ENERGY SOLUTION TO INDUSTRIAL EVOLUTION: QUASI APPROACH

BY

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99/8086EE

DEPARTMENT OF ELECTRICAL AND

COMPUTER ENGINEERING

SCHOOL OF ENGINEERING AND

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FEDERAL UNIVERSITY OF TECHNOLOGY,

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A PROJECT

SUBMITTED IN PARTIAL FUFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) IN ELECTRICAL AND COMPUTER ENGINEERING

To The

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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DECLARATION

I declare that this project is a product of my personal effort exercised under the supervision of Engr. J.G. Kolo, a lecturer in the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

07-12-05

Alhassan Sunday .Y.

99/8086EE

Date

CERTIFICATION

This project has been supervised, read and is now certified adequate for the partial fulfillment of the requirements for the awards of a Bachelor degree (B.Eng.) in Electrical and Computer Engineering.

Engr. J.G Kolo

Supervisor

07/12/05

Signature / Date

Engr. D. Abdullahi

Head of Department

Signature / Date 06/02/06

External Examiner

Signature / Date

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

I will want to acknowledge fist and fore most the one in whom I live, move and have my being-GOD- the source and generous giver of all things. Lord i give you unreserved praise for this project work.

I acknowledge the department for giving me the opportunity to work on this project and my supervisor, Engr. J. Kolo for all his assistance and assessment of my research work. Sir, it is a big previledge working with you. The lecturers of the department, who have taken the frustrating challange of raising tomorrow's leaders with great zeal and enthusiasm, are not left out. Your reward truely is in heaven.

My family-my God-handpicked family cannot be left out: Daddy and Mama thanks for rasing "rainbow". I also want to appreciate my brothers and sisters, i really love you all.

Special thanks to my uncle Dr H.J Jacob and Family whose unflinching support, love, care and encouragement Iam able to pursue my education successfully. Its only God that can reward you.

Cousins- AhmanJiya, 5mics, Wodu, Susan, Arch. Steven, Moses, and all those whose names are not mentioned because you are all numerous, you all made my stay in FUT an interesting one. I also say thank to Uncles and Aunties like Uncle Musa, Uncle Amos,Aunty Kakaadi, YaAndy, Aunty Naomi and som many others, Iam very grateful for all each of you did and didnt do. They have made all the difference.

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ABSTRACT

Industrialization evolution is a process of social and economic change whereby a human society is transformed from a pre-industrial to an industrial state.

This research aims at profering a Quasi (soft) approach to the energy sector subject as it relates to industrial evolution.

The Quasi approach involves sectionalizing power generation distribution based on government policies and private power investors making the service Regional and more directed towards industrial towns and estates.

The questions of why the Quasi approach, how can it solve the energy problem find fundamental answers in this project work.

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CHAPTER ONE

1.1 INTRODUCTION

Generally, electricity could be accepted to mean supply of electric current. This involves generation, transmission and distribution of the electric current to cunsumers. Electricity is an aspect of the utility sector that is very essential to the smooth and meaningful development of a society. It supports the economy and promotes the well-being of individuals. Effecient functioning of this utility is of paramount importance for the sustenance of its growth and consequential realization of its planning and managerial objectives[20]. One of the biggest bottlenecks to Nigeria's economic growth is the poor condition of the country's infrastructure. The power supply is highly unreliable, forcing most businesses to purchase costly back-up generators. Nigerians power sector has high energy losses (30-35% from generation to billing), a low access to electricity by the population (36%). There is insufficient cash generation because of these insufficiencies and PHCN is consequently reliant on fuel subsidies and funding of capital projects by the Government. At present only 10% or rural households and 40% of the country's total population have access to electricity[13].

The power sector is a critical infrastructure needed for the economic, industrial, technological and social development of Nigeria. Electricity consumption has become one of the indices for measuring the standard of living of a country. In Nigeria, power sector is presently being managed by the Power Holding Company of Nigeria (PHCN) as an integrated utility with generation, transmission and distribution all in the same organization. The National electricity grid presently consists of nine generating stations (3 hydro and 6 thermal) with a total installed generating capacity of 5906MW.

The transmission network is made up of 5000km of 330KV lines, 6000km of 132KV lines, 23 of 330/132KV sub-stations and 91 of 132/32KV substations. The Distrbution sector is comprised of 23,753km of 33KV lines, 19,226km of 11KV lines, 679 of 33/11KV substaion. There are also 1790 distribution transformers and 680 injection substations.

Although the installed capacity of the existing power stations is 5906MW, the maximum load ever recorded was 4,000MW. Presently most of the generating units have broken down due to limited available resources to carry out the needed level of maintenance. The transmission lines are radial and are overloaded. The switchgears are obsolete while power transformers have not been maintained for a long time. The distribution subsector is in dire need of upgrading as many of its distribution transformers are overloaded while the lines look more like "cobwebs".

Overall transmission and distribution losses are in the range of 30-40%. The electricity network has been characterized by constant system collapses as a result of low generating capacity by the few generating stations presently in service. The present installed generating capacity in Nigeria is around 6000MW and PHCN has only been able to generate a maximum of 4,000MW. For a country of more than 120million people, this indeed is grossly inadequate to meet the consumers' electricity demand. The current projected capacity that needs to be into the system is estimated at 10,000MW[21].

1.2 JUSTIFICATION OF THE PROJECT

There is need to profer a feasible or working solution to the energy problem in Nigeria.

There is need for a Re-design of the present architecture to enhance optimum service utility.

There is need to profer sectionally independent service.

There is need to profer short and long term solution in the shortest period to enhance economic development as the energy irregularities has remained the strongest impedance to Nigeria's economic evolution.

1.3 AIM OF THE PROJECT

The research aims at answering the questions:

1. Energy state a. Analysis of the market fall due to shortge of power supply.

   b. Cost of maintening standby plants (Statistical Analysis and Survey

   c. Survey of Generation and Distribution Networks.

2. Why the Quasi Approach?
3. How can it solve the Energy problem?

1.4 SCOPE OF THE PROJECT

This project analyze market production fall due to shortage of power supply. It surveys the cost of maintening standby plants, plant Engineers, technicians etc.

This project analyze the causes of failure in power supply. It profers the Quasi Approach and how it can be achieved considering the provision of a dedicated power Generation, Government policy on having industrial towns, power distribution (local) Network design using the Underground approach and Rating and Servicing plan maintenance policy.

1.5 LIMITATIONS

1. Lack of access to some Generation, Transmission and Distribution offices thus limiting amount of data.
2. The unnecessary official bureaucracies, which hindered the acquisition of some relevant data for the project were another limitation to a more detailed work on the project.
3. Inexperience of some PHCN personel thus having no tangible information on the subject as it relates to Nigeria.
4. Inavailability of some statistical information on Generation, Transmission and Distribution Architectural designs.

1.6 PROJECT LAYOUT

Chapter one gives an introduction of the work by stating the aim and justification of the project along with the limitations and problems encountered in the course of executing the project.

Chapter two lays a foundation for understanding the theory of Electricity and Background of PHCN (Power Holding Company of Nigeria). The Generation, Transmission and Distribution of Electricity is discussed in this chapter. Load estimation of Industrial and Residential areas is discussed. Contributions of Industries to the National Economy are fully talked about.

Chapter three deals with the Quasi (soft) Approach, the drivers for the approach, implementation prerequisite. The New Architecture (Quasi Architecture) is also discussed. Chapter four covers the Generation, Transmission and Distribution Design (A case study) and Availability and Servicing (Maintenance) of Transformers are also discussed. Advantages of Billing method over the existing power method are discussed.

Chapter five put it all in three parts-the conclusion, the recommendation and suggestions-from where the project work began.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND.

The Greeks were the first to discover electricity about 2500 years ago. They noticed that when an amber was rubbed with another material, it become charged with an unknown force that had the power to attract objects such as dried leaves, feathers, bits of cloth, or other lightweight materials. The Greeks called amber electron. The word electric was derived from it and meant " to be like amber", or to have the ability to attract other objects.

This mysterious force remained little more than a curious phenomenon about 2000 years later, when other people began to conduct experiments. In the early 1600s, William Gilbert discovered that amber was not only material that could be charged to attract other objects. He called materials that could be charged electriks and materials that could not be charged no electriks.

About 300 years ago a few men began to study the behaviour of various charged objects. In 1773, a French man named Charles DuFay found that a piece of charged glass would repel some charged objects and attract others. These men soon learned that the force of repulsion was just as important as the force of attraction. From these experiments, two lists were discovered.

LIST A	LIST B
Glass (rubbed on silk)	hard rubber (rubbed on wool)
Glass (rubbed on wool or cotton)	block or sulfur (rubbed on wool or fur)
Mica (rubbed on cloth)	most kinds of rubber (rubbed on cloth)
Abestors (rubbed on cloth or paper)	sealing wax (rubbed on silk, wool or fur)
Stick of sealing wax (rubbed on wool)	glass mica (rubbed on dry wool)

Table 2.1

It was determined that any material in list A would attract any material in list B, and that all materials in list A would repel each other and all materials in B would repel each other[15].

What is electricity?

Electricity is a form of energy. Electricity is the flow of electrons. All matter is made up of atoms, and an atom has a centre, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton and number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current[17].

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity which is a secondary energy source from the conversion of other sources of energy like coal, natural gas, oil, nuclear power and other natural sources which are called primary sources. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually become understood. In the mid-1800s, Thomas Edison changed everyones life- he perfected his invention-the electric light bulb. Prior to 1879, electricity had been in arc lights for outdoor lighting. Edison's invention used electricity to bring indoor lighting to our homes.

To solve the problem of sending electricity over long distances, George Wesringhouse allowed electricity to be efficiently transmitted over long distances. This made it possible to supply electricity to homes and businesses located far from the electric generating plant.

Despite its great importance in our daily lives,most of us rarely stop to think what life would be like without electricty. Yet like air and water, we take electricity for granted. Everyday, we use electricity to do many functions for us- from lighting and heating/cooling homes, to being the power source for televisions and computers. Electricity is a controllable and convenient form of energy used in the applications of heat, light and power[16].

2.2 ELECTRICITY IN NIGERIA (PHCN).

The Power Holding Company of Nigeria formally National Electric Power Authority (NEPA) was established by decree No. 24 of 1st April 1972, with the almagamation of Electricity Corporation of Nigeria (ECN) and Niger Dams Authority (NDA). PHCN was empowered to maintain an efficient, co-ordinated and economic system of electricity supply to all the nooks and crannies of the nation. It started with a humble but steady beginning with only four major power stations serving more than two million customers nationwide.

That propelled the nation's technological and industrial growth, PHCN has become the fasted and biggest growing electricity industry in Africa and indeed developing world with a consumer population of about five million.

The table below is the comparative status of the electricity supply systems from inception of PHCN in 1972 and 1998.

Electricity Supply System:

1972 1998

Total Installed

Generating Capacity

532.6MW 5,958MW

Nations Peak Demand

390MW 2,446MW

Lenght 330KV lines

1,262KM 5,000KM

Lenght 132KV lines

1,012KM 6,000KM

415 Volts Network

15,000 55,143KM

With impending conditions like the ever-rising consumers debts, vandalization of PHCN's installation, high cost of maintenance, inadquate gas supply, low water level at the hydro power stations, high cost of foreign exchange the abysmally low tariff regime, PHCN has always striven to meet its distribution and marketing of stable electricity to its numerous residential, commercial and industrial customers against all odds. Inspite of some of its familiar operational shortcomings, PHCN has made giant strides in the producton and marketing of electricity to nation and beyond[9].

2.2.1 GENERATION

The sector started with the development of the nation's electricity infrastructure from a 2 by '30 kilowatts generating plant at Ijora in 1896 to the construction of a 2MW hydro-electric station at the Kwa falls in 1925 created the need for proper co-ordination of all isolated generating facilities in the country. In 1950, the Electricity corporation of Nigeria (ECN) commenced the exploitation of the water resources of River Niger and by 1962 the Niger Dams Authority was established to build, operate and maintain dams.

There after, the construction of the first phase of Kainji hydro-electric station started and was concluded in 1968.Subsequent phases were constructed and commisioned between 1968 and 1970. simultaneously, 1958 studies were conducted by th ECN for the construction of another hydro-electric facility at Jebba down from Kainji station. This progresses to the construction of the Jebba hydro-electric station which was commissioned in 1986.

The sector currently operates and maintains 8no. Power Stations of the primary energy forms, fossil fired thermal plants and the renewable energy, hydroelectric sources. The Power Stations are variously located in close proximity to the energy resources.

- The 3no. Hydro stations at Kainji, Jebba and Shiroro, take advantage of the geo-topography of the river catchment basins in the north.
- The thermal stations at Sapele, Afam, and Ughelli (Delta) harness the rich oil gas deposits of the Niger Delta in the south.

The only exceptions to the foregoing rule being the load center derived thermal stations at Ijora and Egbin which were built to serve Nigeria's industrial and commercial center, Lagos. Other smaller installations include the following:

- The only coal-fired power station at Oji in Enugu state. The station was commisioned in 1956. Due to obsolescence and aging, the 4no. Steam plants have been recommended for scrapping.
- The so-called isolated stations at Calabar, Kaduna, Makurdi, Mubi Maiduguri, Minna and Suleja. These diesel units, operated off-line to serve specified cities[18].

2.2.1.1 Installation/Commissioning (Existing Units)

The generating facilities at the stations were added in phases though not exactly matching the growth of demand for electricity. In all, from 1965 to 1990, a total of 73no. generating units of various capacities were installed and commissioned in phases at the diferent power stations. Each added unit was at the-art technology. Currently the largest single unit capacities in the grid system are the 220MW steam turbines at Egbin.

2.2.1.2 Installation/Commissioning (New Units)

Since the commissioning of the last phase of 4x150MW units in Shiroro in 1990 to date, no additional unit was commissioned due largely to funds constraints. However the Federal Government in its effort to improve the electricity supply in the country has released funds for the additional of 2x138MW gas turbine units at Afam Power Station. These will be ready for commissioning soon and complete replacement are being considered at Kainji and Delta Power Stations,respectively.

2.2.1.3 Rehabilitation/Re-commissioning

In the intervening years, neglects due primarily to funds constraint as a result of low tariff, devaluation of Naira, and lack of official will have dealt dilapidating effect on the performance of the facilities. This is so much that the global available installed capacity for all the stations is below 50%. Records show that for 15years, the units were not overhauled.

Details of the power Generation stations

The Authority has nine (9) Power Stations, nationwide as follows:

1. Kainji Hydro Power Station: this station located in Niger state along the River Niger is the first Power Station in the country. The 8 generating units were commissioned thus:

* 4 x 80MW 1968
* 2 x 10MW 1976
* 2 x 120MW 1978

2. Jebba Hydro Power Station:this station is located in kwara state down stream of the Kainji Hydro power station. It has 6 units which were commissioned thus:

* 6 x 95MW 1986

3. Shiroro Hydro Power station: this station is located in Niger state on the shiroro Gorge along the Kaduna river. It has four generating units, which were commissioned thus:

* 1 x 150MW 1989
* 3 x 150MW 1990

4. Afam Thermal Power Station: this station was natural gas and is located in the outskirts of Port Harcourt in Riversstate. The station started operation in 1965. the 18 units were commissioned thus:

* 2 x 10.5MW 1965

* 2 x 17.5MW 1965

* 4 x 23.9MW 1976

* 4 x 27MW 1978

* 6 x 75MW 1982

5. Delta Thermal Power Station: this station also uses natural gas and is located in Ughelli, Delta state. The station started operation in 1996. The 20 units were commissioned thus:

* 2 x 36MW 1966

* 6 x 20MW 1975

* 6 x 20MW 1978

* 1 x 100MW 1989

* 5 x 100MW 1990

6. Egbin Thermal Power Station: this station is located in the outskirts of Lagos state. The station is the largest Thermal Power station in the country. It units were commissioned thus:

* 2 x 220MW 1985

* 2 x 220MW 1986

* 2 x 220MW 1987

7. Sapele thermal Power Station: this station is located in Ogorode, Delta state. The station uses both steam and gas turbines. These were commissioned thus:

* 6 x 120MW 1978

* 4 x 75MW 1981

8. Ijora thermal power station: this station which is located in Lagos uses AGO fuel and has 3 units which were commissioned thus:

* 3 x 20MW 1978

9. Oji thermal power station: this station is located on the Oji River in Enugu state. Though presently non-functional, its the only coal-powered station in the country. Its four were commissioned as follows:

* 2 x 5MW 1956

* 2 x 10MW 1956 [19]

2.2.2 TRANSMISSION

Executive Director Transmission – ED (T), is the head of Transmission sector. There are two sub-sectors namely:-

1. Transmission Services
2. Transmission Engineering.

Each of the sub-sectors is headed by a General Manager stationed in the corporate Headquarters Abuja.

2.2.2.1 TRANSMISSION SERVICES

This sub-sector controls the rehabilitation and maintenance of transmission facilities in the Network. For effective coordination, there are six regional outlets located in Lagos, Benin,Enugu, Bauchi, Shiroro and Kaduna.

Each regions are headed by a General Managers. They routinely ensure maintenance and operation of transmission infrastructure in their locations[21].

2.2.2.2 TRANSMISSION ENGINEERING

This sub-sector is entrusted with the design and implementation of new transmission projects. Their core competencies include:-

- Power System Planning
- Conctruction of transmission lines.
- Transmission Network Expansion.
- Materials Standard, Communications, Support,Protection and Control.
- Sub-Station Design Construction, Power Transformer and Reactors and Equipment performance Analysis.
- Erosion control and tower protection

The primary function of the Transmission Sector is to convey Electricity from Generation to Distribution via 330KV and 132KV transmission lines while ensuring minimal load loss along transmission lines[11].

Other functions of the Sector are:

- Keeps record of total energy supplied to Distribution
- Maintains transmission lines in circuit.
- Monitior capacity utilization of power transformers in the Network.
- Ensures transmission network planning and expansion and bulk transfer of Electricity to new locations.
- Monitors outages, and energy loss due to forced and planned outages.
- Maintains statistics of average interruption frequency and interruption duration indices.

- Keep statistics of value of load lost in the course of conveying power from Generation to Distribution.

The transmission level of the PHCN grid presently integrates 24 Nos. 330KV transformer/switching substations interconnected by 39 Nos. 330KV lines covering a total distance of 4,970KMs.

The subtransmission level however integrates 92 Nos 132KV substations and 5 Nos. 66KV substations interconnected by 109 Nos 132KV lines covering a total distance of 4,840Km

The geographical coverage of this transmission grid is the entirety of Nigeria which spans an area of 923,768Km. The table 2.2 below shows the Transmission line type, No installed and total transmission lin lenght[21].

SUBSTATION OR TRANSMISSION LINE TYPE	NO. INSTALLED	TOTAL TRANSMISION LINE LENGHT
330KV TRANSFORMER/SWITCHING SUBSTATIONS	24	-
132KV "	92	-
66KV "	5	-
330KV TRANSMISSION LINES	39	4,970 KMS
132KV " "	109	4,840 KMS

Table 2.2

It is worthy of note that the Transmission Network in Nigeria is a single grid.

Apo 132KV Transmission station line diagram is shown in fig. 2.1 overleaf

132/33KV40MVA MOBITRA AT APO T/S

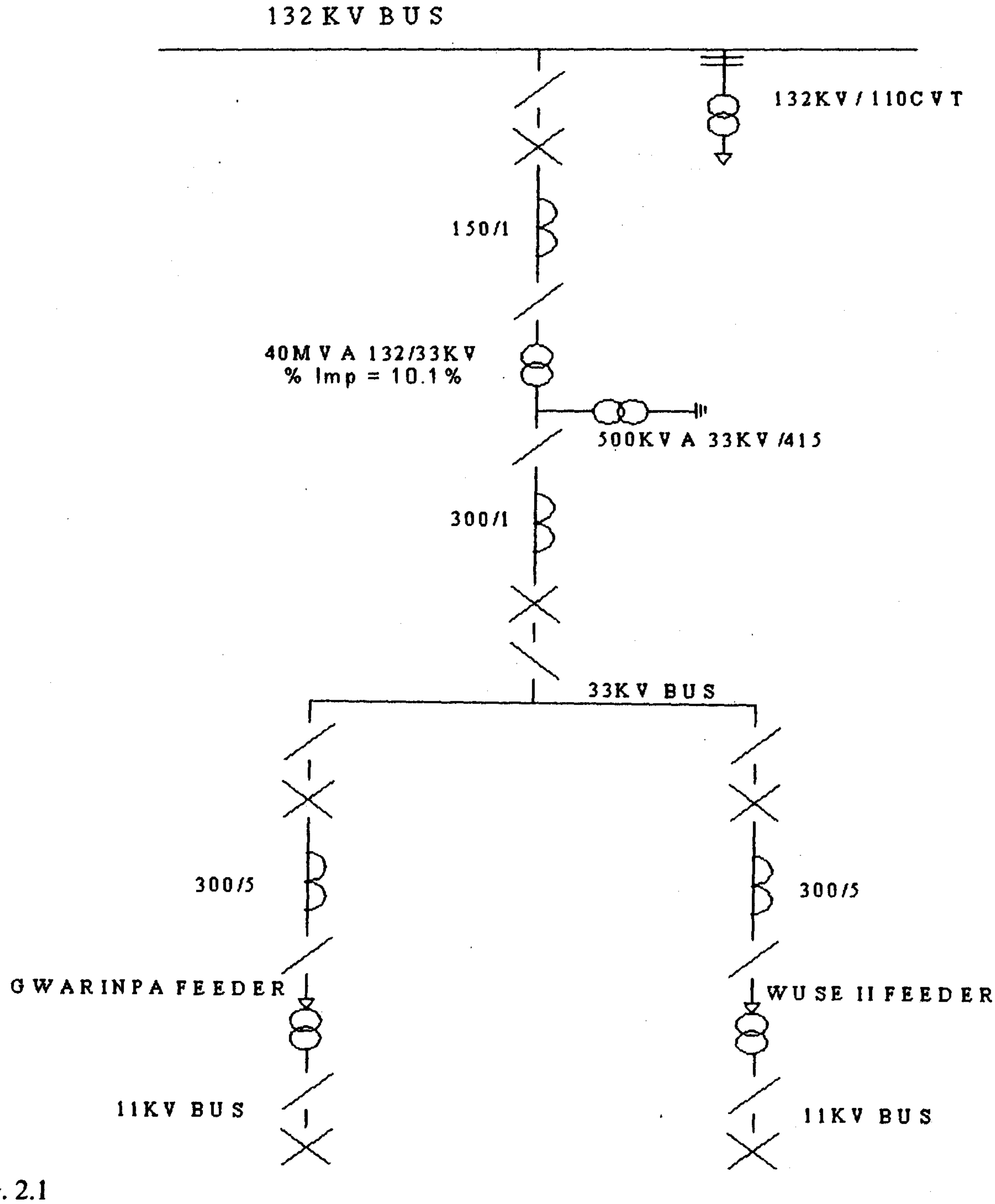


FIG. 2.1

2.2.3 DISTRIBUTION

Executive Director (Distribution) – ED (D), is the head of Distribution Sector. The Sector has a General Manager (Distribution in the Corporate Headquarters Abuja with two Assistant General Managrs under him. The two AGMs are AGM (Distribution, Planning and Standard) and the AGM (D) HQ.

Major Activities

The distribution sector has the responsibility to make available to the consumers at various level the generated and transmitted electricity. The zonal office controls the voltage at 33KV while the Districts take care of 11KV and the 415V[22].

DELTA/STAR CONNECTION OF AN 11KV/415V TRANSFORMER

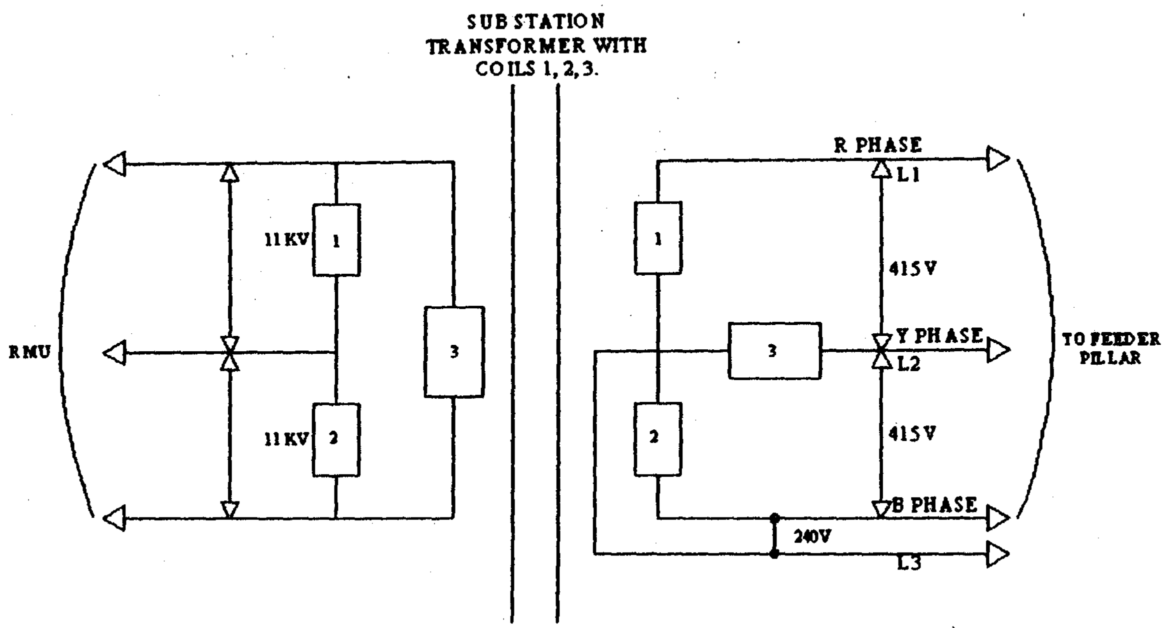


Fig. 2.2

The fig.2.2 Above shows the delta connection of the primary and star connection of the secondary of an 11KV/415V sub-station transformer giving a four(4) wire distribution.

1 415V 3 – phase supply

3 240V 1 – phase supply

The three phase 415V supply is used for supplying small industrial and commercial areas. 240V supply is always provided for street ligthening and individual domestic consumers. The neutral of the transformer is connected to the earth. At the consumers end, another earth terminal may locally be established to provide a three wire terminal, brown(life), blue(neutral), white/green(earth) connected to equipment with a three pin socket.

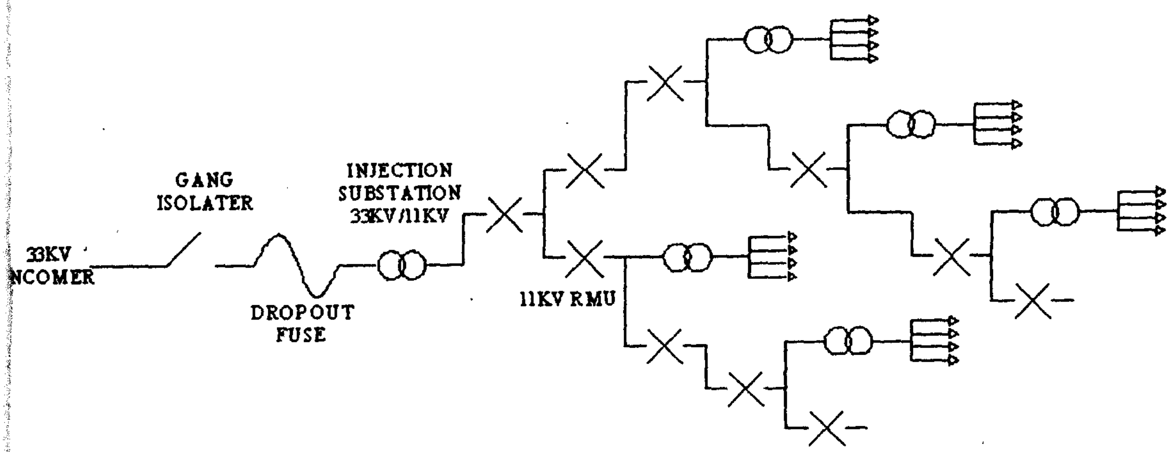
another earth terminal may locally be established to provide a three wire terminal, brown(life), blue(neutral), white/green(earth) connected to equipment with a three pin socket. In a four conductor overhead conductor supply i.e from the feeder pillar, the neutral wire is nearest to the ground so that it could fall off and drop to ground without causing any harm. The feeder pillar is a low voltage(LV) panel that feeds loads between phases at 415V for small industrial and commercial supply.

The transmission of electrical power at 415/240V from the feeder pillar through overhead aluminiunm conductor and or underground cable to the circuit breaker, metre and distribution board. The distribution board consists of Mini Circuit Breaker(MCB) and fuses of various sizes through which domestic appliances are fed[23].

2.2.3.1 Radial and Ring Distribution

A distribution system may be radial or ring. In a radial system, the consumer's sub-station are connected in series along the lenght of the circuit away from the supply point. Anyway fault occuring in a radial distribution cannot be isolated without disconnecting the succeeding consumers.

ADIAL DISTRIBUTION SYSTEM



. 2.3

a ring system, the consmers sub-stations are fed from two directions so that faults can be connected without loss of supply to other consumers. A tyical ring system is shown in Fig. below

RING DISTRIBUTION SYSTEM

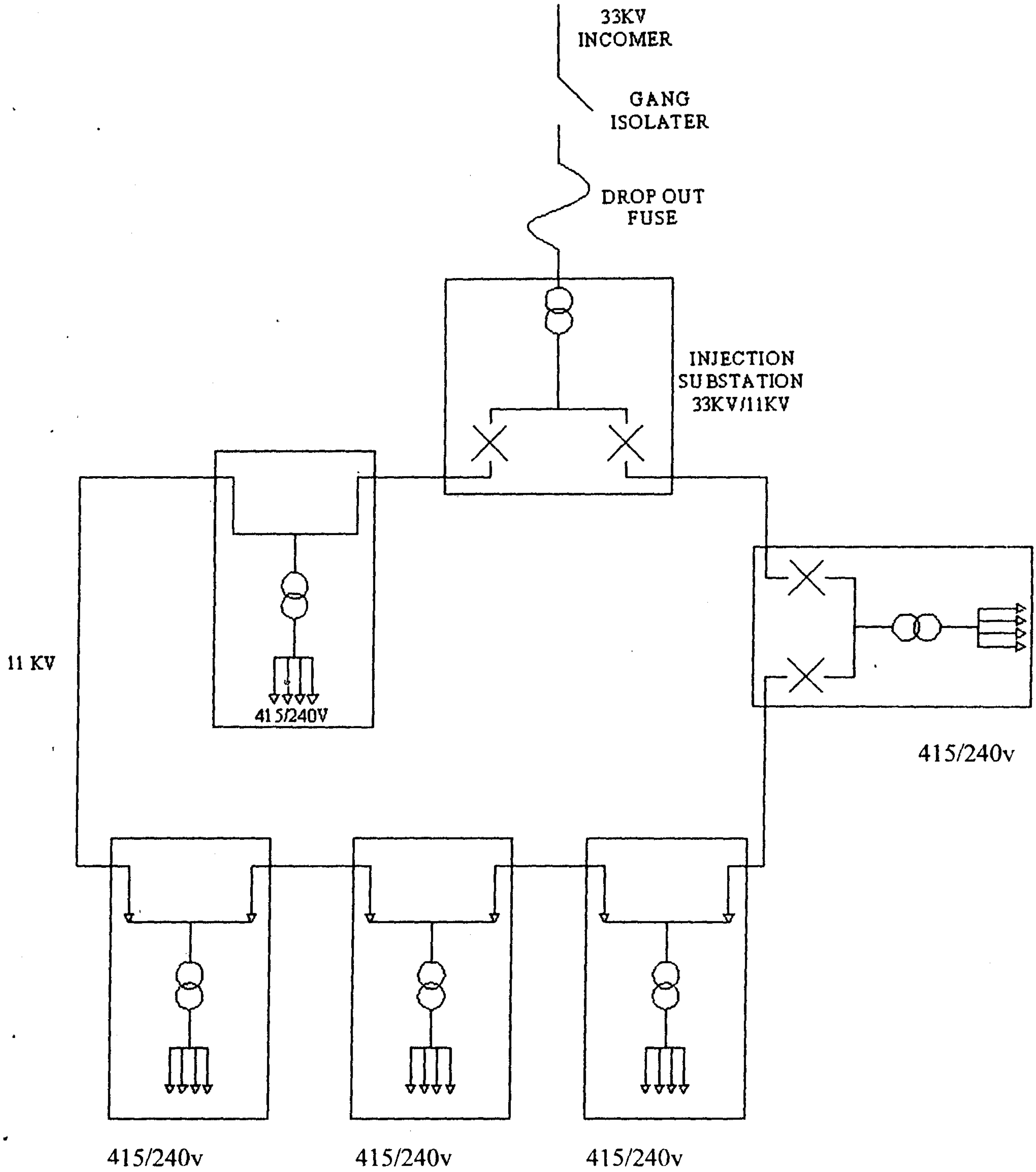


Fig 2.4

The fig. 2.4 above consists of 33KV/11KV injection sub-station, five(5) 11KV/415V distribution sub-station. The secondary outputs of the transformer at 415/240V are connected to the small commercial and domestic consumers throuh the fuses in the feeder pillar. Electricity supply regulations requires that the sub-stations be protected by a two metre high wall fence so that no unauthorized persons may gain access to the potentially dangerous equipments for 11KV distribution.

The ring distribution system offers greater security of supply. The maintenance of a secure supply is an important consideration for any electrical Engineer because no industrial development can take place without a steady and reliable power supply[23].

AB15 2X 15MVA 33/11KV INJECTION SUBSTATION

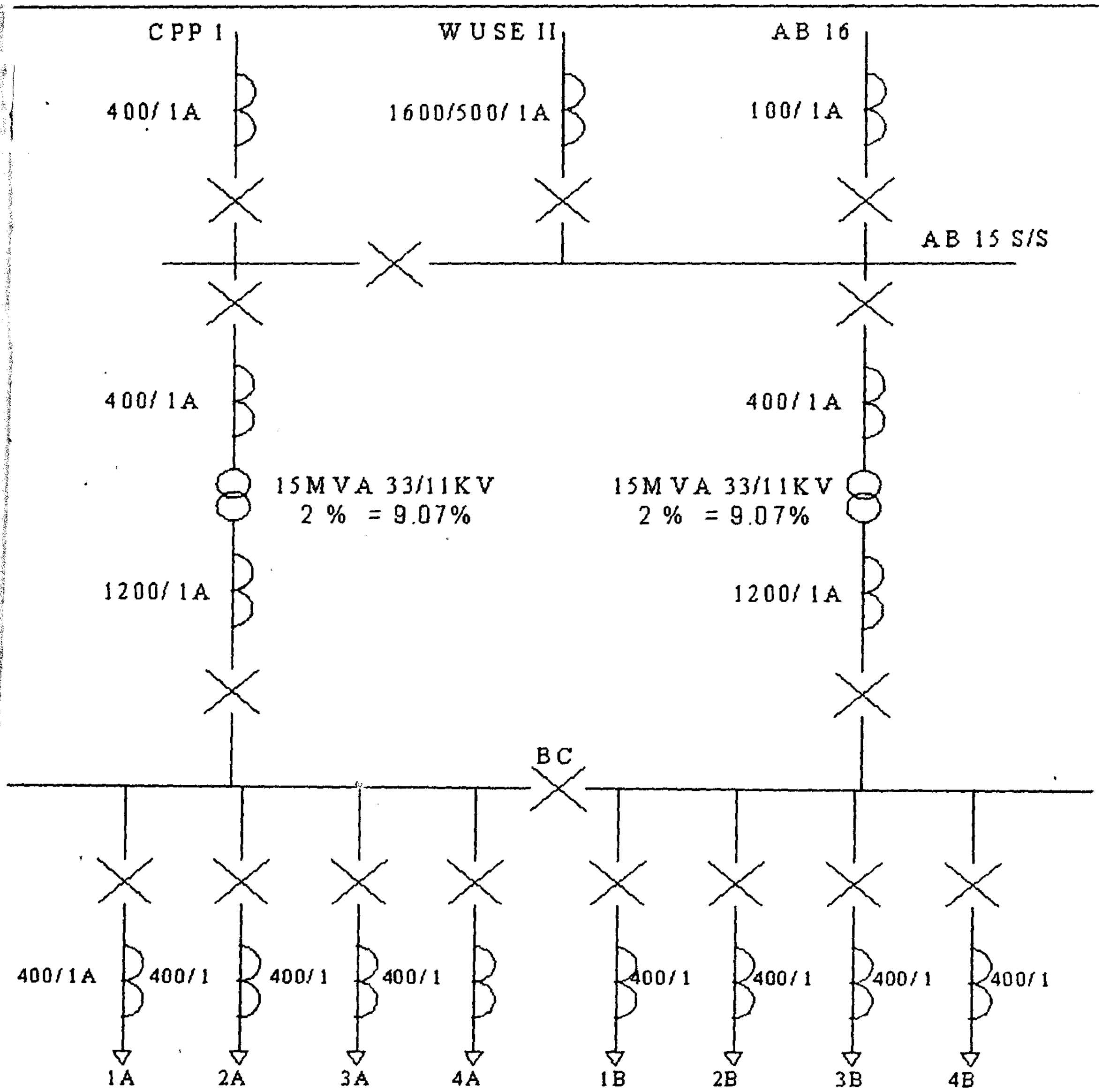


Fig. 2.5

The line diagram for the Distribution degign for Abuja AB15 2x15 33/11KV Injcction Substation is shown in Fig. 2.5 above.

2.3 ELECTRIC LOAD (LOAD ESTIMATION)

Obtain a general layout, mark it with the major loads at various locations, and determine the approximate total plant load in kilowatts or kilovolt-amperes. Initially the amount of accuarate load data may be limited. Some loads such as lighting and air conditioning may be estimated from generalized data. The majority of industrial plant loads are a function of the process equipment and such information will have to be obtained from process equipment designers. Since their design is often concurrent with power system design, initial information will be subject to change. It is therefore important that there be continuing coordination with the other design diciplines. For example, a change from electric powered to absorption refrigeration or a change from electrostatic to high energy scrubber air polltion control can change the power requirements for these devices by several orders of magnitude. The power system load estimates will require continual refinement until job completion[22].

2.3.1 DEMAND:

The sum of the electrical rating of each piece of equipment will give a total connected load. Because some equipment operates at less than full load and some intermittently, the resultant demand upon the power source is less than the connected load[14].

2.3.2 LOAD BALANCING

The fig 2.6 below shows a four wire of 3 phase distribution system derived from a delta/star connection of a secondary of a 11KV/415V distribution sub-station transformer.

A FOUR WIRE OF 3 PHASE DISTRIBUTION SYSTEM

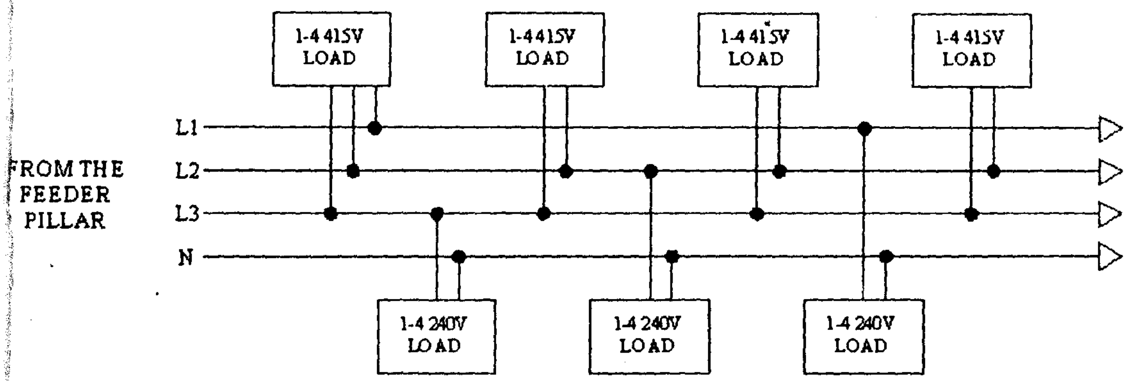


Fig. 2.6

At the substation, the star point is earth through an earth electrode sunked into the ground and from this point is the neutral taken as the 4th conductor. When connecting single phase load into a three phase supply, care should be taken to distribute the loads equally across the three phases so that each phase carry the same current. Equally dividing the single phase load across the three phase supply is known as load balancing. Failure to balance the load results in STROBOSCOPIC EFFECT.

Note should be taken that the 415V three phase load such as Electric motor has balanced phases since the resistance of each phase is the same[23].

2.3.3 LOAD MANAGEMENT CONTROL

A number of utilities have assumed control of devices that will switch off loads on their system automatically when undesirable demand levels are being reached. This involves the identification of noncritical loads that can be placed under the control of the utility with agreed-upon constraints regarding maximum time to be left off. Agreements with consumers include favourable " interruptible " rate schedules. These may be controlled by means of signals transmitted by radio, carrier, or telephone communication.

2.4 SERVICING

Servicing as to do with maintenance and maintenance engineering is that function of manufacturing management that is concerned with the day-to-day problem of keeping the physical plant in good operating condition. It is necessary to ensure availability of the machines and services needed by other parts of the organization for the performance of their functions at an optimum return on the investment, whether this investment is in machinery, materials or employees[6].

2.4.1 SCOPE OF MAINTENANCE

Basically, the maintenance department is meant to keep service equipment and production machinery in satisfactory conditions. The main focus of maintenance is therefore to anticipate and prevent interruptions in operation and keep equipment in good condition for high efficiency performance.

The principal objective of maintenance include:

i. to extend the useful lifespan of an equipment

ii. to ensure operational readiness of all equipment required particularly for emergency purposes.

iii. to reduce total cost of inventory

iv. to reduce stoppages and resultant loss in production

v. to ensure the safety of personnel using equipment

vi. to avoid exorbitant expenses on the repair of equipment which might occur if the same equipment was maintained and did not fail.

2.4.2 MAINTENANCE POLICIES

Essentially, maintenance policy must address the question of the size and extent of the maintenance facilities. Policies that ensure possible completion of necessary maintenance work and at the same time keep costs at a reasonable level should be adopted. The following facts should normally be considered while establishing maintenance policy.

1. Some work should be contracted out during peak period to avoid much delay and also avoid hiring temporary help.

2. Some work should be defered to slack period (overhaul work, painting projects) are handled on this basis.

3. Machines and equipments should be replaced at the optimum time (normally available with manufacturers).

In the present Power Holding Comany of NigeriaNetwork, maintenance culture is almost not in existence. Most of the works contracted out for maintenance of the machines and equiments are always not executed efficiently because of the level of corruption in the country. The contractors have a certain amount of money of the contract that is always given to the PHCN officials ,that are suppose to monitor and make sure the work is done accordingly. The work always ended up not been done and nobody questions why because they are all involved and guilty.

Also, most of the machines and equipments are always not replaced at the optimum time. They always wait till when there is a total breakdown before any action will be taken, this immensely affects and brings about why we always have power failures frequently.
Moreso, most of the technical staffs used for the maintenance work have just little knowledge about the work they carry out. Workers are not been employed on the basis of what

knowledge they have about the work but by who they know. All these affects the maintenance of machines and equiments we have in the present PHCN.

2.5 INDUSTRIALIZATION

Industrialization or an industrial revolution is a process of social and economic change whereby a human society is transformed from a pre-industrial to an industrial state. This social and economic change is closely intertwined with technological innovation, particularly the development of large scale energy production and metallurgy. Industrilization is also related to some form of philosophical change, or to a different attitude in the perception of nature, though whether these philosophical changes are caused by industrilization or vice-versa is subject to debate.

Pre-industrial economies often rely on sustenence standards of living, whereby large portions of the population focus their collective resources on producing only what can be consumed by them, though there have been quite a few pre-industrial economies with trade and commerce as a significant factor, enjoying wealth far beyond a sustenance standard of living. Famines were frequent in most pre-industrial societies, although some such as the Netherlands and England of the 17th and 18th centuries and the ancient classical civilization were able to escape the famine cycle through increasing trade and commercialization of the agricultural sector[15].

2.6 NETWORK ARCHITECTURE

The present architecture for PHCN may be too large to handle. Thus it is broken down to voltage rated architecture. A 33KV Network Architecture for Abuja is shown in fig2.7 overleaf[8].

33KV SCHEMATIC DIAGRAM

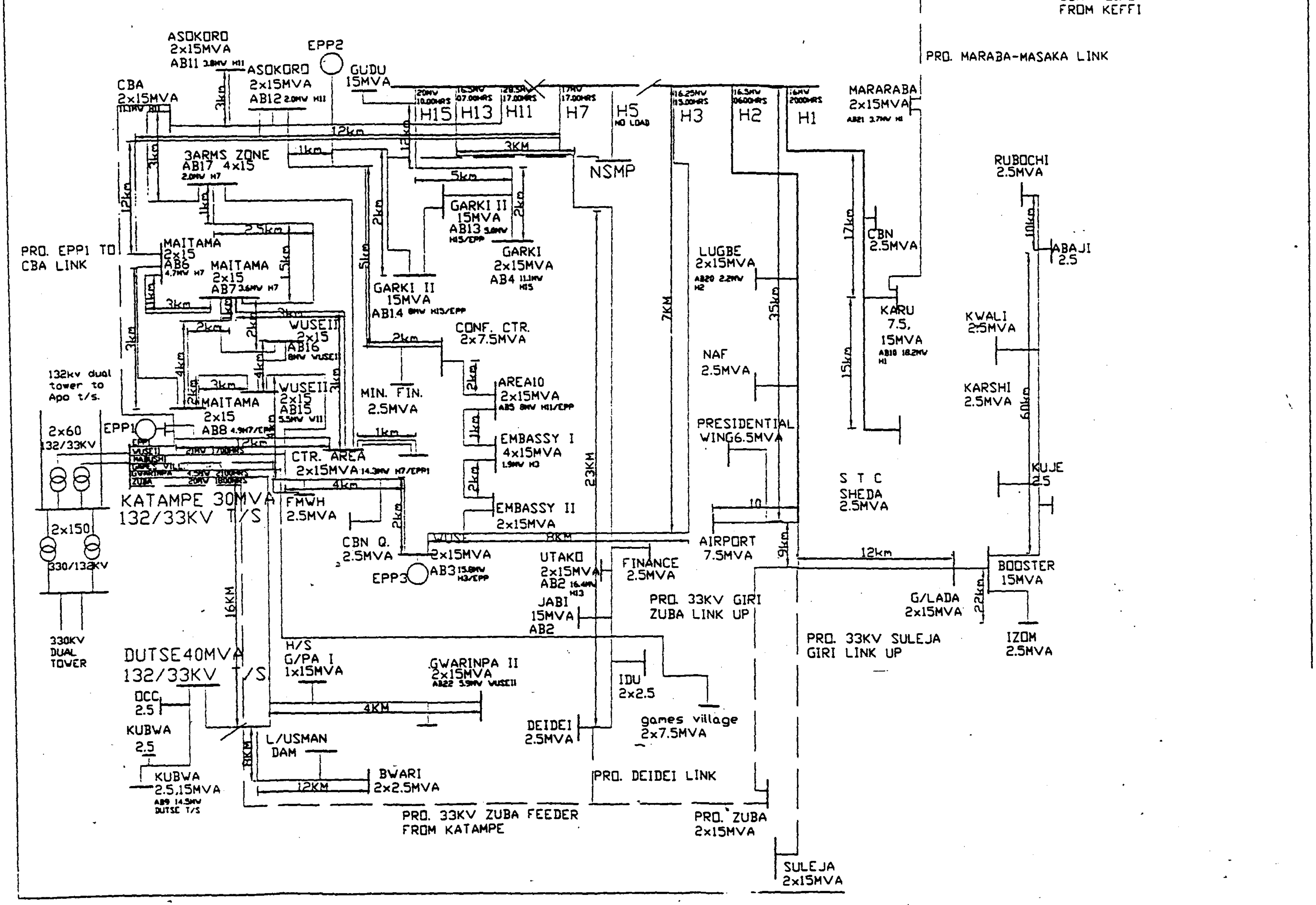


Fig. 2.7

CHAPTER THREE

3.1 THE QUASI APPROACH

As the name implies, it is a soft approach to the energy problem that has plagued our industrial development for over two decades

It is a soft approach in that it does not profer a total solutuon to the entire problem instead it solves a part of the problem only which is why it is soft or partial.

The targeted area of solution here is a proposed industrial layout and estates that will be built or developed across the country.

Once implemented, an investor could decide where he wants to establish his company having considered energy and socio-political conditions in such a geographical zone.

A balanced and virtually independent power system will be embarked upon to service the proposed industrial layout and estate.

The remaining of this chapter shall deal with the WHY and HOW of this approach and the preconditions for it to thrive. The implementation will be discussed in the next chapter.

3.1.1 THE DRIVERS FOR THE APPROACH

The drivers for this approach are fundamental factors why the approach is necessary. These are:

- the approximately zero feasibility of the hard approach
- size of the present system

These shall be discussed some what closely

3.1.1.1 FEASIBILITY OF THE HARD APPROACH

The hard approach is a total/absolute approach to solving any problem. Here the hard approach imply finding a total working solution to the power problem in Nigeria.

Even if the sophisticated and expensive infrastructure of the generation system is rejuvenated and some replacement of equipments made, there still exist a difficult problem of solving the distribution problem which is one of the major complications in the existings system.

However, it is a common fact that government is not known to be a profit making entity which is the main reason why the government has refused the demand from PHCN (then NEPA), when in the year 2002, it requested for about 600 billion Naira to fix the power sector.

The private individuals and corporate bodies must be allowed to invest into the sector. It is however evident that seldom can these prospective investors be ready to invest such large amount of money. Therefore, there is need to sectionalize the project/service which is the Quasi approach.

The distribution network of the present system is so sophisticated that attempting an absolute approach might mean a collapse of some buildings, Timber felling, amongst other complicated duties to be executed. Settling those affected again is another thing the government may not be willing to do nor will any private investor called into the distribution system be quite willing to do any soon. Because of these few lapses that will remain here and there, citing of any industry around would still mean such industries sufferring failures associated with distribution network problem. This is fundamental reason why the Quasi approach which is actually sectionlization of the power system is necessary[8].

3.1.1.2 SIZE OF THE PRESENT SYSTEM

Another Driver for the approach is the size of the present system. The present system is quite large and the problems responsible for the the persistent failure of the present system are as well enormous. Attempting a hard approach would mean a total overhauling of the

- generation scheduling (could be done using daily load curve. A plot of load in MW against Time in HR).
- System state analysis
- Generation ordering and Active load dispatching amongst others.
- Power system frequency

3.1.2.1GENERATION SCHEDULING:

This begins with a review of current plant availability at all power stations on the grid.The reliability of the generation schedule depends on the accuracy and dependability of plant status reports required to be sent in by various power plants everyday (by 6.00am). A wrong figure of plant availability will create difficulty in frequency control as the control room now has to make last minute rush changes to a carefully prepared schedule.

The ultimate objective of our economic generation schedules is to minimize fuel cost or water usage by hydro turbines or total daily energy production, taking into consideration the following:

1.0 Actual unit cost of Thermal fuel type (Natural gas, HPFO/LPFO, AGO or Coal).

2.0 Heat rate of turbine type (Steam turbine/Gas turbines).

3.0 Efficiency curves of hydro turbines.

4.0 Spinning reserve requirements.

5.0 Unit limitations (minimum load for stability, rate of loading, peculiar unit fault, etc.)

Based on some considerations, the inmerit plant are scheduled to be committed hour by hour on an electronic generation schedule spreadsheet displayable on PCs used by system controllers in the control room. Spinning reserves-the spare generation capacity of synchronized loaded plant are planned into the schedule, inorder to cope with sudden loss of generation and reserves are divided into two parts:

Generation, Transmission and Distribution system. This manumental task would of course be too sophisticated to be cleared, considering the size of the distribution system to fix. Hence the need to sectionalize the system inorder to achieve a reasonable reliability and availability that can support industrialization; Yet the question that would linger on is of what part of the country would be sectionalized for the soft fix to encourage industrilization? Does that mean other sections cannot be sectioned and fixed? Thus for socio-political reasons, every geopolitical zone in the country must be fixed, which implies the entire system must be fixed. This bouncing back to the "hard approach".Thus would be too expensive for the Government to jump into. Analysis, troubleshooting and implementation of the fixing programme would take time and several considerations by intending private sectors that may work on the present system. Hence the Quasi approach would go along way profering a quick solution to the energy problem[8].

Financial factor has as well as been a major driver for this approach to the energy solution in Nigeria.

Several existing business organization in Nigeria, have it very tough keeping their power plants up and running and as such only these with a good chance in the competitive market environment, find it some what comfortable but others dont.

Thus coming in to invest in an economy under such condition is quite untoward for many. However the Quasi approach will give such investor a feel of relief as they wouldnt need to spend as much utilizing power yet with graet reliability. Below is a table of Energy Value of some Organization in Nigeria.

ORGANIZATION	COST	UNIT	DURATION
MTN NIGERIA LIMITED	2,10000	1 base station	30 days
INTERCELLULAR NIG. LTD	1,480000	1 base station	30days
VMOBILE NIG. LTD.	2,080000	1 base station	30 days
GLOBACOM NIG. COM.	2,420000	1 base staion	30 days

Table 3.1

The figure above might be slightly inflated since the services are usually issued to contractors. However even if the contractors make 25% profit, it still means 75% of the values of MTN monthly Energy bill per base staion is atill 1.575million which is pretty high.

3.1.2 IMPLEMENTATION METHODOLOGY

The method of implementing the Quasi approach is a design and implementation of an independent power system. It involves setting up generating stations in several states across the country, that will generate a certain amount of Megawatt of power and send to a Zonal Control Centre (ZCC) which collates generation from several terminals and transmit to various states where the industrial layouts and estates are cited.

For the sake of implementation speed, several organizations may be involved ranging from the generation through Transmission to Distribution. Subtransmission stations will be set up as well as distributuion stations.

The economics of the scheme will be justified depending on how effectively the Zonal Control Centre (ZCC) performs their tasks which include:

1.0 Effective (Available for rapid deployment within a few seconds of generation shortfall).

2.0 Longterm (Available for deployment from 5minutes after loss).

The value of the effective reserves must meet 100% of the largest possible loss contigency[8].

3.1.2.2 SYSTEM STATE ANALYSIS:

The power system can be in any or a combination of the four following states.

1. Normal (Steady) state
2. alert state
3. emergency (collapse) state
4. restorative state

3.1.2.3 GENERATION ORDERING AND ACTIVE LOAD DISPATCHING

Steady state frequency control begins with ordering of generation to meet demand. Economic generation ordering and active dispatching is done by the Zonal Control Room, based on the hourly generation schedule for the day. Units are called up (committed) to be placed on bars to attain target generation levels specified on the schedule.Since the forecast and schedule has taken into account spinning reserve allocation, the Zonal Control Room now keeps a close watch on the power system frequency. Loading or deloading dsipatch instructions are now passed to different plant during normal operations as the schedule specifies while keeping system frequency at target. This is steady state frequency control[8].

3.1.2.4 POWER SYSTEM FREQUENCY

The power system frequency depends on the balance active power (MW) demand and active power generation. When active power generation by all units in a system exactly equals the total demand plus losses, the frequency of the system is a constant.

This is beautiful equilibrium when achieved, results in a frequency of 50HZ. – the frequency required by all consumer equipment for normal operation.

When power ggeneration in the system exceeds total demand plus losses, the frequency rises above 50HZ and vice versa.

In all real power systems, power demand is never constant, as someone is always turning some electrical device on or off. Variable power devices (A/Cs, Refrigerators, lifts, Irons etc) are also constantly drawing power as required from the power system.

Furthermore, generators on the system may trip due to some fault-dumping its share of generation on other generators still in synchronism on the system.

Principally there must exist system planning department or section whose responsibility is the planning of the Generation and Transmission Grid system operations from the Zonal Control Centre and Area Control Centres on daily bassis to ensure Economic, Reliable and Safe Operations of all generation and transmission equipment everywhere on the interconnected system.

For system interoperability and integration, the Control Centres must all be interconnected and as well to the existing National Grid in case of special service demand or emergencies. However the Quasi system can go in full Island operation[8].

3.2 IMPLEMENTATION PREREQUISITE

The implementation of the energy solution scheme herein discussed cannot be successful excepted, there exist appropriate conditions under which this can work.These are the prerequisite and are here under discussed:

- willing Investors
- regulatory Body
- government committment
- technical-know-how

It is imperative to note that before any technological development, there must exist the idea, a market environment to operate it, willing customers base and regulatory body to regulate and monitor the goings.

3.2.1 Willing Investors: Before there can be any success in this energy scheme, there must be investors that are willing and as a matter of fact , a Memorandum Of Undertaking (MOU) must be signed with necessary conditions and clauses of operation clearly stated. This is to give an idea or rough estimate of consumption demand. There also has to be other set of investors who will not do the core investment in the production of manufacturing/processing business but in Residential estate that the workers and some other persons can reside and the energy will as well be fed from the Quasi Grid.

3.2.2 Regulatory Body: for smooth operation of the Quasi Energy system as well as a whole, for interoperability of the generating stations and the Zonal Control centres.

Billing system and tariff moderation and miscellaneous service terms, there must be a Government constituted regulatory body.

This agency will as well be responsible for town planning enforcement, moderating the housing estate managers e.t.c. Licensing of newer investors and license renewal among others are the functions of this organ.

3.2.3 Government Committment: The government must on its own part make committment to create a profitable market condition for the prospective investors. It must be ready to ban several importations of goods that the prospective investors. Sometimes socio-economic politics will be required as some companies whose product will be banned will automatically be forced to have a product plant in Nigeria and assembling plant in Nigeria in cases where we dont have the raw materials otherwise they stand to loose the largest population in Africa.

3.2.4 Technical-know-how: there must be an available man power to implement the scheme. Power and electromechanical engineers must be trained who will do the Network design, implementation and management for optimum operation.

All these are preconditions that must be met before we can achieve the necessary industrial evolution in Nigeria. Thus abating crime, robbery and socio evils caused by unemployment[8].

CHAPTER FOUR

4.1 THE NEW ARCHITECTURE

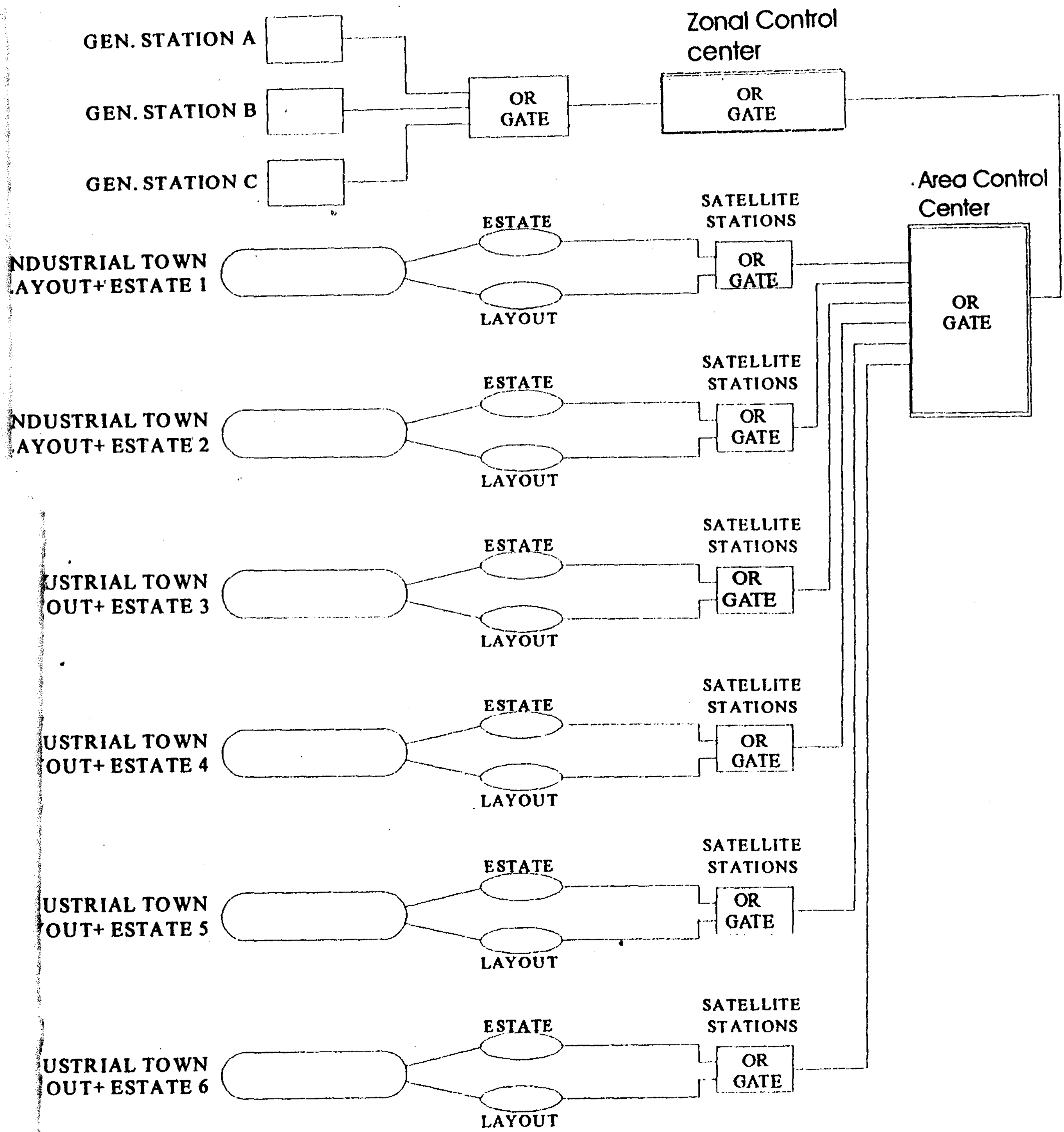


Fig. 4.1

The new architecture is not meant to face out the already existing PHCN Network. It is meant to service only the Industrial sector.

The Grid system is the interconnection of Power stations, transmission lines and distribution stations to meet the objective of supply of Electricity to the consumers.

The Generation station A is generating at 350MW, Generattion station B is generating at 450MW while Generation staion C is generating at 650MW. Each of the Industrial Layout has a maximum capacity of 30MW. From the new architecture, the Zonal Control Centre controls both the generating stations and the Area Control Centre. The Zonal Control Centre does the planning work. It plans the generation and transmission grid system operations on daily basis to ensure reliable, economic and safe operations of all the generation and transmission equipment everywhere on the interconnected system. The Zonal Control Centre also oversee what the three generation stations have and plan against it to bring about even distribution of electricity. For example, if the generation station A can generate 200MW, generating station B can generate150MW and generating station C can generate 250MW, the Zonal Control Centre will now decide if they are all to generate at this capacity at the same time or not to meet up with the objective of stable supply of electricity to the Area Control Centre (ACC). The Area Control Centre is inturn to distribute the electricity generated from generating stations A,B and C through the Zonal Control Centre to all the Satellite Stations 1-6 so that there wont be load shedding and power interruption. The Area Control Centre does the major work. For example, if there is a sudden load drop at any of the Satellite Stations, the Area Control Centre decodes the fault and finds immediate solution to it to avoid system failure or power failure.

From the new Architecture Design, the significance of the OR Gate is that even if the five (5) states are down, the last one will still be up and running.

Also, even if there is any load drop on the Estate Network, the layout should be up and running. This means it is a ring distribution. The major advantage of this ring system is that it enable a faulty section of the line to be disconnected without interrupting service to consumers[4].

Overhead Towers are used in carrying conductors from the generating stations through the Zonal Control Centre to the Area Control Centres because of the weight and the long distance covered.

Underground cable system is used between the Satellite Stations and the layouts because it is economical. Underground system is not exposed to damage and interruptions from storms, traffic, felling of trees etc[1].

Because a fail free power system is neither economically justifiable nor technically feasible, faults can occur in any power system component-generators-transformers, buses, lines etc. So power system protection is always carried out. Faults are detected automatically by means of relays, and the faulty section (say a line transformer or generator). The combination of relays and circuit breakers is known as the Protective system. The salient features of power system protection are:

i. Speed: Faults at any point in the system must be detected and isolated in the shortest possible time. This time is of the order of 30-100ms, depending upon the fault level of the section involved.

ii. Sensitivity: Realying equipment must be sufficiently sensitive to operate reliably when required under conditions that reduce the least operating tendency.

iii. Selectivity: relaying equipment must clearly discriminate between normal and abnormal system conditions so that it never operates umnecessarily.

iv. Reliability: Relaying equipment must be found in healthy operating condition when called upon to act, as years might elapse between two consecutive operations of relays at a particular station.

v. On important lines the protective system, after once isolating the fault, must try to reclose the breakers restoring the system to its original configuration. This is necessary, as many faults (arcing faults) are self clearing, and the system must be healthy in this respect[5].

4.2. DISTRIBUTION DESIGN [A CASE STUDY]

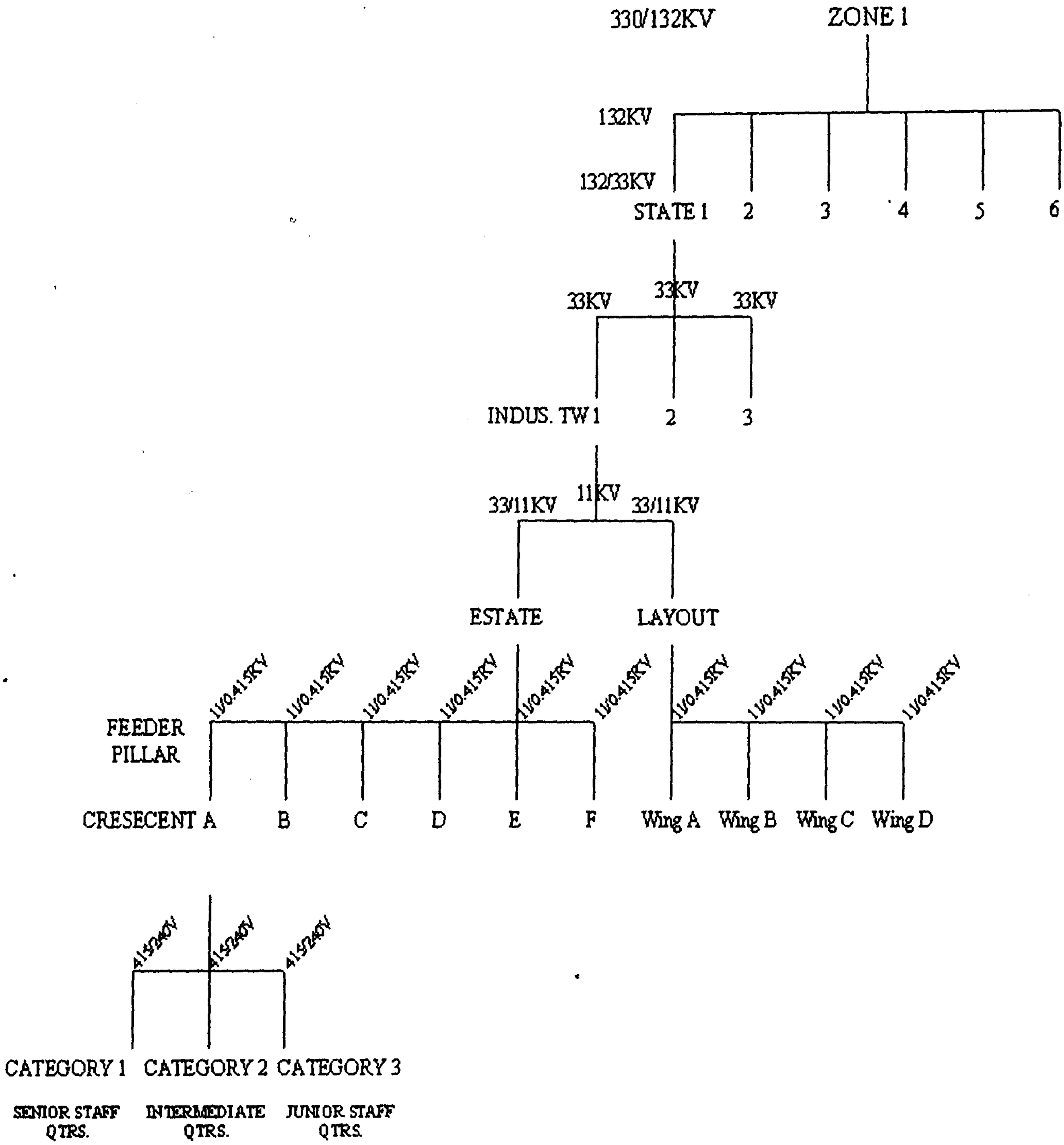


Fig. 4.2

Senior Staff Qtrs.	Intermediate Qtrs.	Junior Staff Qtrs.
Duplex	3 BedRoom Flat	1 BedRoom Flat
5 A/Cs	2 A/Cs	-
1 washing machine	-	-
1 Freezer/Fridge	1 Fridge	-
1 Cooker	1 Cooker	-
4 Heaters	2 Heaters	-
4- 13Amps	3- 13Amps	3- 13Amps
4- 15Amps	3- 15Amps	3- 15Amps

Each generating station must be connected to the electrical grid so that it can feed power to the system and have power available for startup. In addition, the necessary transformer and swtich gear for station equipment (motors for pumps, fans, crushers, pulverizers, conveyors, etc.) must be available.

Since current is generated at a voltage less than that used for main-line transmission, a step-up transformer must be provided between the generator and transmission line. Further, since station equipment runs at substantially lower voltages than are generated, step-down transformers must be provided to meet station requirements. To assure power to operate equipment when the generator is down and to start up the plant, one or more seperate tie lines feeding the plant from the grid are needed. Step-down transformers from this line are also needed.

From the distribution Design (Zone 1 as a case study), the voltage is step-down from 330KV station to 132KV.

From state 1, the transmission sub-station will be step-down to 33KV which will now be taken to the Injection Sub-station which is 33/11KV.

From the industrial Town 1, that is, the Injection Sub-station 33/11KV, the voltage will be step-down from 11KV to 415V of the estate and the Industrial layout.

From the industrial layout which is 33/0.415KV, the voltage supply is taken to the industry which inturn distributes to the industry control panel where all the machines take their supply from. Some of them are designed in 3-phases and some in single phases. The single phases are used for water pumping machine and some other related equipments while the 3-phases are used for equipments like induction motors, heat exchangers, lifting machines, compressors, etc.

For the estate which is further divided into Crescents, the voltage will be step-down to 415/240V, that is from the feeder pillar 3 wire and a neutral.

From category A, the voltage supply will be taken to quarters, that is either in single phase (2-wire ie. a phase and a neutral) and in 3-phases (4wire ie. 3-phases and a neutral) where it will now enter the Distribution Board (DB). It will now be distributed through the star blocks to individual points, that is the lightening, socket outlets, cooker units, heaters, air conditioning etc.

For the categories A-F and Wings A-D, there is proper load balancing because of the kind of appliances and equipments used to avaoid stroboscopic effect.

It is also worthy of note that the Crescents A-F are based on town planner's design and the load estimation is easily carried out because of the proper planning. This avoids the problem of over loading due to unproper planning.

The distribution system here is underground. This is because the voltage regulation of the underground cable system is more effecient as compared with the overhead. The charging current in an underground cable is many times more than the overhead bare conductor line for the same voltage rating. This is due to the cable having comparatively more capacitance. Even an electric engineer must agree that an uderground gas pipeline is preferable to an overhead power line. Also, the underground system is not exposed to damage and interruptions from storms, traffic, tree felling, etc[7].

4.3. TRANSMISSION DESIGN [A CASE STUDY].

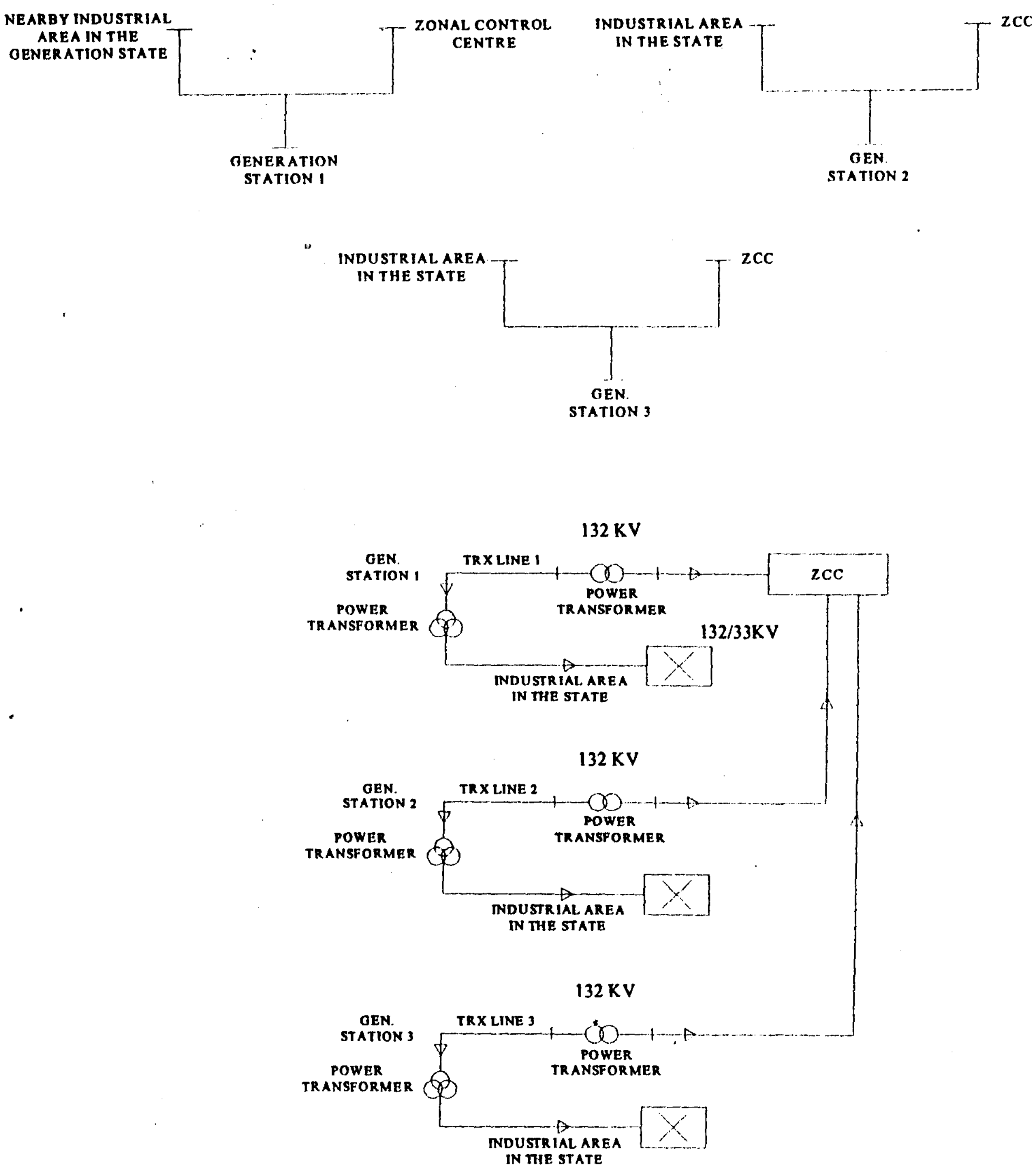


Fig.4.3

The grid system on transmission is to meet the objective of supply of electricity through the Zonal Control Centre to the distribution transformer stations and industrial areas. In this transmission design, since the distance between the generating stations and the transmissiom stations here is regional, there is no need for transmitting at 330KV. Thus, the amount spent on purchasing hghly expensive step-up power transformers will be eliminated, hence transmission is at 132KV from the generating stations to the Zonal Control Centre (ZCC).

Also, the Zonal Control Centre here is centralized among the states making up the Zone. This reduces transmitting at very long distances which usually brings about high voltage drop due to line resistances.

Because of centralization, some very large industrial customers may draw their power directly from the grid. The Zonal Control Centre forms an intermediate and move fine meshed link between the generating stations and the distribution circuits.

Transmission line conductors are run through overhead towers. The overhead lines are suspended from insulators which are themselves supported by towers. The span between two towers is between 370-460m (1200-1500ft). In specifying towers and lines, ice and wind loadings are taken into account, as well as extra forces due to a break in the lines on one side of a tower. For lower voltages and districution circuits wooden or reinforced concrete poles are used with conductors supported in horizontal formations. The live conductors are insulated from the towers by insulators[6].

Overhead line conductors usually comprise a stranded steel core (for mechanical strenght) surrounded by aluminium wires which form the conductor.

Over head power lines are used here because they are less expensive than running the lines through underground cables which are mostly used for very short distances only at most few kilometers. In an overhead line, the spacings between the phases are very large, typically many meters. This is necessary because of poor insulating characteristics of air. The large spacings are the cause of the bulkiness of a power line, but at the same time, they are the cause of a great reduction in the shunt capacitance between the phase and the ground[3].

Pilot relays or distance relays are used to protect the High Voltage lines. Distance relays are used because it can operate by sensing impedance to fault or its suitable modification can accomplish this because their operation does not depend upon the line current alone. The impedance to fault depends only upon the distance to fault and the nature of fault, and is completely independent of how the faulted line is connected in the network. Also, as a consequence, the relay setting is insensitive to network modification and growth, a factor which is an additional handicap of overcurrent relays. Inorder that the relays must be employed at each end, and must be accompanied by directional relays which help the relay to recognise if the fault is on the protected line[5].

4.4 SERVICING

Proper maintenance is fully carried out here, the various types of maintenance are discussed below:

TYPES OF MAINTENENCE

The maintenance department like any other department in a large industrial orgainization must prove its efficiency and justify its cost. Bad planning can render the execution of the simplest of maintenance task costly and time consuming. For any large industrial complex, there should be the categorization of maintenace work into the following:

1. Routing maintenance: under this maintenace method, inspection, minor repairs, cleaning, oiling, temperature and vibration measurement and other similar activities deterioration and malfunction of the palnt and equipment are prevented. This type of maintenance does not require sophisticatedd maintenance techniques.

2. Breakdown maintenance: under this method, repair is performed when signs of an imminent breakdown are seen. When an equipment has stopped due to breakdown or when the equipment's performance declines to a harmful level. Inorder words, this is the type of maintenance that provides repairs after stoppage of plant operation.

3. Preventive maintenance: this method attempts to prevent breakdowns and performance decline by evaluating the degree of deterioration through past inspection results, breakdown stastitics, other experiential data and daily checking activities. Preventive maintenace on a predetermined schedule. It helps to keep equipment in good condition to prevent breakdowns and also to keep safety and environmentally sensitive equipment in top shape.

Preventive maintenance is undertaken before need arises and aims at minimizing the possibility of unanticipated production interruptions or major breakdown.

i. proper design and installation of equipment.

ii. periodic inspection of plant and equipment to prevent breakdowns before they occur.

iii. repetitive servicing, up keep and overhaul of equipment.

iv. and adequate lubrication, cleaning and painting of building and quipment.

Inspection is the key to all preventive maintenance program. It should cover virtually everytthing including production machinery, motors, controls, materials, handling equipment, process equipment, lighting, buildings and plant services.

A well conceived preventive maintenance program have the following features:

a. proper identification of all item to be included in the program

b. adequate records covering, volume of work, cost, e.t.c

c. inspection of a definate schedule with standing orders on specific assignments.

d. use of checklist by inspectors

e. An inspection frequency schedule may vary from as often as once every six hours to as little as once per year.

f. well qualified inspectors have craftmen familiar with item, being inspected and capable of making simple repairs at the time trouble is observed.

g. use of repair budgets for major items of equipment

h. admistrative procedures that provide necessary fulfilment and follow-up on program.

These are some of the advanteges of preventive maintenance:

i. greater safety for workers

ii. decreased production down time

iii. fewer large scale repairs made before breakdown

iv. less cost for simple repair made before breakdown.

v. less standby equipment required

vi. better spare parts control

vii. identication of items with maintenance costs.

viii. lower unit cost of manufacture.

Inspection is the key to all preventive maintenence program.

4. Predictive maintenance:this is newer type of maintenece. It is predictive type of maintenance that involves the use of sensitive instrument (e.g. vibration analyzers, audio gauges, optical tooling, pressure, temperature and resistance gauges) to predict trouble. Conditons measured periodically or on contineous basis-give the maintenance people signals on imminence need for overhaul. This will allow anextension to the service life without fear

of failure. Predictive maintenece is condition monitoring on a pre-determined schedule, while the eqipment is operating. Preventive maintenance requires the equipment to be shutdown, but predictive maintenance does not. Condition monitoring means that the condition of the equipment is monitored with an instrument or analyzer and the result are compared with a pre-established physical parameter or limit. If the condition exceeds pre-established criteria, the equipment is taken out of service for repair of modificaations.

5. Corrective maintenance: the main objective of this objective method is to make various improvement to reduce equipment deterioration and to facilitate daily checkup inspection and repair activities. Under this method, improvements are actively made o equipment so as to achieve a greater maintenance efect. In this period of economic depression in the country coupled with low plant investments, we have to strive to meet reduction in maintenance costs and also increase the reliability of our equipment through the practice of effective maintenace management in all our eneterprises both public and private[2].

4.5.2 AVAILABILITY

The availability under the Generation is such that there is multiple Generation stations so that is one generation station is down, the other ones will be up and running and they will substitute for the one that is down.

The use of low scale turbines is highly in use here. Assuming Generation station A ia generating 60MW, a 2nos x 30MW units can be used so that if one 30MW is down, the other 30MW will be up and running. Preferably, a 4nos x 15MW (60MW) is used so that the failure of one unit 15MW leaves the remaining 3nos x 15MW (45MW) to be fully functioning.this greatly help in maintening stable power supply in the system.

The availabilty under the Transmission system is such that the states directly feed from the Generation station nearest to them and they are still connected to the Zonal Control Centre so that when when the generation station nearest to them that is serving them directly is down,they can as well be fe from the Zonal Control Centre. This enhances maximum power supply at all times in the system.

The availability under the Distribution system is an underground network. Underground system is used instead of overhead because it is more economical.Underground system is not exposed to damage and interruptions from storms, traffic, tree felling etc. It is constructed in such a way that faults can easily be traced incase there is one[4].

4.5.1 Billing Method Versus Existing Power economic

The billing system is used here because of the following advantages over the existing PHCN present system

1. It reduces the cost of paying workers which are employed to carry out the duty of sharing of bills.
2. It solves the problem of consumers embarassing PHCN staffs when they go for disconnection of those that didnt pay bills. Inshort there wont be need for PHCN staffs to go for disconnection.
3. It makes consumers to be disciplined and conscious of what they consume, so appliances that are not needed in the home at a particular time will not be switched on, they will only be switched on when they are to be used.
4. It solves the problem of consumer's complain over non-proper billing of what they consumed. This billing system is based on pay as you use.

5. It also solve the problem of misunderstanding between the consumers and the PHCN staffs when they go for meter reading. Some consumers lock their doors or gates when going to work not given the PHCN staffs access to the house to take the accurate reading of the meter.

CHAPTER FIVE

RECOMMENDATION AND CONCLUSION

5.1 RECOMMENDATIONS

I recommend that a dedicated power generation which could be done by private power investors be allowed to come and invest in the country. This will help to reduce the shortage of power supply in the country.

I recommend that the distribution network should be decentralized to a regional type. This will help to ease signal sending from the small scale generating plants.

I also recommend that individuals of the member of the society should be able to sue PHCN to court for damages of their equipment due to abnormal power supply from PHCN.

5.2 SUGGESTION

As final words I would love to suggest to the department that could forestall our posterity as a department, a school and as inividuals.

The department should encourgae students in selecting project topics to go for challenging options that will not only fetch them the grades while adding to the pile of Irrelevant material and turning the lab to to a dumping ground but in line with what was stated in the departmental handbook, "one with national relevance". Patriotism isn't an ingrate; it appreciates such acts. The school curriculum should be revised with the aim of bringing the practice of engineering and the learning in close proximity to the student.

The department should liase with firms that exist in the locality so that attachments can be made for willing students to give them an out of the classroom approach to learning which undoubtedly would expand their horizon.

Seminars and workshops be organised to enlighten students on arms of electrical and electronic engineering that time and chance would not permit to be included in the curriculum.

Practising engineers should be invited to take some topics in some courses especially those for which the lecturer in charge is not so learned. We are not all knowing!
Students should be made to undertake semesterial from 300 level to prepare them for their final year projects.

Students should be given topics or made to choose one, before or during their SIWES program to give them time to work on the project and produce a worthy documentation of it. Proper documentation of projects should be made to avoid excessive repetition of projects and a plan should be made to ensure that study is continued on topics like this one via final year projects. This causes for continuity; a virtue that ensures sustained development.

There should be continued work on this subject-the development of software to help in the assignment of frequencies or the design and construction of a field strenght meter whose unavailability was impediment to the project work.

5.3 CONCLUSION

The subject of Industrial Evolution as a research project is challanging as it is interestingly realistic. A successful implementation of this project will encourage investors to invest in the country with a reliable power system, it will alleviate poverty vis-a-vis industrilization because there will be emloyment opportunities. It will also help the country in meeting up to international and domestic market demand. It will also improve export rate.

The project is a product based on the factors that are within our reach and could be highly pessimistic as well as being to a corresponding degree, highly optimistic in it's results and assessments.

In conclusion, we would not need to wait until PHCN can make everything okay before we can experience industrial evolution.

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