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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
KANAKALA PAVAN KUMAR (Reg. No: 41140041) who carried
out the internship training programme on study of substation
equipment and equipment maintenance work at
220/132/33kvsubstation from **09.06.2023 to 15.06.2023**

INTERNAL GUIDE

HEAD OF THE DEPARTMENT

SUBMITTED ON : _____

INTERNAL EXAMINER

EXTERNAL EXAMINER

DECLARATION

I, **KANAKALA PAVAN KUMAR** hereby declare that the internship report entitled **TRAINING AT 220/132/33 KV SUBSTATION** done by me is submitted on behalf of Internship completion in 1 week, gained knowledge and experience.

DATE:

PLACE: CHENNAI

A handwritten signature in blue ink, appearing to read 'Pavan Kumar', with a stylized, cursive script.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I have made efforts in this training. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to APTRANSCO for their guidance and constant supervision as well as for providing necessary information regarding the training & also for their support in completing the internship.

I would like to express my gratitude towards my parents for their kind cooperation and encouragement which helped me in the completion of this training. I would like to express my special gratitude and thanks to the substation people for giving me such attention and time.

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CHAPTER 1

INTRODUCTION ABOUT THE COMPANY

- AP TRANSCO came into existence on 1.02.1999 as a consequence of restricting the erstwhile AP State Electricity Board (APSEB) to look after the transmission of electricity in Andhra Pradesh. From February 1999 to June 2005 AP Transco remained a single buyer in the state purchasing power from various Generators and selling it to DISCOMS by the terms and conditions of the individual PPAs at the Bulk supply Tariff (BST) rates. Presently AP Transco has ceased to do power trading and has retained with power of controlling the system operation of power transmission.

1.1 SUBSTATION

- A Substation is a part of an electrical generation transmission and distribution system. Substations transform voltage from high to low, or the reverse, or perform any other several important functions.

1.1.1 CLASSIFICATION OF SUBSTATIONS

- The three principal machining processes are classified as turning, drilling, and milling. Other operations falling into miscellaneous categories include shaping, planning, boring, broaching, and sawing.

1.1.2 According To The Service Requirement

- Following the service performed, substations are classified as

1. Switching substation.
2. Transformer substation.
3. Power factor substation.
4. Frequency changer substation.

1.1.3 ACCORDING TO THE CONSTRUCTIONAL FEATURES

- By the constructional features substations are classified as
- 1. Indoor substations.

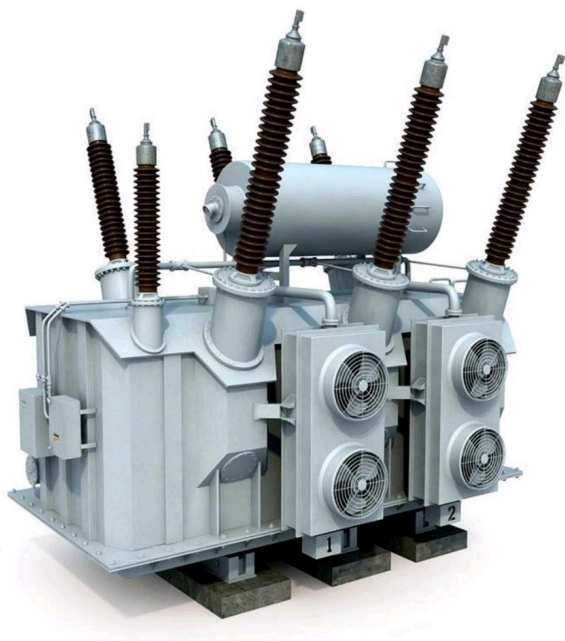
2. Outdoor substations.
3. Underground substations.
4. Pole-mounted or Plinth mounted substations.

1.1.4 ACCORDING TO CONVENTIONAL AND AUTOMATION SUBSTATIONS

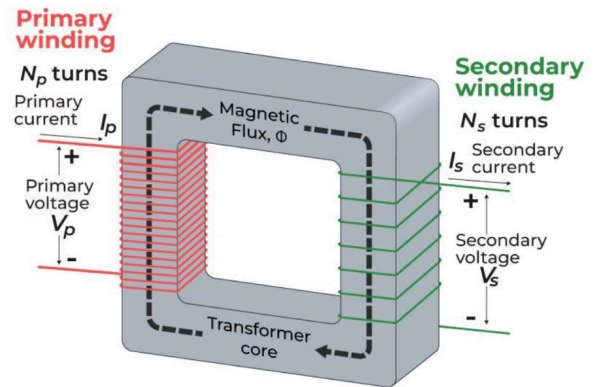
1. Conventional electrical substations are traditional installations that have been in use for many years. They consist of various electrical equipment, such as transformers, circuit breakers, disconnect switches, and busbars, housed within a physical building or structure.
2. Automation substations, also known as digital or intelligent substations, are modernized versions of conventional substations that incorporate advanced automation and control technologies.
3. Conventional substations have Manual Operation, Human Monitoring, Manual Fault Detection and Recovery, and Automation substations have integration with Smart Grid, Enhanced Fault Detection and Recovery, and advanced Control Systems.

1.2 TRANSFORMER

- A transformer is a static device, that transfers electrical energy from one circuit to another circuit without changing frequency, while doing so the voltage may increase or decreases with a corresponding decrement or increment of current
- A transformer consists of two windings. The winding connected to the supply is called Primary Winding and the winding connected to the load is called the secondary winding. In an ideal transformer, the induced in the secondary winding (V_s) is proportional to the primary voltage (V_p) and is given by the LY ratio of a number of turns in the secondary (N_s) to the no of turns in the primary (N_p).



EMF Equation of Ideal Transformer



1.2.1 WORKING PRINCIPLE

- It mainly consists of two inductive coils which are electrically separated but magnetically linked through a path of low reluctance as shown. When one coil of the transformer is connected to an A.C. supply main, an alternating flux is set up in the laminated core, most of this flux links with the other coil and produces mutually induced emf (according to Faradays Laws of ElectroMagnetic Induction).
- When the transformer rises the voltage i.e., when the output voltage of the transformer is higher than its input voltage. It is called the Step-Up Transformer and when it lowers the voltage i.e., when its output voltage is less than input is called the Step Down Transformer.
- When the transformer must not be connected to the DC source. If the primary winding of the transformer is connected to a DC supply main the flux produced will not vary but remains constant in magnitude and therefore, no emf will be induced in the secondary except at the time of switching on. The primary winding gets short-circuited due to low-resistance winding and draw high currents which may damage the windings.
- EMF Equation of the transformer-4.44. $\frac{E_2}{E_1} = \frac{V_2}{V_1} = \frac{N_2}{N_1}$
- Transformer ratio $K = \frac{E_2}{E_1} = \frac{V_2}{V_1} = \frac{N_2}{N_1}$
- Voltage Regulation $\frac{V_1 - V_2}{V_2} \times 100$
- Efficiency = output/output + losses

1.2.2 CLASSIFICATION OF TRANSFORMERS:

Transformers may be classified into four types. They are

1. Power Transformers

- Step Up Transformer
- Step Down Transformer

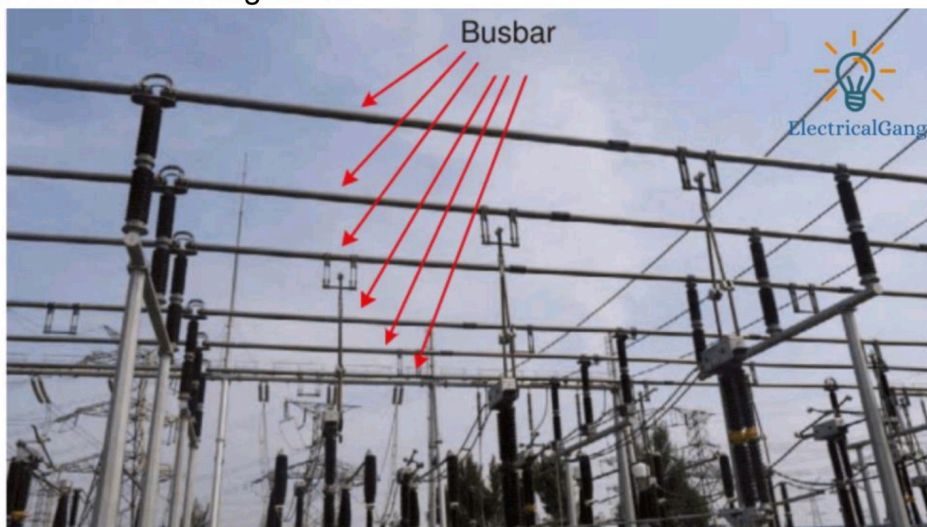
2. Distribution Transformer

3. Instrument Transformer

- Current Transformer
 - Potential Transformer
- #### 4. Welding Transformers

1.3 BUS-BARS:

- When several lines operating at the same voltage have to be directly connected electrically. Bus-bars are used as the common electrical components. Bus bars are Copper or Aluminium bars & operated at a constant voltage. The incoming and outgoing lines in the ss are connected to the Busbars
 - The most commonly used Bus bar arrangement in substation are
1. Single Bus-bar arrangement
 2. Single Bus-bar system with sectionalisation
 3. Double Bus-bar arrangement



1.3.1 Single Bus-bar Arrangement

- As the name suggests, it consists of a single bus-bar, and all the incoming and outgoing lines are connected to it. The chief advantages of this type of arrangement are low initial cost, less maintenance, and simple operation.
- However, the principal disadvantage of a single bus-bar system is that if repair is to be done on the bus-bar or a fault occurs on the bus, there is a complete interruption of supply.

1.3.2 Single Bus-bar system with sectionalisation

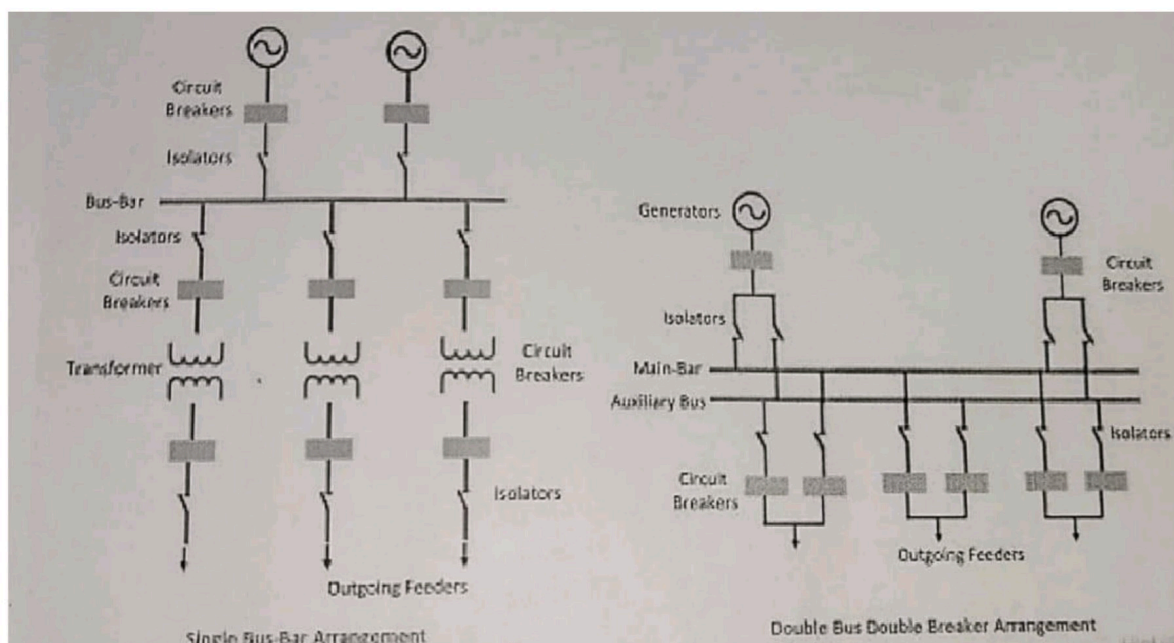
- In this arrangement, the single bus bar is divided into sections and the load is equally
- distributed on all the sections. Any two sections of the busbar are connected by a circuit breaker and isolators.

1.3.3 Double Bus-bar Arrangement

- This system consists of two bus-bars, a "main" bus-bar and a "spare" bus-bar. Each bus bar has the capacity to take up the entire sub-station load.
- The incoming and outgoing lines can be connected to either bus-bar with the help of a bus-bar coupler which consists of a circuit breaker and isolators. Ordinarily, the incoming and outgoing lines remain connected to the main busbar.
- However, in case of repair of the main bus-bar or fault occurring on it, the continuity of supply to the circuit can be maintained by transferring it to the spare bus-bar. For voltages exceeding 33kV, a duplicate bus-bar system is frequently used.

1.4 ISOLATORS

- One of the prime requests for full safety in carrying out work pieces of equipment in electrical installation is to disconnect reliably to the unit the section from all other



Single bus bar arrangement

Double bus bar arrangement

live parts of the installation. The guard against mistakes. This must be done by an apparatus which means a visible break in the circuit such apparatus is known as an isolator.

- Isolators are used only for connecting part of the electrical installation after first de-energizing and then by opening their circuits with the respective breakers.



- **1.41 Types Of Isolators:**

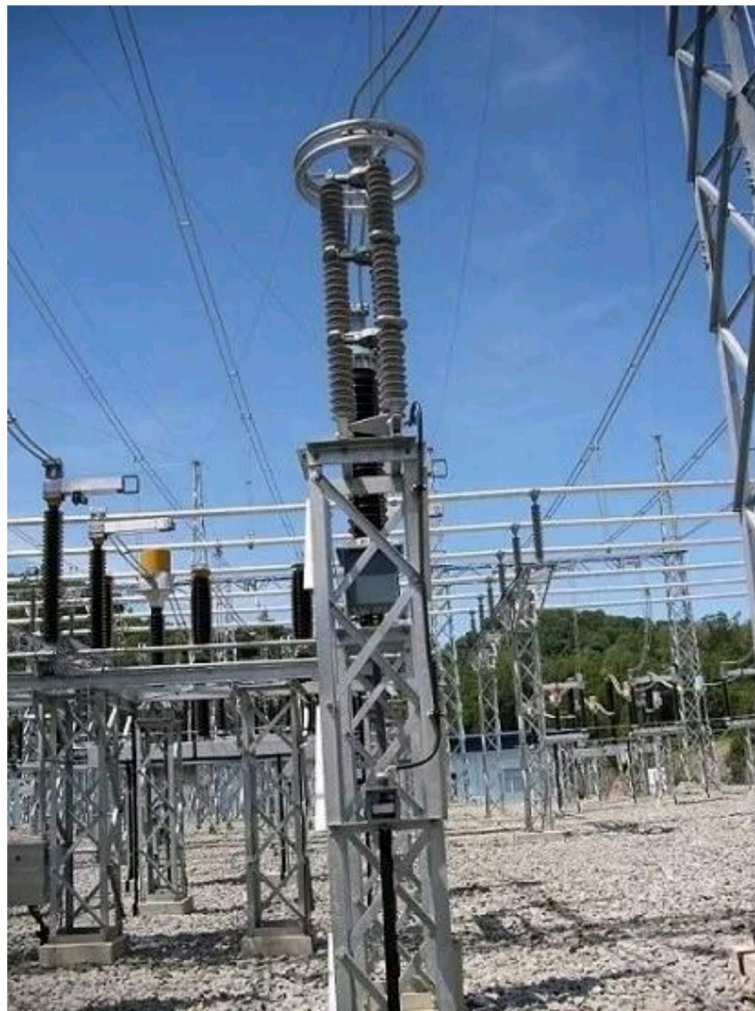
1. Based on the number of poles (single pole & 3 pole)
2. Based on their service (indoor & outdoor)
3. Isolators for earthing
4. Single break & double break isolators.

- **1.5 Lightning Arrester:**

- The device which is used for the protection of the equipment at the substations against traveling waves, such type of device is called a lightning arrester or surge diverter.
- In other words, lightning arrester diverts the abnormally high voltage to the ground without affecting the continuity of supply. It is connected between the line and the earth, i.e., in parallel with the equipment to be protected at the substation.

- **1.5.1 Working Of Lightning Arrester**

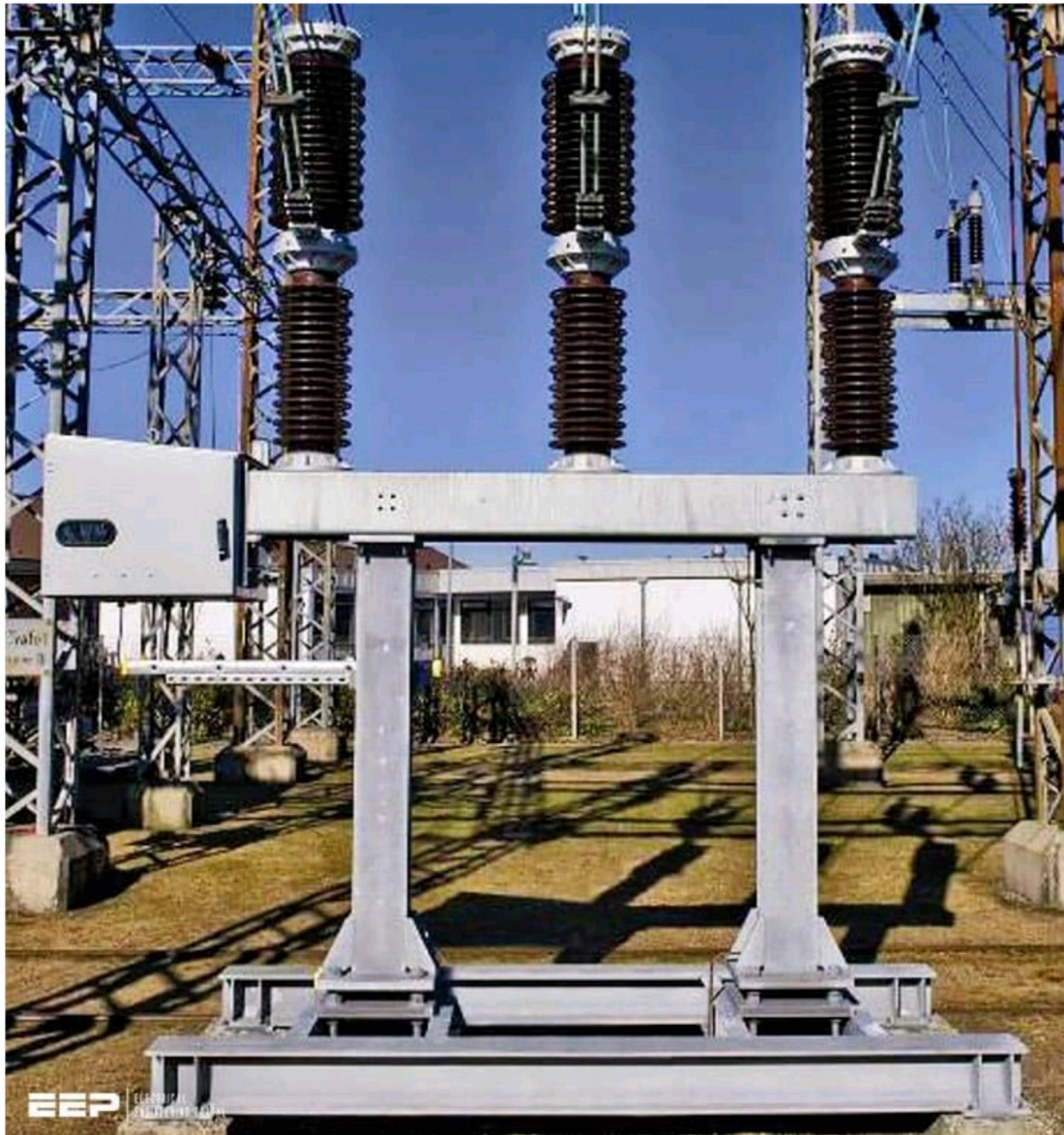
- When a traveling wave reaches the arrester, it sparks over at a certain prefixed voltage. The arrester provides a conducting path to the waves of relatively low impedance between the line and the ground. The surge impedance Z_s of the line restricts the amplitude of the current flowing to ground



1.6 CIRCUIT BREAKER :

- A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected.
- Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.
- The generic function of a circuit breaker, RCD, or a fuse, as an automatic means of removing power from a faulty system is often abbreviated as OCPD (Current Protection Device).

1.6.1 Working Principle Of Circuit Breaker



- Circuit breaker essentially consists of fixed and moving contacts. These contacts are touching each other and carrying the current under normal conditions when the circuit is closed.
- When the circuit breaker is closed, the current-carrying contacts, called the electrodes, engage each other under the pressure of a spring.
- During normal operating conditions, the arms of the circuit breaker can be opened or closed for switching and maintenance of the system. To open the circuit breaker, only pressure is required to be applied to a trigger.

1.7 SF6 CB

1. It is a highly inert gas
2. It is an electronegative gas & absorbs free electrons

3. Superior arc quenching property
4. It is heavy
5. Good dielectric strength
6. Good arc extinguishing property

1.7.1 Working Principle of SF6 Circuit Breaker

- In normal operating conditions, the contacts of the breaker are closed. When the fault occurs in the system, the contacts are pulled apart, and an arc is struck between them. The displacement of the moving contacts is synchronized with the valve which enters the high-pressure SF6 gas in the arc interrupting chamber at a pressure of about 16 kg/cm^2 .



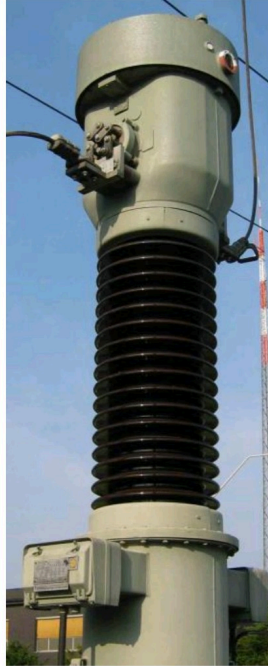
- The SF6 gas absorbs the free electrons in the arc path and forms ions which do not act as a charge carrier. These ions increase the dielectric strength of the gas and hence the arc is extinguished. This process
- Reduces the pressure of the SF6 up to 3 kg / cm^2 thus; it is stored in the low-pressure reservoir. This low-pressure gas is pulled back to the high-pressure reservoir for re-use.

1.8 Current Transformer:

- A current transformer (CT) is a type of transformer that is used to measure alternating current (AC). It produces a current in its secondary which is proportional to the current in its primary.
- A current transformer provides a secondary current that is accurately proportional to the current flowing in its primary. The current transformer presents

a negligible load to the primary circuit. Current transformers are the current-sensing units of the power system and are used at generating stations, electrical substations, and in industrial and commercial electric power distribution.

- Current transformers are used extensively for measuring current and monitoring the operation of the power grid. Along with voltage leads, revenue-grade CTs drive the electrical utility's watt-hour meter on many larger commercial and industrial supplies. Current transformers can be mounted on the low-voltage or high-voltage leads of a power transformer.



1.8 Potential Transformer (PT):

- The potential transformer may be defined as an instrument transformer used for the transformation of voltage from a higher value to a lower value. This transformer steps down the voltage to a safe limit value which can be easily measured by ordinary low-voltage instrument like a voltmeter, wattmeter, and watt-hour meters, etc.

1.8.1 Construction of Potential Transformer:

- The potential transformer is made with a high-quality core operating at low flux density so that the magnetising current is small. The terminal of the transformer should be designed so that the variation of the voltage ratio with load is minimal and the phase shift between the input and output voltage is also minimal.
- The primary winding has a large number of turns, and the secondary winding has a much smaller number of turns. For reducing leakage reactance, the coaxial winding is used in the potential transformer. The insulation cost is also



reduced by dividing the primary winding into sections which reduced the insulation between the layers.

1.8.2 Connection of Potential Transformer:

- The potential transformer is connected in parallel with the circuit. The primary windings of the potential transformer are directly connected to the power circuit whose voltage is to be measured. The secondary terminals of the potential transformer are connected to the measuring instrument like the voltmeter, wattmeter, etc. The secondary windings of the potential transformer are magnetically coupled through the magnetic circuit of the primary windings.
- The primary terminal of the transformer is rated for 400V to several thousand volts, and the secondary terminal is always rated for 400V. The ratio of the primary voltage to the secondary voltage is termed as transformation ratio or turn ratio.

1.9 BATTERY ROOM:

Batteries in substations are essential as these are used for Auxiliary power sources. When there is no power from the main station, batteries are used to supply power to the meter and other equipment. Batteries provide energy for your power circuit breakers to trip off faults.



In a Substation DC power is supplied in the Following feeders of a panel:

- Trip and Closing circuit of the Circuit breaker
- Protection Relay
- Isolator control circuit
- Indication lamp, Alarm, Facia
- PLCC panel
- Emergency lamps in the Control room

1.9.1 RELAY

- In electrical engineering, a protective relay is a complex electromechanical apparatus, often with more than one coil, designed to calculate operating conditions on an electrical circuit and trip circuit breakers when a fault is detected.
- Overload - Overload protection requires a current transformer which simply measures the current in a circuit. If this current exceeds a pre-determined level, a circuit breaker or fuse should operation



CHAPTER 2

NATURE OF WORK DONE

- The nature of work done by APTRANSCO typically includes a range of activities related to the transmission and management of electrical power within the state. APTRANSCO's primary responsibility is to transmit electricity from power generation sources (such as power plants) to various distribution companies and substations across the state. This involves operating and maintaining a network of high-voltage transmission lines and substations. The operation of the state's power grid includes monitoring the flow of electricity, voltage levels, and grid stability.
- In the course focused on substation equipment and equipment maintenance work at a 220/132/33 kV substation, participants engage in a comprehensive learning experience. They acquire technical knowledge about the operation and maintenance of substation components like transformers, circuit breakers, and switchgear. This knowledge enables them to perform critical tasks such as routine inspections, testing, cleaning, and troubleshooting.
- Maintenance engineers and technicians in a 220 kV substation are responsible for planning and scheduling maintenance activities. This includes creating maintenance schedules, prioritizing tasks, and coordinating with other teams to minimize downtime. Regularly scheduled preventive maintenance is crucial to prevent equipment failures. This involves inspecting, cleaning, testing, and servicing substation equipment to identify and address potential issues before they lead to breakdowns.
- Regular inspections of substation equipment are conducted to check for signs of wear, corrosion, loose connections, or any other abnormalities. Inspections help in identifying problems early and taking corrective action. Technicians perform various tests on equipment, such as transformer oil testing, circuit breaker testing, and insulation resistance testing, to assess the condition of the equipment and detect any performance deviations.
- Transformer oil is critical for the health of transformers. Regular oil sampling and analysis are conducted to monitor the condition of the oil and the transformer

itself. Any contamination or degradation is addressed promptly. When equipment is found to be faulty or beyond repair, maintenance personnel are responsible for arranging repairs or replacements. This may involve coordinating with suppliers, ordering spare parts, and overseeing the repair process.

- In the event of unexpected equipment failures or emergencies, maintenance teams must respond promptly to minimize downtime and prevent power outages. Detailed records of maintenance activities, equipment history, and test results are maintained. This documentation is essential for tracking equipment performance and compliance with maintenance schedules.
- Maintenance teams ensure compliance with environmental regulations when handling materials such as transformer oil or other hazardous substances. Spill containment and disposal protocols are followed. Substations may undergo upgrades or modernization projects to enhance efficiency and reliability. Maintenance teams may be involved in planning and implementing these projects.
- Safety procedures are a paramount aspect of the course, emphasizing protocols like lockout/tagout to ensure the well-being of personnel during maintenance activities. Participants also gain insights into environmental compliance, learning how to handle materials like transformer oil responsibly.
- a protective relay is a complex electromechanical apparatus, often with more than one coil, designed to calculate operating conditions on an electrical circuit and trip circuit breakers when a fault is detected.
- earthing" connecting the neutral point of a supply system or then on current carrying parts of electrical apparatus to the general mass of earth in such a manner that at all times an immediate discharge of electrical energy takes place without danger The connection to the earth using an earth electrode the earthing is done using several ways. The most commonly used earthing types are Pipe Earthing and plate Earthing.

CHAPTER 3

METHODS AND PROCESSES

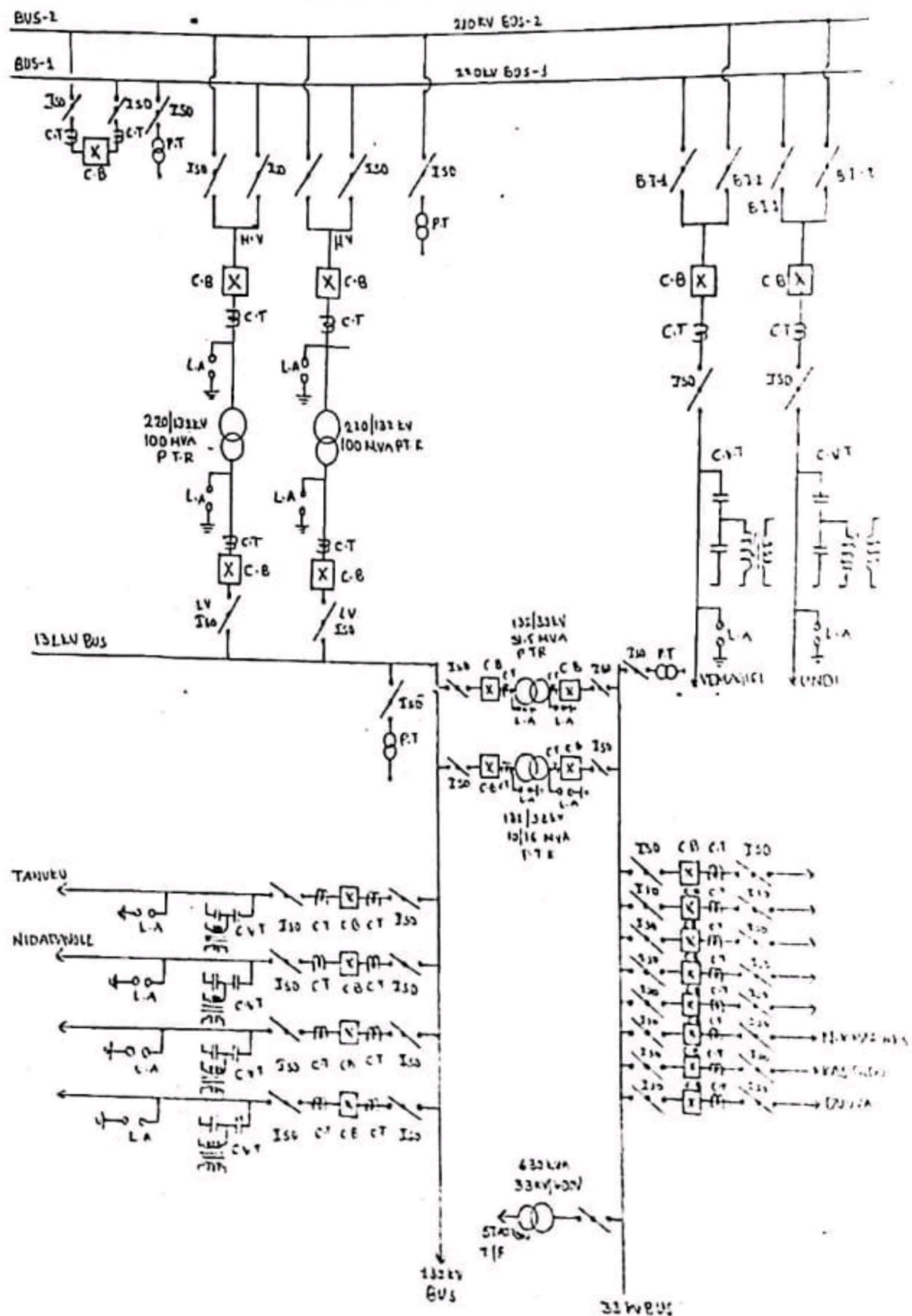
3.1 METHODS

- In a 220/132/33kV substation, several methods and equipment are used to ensure the safe and efficient transmission and distribution of electrical power. Here are some common methods and components you'd find in such a substation
- Transformers have Step-up and step-down transformers that are used to change the voltage levels between 220kV, 132kV, and 33kV, as well as for further distribution to lower voltage levels. Circuit Breakers are High-voltage circuit breakers installed to interrupt the flow of electricity in case of faults or overloads, protecting the equipment and the power system.
- Isolators or Disconnect Switches are used for isolating sections of the electrical network for maintenance or repair work without shutting down the entire substation. Lightning Arresters are used to protect against lightning strikes and voltage surges, lightning arresters or surge arresters are employed.
- Busbars are used for carrying electrical power within the substation and for connecting various components such as transformers, circuit breakers, and disconnect switches. Various protective relays and systems are installed to detect faults and abnormal conditions in the electrical network and initiate appropriate actions to mitigate them.
- In these substations, we use SF6 circuit breakers to reduce the short circuit. Control and Monitoring Systems are SCADA (Supervisory Control and Data Acquisition) systems are used for remote monitoring and control of the substation's equipment and operations. Earthing and Grounding Proper grounding and earthing systems are crucial for safety and to prevent electrical hazards.
- Backup batteries and DC power systems provide power for control and protection circuits in case of a power outage. A control room houses the operators and monitoring equipment to oversee the substation's operations.

3.2 PROCESSES

- Step-down transformer substations typically use step-down transformers to lower the voltage from 220kV to 132kV, and then further to 33kV for distribution.
- Circuit breakers are used to control and protect the electrical circuits in the substation. They can interrupt the flow of electricity in case of faults or overloads.
- Isolators and Switches are used to isolate sections of the substation for maintenance or to redirect the flow of electricity when needed.
- Busbars are conductive bars that distribute electrical power within the substation, connecting various components and equipment.
- Protection and Control Systems include relays and protection devices that monitor the substation's health and respond to abnormal conditions by isolating faulty sections and maintaining system stability.
- Current transformers (CTs) and voltage transformers (VTs) are used to measure current and voltage levels for monitoring and control purposes.
- A central control room is where operators monitor and control the substation's various processes and equipment. Surge arresters protect equipment from voltage spikes and lightning strikes
- A proper grounding system ensures safety and helps dissipate fault currents into the ground
- . Communication and SCADA Systems enable remote monitoring and control of the substation, allowing operators to manage the substation from a central location.

220/132/33 KV SUBSTATION, DUVVA
SINGLE LINE DIAGRAM



CHAPTER 4

KNOWLEDGE AND EXPERIENCE

4.1 KNOWLEDGE GAINED

- How the relays work and different types of relays such as Buchholz relays. Differential relays. O/C & E/F relays. REF relays. Over-fluxing relays.
- About the power distribution network and consumer connection
- Studied about the DC panels and the need for DC panels
- Studied about the circuit breaker, their working principal, and different types of circuit breaks
- Studied about the SF6 circuit breaker in the 132kv side
- Learned about the vacuum circuit breaker in the 33kv side
- Studied different types of conductors such as :
 1. zebra twin conductor
 2. pantheon conductor
 3. work conductor
- learned about the capacitor voltage transformer
- studied on CVT and working of CVT

4.2 EXPERIENCE

- Working with high-voltage equipment requires a deep understanding of electrical principles, including power generation, transmission, and distribution.
- Safety is paramount in a high-voltage substation. You would have learned and practiced strict safety procedures to protect yourself and others from electrical hazards. You likely gained experience in the maintenance and operation of various substation equipment, such as transformers, circuit breakers, disconnect switches, and protective relays.
- You may have developed the ability to diagnose and troubleshoot electrical issues and faults in the substation to ensure reliable power distribution.
- Understanding how to safely switch equipment in and out of service is crucial for maintaining the integrity of the power grid.
- Knowledge of protective relays and systems to detect and respond to electrical faults and disturbances.
- Experience with substation control systems and SCADA (Supervisory Control and Data Acquisition) for monitoring and managing substation operations.
- Collaboration with a team of engineers, technicians, and operators is often required for effective substation operation and maintenance. Awareness of and adherence to local and national regulations and standards governing substation operations and safety.

- Preparedness for responding to emergencies, such as equipment failures or power outages, in a timely and safe manner. Understanding the environmental impact of substation operations and ensuring compliance with environmental regulations.
- Keeping accurate records, conducting inspections, and generating reports on substation performance and maintenance activities.
- Substations are used to detect and isolate failures in the transmission system as quickly as possible. Short-circuit or overload currents in large substations can leave thousands of people without electricity.
- Substations are electrical systems that control equipment, generators, and electrical circuits. They're mainly used to convert AC to DC.



CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

- During my internship at the 220kV substation, I gained valuable insights into the operation and maintenance of high-voltage electrical systems. My responsibilities included assisting with equipment inspections, conducting routine maintenance tasks, and learning about safety protocols.
- I also had the opportunity to work with a team of experienced engineers and technicians, which allowed me to develop practical skills and knowledge in the field of electrical engineering.
- Substations like these play a crucial role in the power grid by stepping up or down voltage levels as electricity is transmitted from power generation sources to distribution networks and eventually to consumers.
- Throughout the internship, I was exposed to various components of the substation, such as transformers, circuit breakers, and protective relays. I learned how to troubleshoot issues, perform voltage and current measurements, and ensure the reliability of the substation's electrical supply.
- 220kV, 132kV, and 33kV are commonly used voltage levels in high-voltage electrical systems.
- - 220kV is considered extra high voltage (EHV), while 132kV and 33kV are high voltage (HV) levels.
- These substations also include circuit breakers, switchgear, and other protective and control equipment to ensure the safe and reliable operation of the grid.
- Substations are essential for maintaining the quality and reliability of electrical power supply.
- - They help manage voltage levels and route electricity to where it's needed.

5.2 CONCLUSION

- In this project i studied about The operation of different equipment present in 220/132/33kv substation, Duvva. I have studied about the control unreal a panel and its operation.
- Electrical energy occupies the top position in the electrical hierarchy it finds in numerable uses in home, industry, agriculture an event in transport.besides it's used for domestic, commercial and industrial purpose it is requiredfor increasing defence and agricultural production.
- Alpha numerical relays are being used which are more compact in size and reliable when compared to other relays.
- Some of the advanced and developed nations of North America and Europe has very high annual per capita consumption of electrical energy say from 8 to 13,000 kWh, while in most of Asia and Latin America it is too low to be considered.

- India had an annual per capita consumption of electrical energy of, 15.5 kWh in 1950, one not for kWh in 1979, 154 kWh in 1984, 299 kWh in 1993, 349 kWh in 1997, the annual per capita consumption of Japan 8000 kWh. UK 7200 kWh and USSR 6000 kWh. The United states has only 6% of world population but accounts for over 30% of electrical consumption of the world

