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Electric Load Evaluation in G.R.A Phase 2, Port Harcourt for improved distribution

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ABSTRACT

This dissertation is a study about the electric load flow evaluation of power supply to G.R.A, Port Harcourt for improved distribution. Field survey, collection and analysis of data collected. The injection substation that supply electricity to G.R.A, Port Harcourt was the first task in this study. This study used Electric transient simulation and from the simulation, the existing distribution network had low voltage profile problem and overloading of transformers. To address, capacitor banks were introduced at some buses so as to improve voltage upgrade and performance on the distribution network. The simulation of the improved distribution network shows that the voltage profile has improved with the statutory limit of 95% and the loading of the transformers are all below 60%. The method used is fast decoupled load flow method. This decoupling method is fast, very simple and efficient. Its accuracy is comparable to that of Newton- Raqphson method. The research work examined the existing state of the electrical power network at G.R.A. 11KVA distribution network taking its power supply from Golden lily 33/11KV injection substation. The present study state was modeled in electrical transient analyzer (ETAP) with the application of voltage equation, power flow; equation etc for the purpose of investigating system conditions in terms of voltage stability (Weather there is a strong mis-match between nominal declared voltage with regards to IEE regulation and existing operating voltage) in order to enhance system performance. The existing network simulation results revealed that the system is overloaded and there are marginal overload in some of the buses. To avoid system breakdown or collapse that may result sin blackout, it is necessary to ensure that system components such as transformers, cables, feeder line, generator etc are not overloaded beyond its operating capacity. Importantly, the study engaged optimization strategy of improving system overload by determining the optimal size of the capacitor bank required to improve the specific bus overload problem on the network in a view to enhance power quality, voltage profile and power factor. We recommend that Build an injection substation for G.R.A Port Harcourt alone. Have an overload relay to transformer protection than using a fuse which people will wire without following the specification. Undersized cables in the network should be replaced. Integrating capacitor bank compensator where necessary in order to reduce voltage instability problems, electricity cost due to excessive losses. Periodic load flow analysis should be carried out by the electricity distribution company (PHEDC) to ascertain the status of network without over stressing it. company (PHEDC) to ascertain the status of network without over stressing it.

1. INTRODUCTION

An Electric Power System consist of the Generating station, Transmission station and Distribution stations. Electrical power is transmitted by high voltage transmission lines from sending end substation to receiving end substation. At the receiving end substation, the voltage is been stepped down to a lower value (say 33kV, or even 11kV) as the case may be.

The transmission system is further divided into primary and secondary transmission.
Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage with the use of transformers. The primary distribution line carries this medium voltage power to the distribution transformers located near the customers' premises.

Distribution transformers again lower the voltage to the level suitable for household utilities and hence feed several customers through the secondary distribution lines (distributors) at the same voltage. Residential and commercial customers are connected to the secondary distribution lines through the service drops. Although electrical power customers in need of higher amoun-t of power may be connected directly to the primary distribution line or the sub transmission level.

There is no doubt that electrical energy is the most popular form of energy as well as the key of industrialization and as such every nation is doing everything humanly possible to improve its electrical power generation as well as enhancing the power transmission and distribution system in order to make it efficient and reliable to meet with the ever growing power demand of their respective countries.

In practice, the demand for electrical power always exceeds the supply especially in a developing country like Nigeria resulting to undesirable power sharing (load shedding) thereby resulting to epileptic power supply system.

However, in Nigeria the limiting factors to efficient and reliable power supply apart from low power generation may include: poor or inefficient voltage control system, poor transmission networks, highly overloaded transmission feeders due to lack of planning, faulty distribution system on the part of the electrical supplier (PHED), voltage drop along the line and from the distribution system due to the flow of current and load variations on the consumer end, damage to substation, transmission and distribution network, short circuit or over loading of electrical mains and tripping of power system. These factors have resulted to unreliable voltage variations and frequent power outages.

An efficient power supply is one that seeks to overcome these shortcomings and delivers good quality electrical power to load consumers and industrial users. For an efficient and reliable distribution system, the power flow analysis is a very fundamental tool because its results play a major role during the operational stages as well as during expansion and design stages. The purpose of any load flow analysis is basically to compute accurate steady state voltages and voltage angle of all buses in the network, the real and reactive power flow into every line and transformers under a known generation and load. The study gives steady state solutions of the voltages at all the buses for a particular load condition.

In this study, we will use the Fast Decoupled Newton-Raphson load flow analysis to analyse electrical power supply to G.R.A phase 2 Port Harcourt because this method gives the solution of non-linear simultaneous equations in rectangular or polar form. The total time taken to get the convergent criteria is less, and the number of iterations required to get the convergent criteria are limited as it does not depend on the number of buses.

G.R.A phase 2 is located within G.R.APort Harcourt in Rivers State, Nigeria. Electricity is being supplied to G.R.A phase 2 from the 11kV waterlines feeder, 11kV Omerelu feeder, and 11kV Rumuomoi feederlocated in the Rumuola (Golden lilly 33/11kV lines) Port Harcourt.However, challenges emerge as the city expands; low voltages are experienced in some areas which led to the installation of transformers without planning, resulting to overloading of the feeder and also drop in voltage due to the distance covered by the transmission line which serves the area. Despite these challenges, there is the insufficient megawatt from the National Grid to the state.

Electrical Energy plays a dominant role in the socio-economic development of the state. In view of this, this research identifies the numerous problems on the network and it becomes paramount to carry out proper load flow analysis with a view to achieve efficient supply of power in the area in particular and the state at large.

G.R.A phase 2, Port Harcourt electric power distribution network is faced with the following problems:

1. Low voltage
2. Voltage drop due to the distance covered by the transmission line
3. Over loading of distribution transformers on the following feeders as listed

below:

   i. Waterlines 11kV feeder
   ii. Omerelu11kV feeder
   iii. Rumuomoi 11kV feeder

The aim of this research work is to evaluate the electric load in GRA phase 2, Port Harcourt.

The objectives of this research work are:

1. Together important information about the physical conditions of the electric power distribution network for G.R.A phase 2, Port Harcourt
2. To carry out a field survey and interaction with Port Harcourt Electricity Distribution Company(PHED) to obtain relevant information/data for the project
3. Model and carry out load flow analysis using ETAP.

The scope of this research work is targeted at the electric load evaluation in G.R.A phase 2, Port Harcourt for improved distribution so that the network will not suffer electricity interruption, overloading and high losses.

This research work shall provide adequate information for future planning expansion/upgrade of power systems on the network. It will also determine real and reactive power that flow at G.R.A phase 2, ascertain the power losses on the network and finally present findings of results and make recommendation on the solution to the problems.

2. RELATED WORKS

Load flow analysis forms an essential pre-requisite for power system studies. Considerable research has already been carried out in the development of computer programs for load flow analysis of large power systems. However, these general purpose programs may encounter convergence difficulties when a radial distribution system with a large number of buses is to be solved and hence, development of a special program for distribution studies becomes necessary. There are many solution techniques for load flow analysis such as: Gauss Seidel, Newton-Raphson, Fast Decoupled algorithm etc.

According to the (Ahmed, 2013) that potwer flow analysis is the solution for the operating condition of a power system. Power flow analysis is used for power system planning, operational planning and operations/construct (Brown, 2013) also employed in multiple assessments, stability analysis and system optimization.

The efficient load flow method is used to model the characteristics features of Radial Distribution Networks (RDN) in the area of distributed system automation such as Volt/Var Planning (VVP), optimal sizing and placement of distributed generators and network reconfiguration flow profile. Popular methods like the Gauss Seidel, Newton-Raphson, Fast Decoupled load flow and other versions might be unsuitable for solving load flow program and sometimes fail to converge because distribution feeders have a high R/X ratio, huge number of buses and radial structure topology which makes the system ill-conditioned when solving for the respective load.

In the view of these scholars (Li et al, 2014) they stated that algorithm have been developed to tackle the load flow power, where the authors have formed node-branch incidence matrix that de'gnb e4pict the relationship between the bus injection powers and branch powers, then an estimated voltage drop and angle formulas were used along with the incidence matrix to solve the load fjilow power.

(Li *etal.*, 2016) modifies the previously mentioned algorithm to counter the fundamental error problem resulting in high precision results for both weakly-meshed/meshed networks.(Jabr.*etal.*, 2012) used the same convex formulation to obtain the optimal configuration for RDN that minimizes its real power waste.

This paper has modelled the load flow power of Radial Distribution Network asQuadratic ally Constrained Convex Optimization Problem (QCCOP)convexification of the continuous decision variables of the optimization problem guaranteed the global optimality of the acquired solution. Moreover, the solution was obtained using interior-point method algorithm via CPLE X optimization software after passing the parameters from MATLAB. The proposed algorithm has shown high computational efficiency, which paves the way for real time optimization problems regarding the operation of Radial Distribution Network.

Kipkirui and Abungu (2009) in their paper proposed decoupled load flow method using MATLAB 7.6 (r2013b) to develop an efficient and reliable program and PSAT (Power System Analysis Toolbox) as a validating tool. The procedural methods calculated and analysed a well-conditioned load study with minimal losses on the buses, branches and the minimal number of iteration required for convergence were noted. IEEE 14 bus system was used as the test system in the research work.

According to Izuegbunam*etal.*, 2011 , the Nigerian Electric Power Transmission network operated by Transmission Company of Nigeria (TCN) operates at a very high pressure of 330kV while its lower transmission pressure is 132kV.The planning, design and operation of power systems requires load flow computations to analyse the steady state performance of the power system under various operating conditions and to study the effects of changes in the configuration of equipment. In their view, the very low bus voltage and poor power magnitude obtained from this study without voltage compensation revealed the reality of the perpetual poor power supply to the North West part of Nigeria.

This project which seems to bea prototype of the entire network can be solved using load flow studies which involves the use of computer programs designed specifically for this purpose.

The power flow studies is a tool used to find the steady or operating conditions of power systems for given sets of load and generation value. But when the input conditions are uncertain, different incidence are considered for the required range of uncertainty, and reliable solution algorithms that accept the effect of data uncertainty into the power flow analysis will be required.

According to (Su, 2005) and (Chen et al., 2008), probabilistic methods are tools for planning studies. Though there are different short comings as a result of non-normal probability distribution and the statistical dependence of the input data as well as the problems associated with identifying probability distribution for some input data accurately.

In their view (Zian Wang et al., 2009) suggested a method for solving the load flow using interval arithmetic taking the uncertainty at the nodal values. Their articles also stated that the required solution to the non-linear equations can be obtained by interval Newton operator, Krawczyk operator or Hansen-Sengupta operator.

(Barboza et al., 2004) and (Barboza et al., 2005) also gave the methodology for solving the uncertain power flow problems and a mathematical representation was applied to the load flow analysis by considering Krawczyk's method to solve the non-linear equations. It is mentioned that the existing problem of excessive corvation in solving the interval linear equation could be overcome by Krawczyk's method. In this method the linearized power flow equations should be preconditioned by an M-matrix in order to guarantee convergence. The scholar also said that (Wang et al., 2005) the set of non-linear equations were solved by Gauss-Seidel method. Preconditioning is required but if interval input is too cumbersome, convergence is not guaranteed, that is why this method cannot give an exact solution. (Yu et al., 2009) Fast Decoupled power flow using interval arithmetic has been used to obtain the solution to the power flow with uncertainty.

This algorithm converges very fast and considers retaining the midpoint of the load flow studies. This is a specific feature that ensures the convergence in accordance with the punctual load flow studies. The algorithm is effective and avoids unnecessary computation effort like preconditioning.

Jayaprakash, etal,(2016) in their work on load flow analysis to investigate the performance of electrical system during normal and abnormal operating conditions, provided information needed to: minimize MW and MVar losses; optimize circuit usage; develop practical voltage profiles; develop equipment specification guidelines and identifies transformer tap settings.

ETAP is computer based software that simulates real time steady-state power system operations, enabling the computation of system bus voltage profiles, real and reactive power flow and line losses etc. (Jayaprakash, *et al.*, 2016).

Load flow study is a tool in power system analysis, and as such balanced conditions and single phase analysis are determined using this tool. It also solve the problems in the voltage magnitude and phase angle at each bus, the active and reactive power flow voltage magnitude, voltage phase angle, real power injection and reactive power injections.

The sinusoidal steady state condition of the fully system voltages, real power and reactive power generated, and line losses are also determined using this analysis.

In the view of (Klingman and HimmeIbau 2008) the slack bus set the angle difference between two voltages, the angle of the slack bus is not important, although it sets the reference angles of all the other bus voltages.

The main objective for the calculation of power flow study is to find the magnitude of voltage /V/ and the phase angle (δ) of the power losses at each bus section, the real and reactive power flowing in each line of the power system.It was observed that Newton-Raphson’s approach has made the calculations easier because the number of buses increased while the number of iterations decreased.

Load flows are required to analyse the steady state performance of the power system during planning, design and operation of electrical power systems.

These load flow studies can be done using computer programs designed specifically for this purpose.

According to (Abdulkareem,*et al.*, 2014) model and doing simulation are methods used to overcome the computational problems of power flow solution using load flow iterative technique such as Newton-Raphson and Gauss-Seidel. It needs a model based on real condition. The making of this model must be based on real and valid data so that the model can represent real condition.

In their view they stated that the very low bus voltages and poor power magnitude obtained from their study without voltage compensation at Agbefa 11KV feeder emphasise the reality of the epileptic poor power supply at the Abule-Egba part of Lagos State, Nigeria. In a view to supplement this disturbing situation, it was recommended that relevant parties engage in the reduction of power loss on the distribution network via correct sizing and location of reactive power support. If not properly applied or sized, the reactive power from capacitor banks can create even more losses and high voltage that can damage light load.

In an electrical Power system, power flows from generating station to the load through different branches of the network. According to (Afolabi, *et al.*, 2015) that the flow of active and reactive power is known as load flow or power flow. Power flow analysis is an important tool used by mostly power engineers for planning and determining the steady state operations of a power system. Also (Mageshvaran*et al.*, 2008) said that load flow studies is to determine the various bus voltages/phase angles, active and reactive power flow through different branches, generators, transformers, settings and load under steady state conditions. The power system is modelled by an electric circuit which consist of generation, transmission and distribution networks. The researchers (Elgerd, 2012) and (Kothari and Nagreth, 2007) said that the main information obtained from the load flow or power flow analysis consist of phase angles of load flow bus voltage and magnitude, reactive powers and voltage phase angles of generator buses, real and reactive power flow on transmission lines and power of the reference bus; other variables also being specified.

The load flow problem equations are non-linear and as such it requires iterative techniques such as Newton- Raphson, Gauss-seideletc in solving it. According to (Aroop et al., 2015) and (Milano, 2009), the development of these methods mainly led to the basic requirement of load flow calculation such as convergence properties, memory requirement, computing efficiency, convenience and flexibility of the implementation. However, it was concluded that in planning of a power system, Gauss-Seidel method can be used especially for a small system with less computational complexity due to the good computational characteristics it exhibited. The effective and most reliable amongst the three load flow methods is the Newton-Raphson method because it converges fast and is more accurate.

(Ochi, *etal.,* 2013) in their view proposed 'a fast decoupled load flow calculation method for distribution systems with high R/X ratio'. The method was based on a coordinate transformation in Y-matrix for Jacobianmatrix in the load flow method. But comparing it with the Newton- Raphson's method, it was found that a short computational time was realized although its convergence characteristics worsen. In a bid to solve the problem, a coordinate transformation in Y-matrix of the fast decoupled method for better convergence was employed (Ochi *etal.,* 2013).

According to Ajabuegoetal,(2017) in their work considered the impact of distributed generation(DG) on the quality of electricity supply in Port Harcourt network. They gave account on the impact of both the present and the future load demand. In achieving this, power flow analysis and continuous power flow (CPF) optimization method was used to achieve the simulation.The simulation was done using MATLAB 7.9 Power System Analysis Toolbox (PSAT) Simulink environment to analyse the network. The result shows that the dispersion level of DG's among the buses increases, there was a very remarkable improvement in the voltage profile, real and reactive power and load ability of the network.

Ibeni (2017) in his work on Load Flow Analysis of Port Harcourt Electricity Network by using Fast Decoupled and Newton-Raphson methods showed that the power dispatched from the national grid network to the transmission substations were inadequate, and as such each injection substation had percentage of loading of the power available.

From the simulation results, it showed that sufficient power is required from the grid to the various injection substations via Port Harcourt Town (Z4) control transmission substation because the lack of adequate power supply from the grid to the transmission substations down to the distribution injection substations will result to power sharing and to address this anomaly it was recommended that: The 33kv distribution network be expanded by installing more transformers, protective systems, and capacitors banks as realized from the affected buses so as to keep the desirable voltage limits; the injection substations for the network under consideration should be made to operate at least 80 per cent of power supply to the secondary distribution network; the reactive power demanded locally at the bus injection substation can be used to minimize the line power loss associated with the network; there should be a periodic load flow analysis carried out by the Electricity Distribution Company to ascertain the status of the network without over stressing it.

According to Kriti (2014) in his work on the 'Comparison between Load Flow Analysis, Methods in Power System Using MATLAB'. He stated that the analysis, designing, and comparison between different load flow system techniques such as Newton-Raphson

,Gauss-Seidel etc. in power system using MATLAB was done successfully and the desired results were obtained. In Gauss-Seidel method, it was found that the rate of convergence was slow, it can be easily programmed and the number of iterations increases directly with the number of buses in the system whereas in the Newton-Raphson method, the convergence was very fast and the number of iterations is independent of the size of the system; the solution is high as obtained. It was stated as observed that in Newton Raphsonmethod, convergence is not sensitive to the choice of slack bus. In conclusion it was practical that only the Newton-Raphson and the Fast decoupled load flow methods were the most popular methods. The fast decoupled load flow is definitely superior to the Newton-Raphson method because of its speed and storage capability (Kriti, 2014).

3. MATERIALS AND METHOD

3.1 Materials

Port Harcourt Electricity Distribution company (PHEDC) is the major source in which data for this research work is collected. The data gathered are: Installed capacity of transmission substation, installed capacity of injection substation examined feeders, total number of power rating of distribution transformers and single – line diagram of power distribution network for G.R.A

In the course of the study, gathering of important data of different types is an essential task various books, thesis and theories have been referred to.

3.2 Method

Fast decoupled method was used and the simulation on the feeders was done using ETAP

3.3 Description of the System

In this study the analysis considered

i. Conductor: (160mm^2) aluminum conductor steel reinforced (ACSR)
ii. Voltage rating of the distribution transformer (33/11kV,11/0o.4154kV)
iii. Date from the injection station feeders
iv. E – tap Application programe software for simulation

The injections sub-stations consist of & outgoing feeders namely: Omerelu, Waterline, Rumuola, New GRA, Romuomoi, Barrack, Shell industrial and Bori Camp.

Table 3.1: Show the Feeders Examined in this study, number of distribution Transformers, Feeders Route Length, Feeder type.

Examined	Feeder Route length (Km)	Feeder type	No of distribution Transformer in KVA								
			1500	1000	750	500	315	300	200	100	50
Omerelu	3.25	Aluminum	1	0	0	11	0	14	8	5	1
Rumuomoi	11.5	Aluminum	0	1	1	34	1	23	31	33	6
Water line	15.85	Aluminum	0	0	0	19	0	30	26	14	0

Source: Port Harcourt Electricity Distribution Company (PHEDC)

Transformer Overloading Determination

To determine the percentage loading of a transformer in a network, the apparent power performance index is been used. For a design rating of a transformer, a transformer being 60% on the rating for design purpose.

$$-\% \text{ loading } \left[\frac{S_{MVA}}{S_{MAX}}\right] \text{x } 100 \qquad (3.1)$$

Wheree

$S_{MAX}$is the MVA rating of the transformer

$S_{MVA}$is the operating MVA from power flow calculation

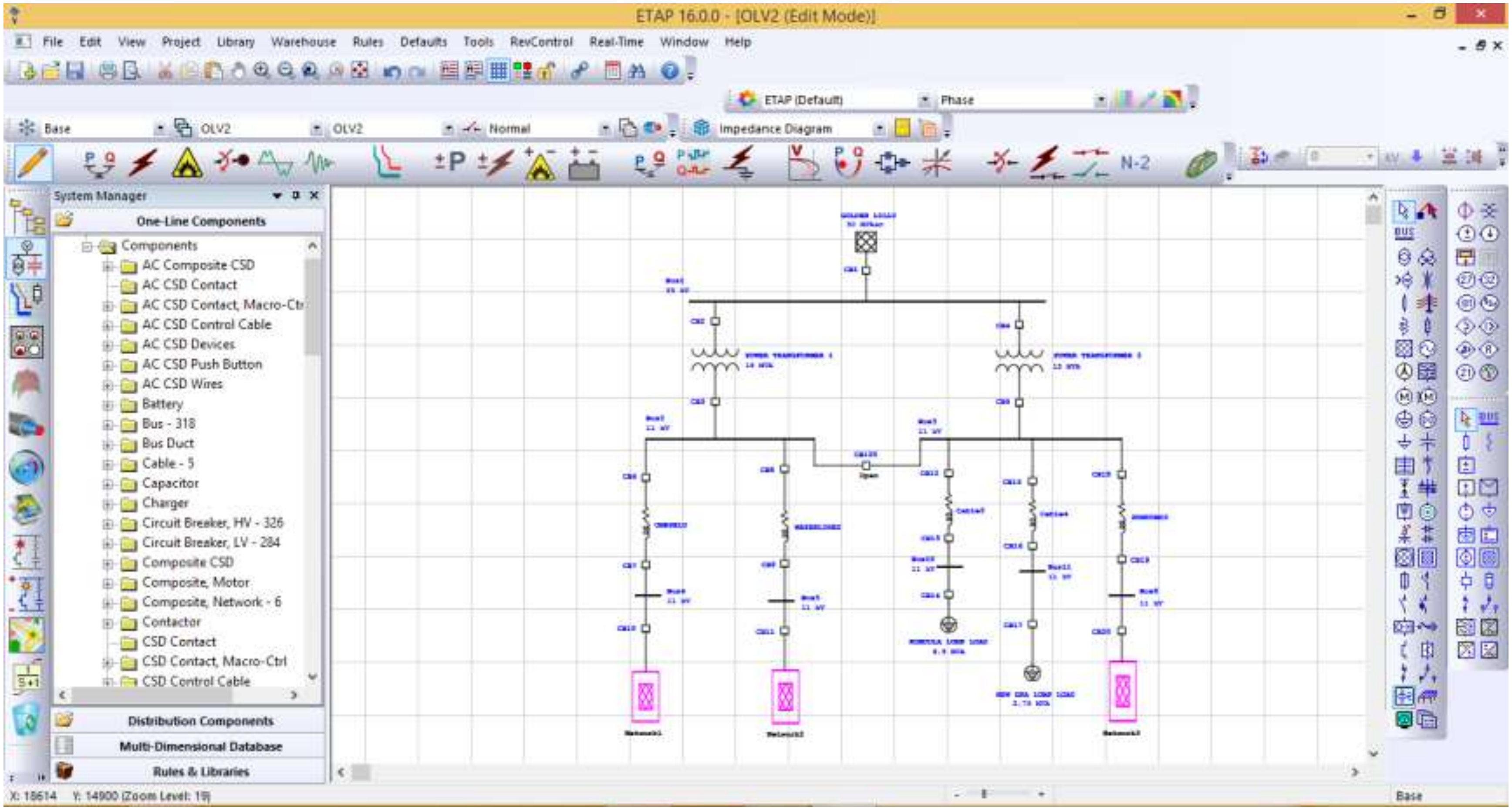

Figure 3.1: Systematic Diagram of power supply network at golden lillysubstation (existing case study not simulated)

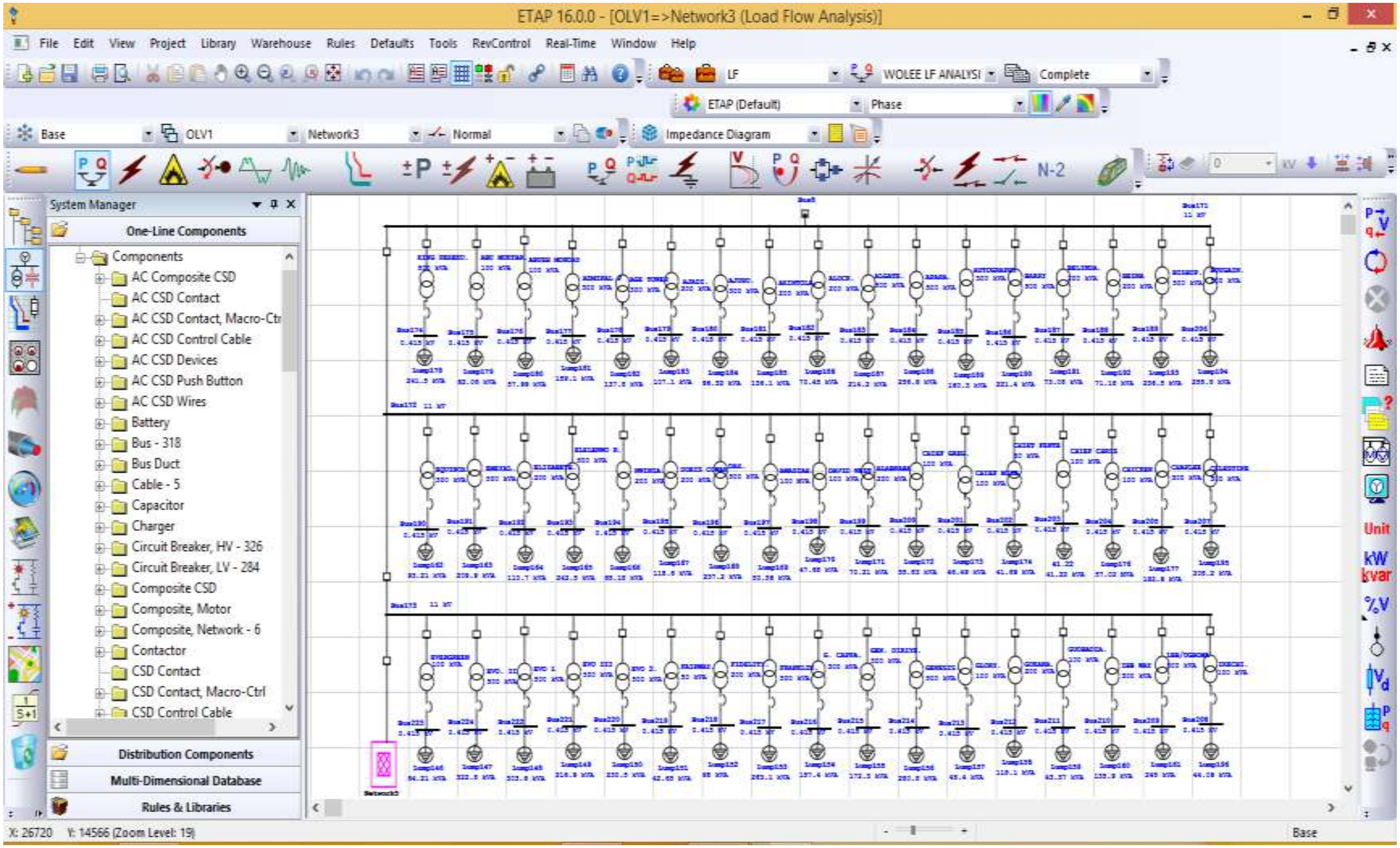

Figure. 3.2: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

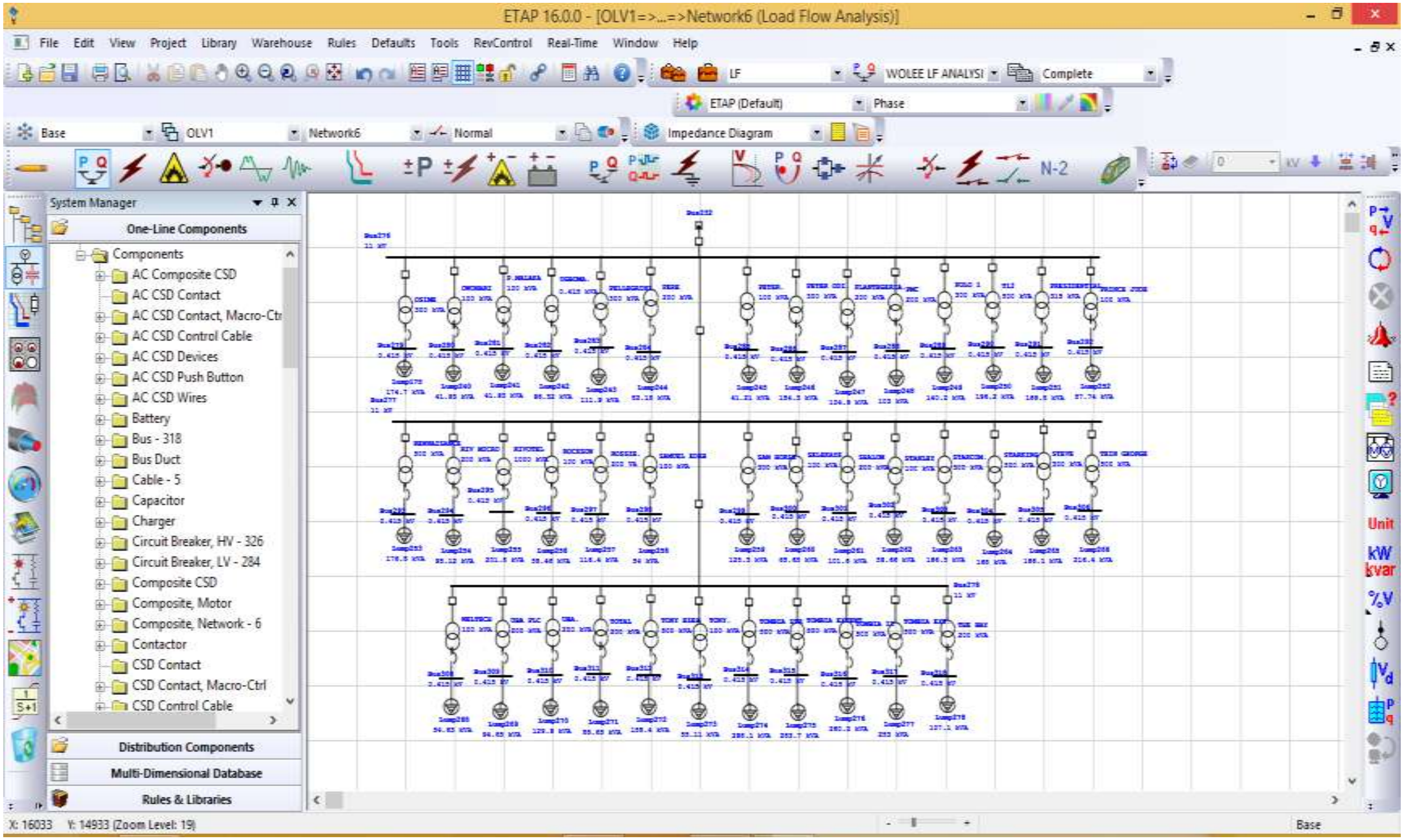

Figure. 3.3: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

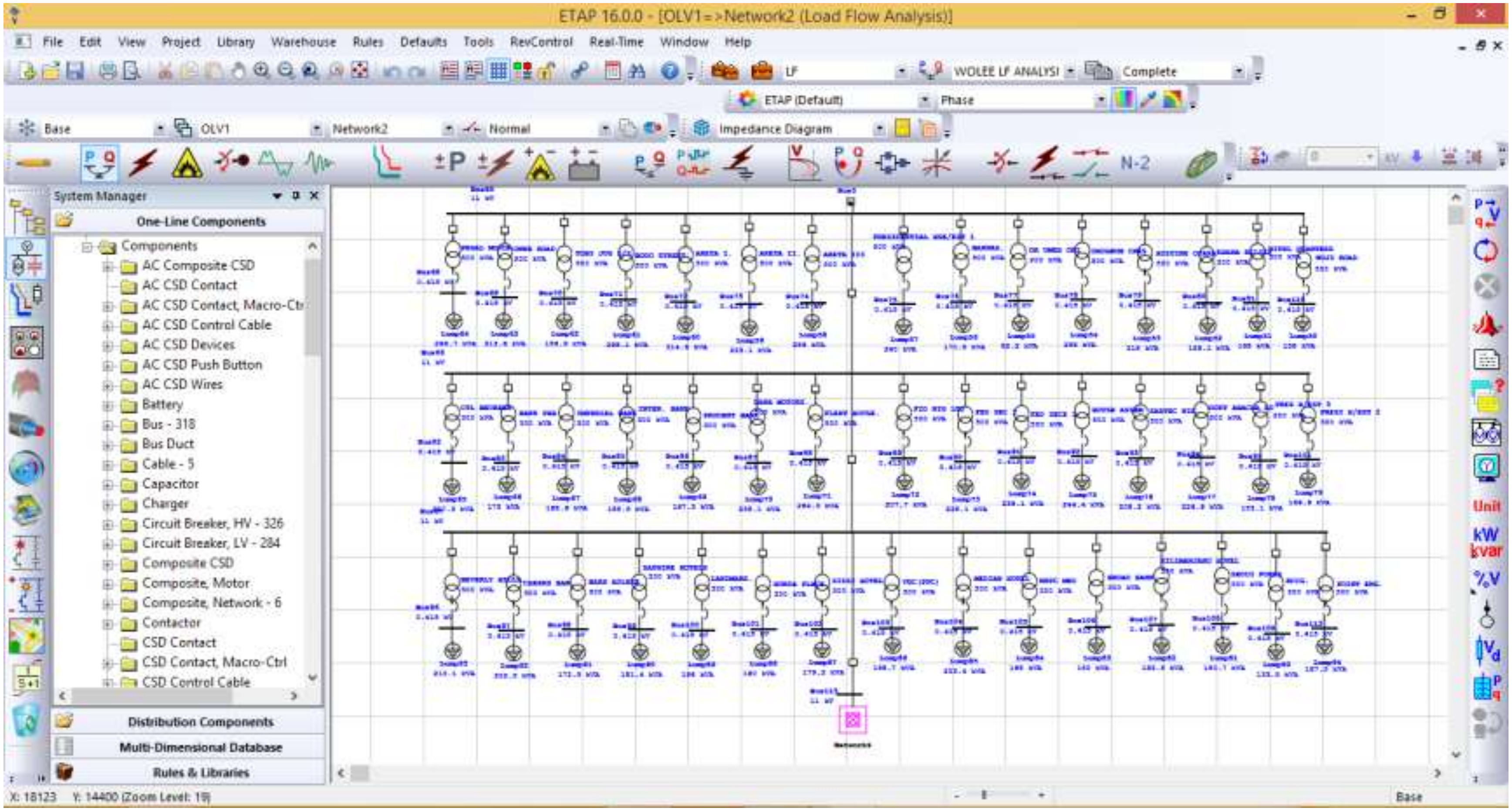

Figure 3.4: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

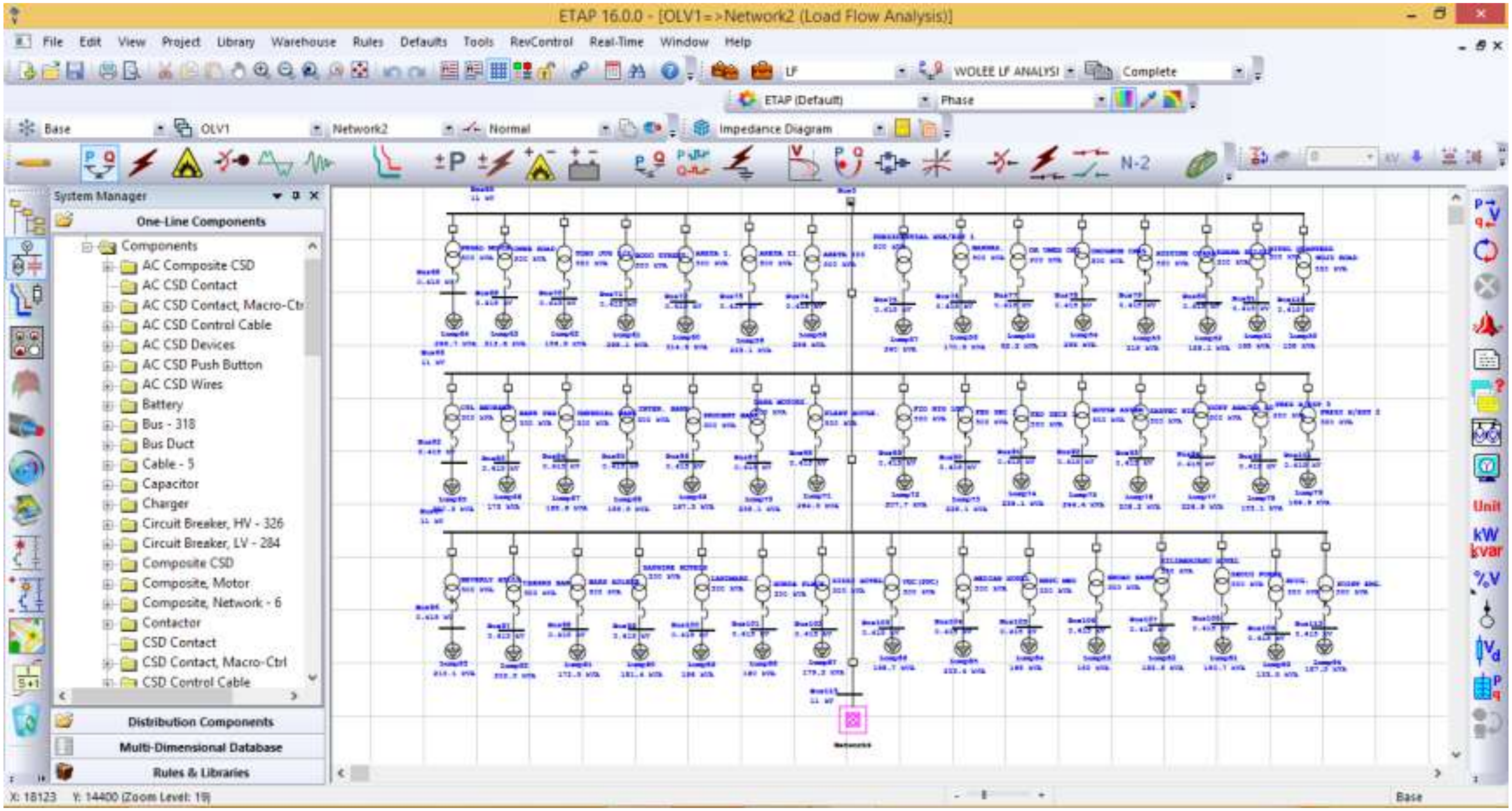

Figure. 3.5: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

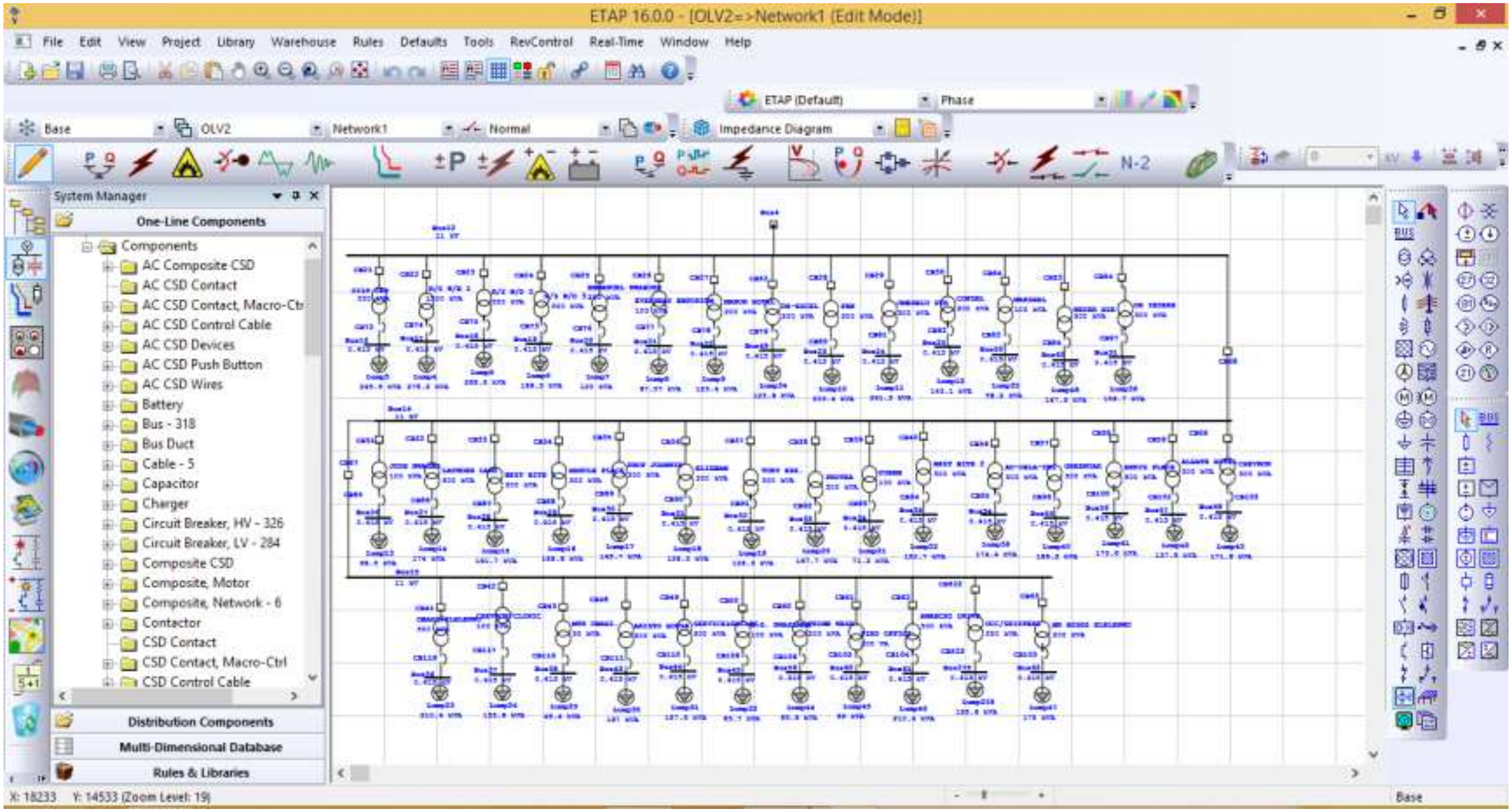

Figure. 3.6: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

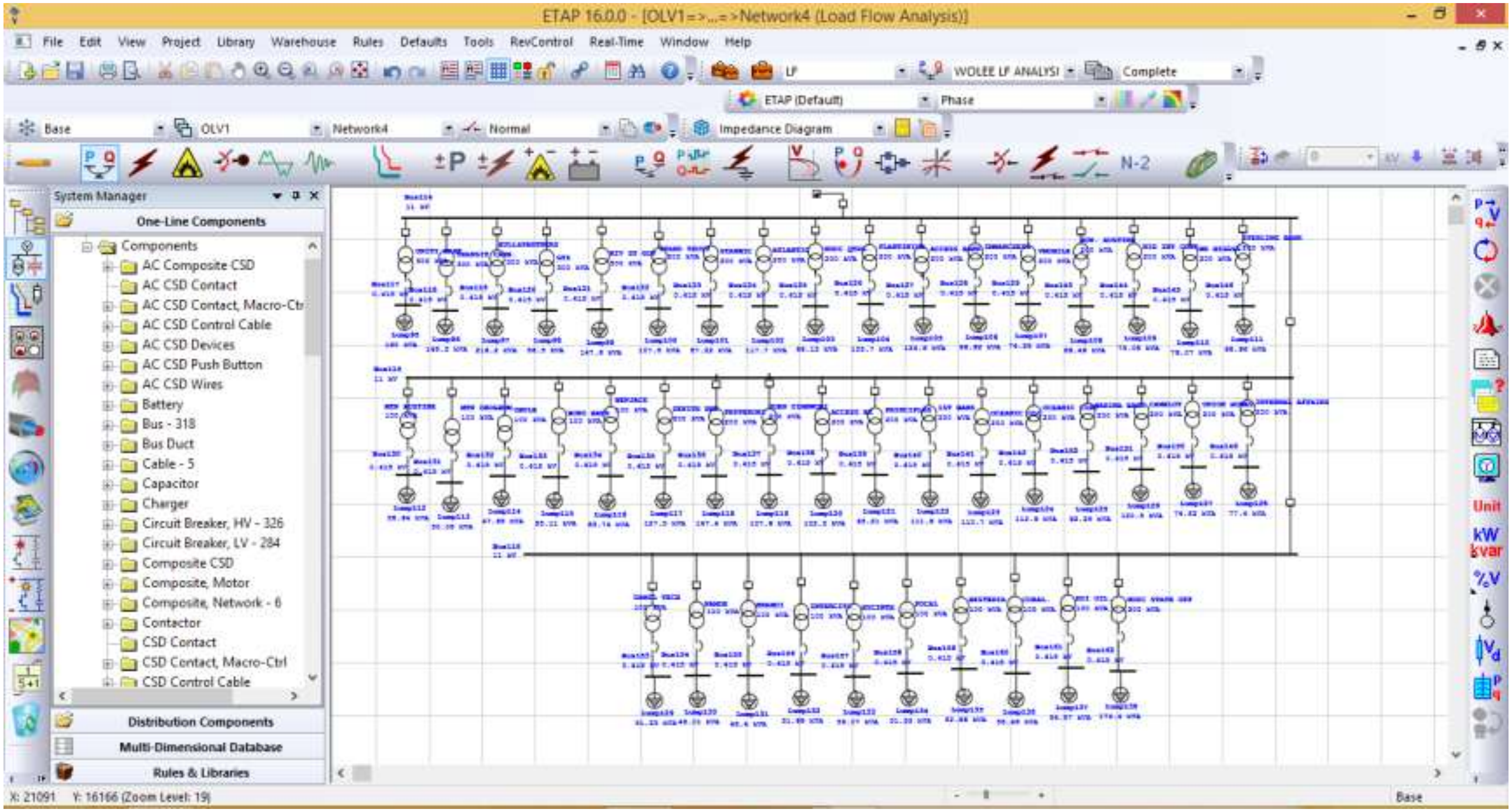

Figure. 3.7: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Not Simulated)

1. **Rivers state water board II. Transformer (500KVA) from the loading data collected**

The current, $1 = \frac{1_R + 1_Y + 1_B + 1_N}{3}$ (3.2)

$$1 = \frac{1_R + 1_Y + 1_B + 1_N}{3}$$

$$= \frac{392 + 332 + 348 + 50}{3}$$

$$= 1 = \frac{1122}{3} = 374 \text{ A}$$

Operating KVA of the loads, S_{VA}

$S_{VA} = \sqrt{3\ xVx\ 1}$ (3.3)

= 1.7320 x 0.415 KV x 374 A

S_{VA} = 268.82KV

% loading $= \frac{S_{VA}}{S_{MAX}}$ x 100%

S_{MAX} = Rating of the transformer in KVA

∴ % loading = $\frac{268.82}{500}$ 100%

= 0.53764 x 100

% loading = 54%

The active power, $P\sqrt{3}$ VI COSØ (3.4)

Cos Ø = 0.8

$\sqrt{3\ v\ 1}$268.82KVA

P = 268.82 x 0.8

$\sqrt{3}$ V I

∴ = Active power = 215.06 KVA

The reactive power, Ø, $\sqrt{3}$VI Sin Ø (3.5)

$\sqrt{3\ v\ 1}$ = 268.82 KVA

Sin Ø = 0.6

∴ = Active power = 215.06 KVA

The reactive power, ∅ = $\sqrt{3\ v\ 1}1$ sins ∅

$\sqrt{3\ v\ 1}$ = 268.82 KVA

Sin ∅ = 0.6

The reactive power, = 268.82 KVA x 0.6

∅ = 1.61. 29 KVA

Complex power S = P + j Q (3.6)

= 215.06 + j 161.29

RUMUOMOI FEEDERS

1 60 King Perekunle Transformer 500kVA

The current, 1 = $\frac{1_R + \ 1_Y + 1_B + 1_N}{3}$

= $\frac{320+280+334+74}{3}$

= $\frac{1008}{3}$

=241.52 A

S_{VA} = $\sqrt{3\ x\ V\ x\ 1}$

= 1.7321 x 0.415 kV x 336 A

= 241.52 kVA

% loading =$\frac{S_{VA}}{S_{MAX}}$ x 100%

= $\frac{241.52\ kVA}{500kVA}$ x 100%

$$0.4830\ \text{x}\ 100$$

= 487%

The active power, P$\sqrt{3\ v\ 1\cos\emptyset}$

$$241.52\ \text{x}\ 0.8$$

= 193.22 kVA

The reactive power, ∅ = $\sqrt{3\ v\ 1\,\text{Sin}\,\emptyset}$

But $\sqrt{3\ v\ 1\ Sin}\,\emptyset$

= $241.52\ \text{x}\ 0.8$

= 193.22kVA

Complex power, S = P + j Q

= 193.22 + j 144.91

2. Abu Muxtar street Transformer 500kVA

The current, 1 = $\frac{1_R + 1_Y + 1_B + 1_N}{3}$

= $\frac{69+77+80+33}{3}$

= $\frac{259}{3}$

=86.33 A

S_{VA} = $\sqrt{3\ x\ V\ x\ 1}$

= 1.7321 x 0.415 kV x 86.33 A

= 62.06kVA

% loading = $\frac{S_{VA}}{S_{MAX}}$ x 100%

= $\frac{62.06\ kVA}{50kVA}$ x 100%

$$0.62.06\ \text{x}\ 100$$

= 62%

The active power, P$\sqrt{3\ v\ 1\cos\emptyset}$

$$62.06 \text{ x } 0.8$$

= 49.65kVA

The reactive power, $\emptyset = \sqrt{3\ v\ 1\ \mathrm{Sin}\ \emptyset}$

But $\sqrt{3\ v\ 1\ Sin}\,\emptyset$

= $62.06 \text{ x } 0.6$

= 37.24kVA

Complex power, S = P + j Q

= 49.65 + j 37.24

Table 3.2: Transformer Capacity and Load Reading

S/No	**TRANSFORMER NAME**	**DTR CAPACITY (KVA)**	**LOAD READING BEFORE LOAD BALANCING**			
			R	Y	B	N
1	R/STATE WATER BOARID I	1500	400	381	320	60
2	R/STATE WATER BOADR II	500	392	332	348	50
3	R/STATE WATER BOADR III	500	281	248	248	43
4	FBN MORTGAGES	500	322	239	261	27
5	LAUNDER LAND	500	233	241	214	38
6	PROF JOHNNIE (BIRAGI STR)	300	156	200	199	53
7	ELIGBAM COMMUNITY	300	189	210	243	23
8	NEDER HOUSE	300	202	186	217	12
9	DR. IBIERE	300	187	150	290	27
10	BEST BITE 1	300	261	254	221	64

11	BEST BITE 2	300	184	196	232	17
12	TONY EZE	300	104	207	122	94
13	PROTEA (AHAM UKO)	300	197	206	253	44
14	HANDY PLACE	300	241	221	210	37
15	CHEVRON CLUBE (ELELENWO)	300	209	218	233	56
16	AU-DELA-DES FRONTIER HOTELS	300	217	228	235	48
17	GREENOAK SEC. SCH.	300	210	257	231	79
18	ANKYS PLACE	500	206	253	201	73
19	ALGATE HOTEL	300	178	165	201	31
20	MANOR HOTEL	200	150	159	170	56
21	HOTEL DE-EXCELLENCE	200	146	163	180	28
22	EMMANUEL NWABUKO	200	160	140	172	29
23	CONSEL SPECIALIST CLINIC	300	188	179	201	29
24	CHEVRON CLINIC (OBAGI)	200	176	155	203	25
25	MARSHAL EMPORIUM	100	83	78	69	17
26	EVERYDAY EMPORIUM	100	6	81	97	38
27	I.G.NWAKAMMA	100	81	93	72	20
28	DUBEM UKPAKA	100	72	109	93	23
29	SERVICE & SMILES	500	224	275	263	21
30	SAMURAI (ARISTO HOUSE)	500	235	289	231	67
31	OMERELU STREET	500	256	283	371	97
32	OBAGI/BIRABI STREET	500	275	313	219	71
33	DISTRICT OFFICE	500	370	225	300	131
34	JUDE NWAGBO	100	73	87	93	37
35	MTN OBAGI STR	50	63	67	59	13

1	#60 KING PEREKUNLE	500	320	280	334	74
2	ABU MUKTAR	100	69	77	80	33

3	ABUEH MONDAY	100	71	80	60	31
4	ADMIRAL PORBENI	300	202	208	210	44
5	AGE TOWER	300	212	150	194	19
6	AJADI ADEBAYO	200	158	121	145	23
7	AJURU CHIZOM	300	128	109	123	42
8	AKINTOLA WILLIAMS	200	188	194	148	38
9	ALCON MDS HOUSE	200	75	88	95	36
10	ALGATE HOTELS/CONGRESS	500	220	301	317	56
11	APARA RD	500	318	336	352	72
12	AUTOGRAPHY	300	204	211	209	45
13	BARRY NPIGI	500	296	327	205	96
14	BELINDA OSORU	200	79	90	97	39
15	BESNA	200	82	87	93	35
16	BISHOP DIMIERI	500	304	308	302	73
17	BOUGAINVILLEA HOTEL	500	256	283	371	170
18	CELESTINE OMEHIA	300	255	324	240	50
19	CHARLESGATE	300	237	259	293	16
20	CHICKEN REPUBLIC	100	95	40	71	20
21	CHIEF CHRIS	100	84	63	75	30
22	CHIEF E. N. NWAKAMA	200	85	63	75	30
23	CHIEF FENTE ABRAKASA	500	55	57	42	20
24	CHIEF GREG OGBEIFUN	100	93	51	71	17
25	CHIEF MIKE	100	87	35	75	10
26	CHIEF F. ALABRABA	100	89	73	42	41
27	DAVID WEST	100	63	47	72	30
28	DAX HOLDING	500	320	271	62	116
29	DR. AMAZIAH	100	73	55	90	22
30	DR. MRS. DORIS COWAN	200	140	169	59	34

31	DR. NWINIA	200	89	87	283	35
32	ELELENWO RELIEF	500	303	380	61	60
33	ELIZABETH GEORGE	200	162	149	152	42
34	EMEYAL/ELELENWO (FERGUSON)	500	313	272	61	51
35	QUINOX	300	131	107	269	40
36	EVERGREEN HALLS	100	65	78	109	30
37	EVO II	500	429	407	414	97
38	EVO I	500	401	405	399	62
39	EO III (EVO RD/KING PEREKULE)	500	221	257	346	81
40	EVO 2 RELIEF (GROSSVENOR)	500	370	275	250	67
41	FAIRWAY OFFSHORE	50	50	59	122	17
42	FIDELITY BANK – OBAGI STREET	200	152	101	370	54
43	FRANKLIN HOTELS	500	317	310	223	101
44	G. CAPPA	300	253	310	218	34
45	GENERAL DIRIYE	300	217	147	387	62
46	GENESIS FOODS LTD (BIRABI)	500	371	222	57	58
47	GLORY BARGOIN	100	68	356	127	30
48	GOKANA VENTURES	200	130	47	40	84
49	GUOBADIA IBUDE	100	62	152	170	22
50	IBB WAY (OFF CHIBUIKE AMAECHI DRIVER)	300	126	57	329	56
52	IKECHI WIGWE	100	70	306	101	28
53	INNOCENT DEIN	200	133	53	91	70
54	JACK RICH TEIN	100	78	148	198	5
55	JEVNIK/TOMIBA	500	370	67	38	110
56	JOE BERGER	50	40	275	242	16
57	JULIUS BERGER	500	310	57	392	70

58	KENCHEZ NIG. LTD.	500	360	157	133	42
59	KENNETH OKAGUA	300	123	389	57	38
60	LAWSON JACK	100	67	98	247	30
61	LE MERIDIEN	750	209	62	77	34
62	LENU PLAZA	100	67	182	39	31
63	LOUISE DRIVE	100	55	80	388	14
64	LOUISE DRIVE II	500	318	34	360	43
65	LOWIS DRIVE	500	320	336	35	53
66	LYTE CONCEPT	100	57	44	118	17
67	MASS CENTRAL	200	127	134	51	69
68	MANAGER	200	130	98	107	57
69	MARCUS RUS	50	56	66	35	9
70	MARK ORUCHE	200	132	100	20	71
71	METRO PARK	100	61	37	310	21
72	MICRO FINANCE BAN	100	57	42	98	32
73	MIKE EZENWAFOR (PALOMO TOTEL)	100	300	301	53	65
74	MR BIGGS	100	101	117	98	51
75	MRS IJEOMA ABIAZIM	100	68	41	53	20
76	MRS KATE N. AJOKU E.	300	140	87	107	41
77	MTN (BIMKOL CRESCENT)	100	68	61	57	22
78	MTN (TOMBIA EXT/MANDELA)	50	53	47	48	18
79	MTN KING PEREKULE STR	50	52	50	44	19
80	MUSA KIDA	100	70	55	41	15
81	NAFDAC	100	152	112	121	38
82	NDDC OTRS	300	162	149	109	42
83	NENA (HOTEL PRESIDENTAL/ABA RD)	500	257	26	238	58
84	NORWEGIAN INT’L SCHOOL	500	213	231	217	40

85	OBAGI/ELELENWO	500	322	203	286	38
86	OBANOBAN	300	240	157	330	62
87	OCEANEERING	300	52	51	31	27
88	ODIKI GEORGE	200	127	131	100	50
89	OGBUECHI IFEANYI	200	197	184	167	19
90	OIL PET RESORUCES	200	55	47	140	30
91	ORLANDO COURTS	300	156	203	199	50
92	P.S.UGBOMA	200	114	157	97	40
93	POLO CLUB 2	500	235	287	261	36

			R	Y	B	N
1	PEGAL MOTOR	500	323	417	261	112
2	ONNE ROAD	500	402	406	409	92
3	TOBY JUG SUBSTATION	500	206	208	211	42
4	BODO STREET	500	314	379	489	62
5	ARETA 1	500	408	406	408	92
6	ARETA II (AERO CONTRACTORS)	500	361	250	259	61
7	ARETA I	500	358	277	318	53
8	PRESIDENTIALH/ESTATE I	500	228	365	346	64
9	BARNAX	500	312	173	181	47
10	DR UMEH OBI	500	80	121	123	19
11	OROGBUM CRESCENT	500	342	333	338	68
12	AUGTINE OPARA (NSIRIM CRESCENT)	500	278	319	228	85
13	KHANA RELIEF	500	225	212	201	26
14	NTEL QUARTERS	500	214	215	233	39
15	WOJI RD	500	212	237	190	21
16	PRESENTIAL H/ESTATE II	500	246	238	145	76
17	PRESENTIAL H/ESTATE III	500	136	196	236	68
18	DOFF ABACHA ROAD	500	350	270	282	45

19	ZARTEC. NIG. LTD	500	250	272	282	65
20	HOUSE OF ASSEMBLY	500	320	340	280	80
21	FEDERAL SECRETARIAT I	500	270	290	310	111
22	FEDERAL CRETARIAT 2	500	323	239	308	82
23	FIDDLE NIG. LTD	500	230	270	300	67
24	FLEET HOUSE	500	320	350	331	102
25	DANA MOTORS	300	270	310	296	105
26	PRUDENT BANK [OCEANEERING]	300	170	240	221	67
27	INTER CONTINENTAL BANK	300	163	291	237	83
28	IMPERIAL BANK	300	232	211	201	61
29	CTL BEUREEN	300	238	256	209	19
30	CTL BEUREEN	300	283	295	249	38
31	BEVERLY HILLS HOTEL	300	293	284	263	37
32	CHEERS BAR	300	243	275	281	46
33	BARRISTER ADELEKE	300	247	229	211	38
34	SAPHIRE HOTELS	300	251	211	247	48
35	LANDMARK HOTELS	300	212	206	324	76
36	THE HONDA PLACE	300	217	221	274	81
37	SISSI HOTEL	300	211	248	255	34
38	VGC (PPC)	300	240	213	214	41
39	MEDIAN HOTEL & APT	300	322	203	286	38
40	NNPC MEDICAL	300	260	201	198	42
41	BROAD BANK	300	183	126	230	87
42	KILIMANJARO HOTEL	300	210	223	217	28
43	SEDCO FOREX (NDDC)	300	217	201	181	30
44	RCCG (KINGS PALACE)	300	215	156	146	40
45	POINT ENGINEERING	300	198	218	241	42
46	UNITY BANK	300	242	271	248	32
47	TRANSIT CARE HOTEL	300	199	186	218	47
48	HULL & PARTNERS (UNION BANK)	300	186	207	198	51
49	GTS PROPERTIES & INV	300	87	103	112	59

50	RIVERS STATE GOVR-WOJI RD	300	139	191	219	67
51	STANDARD TRUST	200	160	120	256	14
52	STANBIC BANK	200	122	103	100	39
53	FIRST ATLANTIC BANK	200	128	104	187	72
54	NDDC QTRS	200	100	87	61	28
55	PLATINIUM BANK	200	140	115	136	55
56	ACCESS BANK	200	130	160	145	85
57	IMMARCHES MALL	200	127	125	118	47
58	V-MOBILE	200	101	82	96	31
59	HON. AUSTINE OPARA	200	89	112	61	28
60	NIG. INT. CONT. BANK	200	76	84	106	39
61	MR. BIGGS OUTLET	200	98	100	87	50
62	STERLING BANK	200	117	130	109	56
63	INTERNAL AFFAIRS	200	84	97	113	29
64	UNION HOMES & SAVINGS	200	70	88	120	33
65	CAMELOT HOTEL	200	132	146	128	97
66	MARINA BANK	200	121	118	91	47
67	OCEANIC BANK (CIRCULAR ROAD)	200	118	166	157	30
68	OCEANIC BANK (OLU OBASANJO)	200	112	150	176	24
69	ACCESS BANK (OLU OBASANJO)	200	130	121	177	32
70	FIRST BANK 2 (OLU OBASANJO)	200	134	164	133	36
71	PRINCIPLES NIG LTD	200	112	123	108	46
72	JOHN DIMNWOBI	200	157	105	169	18
73	PEPPERONI	200	173	196	185	61
74	ZENITH BANK, OLU OBASANJO	200	152	134	197	49
75	BENJACK	100	78	92	69	27
76	BOND BANK	100	95	55	64	16
77	OBULE CHARLES	100	72	60	45	22
78	MTN (OROGBI MORESCENI	100	61	41	92	15
79	MTN (AUSTINE OPARA STR)	100	91	73	69	13
80	DAMIL TECIL NIG. LTD	100	52	51	64	17

81	NAMDE	100	74	56	48	14
82	NNAMDI UDENSI	100	78	44	59	21
83	INTERCITY BANK	100	70	78	51	18
84	HYCINTH OSEJU	100	72	98	51	13
85	FOCAL HOTEL	100	85	51	62	17
86	HESTERIA HOTELS LTD	100	92	61	53	15
87	CORAL REEF HOTEL	100	68	65	93	8
88	KDI OIL & GAS LTD	100	86	77	45	21
89	NDDC STATE OFFICE	300	252	224	201	51

Table 3.2 Distribution Transformer Calculated Value

S/No	TRANSFORMER NAME	Apparent (KVA)	Active Power (KW)	Reactive Power (KVA$_R$)	%loading (%)	Current (A)
1	R/STATE WATER BOARID I	278.18	222.54	166.91	19	387
2	R/STATE WATER BOADR II	268.82	2.5006	161.29	54	374
3	R/STATE WATER BOADR III	196.46	157.17	117.88	39	27.33
4	FBN MORTGAGES	203.42	162.74	122.05	41	283
5	LAUNDER LAND	173.95	139.16	104.37	35	242
6	PROF JOHNNIE (BIRAGI STR)	145.68	116.54	145.37	49	202.67
7	ELIGBAM COMMUNITY	159.34	127.47	95.58	53	221.67
8	NEDER HOUSE	147.84	118.27	88.70	49	205.67
9	DR. IBIERE	150.70	125.36	94.02	52	218
10	BEST BITE 1	191.69	153.35	115.01	64	266.67

11	BEST BITE 2	150.72	120.58	90.43	50	209.67
12	TONY EZE	120.28	101.02	75.77	42	175.67
13	PROTEA (AHAM UKO)	167.72	134.18	100.63	56	233.33
14	HANDY PLACE	169.88	135.90	101.93	57	236.33
15	CHEVRON CLUBE (ELELENWO)	171.56	137.25	102.94	57	238.67
16	AU-DELA-DES FRONTIER HOTELS	174.44	139.55	104.66	58	242.67
17	GREENOAK SEC. SCH.	186.18	148.94	111.71	62	186.18
18	ANKYS PLACE	175.63	140.5	105.38	35	244.33
19	ALGATE HOTEL	137.78	110.22	82.67	46	191.67
20	MANOR HOTEL	123.40	98.72	74.04	61	171.67
21	HOTEL DE-EXCELLENCE	123.88	99.10	74.33	62	172.33
22	EMMANUEL NWABUKO	120.03	96.02	72.02	60	167
23	CONSEL SPECIALIST CLINIC	143.05	114.44	85.83	72	199
24	CHEVRON CLINIC (OBAGI)	133.93	107.15	80.34	67	186.33
25	MARSHAL EMPORIUM	59.18	47.34	35.51	59	82.33
26	EVERYDAY EMPORIUM	67.57	40.54	34.06	68	94
27	I.G.NWAKAMMA	63.74	50.99	38.24	64	68.67
28	DUBEM UKPAKA	71.16	56.93	42.70	71	99
29	SERVICE & SMILES	187.61	150.09	112.57	38	261
30	SAMURAI (ARISTO HOUSE)	196.96	157.57	118.18	39	274
31	OMERELU STREET	241.29	193.03	144.77	48	335.67
32	OBAGI/BIRABI STREET	210.38	168.30	126.23	42	292.67
33	DISTRICT OFFICE	245.84	196.67	147.50	49	342
34	JUDE NWAGBO	69.49	77.19	41.69	70	96.67
35	MTN OBAGI STR	48.40	38.72	29.04	97	67.33

1	60 KING PEREKUNLE	241.52	193.22	144.91	48	336
2	ABU MUKTAR	62.06	49.65	37.24	62	86.33
3	ABUEH MONDAY	57.99	46.39	34.79	81	80.67
4	ADMIRAL PORBENI	159.10	127.28	95.46	53	221.33
5	AGE TOWER	137.78	110.22	82.67	46	191.67
6	AJADI ADEBAYO	107.10	85.68	64.26	54	149
7	AJURU CHIZOM	96.32	77.06	57.79	32	134
8	AKINTOLA WILLIAMS	136.09	108.87	81.65	68	189.33
9	ALCON MDS HOUSE	70.45	56.36	42.27	35	98
10	ALGATE HOTELS/CONGRESS	214.21	171.37	128.53	43	298
11	APARA RD	256.86	205.49	154.12	51	359.33
12	AUTOGRAPHY	160.30	128.24	96.18	53	223
13	BARRY NPIGI	221.40	177.12	132.84	44	308
14	BELINDA OSORU	73.08	58.46	43.85	37	101.67
15	BESNA	71.16	56.93	42.70	36	99
16	BISHOP DIMIERI	236.49	189.19	141.89	47	329
17	BOUGAINVILLEA HOTEL	258.78	209.02	155.27	52	360
18	CELESTINE OMEHIA	208.22	166.58	124.93	69	289.67
19	CHARLESGATE	192.88	154.30	115.73	64	268.33
20	CHICKEN REPUBLIC	57.02	45.62	34.21	57	79.33
21	CHIEF CHRIS	51.52	41.22	30.91	52	71.67
22	CHIEF E. N. NWAKAMA	60.62	48.50	36.37	30	84.33
23	CHIEF FENTE ABRAKASA	41.69	33.35	25.01	83	58
24	CHIEF GREG OGBEIFUN	55.83	44.86	33.50	56	77.67
25	CHIEF MIKE	46.49	37.19	27.89	47	6467
26	CHIEF F. ALABRABA	70.21	56.17	42.13	35	97.67
27	DAVID WEST	47.68	38.14	28.61	48	66.33

28	DAX HOLDING	237.21	189.77	142.33	47	330
29	DR. AMAZIAH	50.56	40.45	30.34	51	70.33
30	DR. MRS. DORIS COWAN	118.61	94.89	71.17	59	165
31	DR. NWINIA	65.18	52.14	39.11	33	90.67
32	ELELENWO RELIEF	242.48	193.98	145.49	49	337.33
33	ELIZABETH GEORGE	110.70	88.56	66.42	55	154
34	EMEYAL/ELELENWO (FERGUSON)	209.90	167.92	125.94	42	292
35	QUINOX	93.21	74.57	55.93	31	129.67
36	EVERGREEN HALLS	64.21	51.37	38.53	64	97.33
37	EVO II	322.75	258.2	193.65	65	449
38	EVO I	303.58	242.86	182.15	61	422.33
39	EO III (EVO RD/KING PEREKULE)	216.85	173.48	130.11	43	301.67
40	EVO 2 RELIEF (GROSSVENOR)	230.67	184.4	138.3	46	320.67
41	FAIRWAY OFFSHORE	42.65	34.12	25.59	85	59.33
42	FIDELITY BANK – OBAGI STREET	98.00	78.4	58.8	49	136.33
43	FRANKLIN HOTELS	263.09	210.47	157.85	53	366
44	G. CAPPA	157.42	125.94	94.45	53	219
45	GENERAL DIRIYE	172.28	137.82	103.37	57	239.67
46	GENESIS FOODS LTD (BIRABI)	280.82	224.66	168.49	56	390.67
47	GLORY BARGOIN	48.40	38.72	29.04	48	67.33
48	GOKANA VENTURES	118.12	94.50	70.87	59	164.33
49	GUOBADIA IBUDE	43.37	34.70	26.02	43	60.33
50	IBB WAY (OFF CHIBUIKE AMAECHI DRIVER)	135.86	108.69	81.52	45	189
52	IKECHI WIGWE	44.09	35.27	26.45	44	61.35
53	INNOCENT DEIN	108.31	86.65	64.99	54	150.67

54	JACK RICH TEIN	57.74	46.19	34.64	58	80.33
55	JEVNIK/TOMIBA	228.35	182.68	137.01	46	317.67
56	JOE BERGER	36.18	28.94	21.71	72	50.33
57	JULIUS BERGER	186.66	149.33	112.00	37	259.67
58	KENCHEZ NIG. LTD.	283.45	226.76	70.07	57	394.33
59	KENNETH OKAGUA	93.93	75.14	56.36	31	130.67
60	LAWSON JACK	51.76	41.41	31.06	52	72
61	LE MERIDIEN	161.02	128.82	96.61	22	224
62	LENU PLAZA	61.10	4.88	36.66	61	85
63	LOUISE DRIVE	34.02	27.22	20.41	34	47.33
64	LOUISE DRIVE II	266.68	231.34	160.01	53	371
65	LOWIS DRIVE	256.14	204.91	153.68	51	365.33
66	LYTE CONCEPT	36.66	29.33	22.00	37	51
67	MASS CENTRAL	107.34	85.87	64.40	54	149.33
68	MANAGER	102.79	82.23	61.67	51	143
69	MARCUS RUS	43.61	34.89	27.17	87	60.67
70	MARK ORUCHE	98.24	78.592	58.94	49	136.67
71	METRO PARK	36.90	29.52	22.14	37	51.33
72	MICRO FINANCE BAN	36.18	28.94	21.71	36	50.33
73	MIKE EZENWAFOR (PALOMO TOTEL)	233.85	187.08	140.31	47	325.33
74	MR BIGGS	87.93	70.34	52.76	44	122.33
75	MRS IJEOMA ABIAZIM	43.61	34.89	26.17	44	60.67
76	MRS KATE N. AJOKU E.	89.86	71.88	53.91	30	125
77	MTN (BIMKOL CRESCENT)	49.84	39.87	29.90	50	69.33
78	MTN (TOMBIA EXT/MANDELA)	39.77	31.82	23.86	80	55.33
79	MTN KING PEREKULE STR	39.54	31.63	23.72	79	55
80	MUSA KIDA	43.37	43.70	26.02	43	60.33

81	NAFDAC	101.35	81.08	60.81	47	141
82	NDDC OTRS	110.70	88.56	66.42	37	154
83	NENA (HOTEL PRESIDENTAL/ABA RD)	203.43	162.74	122.06	41	283
84	NORWEGIAN INT'L SCHOOL	167.98	134.38	100.79	34	233.67
85	OBAGI/ELELENWO	203.43	162.74	122.00	41	283
86	OBANOBAN	189.05	151.24	113.43	68	263
87	OCEANEERING	38.58	30.86	23.15	39	53.67
88	ODIKI GEORGE	97.76	78.21	58.66	49	136
89	OGBUECHI IFEANYI	135.86	108.69	81.52	68	189
90	OIL PET RESORUCES	65.89	52.71	39.53	33	91.67
91	ORLANDO COURTS	145.68	116.54	87.41	49	202.67
95	P.S.UGBOMA	96.32	77.06	57.79	48	134
96	POLO CLUB 2	196.24	156.99	117.74	39	273

1	PEGAL MOTOR	266.68	213.34	160.01	53	371
2	ONNE ROAD	313.64	250.91	188.18	63	436.33
3	TOBY JUG SUBSTATION	159.82	127.86	95.89	32	222.33
4	BODO STREET	298.07	238.46	178.84	60	414.67
5	ARETA 1	314.84	251.87	188.90	63	438
6	ARETA II (AERO CONTRACTORS)	223.07	178.46	133.84	45	310.33
7	ARETA I	256.14	204.91	153.68	51	356.33
8	PRESIDENTIALH/ESTATE I	240.32	192.26	144.19	48	334.33
9	BARNAX	170.84	136.67	102.50	34	237.67
10	DR UMEH OBI	82.18	65.74	49.31	41	144.33
11	OROGBUM CRESCENT	259.01	207.21	155.41	52	360.33
12	AUGTINE OPARA (NSIRIM CRESCENT)	218.04	174.43	130.82	44	303.33
13	KHANA RELIEF	159.10	127.28	95.46	53	221.33
14	NTEL QUARTERS	233.67	134.38	100.78	56	233.67

15	WOJI RD	158.14	126.51	94.88	53	220
16	PRESENTIAL H/ESTATE II	169.64	135.71	101.78	57	236
17	PRESENTIAL H/ESTATE III	153.11	122.49	91.87	77	213
18	DOFF ABACHA ROAD	226.91	181.53	136.15	45	315.67
19	ZARTEC. NIG. LTD	208.22	166.58	124.93	58	289.67
20	HOUSE OF ASSEMBLY	244.40	195.52	146.64	49	340
21	FEDERAL SECRETARIAT I	188.05	188.05	141.04	47	327
22	FEDERAL CRETARIAT 2	228.11	182.49	136.87	46	317.33
23	FIDDLE NIG. LTD	207.74	166.19	124.64	42	289
24	FLEET HOUSE	264.29	211.43	158.57	53	367.67
25	DANA MOTORS	235.06	188.05	141.04	47	327
26	PRUDENT BANK [OCEANEERING]	167.25	133.80	100.35	56	232.67
27	INTER CONTINENTAL BANK	185.46	118.37	111.28	62	258
28	IMPERIAL BANK	168.92	135.14	101.35	56	235
29	CTL BEUREEN	173.00	138.4	103.8	58	240.67
30	CTL BEUREEN	207.26	165.81	124.36	69	288.33
31	BEVERLY HILLS HOTEL	210.13	168.10	126.08	70	292.33
32	CHEERS BAR	202.47	161.98	121.48	68	281.67
33	BARRISTER ADELEKE	172.52	138.02	103.51	58	240
34	SAPHIRE HOTELS	181	145.10	108.83	60	252.33
35	LANDMARK HOTELS	196.00	156.8	117.6	65	272.67
36	THE HONDA PLACE	190.01	152.01	114.01	63	264.33
37	SISSI HOTEL	179.22	143.38	107.53	60	249.33
38	VGC (PPC)	168.69	134.55	101.21	56	234.67
39	MEDIAN HOTEL & APT	203.43	162.74	122.06	68	283
40	NNPC MEDICAL	167.97	134.38	100.78	56	167.97
41	BROAD BANK	150.00	120.00	90.00	50	208.67
42	KILIMANJARO HOTEL	162.45	129.96	97.47	54	226
43	SEDCO FOREX (NDDC)	150.72	120.58	90.43	50	150.72
44	RCCG (KINGS PALACE)	133.46	106.77	80.08	44	185.67
45	POINT ENGINEERING	167.49	133.99	100.49	56	223

46	UNITY BANK	190.01	152.01	114.01	63	264.33
47	TRANSIT CARE HOTEL	148.31	118.65	88.99	49	206.33
48	HULL & PARTNERS (UNION BANK)	216.15	172.92	129.69	72	214
49	GTS PROPERTIES & INV	86.50	69.20	51.90	29	120.33
50	RIVERS STATE GOVR-WOJI RD	147.60	118.08	88.56	49	205.33
51	STANDARD TRUST	107.82	86.26	64.69	54	150
52	STANBIC BANK	87.22	69.78	52.33	44	121.33
53	FIRST ATLANTIC BANK	117.65	94.12	70.59	59	163.67
54	NDDC QTRS	66.13	52.90	39.68	33	92
55	PLATINIUM BANK	105.67	84.54	63.40	53	147
56	ACCESS BANK	124.59	99.67	74.75	62	173.33
57	IMMARCHES MALL	99.92	79.94	59.95	50	139
58	V-MOBILE	74.28	59.42	44.57	37	103.33
59	HON. AUSTINE OPARA	69.49	55.59	41.69	35	96.67
60	NIG. INT. CONT. BANK	73.08	58.46	43.85	37	101.67
61	MR. BIGGS OUTLET	79.07	63.26	47.44	40	110
62	STERLING BANK	98.96	79.17	59.38	50	137.67
63	INTERNAL AFFAIRS	77.40	61.92	46.44	39	107.67
64	UNION HOMES & SAVINGS	74.52	59.62	44.71	52	103.67
65	CAMELOT HOTEL	120.53	96.42	72.32	60	167.67
66	MARINA BANK	92.25	73.8	55.35	46	128.33
67	OCEANIC BANK (CIRCULAR ROAD)	112.86	90.29	67.72	56	157
68	OCEANIC BANK (OLU OBASANJO)	110.70	88.56	66.42	55	154
69	ACCESS BANK (OLU OBASANJO)	102.31	81.85	61.39	51	142.33
70	FIRST BANK 2 (OLU OBASANJO)	111.90	89.52	67.14	56	155.67
71	PRINCIPLES NIG LTD	93.21	74.57	55.93	47	129.67
72	JOHN DIMNWOBI	107.59	86.07	64.55	54	149.67
73	PEPPERONI	147.36	117.89	88.42	74	205
74	ZENITH BANK, OLU OBASANJO	127.47	101.98	76.48	64	177.33
75	BENJACK	63.74	50.99	38.24	64	88.67
76	BOND BANK	55.11	44.09	33.07	55	76.67

77	OBULE CHARLES	47.68	38.14	28.61	48	66.33
78	MTN (OROGBI MORESCENI	50.08	40.06	30.05	50	69.67
79	MTN (AUSTINE OPARA STR)	58.94	47.15	36.36	59	82
80	DAMIL TECIL NIG. LTD	51.28	41.02	30.77	51	71.33
81	NAMDE	46.01	36.81	27.61	46	64
82	NNAMDI UDENSI	48.40	38.72	29.04	48	67.33A
83	INTERCITY BANK	51.99	41.59	31.19	52	72.33
84	HYCINTH OSEJU	56.07	44.86	33.64	56	78
85	FOCAL HOTEL	51.52	41.22	30.91	52	71.67
86	HESTERIA HOTELS LTD	52.96	42.37	31.78	53	73.67
87	CORAL REEF HOTEL	58.46	46.77	35.08	59	81.33
88	KDI OIL & GAS LTD	54.87	43.90	32.92	55	76.33
89	NDDC STATE OFFICE	174.44	139.55	104.66	58	242.67

Design calculation of capacitor Bank

$KVA_r = Kw (\tan \theta_1 - \tan \theta_2)$

Where KW is load flow on the bus in Kw θ_1 is the actual power factor

θ_2 is the Desired power factor

Bus 2.

$KVA_r = Kw (\tan \theta_1 - \tan \theta_2)$

where $\theta_1 - \text{Cos}^{-1} 0.8 = 36.87$

$\theta_2 = \text{Cos}^{-1} 0.95 = 18.20$

KVA_r = Kw (tan 36.87– tan 18.20)

= 14886.510 (0.75 – 0.33)

= 14886.510 x 0.42

= 6252.33

Bus 3

KVA_r = 14808.530 (tan 36.87– tan 18.20)

= 14886.530 x 0.42

= 6219.38

Bus 4

KVA_r = 4226.193 (tan 36.87– tan 18.20)

= 4226.193 (0.75 – 0.33)

= 4226.193 x 0.42

= 1775.00

Bus 4

KVA_r = 10544.010 (tan 36.87– tan 18.20)

= 10544.010 (0.75 – 0.33)

= 10544.010 x 0.42

= 4428.48

Bus 8

KVA_r = 8259.328 (tan 36.87– tan 18.20)

= 8259.348 (0.75 – 0.33)

= 8259.328 x 0.42

= 3468.92

Bus	Load flow (Kw)	KVAr	Size and number of capacitor Bank
2	14886.510	6252.33	300 x 21
3	14808.530	6219.58	300 x 21
4	4226.193	1775.00	300 x 6
5	10544.010	4428.48	300 x 15
8	8259.328	3468.92	300 x 12
10	4520.259	1898.51	300 x 7
11	1908.072	801.39	300 x 3
12	4029.994	1692.60	300 x 6
14	2313.472	971.66	300 x 4
15	679.065	285.21	300
65	4897.252	2056.85	300 x 7
66	3554.252	1492.84	300 x 5
67	2294.878	963.85	300 x 4
113	1365.128	573.35	300 x 2
114	1368.957	573.96	300 x 2
115	757.616	318.20	300 x 2
116	228.204	95.85	300
171	5645.346	2371.05	300 x 8
172	4399.544	1847.81	300 x 7
173	3495.910	1468.28	300 x 5
228	370.910	155.78	300
230	21168.571	910.80	300 x 4
231	202.37-	85.00	300

232	674.160	283.15	300

= 14886.510 x 0.42

= 6252.33

where θ_1 –Cos^{-1} 0.8 = 36.87

θ_2= Cos^{-1} 0.95 = 18.20

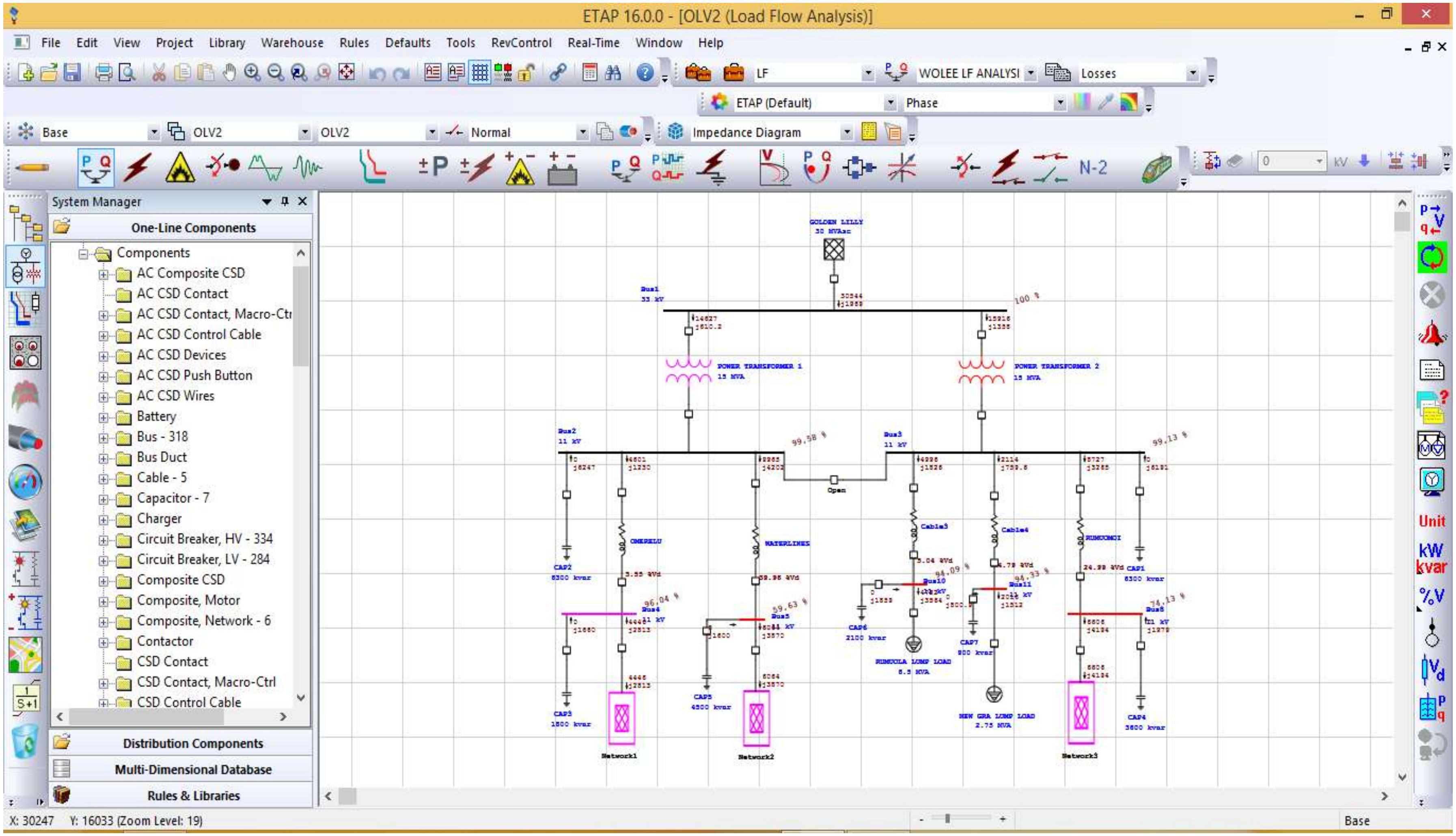

Figure.4.1: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Simulated)

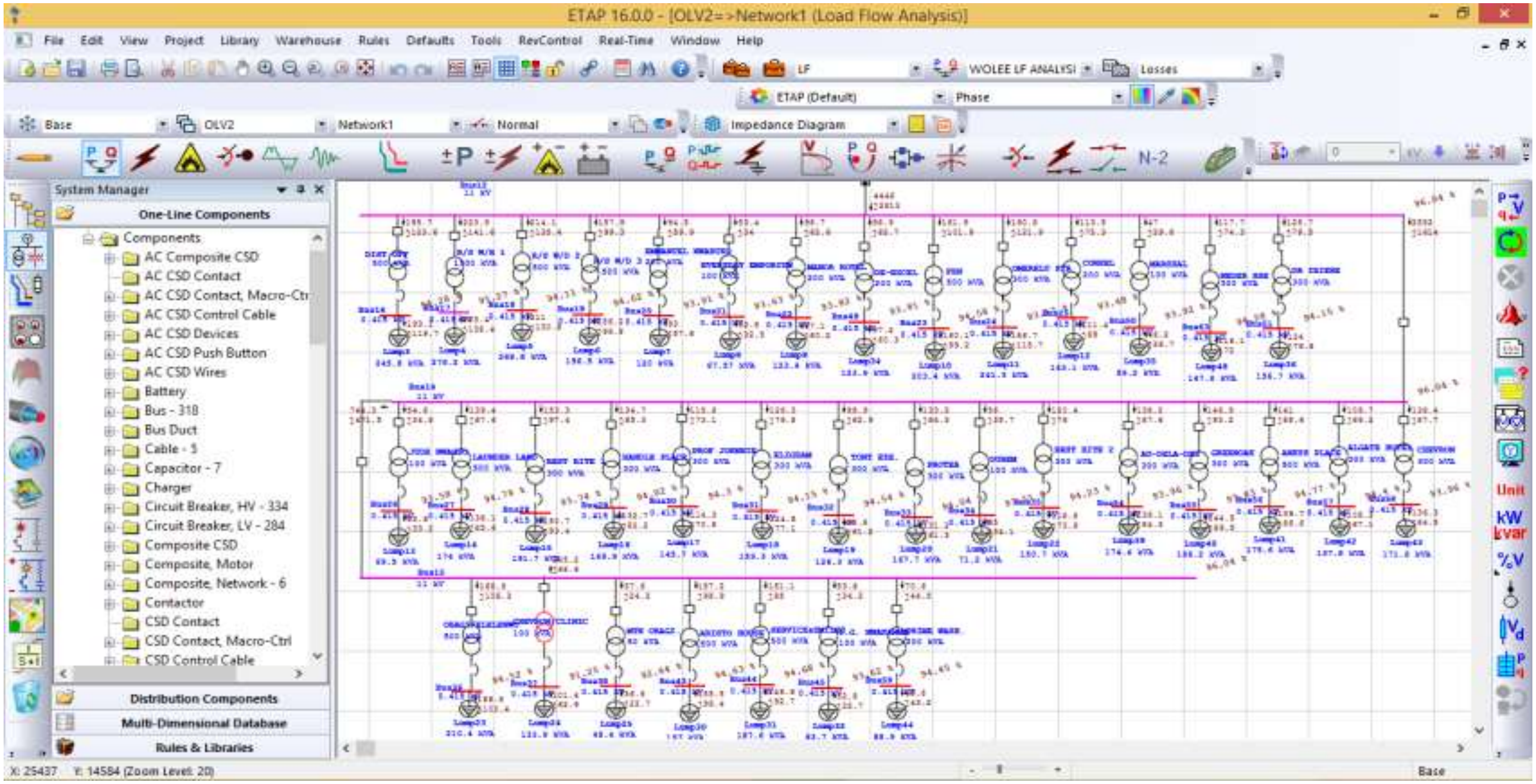

Figure.4.2 : Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Simulated)

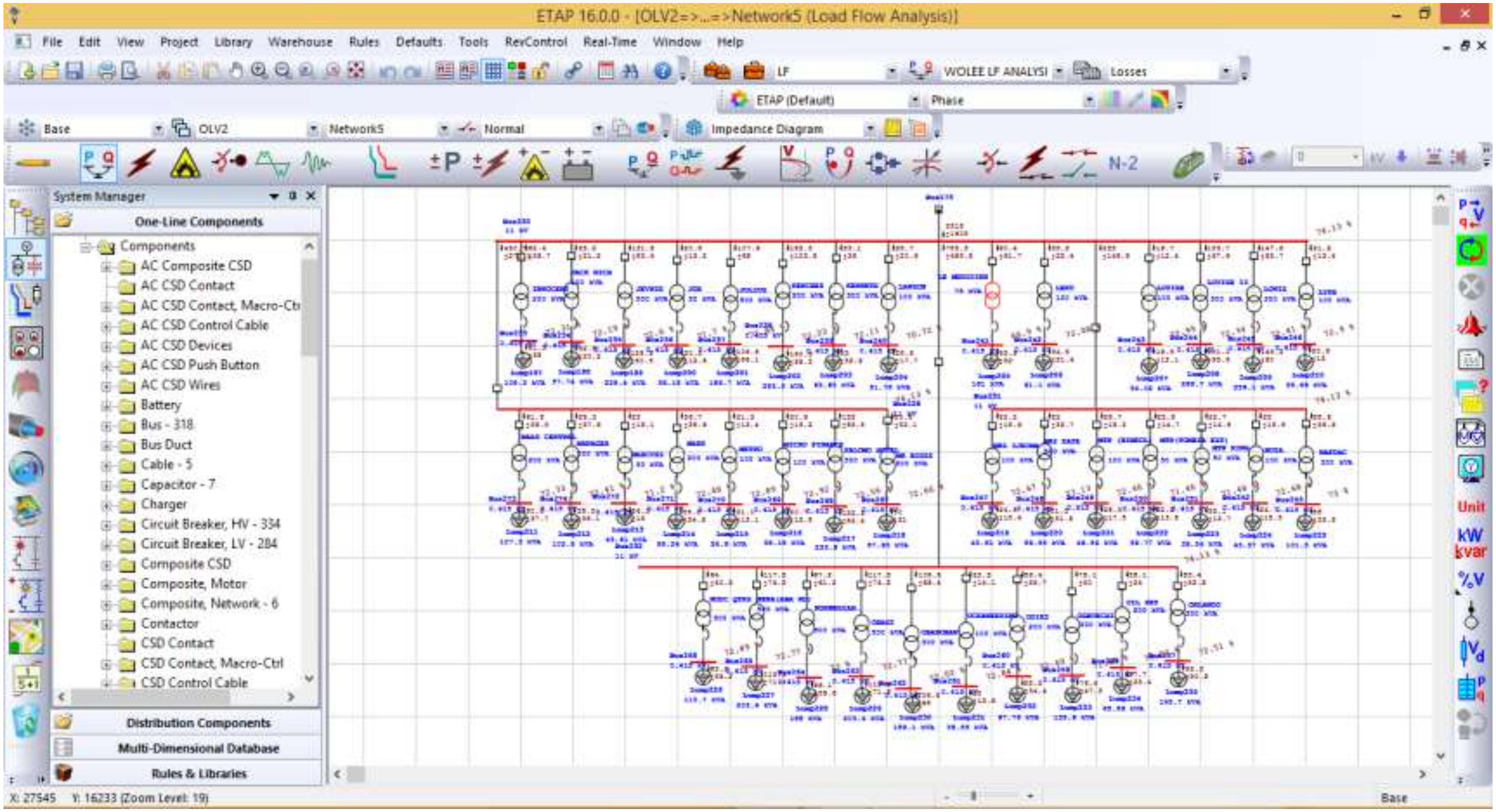

Figure.4.3: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Simulated)

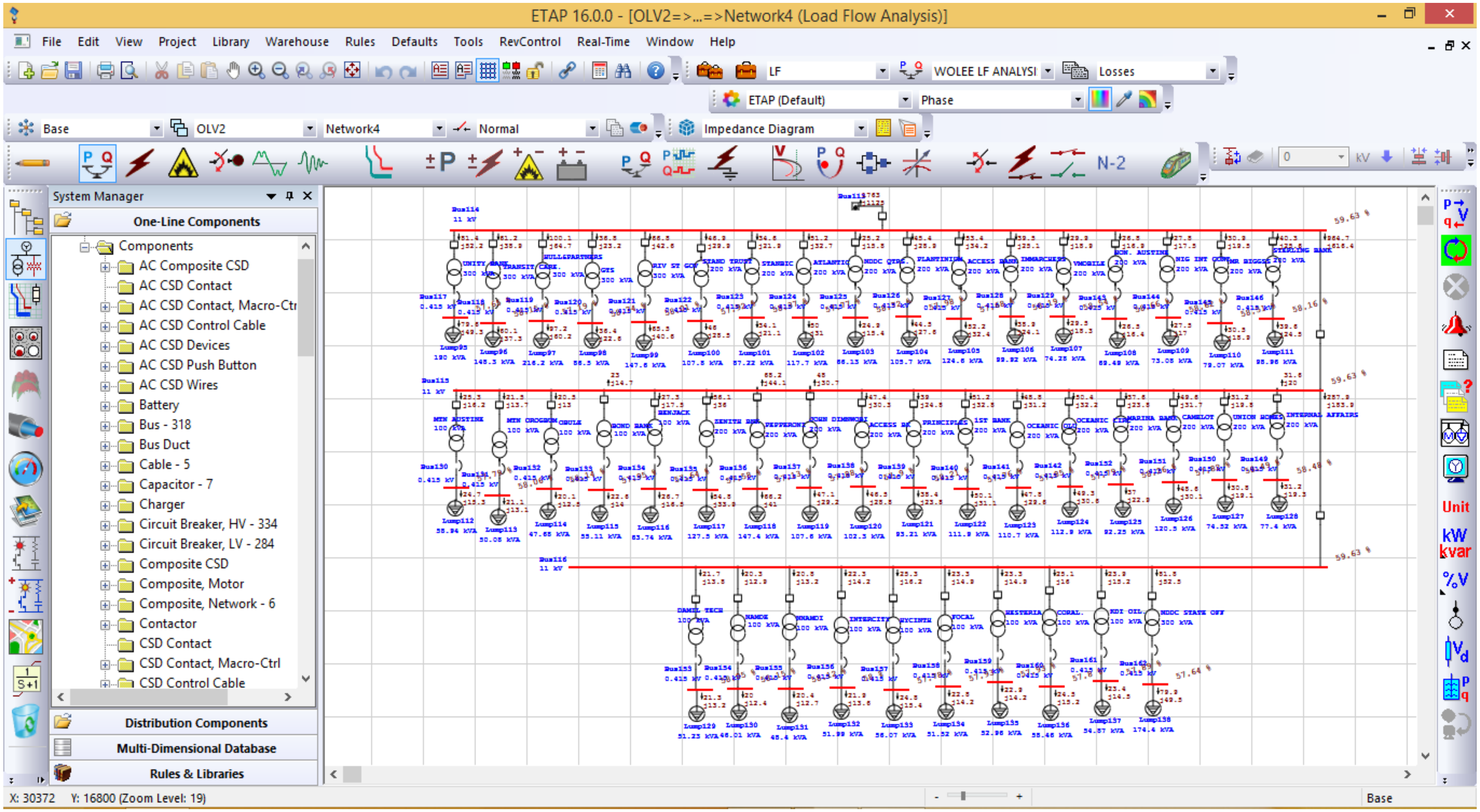

Figure.4.4: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Simulated)

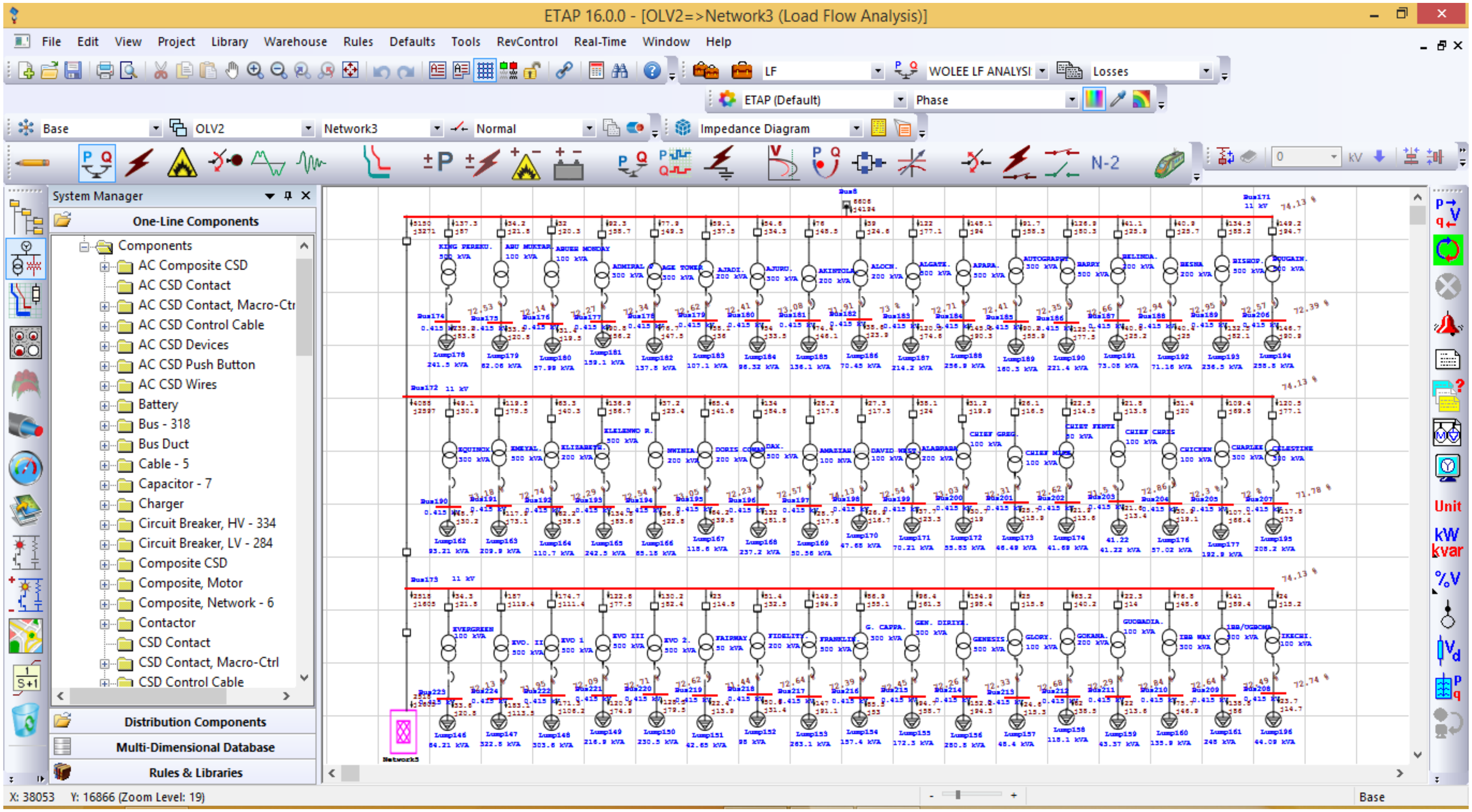

Figure. 4.5: Existing 11 kV Electrical Distribution network for GRA Port Harcourt (Simulated

4. RESULTS AND DISCUSSION

4.1 Result

Presentation of results and subsequent discussion based on analytical methods are presented in tabular and graphical from as shown below

Table 4.1: Shows the existing bus voltage number and bus voltage magnitude improved against bus voltage number.

Bus Voltage Number	Bus Voltage Magnitude (existing)	Bus Voltage Magnitude (Improved)
Bus – 2	92.748	99.583
Bus – 3	91.987	98.822
Bus – 4	88.699	96.037
Bus – 5	44.681	59.559
Bus – 8	64.154	71.052
Bus – 10	86.320	93.145
Bus – 11	88.699	93.012
Bus – 12	88.699	96.037
Bus – 14	88.699	96.037
Bus – 15	44.681	96.037
Bus – 65	44.681	59.559
Bus – 66	44.681	59.559
Bus – 67	44.681	59.559
Bus – 113	44.681	59.559
Bus – 114	44.681	59.559
Bus – 115	44.681	59.559
Bus – 116	44.681	59.559
Bus – 171	64.154	78.904
Bus – 172	64.154	78.904
Bus – 173	64.154	78.904
Bus – 228	64.154	78.904
Bus – 230	64.154	78.904
Bus – 231	64.154	78.904
Bus – 232	64.154	78.904

Discussion: This show that the buses are not within the accepted normal voltage. When a capacitor bank has been place on then, its support the voltage at the buses.

Table 4.2: Shows the existing bus voltage number and bus voltage magnitude of the network before compensation.

Bus Voltage Number	**Bus Voltage Magnitude**
Bus – 2	92.748
Bus – 3	91.987
Bus – 4	88.699
Bus – 5	44.681
Bus – 8	64.154
Bus – 10	86.320
Bus – 11	88.699
Bus – 12	88.699

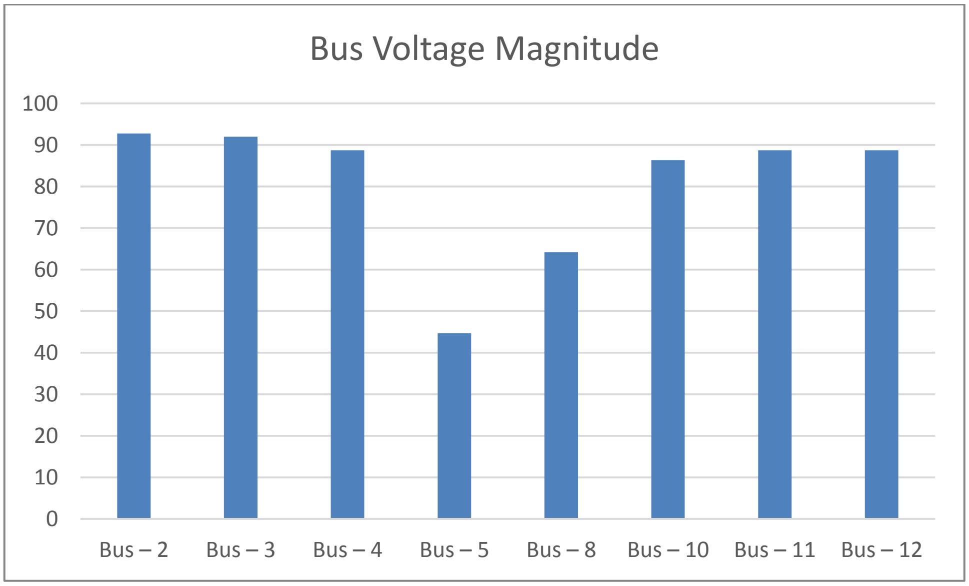

Figure 4.1: Plot of Bus Bar Voltage Magnitude vs The Bus Voltage Number

Discussion: The table and graph show how the existing bus voltage magnitude of the network is before compensation.

Table 4.3: Shows the existing bus voltage number and bus voltage magnitude of the network before compensation.

Bus Voltage Number	**Bus Voltage Magnitude**
Bus – 14	88.699
Bus – 15	44.681
Bus – 65	44.681
Bus – 66	44.681
Bus – 67	44.681
Bus – 113	44.681
Bus – 114	44.681
Bus – 115	44.681

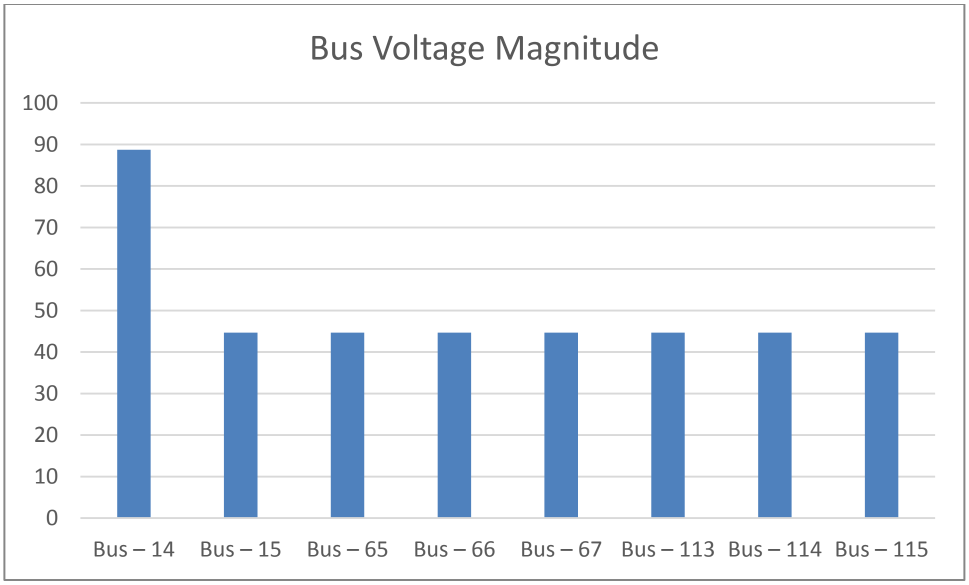

Figure 4.2: Plot of Bus Bar Voltage Magnitude vs The Bus Voltage Number

Discussion: The table and graph show how the existing bus voltage magnitude of the network is before compensation.

Table 4.4: Shows the existing bus voltage number and bus voltage magnitude of the network before compensation.

Bus Voltage Number	**Bus Voltage Magnitude**
Bus – 116	44.681
Bus – 171	64.154
Bus – 172	64.154
Bus – 173	64.154
Bus – 228	64.154
Bus – 230	64.154
Bus – 231	64.154

Bus – 232	64.154

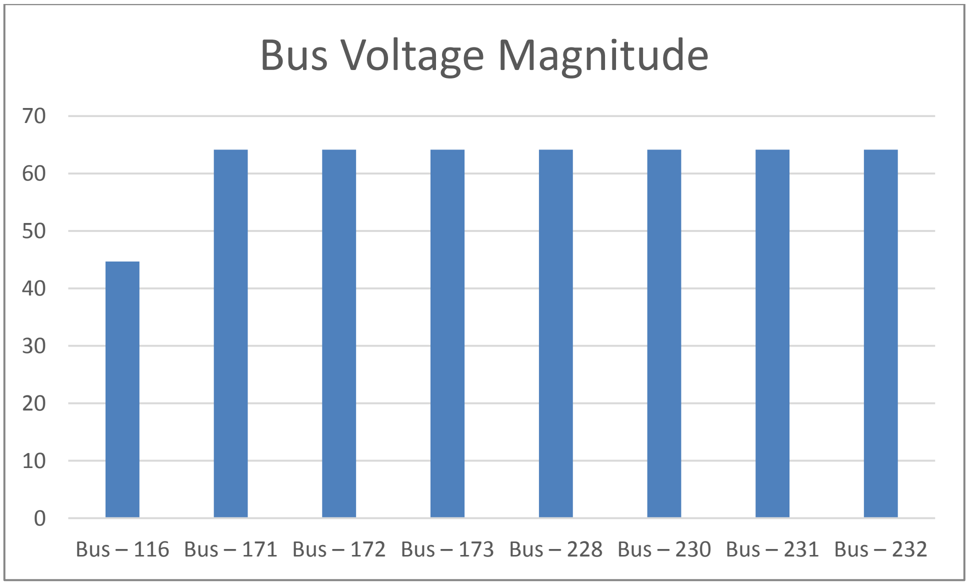

Figure 4.3: Plot of Bus Bar Voltage Magnitude vs The Bus Voltage Number

Discussion: The table and graph show how the existing bus voltage magnitude of the network is before compensation.

Table 4.5: Shows the existing bus voltage number and bus voltage magnitude improved against bus voltage number.

Bus Voltage Number	**Bus Voltage Magnitude (Existing)**	**Bus Voltage Mag natured (improved)**
Bus – 2	92.748	99.583
Bus – 3	91.987	98.822
Bus – 4	88.699	96.037
Bus – 5	44.681	59.559
Bus – 8	64.154	71.052
Bus – 10	86.320	93.145

Bus – 11	88.699	93.012
Bus – 12	88.699	96.037

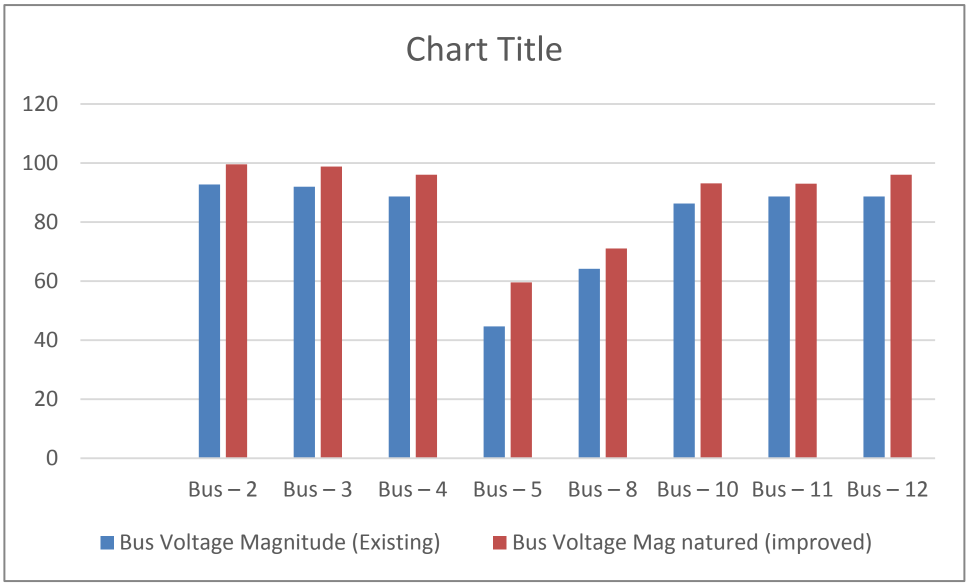

Figure 4.4: Plot of Bus Bar Voltage Magnitude (exsiting)and theBus Voltage Magnitude (Improved) Vs Bus Voltage Number

Discussion: The table and graph show the existing voltage magnitude and improved voltage magnitude. This show that after placing the capacitor banks on the buses, it’s improved the voltage magnitude.

Table 4.6: Shows the existing bus voltage number and bus voltage magnitude improved against bus voltage number.

Bus Voltage Number	Bus Voltage Magnitude (Existing)	Bus Voltage Mag natured (improved)
Bus – 14	88.699	96.037
Bus – 15	44.681	96.037
Bus – 65	44.681	59.559
Bus – 66	44.681	59.559

Bus – 67	44.681	59.559
Bus – 113	44.681	59.559
Bus – 114	44.681	59.559
Bus – 115	44.681	59.559

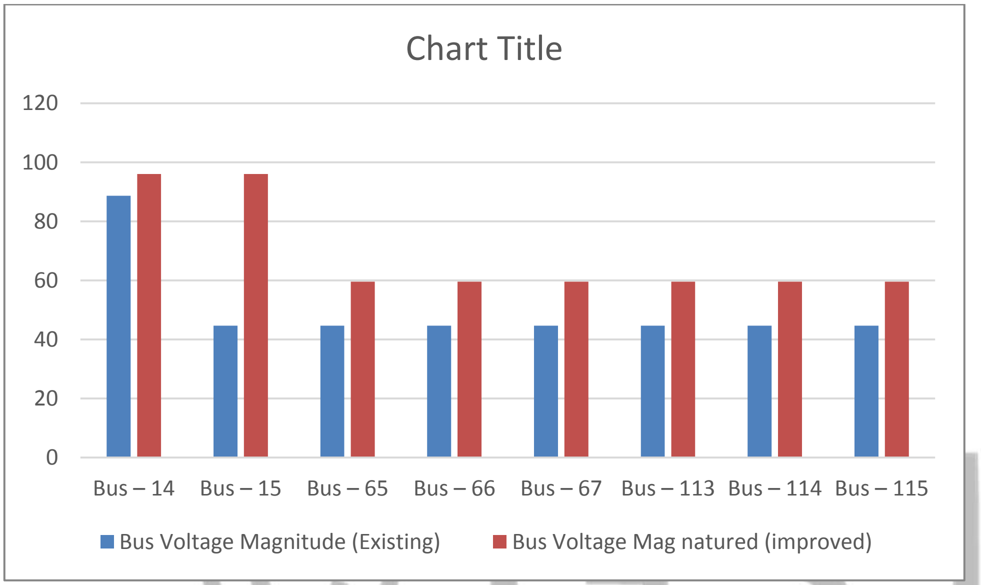

Figure 4.5: Plot of Bus Bar Voltage Magnitude (existing) and the Bus Voltage Magnitude (Improved) Vs Bus Voltage Number

Discussion: The table and graph show the existing voltage magnitude and improved voltage magnitude. This show that after placing the capacitor banks on the buses, it’s improved the voltage magnitude.

Table 4.7: Shows the existing bus voltage number and bus voltage magnitude improved against bus voltage number.

Bus Voltage Number	Bus Voltage Magnitude	Bus Voltage Mag natured

	(Existing)	(improved)
Bus – 116	44.681	59.559
Bus – 171	64.154	78.904
Bus – 172	64.154	78.904
Bus – 173	64.154	78.904
Bus – 228	64.154	78.904
Bus – 230	64.154	78.904
Bus – 231	64.154	78.904
Bus – 232	64.154	78.904

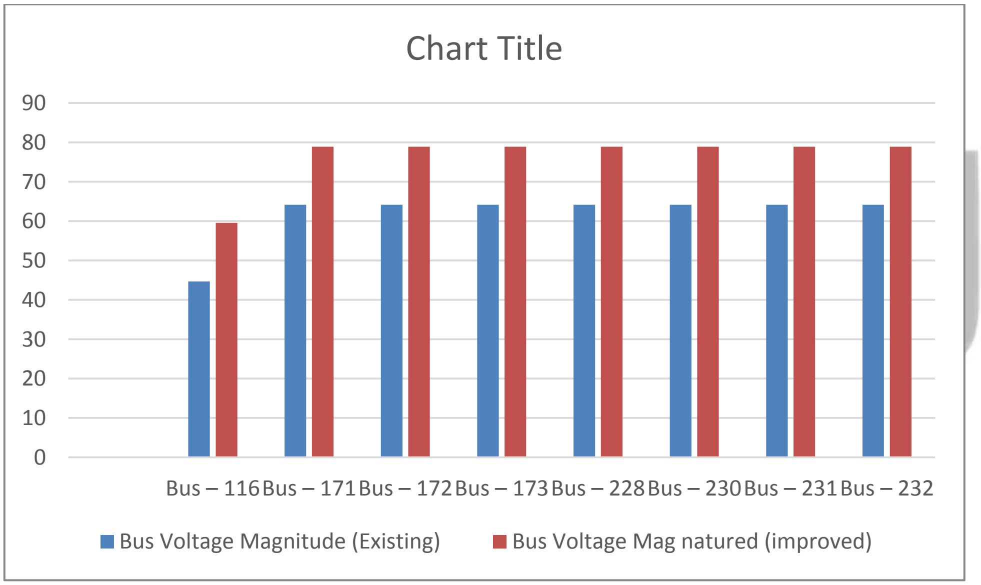

Figure 4.6: Plot of Bus Bar Voltage Magnitude (existing) and the Bus Voltage Magnitude (Improved) Vs Bus Voltage Number

Discussion: The table and graph show the existing voltage magnitude and improved voltage magnitude. This show that after placing the capacitor banks on the buses, it’s improved the voltage magnitude.

4.2 Discussion of Finding

The Electrical load evaluation in GRA 11KVAdistribution network shows the impact of poor power quality on the expected voltage of the distribution network. The case of overload on the network, cables and the existing transformers are of more concern.

The simulation of the system revealed that the system is overloaded and two transformers (Le Meridian and Chevron clinic) are overloaded. The buses that under (existing) operating condition buses 2, 3, 4, 5, 8,10, 11, 12, 14, 15, 65, 66, 67, 113,114, 115, 116, 171, 172, 173, 228, 230, 231, 232 are not within the acceptable normal voltage of ± 5% or 0.95pu – 1.05 pu of the declared voltage and such it creates violation in the system. However, to improve the power quality, voltage, profile, power factor and efficiency of the system, some numbers of capacitor bank noted at 300 KVAR each were optimally sized and allocated to support the voltage at the buses. In order to contribute to the power system operation by reducing losses and improving voltage profile. This also helped to enhanced power flow on the critical part of the network

5. CONCLUSION

Considering the Electric load evaluation in G.R.A Port Harcourt. The research work examined the existing state of the electrical power network at G.R.A. 11KVA distribution network taking its power supply from Golden lily 33/11KV injection substation. The present study state was modeled in electrical transient analyzer (ETAP) with the application of voltage equation, power flow; equation etc for the purpose of investigating system conditions in terms of voltage stability (Weather there is a strong mis-match between nominal declared voltage with regards to IEE regulation and existing operating voltage) in order to enhance system performance.

The existing network simulation results revealed that the system is overloaded and there are marginal overload in some of the buses. To avoid system breakdown or collapse that may result sin blackout, it is necessary to ensure that system components such as transformers, cables, feeder line, generator etc are not overloaded beyond its operating capacity. Importantly, the study engaged optimization strategy of improving system overload by determining the optimal size of the capacitor bank required to improve the specific bus overload problem on the network in a view to enhance power quality, voltage profile and power factor. This is a standard practice and a requirement that the bus voltage in the distribution network shall not be deviated beyond the standard acceptable value of (+5 -± 10%) or (0.95pu – 1.05pu) in order to satisfy statutory regulations and policy practice.

Sequel to the findings, it is hereby concluded that power flow studies is key for planning of future expansion of power system as well as determining the best operating conditions of the existing system. The major contribution of this work is that it has identified the violations at the busses on the network, and these are taken care of by optimally sizing of capacitor bank compensator for system improvement.

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