1.INTRODUCTION

The electric substations are the major portions of the power system and stations are intended to step up or step down the voltage levels as per the requirements. All the station equipment's are having same characteristics and operation producers irrespective of voltage class. Only the size and capacity of the equipment's may vary as accordingly to the voltage levels.

1.1 About KPCL

Karnataka Power Corporation Limited (or **KPCL**) is a company owned by the Government of Karnataka, and is engaged in the Service of generating electric power in the state of Karnataka in India. The modes for generating electric power are hydroelectric, thermal, diesel, gas, wind, and solar. The company was started on 20-07-1970 due to a vision of the Karnataka Government for separate entities for generation and distribution of electric power. This was done, long before world bank dictated power sector reforms were initiated in early 21st century in India. Karnataka Power Corporation Limited began its journey with a humble beginning in 1970. With an installed capacity to 8738.305 MW (2019). A revenue of Rs.77442 million in 2019 as compared, to Rs.1.30 million in 1971.

1.2 About KPTCL

Karnataka Power Transmission Corporation Limited is a registered company under the Companies Act, 1956 was incorporated on 28-7-1999 and is a company wholly owned by the Government of Karnataka with an authorized share capital of Rs. 2182.32 crores. KPTCL was formed on 1-8-1999 by carving out the Transmission and Distribution functions of the erstwhile Karnataka Electricity Board. KPTCL is headed by a Chairman and Managing Director at the corporate office. He is assisted by four functional Directors. The Board of KPTCL consists of a maximum of twelve directors. Karnataka Power Transmission Corporation Limited is mainly vested with the functions of Transmission of power in the entire State of Karnataka and also Construction of Stations & Transmission Lines and maintenance of 400/220/110/66 KV Sub-Stations. Many new lines and Sub-Stations were added & existing stations were modified in the Transmission network. It operates under a license issued by Karnataka Electricity Regulatory Commission. KPTCL has 5 No. of 400 KV Station, 105 No. of 220 KV Station, 423 No. of 110 KV Station and 657 No. of 66 KV Station. The Total Transmission Line in CKMs is 36858 as on 31.03.2019.

- The various wings of KPTCL is as follows:

a) Corporate Office at Kaveri Bhavan, Bangalore.

b) Six Transmission zones, each zone is headed by a Chief Engineer.

c) State Load Dispatch Centre.

d) SCADA (Supervisory Control and Data Acquisition).

e) The annual turnover of the Organization was nearly Rs. 3380 crores during the year 2016-17.

Government vide order No. 69 BSR 2001 Bangalore, dated 15/02/2002 has unbundled KPTCL and formed four distribution companies. Consequent to this the function of distribution of power has been totally separated from KPTCL. KPTCL is now vested with the responsibility of transmitting power all over the State and construction and maintenance of Stations and lines of 66KV and above.

The four newly formed independent distribution companies, which were registered on 30/04/2002, are

- Bangalore Electricity Supply Company, (BESCOM)
- Mangalore Electricity Supply Company, (MESCOM)
- Hubli Electricity Supply Company (HESCOM)
- Gulbarga Electricity Supply Company (GESCOM)
- Chamundeshwari Electricity Supply Company (CESOM)

They have started functioning w.e.f. 01/06/2002. These companies are in charge of distribution of power within their jurisdiction. The Fifth Distribution Company Chamundeshwari Electricity Supply Corporation limited is a company incorporated under the company act 1956 and is a successor entity to Karnataka Power Transmission Corporation Limited (KPTCL) and MESCOM in respect of Distribution and retail supply of Electric power for five districts. Its operation started from 01.04.2005 as per the GOK order E.N.08 P.N. R 2005/262.

1.3 ABOUT HESCOM

First of all, the era of electricity is started as KEB (Karnataka Electricity Board) where it is managing all three wings of power system which are Generation, Transmission and Distribution. Later the government of Karnataka as part of reforms in power sector has unbundled the transmission and distribution activities in the state of Karnataka. As a result, the HESCOM limited was incorporated on 30/04/2002 under the companies act,1956 and the company started operation w.e.f.01/06/2002. The company came into existence with a geographical jurisdiction of Dharwad, Belagavi, Gadag, Haveri, Uttar Kannada, Bagalkot. Vijayapur with an objective to carry on the business of distribution and supply of electricity more efficiently and economically. The Company is operating from Hubbali city and covering the aeras where the agricultural consumption is comparatively on higher side. The company has withstood the initial transitional problems and achieved its objective of improving efficiency and better consumer services. The company today is functioning as a commercial entity in pursuance of power sector reforms undertaken by Government of Karnataka.

This year 2002-2003 was the first year of operation of the company. Hubballi Electricity Supply Company Ltd, (HESCOM) is a Distribution License under Section 14 of Electricity Act, 2003. Hescom is responsible for purchase of power, Distribution and retail supply of electricity to its consumers and also providing infrastructure for open Access, Wheeling and Banking. In its area of operation which includes seven districts of the state.

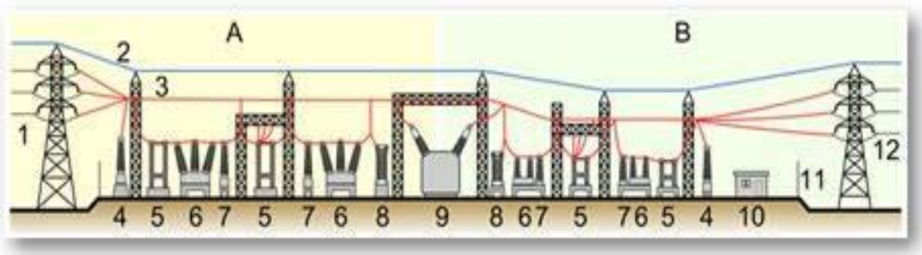
HESCOM is a company registered under the companies Act, 1956, incorporated on 30th April 2002. HESCOM commenced its operation on 1st June 2002. The O&M divisions of HESCOM are further divided into seventy-eight subdivisions. These subdivisions are further divided into 246 O&M section offices. Section offices are the base level offices looking into the operation and maintenance of the distribution system in order to provide reliable and quality power supply to the HESCOM'S consumers.

The company is presently operating through 2 zones, 7 circles, and 24 O&M divisions with an area of 54,513 sq. Kms & population of over 1.66Crs.

2.0 About Sub-station:

2.1 Electrical Sub-station:

An electrical substation is a subsidiary station of an electricity generation, transmission and distribution system where voltage is transformed from high to low or the reverse using transformers. Electric power may flow through several substations between generating plant and consumer, and may be changed in voltage in several substations between generating plant and consumer, and may be changed in voltage in several steps. A substation that has a step up transformer increases the voltage while decreasing the current, while a step-down transformer decreases the voltage while increasing the current for domestic and commercial distribution.



2.1 Fig: Figure of Substation

2.2 Elements of Sub-station:

1. Primary power lines	8. Lightening arrester
2. Ground wire	9. Main transformer
3. Overhead lines	10. Control building
4. Transformer	11. Security fence
5. Disconnect switch	12.Secondary power lines
6. Circuit breaker	A. Primary Power lines side
7. Current transformer	B. Secondary Power lines side

Table. No. 2.2: Elements of Sub-station

Sub-stations generally have,

- Switching equipment
- Protection equipment
- Control equipment
- One or more transformer

2.3 Design:

The main considerations taking into account during the design process are,

- Reliability
- Cost (sufficient reliability without excessive cost)
- Expansion of the station, if required.

2.4 Selection of the location of a substation must consider many factors:

- Sufficient land area
- Necessary clearances foe electrical safety
- Access to maintain large apparatus such as transformers
- The site must have room for expansion due to load growth or planned transmission additions.
- Environment effects, drainage, noise and road traffic effects.
- Grounding must be taking into account to protect passers-by during a short-circuit in the transmission system.
- The substation site must be reasonably central to the distribution area to be served.

3.0. SUBSTATION EQUIPMENTS

3.1 Power Transformer:

A transformer is a device used in the power transmission of electric energy. The transmission current is AC. It is commonly used to increase or decrease the supply voltage without a change in the frequency of AC between circuits. Transformer works on basic principles of electromagnetic induction and mutual induction.

Fig 3.1: Power Transformer

3.1.0. Functional parts of the power transformer

3.1.1. Laminated Iron Core:

A core of the transformer is made up of iron or silicon steel or ferromagnetic materials. The main function of Core to support the winding and to provide a flux flowing path in the magnetic circuit. The soft iron core which made by the metal strips lamination. Each metal strip has thickness near about the 0.5mm. In the figure, you can see the number of metal strips connected to each other with the lamination layer and form a single core.

Laminated Iron Core provides a low reluctance path and high permeability for the flux in the magnetic circuit. And this lamination of the core helps to reduce the eddy current loss and hysteresis loss.

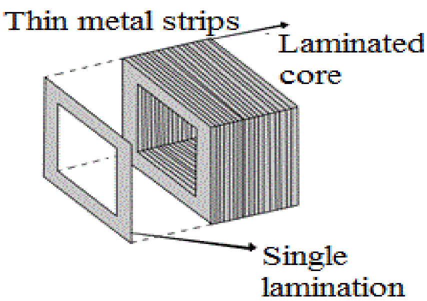


Fig.3.1.1: Laminated iron core

3.1.2 Winding of the Transformer:

The transformer winding is consists of several turns of the copper coil. It is wrapped around the limb or core with the lamination. These windings laminated by the insulation coating because it prevents the short circuit condition.

The winding of the transformer is separated by the primary side and secondary side. On the bases of supply two types as.

I. High voltage winding
II. Low voltage winding

3.1.3 Transformer Tank:

The transformer tank is a cylindrically shaped tank. It is made of steel metal with a high thickness. Core and transformer winding is placed in the transformer tank. The transformer tank is needed to store the oil especially mineral oil. This oil provides insulation and cooling to the transformer winding.

Fig 3.1.3: Transformer Tank

3.1.4 Bushing:

The bushing is an insulating device that is made up of porcelain materials. The terminal of the brushing is provided a path of the conductor to the transformer tank. With the help of the terminal, the transformer gives and provides the supply to another system. In the transformer, two types of the bushing are mostly used – high voltage (HV) bushing and low voltage (LV) bushing. Its rely on the voltage rating may be a high voltage or low voltage.

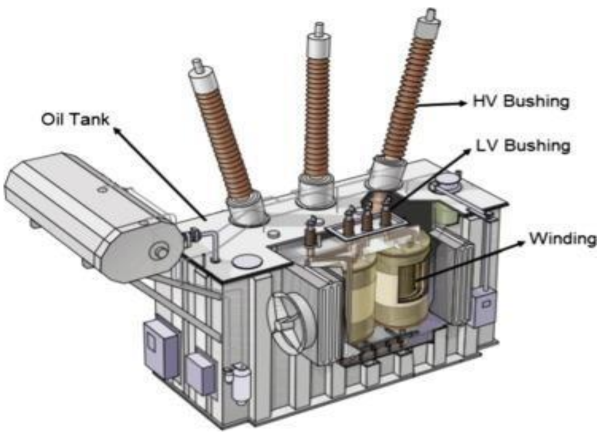


Fig.3.1.4: Bushing

3.1.5 Cooling Tube and Radiator:

The cooling tube is necessary for maintaining the temperature and circulating cooling oil in the transformer. And the radiator is connected with the transformer tank. It is also made of a number of metal strips or pipes. Both the cooling tube and the radiator provide the same function in a different way. When losses occur in the transformer, heat is produced. This heat absorbs by the cooling tube and radiator in the form of cooling systems. It is divided into two types of cooling systems.

- Natural cooling system
- Forced cooling system

In the natural cooling system, a cooling tube and radiator are used. And in the forced cooling system, we can connect extra air fan to the transformer.

3.1.6 Oil temperature Indicator:

Fig 3.1.6: Oil temperature Indicator

It measures the top oil temperature and is used for control and protection of transformer

3.1.7 Winding Temperature Indicator:

Fig 3.1.7: Winding Temperature Indicator

It is specially designed heater which is placed around the operating bellows through which proportional to current passing through the transformer subjected to a load given. It is measured by connecting CT secondary through a shunt resistor inside the WTI to heater coil around the operating bellows.

3.1.8 Oil Surge Relay:

Fig 3.1.8: Oil Surge Relay

It protects the malfunction developed inside the on-load tap changer. It is installed in the pipe between OLTC and oil conservator. It is the protective relay trigger the tripping circuit when the oil exceeds the specified limit.

3.1.9 Pressure Relief Device:

PRD (Pressure Relief Device) is a device which is used for avoiding high oil pressure builds up inside the transformer during the fault conditions. It is fitted on the top of the main tank. The PRD allows rapid release of excessive pressure that may be generated in event of a serious fault. This device is fitted with an alarm/trip switch.

Fig 3.1.9: Pressure Relief Device

3.2.0 Nitrogen Fire Extinguisher:

Different types of Power Transformers are used in power system. The most commonly used Power Transformer is oil filled type. Oil acts as insulating and cooling media. Internal fault that results in an arc inside transformer will cause fire. The fire may spread resulting from ignition of oil, causing explosion of tank, rupture of tank, core and winding and also burning the neighboring equipment’s. Hence, adequate fire protection and extinguishing arrangements are necessary for quenching the fire in the apparatus.

The “Nitrogen injection and drain method” is one of the best fire prevention and extinguishing system for oil filled transformers for indoor/outdoor use. This system is fully automatic and unattended, maintenance free and low cost compare to other systems.

Reasons for fire in oil filled transformers:

1.Fire due to internal causes:

2.Fire due to external causes:

3.Damages caused due to the fire in Oil filled Transformers:

3.2.1 Circuit Breakers:

Circuit breaker is equipment which can open or close a circuit under normal as well as fault conditions. It can be operated manually or using remote control under normal condition and automatically under fault condition. For the latter, relay circuits are used. It consists of moving and fixed contacts enclosed in strong metal tank. Under normal condition contacts remain closed and the CT senses the breaker and it carries full load current.

Fig 3.2.1: Circuit Breakers

When fault occurs, the over-current in the CT primary winding increases the secondary EMF thus energizing the trip coil and moving contacts are pulled down, thus opening the contacts and hence the circuit. The arc produced during is quenched by different medium like SF6 gas, vacuum etc.

3.2.2 Bus-Bars:

The no of lines operating at the same Voltage are directly connected to a common Electrical component called Bus Bar. Bus Bar is of Copper or Aluminium rectangular in cross section operates at constant Voltage. Various incoming & outgoing lines in sub-stations are connected to Bus Bar. Bus Bars receive power from incoming circuits and deliver power to outgoing circuits

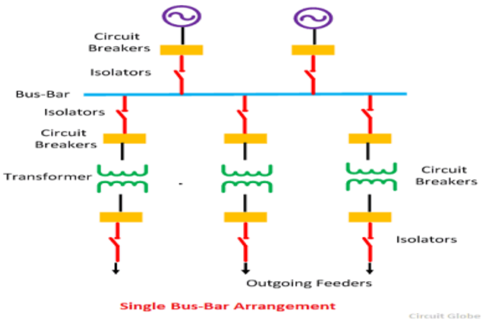


Fig 3.2.2(a) : Bus-Bars

Fig 3.2.2 (b): Single Bus-bar Arrangements

3.2.3 SF6 circuit breaker:

In an SF6 circuit-breaker, the current continues to flow after contact separation through the arc whose plasma consists of ionized SF6 gas. For, as long as it is burning, the arc is subjected to a constant flow of gas which extracts heat from it. The arc is extinguished at current zero, when the heat is extracted by the falling current. The continuing flow of gas finally de- ionizes the contact gap and establishes the dielectric strength required to prevent a re-strike.

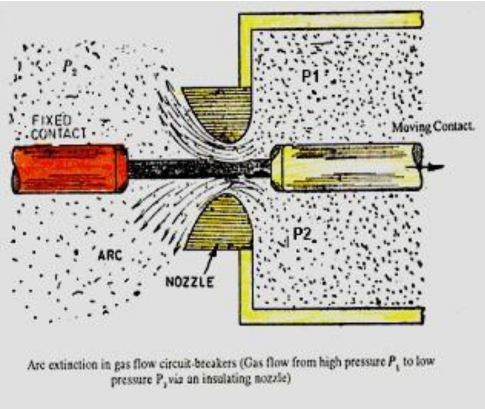


Fig3.2.3:SF6circuitdiagram

The direction of the gas flow, i.e., whether it is parallel to or across the axis of the arc, has a decisive influence on the efficiency of the arc interruption process.

3.2.4 Instrument Transformers:

The lines in the substation operate at high voltage and carry current of thousands of amperes. The measuring instruments and protective devices are designed for low voltage and current and they cannot be used directly on the power lines. This difficulty is overcome by installing instrument transformers. The function is to transfer voltage or current in the power line to values convenient for the operation of measuring instruments and relays. The types of instrument transformers in the substation are:

1) Current Transformer
2) Potential transformer
3) Capacitor voltage transformer (CVT)

3.2.5 Potential Transformers:

The Potential transformer keeps the voltage level within the optimum range. It steps down the transmission end higher voltage to the protection end lower voltage. The protection circuitry is present on the lower voltage side.

PT Details:

Voltage	Voltage Ratios	Connected Ratio
220kV	220kV/110V	220kV/110V
66kV	66kV/110V	66kV/110V
11kV	11kV/110V	11kV/110V

Fig 3.2.5: Potential Transformer

Fig.3.2.5: Potential transformer ratings

3.2.6 Current transformers:

A current transformer reduces or step downs ac currents from higher value lower value. The current transformer steps down the transmission end high current to protection end range.

Fig. 3.2.6 Current Transformer

CT Detail:

Voltage/Line Level	Current Ratios	Connected Ratio
220kV	800/600/400/300/1A	800/1A
66kV	400/200/1A	400/1A
11kV	200/1A	200/1A

Fig.3.2.6: Current transformer rating

3.2.7 Capacitive Voltage Transformer:

Capacitive voltage transformer is a type of voltage transformer which reduces or step downs ac voltages from higher value to lower value.

Fig.3.2.7: Capacitive Voltage Transformer

Details of 220kV line Capacitive Voltage Transformer:

Rated Voltage	230/√3 V
Rated Output	120-40 VA
Total output	120 VA
Weight	1146 lbs.
Rated Load Current	230A
Rated Capacitance	2200pF
Class	AE

Fig.3.2.7: Capacitive Voltage Transformer ratings

3.2.8 Isolators:

In order to disconnect a part of the system for general maintenance and repair, isolator are used. It is a knife switch, designed to open circuit under no load. If isolators are to be opened, the CB connected must be opened first. Otherwise, there is a possibility of the occurrence of the spark at the isolator contacts. After repair, Isolators are first closed at and then the CB is closed. The two types of isolators are line isolators & bus isolators. For bus isolators, there is no earth switch. These are usually located at each side of the circuit breaker.

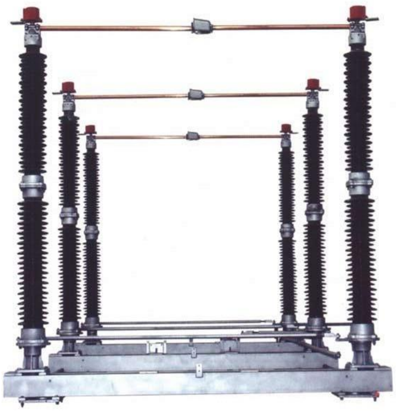


Fig.3.2.8: Isolator

3.2.9 Lightning Arresters:

Lightning Arrestors are used to protect electrical equipment's from damage due to lightning. The high voltage during lightning is discharged to ground by Lightning Arresters. It is usually the first component on the circuit of an incoming line or a Power Transformer. One end of the Lightning Arrestor is connected to the line and the other end to ground. In this substation metal oxide arrestors are used.

fig.3.2.9: Lightning Arresters

Details of 220kV and 66kV lightning arrestor:

Voltage class	220kV	66Kv
Rated Voltage	198kV	60kV
Discharge current	10kA	10kA
Frequency	50Hz	50Hz
Pressure relief class	40kA (rms)	40kA (rms)

Fig.3.2.9: Lightning arrestor ratings

3.3.0 Protective Relays

The protective relaying is one of the several features of power system design. Every part of the power system is protected. The relay is used to give an alarm or to cause prompt removal of any element of power system from service when that element behaves abnormally.

Types of relays used:

- Auto reclose relay
- Earth fault relay
- Winding temperature relay
- Master tripping relay
- Over current relay
- Distance protection relay
- Differential relay
- Trip circuit relay
- Auxiliary relay
- Directional Over current relay

Fig.3.3.0: Relay

3.3.1 Auxiliary room [DC Supply Room]: -

In every sub – station & receiving station a small transformer known as station transformer is installed to supply power to the sub – station & control room at the voltage of 440 V & 230 V. This auxiliary supply is required for lighting circuit, protective circuit & working of auxiliary instruments and for charging the battery. It consists of 55 Batteries connected in series, 2 volts each, thus making a total of 110 volts. In case of DC failure, the power supply must be disconnected because all instrument devices and relays and circuit breakers won't operate. A Battery Charger is present which charges the batteries.

Battery room:

Substation batteries play a vital role in overall reliability of a substation by providing dc power for protection, supervision and control of substation and line equipment. Frequently, transmission or distribution power will be lost or reduced in magnitude during system disturbances (faults) at precisely the same point in time that power is required to isolate the disturbance from the system. Power to control and supervise system components is necessary during any large-scale or system- wide loss of ac power in order to provide circuit-switching power during restoration operations. Continuous monitoring of equipment (and therefore, a continuous power source) is required to detect abnormal conditions.

Fig.3.3.3.1: Battery room of Sub-station

3.3.2 Air Breaker Switch:

Air breaker switch is an isolator. With an air control device & are used for making & breaking the low voltage power line during load condition also.

3.3.3 Fuses:

Fuses are the simple protective devices which protect the circuit from over voltage & short circuit. Fuses are placed in series with circuit to be protected.

3.3.4 Earth Switch:

An earth switch is placed at the incoming & outgoing side of the line. Earth switch is normally open, if there is any repair and maintenance work to be carried then the supply of the line is cut by the circuit breaker then isolators are opened and afterwards earth switch is closed which will discharges all static current on the line to the earth

4. COMMUNICATION NETWORKS

For the operation and administration of an interconnected power system an efficient system of communication is very much essential. The remote control of station demands availability of information of all kinds hence communication networks play a very important role in interconnected power systems.

Important values such as active load have to be telemeter from the various stations to the load dispatch center. High speed carrier relaying is employed on all important connecting lines equipped with automatic reclosure. The equipment required for various services mentioned above are classified as power system communication equipment. The primary modes of communication adopted in KPTCL are

- Power Line Carrier Communication.
- VSAT satellite communication.
- SCADA

4.1: Power Line Carrier Communication:

Carrier communication over power lines is the preferred means of communication when large distance has to be covered. All the data are sent to desired centers through high voltage lines which connect various station and acts as a medium for communication. This is called power line carrier communication. The modulated signal is super imposed on the low frequency power (50 Hz) flow through the high-tension line. The modulated signal carrying the message and data has got a power of about 25W that is sufficient to reach the far end. The carrier equipment’s are trans-receivers and hence transmission and reception occurs at different frequencies to avoid overlapping. Wave Trap, Coupling Capacitor, Telephone equipment, Battery and Float Chargers, are used in Power line carrier communication.

4.2: VSAT Satellite Communication (very small aperture terminal):

In satellite communication the digital data is transmitted over the satellite channel. The satellite channel consists of an uplink, a transponder and a downlink. The uplink connects a transmitting station o ground to the transponder on board a satellite positioned in the geostationary orbit around and earth. The downlink connects the transponder to receiving ground station (at a remote distance away from the transmitter). This is designed to provide an adequate amplification to overcome the effects of the channel noise.

4.3: Supervisory Control and Data Acquisition Center (Scada):

A SCADA system consists of a number of remote terminal units (RTUs) collecting field data and sending that data back to a master station, via a communication system. The master station displays the acquired data and allows the operator to perform remote control tasks.

The accurate and timely data allows for optimization of the plant operation and process. Other benefits include more efficient, reliable and most importantly, safer operations. This result in a lower cost of operation compared to earlier non-automated systems.

On a more complex SCADA system there are essentially five levels or hierarchies:

- Field level instrumentation and control devices
- Marshalling terminals and RTUs
- Communication system
- The master station(s)
- The commercial data processing department computer system

The RTU provides an interface to the field analog and digital sensors situated at each remote site. The communication system provides the pathway for communication between the master station and the remote sites. This communication system can be wire, fiber optic, radio, telephone line, microwave and possibly even satellite. Specific protocols and error detection philosophies are used for efficient and optimum transfer of data.

The master station (or sub-masters) gathers data from the various RTUs and generally provides an operator interface for display of information and control of the remote sites. In large telemetry systems, sub master sites gather information from remote sites and act as a relay back to the control master station. The initial cost of a SCADA system is high. However, it is justified by the following typical reasons:

- Improved operation of the plant or process resulting in savings due to optimization of the system
- Increased productivity of the personnel
- Improved safety of the system due to better information and improved control

- Protection of the plant equipment
- Safeguarding the environment from a failure of the system
- Improved energy savings due to the optimization of the plant
- Improved and quicker receipt of data so that clients can be invoiced more quickly and accurately
- Government regulations for safety and metering of gas (for royalties and tax etc)

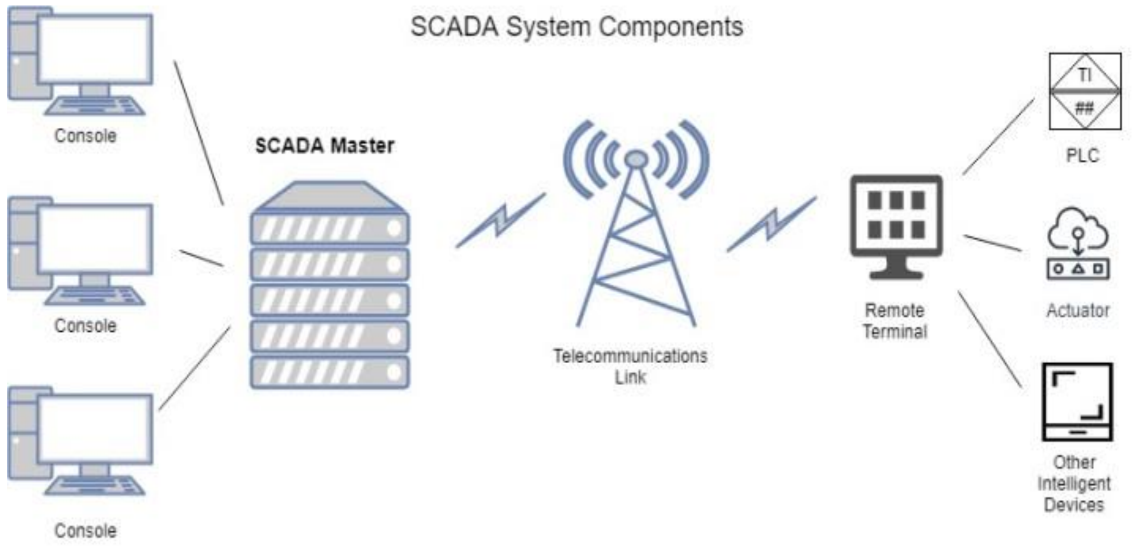


Fig.4.3: Scada System Components

4.4: Control Components:

The following is a list of the major control components of an ICS:

Control Server. The control server hosts the DCS or PLC supervisory control software that is designed to communicate with lower-level control devices. The control server accesses subordinate control modules over an ICS network.

SCADA Server or Master Terminal Unit (MTU):

The SCADA Server is the device that acts as the master in a SCADA system. Remote terminal units and PLC devices (as described below) located at remote field sites usually act as slaves.

Remote Terminal Unit (RTU):

The RTU, also called a remote telemetry unit, is special purpose data acquisition and control unit designed to support SCADA remote stations. RTUs are field devices often equipped with wireless radio interfaces to support remote situations where wire- based communications are unavailable. Sometimes PLCs are implemented as field devices to serve as RTUs; in this case, the PLC is often referred to as an RTU.

Programmable Logic Controller (PLC):

The PLC is a small industrial computer originally designed to perform the logic functions executed by electrical hardware (relays, drum switches, and mechanical timer/counters). PLCs have evolved into controllers with the capability of controlling complex processes, and they are used substantially in SCADA systems and DCSs. Other controllers used at the field level are process controllers and RTUs; they provide the same control as PLCs but are designed for specific control applications. In SCADA environments, PLCs are often used as field devices because they are more economical, versatile, flexible, and configurable than special-purpose RTUs.

Intelligent Electronic Devices (IED):

An IED is a “smart” sensor/actuator containing the intelligence required to acquire data, communicate to other devices, and perform local processing and control. An IED could combine an analog input sensor, analog output, low-level control capabilities, a communication system, and program memory in one device. The use of IEDs in SCADA and DCS systems allows for automatic control at the local level.

Human-Machine Interface (HMI):

The HMI is software and hardware that allows human operators to monitor the state of a process under control, modify control settings to change the control objective, and manually override automatic control operations in the event of an emergency. The HMI also allows a control engineer or operator to configure set points or control algorithms and parameters in the controller. The HMI also displays process status information, historical information, reports, and other information to operators, administrators, managers, business partners, and other authorized users. The location, platform, and interface may vary a great deal.

Data historian:

The data historian is a centralized database for logging all process information within an ICS. Information stored in this database can be accessed to support various analyses, from statistical process control to enterprise level planning.

Input/Output (IO) Server:

The IO server is a control component responsible for collecting, buffering and providing access to process information from control sub-components such as PLCs, RTUs and IEDs. An IO server can reside on the control server or on a separate computer platform. IO servers are also used for interfacing third-party control components, such as an HMI and a control server.

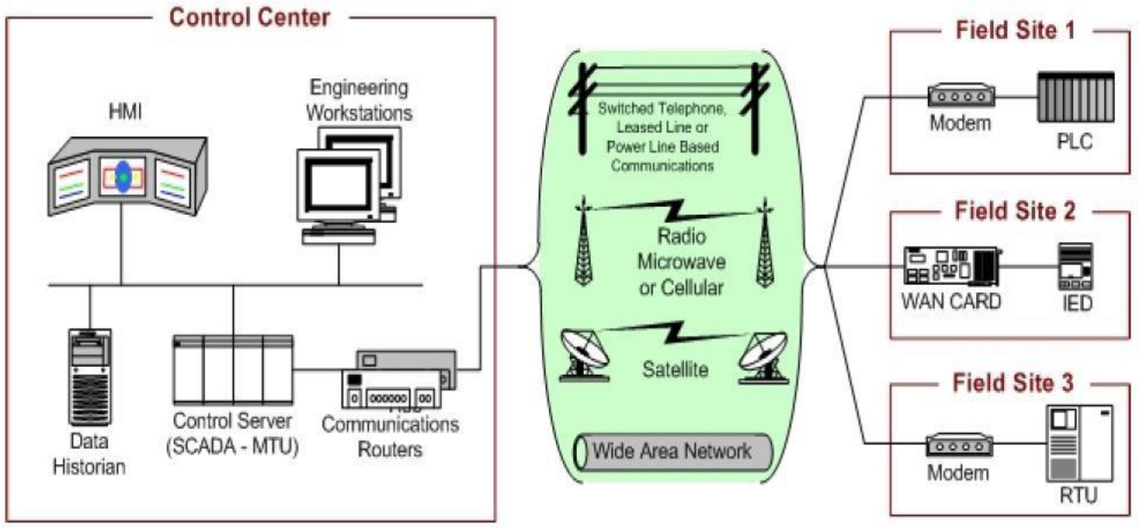


Fig.4.2: Control system of Scada

5.The substations which we have visited during our internship are as follows in the table:

1) CSD-1 : O&M City Sub division-1, HESCOM, Belagavi
2) DIV : O&M Urban Division, HESCOM, Belagavi
3) SS RM1 : 33KV RM-1, Sub Station, HESCOM, Belagavi
4) CO : Corporate Office, HESCOM, Hubballi
5) SO2 : O&M Section Office -2, HESCOM, Belagavi
6) MT DIV BGM: MT Division, HESCOM, Belagavi

5.1: CSD-1 (O&M City Sub division-1): 33/11kV Substation:

Specification of the substation:

1. Operating Voltage: 33/11kV
2. Number of incoming lines: 1
3. Number of power transformer: 3
4. Capacity of power transformer: 5MV each
5. Safety equipment's: Lightning arrester, Circuit breakers, GOS
6. Number of outgoing feeders: 10
7. Capacity of CT's: 11kV, 800-400/1A & 11kV,800-400/1A & 11kV,800- 400/1A
8. Capacity of PT's: 11kV each
9. Types of circuit breakers: SF6 (Sulphur hexafluoride) & MCVCB (vacuum circuit breaker)
10. Types of relays: OCR (Over Current Relay) & EFR (Earth Fault Relays)

There are only one incoming lines of 110kV. It receives from Nehru Nagar. All the three transformers are connected to 33kV which is stepped down to 11kV**.** Three transformers are connected to the single bus bar to step down the voltage with all the protective devices such as isolator, circuit breaker, GOS, LA. The CT's and PT's are fixed at main bus bars, feeders and feeder bus bars for measuring the current and voltage respectively. The 11kV lines are carried up to respective load centers to feed the consumer again by step downing the voltage from 11k/V to 3 phase 440V AC, then supply is given to the consumer from service mains by means of phase and neutral.

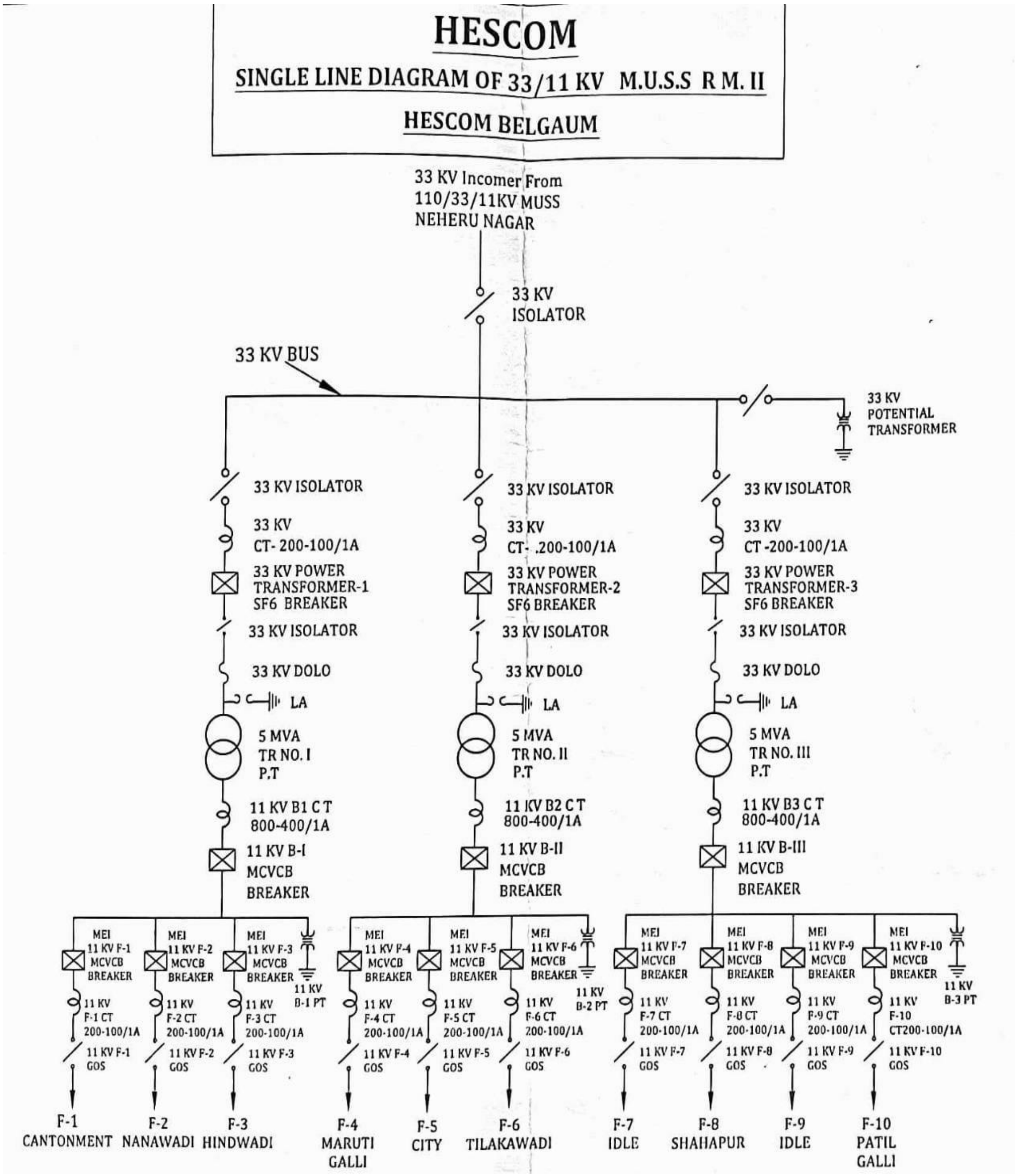


Fig.5.1: Single Line Diagram

Feeders of Substation:

F1. Cantonment	F6. Tilakawadi
F2. Nanawadi	F7. Idle
F3. Hindwadi	F8. Shahapur
F4. Maruti Galli	F9. Idle
F5. City	F10.Patil Galli

Table 5.1: Feeders of the CSD-1 Sub-station

5.2: DIV (O&M Urban Division): 110/33/11kV Substation:

Specification of Substation:

1. Operating voltage: 110/33/11kV

2. Number of incoming lines: 2

3.Number of power transformer: 4

4.Capacity of power transformer: 20MVA,110/33kV (2) & 110/11kV (2)

5.Safety equipment's: Lightning arrester, Circuit breakers, GOS

6.Number of outgoing feeders: 17

7.Capacity of CT's: 110kV,800-400/1A & 33kV,400-200/1A & 11kV,200-100/1A

8.Capacity of PT's: 110kV & 33kV & 11kV

9.Types of circuit breakers: SF6 (Sulphur hexafluoride) & MCVCB (vacuum circuit breaker

10.Types of relays: OCR (Over Current Relay) & EFR (Earth Fault Relays)

There are two incoming lines of 110kV. One from Indal and the other from Kanabargi receiving stations. Among Four transformers two are connected to the 33kV line and the other two are connected to the 11kV line. Line arresters of specific ratings are also present. A capacitor banks are used to correct a power factor or phase shift in an AC power supply. Lead acid batteries are being used in the control room. Protective devices such as lightning arrester, and SF6 circuit breakers are used for the higher rating transmission and Vacuum circuit breakers are used for lower rating transmission. Two transformers are of air forced, oil natural. And other two are air natural, oil natural. 33kV line from transformers to feeders is underground, 11kV lines are overhead lines.

Batteries are used for maintenance of Relays and specific gravity. CT's and PT's are used to reduce the current and voltage levels for the metering purpose.

Fig.5.2: Group Image of internship students at Nehru Nagar Sub-station

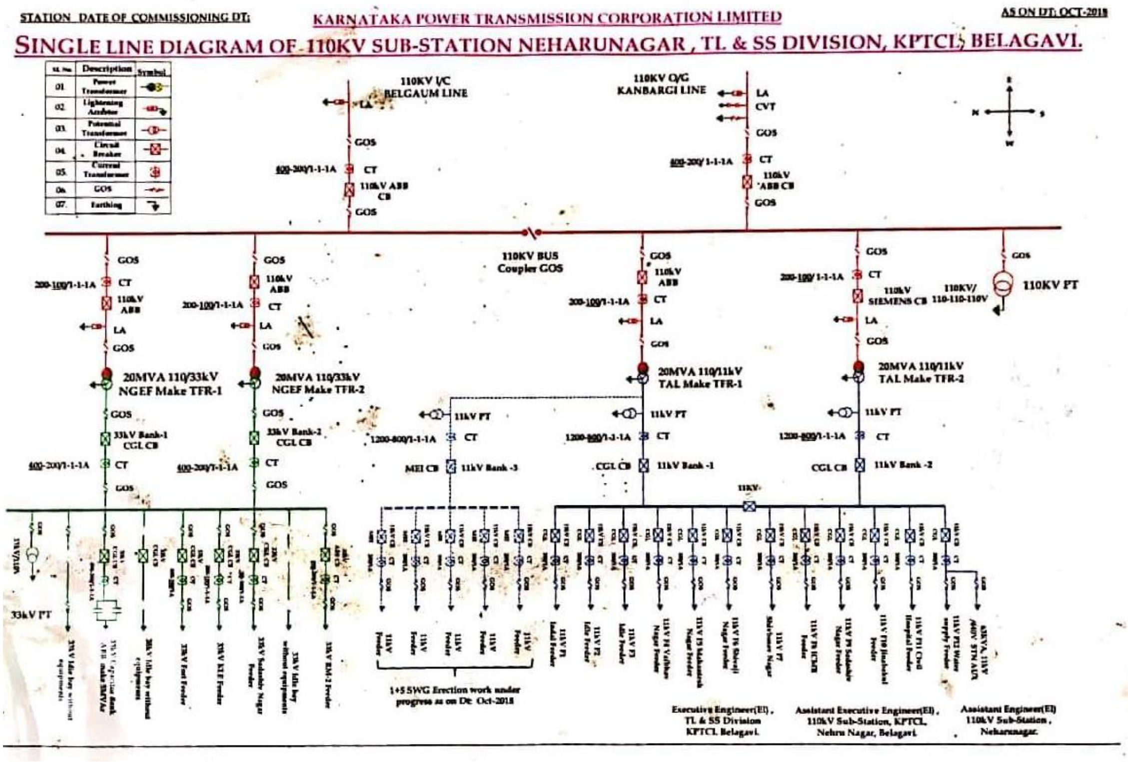


Fig.5.2: Single line diagram

Feeders of the Substation:

F1: Fort	F9: M. M. EXT
F2: KLE	F10: Shivaji Nagar
F3: Sadashiv Nagar	F11: Shivbasav Nagar
F4: RM-2	F12: ICMR
F5: Indal	F13: Jimabakul
F6: Auto Nagar	F14: Civil Hospital
F7: Sambra	F15: Water works
F8: Vaibhav Nagar	F16: Station Auxiliary

Table 5.2: Feeders of Nehru Nagar Sub-station

5.3: SS RM1: 33KV RM-1 Sub Station: 33/11kV Sub-station

Specification of Substation:

1.Operating Voltage: 33/11kV

2.Number of incoming lines: 1

3.Number of power transformer: 3

4.Capacity of power transformer: 5MV each

5.Safety equipment's: Lightning arrester, Circuit breakers, GOS

6. Number of outgoing feeders: 10

7.Capacity of CT's: 11kV, 800-400/1A & 11kV,800-400/1A &

11kV,800- 400/1A

8.Capacity of PT's: 11kV each

9.Types of circuit breakers: SF6 (Sulphur hexafluoride) & MCVCB (vacuum circuit breaker)

10.Types of relays: OCR (Over Current Relay) & EFR (Earth Fault Relays)

There are two incoming lines for the substation of 33kV. One from Macche and other one is from Vadgaon. Three transformers are connected to the single bus bar to step down the voltage with all the protective devices such as isolator, circuit breaker, GOS, LA. The CT's and PTs are fixed at main bus bar, feeders and feeder bus bars for measuring the current and voltage respectively. The 11kV lines are carried up to respective load centers to feed the consumer again by step downing the voltage from 11kV to 3-phase 440V AC, then supply is given to the consumer from service mains by means of phase and neutral.

Feeders of the station:

F1: Station Control	F6: Udyambag 2
F2: Udyambag	F7: Majagaov
F3: RPD	F8: Haliyar
F4: Idle	F9: Phadke
F5: KLE	F10: Idle

Table 5.3: Feeders of SS RM1 Sub-station

5.4: CO (Corporate Office): Head office of Hescom at Hubballi

In this section we have learnt about the SCADA:

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organization to control industrial processes locally or at remote locations. Monitor, gather, and process real-time data.

Fig.5.4: Karnataka State Power Flow

Fig. 5.4.a: Image of the internship Student at Hubblli

Architecture of Scada system:

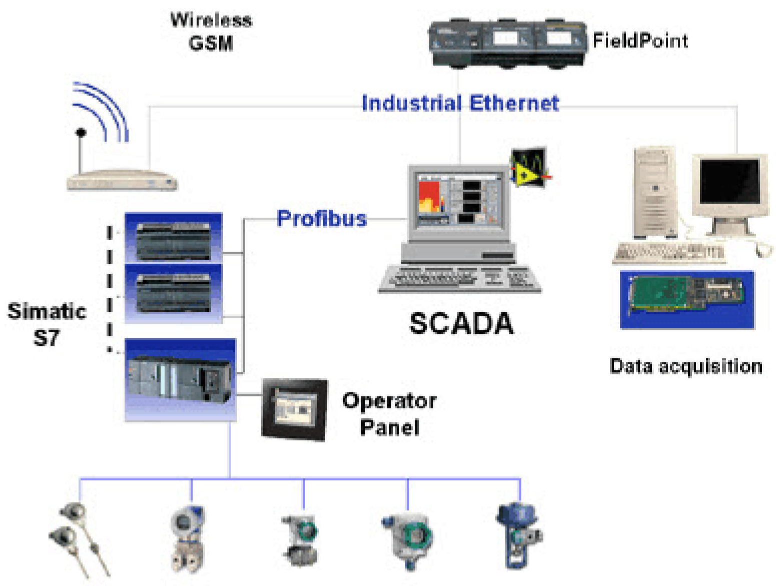


Fig.5.4. b: Architecture of Scada System

Advancement in Intelligent Instrument and Remote Terminal Units (RTU's) / Programmable Logical Controllers (PLC's) have made the process-control solution in many of the industries to be easily managed and operated by utilizing the benefits of a Scada system.

Applications Of Scada:

- Process industries
- Oil and gas,
- Electrical power generation
- Distribution and utilities
- Water and waste control, and so on

SCADA in power system can be defined as the power distribution application which is typically based on the software package. The electrical distribution system consists of several substations; These substations are have multiple number of controllers, sensors and operator-interface points.

In general, for controlling and monitoring a substation in real time PLCs, Circuit breakers and power monitors are used. Data is transmitted from the PLCs and other devices to a computer-based-Scada node located at each substation. One or more computers are located at different centralized control and monitoring points.

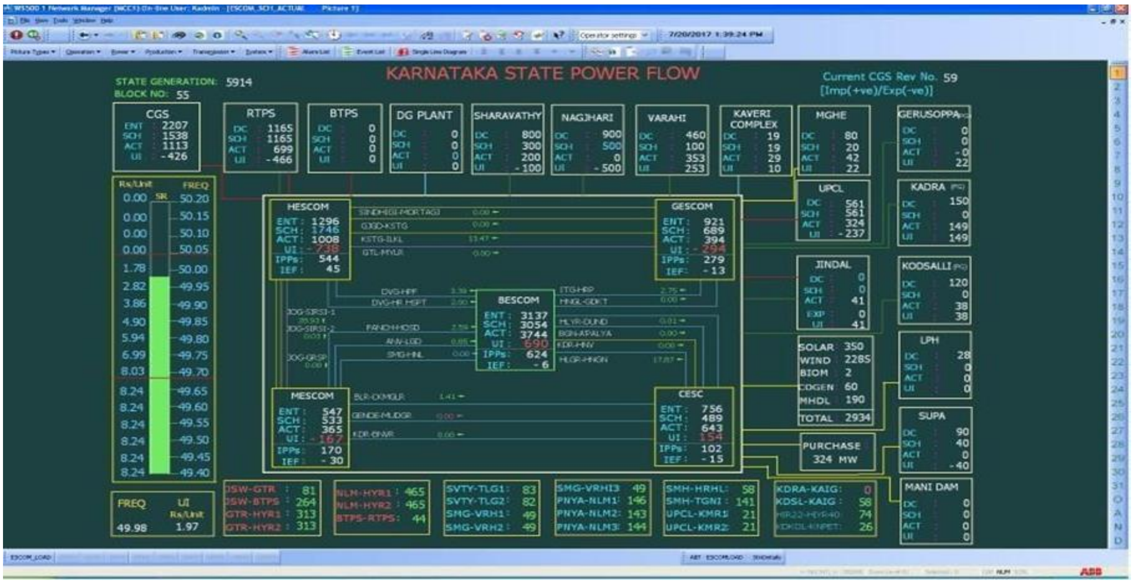


Fig.5.4. a: Karnataka State Power Flow

Scada system usage have became popular from the 1960s with the increase in need of monitoring and controlling the equipment. Early systems are built using mainframe computers were expensive as they were manually operated and monitored. SCADA systems with maximum efficiency at reduced cost, according to the alarming requirements of the company.

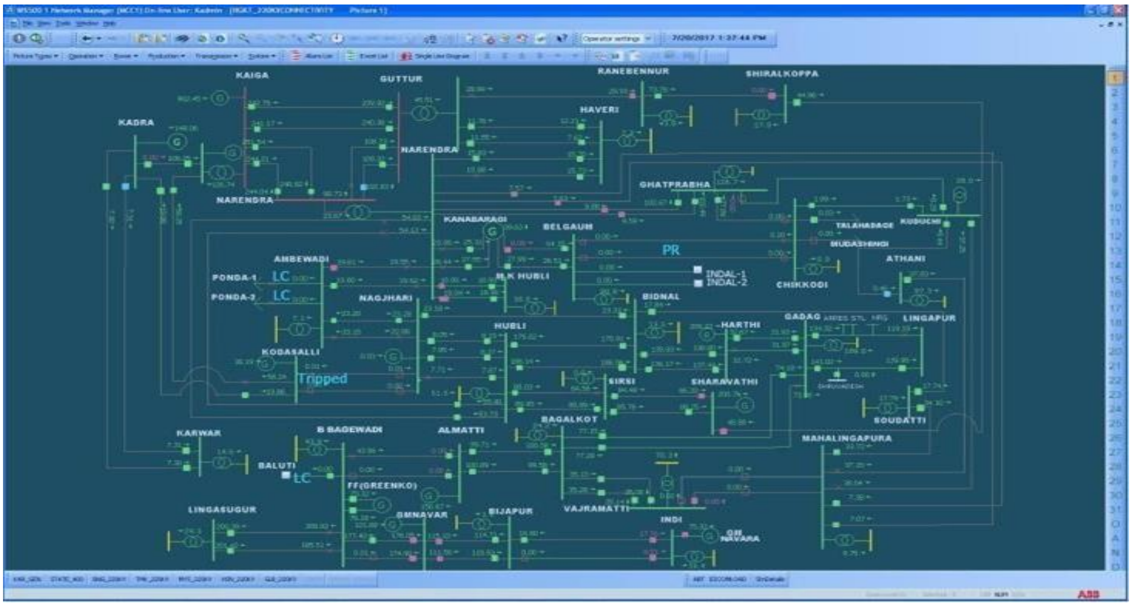


Fig.5.4. b: Different sub-stations under Hescom

5.5: SO_2 (O&M Section Office -2): 33/11kV Substation

There are two primary substation insulation systems in the world, Gas insulation and Air insulated substation. Simply put, in the GIS system, all the live components are enclosed in a grounded metal enclosure, then the whole system housed in a chamber full of gas. Gas insulated substations (GIS) primarily use sulphur Hexafluoride gas as the primary insulator. SF6 is non-toxic, maintains atomic and molecular properties even at high voltages, high cooling properties, and superior arc quenching properties.

This station is also GIS (Gas Insulated Station).

Specification of Sub-station:

1.Operating voltage: 33/11kV

2.Number of incoming lines: 2

3.Number of power transformer: 3

4.Capacity of power transformer: 8MVA each

5.Safety equipment's: Lightning arrester, Circuit breakers, GOS

6.Number of outgoing feeders: 14

7.Capacity of CT's: 33kV, 200-100/1A &11kV, 200-100/1A

8.Capacity of PT's: 33/11kV

9.Types of circuit breakers: SF6 (Sulphur hexafluoride)

10.Types of relays: OCR (Over Current Relay) & EFR (Earth Fault Relays)

.

Fig.5.5.1: SO_2 Sub-station

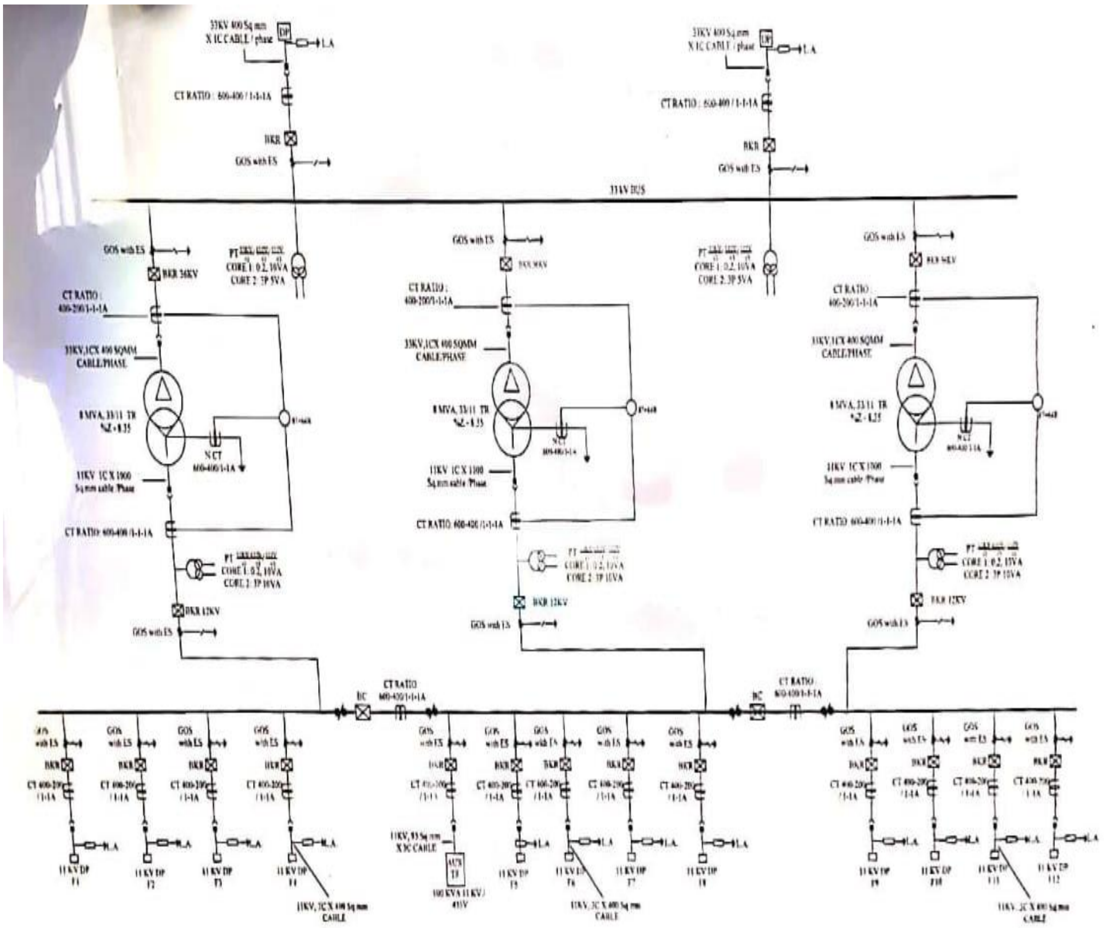


Fig.5.5.2: Single line diagram

Feeders of the station:

F1. Idle	F7. MES
F2. Hindwadi	F8. Cantonment
F3. Jakkai Honda	F9. Idle
F4. Swami Vivekananda	F10. Idle
Aux	F11. Nanawadi
F5. Patil	F12. Shahpur
F6. City	F13. Kaphilwar

Fig.5.5: Feeders of the SO_2 Sub-station

5.6: MT DIV BGM (Meter testing division):

Meter testing:

Fig.5.6: Meter Testing

The performance tests of an energy meters as per the IEC standards are divided mainly in three segments which include its mechanical aspects, electrical circuiting and climatic conditions.

1. Mechanical component tests.
2. Climatic conditions test includes those limits which influence the performance of the meter externally.
3. Electrical requirements covered many tests before giving accuracy certificate. Under this segment, energy meter is tested for.

The accuracy of the power and energy reference meter is available up to0.01%. The reference meter measures all main and influencing quantities inclusive harmonic analysis and distortion of the test signals.

Standard Tests for Energy Meters:

- Mechanical component test.
- Climatic conditions test includes those limits which influence the performance of the meter externally.
- Electrical requirements covered many tests before giving accuracy certificate. Under this segment, energy meter is tested for.
- Heating effect
- Proper Insulation
- Supply of Voltage
- Electromagnetic compatibility

Types of Energy meters:

- Electro Mechanical induction type Energy Meters
- Electronic Energy Meters
- Smart Energy Meters

Revolution of Energy Meter:

Fig.5.6: 3 Phase energy meters

Fig.5.6. a: 3 Phase energy meters

Fig.5.6. b: Single Power Energy Meters

Specification of Substation:

1.Operating voltage: 33/11kV

2.Number of incoming lines: 2

3.Number of power transformer: 2

4.Capacity of power transformer: 5MVA, 33/11kV each

5.Safety equipment’s: Lightning arrester, Circuit breakers, GOS

6.Number of outgoing feeders: 6

7.Capacity of CT’s: 33kV, 200-100/1A &11kV, 200-100/1A

8.Capacity of PT’s: 33/11kV

9.Types of circuit breakers: SF6 (Sulphur hexafluoride)

10.Types of relays: OCR (Over Current Relay) & EFR (Earth Fault Relays)

There are two incoming lines for the substation of 33kV. One from Nehru nagar and other one is from Vadgaon. Three transformers are connected to the single bus bar to step down the voltage with all the protective devices such as isolator, circuit breaker, GOS, LA. The CT’s and PTs are fixed at main bus bar, feeders and feeder bus bars for measuring the current and voltage respectively. The 11kV lines are carried up to respective load centers to feed the consumer again by step downing the voltage from 11kV to 3-phase 440V AC, then supply is given to the consumer from service mains by means of phase and neutral.

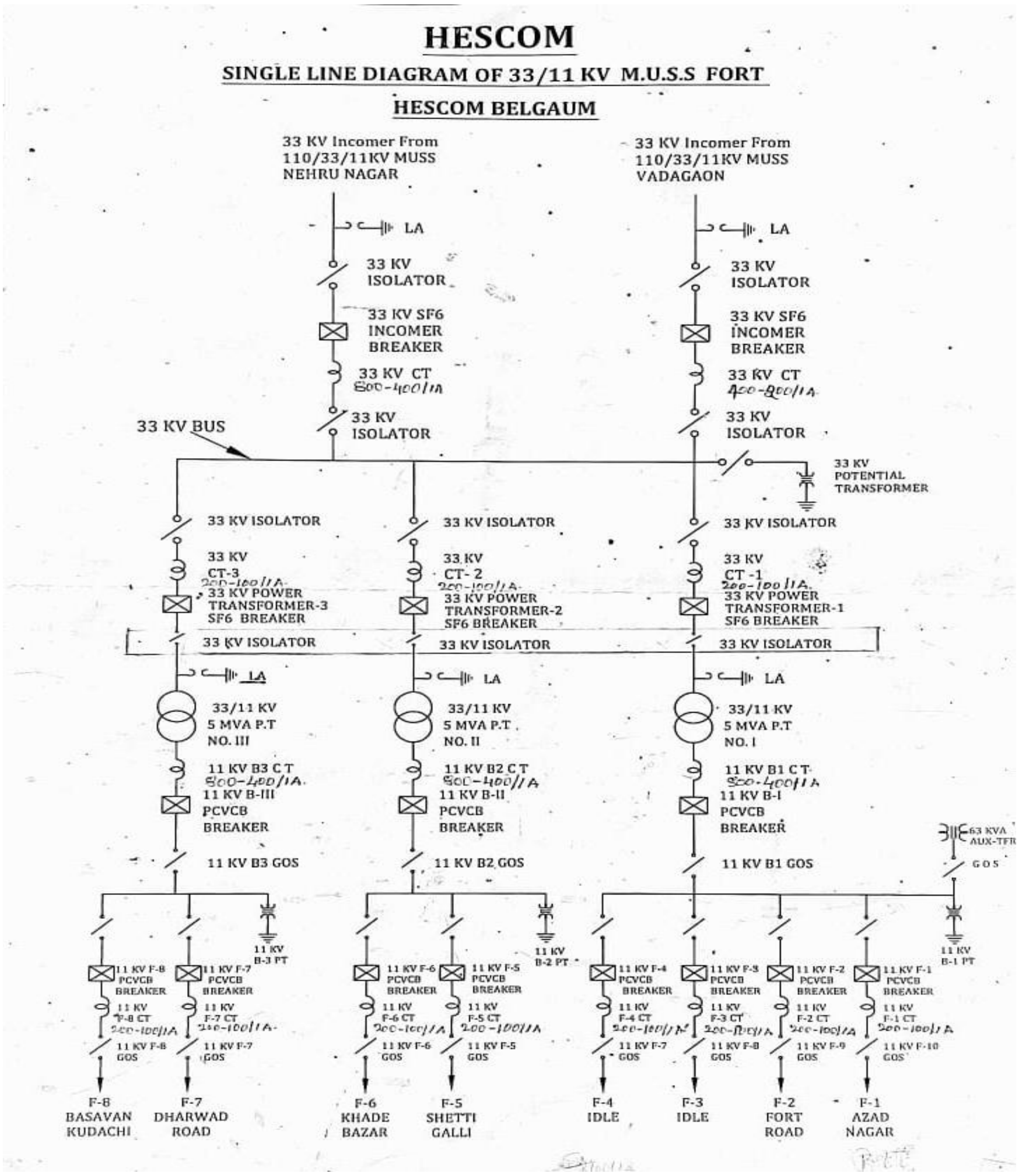


Fig.5.6: Single line Diagram

Feeders of the station:

F1: Azad Nagar	F5: Shetti Galli
F2: Fort Nagar	F6: Khade Nagar
F3: Idle	F7: Dharwad Road
F4: Idle	F8: Basavan Kudachi

Table 5.6: Feeders of MT DIV Sud-station

6. Conclusion:

Overall, the training was very helpful in gaining technical knowledge as well as the professional ethics followed in industries. Training was highly beneficial for understanding the various operational aspects of substations and related things. The training involved thorough learning, understanding and application of various technical aspects in real time. Training gave exposure to practical application of theoretical aspects in real time.

I believe this training would help me in building a good platform for my career.

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