an outdoor sub-station with equipment connected overhead on H-pole or 4-pole configuration. It's the most cost effective form of sub-station for voltages not exceeding 11 kV.

2.3 Components of Sub-Station

- **Incoming Circuit:** Lightning arrestor, Overhead earth wire, Isolator, Fuses, Earth switch etc. incoming lines.
- **Transformer:** Transformer is a static piece of electric equipment which transformer ac electric powers from one circuit to another by step-up or step-down the voltage at the same frequency.
- **Low Voltage Switch-gear Panel:** Bus-bars, Isolator, Fuses, Magnetic contractors, Air break switch, Various types of no-fuse breaker, Indicating instruments, Various protective relays etc. and PFI capacitor.
- **Outgoing Lines:** To another switchgear & protective device suitable for the loads taking electricity.

2.4 Comparison Between Outdoor & Indoor Sub-Station

Table 2.1: Comparison between outdoor and indoor sub-station

Sl. No	Particular	Outdoor Sub-Station	Indoor Sub-Staion
1.	Space needed	More	Less
2.	Erection time	Less	More
3.	Capital cost	Low	High
4.	Fault location	Easier	Difficult
5.	Operation	Difficult	Easier

CHAPTER 3

EQUIPMENT OF NARRAYANBGANJ PBS-1 SUB-STATION

The equipment needed for a transformer sub-station depends upon the sort of sub-station, service requisite and therefore the degree of protection wanted. Depend upon the type of sub-station in **Narrayanganj PBS-1** it required various type of equipment. Whatever, more commonly equipment are given below: **Bus Bar, Isolator, Isolator, Current Transformer (CT), Potential Transformer (PT), Power Transformer, Circuit Breaker, Lighting Arrester (LA), ACR, OCR, AVR and Relay etc.**

3.1 Bus-Bar

While a number of lines working ate similar voltage have to be directly istalled electrically, bus-bars are used as the regular electrical component. Normally bus-bars utilized in the sub-stations are of copper or aluminum and they are ultimately round and solid. The most ordinarily used bus-bar arrangements in a sub-station are:

- Single bus-bar arrangement
- Single bus-bar system with sectionalized
- Double bus-bar arrangement

3.2 Insulators

The insulators serve two determinations. Insulators support the conductors and restrict the current to the conductors. The most ordinarily used substantial for the manufacture of insulators is porcelain. There are a number of insulators such as pin type, suspension type, disk type insulator, post insulator etc. and there uses in the sub-station will depend upon the service condition. For an example, post insulator is used for bus-bars.

3.3 Isolator

In a sub-station, it's typically desired to disconnect a part of the system for common maintenance and repairs. This is skilled through an isolating switch or isolator. On the other hand, An isolator is a mechanical switching device which is in the open position, and permits for isolation of the input and output of a device. Isolator switches are worked only the lines within that they're connected carry no current.

3.3.1 Types of Isolator:

There are different types of isolators, such as:

- **Double Break Isolator:** The rotating isolator is a 3-pole double break isolator, that's a rotating type team activated and has been worked and designed for any sort of demanding outdoor application.
- **Single Break Isolator**: It's normally knife switch that's designed to open a circuit under on load. The main purpose of using isolator is to isolate one percentage of circuit from the other.

Based on the position of the isolator, it can be classified in three ways:

- Line Isolator: Isolator an incoming or outgoing line from the bus.
- Bus Isolator: Isolator two section of the bus.
- Transformer Isolator: Isolate the transformer from the bus or the lines.

- **Pantograph Type Isolator:** The pantograph isolator installs on the support insulator and transfer on the movement of the operating rod insulator to the arms of the pantograph isolator.

3.3.2 Use of Isolator

An Isolator switch has no protection capability and is used to bodily disconnect any circuit while repairing etc. are done. In a sub-station, switchyard is an isolator switch would be used to bodily disconnect some incoming high voltage lines to permit work on the transmission line to be performed.

3.3.3 Type of Isolator Which Use in Sub-Station

Generally, pantograph and HCB type isolators are used at 400 kV and 220 kV sub-station which operated by remote or manually. Double break type isolators are used at 33 kV sub-station.

3.3.4 Difference Between Isolator & Circuit Breaker

Table 3.1: Difference between isolator and circuit breaker

Isolator	Circuit Breaker
1. Isolator exists an off-load device	1. Circuit breaker exists an on-load device
2. Operate by manually	2. Operate by power

3.4 Current Transformer (CT)

A current transformer is essentially a step-up transformer that steps down the current to a known ratio. A current transformer in which the secondary current is proportional to the primary current and changes from it by an angle that's approximately zero. The primary of this transformer

contains one or more turns of heavy wire connected in series with line and the secondary contains a large number of turns of fine wire and gives for the measuring instruments.

The basic principle of the current transformer is that the similar as that of the power transformer. Similar the power transformer, the current transformer has a primary and a secondary winding also. When an alternating current flows over the primary winding, alternating magnetic flux is produced, which then convinces alternating current in the secondary winding.

3.5 Potential Transformer (PT)

It's basically a step down transformer and step down the voltage to a known ratio. The primary of this transformer contains a large number of turns of good wire connected through the line and the secondary winding contains a few turns and gives for measuring instruments and relays a voltage that could be identified fraction of the line voltage.

3.6 Rating of Potential Transformer

Table 3.2: Rating of potential transformer.

Type	**Potential Transformer (1,2)**	**Potential Transformer (3,4)**
Voltage rating	33/0.11 KV	11/0.11 KV
Code name	PT (HT)	PT (LT)

3.7 Power Transformer

The Power transformer is a one form of transformer, that's used to transfer electrical energy in any fragment of the electrical or electronic circuit in the middle of the generator and the distribution primary circuits. These are small power transformers, medium power transformers and big power transformers.

Figure 3.1: Power Transformer of Narayanganj PBS-1

3.7.1 Main Parts of Transformer:

According to construction transformer contains following parts:

- Main tank
- Laminated core
- Windings
- Oil temperature meter
- Transformer oil
- Tap changing switch
- Conservator

- Radiator
- Breather
- Bushing
- Buchholz Relay
- Pressure relief vent

3.7.1.1 Main Tank

It’s a main fragment of transformer. It’s steel ready box. Transformer core is positioned inside this tank. Windings and different useful devices are positioned inside this tank. It’s filled with insulating oil and also called mineral oil. It has usually cylindrical or cubical form depending on transformer structure. It is covered internally and externally with shade for safety point of view.

3.7.1.2 Laminated Core

Core is formed with laminated steel sheet in all kind of transformers to afford continuous magnetic path and moreover to afford minimum air gap. For this purposes, silicon augmented steel is utilized. Sometimes heat conduct is also used on steel to extend permeability of steel. The core isn’t designed to possess any currents flow by it. It’s though a conducting loop that skills a changing magnetic flux, it will therefore have small currents induced in it - these are named 'eddy currents'**.**

The core is laminated to reduce these to a lowest as they restrict with the proficient transfer of energy from the primary coil to the secondary one. The eddy currents cause energy to be lost from the transformer by means of they heat up the core - that means electrical energy is being unused as unwanted heat energy.

Laminated means that 'prepared of insulated layers of iron 'glued' together' instead of being in a single solid 'lump'. A laminated core includes a higher resistance than a non-laminated one with the same number of domains. It so doesn’t get such massive a currents persuaded in it.

3.7.1.3 Windings

In a single phase transformer, two winding transformer, two windings would be existent as shown. The one that is joined to the voltage source and generates the magnetic flux known as the primary winding, and the second winding named the secondary in which a voltage is convinced by means of mutual induction.

3.7.1.4 Oil Temperature Meter

It's used to measure temperature of oil. In a high power transformer, thermometer is additionally utilized inside windings that measure temperature of windings. Whenever temperature rise up to risky level, it triggers alarm signal. Dial type thermometers are generally utilized for triggering of alarms in abnormal situations. It gives reading openly by a device. When oil temperature rises to specific level, it gives indication to alarm circuit. Thermometer naturally positioned close to transformer name plate.

3.7.1.5 Transformer Oil

Transformer oil or insulating oil exists an oil that's constant at high temperatures and has glorious electrical insulating possessions. It's utilized in the oil-filled transformers, some forms of high-voltage capacitors, and some forms of high-voltage switches and circuit breakers. It's utilities are to insulate, conquer corona discharge and arcing, and to assist as a coolant. Transformer oil is most frequently based on mineral oil, however different constructions with better engineering or environmental possessions are rising in popularity.

3.7.1.6 Tap Changing Switch

Tap changing switch is used to regulate secondary voltage in case of low voltage in primary side of transformer. Tap changing switch are linked with high voltage side of transformer. Two forms of tap changing switches are utilized:

- **Off load switch**: It's used to alteration winding voltage ratio. As it name recommend off load tap changing switch castoff only in transformer off state.

- **On Load Switch:** On load switch can be utilized with on load transformer.

3.7.1.7 Conservator

It's a small tank that's used in high power transformers. It's attached overhead the main tank of transformer. It's cylinder-shaped. Main tank & conservator tank associated to every alternative by a pipe. Buchholz relay is cast-off in the middle of conservator tank and main tank in transformers having capability more than 1 MVA. Conservator tank have subsequent functions in transformer:

- It provides place for hot transformer oil to enlarge. It also provides oil in transformer when oil come to be cool.
- It moreover utilizes to decrease oxidation by reducing area of oil around air.

3.7.1.8 Radiator

Radiator is a bank of hollow pipe line that is used to transfer the thermal energy from one medium to another for the purpose of cooling. Some Bank are used at the power transformer for cooling the transformer oil along with reduces the winding temperature under loading condition. The radiators are connected to the transformer through the pipe line at upper and lower side of the transformer.

In 50KVA above transformers, radiators are cast-off with main tank of transformer for cooling persistence. Radiator creates cooling in transformer more operative. This process of cooling is known as **ONAN** (Oil Natural Air Natural).

In 26MVA and above transformers, cooling fans also are recycled on radiator. When temperature turn into greater than 75º, temperature oil gauge turns on cooling fans. This process of cooling is known as **ONAF** (Oil Natural Air Forced).

3.7.1.9 Breather

Breather is a device that is used for breathing of transformer. It means that air go in or out from transformer with the assistance of breather. Now the Question is to be why we'd breather in

transformer? Because while hot oil enlarges, air go out from transformer and while oil contracts after cooling, air go into in transformer. Breather one side is linked with conservator tank. A mirror tube is positioned inside breather. The mirror tube occupied with calcium chloride otherwise silica gel. When air arrives in transformer, this air contains wetness. Silica gel engross wetness and only permit dry air to go in in transformer. In this method breather with the help of silica get end wetness comprise air to pass into transformer & evade oxidation in transformer main tank. At the time silica gel color distinctions from blue to pink when absorbing specified amount of wetness from air. We can use again this silica gel when heating it.

3.7.1.10 Bushings

Bushings are recycled to take windings terminals out of tank and additionally usage for insulation. For examples porcelain, oil filled & capacitor form bushings. Arching horns are moreover associated with bushings to give shield from lightning. In above 34 KV transformer, fully wrapped condenser type bushings are recycled. In fewer than 25KV transformer pure bushings are used.

3.7.1.11 Buchholz Relay

Buchholz relay is a gas-actuated relay put in oil absorbed transformers for safety contrary to all sorts of faults. It's used to give an alarm in case of initial faults in the transformer and to disengage the transformer from the supply in the event of simple internal errors. It's typically fitted in the pipe attaching the conservator to the main tank. Buchholz relay gives protection for low oil level & high temperature.

3.7.1.12 Pressure Relief Vent

It's a curve type mirror pipe linked with main tank of transformer. It provides security to transformer from better pressure. Sometimes better pressure is settled inside a transformer because of breakdown of oil. It's essential part of high power transformer. Transformer can spurt without pressure relief vent also.

3.8 Types of Transformer

- Furnace transformer
- Welding transformer
- Regulating transformer
- Current & voltage transformer
- High frequency transformer
- Rectifier transformer
- Short circuit testing transformer

3.9 Test of Transformer Oil

Transformer oil, a form of insulating and cooling oil used in transformers and other electrical equipment, has to be tested periodically to make sure that it's still fit for purpose. This is because it tends to deteriorate over time. Dark down and cloudy color indicates the deterioration of the oil condition. Sample of the transformer oil is taken from the bottom of the tank. In testing voltage should be increased gradually. For testing of transformer cooling oil two methods are available. One is oil in the good form should withstand 45KV for one minute in a typical oil-testing cup with 4mm gap stuck between electrodes. Another is oil in good form should withstand 25KV for one minute in a typical oil-testing cup with 2.5mm stuck between electrodes.

Figure 3.2: Transformer Oil Test Machine of Narrayanganj PBS-1

3.10 Power Transformer Protection

Table 3.3: Power transformer protection.

Abnormal Condition	Protection	Remarks
Incipient fault under oil level resulting in breakdown of oil, fault between phase & between phase and earth.	1.Buchholz relay sounds alarm. 2.Rapid pressure valve.	Buchholz relay used for transformer of rating 500 KVA or directly above.
Large internal faults are phase to phase, phase to ground below oil level.	1.Buchholoz relay tips the circuit breaker.	Buchholz relay moreover slow & less sensitive. Buchholz relay for trip-changer too.

Saturation of magnetic circuit.	1.Over fluxing protection. 2.Over voltage protection.	For important generator transformer and feeder transformer.
Earth faults	1.Differential protection 2.Ground fault relay	For transformer of and above 5 MVA
Through faults	1.Graded time lag over current relay. 2.HRC fuse	1.Protection of distribution transformer. 2.Small distribution transformer up to 500 KVA.
Overloads	1.Thermal overloads relays 2.Temperature relays sound alarm.	Generally, temperature indicator are providing on the transformer increase is indicated on control board also. Fans started at certain temperature.
High voltage surges due to lighting, switching.	1.Horn gap. 2.Lighting arrester.	Not favored for important transformer. In addition to lighting arresters for incoming lines.

3.11 Circuit Breaker

Circuit breakers are usually positioned so that each transformer, bus bar, distribution line etc. can be fully separated from the respite of the system. These circuit breakers should have adequate capacity in order that they can carry temporarily the maximum short-circuit current that may flow through them, and then disturb this current. A circuit breaker may be a piece of equipment that can,

- Create or break a circuit either manually or by remote controller under standard form.
- Break a circuit automatically below fault form.
- Make a circuit either manually or by remote controller below fault form.

In Narrayanganj PBS-1 uses Vacuum Circuit Breaker. Working principle is descried below.

3.11.1 Vacuum Circuit Breaker

A breaker that's used vacuum as an arc destruction medium is named a vacuum circuit breaker. In the circuit breaker, the fixed & moving contact is bounded in an eternally wrapped vacuum interrupter. The arc is inexistent because the contacts are disconnected in high vacuum. It's generally utilized for medium voltage level ranging from 11 KV to 33 KV.

3.11.2 Working Principle of Vacuum Circuit Breaker

While the contacts of the breaker are unlocked in vacuum, an arc is formed between the contacts through the ionization of metal vapors of the contacts. However, the arc is rapidly quenched as a result of the metallic vapors, electrons and ions created throughout arc rapidly condense on the exteriors of the circuit breaker contacts, resulting in fast recovery of dielectric strength.

The concentration of vapor be governed by the current in the arcing. Because of the reducing mode of current wave their amount of discharge of vapor fall and after the current zero, the medium reclaims its dielectric strength providing vapor density about the contacts reduced. From this time, the arc doesn't restrike once more as a result of the metal vapor is rapidly removed from the contact zone.

Figure 3.3: VCB of Narayanganj PBS-1

3.12 Lightning Arrester

A lightning arrester is a device that's used on electric power systems and telecommunication systems to defend the insulation & conductors of the system since the harmful possessions of lightning.

3.12.1 Working Principle Lightning Arrester

The lightning arrester or surge diverter give protection in contradiction of such surges. The act of the lightning arrester or surge diverter is given below:

- Under normal action, the lightning arrester is off the line such it conducts no current to ground or gap is non-conducting.
- It shouldn't inducement any current throughout normal working situation such as it triggers over voltage must be above the normal or abnormal power frequency that may occur in the system.
- On the incident of overvoltage, the air insulation through the gap breaks down and an arc is formed, provided that a low resistance path for the surge to the earth.
- The power frequency current following the breakdown must be interjected when the transitory voltage has fall down the breakdown rate.

3.12.2 Calculation of Lightning Arrester Rating

Lighting arrestor are connected between Phase and Ground, while the system voltage is regarded in Phase to Phase voltage. An example for a 33 kV system the phase to phase voltage is 33 kV & phase to ground voltage is (33/√3) 19.05 kV.

3.13 ACR (Automatic Circuit Re-closer)

In electric power distribution, automatic circuit re-closer (ACR) is a class of switchgear that is planned for use on overhead electricity distribution networks to perceive and interrupt temporary errors. Moreover known as Re-closer or Auto re-closer, ACR is fundamentally high voltage rated circuit breakers with combined current and voltage sensors and a protection relay, augmented for usage as an overhead network distribution defense skill. In Narrayanganj PBS-1 utilizes ACR in Sub-Station.

Figure 3.4: ACR of Narrayanganj PBS-1 Sub-Station

3.14 OCR (Oil Circuit Re-closer)

In electric power distribution, oil circuit re-closer (OCR) is a class of switchgear that is designed for usage on overhead electricity distribution networks to perceive and interrupt temporary errors.

3.14.1 Classification of Oil Circuit Re-closer (OCR)

- Single phase
- Three phase

Control by Oil and Hydraulic.

3.14.2 Use of Oil Circuit Re-closer (OCR)

Oil circuit is a protection device which is used to protect the device and other instruments of any kinds of fault.

3.15 Automatic Voltage Regulator (AVR)

A voltage regulator is a device which control the voltage in lower level.

3.15.1 Main Parts of Automatic Voltage Regulator

- Rounding terminal
- Regulator base
- Phase valve
- Name plate
- Control box
- Control box grounding
- Oil level indicator
- Bushing
- Terminal Box
- polymeric surge arrester
- Eye for core & coil lifting
- Cover fixing

3.15.2 Description & Operation of AVR

Voltage regulators are ordinarily used to regulate the voltage on a main AC power line. This form of regulator working with the transformer which has several taps. The regulator links to tap with a higher voltage of its output voltage is too low & switches to tap a with a lower voltage if its output

voltage is excessively high. The main regulator won't alternate taps lest the output voltage varies from the desired voltage by some lowest amount. A voltage regulator is an electric regulating device which is made to automatically withstand an endless level of voltage or to put a cover on how much voltage be able to pass through. The voltage regulator contains adopters, capacitors, diodes, thermostats, there're several utilities of an automatic voltage regulator. The basic utilities of the automatic voltage regulators are: First and notable, its utilized as a rectifier and by means of a potential divider. Rectifier is also an electric device used to renovate the alternative current to direct current for additional electric processing. Most of the electric appliance needs a direct current for their working and can't operate on alternative current. Concerning potential dividers, they're electrical recycled for the break out of input voltage to take it to a preferred output voltage for instance the wants.

3.15.3 Advantage of Automatic Voltage Regulator (AVR)

- Simplicity of design
- Space savings
- Low noise
- Low cost

3.15.4 Disadvantage of Automatic Voltage Regulator (AVR)

- Low proficiency if the input output difference is large
- May need a hotness descend
- Skilled exclusive of step-down operation

3.16 Fuse

A fuse is a little piece of metal implanted in the circuit, that softens while extreme excess current flows concluded it and hence breaks the circuit.

Figure 3.5: Fuse of Narrayanganj PBS-1

3.16.1 Types of Fuse

- High voltage
- Low voltage

3.16.2 Characteristics of Fuse Element

- Low melting point such as tin, lead.
- High conductivity such as silver, copper.
- Low cost such as lead, tin, copper.

3.16.3 Advantages of Fuse

- It’s the cheapest from the defense available.
- It needs no maintenance.
- It can pause the substantial short circuit currents without noise or smolder.
- The minimum times of operation can be prepared much littler than the circuit breakers.

3.16.4 Disadvantage of Fuse

- Time is misplaced rewiring or replacing a fuse after operation.
- On heavy little circuit discernment between fuses in series can’t be obtained if there are inadequate change in the sizes of the fuses disturbed.

3.17 Relay

A relay is a device used to regulate the process of a magnetic contactor or extra device. Relay operate as a function of current, voltage, temperature, pressure & supply the “intelligence” that’s necessary to give automatic acceleration, protect against overload, under voltage, excessive speed, excessive torque, etc.

CHAPTER-4

BUS-BAR ARRANGEMENT

4.1 Bus-bar Arrangement

In electric power distribution, a bus-bar is a trick slip of copper or aluminum which conducts electricity surrounded by a switch board, distribution board, sub-station or other electric tools. The various types of bus bar arrangement are used in the power system. The subsequent are the electrical concerns leading the choice of any one specific arrangement.

- The bus-bar arrangement is simple & easy in repairs.
- The repairing of the system didn't disturb their steadiness.
- The construction of the bus-bar is low-cost.

The small sub-station wherever steadiness of the supply isn't necessary uses the single bus bar. But in a large sub-station, the extra bus bar is used in the system so that the disruption doesn't take position in their supply.

Figure 4.1: Bus-Bar Arrangement of Narrayanganj PBS-1

4.2 Types of Electrical Bus-Bar Arrangement

- Single bus-bar arrangement
- Single bus-bar arrangement with bus sectionalized
- Double bus-bar arrangement
- Double bus-bar arrangement with bus sectionalized
- Ring main bus-bar arrangement

4.2.1 Single Bus-Bar Arrangement

The arrangement has only one bus-bar beside the switch. All the sub-station tools alike the transformer, generator, and the feeder is linked to this bus-bar simply.

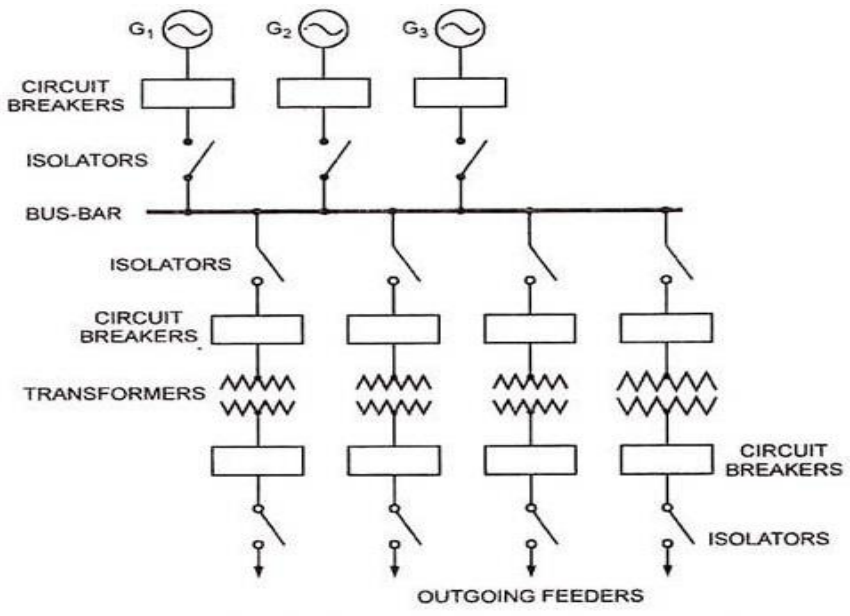

Figure 4.2: Single Bus-Bar Arrangement

4.2.1.1 Advantage of Single Bus-Bar Arrangement

- Little primary rate
- Fewer repairs
- Simple in action
- Very simple design

4.2.1.2 Disadvantage of Single Bus-Bar Arrangement

One nevertheless major difficult of these types of arrangement is that, repairs of tools of any anchorage can't be possible without disturbing the feeder or transformer linked to that anchorage. The arrangement gives the less suppleness and hence utilized in the small sub-station wherever steadiness of supply isn't important.

4.2.2 Single Bus-Bar Arrangement with Bus Sectionalized

In this form of bus bar arrangement, the circuit breaker & isolating switches are utilized. The isolator disengages the damaged section of the bus bar, henceforth guards the scheme from whole shutdown. This form of arrangement customs one accumulation circuit breaker so that it can't much increase the cost of the system.

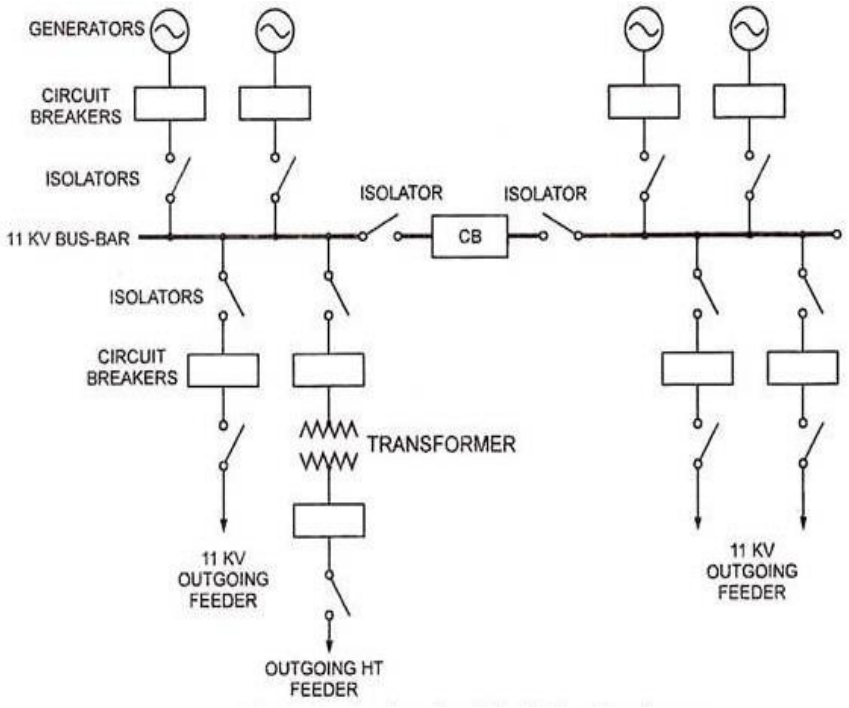

Figure 4.3: Single Bus-bar Arrangement with Bus Sectionalized

4.2.2.1 Advantage of Single Bus-bar Arrangement with Bus Sectionalized

- The defective section is removed without distressing the steadiness of the supply.
- The repairs of the dissimilar section can be done without troubling the system supply.
- The scheme has a current restrictive reactor that decreases the incidence of the error.

4.2.2.2 Disadvantages of Single Bus-Bar Arrangement with Bus Sectionalized

- The system customs the extra circuit breaker & isolator that increases the cost of the scheme.

4.2.3 Double Bus-Bar Arrangement

This form of arrangement needs two bus-bar & two circuit breakers. It doesn't need any supplementary equipment alike bus coupler and switch.

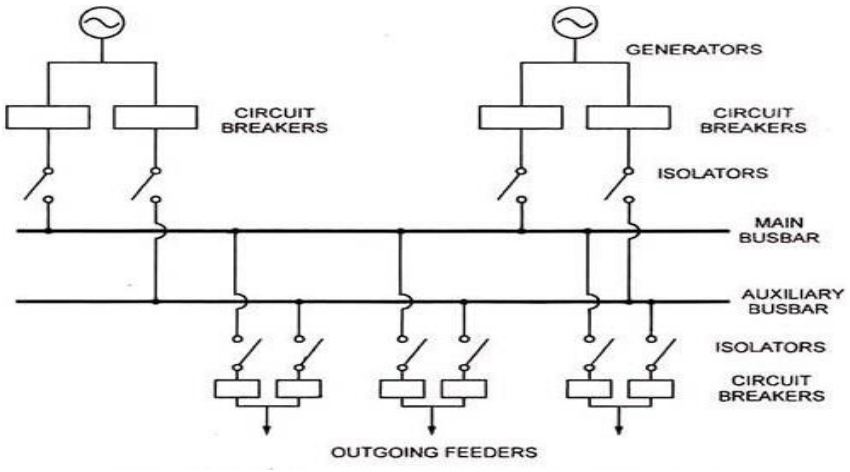

Figure 4.4: Double Bus-Bar Arrangement

4.2.3.1 Advantages of Double Bus-Bar Arrangement

- Double bus bar arrangement rises the reliability and elasticity of the scheme.
- The steadiness of the supply remains equal as the load is moveable from one bus to another on the incidence of the error.

4.2.3.2 Disadvantage of Double Bus-Bar Arrangement

- The arrangement doesn't certify the breaker repairs without disturbance.
- Their maintenance cost is very high.

4.2.4 Double Bus-Bar Arrangement with Bus Sectionalized

In this sort of bus arrangement, the sectionalized main bus-bar is utilized besides the secondary bus-bar. Any section of the bus bar eliminates from the circuit for repairs and it's attached to any of the secondary bus-bar. Sectionalizing of the secondary bus-bar isn't needed since it would rise the cost of the system.

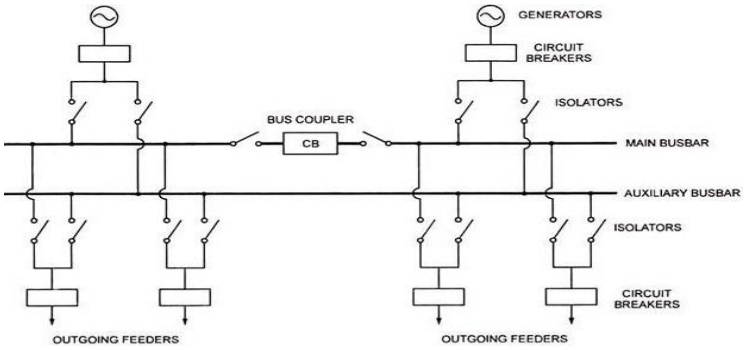

Figure 4.5: Double Bus-Bar Arrangement with Bus Sectionalized

4.2.5 Ring Main Bus-bar Arrangement

In such kind of arrangement, the termination of the bus-bar is linked back to the initial point of the bus to form a ring.

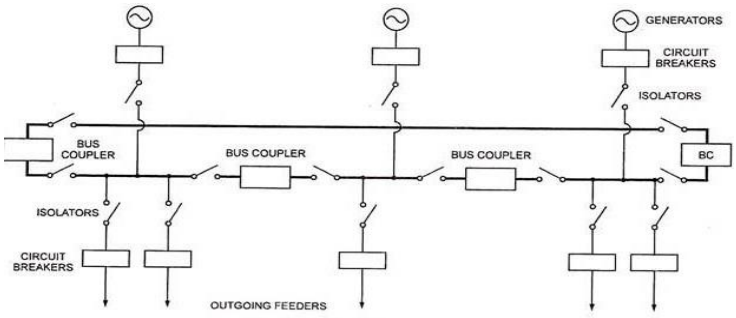

Figure 4.6: Ring Main Bus-bar Arrangement

4.2.5.1 Advantages of Ring Main Bus-Bar Arrangement

- Such kind of arrangement will give two paths for the source.
- In this arrangement, a circuit breaker can be sustained without disturbing the source.

4.2.5.2 Disadvantages of Ring Main Bus-Bar Arrangement

- Complications happen in the accumulation of the new circuit.
- Overloading happens on the system.

4.3 Bus-Bar Protection

If an error happens on a bus-bar, significant destruction and disruption of supply will happen lest some usage of quick-acting automatic fortification is provided to isolate the defective bus-bar. In the result of error on any section of the bus-bar, all the circuit tools linked to that section must be stripped out to provide whole isolation.

4.3.1 Types of Bus-Bar Protection

The two most ordinarily recycled scheme for bus-bar shield are given below:

- Differential protection
- Error bus protection

CHAPTER-5

DISTRIBUTION SYSTEM

5.1 Distribution Transformers

Distribution transformer is an electrical transformer which is utilized to transfer electrical energy from a primary distribution circuit to a secondary distribution circuit according to size.

Figure 5.1: Distribution Transformer

5.2 Uses of Distribution Transformer

Distribution transformer is an electrical transformer which is utilized to hold electrical power from a primary distribution circuit to a secondary distribution circuit. Electrical energy is recognized over distribution transformers to negligible high voltage level on distribution situation right down to end-use levels. This can even be utilized to transfer current surrounded by a secondary distribution circuit or to the service circuit.

5.3 Fittings of Distribution System

Electric power distribution is the last stage in the distribution of electric power, it transmits electricity from the transmission system to different customers.

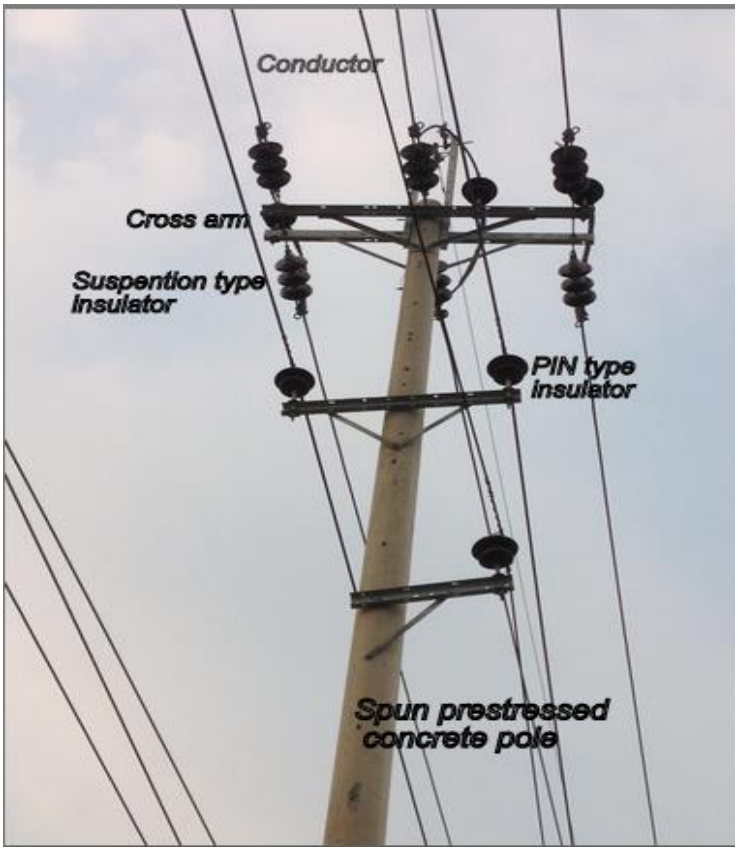

Figure 5.2: Fittings of Distribution System

5.4 Main Components of Overhead Lines

An overhead line may be utilized to convey or distribute electric power. While creating an overhead line, it should be confirmed that mechanical strength of the line is such therefore to give contrary to the most possible weather circumstances. In over-all, the main mechanisms of an overhead line are given below:

- Conductors
- Supports
- Insulators
- Cross arms
- Miscellaneous items

5.4.1 Conductor

An electrical conductor is an ingredient in which electrical charge carriers, generally electrons, move simply from atom to atom with the application of voltage. Copper, steel, gold and aluminum are similarly good conductors.

5.4.2 Pole

The subsidiary structures for overhead line conductors are several sorts of poles and towers named line supports. In over-all, the line supports should have the subsequent assets:

- High mechanical strength
- Light in weight while not the loss of mechanical strength.
- Cheap in cost
- Economical to preserve.
- Longer life.
- Easy accessibility of conductors for repairs.

Figure 5.3: Pole of Narrayanhanj PBS-1

5.4.3 Types of Pole

The line supports are utilized for transmission & distribution of electrical power are of several sorts. These are-

- Wooden poles
- Steel poles
- SPC poles
- Lattice steel towers.

The choice of subsidiary structure for a specific case depends upon the line area, X-sectional area, line voltage, cost and local circumstances.

5.5 Insulator

The overhead line conducts should be reinforced on the poles or tower in such system that current from conducts don't flow to ground through supports such as line conducts must be accurately insulated from supports. In over-all, the insulator should have the follows desirable assets:

- High mechanical strength.
- High electric resistance of insulator material.
- High relative permeability of insulator material.
- The insulator should be non-porous, free from impurities and blows otherwise the permeability will be dropped.
- High proportion of puncture strength to flashover.

5.5.1 Types of Insulator

The most ordinarily used insulators are given below:

- Pin type insulators
- Suspension type insulators
- Strain insulators
- Shackle insulators

5.5.1.1 Pin Type Insulator

The pin type insulator is protected to the cross arm on the pole. There is a grove on the upper end of the insulator for covering conductor. Pin type insulators are utilized for the transmission & distribution of electric power at voltages up to 33KV.

Figure 5.4: Pin type insulator

5.5.1.2 Suspension Type Insulator

The ratio of the pin type insulator rises rapidly as the working voltage is enlarged. Thus, this sort of insulators isn't economical beyond 33KV. For high voltage (>33KV), it's a standard repetition to use suspension type insulator.

Figure 5.5: Suspension type insulator

5.5.1.3 Strain Insulator

While there's a dead end of the line or there's a correct or shape curve, the line is endangered to superior tension. For the low voltage (<11KV) shackle insulator are utilized as strain insulator.

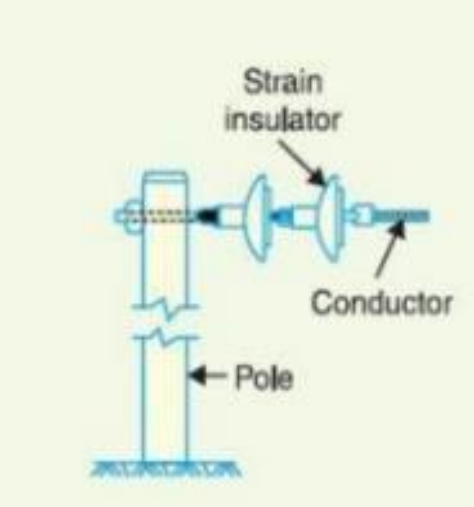

Figure 5.6: Strain insulator

5.5.1.4 Shackle Insulator

In initial days, the shackle insulators were utilized as strain insulator. But at present, they're repeatedly used for low voltage distributions lines. Such insulator can be utilized either in a horizontal place or in a vertical place.

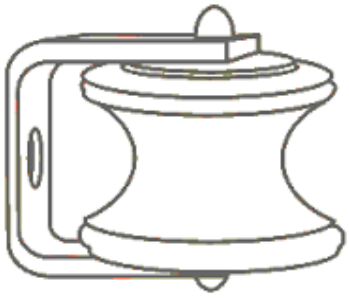

Figure 5.7: Shackle insulator

5.6 Instrument Transformer

For calculating high voltage, low range voltmeter is used with a high resistance attached in series with them. But it's not suitable to use these methods with alternating current & voltage

instruments. For these persistence, particularly constructed perfect ratio instrument transformers are working in conjunction with ordinary low range A.C instruments.

5.6.1 Types of Instrument Transformer

- Potential Transformer
- Current Transformer

5.7 Repair

In every plant there are lots of elements that need to be tested in a routine basis. Moreover, electrical elements need to be repair properly in order to make lasted for a long time. So in Narrayanganj PBS-1, there are certain testing and maintenance procedures that we were told about.

Figure 5.8: Transformer Repairing in Workshop of Narrayanganj PBS-1

5.8 Heating Chamber of Transformer

Transformer heating & drying system contains two drying or oil filling vacuum chambers. These chamber may be worked either manually through touch screens provided by manufacturer, or remotely from the computer. Each chamber be made of 3 stations for transformers. An I2R system is added to these chamber so as to fall cycle time by using electric power to heat transformers to concentration on vacuum and oil filling temperature. The I2R contains three autonomous sub-systems which can be linked to either chambers. The I2R systems labeled System1, System2, System3 are rated for units up to 4MVA and as a result will be feeding station 1/2/3 of either chambers.

Figure 5.9: Heating Chamber of Transformer in Narrayanganj PBS-1

5.9 Feeder

In power engineering, a feeder line is part of an electric distribution network, generally a radial circuit of intermediate voltage. The idea of feeder lines is also important in public transportation.

Figure 5.10: Feeding System of Sub-Station in Narrayanganj PBS-1

CHAPTER-6

POWER FACTOR

6.1 Power Factor

The cos of angle between voltage & current in alternating current circuit is named power factor. In an A.C. circuit, there's normally a phase difference concerning voltage and current. The term cos φ is named the power factor of the circuit.

6.2 Power Factor Improvement (PFI)

Power factor is the ratio in the middle of the KW and the KVA pinched by an electrical load wherever the KW is the actual load power and the KVA is the apparent power. It's a measure of how effectually the current is being converted into advantageous work output more partially is a good indicator of the outcome of the load current on the proficiency of the supply system.

A load with a power factor of 1.0 result in the most proficient loading of the supply & a load with a PF of 0.5 will result in considerable higher losses in the supply system. A poor power factor can be the result of either a substantial phase difference concerning the voltage and the current at the load stations, or it can be owing to a higher harmonic content or distorted or discontinuous current waveform. The actual power factor is to be 0.95. Reactive current following in the supply is mentioned to as reactive power and is typically expressed in VARs or KVARs. A VAR is the product of reactive current & the applied voltage.

Figure 6.1: PFI Control Board

6.3 Power Factor Plant Construction

- Capacitor Bank
- Magnetic Contactor
- Panel Box
- PFI Relay
- Trap
- Connecting Wire
- Switch Board
- HRC Fuse

6.4 Power Triangle

We know that the reactive load such as inductors & capacitor dissolve zero power, however the point that drop voltage and draw current provides the deceiving impression that they actual do dissolve power. This “Phantom power” is named reactive power and it’s measured in a unit is

known as Volt-Amps-Reactive (VAR) rather than watts. The actual quantity of power being utilized in a circuit is named true power and it's measured in watts.

Apparent power is the measured in the unit of Volt-Amps (VA). Reactive power is a purpose of a circuits reactance (X). Apparent power is the purpose of a circuits entire impedance (Z).

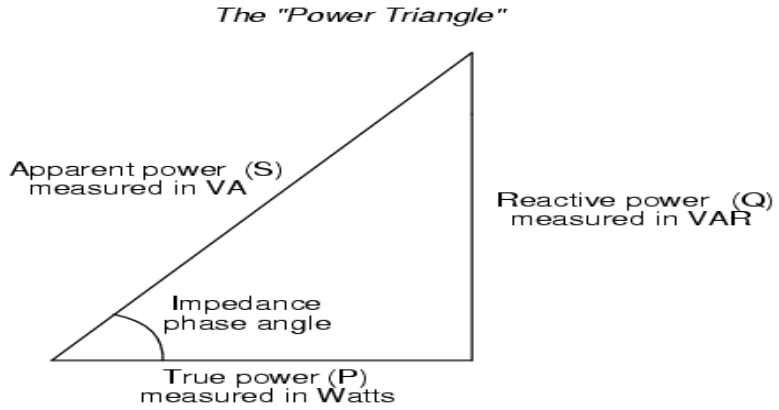

Figure 6.2: Power Triangle

Power triangle is relating apparent power to true power and reactive power. Using the laws of trigonometry, we can solve for the length of any side, given the lengths of the two sides, or the lengths of one side an angle.

6.5 Disadvantage of Low Power Factor

- Large kVA rating of tools.
- Superior conductor size.
- Large copper losses.
- Reduced controlling capacity of structure
- Poor voltage regulation

6.6 Cause of Low Power Factor

- Most of the alternating current motors are of indicator category that have low lagging power factor. This types motors operate at a power factor that is particularly small on well-lit load (0.2 to 0.3) and growths to 0.8 or 0.9 at full load.
- Arc lamps, electrical discharge lamps and industrial heating furnaces activate at low lagging power factor.
- The load on the power system is changing; being high throughout morning and evening and low at additional times. For the duration of the low load period, supply voltage is enlarged that rises the magnetization current. This results in the reduced power factor.

6.7 Power Factor Improvement Equipment

- Static capacitors
- Synchronous condenser
- Phase advancers

6.7.1 Static Capacitors

The power factor may be upgraded by fixing capacitors in parallel with the tools working at lagging power factor. The capacitor attracts a primary current and partly or completely defuses the lagging reactive factor of load. Static capacitors are continuously used for power factor development in industrial unit.

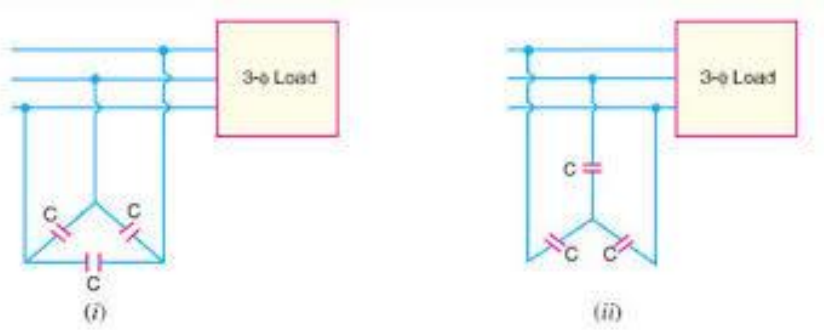

Figure 6.3: Static capacitors

6.7.1.1 Advantages of Static Capacitors

- Little losses.
- Required little repairs.
- Can be easily installed.
- Need no foundation.
- They can work below usual atmospheric situations.

6.7.1.2 Disadvantages of Static Capacitors

- They have little service life starting from 8 to 10 years.
- Can be without difficulty damage.
- When the capacitors are broken, their restoration is improvident.

6.7.2 Synchronous Condenser

A synchronous motor takes a primary current while over excited named synchronous condenser. While such an appliance is linked in parallel with the supply, it takes a primary current that partly defuses the lagging reactive element of the load. Thus the power factor is upgraded.

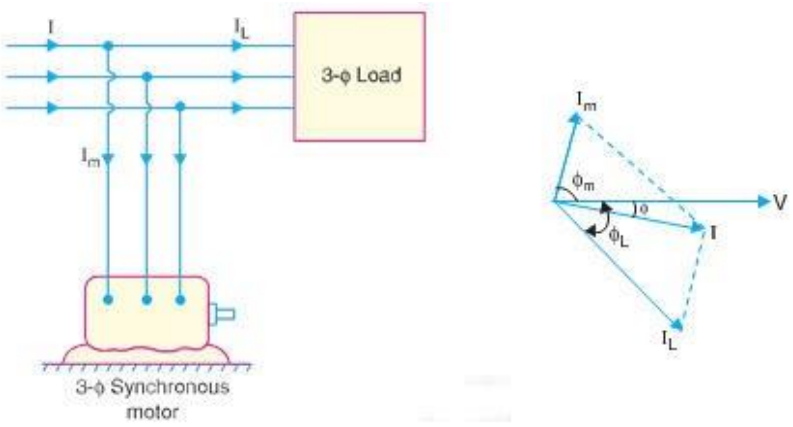

Figure 6.4: Synchronous Condenser

6.7.2.1 Advantages of Synchronous Condenser

- Motor windings have high thermal stability.
- Errors can be removed without no trouble.

6.7.2.2 Disadvantages of Synchronous Condenser

- Extensive losses in the motor.
- Repairing cost is high.
- It produces noise.

6.7.3 Phase Advancers

They are used to recover the power factor of induction motors. The low power factor of an induction motor is just because of the fact that it's stator winding inducements exciting current. If the exciting ampere turns may be delivered from some additional a.c. sources, then the stator winding will be relieved of exciting current. Thus the power factor of the motor can be developed.

CHAPTER 7

PROTECTION PART

7.1 Neutral Grounding Resistance (NGR)

Neutral grounding resistance are used to restrict the earth fault current during fault condition below a certain value. This is done for high voltage side because due to high voltage and low winding resistance fault current is very high and the windings are not designed to carry such a large current, so it is the place where neutral grounding resistance comes to play. Neutral grounding resistance are used in 11KV generating station is to limit the fault current within the specified limit.

7.2 Earth Screen

The power station and the sub-station are generally having much expensive tools. These stations can be endangered from direct lighting strikes by providing earth screens. It contains a network of copper conductors mounted all over the electrical tools in the sub-station or power station. The screen is correctly joined to the earth on at least two facts through low impedance. On the incidence of direct stroke on the station the screen gives a low resistance path by that lighting surge are connected to the ground.

7.3 Lighting Arrestor

Lighting arrestors are protective device for limiting surge voltage due to lighting strikes. A lighting arrester is a device that is used on electrical power system to defend the insulation & conductors of the system from the destructive effects of lighting. The usual lighting arrester has a high voltage station and a ground station.

7.4 Surge Absorber

Surge absorber is a defensive device that reduces the keenness of wave front of a surge by absorbing surge energy.

Although each surge diverter and surge absorber remove the surge, the way in which it's done is different in the two devices. The surge diverter diverts the surge to ground however the surge absorber fascinates the surge energy.

7.5 Fire Protection

The fire protection device should be kept in store yard for safety of equipment's during storage. It can be useful in the time of danger. This includes fire extinguishers, constant supply of water.

CHAPTER 8
CONCLUSION

8.1 Conclusion

Sub-station equipment exists at several scales all through a power system. In over-all, they signify an interface between altered levels or section of the power system, with the proficiency to switch or re-configure the connections mid various transmission and distribution lines. The major places embrace a control room from which the operations are corresponding. Reduced distribution sub-station follows the similar principle of receiving power at higher voltage on one side and transfer out a numbers of distribution feeders at lower voltage. The vital factor of sub-station is the transformer, as it gives the operative in enface between the high & lower voltage parts of the system. Other essential apparatuses are circuit breaker & switches. Breakers help as defensive device that open automatically in the result of error. Switches are governor devices that can be open or closed purposely to launch or break a connection.

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