Integration and Evacuation Study for National Integrated Power Projects

Final Report of In-house Study

Produced by:
NIPP In-house Grid Study Team/PHCN led by Engr. F. A. Somolu (FNSE); SSAP

VOLUME 1: EXECUTIVE SUMMARY AND BACKGROUND REPORT

April 2007

Plot 441 Zambezi Crescent
Maitama District
Abuja

PHCN
Power Holding Company Of Nigeria Plc

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VOLUME 1: EXECUTIVE SUMMARY AND BACKGROUND REPORT

Executive Summary

1.0 INTRODUCTION

This Executive Summary has been prepared to summarise the objectives, significant issues, main conclusions and recommendations, and next steps in relation to an integration and evacuation study for the National Integrated Power Projects (NIPP).

Pursuant to its avowed mission to stabilize electricity supply in the country as a key plank of its economic programme, the Federal Government has embarked on the National Integrated Power Projects (NIPP), and others, designed to boost total generation capacity to at least 10,000 MW by 2007.

Under the NIPP, seven power stations (designated as "NIPP Plants" in this report) are to be constructed at Calabar, Egbema, Eyaen, Gbarain, Ikot Abasi, Omoku, and Sapele. These are in addition to ongoing construction of power stations at Alaoji, Geregu, Omotoso, and Papalanto. The latter four are referred to as "FGN Plants" in this report.

For seamless operation of these power plants with the rest of the Grid when completed, as well as evacuating, wheeling, and delivering the generated power to the load centres and bulk-load customers of Power Holding Company of Nigeria (PHCN), it is necessary to carry out integration and evacuation studies to determine, among others, gaps that need to be filled in transmission lines (330 kV and 132 kV), substations (330/132 kV and 132/33 kV), and associated equipment in order to meet this task. Filling these gaps will entail the need for reinforcement and expansion of existing facilities and the construction of new ones.

2.0 BACKGROUND

For about two decades, there had been no significant addition to the available generation on the PHCN (erstwhile NEPA – National Electric Power Authority) system. Nor was there any appreciable expansion of the transmission network. The result is acute power shortages and a radial, fragile Grid.

This rather dismal scenario changed in 2004 when the Federal Government commenced a massive expansion of the Nigerian electricity industry with the construction of four power stations designed to add about 1,494 MW to the Grid in the first phase (2007) and an additional 2,148 MW in the second phase (2008). The Government followed this up with the construction of seven power stations in the Niger Delta, which will add another 2,599 MW in 2007.

The total available generation by the end of 2007 is anticipated to exceed 10,000 MW – about *double* of the current available capacity. Perhaps the magnitude of the national Integrated Power Project (NIPP) is better appreciated if one considers the fact that the country's entire generation capacity, which took over forty years to develop, is being doubled in just four years. In addition, there are concurrent projects in transmission, distribution, communication and control as well as gas supply. By mid 2005, the sum total of the entire projects were brought under one corporate governance called NIPP.

Ordinarily these projects, laudable as they are, ought to have been preceded by a comprehensive study of the grid to determine the best location for the generating plants and the most efficient grid network structure. This was not done apparently due to the exigencies of the situation at that time. Realising this shortfall in the National Integrated Power Projects planning program, the then Technical committee commissioned this Integration and Evacuation study with the sole aim of determining whether the committed transmission projects can evacuate the generating plants as presently located.

3.0 POWER FLOW STUDY

Power flow analyses were carried out under four different scenarios to evaluate resultant voltage profiles and equipment loadings given ongoing and committed NIPP projects.

The power flow analyses (carried out on only 330 kV voltage level in the interim) show that ongoing transmission projects and transmission projects under the NIPP transmission development plan can evacuate the generation capability being built or has been committed under the first phase of the NIPP (i.e. 7 NIPP Plants + Phase 1 of 4 FGN Plants). This is, however, under N-0 condition, i.e. no loss of any (critical) circuit. Also, additional transformation capacity (at 330/132 kV and 132/33 kV) as well as additional 132 kV transmission circuits will be required, and these will be determined in follow-up studies.

The voltage profile is generally good.

Committed compensation schemes and operations manipulations are considered adequate to address isolated voltage issues.

A major concern is possible transmission congestion in the Benin – Lagos axis and a bottleneck in Benin.

The power flow study also shows that the generation capability being built or has been committed under the second phase of the NIPP cannot be evacuated even with the commissioning of ongoing or committed transmission projects.

4.0 SHORT CIRCUIT STUDY

Short circuit analysis was carried out to determine fault current levels at the various buses within the interconnected system for the purpose of checking switchgear rating adequacy and for effective protective relay coordination and setting.

Short circuit studies indicate that fault levels at Benin, Alaoji, and Afam 330 kV Substations – and indeed at some other substations – may exceed the rating of existing switchgear when the planned power plant and transmission development projects in the area are completed.

In the case of ongoing Alaoji Power Station project, the fault level is estimated to reach about 54 kA. This is well in excess of the 40 kA rating of switchgear already ordered.

Outline studies on the proposed Mambilla Hydroelectric Power Station show possible fault level increases of up to 16% in the NIPP area on account of Mambilla.

Possible measures to reduce excessive fault levels were outlined. One that is readily applied is network splitting.

5.0 STABILITY STUDY

Transient stability may be defined as the ability of the grid / system to maintain equilibrium and re-establish itself into steady state condition, following a major disturbance (faults) on the network.

Before the start of transient stability studies, it is necessary to first simulate a case corresponding to a normal situation in a steady state power flow, and to see the ability of the system to face an incident. The power flow study will establish the initial conditions, such as busbar voltages, load (P and Q), angles, etc.

For transient stability studies, the following four variables are presented graphically to allow an easy diagnosis of the stability of the system:

- Active Power: P_e, expressed in MW (electrical power)
- Mechanical Power: P_m, expressed also in MW (turbine power)
- Voltage at the terminal of the generators: expressed in pu
- Angle (∂): It is expressed in degrees for each generator. The angle is related to the inertia centre, representing the centre of gravity of the system.

The main conclusions of the stability study are as follows:

Calabar Power Station

Under normal conditions, all lines in circuits (case 1a), the stability of Calabar Power Station with respect to the rest of generating units on the grid is good. The main reasons of this good level of stability are the good performance of the speed governors and voltage regulators.

In practice, the synchronism of the system in case of short circuit is largely dependent on some unfavourable conditions such as; Line outage during maintenance, Longer clearing time of the relays & circuit breakers and Failure of the communication between the substations.

It is therefore necessary to consider specific conditions (for example longer working time of relays / circuit breakers, auto reclosing mechanism etc) to generate instability. This is simulated by considering longer fault clearing times (200 milliseconds) to generate instability. Fault duration of up to 200 milliseconds on Calabar bus will lead to instability. Therefore, with a proper relay co-ordination, a clearing time of up to 150 milliseconds may be allowed on Calabar bus without system instability.

<u>Egbema, Eyaen, Gbarain, Ikot-Abasi & Omoku Power Stations</u>

For Egbema, Eyaen, Gbarain, Ikot-Abasi & Omoku Power Stations the results are not too different from Calabar; the same diagnosis hold. A fault clearing time of up to 150 milliseconds can also be allowed on the Power Stations bus without system instability.

<u>Sapele Power Station</u>

For Sapele Power Station the results are significantly different from the rest of the Six Power Plants (Egbema, Eyaen, Gbarain, and Ikot-Abasi & Omoku). Sapele Power Plant remain stable for fault clearing time of up to 250 millisecond without system instability.

Under normal conditions, the stability of Sapele Power Station with respect to the rest of PHCN system is excellent.

This diagnosis relates to a system with four units in operation in Sapele Power Station. The main reasons of this good level of stability are-:

- the strong electrical connection of Sapele Power Plant with the rest of the system,
- the good performance of the speed governors and voltage regulators.

Measures to improve the stability of the system were recommended.

6.0 RECOMMENDATIONS AND CONCLUSION

This in-house study for the National Integrated Power Projects (NIPP) was carried out with the main objective of determining the adequacy or otherwise of the ongoing transmission system expansion to evacuate the generation capability being built or has been committed.

The following are the main recommendations:

6.1 Follow-up in-house studies (down to 132 kV and 33 kV voltage levels) to determine, among other things, a two-level transmission development plan:

- ✓ Level 1: Transmission development plan to enable the evacuation of the generation capability being built or has been committed under the second phase of the National Integrated Power Projects (i.e. 7 NIPP Plants + Phase 2 of 4 FGN Plants);
- ✓ Level 2: Transmission development plan to enable the unconstrained operation of the Grid, i.e. to give the Grid at least N-1 capability.

6.2 Possible measures to reduce excessive fault levels were outlined in the report. One that is readily applied is network splitting. Implementation plan for these measures should be worked out with contractors.

6.3 Reduction of fault clearing time, less than 150 milliseconds clearing time is recommended for 330kV lines and power stations according to this report. A fault clearing time of less than 100 milliseconds has been attained in some scheme.

Modern fast acting AVR should be used; as this will force up the voltage as the generator passes through the steady –state limiting angle $\partial = 90^{\circ}$ degrees, thereby increasing the power output of the machine so that instead of the power falling after $\partial = 90^{\circ}$ degrees; it is maintained and synchronism retained.

Turbine fast valving or bypass valving to control the accelerating power during and after fault will also improve system stability.

Dynamic breaking by the use of shunt resistor across the generator terminals can also be used to limit rotor swings.

7.0 NEXT STEPS

The following actions are recommended as next steps from the in-house study:

7.1 Establishment of a Reference Database

7.2 Nationwide Load Survey

7.3 Phase Unbalance Study

7.4 Detailed Integration Study for Mambilla Hydroelectric Power Project

Background Report

1.0 INTRODUCTION

1.1 Preamble

Making power available to all consumers at the flip of the switch, at all times, is the goal of any serious government. Nigeria is not an exception. The Federal Government has taken some bold steps towards achieving this goal. This in-house grid study is one of them.

As stated earlier, three major studies namely Power Flow Analysis, Short Circuit Level Computations and Stability Evaluations were undertaken aimed at establishing the ability of post-NIPP transmission infrastructure to evacuate the committed generation projects and ensure a fully integrated system. It must be noted however, that grid study is typically a continuous exercise due to a continually changing network structure.

In this volume I of the three volume report, the motivation for the study, as well as common features in volumes II and III which need not to be repeated in each volume are presented.

1.2 Background

It can be recalled that the country's Generation capacity went from 300MW in the 70's to about 4700MW in the late 80's and since then no significant investment has been made in generating more power in the country. Currently the country generates about 3500MW, which is about 74% of the generation capacity in the late 80's.

Faced with a ramped decline in the electric power generating capacity, the Federal Government of Nigeria in 2004/2005 embarked on a massive expansion of the power industry through construction of 11 generating stations with corresponding expansion in the transmission and distribution infrastructure under the National Integrated Power Projects.

Ordinarily these projects, laudable as they are, ought to have been preceded by a comprehensive study of the grid to determine the best location for the generating plants and the most efficient grid network structure. This was not done apparently due to the exigencies of the situation at that time. Realising this shortfall in the National Integrated Power Projects planning program, the then Technical committee commissioned this Integration and Evacuation study with the sole aim of determining whether the committed transmission projects can evacuate the generating plants as presently located.

1.3 National Integrated Power Project (NIPP)

Under the NIPP, seven power stations (designated as “NIPP Plants” in this report) are to be constructed at Calabar, Egbema, Ihovbor (Eyaen), Gbarain, Ikot Abasi, Omoku, and Sapele. These are in addition to the construction of power stations at Alaoji, Geregu, Omotoso, and Papalanto. The latter four are referred to as “FGN Plants” in this report.

All the committed projects under the NIPP are gas-powered plants. Although this does not represent a good generation mix, it is as a result of the abundant gas reserve of the nation. The seven power stations are sited in the Niger Delta area, close to the gas fields.

The Federal Government being committed to developing the Niger Delta region of the country politically decided that the seven power plants be located in each of the seven Niger Delta States. Figures 1 and 2 shows the locations of the NIPP and the PHCN Grid Circuit Diagram respectively.

1.4 Deliverable

The NIPP plants are far from the load centres namely Lagos, Kaduna, Kano, Maiduguri, etc. This necessitates, among other reasons, massive investment in transmission infrastructure to wheel the power to these load centres optimally.

Normally an integration and evacuation study of this nature ought to have been carried out before the projects were sited and committed but the reverse is the case.This study is therefore aimed at determining if the system as being built can effectively evacuate the power generated from the NIPP power plants and what gaps there are to be filled in terms of transformation capacity among others.

The final report of the Integration and Evacuation Study is the deliverable of the in-house study.

1.5 Contents of Report

The Final Report is in three volumesand the contents are:

- **Volume I (Executive Summary):** This a condensed view of the study. It presents the preamble and background of the NIPP projects. It also summaries the other two volumes which are the power flow and short circuit studies and the stability studies. The recommendations and conclusions reached from the study as well as the next steps to be takenare also stated in this volume.
- **Volume 2 (Power Flow and Short Circuit Studies):** This presents themethodology, scenarios and result of power flow studies to determine theadequacy or otherwise of the ongoing transmission system expansion toevacuate the generation capability being built or has been committed. Volume2 also presents the results of short circuit studies to determine the transmission system fault levels over the study period.
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- **Volume 3 (Stability Studies):** This presents the methodology, scenarios and results of transient stability studies undertaken to assess system stability over the study period. Relevant diagrams of the stability runs made form which conclusions were drawn are also included in this volume.

2.0 METHODOLOGY

2.1 Study Overview

The main objective of this study was to investigate the capacity of the PHCN Grid for an unconstrained evacuation of the entire output from the existing generation and proposed generation, details of which existing and proposed generation are given subsequently.

Power flow studies were undertaken to determine the adequacy or otherwise of the ongoing transmission system expansion to evacuate the generation capability being built or has been committed. Fault level studies to determine transmission system fault levels and transient stability studies to assess system stability were also undertaken. Contingency and security analyses were also carried out.

One important collateral result of this study was an unprecedented extensive documentation of data for the PHCN system. We propose, as a part of next steps, that these data be built into a databank in the first instance and subsequently, into a comprehensive database.

2.2 Scenarios

The following scenarios were used in carrying out the study:

Scenario #1 – Base Case

Target year: 2006

Generation	= 3,774.1 MW
Load	= 3,705.6 MW
Plants	= Existing Plants (as at September 2006)

Figure 3 shows the base case network.

Scenario #2 – Base Case + FGN + NIPP

Target year: 2007

Generation = 11,232.5 MW

Load = 8,985 MW

Plants = Existing Plants + 4 FGN Plants (1st Phase) + 7 NIPP Plants

Figure 4 shows the network studied in this scenario.

Scenario #3 – Base Case + FGN + NIPP + IPPs

Target year: 2007/2008

Generation = 20,180.5 MW

Load = 16,000 MW

Plants = Existing Plants + 4 FGN Plants (1st Phase & 2nd Phase) + 7 NIPP Plants + Committed IPPs

Scenario #4 – Mambilla and Other Scenarios

Target year: 2020 (?)

Generation = 25,000 MW

Load = 20,000 MW

These "futuristic" scenarios were cursorily examined to outline the direction for future detailed studies, as a part of the next steps.

Appendix D gives a list of the plants.

Scenario #2 was studied in particular detail, as Government's policy and action for the power industry in the near- and medium-term is centred on 10,000 MW generation.

2.3 Load Forecast

The PHCN peak of 8 August 2005 is chosen as the base case. The peak load was 3,705.6 MW and has not been significantly surpassed to date. The load despatch and generation despatch are shown in Appendix C and Appendix D, respectively.

Accurate load forecast is difficult because of the existence of much suppressed load (load demand that cannot be supplied due to insufficient generation) and captive generation (load not connected to the Grid) for about two decades. In fact, this electricity supply situation gave rise to Government's current massive intervention in the power industry.

Until enough generation capacity to match the load becomes available, and/or a detailed nation-wide load survey is carried out (as recommended in this report in the next steps), any load forecast exercise would be conjectural. All the same, various heuristic approaches have been used to arrive at a load forecast of about 6,000 MW and 7,000 MW for 2007 and 2008, respectively.

However, the peak loads studied in this report are 8,985 MW and 16,000 MW for 2007 and 2008, respectively. These loads are about 80% of the total generation capacity that is projected to become available during the period under study. Studying these peaks rather than the actual forecast loads is in line with the main objective of the study, namely to determine the adequacy or otherwise of the ongoing transmission system expansion to evacuate the generation capability being built or has been committed. The load despatch and generation despatch for these loads are also shown in Appendix C and Appendix D, respectively.

2.4 Approach

The following approach was adopted in carrying out the study:

❶ Collect and validate data and then establish a credible (calibrated) base case power flow model using NEPLAN system analysis software

❷ Model the defined scenarios using NEPLAN

❸ Carry out system analysis – power flow analysis, contingency analysis, fault level analysis, and stability analysis

❹ Abstract the conclusions and recommendations from the analyses and write report

2.5 Study Team

Government graciously accepted the recommendation from Engr. F. A. Somolu, Senior Special Assistant (Power Sector Reform) to the President and Commander-in-Chief of the Armed Forces, Chief Olusegun Obasanjo, to carry out the study in-house. The reasons for carrying out the study in-house are:

- to fast-track the study (less than three months was available for the study from inauguration to submission of Final Report)
- to save cost (the budget estimate for the in-house study was a small fraction of consultants' quoted price)
- to further equip and increase in-house capability and know-how. This is considered very necessary because in power system operations, so many scenarios will have to be modelled and studied all of the time thus outsourcing each exercise will be impracticable.

The study was accordingly carried out by a team of staff from Power System Planning Division (PSPD) at PHCN Corporate Headquarters and others from relevant sectors / departments of PHCN – Project Management Unit (PMU), National Control Centre (NCC), and System Operations (S/O).

Engr. F. A. Somolu was the leader of the in-house study team. Other members of the team were:

1.	Dr. F. N. Okafor	-	Special Assistant to SSAP-P
2.	Engr. O. S. Egberongbe	-	PSPD
3.	Engr. F. K. O. Zaccheaus	-	PMU
4.	Engr. A. A. Alade	-	NCC
5.	Engr. E. A. Anumaka	-	PSPD
6.	Engr. P. A. Aribaba	-	PSPD
7.	Engr. C. A. Anyanwu	-	PSPD
8.	Engr. T. A. Inugonum Ph.D.	-	PSPD
9.	Engr. M. A. Ajibade	-	PSPD
10.	Engr. B. A. Ishola	-	NCC

11. Engr. E. Abutu	-	PSPD
12. Mr. A. Rotimi	-	S/O
13. Engr. S. Asuku	-	PSPD
14. Mr. O. A. Essien	-	PSPD
15. Ayodeji Ogunsina	-	Office of SSAP
16. Ovie O. Adjekpiyede	-	Office of SSAP

3.0 DATA COLLECTION AND ANALYSIS

3.1 Data Collection

The starting point for any study is data collection. Accurate data are a critical success factor in the modelling process.

Data were collected on power plant, transmission lines, and substations (transformers and circuit breakers).

3.2 Questionnaire

Hard and soft copies of data collection forms were sent to all the field stations prior to site visits. A sample of the data questionnaire is shown in Appendix A.

3.3 On Site Visit

Visits were undertaken to all field stations to, among other things:

- collect missing data;
- validate collated data;
- collect pictorial data.

A list of stations visited is shown in Appendix B.

3.4 Data Validation and Integrity Check

Initial data collation was done in the office and this was followed by preliminary data validation in the office and on site.

The data were thereafter checked for internal consistency. Gaps and data deemed to be erroneous were filled with typical values to enable the modelling process to proceed while efforts were on to obtain the correct data from the field stations or from consultants / contractors that constructed / installed the facility / equipment so affected.

3.5 Next Steps – Mini Database

One important collateral result of this study was an unprecedented extensive documentation of data for the PHCN system. We propose that these data be built into a databank in the first instance and subsequently, into a comprehensive database.

This will ensure the availability of up-to-date data for studies and planning. It will also ensure that subsequent studies are based on the same set of data so as to enable credible comparison of the results of these studies.

4.0 TRANSMISSION SYSTEM PLANNING CRITERIA

4.1 Nominal Ratings on PHCN Grid

Power systems operate at different voltage levels coupled by transformers and their associated circuit breakers. Nominal ratings of the PHCN Grid equipment are as listed below.

1. Transmission voltage: **330 kV**
2. Sub-transmission voltages: **33 kV, 132 kV**
3. Primary distribution feeder voltages: **11 kV, 33 kV**
4. Secondary distribution feeder voltage: **415 V** (three-phase)**, 230V** (single-phase)
5. Power transformer voltage ratings: **330/132/33 kV, 330/132/13.8 kV, 132/33/11 kV, 132/33 kV, 132/11 kV**
6. Power transformer power ratings: **162 MVA, 150 MVA, 90 MVA, 60 MVA, 45 MVA, 30 MVA**
7. Circuit Breaker current ratings: **16 kA, 17 kA, 20 kA, 30 kA, 31.5 kA, 40 kA, 50 kA**
8. Circuit Breaker voltage ratings: **11 kV, 33 kV, 132 kV, 330 kV**

4.2 Voltage Limits

Current voltage limits are shown in the table below.

Nominal Voltage Level	Minimum Value		Maximum Value	
	kV	pu	kV	pu
330 kV	313.5	0.95	346.5	1.05
132 kV	118.8	0.90	145.0	1.098
33 kV	31	0.94	34.98	1.06
16 kV	15.2	0.95	16.8	1.05
11 kV	10.45	0.95	11.55	1.05
415 V	390.1 V	0.94	439.9 V	1.06
230 V	216.2 V	0.94	243.8 V	1.06

However, under the aegis of West Africa Power Pool (WAPP), Nigeria may adopt the following voltage limits when the new WAPP operation code is completed and ratified:

- ❖ under normal operating condition: ±5%
- ❖ under emergency operating condition: ±10%

This is in line with international best practices. Accordingly, we carried out the study based on these best-practices voltage limits.

4.3 Frequency Limits

Frequency control on the power system is within the limits of 50 Hz ±2.5% (i.e. 48.75 – 51.25 Hz).

4.4 Thermal Ratings for Transmission Lines

The capability of most transmission lines is presently determined by their thermal ratings. Rating can be substantially increased if the overall rating approach is based on recognising that thermal ratings have three different aspects: planning, dispatch, and operations. The general approach to transmission line ratings has been deterministic. The key reason is that transmission lines must be operated within safe clearances at all times. The combination of a probabilistic planning approach combined with a deterministic operations view can pragmatically increase transmission capabilities by 20-30% with 99% availability and a 100% safety.

The 330 kV circuits use twin Bison conductors (350 mm^2 Aluminium Conductor, Steel Reinforced) which under local conditions have a continuous current rating of about 680 A per conductor. This equates to a continuous maximum thermal rating of 777 MVA.

The loading limits adopted for transmission lines are:

- ❖ under normal operating condition: within 85% of thermal rating
- ❖ under emergency operating condition: within 100% of thermal rating

4.5 Generator Loading Limits

The limit of generator loading in PHCN system is ±5% of the name plate rating.

4.6 Transformer Loading Limits

Power transformers are not to be loaded above 85% of their name plate rating. Nevertheless a large number of power transformers in the system are being overloaded.

4.7 Reserve Margin

Reserve margin is the unused capacity above system demand, which is required to cater for regulation, short-term load forecasting errors, and unplanned plant outages. It consists of spinning reserve, quick reserve, and slow reserve.

The transmission system shall be operated to provide for a level of operating reserve sufficient to account for such factors as errors in forecasting, generation and transmission equipment unavailability, number and size of generating units, system equipment forced outages, maintenance schedules, and regulating requirements. Appropriate steps shall be taken to protect the power system against the next contingency, following the loss of generation resources or load.

A first step to meeting the reserve margin requirements of a power system is to allow a spinning reserve equal to the largest generation unit in the system. For PHCN, this is 220 MW. This could approach 1,000 MW with the proposed combined cycle plants.

4.8 N-1 Criterion

The N-1 criterion means that a power system is sufficiently reliable if it is able to operate acceptably under any unplanned outage of equipment due to a single cause. A single cause could be a generating unit or a transmission line or a power transformer being out of service due to unplanned outage.

The PHCN network is largely radial and so hardly meets the N-1 criterion in any part of the Grid.

5.0 NEPLAN ENVIRONMENT AND CAPABILITIES

NEPLAN, short for *Network Planning*, is an analysis tool for electricity, water, and gas developed by Busarello+Cott+Partner Inc of Switzerland. This in-house study for NIPP was carried out using NEPLAN. Comparative study will be carried out later with other tools, such as PSS/E, CYME, and EUROSTAG. This will further build in-house capability in system analysis, which is a major objective of the in-house study.

5.1 Features

- NEPLAN has excellent graphical user interface and is very user friendly indeed.
- NEPLAN is scalable: you pay for the modules you need.
- It is readily ported from one system to another.
- It has an equipment library feature.
- Its database can be migrated to other platforms, e.g. PSS/E and MS Excel.

5.2 Modules

- Graphical Database Editor
- Power Flow
- Unbalanced Power Flow
- Power Flow with Load Profiles
- Optimal Separation Points
- Optimal Transmission Network (OPF)
- Optimal Distribution Network
- Short Circuit
- Distance Protection
- Harmonic Analysis
- Motor Starting
- Selectivity Analysis
- Dynamic Analysis
- Voltage Stability

- Small Signal Stability
- Network Reduction
- Investment Analysis
- Reliability Analysis
- Overhead Line Calculation
- DVG-Interface and GIS-Interface
- Database Driver (ODBC)

Appendix

Appendix A: Data Questionnaire

DATA COLLECTION FORM FOR TWO WINDING TRANSFORMERS

(1) STATION --

(2) MAKE --

(3) SERIAL No: --

(4) DATE OF MANUFACTURE: ---

(5) VECTOR GROUP: ---

(6) COOLING: --

(7) TYPE (SHELL OR CORE) ---

(8) YEAR INSTALLED, MUST BE REMOVED OR REPAIRED

(a) Commissioning of a new transformer ---------------------------------

(b) Decommissioning of existing transformer ---------------------------------

(c) Commissioning of transformer from another station -------------

(d) Relocation of transformer to another station -----------------------

(e) In reserve, not connected but available in the substation since

(year) --

(f) General remark

(9) NOMENCLATURE:…………………………………………………………............

(10) **EARTHING POLICY**:

(a) Direct (Yes or No) --

(b) Over a reactor (Yes or No) ---

(c) Over an earthing transformer (Yes or No) --------------------------------

(d) Resistance (Yes or) ---

(e) No earthing (Yes or No) ---

(11) **REGULATION**

(a) Tap range (No of taps) --

(b) Regulating range above nominal tap (% of nominal voltage) -----

(c) Regulating range below nominal tap (% of nominal voltage) -----

(d) Nominal tap (tap position) ---

(e) Regulating step (% of nominal voltage) --------------------------------

(f) TYPE: Regulated at no load (Yes or No) --------------------------------

Regulated under load (Yes or No) ---

Mixed (yes or No) --

(12) **LOSSES**

(a) Copper losses (series resistance in KW at 75^{o}C) -----------------------

(b) Iron Losses (in KW) --

(c) Magnetising current (Amps) at side I (Primary) -----------------------

(13) **CHARACTERISTICS**

(a) VN1: Nominal Voltage side Nom 1 (KV) --------------------------------

(b) VN2: Nominal voltage side Nom2 (KV) --------------------------------

(c) Pnom: Nominal power (MVA) ---

(d) Pmax: Maximum tolerated power in steady state (MVA) if not equal to Pnom --

(14) **IMPEDANCES**

Xcc: direct short-circuit reactance----------------------------------

X12: Zero sequence reactance between terminals 1 and 2 -----

XIN: zero sequence reactance between terminal 1 and neutral conductor --

X2N: sequence reactance between terminal 2 and neutral Conductor ---r----------

Note: All reactances are given in % and ohms at the nominal tap position of the transformer. The values in ohms are given for side 1.

All zero-sequence impedances are to be specified.

DATA COLLECTION FORM FOR THREE WINDING TRANSFORMERS

(1) STATION --

(2) MAKE ---

(3) SERIAL No. --

(4) DATE OF MANUFACTURE ---

(5) VECTOR GROUP ---

(6) COOLING --

(7) TYPE (SHELL OR CORE) --

(8) AUTOTRANSFORMER (YES OR NO) --

(9) YEAR INSTALLED, MUST BE REMOVED OR REPAIRED

(a) Commissioning of a new transformer ---------------------------------

(b) Decommissioning of existing transformer ---------------------------------

(c) Commissioning of transformer from another station --------------

(d) Relocation of transformer to another station -----------------------

(f) In reserve, not connected but available in the substation since

(year) --

(g) General remarks---

(10) NOMENCLATURE --

(11) **EARTHING POLICY**

(a) Direct (Yes or No) --

(b) Over a reactor (Yes or No) --

(c) Over an earthing transformer (Yes or No) ---------------------------------

(d) Resistance (Yes or) --

(e) No earthing (Yes or No) --

(12) **REGULATION**:

(a) Tap range (No of taps) ---

(b) Regulating range above nominal tap (% of nominal voltage) -----

(c) Regulating range below voltage nominal tap (% of nominal voltage)

(d) Nominal tap (tap position) ---

(e) Regulating step (% of nominal voltage) ---------------------------------

(f) TYPE: Regulated at no load (Yes or No) ---------------------------------

Regulated under load (Yes or No) --

Mixed (yes or No) ---

(13) **LOSSES**

(a) Copper losses (series resistance in kW at 75^{o}C)for each pair of

winding --

(b) Iron Losses (in KW) ---

(c) Magnetising current (Amps at side I) ---------------------------------

(14) **CHARACTERISTICS**

VN1 Nominal Voltage side Nom1(KV) where VN1> VN2> VN3

VN2: Nominal voltage side Nom2 (KV) ---------------------------------

VN3: Nominal voltage side Nom3 (KV) ---------------------------------

(15) **NOMINAL POWER**

(a) PN1 Maximum tolerated power in steady state for winding 1

(MVA) --

(b) PN2 Maximum tolerated power in steady state for winding 2

(MVA) --

(c) PN3 Maximum tolerated power in steady state for winding 3 (MVA) --

(16) **IMPEDANCES**

Z12 Short-circuit reactance between windings 1 and 2 --------------

Z13 Short – circuit reactance between windings 1 and 3 -----

Z23 short- circuit reactance between windings 2 and 3 -----

(17) **ZERO SEQUENCE IMPEDANCES**

X12: Sequence reactance between terminals 1 and 2 both in star

----

XIN: Zero sequence reactance between terminals 1 in star, and 3 in delta ---

X2N Zero sequence reactance between terminals 2 in star and 3 in delta ---

Note: All reactances are given in % and ohms at the nominal tap position of the transformer. The values in ohms are given for side 1. All known and measurable zero sequence impedances are to be specified.

DATA COLLECTION FORM FOR TRANSMISSION LINES

(1) **GENERAL**

(a) The names of the nodes at line terminals ------------ and ---------------

(b) Nominal Voltage(KV)--

(c) TYPE (SC or DC) --

(d) Operational code attributed to the line ----------------------------------

(e) Tower Sketch and dimensions (example see attached)

(2). **CHARACTERISTICS**

(a) Steel diameter (mm) --

(b) Length of line (km) --

(c) Conductor diameter --

(d) number of conductors per phase ---

(e) Conductor code name ---

(f) Maximum power tolerated in steady state (MVA) -----------------------

(g) Line section (mm^2) The section is the one of one single conductor even if twin conductors ---

(h) Characteristic impedance (ohms) ---

(i) Natural power (MW) --

(3). **IMPEDANCES:**

(a) Direct (i.e. positive-sequence impedance)

R1 – Resistance (Ohms /km) ---

X1 – Reactance (Ohms/ km) ---

(b) Zero-sequence impedance

R0 – Resistance (Ohms /km) ---

X0 – Reactance (Ohms /km) ---

(c) Shunt Admittance

BL – Positive sequence susceptance (μS, Micromhos/Km) -----

B0 – Zero sequence susceptance (μS, Micromhos/km) -------------

DATA COLLECTION FORM FOR GENERATORS

(1) **ELECTRICAL PARAMENTERES**

(a) Apparent Power (MVA) --

(b) Maximum Active Power (MW) --

(c) Terminal Voltage (KV)

Nominal ---

Minimum ---

Maximum ---

(d) Saturation parameters of the main generator -----------------------

(e) Generator Impedance based on p.u of nominal voltage and power

(i) Stator resistance (R_s) --

(ii) Leakage reactance (X_s) --

(iii) Synchronous reactance in d-axis (X_d) -----------------------

(iv) Transient reactance in d-axis (X^{I}_{d}) -----------------------

(v) Sub transient reactance in d-axis (X^{II}_{d}) -----------------------

(vi) Synchronous reactance in q-axis (X_q) -----------------------

(vii) Transient reactance in q-axis (X^{I}_{q}) --------------------------------

(viii) Sub-transient reactance in q-axis (X^{II}_{q}) -----------------------

(f) Transient time constant (secs) in d – axis (T^{I}_{do}) -----------------------

(g) Subtransient time constant (secs) in d-axis (T^{II}_{do}) -----------------------

(h) Transient time constant (secs) in q – axis (T^{I}_{qo}) -----------------------

(i) Substransient time constant (secs) in q- axis (T^{II}_{qo}) -------------

(j) Constant of inertia (H) in MWs/MVA ---------------------------------

(2) **EXCITATION**

(a) TYPE Brushless with or without pilot generator, static, or other) -----

(b) BLOCK DIAGRAM FOR EXCITATION AND AUTOMATIC VOLTAGE REGULATOR AND RELATED NUMERICAL DATA (Including the per unit system)

(c) BLOCK DIAGRAM OF POWER SYSTEM STABILIZER (PSS) IF AVAILABLE AND RELATED NUMERICAL DATA

(d) UNDER- AND OVER-EXCITATION BLOCK DIAGRAM AND RELATED NUMERIAL DATA

(e) STATE IF OVERFLUX LIMITER IS INCORPORATED.

(3) **SPEED REGULATION**

PROVIDE BLOCK DIAGRAM AND RELATED NUMERICAL DATA

(4) **CAPABILITY CURVES**

Provide showing the operating area in the plane P and Q versus voltage.

DATA COLLECTION FORM FOR SUBSTATION CONFIGURATIONS

(1) ONE – LINE DIAGRAM OF SUBSTATION INCLUDING SWITCHING ARRANGEMENT

(2) INDICATE POWER RATINGS OF TRANSFORMERS

(3) INDICATE CURRENT RATINGS OF THE BUS-BAR – AND ASSOCIATED ELEMENTS (BREAKERS, ISOLATORS ETC)

(4) PROVIDE SHORT – CIRCUIT CAPACITY RATINGS OF ALL SUBSTATION EQUIPMENT .

DATA COLLECTION FORM FOR REACTORS

1. **STATION** ....

2. **MAKE** ....

3. **SERIAL NO** ....

4. **DATE OF MANUFACTURE** ....

5. **VECTOR GROUP** ....

6. **TYPE (SHELL OR CORE)** ....

7. **YEAR INSTALLED MUST BE REMOVED OR REPAIRED**

   (a) Commissioning of a new reactor ....

   (b) De-commissioning of existing reactor ....

   (c) In reserve, not connected but available in the substation

   since (Year) ....

   (d) General remark ....

8. **NOMEN CLATURE** ....

9. **COOLING** ....

10. **RATED CURRENT AT ONAN RATED POWER AND RATED VOLTAGE TAP:**

    (a) HV WINDING (A) ....

    (b) AUXILLIARY WINDING (A) ....

11. **DIRECT IMPEDANCE AT RATED VOLTAGE:**

    (a) Reactor (Ohms) ....

    (b) Auxiliary Winding (%) ....

12. **ZERO SEQUENCE IMPEDANCE AT RATED VOLTAGE**

    (a) Reactor (Ohms) ....

    (b) Auxiliary winding (%) ....

13. **CONNECTION AT SUBSTATION SWITCHABLE (YES OR NO)**

    ....

DATA COLLECTION FORM FOR CAPACITORS

1. **STATION** …………………………………………………………………………

2. **MAKE** …………………………………………………………………………

3. **SERIAL NO.** ……………………………………………………………………

4. **DATE OF MANUFACTURE** ………………………………………………..

5. **YEAR INSTALLED, DECOMMISSIONED**

   (a) Commissioning of a New Capacitor ……………………………………

   (b) Decommissioning of Existing Capacitor … ……………………………

   (c) Commissioning of Existing Capacitor …………………………………...

6. **TYPE**

   (a) Fixed (Yes Or No) ………………………………………

   (b) Mobile (Yes Or No) ………………………………………

   (c) Switchable or Unswitchable ……………………………..

   (d) Single or Three Phase) ……………………………………

7. **TRANSMISSION SYSTEM DETAILS**

   (a) Rated Nominal Voltage (KV) ………………………….

   (b) Maximum Voltage (KV) ………………………………

   (c) Frequency (HZ) ………………………………………..

   (d) Effectively earthed (Yes or No) ………………………

   (e) Short-Circuit Level (MVA) ……………………………

   (f) Voltage Tolerance (%) …………………………………

8. **CHARACTERISTICS**

   (a) Rated Bank Power (MVAR) …………………………..

   (b) Maximum 50HZ Symmetrical Short-circuit current (kA)rms ……………

DATA COLLECTION FORM FOR LARGE LOADS

1. **LOCATION** ………………………………………………………………………………

2. **TYPE OF LOAD (INDUSTRIAL OR COMMERCIAL)** ......…………………………

3. **NAME OF LOAD** ..……………………………………………………………………...

4. **LOAD SIZE (MW, MVAR)** ………………………………………………………........

5. **POWER FACTOR SEEN FROM SUBSTATION FEEDERS** ………………………

6. **RATED VOLTAGE OF LOAD (KV)** ..…………………………………………………..

7. **LOAD CHARACTERISTICS** ……………………………………………………………..
   Note: *Provide detailed operational features of the load (e.g. fluctuation, Harmonics, etc.).*

8. **TYPICAL DAILY LOAD CURVES FOR WET AND DRY SEASONS FOR;**

   (a) Typical Working day ………………………………………………………..

   (b) Typical Sunday ………………………………………………………………

[redacted]

Appendix B: List of Stations Visited

ALPHABETICAL LIST OF ALL STATIONS VISITED

NB: STATIONS IN small letters ARE EITHER UNDER CONSTRUCTION OR PLANNED

REGION	330 KV SUBSTATION	132 KV SUBSTATION
BAUCHI	GOMBE	BAUCHI
	JOS	BIU
		DOMBOA
	Damaturu	GOMBE
	Jalingo	JOS
	Maiduguri	MAIDUGURI
	Yola	POTISKUM
		SAVANAH
		YOLA
BENIN	AJAOKUTA	BENIN
	ALADJA	EFFURUN
	BENIN	IRRUA
	DELTA	OKENE
		UGHELLI
	Benin North	UKPILLA
	Lokoja	
	Omotosho	
ENUGU	AFAM	ABA TOWN
	ALAOJI	ABAKALIKI
	NEW HAVEN	APIR
	ONITSHA	AWKA
		CALABAR
	Ahoada	EKET
	Calabar	GCM
	Ikot Abasi	ITU
	Makurdi	NEW HAVEN
	Owerri	NKALAGU
	Port Harcourt	OJI RIVER
	Yenegoa	ONITSHA
		OTUKPO
		OWERRI
		PORT HARCOURT

ALPHABETICAL LIST OF ALL STATIONS VISITED

REGION	330 KV SUBSTATION	132 KV SUBSTATION

NB: STATIONS IN small letters ARE EITHER UNDER CONSTRUCTION OR PLANNED

REGION	330 KV SUBSTATION	132 KV SUBSTATION
		(MAIN)
		PORT HARCOURT (TOWN)
		UYO
		YANDEV
KADUNA	KUMBOTSO	DAKATA
	MANDO	DAN-AGUNDI
		FUNTUA
	Zaria	GUSAU
		HADEJIA
		KADUNA TOWN
		KANKIA
		KATSINA
		KUMBOTSO
		MANDO
		ZARIA
LAGOS	AJA	ABEOKUTA
	AKANGBA	AGBARA
	AYEDE	AIYEDE
	EGBIN	AJA
	IKEJA WEST	AKANGBA
	OSHOGBO	AKOKA
		AKURE
	Alagbon	ALAGBON
	Erunkan	ALAUSA
	Ilorin	ALIMOSHO
	Papalanto	AMUWO-ODOFIN
	Sakete	APAPA ROAD
		EJIGBO
		IBADAN NORTH
		IFE
		IJEBUODE
		IJORA
		IKORODU
		ILESHA
		ILORIN
		ILUPEJU
		ISEYIN
		ISOLO

ALPHABETICAL LIST OF ALL STATIONS VISITED

NB: STATIONS IN small letters ARE EITHER UNDER CONSTRUCTION OR PLANNED

REGION	330 KV SUBSTATION	132 KV SUBSTATION
		ITIRE
		JERICHO
		MARYLAND
		OFA
		OGBA
		OJO
		OMUARAN
		ONDO
		OSOGBO
		OTTA
		OWORORSHONKI
		PAPALANTO
		SHAGAMU
SHIRORO	BIRNIN KEBBI	AKWANGA
	JEBBA	APO
	KATAMPE	BIDA
	SHIRORO	BIRNIN-KEBBI
		JEBBA
	Gwagwalada	KATAMPE
	Sokoto	KONTOGORA
	Zaria	KUBWA
		MINNA
		SHIRORO
		SOKOTO
		SULEJA
		TEGINA
		T-MAFARA

Appendix C: Load Distribution

REGION	SUBSTATION	SCENARIO #1: BASE CASE 3,705.6 MW	SCENARIO #2 8,985 MW	SCENARIO #3 16,000 MW
Lagos	Aja	200	380	630
	Alagbon		302	429
	Akangba	400	650	1235
	Ayede	240	420	724
	Egbin	260	400	788
	Erukan		340	556
	Ganmo		150	215
	Ikeja West	550	925	1663
	Osogbo	180	430	876
	Papalanto		150	236
	Sakete		110	158
Lagos Total Allocation		**1830**	**4257**	**7510**
Benin	Ajaokuta	15	26	67
	Aladja Steel	43	78	139
	Benin Main	120	218	389
	Benin North		108	192
	Delta	44	80	142
	Omotoso		120	221
Benin Total Allocation		**222**	**630**	**1150**
Enugu	Afam	64	117	208
	Alaoji	250	454	816
	Calabar		90	160
	Makurdi		90	160
	New Haven	135.6	247	450
	Onitsha	152	276	490
	Owerri		90	160
	Port Harcourt		180	320
Enugu Total Allocation		**601.6**	**1544**	**2764**
Bauchi	Damaturu		62	109
	Gombe	80	141	251
	Jalingo		61	109
	Jos	80	141	251
	Maiduguri		115	205
	Yola		82	147
Bauchi Total Allocation		**160**	**602**	**1072**
Kaduna	Kumbotso	260	433	772
	Mando	230	382	680
	Zaria		131	232
Kaduna Total Allocation		**490**	**946**	**1684**
Shiroro	Birni Kebbi	85	141	251

REGION	SUBSTATION	SCENARIO #1: BASE CASE 3,705.6 MW	SCENARIO #2 8,985 MW	SCENARIO #3 16,000 MW
Shiroro (Cont'd)	Gwagwalada		173	308
	Jebba	12	19	34
	Katampe	185	307	547
	Lokoja		70	125
	Shiroro	120	200	355
	Sokoto		112	200
Shiroro Total Allocation		**402**	**1022**	**1820**

[redacted]

Appendix D: Schedule of Power Plant

	Generation Station	Unit Size (MW)	1st Scenario (Base Case) (MW)	2nd Scenario (MW)	3rd Scenario (MW)
	OKPAI	3 x 178.5	298	535.5	535.5
	DELTA II	6 x 25	100	150	150
	DELTA III	6 x 25	0	150	150
	DELTA IV	6 x 100	238	600	600
	SAPELE ST	6 x 120	77	720	720
	EGBIN	6 x 220	1226	1320	1320
	AES	9 x 30	237.1	270	270
	JEBBA	6 x 95	415	570	570
	KAINJI (GT5 & GT6)	2 x 120	0	240	240
	KAINJI (GT7, 8, 9 & 10)	4 x 80	164	320	320
	KAINJI (GT11 & GT12)	2 x 100	126	200	200
	SHIRORO	6 x 150	530	600	600
	AFAM I-III (GT5 & GT6)	2 x 20	35	40	
	AFAM IV	6 x 100	52	600	
	AFAM V	2 x 138	276	276	276
EXISTING PLANTS	AJAOKUTA	2 x 55	0	60	60
	PAPALANTO PHASE 1	8 x 42		336	336
	OMOTOSO PHASE 1	8 x 42		336	336
	GEREGU PHASE 1	3 x 148		444	444
FGN PHASE I	ALAOJI PHASE 1	3 x 126		378	378
	CALABAR	5 x 113		565	565
	EGBEMA	3 x 113		339	339
	EYAEN	4 x 113		452	452
	GBARAN	2 x 113		226	226
	IKOT ABASI	3 x 113		339	339
	SAPELE	4 x 113		452	452
NIPP PLANTS	OMOKU	2 x 113		226	226
	GEREGU PHASE 2	3 x 148			444
	OMOTOSO PHASE 2	4 x 126			504
	PAPALANTO PHASE 2	4 x 126			504
FGN PHASE II	ALAOJI PHASE 2	1 x 126, 2 x 285			696
	ICS POWER	6 x 100			600
	SUPERTEK NIG.				1000
	ETHIOPE				2800
NEWLY LICENSED IPPs	FARM ELECTRIC				150
	AFAM VI (SHELL)	5 x 150			750
	BONNY(MOBIL)	3 x 130			390
	CHEVRON TEXACO	3 x 250			750
OIL MAJORS	TOTALFINALELF (1&2)	4 x 125			500
	Omoku Rivers State			100	100
	ALSCON	6 x 90		200	200
	IBOM POWER 1	2 x 38, 1 x 112		188	188
OTHER IPPs	IBOM POWER 2				500
	TOTAL		**3774.1**	**11232.5**	**20180.5**

Appendix E: Power Plant Data

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
OKPAI	GT1	GAS	ALSTOM	210	15.75+/-5%	0.85		0.19 +/- 10%		0.2		0.25+- 10%		0.4
	GT2	GAS	ALSTOM	210	15.75+/-5%	0.85		0.19 +/- 10%		0.2		0.25+- 10%		0.4
	ST1	STEAM		210	15.75+/-5%	0.85		0.19 +/- 10%		0.2		0.25+- 10%		0.4
DELTA I	GT1	GAS		45										
	GT2	GAS		45										
DELTA II	GT3	GAS	MEIDEN	29.725	11.5 +/-5%	0.8	0.13	0.15			0.19	0.21		
	GT4	GAS	MEIDEN	29.725	11.5 +/-5%	0.8	0.13	0.15			0.19	0.21		
	GT5	GAS	MEIDEN	29.725	11.5 +/-5%	0.8	0.13	0.15			0.19	0.21		
	GT6	GAS	MEIDEN	29.725	11.5 +/-5%	0.8	0.13	0.15			0.19	0.21		
	GT7	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT78	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
DELTA III	GT9	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT10	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT11	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT12	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT13	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
	GT14	GAS	SIEMENS	29.725	11.5 +/-5%	0.8	0.105	0.129	0.115	0.142	0.151	0.168	0.283	0.313
DELTA IV	GT15	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
	GT16	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
	GT17	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
	GT18	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
	GT19	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
	GT20	GAS	GE	133.75	11.5 +/-5%	0.85	0.171	0.226	0.166	0.223	0.241	0.319	0.542	0.542
SAPELE	ST1	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		
	ST2	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
	ST3	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		
	ST4	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		
	ST5	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		
	ST6	STEAM	BBC	133.97	15.75+/-5%	0.9	0.16	0.16			0.2	0.215		
	GT1	GAS	BBC	110	10.5+/-7.5%	0.8	0.133	0.154			0.2	0.21		
	GT2	GAS	BBC	110	10.5+/-7.5%	0.8	0.133	0.154			0.2	0.21		
	GT3	GAS	BBC	110	10.5+/-7.5%	0.8	0.133	0.154			0.2	0.21		
	GT4	GAS	BBC	110	10.5+/-7.5%	0.8	0.133	0.154			0.2	0.21		
EGBIN	ST1	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
	ST2	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
	ST3	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
	ST4	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
	ST5	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
	ST6	STEAM	HITACHI	245.8	16	0.9	0.23	0.28	0.23	0.28	0.26	0.31	0.45	0.5
AES	GT 1	GAS	GEC ALSTOM	38.6	10.5	0.8	0.105				0.2			
	GT 2	GAS	GEC ALSTOM	38.6	10.5	0.8	0.105				0.2			
	GT 3	GAS	GEC ALSTOM	38.6	10.5	0.8	0.105				0.2			
	GT 4	GAS	JOHN BROWN	39.54	10.5	0.8	0.105				0.2			
	GT 5	GAS	JOHN BROWN	39.54	10.5	0.8	0.105				0.2			
	GT 6	GAS	JOHN BROWN	39.54	10.5	0.8	0.105				0.2			
	GT 7	GAS	IUKA	40.5	10.5	0.9	0.105				0.2			

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
	GT 8	GAS	IUKA	40.5	10.5	0.9	0.105				0.2			
	GT 9	GAS	IUKA	40.5	10.5	0.9	0.105				0.2			
JEBBA	2G1	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
	2G2	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
	2G3	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
	2G4	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
	2G5	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
	2G6	HYDRO	HITACHI	119	16	0.85	0.24		0.24		0.26			
KAINJI	1G5	HYDRO	HITACHI	126	16	0.95	0.22		0.22		0.30			
	1G6	HYDRO	HITACHI	126	16	0.95	0.22		0.22		0.30			
	1G7	HYDRO	ASEA	85	16	0.95	0.22		0.22		0.30			
	1G8	HYDRO	ASEA	85	16	0.95	0.22		0.22		0.30			
	1G9	HYDRO	ASEA	85	16	0.95	0.22		0.22		0.30			

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
	1G10	HYDRO	ASEA	85	16	0.95	0.22		0.22		0.30			
	1G11	HYDRO	HITACHI	115	16	0.95	0.20		0.22		0.26			
	1G12	HYDRO	HITACHI	115	16	0.95	0.20		0.22		0.26			
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5	15.65	0.85	0.2	0.2	0.24	0.24	0.3	0.3	0.24	0.24
	UNIT2	HYDRO	RADE KONCAR	176.5	15.65	0.85	0.2	0.2	0.24	0.24	0.3	0.3	0.24	0.24
	UNIT3	HYDRO	RADE KONCAR	176.5	15.65	0.85	0.2	0.2	0.24	0.24	0.3	0.3	0.24	0.24
	UNIT4	HYDRO	RADE KONCAR	176.5	15.65	0.85	0.2	0.2	0.24	0.24	0.3	0.3	0.24	0.24
AFAM I	GT1	GAS	BBC	16	10.5 ±7.5	0.8		0.13				0.18		
	GT2	GAS	BBC	16	10.5 ±7.5	0.8		0.13				0.18		
	GT3	GAS	BBC	25	10.5 ±7.5	0.8		0.13				0.19		
	GT4	GAS	BBC	25	10.5 ±7.5	0.8		0.13				0.19		
AFAM II	GT5	GAS	BBC	30	10.5 ±7.5	0.8		0.12				0.21		
	GT6	GAS	BBC	30	10.5 ±7.5	0.8		0.12				0.21		
	GT7	GAS	BBC	30	10.5 ±7.5	0.8		0.12				0.21		
	GT8	GAS	BBC	30	10.5 ±7.5	0.8		0.12				0.21		
AFAM III	GT9	GAS	BBC	34	10.5 ±7.5	0.8		0.12				0.15		
	GT10	GAS	BBC	34	10.5 ±7.5	0.8		0.12				0.15		
	GT11	GAS	BBC	34	10.5 ±7.5	0.8		0.12				0.15		
	GT12	GAS	BBC	34	10.5 ±7.5	0.8		0.12				0.15		
AFAM IV	GT13	GAS	BBC	110	10.5 ±7.5	0.8		0.154				0.21		
	GT14	GAS	BBC	110	10.5 ±7.5	0.8		0.154				0.21		
	GT15	GAS	BBC	110	11.5± 5	0.8		0.137				0.211		
	GT16	GAS	BBC	110	11.5± 5	0.8		0.137				0.211		
	GT17	GAS	BBC	110	11.5± 5	0.8		0.137				0.211		
	GT18	GAS	BBC	110	11.5± 5	0.8		0.137				0.211		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
AFAM V	GT19	GAS	SIEMENS	162.69	15.75± 5	0.85	0.121				0.184			
	GT20	GAS	SIEMENS	162.69	15.75± 5	0.85	0.121				0.184			
PAPALANTO	GT1	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT2	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT3	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT4	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT5	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT6	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT7	GAS	CNME	48	10.5	0.8	0.148				0.22			
	GT8	GAS	CNME	48	10.5	0.8	0.148				0.22			
OMOTOSO	GT1	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT2	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT3	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT4	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT5	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT6	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT7	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
	GT8	GAS	NANJING	47.5	10.5+/-5%	0.8		0.17		0.17		0.231	0.231	
GEREGU	GT1	GAS	SIEMENS	174	15.75+/-5%	0.85	0.0121+/-15%				0.184+/-15%			
	GT2	GAS	SIEMENS	174	15.75+/-5%	0.85	0.0121+/-15%				0.184+/-15%			
	GT3	GAS	SIEMENS	174	15.75+/-5%	0.85	0.0121+/-15%				0.184+/-15%			
ALAOJI	GT1	GAS		141.25	15	0.85	0.132	0.164	0.16	0.195	0.19	0.231	0.23	0.33

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
	GT2	GAS		141.25	15	0.85	0.132	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	GT3	GAS		141.25	15	0.8	0.132	0.164	0.16	0.195	0.19	0.231	0.23	0.33
CALABAR	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT3	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT4	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT5	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
EGBEMA	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT3	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
EYAEN	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT3	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT4	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
GBARAN	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
IKOT ABASI	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	TERMINAL VOLTAGE (kV)	RATED P.F. (pu)	$X''_{d\ sat.}$ (pu)	$X''_{d\ unsat}$ (pu)	$X''_{q\ sat.}$ (pu)	$X''_{q\ unsat.}$ (pu)	$X'_{d\ sat.}$ (pu)	$X'_{d\ unsat.}$ (pu)	$X'_{q\ sat.}$ (pu)	$X'_{q\ unsat.}$ (pu)
	UNIT3	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
SAPELE	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT3	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT4	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
OMOKU	UNIT1	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33
	UNIT2	GAS	GE	141.25	15	0.8	0.13	0.164	0.16	0.195	0.19	0.231	0.23	0.33

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
OKPAI	GT1	GAS	ALSTOM	210		2.53		2.36		0.19		0.086		0.17
	GT2	GAS	ALSTOM	210		2.53		2.36		0.19		0.086		0.17
	ST1	STEAM		210		2.53		2.36		0.19		0.086		0.17
DELTA I	GT1	GAS		45										
	GT2	GAS		45										
DELTA II	GT3	GAS	MEIDEN	29.725	1.59	1.8								
	GT4	GAS	MEIDEN	29.725	1.59	1.8								
	GT5	GAS	MEIDEN	29.725	1.59	1.8								
	GT6	GAS	MEIDEN	29.725	1.59	1.8								
	GT7	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT78	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
DELTA III	GT9	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT10	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT11	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT12	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT13	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
	GT14	GAS	SIEMENS	29.725	1.34	1.44	1.16	1.37	0.11	0.136	0.096	0.07		0.105
DELTA IV	GT15	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
	GT16	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
	GT17	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
	GT18	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
	GT19	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
	GT20	GAS	GE	133.75	1.905	1.905	1.835	1.835	0.161	0.214	0.077	0.096		0.181
SAPELE	ST1	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13
	ST2	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13
	ST3	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13
	ST4	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
	ST5	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13
	ST6	STEAM	BBC	133.97	1.77	2.4				0.164		0.087		0.13
	GT1	GAS	BBC	110	1.77	2.17						0.083		0.13
	GT2	GAS	BBC	110	1.77	2.17						0.083		0.13
	GT3	GAS	BBC	110	1.77	2.17						0.083		0.13
	GT4	GAS	BBC	110	1.77	2.17						0.083		0.13
EGBIN	ST1	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
	ST2	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
	ST3	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
	ST4	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
	ST5	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
	ST6	STEAM	HITACHI	245.8	1.87	2	1.87	2		0.23		0.16		
AES	GT 1	GAS	GEC ALSTOM	38.6	1.76		1.62							
	GT 2	GAS	GEC ALSTOM	38.6	1.76		1.62							
	GT 3	GAS	GEC ALSTOM	38.6	1.76		1.62							
	GT 4	GAS	JOHN BROWN	39.54	1.76		1.62							
	GT 5	GAS	JOHN BROWN	39.54	1.76		1.62							
	GT 6	GAS	JOHN BROWN	39.54	1.76		1.62							
	GT 7	GAS	IUKA	40.5	1.76		1.62							
	GT 8	GAS	IUKA	40.5	1.76		1.62							
	GT 9	GAS	IUKA	40.5	1.76		1.62							
JEBBA	2G1	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
	2G2	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		
	2G3	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		
	2G4	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		
	2G5	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		
	2G6	HYDRO	HITACHI	119	0.69		0.48		0.24		0.15	0.24		
KAINJI	1G5	HYDRO	HITACHI	126	0.85		0.55		0.22		0.19			
	1G6	HYDRO	HITACHI	126	0.85		0.55		0.22		0.19			
	1G7	HYDRO	ASEA	85	0.85		0.55		0.22		0.19			
	1G8	HYDRO	ASEA	85	0.85		0.55		0.22		0.19			
	1G9	HYDRO	ASEA	85	0.85		0.55		0.22		0.19			
	1G10	HYDRO	ASEA	85	0.85		0.55		0.22		0.19			
	1G11	HYDRO	HITACHI	115	0.65		0.50		0.21		0.14			
	1G12	HYDRO	HITACHI	115	0.65		0.50		0.21		0.14			

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5	0.8	0.8	0.49	0.49	0.22	0.22	0.11	0.11		
	UNIT2	HYDRO	RADE KONCAR	176.5	0.8	0.8	0.49	0.49	0.22	0.22	0.11	0.11		
	UNIT3	HYDRO	RADE KONCAR	176.5	0.8	0.8	0.49	0.49	0.22	0.22	0.11	0.11		
	UNIT4	HYDRO	RADE KONCAR	176.5	0.8	0.8	0.49	0.49	0.22	0.22	0.11	0.11		
AFAM I	GT1	GAS	BBC	16		1.27		1.143						
	GT2	GAS	BBC	16		1.27		1.143						
	GT3	GAS	BBC	25		1.3		1.17						
	GT4	GAS	BBC	25		1.3		1.17						
AFAM II	GT5	GAS	BBC	30		2.25		2.025						
	GT6	GAS	BBC	30		2.25		2.025						
	GT7	GAS	BBC	30		2.25		2.025						
	GT8	GAS	BBC	30		2.25		2.025						
AFAM III	GT9	GAS	BBC	34		2.09		1.881						
	GT10	GAS	BBC	34		2.09		1.881						
	GT11	GAS	BBC	34		2.09		1.881						
	GT12	GAS	BBC	34		2.09		1.881						
AFAM IV	GT13	GAS	BBC	110		2.17						0.132		0.088
	GT14	GAS	BBC	110		2.17						0.132		0.088
	GT15	GAS	BBC	110		2.37						0.152		0.081
	GT16	GAS	BBC	110		2.37						0.152		0.081
	GT17	GAS	BBC	110		2.37						0.152		0.081
	GT18	GAS	BBC	110		2.37						0.152		0.081
AFAM V	GT19	GAS	SIEMENS	162.69	1.91									
	GT20	GAS	SIEMENS	162.69	1.91									
PAPALANTO	GT1	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT2	GAS	CNME	48	2.47	2		2		0.19		0.095		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
	GT3	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT4	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT5	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT6	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT7	GAS	CNME	48	2.47	2		2		0.19		0.095		
	GT8	GAS	CNME	48	2.47	2		2		0.19		0.095		
OMOTOSO	GT1	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT2	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT3	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT4	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT5	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT6	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT7	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
	GT8	GAS	NANJING	47.5		2.38		2.38		0.1941		0.103		0.137
GEREGU	GT1	GAS	SIEMENS	174		1.918+/-15%								
	GT2	GAS	SIEMENS	174		1.918+/-15%								
	GT3	GAS	SIEMENS	174		1.918+/-15%								
ALAOJI	GT1	GAS		141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	GT2	GAS		141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	GT3	GAS		141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
CALABAR	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
	UNIT3	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT4	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT5	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
EGBEMA	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT3	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
EYAEN	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT3	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT4	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
GBARAN	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
IKOT ABASI	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT3	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
SAPELE	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$X_{d\ sat.}$ (pu)	$X_{d\ unsat.}$ (pu)	$X_{q\ sat.}$ (pu)	$X_{q\ unsat.}$ (pu)	$X_{2\ sat.}$ (pu)	$X_{2\ unsat.}$ (pu)	$X_{0\ sat.}$ (pu)	$X_{0\ unsat.}$ (pu)	$X_{L\ sat.}$ (pu)	$X_{L\ unsat.}$ (pu)
	UNIT3	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT4	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
OMOKU	UNIT1	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119
	UNIT2	GAS	GE	141.25		1.82	1.35	1.66	0.129	0.16		0.08	0.078	0.119

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
OKPAI	GT1	GAS	ALSTOM	210	0.25		0.0026	0.015 at 95°C	0.0011at 95°C	1.291	188		0.46	0.021
	GT2	GAS	ALSTOM	210	0.25		0.0026	0.015 at 95°C	0.0011at 95°C	1.291	188		0.46	0.021
	ST1	STEAM		210	0.25		0.0026	0.015 at 95°C	0.0011at 95°C	1.291	188		0.46	0.021
DELTA I	GT1	GAS		45										
	GT2	GAS		45										
DELTA II	GT3	GAS	MEIDEN	29.725									0.5	
	GT4	GAS	MEIDEN	29.725									0.5	
	GT5	GAS	MEIDEN	29.725									0.5	
	GT6	GAS	MEIDEN	29.725									0.5	
	GT7	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT78	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
DELTA III	GT9	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT10	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT11	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT12	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT13	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
	GT14	GAS	SIEMENS	29.725						8.46	93.01		0.748	0.041
DELTA IV	GT15	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
	GT16	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
	GT17	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
	GT18	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
	GT19	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
	GT20	GAS	GE	133.75			0.004	0.018	0.007	0.004	0.016	9.62		0.032
SAPELE	ST1	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	
	ST2	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	
	ST3	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	
	ST4	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
	ST5	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	
	ST6	STEAM	BBC	133.97	0.322					2.21		1.18	0.51	
	GT1	GAS	BBC	110	0.13					0.92		1.41		
	GT2	GAS	BBC	110	0.13					0.92		1.41		
	GT3	GAS	BBC	110	0.13					0.92		1.41		
	GT4	GAS	BBC	110	0.13					0.92		1.41		
EGBIN	ST1	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
	ST2	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
	ST3	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
	ST4	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
	ST5	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
	ST6	STEAM	HITACHI	245.8	0.25	0.102	0.401 at 95 °C	5.72 at 95°C	8.09 at 95°C			6.5		0.93
AES	GT 1	GAS	GEC ALSTOM	38.6								3.1		
	GT 2	GAS	GEC ALSTOM	38.6								3.1		
	GT 3	GAS	GEC ALSTOM	38.6								3.1		
	GT 4	GAS	JOHN BROWN	39.54								3.1		
	GT 5	GAS	JOHN BROWN	39.54								3.1		
	GT 6	GAS	JOHN BROWN	39.54								3.1		
	GT 7	GAS	IUKA	40.5								3.1		
	GT 8	GAS	IUKA	40.5								3.1		
	GT 9	GAS	IUKA	40.5								3.1		
JEBBA	2G1	HYDRO	HITACHI	119	0.14					9.2	19			0.02

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
	2G2	HYDRO	HITACHI	119	0.14					9.2	19			0.02
	2G3	HYDRO	HITACHI	119	0.14					9.2	19			0.02
	2G4	HYDRO	HITACHI	119	0.14					9.2	19			0.02
	2G5	HYDRO	HITACHI	119	0.14					9.2	19			0.02
	2G6	HYDRO	HITACHI	119	0.14					9.2	19			0.02
KAINJI	1G5	HYDRO	HITACHI	126						6	175			0.02
	1G6	HYDRO	HITACHI	126						6	175			0.02
	1G7	HYDRO	ASEA	85						6	19			0.02
	1G8	HYDRO	ASEA	85						6	19			0.02
	1G9	HYDRO	ASEA	85						6	19			0.02
	1G10	HYDRO	ASEA	85						6	19			0.02
	1G11	HYDRO	HITACHI	115						9	19			0.02
	1G12	HYDRO	HITACHI	115						9	19			0.02

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5	0.16	0.15						3.24		0.0512
	UNIT2	HYDRO	RADE KONCAR	176.5	0.16	0.15						3.24		0.0512
	UNIT3	HYDRO	RADE KONCAR	176.5	0.16	0.15						3.24		0.0512
	UNIT4	HYDRO	RADE KONCAR	176.5	0.16	0.15						3.24		0.0512
AFAM I	GT1	GAS	BBC	16								8.2		0.03
	GT2	GAS	BBC	16								8.2		0.03
	GT3	GAS	BBC	25								9.3		
	GT4	GAS	BBC	25								9.3		
AFAM II	GT5	GAS	BBC	30								6.7		
	GT6	GAS	BBC	30								6.7		
	GT7	GAS	BBC	30								6.7		
	GT8	GAS	BBC	30								6.7		
AFAM III	GT9	GAS	BBC	34								6		
	GT10	GAS	BBC	34								6		
	GT11	GAS	BBC	34								6		
	GT12	GAS	BBC	34								6		
AFAM IV	GT13	GAS	BBC	110								6.0*	0.54	0.6*
	GT14	GAS	BBC	110								6.0*	0.54	0.6*
	GT15	GAS	BBC	110								6.0*	0.5	
	GT16	GAS	BBC	110								6.0*	0.5	
	GT17	GAS	BBC	110								6.0*	0.5	
	GT18	GAS	BBC	110								6.0*	0.5	
AFAM V	GT19	GAS	SIEMENS	162.69									0.63	
	GT20	GAS	SIEMENS	162.69									0.63	
PAPALANTO	GT1	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT2	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
	GT3	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT4	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT5	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT6	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT7	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
	GT8	GAS	CNME	48		0.137	0.0036 at 20 °C	0.132 at 20°C					0.46	
OMOTOSO	GT1	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT2	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT3	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT4	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT5	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT6	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT7	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
	GT8	GAS	NANJING	47.5						3.84	138.8	4	0.49	0.048
GEREGU	GT1	GAS	SIEMENS	174										
	GT2	GAS	SIEMENS	174										
	GT3	GAS	SIEMENS	174										
ALAOJI	GT1	GAS		141.25	0.196		0.0027 at 75 °C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	GT2	GAS		141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	GT3	GAS		141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
CALABAR	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
	UNIT3	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT4	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT5	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
EGBEMA	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT3	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
EYAEN	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT3	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT4	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
GBARAN	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
IKOT ABASI	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT3	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
SAPELE	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	X_p (pu)	X_c (pu)	R_1 (pu)	R_2 (pu)	R_0 (pu)	R_a (mΩ)	R_f (mΩ)	H constant (MWs/MVA)	D constant (MW/Hz)	$T''_{d0\ sat.}$ (s)
	UNIT3	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT4	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
OMOKU	UNIT1	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05
	UNIT2	GAS	GE	141.25	0.196		0.0027at 75°C	0.0188at 75°C	0.0041at 75°C	1.2	93	1.37	0.59	0.05

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
OKPAI	GT1	GAS	ALSTOM	210		0.032		0.016		0.016		10.12		0.93
	GT2	GAS	ALSTOM	210		0.032		0.016		0.016		10.12		0.93
	ST1	STEAM		210		0.032		0.016		0.016		10.12		0.93
DELTA I	GT1	GAS		45										
	GT2	GAS		45										
DELTA II	GT3	GAS	MEIDEN	29.725								5.46		
	GT4	GAS	MEIDEN	29.725								5.46		
	GT5	GAS	MEIDEN	29.725								5.46		
	GT6	GAS	MEIDEN	29.725								5.46		
	GT7	GAS	SIEMENS	29.725				0.031				5.87		
	GT78	GAS	SIEMENS	29.725				0.031				5.87		
DELTA III	GT9	GAS	SIEMENS	29.725				0.031				5.87		
	GT10	GAS	SIEMENS	29.725				0.031				5.87		
	GT11	GAS	SIEMENS	29.725				0.031				5.87		
	GT12	GAS	SIEMENS	29.725				0.031				5.87		
	GT13	GAS	SIEMENS	29.725				0.031				5.87		
	GT14	GAS	SIEMENS	29.725				0.031				5.87		
DELTA IV	GT15	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
	GT16	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
	GT17	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
	GT18	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
	GT19	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
	GT20	GAS	GE	133.75		0.075		0.023		0.023		3.713		0.352
SAPELE	ST1	STEAM	BBC	133.97				0.017				8.61		
	ST2	STEAM	BBC	133.97				0.017				8.61		
	ST3	STEAM	BBC	133.97				0.017				8.61		
	ST4	STEAM	BBC	133.97				0.017				8.61		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
	ST5	STEAM	BBC	133.97				0.017				8.61		
	ST6	STEAM	BBC	133.97				0.017				8.61		
	GT1	GAS	BBC	110				0.013				8.8		
	GT2	GAS	BBC	110				0.013				8.8		
	GT3	GAS	BBC	110				0.013				8.8		
	GT4	GAS	BBC	110				0.013				8.8		
EGBIN	ST1	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
	ST2	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
	ST3	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
	ST4	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
	ST5	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
	ST6	STEAM	HITACHI	245.8		0.11		0.055				7.1		1
AES	GT 1	GAS	GEC ALSTOM	38.6										
	GT 2	GAS	GEC ALSTOM	38.6										
	GT 3	GAS	GEC ALSTOM	38.6										
	GT 4	GAS	JOHN BROWN	39.54										
	GT 5	GAS	JOHN BROWN	39.54										
	GT 6	GAS	JOHN BROWN	39.54										
	GT 7	GAS	IUKA	40.5										
	GT 8	GAS	IUKA	40.5										
	GT 9	GAS	IUKA	40.5										
JEBBA	2G1	HYDRO	HITACHI	119								5.2		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
	2G2	HYDRO	HITACHI	119								5.2		
	2G3	HYDRO	HITACHI	119								5.2		
	2G4	HYDRO	HITACHI	119								5.2		
	2G5	HYDRO	HITACHI	119								5.2		
	2G6	HYDRO	HITACHI	119								5.2		
KAINJI	1G5	HYDRO	HITACHI	126								5.6		
	1G6	HYDRO	HITACHI	126								5.6		
	1G7	HYDRO	ASEA	85								5.6		
	1G8	HYDRO	ASEA	85								5.6		
	1G9	HYDRO	ASEA	85								5.6		
	1G10	HYDRO	ASEA	85								5.6		
	1G11	HYDRO	HITACHI	115								6.5		
	1G12	HYDRO	HITACHI	115								6.5		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5		0.34		0.266				5.57		
	UNIT2	HYDRO	RADE KONCAR	176.5		0.34		0.266				5.57		
	UNIT3	HYDRO	RADE KONCAR	176.5		0.34		0.266				5.57		
	UNIT4	HYDRO	RADE KONCAR	176.5		0.34		0.266				5.57		
AFAM I	GT1	GAS	BBC	16				6.5	0.39					
	GT2	GAS	BBC	16				6.5	0.39					
	GT3	GAS	BBC	25										
	GT4	GAS	BBC	25										
AFAM II	GT5	GAS	BBC	30										
	GT6	GAS	BBC	30										
	GT7	GAS	BBC	30										
	GT8	GAS	BBC	30										
AFAM III	GT9	GAS	BBC	34										
	GT10	GAS	BBC	34										
	GT11	GAS	BBC	34										
	GT12	GAS	BBC	34										
AFAM IV	GT13	GAS	BBC	110		0.013		8.8		0.8				
	GT14	GAS	BBC	110		0.013		8.8		0.8				
	GT15	GAS	BBC	110		0.025		5.3		0.46				
	GT16	GAS	BBC	110		0.025		5.3		0.46				
	GT17	GAS	BBC	110		0.025		5.3		0.46				
	GT18	GAS	BBC	110		0.025		5.3		0.46				
AFAM V	GT19	GAS	SIEMENS	162.69										
	GT20	GAS	SIEMENS	162.69										
PAPALANTO	GT1	GAS	CNME	48		10		0.03				10		
	GT2	GAS	CNME	48		10		0.03				10		

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
	GT3	GAS	CNME	48		10		0.03				10		
	GT4	GAS	CNME	48		10		0.03				10		
	GT5	GAS	CNME	48		10		0.03				10		
	GT6	GAS	CNME	48		10		0.03				10		
	GT7	GAS	CNME	48		10		0.03				10		
	GT8	GAS	CNME	48		10		0.03				10		
OMOTOSO	GT1	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT2	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT3	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT4	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT5	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT6	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT7	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
	GT8	GAS	NANJING	47.5		0.048		0.0535				10.2		10.2
GEREGU	GT1	GAS	SIEMENS	174										
	GT2	GAS	SIEMENS	174										
	GT3	GAS	SIEMENS	174										
ALAOJI	GT1	GAS		141.25		0.05		0.04		0.04		15.5		4.7
	GT2	GAS		141.25		0.05		0.04		0.04		15.5		4.7
	GT3	GAS		141.25		0.05		0.04		0.04		15.5		4.7
CALABAR	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT3	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
	UNIT4	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT5	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
EGBEMA	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT3	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
EYAEN	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT3	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT4	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
GBARAN	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
IKOT ABASI	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT3	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
SAPELE	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT3	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T''_{d0\ unsat.}$ (s)	$T''_{q0\ sat.}$ (s)	$T''_{q0\ unsat.}$ (s)	$T''_{d\ sat.}$ (s)	$T''_{d\ unsat.}$ (s)	$T''_{q\ sat.}$ (s)	$T''_{q\ unsat.}$ (s)	$T'_{d0\ sat.}$ (s)	$T'_{d0\ unsat.}$ (s)	$T'_{q0\ sat.}$ (s)
	UNIT4	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
OMOKU	UNIT1	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7
	UNIT2	GAS	GE	141.25		0.05		0.04		0.04		15.5		4.7

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
OKPAI	GT1	GAS	ALSTOM	210			0.99		0.16					
	GT2	GAS	ALSTOM	210			0.99		0.16					
	ST1	STEAM		210			0.99		0.16					
DELTA I	GT1	GAS		45										
	GT2	GAS		45										
DELTA II	GT3	GAS	MEIDEN	29.725										
	GT4	GAS	MEIDEN	29.725										
	GT5	GAS	MEIDEN	29.725										
	GT6	GAS	MEIDEN	29.725										
	GT7	GAS	SIEMENS	29.725			0.637							
	GT78	GAS	SIEMENS	29.725			0.637							
DELTA III	GT9	GAS	SIEMENS	29.725			0.637							
	GT10	GAS	SIEMENS	29.725			0.637							
	GT11	GAS	SIEMENS	29.725			0.637							
	GT12	GAS	SIEMENS	29.725			0.637							
	GT13	GAS	SIEMENS	29.725			0.637							
	GT14	GAS	SIEMENS	29.725			0.637							
DELTA IV	GT15	GAS	GE	133.75			0.47		0.352					
	GT16	GAS	GE	133.75			0.47		0.352					
	GT17	GAS	GE	133.75			0.47		0.352					
	GT18	GAS	GE	133.75			0.47		0.352					
	GT19	GAS	GE	133.75			0.47		0.352					
	GT20	GAS	GE	133.75			0.47		0.352					
SAPELE	ST1	STEAM	BBC	133.97			0.77							
	ST2	STEAM	BBC	133.97			0.77							
	ST3	STEAM	BBC	133.97			0.77							
	ST4	STEAM	BBC	133.97			0.77							

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
	ST5	STEAM	BBC	133.97			0.77							
	ST6	STEAM	BBC	133.97			0.77							
	GT1	GAS	BBC	110			0.8							
	GT2	GAS	BBC	110			0.8							
	GT3	GAS	BBC	110			0.8							
	GT4	GAS	BBC	110			0.8							
EGBIN	ST1	STEAM	HITACHI	245.8										
	ST2	STEAM	HITACHI	245.8										
	ST3	STEAM	HITACHI	245.8										
	ST4	STEAM	HITACHI	245.8										
	ST5	STEAM	HITACHI	245.8										
	ST6	STEAM	HITACHI	245.8										
AES	GT 1	GAS	GEC ALSTOM	38.6										
	GT 2	GAS	GEC ALSTOM	38.6										
	GT 3	GAS	GEC ALSTOM	38.6										
	GT 4	GAS	JOHN BROWN	39.54										
	GT 5	GAS	JOHN BROWN	39.54										
	GT 6	GAS	JOHN BROWN	39.54										
	GT 7	GAS	IUKA	40.5										
	GT 8	GAS	IUKA	40.5										
	GT 9	GAS	IUKA	40.5										
JEBBA	2G1	HYDRO	HITACHI	119			2							

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
	2G2	HYDRO	HITACHI	119			2							
	2G3	HYDRO	HITACHI	119			2							
	2G4	HYDRO	HITACHI	119			2							
	2G5	HYDRO	HITACHI	119			2							
	2G6	HYDRO	HITACHI	119			2							
KAINJI	1G5	HYDRO	HITACHI	126			2							
	1G6	HYDRO	HITACHI	126			2							
	1G7	HYDRO	ASEA	85			2							
	1G8	HYDRO	ASEA	85			2							
	1G9	HYDRO	ASEA	85			2							
	1G10	HYDRO	ASEA	85			2							
	1G11	HYDRO	HITACHI	115			2.6							
	1G12	HYDRO	HITACHI	115			2.6							

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5			2.089							
	UNIT2	HYDRO	RADE KONCAR	176.5			2.089							
	UNIT3	HYDRO	RADE KONCAR	176.5			2.089							
	UNIT4	HYDRO	RADE KONCAR	176.5			2.089							
AFAM I	GT1	GAS	BBC	16			Brush			Fixed			N/A	
	GT2	GAS	BBC	16			Brush			Fixed			N/A	
	GT3	GAS	BBC	25			Brush			Fixed			N/A	
	GT4	GAS	BBC	25			Brush			Fixed			N/A	
AFAM II	GT5	GAS	BBC	30			Brush			Fixed			N/A	
	GT6	GAS	BBC	30			Brush			Fixed			N/A	
	GT7	GAS	BBC	30			Brush			Fixed			N/A	
	GT8	GAS	BBC	30			Brush			Fixed			N/A	
AFAM III	GT9	GAS	BBC	34			Brush			Fixed			N/A	
	GT10	GAS	BBC	34			Brush			Fixed			N/A	
	GT11	GAS	BBC	34			Brush			Fixed			N/A	
	GT12	GAS	BBC	34			Brush			Fixed			N/A	
AFAM IV	GT13	GAS	BBC	110		0.36	Brush	N62-P		Fixed			N/A	
	GT14	GAS	BBC	110		0.36	Brush	N62-P		Fixed			N/A	
	GT15	GAS	BBC	110			Brush			Fixed				
	GT16	GAS	BBC	110			Brush			Fixed				
	GT17	GAS	BBC	110			Brush			Fixed				
	GT18	GAS	BBC	110			Brush			Fixed				
AFAM V	GT19	GAS	SIEMENS	162.69			Brush			Fixed				
	GT20	GAS	SIEMENS	162.69			Brush			Fixed				
PAPALANTO	GT1	GAS	CNME	48			0.7							
	GT2	GAS	CNME	48			0.7							

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
	GT3	GAS	CNME	48			0.7							
	GT4	GAS	CNME	48			0.7							
	GT5	GAS	CNME	48			0.7							
	GT6	GAS	CNME	48			0.7							
	GT7	GAS	CNME	48			0.7							
	GT8	GAS	CNME	48			0.7							
OMOTOSO	GT1	GAS	NANJING	47.5			0.574							
	GT2	GAS	NANJING	47.5			0.574							
	GT3	GAS	NANJING	47.5			0.574							
	GT4	GAS	NANJING	47.5			0.574							
	GT5	GAS	NANJING	47.5			0.574							
	GT6	GAS	NANJING	47.5			0.574							
	GT7	GAS	NANJING	47.5			0.574							
	GT8	GAS	NANJING	47.5			0.574							
GEREGU	GT1	GAS	SIEMENS	174										
	GT2	GAS	SIEMENS	174										
	GT3	GAS	SIEMENS	174										
ALAOJI	GT1	GAS		141.25			1.29		0.65					
	GT2	GAS		141.25			1.29		0.65					
	GT3	GAS		141.25			1.29		0.65					
CALABAR	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
	UNIT3	GAS	GE	141.25			1.29		0.65					

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
	UNIT4	GAS	GE	141.25			1.29		0.65					
	UNIT5	GAS	GE	141.25			1.29		0.65					
EGBEMA	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
	UNIT3	GAS	GE	141.25			1.29		0.65					
EYAEN	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
	UNIT3	GAS	GE	141.25			1.29		0.65					
	UNIT4	GAS	GE	141.25			1.29		0.65					
GBARAN	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
IKOT ABASI	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
	UNIT3	GAS	GE	141.25			1.29		0.65					
SAPELE	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					
	UNIT3	GAS	GE	141.25			1.29		0.65					

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T'_{q0\ unsat.}$ (s)	$T'_{d\ sat.}$ (s)	$T'_{d\ unsat.}$ (s)	$T'_{q\ sat.}$ (s)	$T'_{q\ unsat.}$ (s)	$T_{d0\ sat.}$ (s)	$T_{d0\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	$T_{d\ sat.}$ (s)
	UNIT4	GAS	GE	141.25			1.29		0.65					
OMOKU	UNIT1	GAS	GE	141.25			1.29		0.65					
	UNIT2	GAS	GE	141.25			1.29		0.65					

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
OKPAI	GT1	GAS	ALSTOM	210				0.54	Brush		5%	Fixed	
	GT2	GAS	ALSTOM	210				0.54	Brush		5%	Fixed	
	ST1	STEAM		210				0.54	Brush		5%	Fixed	
DELTA I	GT1	GAS		45									
	GT2	GAS		45									
DELTA II	GT3	GAS	MEIDEN	29.725					Brushless		4%	Fixed	
	GT4	GAS	MEIDEN	29.725					Brushless		4%	Fixed	
	GT5	GAS	MEIDEN	29.725					Brushless		4%	Fixed	
	GT6	GAS	MEIDEN	29.725					Brushless		4%	Fixed	
	GT7	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT78	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
DELTA III	GT9	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT10	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT11	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT12	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT13	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
	GT14	GAS	SIEMENS	29.725				0.145	Brush		4%	Fixed	
DELTA IV	GT15	GAS	GE	133.75				0.285	Brush		4%	Fixed	
	GT16	GAS	GE	133.75				0.285	Brush		4%	Fixed	
	GT17	GAS	GE	133.75				0.285	Brush		4%	Fixed	
	GT18	GAS	GE	133.75				0.285	Brush		4%	Fixed	
	GT19	GAS	GE	133.75				0.285	Brush		4%	Fixed	
	GT20	GAS	GE	133.75				0.285	Brush		4%	Fixed	
SAPELE	ST1	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230
	ST2	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230
	ST3	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230
	ST4	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
	ST5	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230
	ST6	STEAM	BBC	133.97				0.36	Brush		5.50%	Fixed	2230
	GT1	GAS	BBC	110									
	GT2	GAS	BBC	110									
	GT3	GAS	BBC	110									
	GT4	GAS	BBC	110									
EGBIN	ST1	STEAM	HITACHI	245.8				0.54					
	ST2	STEAM	HITACHI	245.8				0.54					
	ST3	STEAM	HITACHI	245.8				0.54					
	ST4	STEAM	HITACHI	245.8				0.54					
	ST5	STEAM	HITACHI	245.8				0.54					
	ST6	STEAM	HITACHI	245.8				0.54					
AES	GT 1	GAS	GEC ALSTOM	38.6									
	GT 2	GAS	GEC ALSTOM	38.6									
	GT 3	GAS	GEC ALSTOM	38.6									
	GT 4	GAS	JOHN BROWN	39.54									
	GT 5	GAS	JOHN BROWN	39.54									
	GT 6	GAS	JOHN BROWN	39.54									
	GT 7	GAS	IUKA	40.5									
	GT 8	GAS	IUKA	40.5									
	GT 9	GAS	IUKA	40.5									
JEBBA	2G1	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
	2G2	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	
	2G3	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	
	2G4	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	
	2G5	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	
	2G6	HYDRO	HITACHI	119				0.23	Brush	Elektron-Turbinenregler	4%	Both	
KAINJI	1G5	HYDRO	HITACHI	126				0.26	Brush	Voist-Alpine		Fixed	
	1G6	HYDRO	HITACHI	126				0.26	Brush	Voist-Alpine		Fixed	
	1G7	HYDRO	ASEA	85				0.26	Brush	HPC642,Electronic-Auto	0.02-0.1	Both	
	1G8	HYDRO	ASEA	85				0.26	Brush	HPC642,Electronic-Auto	0.02-0.1	Both	
	1G9	HYDRO	ASEA	85				0.26	Brush	HPC642,Electronic-Auto	0.02-0.1	Both	
	1G10	HYDRO	ASEA	85				0.26	Brush	HPC642,Electronic-Auto	0.02-0.1	Both	
	1G11	HYDRO	HITACHI	115				0.2	Brush	See remarks	0.02-0.2	Both	
	1G12	HYDRO	HITACHI	115				0.2	Brush	See remarks	0.02-0.2	Both	

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
SHIRORO	UNIT1	HYDRO	RADE KONCAR	176.5					Brushless	EGC 79	5%	Free	
	UNIT2	HYDRO	RADE KONCAR	176.5					Brushless	EGC 79	5%	Free	
	UNIT3	HYDRO	RADE KONCAR	176.5					Brushless	EGC 79	5%	Free	
	UNIT4	HYDRO	RADE KONCAR	176.5					Brushless	EGC 79	5%	Free	
AFAM I	GT1	GAS	BBC	16									
	GT2	GAS	BBC	16									
	GT3	GAS	BBC	25									
	GT4	GAS	BBC	25									
AFAM II	GT5	GAS	BBC	30									
	GT6	GAS	BBC	30									
	GT7	GAS	BBC	30									
	GT8	GAS	BBC	30									
AFAM III	GT9	GAS	BBC	34									
	GT10	GAS	BBC	34									
	GT11	GAS	BBC	34									
	GT12	GAS	BBC	34									
AFAM IV	GT13	GAS	BBC	110									
	GT14	GAS	BBC	110									
	GT15	GAS	BBC	110									
	GT16	GAS	BBC	110									
	GT17	GAS	BBC	110									
	GT18	GAS	BBC	110									
AFAM V	GT19	GAS	SIEMENS	162.69									
	GT20	GAS	SIEMENS	162.69									
PAPALANTO	GT1	GAS	CNME	48									
	GT2	GAS	CNME	48									

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
	GT3	GAS	CNME	48									
	GT4	GAS	CNME	48									
	GT5	GAS	CNME	48									
	GT6	GAS	CNME	48									
	GT7	GAS	CNME	48									
	GT8	GAS	CNME	48									
OMOTOSO	GT1	GAS	NANJING	47.5				0.036	Brushless				
	GT2	GAS	NANJING	47.5				0.036	Brushless				
	GT3	GAS	NANJING	47.5				0.036	Brushless				
	GT4	GAS	NANJING	47.5				0.036	Brushless				
	GT5	GAS	NANJING	47.5				0.036	Brushless				
	GT6	GAS	NANJING	47.5				0.036	Brushless				
	GT7	GAS	NANJING	47.5				0.036	Brushless				
	GT8	GAS	NANJING	47.5				0.036	Brushless				
GEREGU	GT1	GAS	SIEMENS	174					Brush				
	GT2	GAS	SIEMENS	174					Brush				
	GT3	GAS	SIEMENS	174					Brush				
ALAOJI	GT1	GAS		141.25									
	GT2	GAS		141.25									
	GT3	GAS		141.25									
CALABAR	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
	UNIT3	GAS	GE	141.25									

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
	UNIT4	GAS	GE	141.25									
	UNIT5	GAS	GE	141.25									
EGBEMA	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
	UNIT3	GAS	GE	141.25									
EYAEN	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
	UNIT3	GAS	GE	141.25									
	UNIT4	GAS	GE	141.25									
GBARAN	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
IKOT ABASI	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
	UNIT3	GAS	GE	141.25									
SAPELE	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									
	UNIT3	GAS	GE	141.25									

STATION	NOMEN-CLATURE	TYPE	MAKE	RATING (MVA)	$T_{d\ unsat.}$ (s)	$T_{q0\ sat.}$ (s)	$T_{q0\ unsat.}$ (s)	Ta (s)	Excitation Type	Governor Type	Droop Setting	Fixed / Free	Heat Rate (kcal/kWh)
	UNIT4	GAS	GE	141.25									
OMOKU	UNIT1	GAS	GE	141.25									
	UNIT2	GAS	GE	141.25									

[redacted]

Appendix F: Schedule of Generator Transformers

STATION	NOMEN-CLATURE	RATING		COOLING	VECTOR GROUP
		POWER	VOLTAGE		
		MVA	kV		
DELTA	T4	54/72/81	138/11.5/11.5/11.5	OA/FA/FA	Yd
"	T5	45/81	138/11.5/11.5/11.5	ONAN/ONAF	YNddd1
"	T6	54/72/81	138/11.5/11.5/11.5	OA/FA/FA	YNddd1
DELTA IV	GT15	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
"	GT16	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
"	GT17	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
"	GT18	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
"	GT19	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
"	GT20	72/96/120	345/11.5	ONAN/ONAF /ONAF	YNd1
DELTA	Interbus	90/120/150	330/132	ONAN/ONAF /ONAF	YNa0d1
SAPELE	T1	90/140	345/15.75	ONAN/ONAF	YNd1
"	T2	90/140	345/15.75	ONAN/ONAF	YNd1
"	T3	90/140	345/15.75	ONAN/ONAF	YNd1
"	T6	90/140	345/15.75	ONAN/ONAF	YNd1
"	T4	105/14O	345/15.75	ONAN/ONAF	YNd1
"	T 5	105/14O	345/15.75	ONAN/ONAF	YNd1
"	T9	126/168.5	345/10.5	ONAN/ONAF	YNd1d1
"	T10	126/168.5	345/10.5	ONAN/ONAF	YNd1d1
OKPAI	GT1	140/205	330/15.75	ONAN/ONAF	YNd11
"	GT2	140/205	330/15.75	ONAN/ONAF	YNd11

STATION	NOMEN-CLATURE	RATING		COOLING	VECTOR GROUP
		POWER	VOLTAGE		
		MVA	kV		
"	GT3	140/205	330/15.75	ONAN/ONAF	YNd11
"	GT4	140/205	330/15.75	ONAN/ONAF	YNd11
AFAM PS	GT13	109/168	10.5/345	ONAN/ONAF	YNd1/d1
"	GT14	109/168	10.5/345	ONAN/ONAF	YNd1/d1
"	GT15	109/168	10.5/345	ONAN/ONAF	YNd1/d1
"	GT16	109/168	10.5/345	ONAN/ONAF	YNd1/d1
"	GT17	109/168	10.5/345	ONAN/ONAF	YNd1/d1
"	GT18	109/168	10.5/345	ONAN/ONAF	YNd1/d1
	GT19	163	15.7/345	ODAF	YNd11
"	GT20	163	15.7/345	ODAF	YNd11
"	Interbus	162	330/132	ONAN/ONAF	
JEBBA GS	T1	119	16/330	*ODWF*	YNd1
"	T2	119	16/330	*ODWF*	YNd1
"	T3	119	16/330	*ODWF*	YNd1
"	T4	119	16/330	*ODWF*	YNd1
"	T5	119	16/330	*ODWF*	YNd1
"	T6	119	16/330	*ODWF*	YNd1
KAINJI GS	T5	145	16/330	*FOW*	YNd1
"	T6	145	16/330	*FOW*	YNd1
"	T7	184	16/330	OFAF	YNd1
"	T8				
"	T9	183.6	16/330	OFW	YNd1
"	T10				
"	T11	115	16/330	*FOW*	YNd1
"	T12	115	16/330	*FOW*	YNd1
Shiroro GS	411G1	200	15.2/330	OFWF	YNd1
"	411G2	200	15.2/330	OFWF	YNd1
"	411G3	200	15.2/330	OFWF	YNd1
"	411G4	200	15.2/330	OFWF	YNd1
EGBIN G.S	GT1	270	16/330	*ONAN/ONAF*	YNd1
"	GT2	270	16/330	*ONAN/ONAF*	YNd1

STATION	NOMEN-CLATURE	RATING		COOLING	VECTOR GROUP
		POWER	VOLTAGE		
		MVA	kV		
"	GT3	270	16/330	*ONAN/ONAF*	YNd1
"	GT4	270	16/330	*ONAN/ONAF*	YNd1
"	GT5	270	16/330	*ONAN/ONAF*	YNd1
"	GT6	270	16/330	*ONAN/ONAF*	YNd1
	GT1	60	10.5/132	*ONAN/ONAF*	YNd1
	GT2	40	11.5/132	*ONAN/ONAF*	YNd1
	GT3	40	11.5/132	*ONAN/ONAF*	YNd1
AES	GT4	40	11.5/132	*ONAN/ONAF*	YNd1
EGBIN	Interbus 1	150	330/132/33	ONAN/OFAF	YyOd1
GEREGU	GT1	168	345/15.75	ODAF	YNd11
"	GT2	168	345/15.75	ODAF	YNd11
"	GT3	168	345/15.75	ODAF	YNd11
OMOTOSHO	T1	105	346.5/10.5	ODAF	YNd1
"	T2	105	346.5/10.5	ODAF	YNd1
"	T3	105	346.5/10.5	ODAF	YNd1
"	T4	105	346.5/10.5	ODAF	YNd1
"	Interbus 2	150	330/132/33	ONAN/OFAF	YyOd1
PAPALANTO	GT1	346.5	10.5/330	*ODAF*	YNd1
"	GT2	346.5	10.5/330	*ODAF*	YNd1
"	GT3	346.5	10.5/330	*ODAF*	YNd1
"	GT4	346.5	10.5/330	*ODAF*	YNd1
ALAOJI		102/136/170	15/330kV		
Gbaran NIPP	GT1	90/143	139/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	139/15	*ONAN/ONAF*	YNd1
Calabar	GT1	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT3	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT4	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT5	90/143	343/15	*ONAN/ONAF*	YNd1
Egbema	GT1	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	343/15	*ONAN/ONAF*	YNd1

STATION	NOMEN-CLATURE	RATING		COOLING	VECTOR GROUP
		POWER	VOLTAGE		
		MVA	kV		
"	GT3	90/143	343/15	*ONAN/ONAF*	YNd1
Ihovbor	GT1	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT3	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT4	90/143	343/15	*ONAN/ONAF*	YNd1
Ikot Abasi	T1	90/143	343/15	*ONAN/ONAF*	YNd1
"	T2	90/143	343/15	*ONAN/ONAF*	YNd1
"	T3	90/143	343/15	*ONAN/ONAF*	YNd1
Sapele	GT1	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT3	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT4	90/143	343/15	*ONAN/ONAF*	YNd1
Omoku	GT1	90/143	343/15	*ONAN/ONAF*	YNd1
"	GT2	90/143	343/15	*ONAN/ONAF*	YNd1

Appendix G: Schedule of Transmission Lines

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
1	ALAOJI - ONITSHA	T4A	138	SC	BISON	2	760	363	300
	ONITSHA - ALAOJI	T4A	138	SC	BISON	2	760	363	300
2	ALAOOJI - AFAM*	F1A & F2A	25	DC	BISON	2	2x760	363	300
	AFAM - ALAOJI*	F1A & F2A	25	DC	BISON	2	2x760	363	300
3	NEW HAVEN - ONITSHA	T3H	96	SC	BISON	2	760	363	300
	ONITSHA - NEW HAVEN	T3H	96	SC	BISON	2	760	363	300
4	ONITSHA - OKPAI*		80	DC	BISON	2	2x760	363	300
	OKPAI - ONITSHA *		80	DC	BISON	2	2x760	363	300
5	BENIN - OSOGBO	H7B	251	SC	BISON	2	760	363	300
	OSOGB - BENIN	H7B	251	SC	BISON	2	760	363	300
6	BENIN - ONITSHA	B1T	137	SC	BISON	2	760	363	300
	ONITSHA - BENIN	B1T	137	SC	BISON	2	760	363	300
7	BENIN - SAPELE	S3B & S4B	50	DC	BISON	2	2x760	363	300
	SAPELE - BENIN	S3B & F4A	50	DC	BISON	2	2x760	363	300
	BENIN - SAPELE	S5B	50	SC	BISON	2	760	363	300
	SAPELE - BENIN	S5B	50	SC	BISON	2	760	363	300
8	BENIN - DELTA*	G3B	107	SC	BISON	2	760	363	300
	DELTA - BENIN*	G3B	107	SC	BISON	2	760	363	300
9	BENIN - AJAOKUTA	B12J	195	SC	BISON	2	760	363	300
	AJAOOKUTA - BENIN	B12J	195	SC	BISON	2	760	363	300
	BENIN - AJAOKUTA	B11J	195	SC	BISON	2	760	363	300
	AJAOKUTA - BENIN	B11J	195	SC	BISON	2	760	363	300
10	SAPELE - ALADJA	S4W	63	SC	BISON	2	760	363	300
	ALADJA - SAPELE	S4W	63	SC	BISON	2	760	363	300
11	DELTA - ALADJA*	G1W	32	SC	BISON	2	760	363	300

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
	ALADJA - DELTA*	G1W	32	SC	BISON	2	760	363	300
12	IKEJA WEST - BENIN	B5W & B6W	280	DC	BISON	2	2x760	363	300
	BENIN - IKEJA WEST	B5W & B6W	280	DC	BISON	2	2x760	363	300
13	IKEJA WEST - EGBIN	N7W & N8W	62	DC	BISON	2	2x760	363	300
	EGBIN - IKEJA WEST	N7W & N8W	62	DC	BISON	2	2x760	363	300
14	IKEJA WEST - OSOGBO*	H1W	252	SC	BISON	2	760	363	300
	OSOGB - IKEJA WEST*	H1W	252	SC	BISON	2	760	363	300
15	IKEJA WEST - AYEDE*	W2A	137	SC	BISON	2	760	363	300
	AYEDE - IKEJA WEST*	W2A	137	SC	BISON	2	760	363	300
16	IKEJA WEST - AKANGBA*	W4L	18	SC	BISON	2	760	363	300
	AKANGBA - IKEJA WEST*	W4L	18	SC	BISON	2	760	363	300
	IKEJA WEST - AKANGBA*	W5L	18	SC	BISON	2	760	363	300
	AKANGBA - IKEJA WEST*	W5L	18	SC	BISON	2	760	363	300
17	EGBIN - AJA*	N1J & N2J	14	DC	BISON	2	2x760	363	300
	AJA - EGBIN*	N1J & N2J	14	DC	BISON	2	2x760	363	300
18	OSOGBO - JEBBA	J1H	157	SC	BISON	2	760	363	300
	JEBBA - OSOGBO	J1H	157	SC	BISON	2	760	363	300
	OSOGBO - JEBBA	J2H	157	SC	BISON	2	760	363	300
	JEBBA - OSOGBO	J2H	157	SC	BISON	2	760	363	300
	OSOGBO - JEBBA	J3H	157	SC	BISON	2	760	363	300
	JEBBA - OSOGBO	J3H	157	SC	BISON	2	760	363	300
19	OSOGBO - AYEDE	H2A	115	SC	BISON	2	760	363	300
	AYEDE - OSOGBO	H2A	115	SC	BISON	2	760	363	300
20	KADUNA - SHIRORO	R1M	96	SC	BISON	2	760	363	300
	SHIRORO - KADUNA	R1M	96	SC	BISON	2	760	363	300
	KADUNA - SHIRORO	R2M	96	SC	BISON	2	760	363	300
	SHIRORO - KADUNA	R2M	96	SC	BISON	2	760	363	300
21	KADUNA - JOS	M2S	197	SC	BISON	2	760	363	300
	JOS - KADUNA	M2S	197	SC	BISON	2	760	363	300

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
22	KADUNA - KANO*	M6N	230	SC	BISON	2	760	363	300
	KANO - KADUNA*	M6N	230	SC	BISON	2	760	363	300
23	JOS - GOMBE	SIE	265	SC	BISON	2	760	363	300
	GOMBE - JOS	SIE	265	SC	BISON	2	760	363	300
24	SHIRORO - KATAMPE*	R4B & R5B	144	DC	BISON	2	2x760	363	300
	KATAMPE - SHIRORO*	R4B & R5B	144	DC	BISON	2	2x760	363	300
25	SHIRORO - JEBBA*	J3R	244	SC	BISON	2	760	363	300
	JEBBA - SHIRORO*	J3R	244	SC	BISON	2	760	363	300
	SHIRORO - JEBBA*	J7R	244	SC	BISON	2	760	363	300
	JEBBA - SHIRORO*	J7R	244	SC	BISON	2	760	363	300
26	BIRNIN KEBBI - KAINJI	K3R	310	SC	BISON	2	760	363	300
	KAINJI - BIRNIN KEBBI	K3R	310	SC	BISON	2	760	363	300
27	JEBBA GS - JEBBA TS	B8J & B9J	8	DC	BISON	2	2x760	363	300
	JEBBA TS - JEBBA GS	B8J & B9J	8	DC	BISON	2	2x760	363	300
28	KAINJI - JEBBA	K1J	81	SC	BISON	2	760	363	300
	JEBBA - KAINJI	K1J	81	SC	BISON	2	760	363	300
29	KAINJI - JEBBA	K2J	81	SC	BISON	2	760	363	300
30	JEBBA - KAINJI	K2J	81	SC	BISON	2	760	363	300
	AFAM - PORT HARCOURT (ONNE)	F1N	45	DC	BISON	2	2x760	363	300
	PORT HARCOURT (ONNE) - AFAM	F1N	45	DC	BISON	2	2x760	363	300
	ALAOJI - IKOT EKPENE		38	DC	BISON	2	2x760	363	300
	IKOT EKPENE - ALAOJI		38	DC	BISON	2	2x760	363	300
	IKOT EKPENE - CALABAR		72	DC	BISON	2	2x760	363	300
	CALABAR - IKOT EKPENE		72	DC	BISON	2	2x760	363	300
	2ND BENIN - ONITSHA	B1T2	137	SC	BISON	2	760	363	300
	ONITSHA - BENIN	B1T2	137	SC	BISON	2	760	363	300
	IKEJA WEST - EGBIN	B5W1	62	SC	BISON	2	760	363	300
	EGBIN - IKEJA WEST	B5W1	62	SC	BISON	2	760	363	300
	BENIN - EGBIN	B5W2	218	SC	BISON	2	760	363	300
	EGBIN - BENIN	B5W2	218	SC	BISON	2	760	363	300

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
	GOMBE - YOLA		217	SC	BISON	2	760	363	300
	YOLA - GOMBE		217	SC	BISON	2	760	363	300
	YOLA - JALINGO		132	SC	BISON	2	760	363	300
	JALINGO - YOLA		132	SC	BISON	2	760	363	300
	AYEDE - PAPALANTO	W2A1	60	SC	BISON	2	760	363	300
	PAPALANTO - AYEDE	W2A1	60	SC	BISON	2	760	363	300
	IKEJA WEST - PAPALANTO	W2A2	30	SC	BISON	2	760	363	300
	PAPALANTO - IKEJA WEST	W2A2	30	SC	BISON	2	760	363	300
	IKEJA WEST - OMOTOSO	B6W1	160	SC	BISON	2	760	363	300
	OMOTOSO - IKEJA WEST	B6W1	160	SC	BISON	2	760	363	300
	BENIN - OMOTOSO	B6W2	120	SC	BISON	2	760	363	300
	OMOTOSHO - BENIN	B6W2	120	SC	BISON	2	760	363	300
	GEREGU - AJAOKUTA		5	DC	BISON	2	2x760	363	300
	AJAOKUTA - GEREGU		5	DC	BISON	2	2x760	363	300
	GOMBE - DAMATURU		135	SC	BISON	2	760	363	300
	DAMATURU - GOMBE		135	SC	BISON	2	760	363	300
	DAMATURU - MAIDUGURI		140	SC	BISON	2	760	363	300
	MAIDUGURI - DAMATURU		140	SC	BISON	2	760	363	300
	IKEJA WEST - SAKETE		70	SC	BISON	2	760	363	300
	SAKETE - IKEJA WEST		70	SC	BISON	2	760	363	300
	JOS - MAKURDI	S1K	230	DC	BISON	2	2x760	363	300
	MAKURDI - JOS	S1K	230	DC	BISON	2	2x760	363	300
	MAKURDI - ALIADE	D1M	50	DC	BISON	2	2x760	363	300
	ALIADE - MAKURDI	D1M	50	DC	BISON	2	2x760	363	300
	NEW HAVEN SOUTH - ALIADE	S1D	150	DC	BISON	2	2x760	363	300
	ALIADE - NEW HAVEN SOUTH	S1D	150	DC	BISON	2	2x760	363	300
	IKOT EKPENE - NEW HAVEN SOUTH	K1S	143	DC	BISON	2	2x760	363	300
	NEW HAVEN SOUTH - IKOT EKPENE	K1S	143	DC	BISON	2	2x760	363	300
	IKOT EKPENE - NEW HAVEN SOUTH	K1S	143	DC	BISON	2	2x760	363	300
	NEW HAVEN SOUTH - IKOT	K1S	143	DC	BISON	2	2x760	363	300

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
	EKPENE								
	NEW HAVEN SOUTH - NEW HAVEN		5	DC	BISON	2	2x760	363	300
	NEW HAVEN - NEW HAVEN SOUTH		5	DC	BISON	2	2x760	363	300
	AFAM - IKOT EKPENE		90	DC	BISON	2	2x760	363	300
	IKOT EKPENE - AFAM		90	DC	BISON	2	2x760	363	300
	OWERRI - ALAOJI	A1W	60	DC	BISON	2	2x760	363	300
	ALAOJI - OWERRI	A1W	60	DC	BISON	2	2x760	363	300
	OWERRI - ONITSHA	W1T	75	DC	BISON	2	2x760	363	300
	ONITSHA - OWERRI	W1T	75	DC	BISON	2	2x760	363	300
	EGBEMA - OMOKU	O1G	30	DC	BISON	2	2x760	363	300
	OMOKU - EGBEMA	O1G	30	DC	BISON	2	2x760	363	300
	OWERRI - EGBEMA	G1W	30	DC	BISON	2	2x760	363	300
	EGBEMA - OWERRI	G1W	30	DC	BISON	2	2x760	363	300
	OSOGBO - GANMO	J7H2	87	SC	BISON	2	760	363	300
	GANMO - OSOGBO	J7H2	87	SC	BISON	2	760	363	300
	JEBBA - GANMO	J7H1	70	SC	BISON	2	760	363	300
	GANMO - JEBBA	J7H1	70	SC	BISON	2	760	363	300
	AJAOKUTA - LOKOJA	J1A	38	DC	BISON	2	2x760	363	300
	LOKOJA - AJAOKUTA	J1A	38	DC	BISON	2	2x760	363	300
	LOKOJA - GWAGWALADA	A1G	140	DC	BISON	2	2x760	363	300
	GWAGWALADA - LOKOJA	A1G	140	DC	BISON	2	2x760	363	300
	IKEJA WEST - ERUNKAN	N8W1	32	SC	BISON	2	760	363	300
	ERUNKAN - IKEJA WEST	N8W1	32	SC	BISON	2	760	363	300
	EGBIN - ERUNKAN	N8W2	30	SC	BISON	2	760	363	300
	ERUNKAN - EGBIN	N8W2	30	SC	BISON	2	760	363	300
	IKOT ABASI - IKOT EKPENE		75	DC	BISON	2	2x760	363	300
	IKOT EKPENE - IKOT ABASI		75	DC	BISON	2	2x760	363	300
	BENIN - BENIN NORTH	B1N	20	SC	BISON	2	2x760	363	300
	BENIN NORTH - BENIN	B1N	20	SC	BISON	2	2x760	363	300
	BENIN - BENIN NORTH	B11J1	20	SC	BISON	2	2x760	363	300

S/N	NAME	NOMEN-CLATURE	LENGTH (km)	TYPE (DC/SC)	CONDUCTOR NAME	CONDUCTORS PER PHASE	THERMAL RATING (MVA)	SIL (MW)	Zc (Ω)
	BENIN NORTH - BENIN	B11J1	20	SC	BISON	2	2x760	363	300
	BENIN - BENIN NORTH	B12J1	20	SC	BISON	2	2x760	363	300
	BENIN NORTH - BENIN	B12J1	20	SC	BISON	2	2x760	363	300
	BENIN NORTH - AJAOKUTA	B11J2	195	SC	BISON	2	2x760	363	300
	AJAOKUTA - BENIN NORTH	B11J2	195	SC	BISON	2	2x760	363	300
	BENIN NORTH - AJAOKUTA	B12J2	195	SC	BISON	2	2x760	363	300
	AJAOKUTA - BENIN NORTH	B12J2	195	SC	BISON	2	2x760	363	300
	BENIN NORTH - EYAEN		5	DC	BISON	2	2x760	363	300
	EYAEN - BENIN NORTH		5	DC	BISON	2	2x760	363	300
	AJA - ALAGBON	J24B & J25B	26	DC	BISON	2	2x760	363	300
	ALAGBON - AJA	J24B & J25B	26	DC	BISON	2	2x760	363	300
	SHIRORO - GWAGWALADA	R4B1	114	DC	BISON	2	2x760	363	300
	GWAGWALADA - SHIRORO	R4B1	114	DC	BISON	2	2x760	363	300
	GWAGWALADA - KATAMPE	R4B2	30	DC	BISON	2	2x760	363	300
	KATAMPE - GWAGWALADA	R4B2	30	DC	BISON	2	2x760	363	300
	OWERRI - AHOADA	W22H	73	DC	BEAR	1	2x126	48	360
	AHOADA - OWERRI	W22H	73	DC	BEAR	1	2x126	48	360
	AHOADA - YENAGOA	H24Y	46	DC	BEAR	1	2x126	48	360
	YENAGOA - AHOADA	H24Y	46	DC	BEAR	1	2x126	48	360
	YENAGOA - GBARAN-UBIE		5	DC	BEAR	1	2x126	48	360
	GBARAN-UBIE - YENAGOA		5	DC	BEAR	1	2x126	48	360

Lines in yellow will cease to exist during scenarios after the Basecase.

- **Owerri - Ahoada - Yenagoa - Gbaran Ubie are 132 kV Lines with BEAR conductor.**
- **The rest are 330 kV lines with twin BISON conductor.**

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
1	ALAOJI - ONITSHA	138	SC	0.330646	0.041900	0.986413	0.125000	3.486778	0.524000	2.488655	0.374000
	ONITSHA - ALAOJI	138	SC	0.330646	0.041900	0.986413	0.125000	3.486778	0.524000	2.488655	0.374000
2	ALAOOJI - AFAM*	25	DC	0.303000	0.006956	0.997000	0.022888	3.812000	0.103782	2.295000	0.062481
	AFAM - ALAOJI*	25	DC	0.303000	0.006956	0.997000	0.022888	3.812000	0.103782	2.295000	0.062481
3	NEW HAVEN - ONITSHA	96	SC	0.331238	0.029200	0.984638	0.086800	3.491353	0.365000	2.486991	0.260000
	ONITSHA - NEW HAVEN	96	SC	0.331238	0.029200	0.984638	0.086800	3.491353	0.365000	2.486991	0.260000
4	ONITSHA - OKPAI*	80	DC	0.303000	0.022259	0.997000	0.073242	3.812000	0.332101	2.295000	0.199940
	OKPAI - ONITSHA *	80	DC	0.303000	0.022259	0.997000	0.073242	3.812000	0.332101	2.295000	0.199940
5	BENIN - OSOGBO	251	SC	0.331039	0.076300	0.984873	0.227000	3.490172	0.954000	2.487753	0.680000
	OSOGB - BENIN	251	SC	0.331039	0.076300	0.984873	0.227000	3.490172	0.954000	2.487753	0.680000
6	BENIN - ONITSHA	137	SC	0.330674	0.041600	0.985664	0.124000	3.492121	0.521000	2.486712	0.371000
	ONITSHA - BENIN	137	SC	0.330674	0.041600	0.985664	0.124000	3.492121	0.521000	2.486712	0.371000
7	BENIN - SAPELE	50	DC	0.302742	0.013900	0.997524	0.045800	3.820018	0.208000	2.295684	0.125000
	SAPELE - BENIN	50	DC	0.302742	0.013900	0.997524	0.045800	3.820018	0.208000	2.295684	0.125000
	BENIN - SAPELE	50	SC	0.302742	0.013900	0.997524	0.045800	3.820018	0.208000	2.295684	0.125000
	SAPELE - BENIN	50	SC	0.302742	0.013900	0.997524	0.045800	3.820018	0.208000	2.295684	0.125000
8	BENIN - DELTA*	107	SC	0.331000	0.032522	0.985000	0.096781	3.490000	0.406665	2.490000	0.290142
	DELTA - BENIN*	107	SC	0.331000	0.032522	0.985000	0.096781	3.490000	0.406665	2.490000	0.290142
9	BENIN - AJAOKUTA	195	SC	0.312738	0.056000	0.988477	0.177000	3.508276	0.745000	2.500530	0.531000
	AJAOOKUTA - BENIN	195	SC	0.312738	0.056000	0.988477	0.177000	3.508276	0.745000	2.500530	0.531000
	BENIN - AJAOKUTA	195	SC	0.312738	0.056000	0.988477	0.177000	3.508276	0.745000	2.500530	0.531000
	AJAOKUTA - BENIN	195	SC	0.312738	0.056000	0.988477	0.177000	3.508276	0.745000	2.500530	0.531000
10	SAPELE - ALADJA	63	SC	0.328429	0.019000	0.985286	0.057000	3.483610	0.239000	2.492457	0.171000
	ALADJA - SAPELE	63	SC	0.328429	0.019000	0.985286	0.057000	3.483610	0.239000	2.492457	0.171000
11	DELTA - ALADJA*	32	SC	0.331000	0.009726	0.985000	0.028944	3.490000	0.121620	2.490000	0.086772
	ALADJA - DELTA*	32	SC	0.331000	0.009726	0.985000	0.028944	3.490000	0.121620	2.490000	0.086772
12	IKEJA WEST - BENIN	280	DC	0.302975	0.077900	0.995657	0.256000	3.810836	1.162000	2.295684	0.700000
	BENIN - IKEJA WEST	280	DC	0.302975	0.077900	0.995657	0.256000	3.810836	1.162000	2.295684	0.700000
13	IKEJA WEST - EGBIN	62	DC	0.302110	0.017200	0.995908	0.056700	3.806392	0.257000	2.280873	0.154000
	EGBIN - IKEJA WEST	62	DC	0.302110	0.017200	0.995908	0.056700	3.806392	0.257000	2.280873	0.154000

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
14	IKEJA WEST - OSOGBO*	252	SC	0.331000	0.076595	0.985000	0.227934	3.490000	0.957754	2.490000	0.683326
	OSOGB - IKEJA WEST*	252	SC	0.331000	0.076595	0.985000	0.227934	3.490000	0.957754	2.490000	0.683326
15	IKEJA WEST - AYEDE*	137	SC	0.331000	0.041641	0.985000	0.123916	3.490000	0.520684	2.490000	0.371491
	AYEDE - IKEJA WEST*	137	SC	0.331000	0.041641	0.985000	0.123916	3.490000	0.520684	2.490000	0.371491
16	IKEJA WEST - AKANGBA*	18	SC	0.331000	0.005471	0.985000	0.016281	3.490000	0.068411	2.490000	0.048809
	AKANGBA - IKEJA WEST*	18	SC	0.331000	0.005471	0.985000	0.016281	3.490000	0.068411	2.490000	0.048809
	IKEJA WEST - AKANGBA*	18	SC	0.331000	0.005471	0.985000	0.016281	3.490000	0.068411	2.490000	0.048809
	AKANGBA - IKEJA WEST*	18	SC	0.331000	0.005471	0.985000	0.016281	3.490000	0.068411	2.490000	0.048809
17	EGBIN - AJA*	14	DC	0.303000	0.003895	0.997000	0.012817	3.812000	0.058118	2.295000	0.034990
	AJA - EGBIN*	14	DC	0.303000	0.003895	0.997000	0.012817	3.812000	0.058118	2.295000	0.034990
18	OSOGBO - JEBBA	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
	JEBBA - OSOGBO	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
	OSOGBO - JEBBA	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
	JEBBA - OSOGBO	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
	OSOGBO - JEBBA	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
	JEBBA - OSOGBO	157	SC	0.330862	0.047700	0.984955	0.142000	3.491779	0.597000	2.491621	0.426000
19	OSOGBO - AYEDE	115	SC	0.330488	0.034900	0.984835	0.104000	3.489440	0.437000	2.491316	0.312000
	AYEDE - OSOGBO	115	SC	0.330488	0.034900	0.984835	0.104000	3.489440	0.437000	2.491316	0.312000
20	KADUNA - SHIRORO	96	SC	0.331238	0.029200	0.984638	0.086800	3.481788	0.364000	2.486991	0.260000
	SHIRORO - KADUNA	96	SC	0.331238	0.029200	0.984638	0.086800	3.481788	0.364000	2.486991	0.260000
	KADUNA - SHIRORO	96	SC	0.331238	0.029200	0.984638	0.086800	3.481788	0.364000	2.486991	0.260000
	SHIRORO - KADUNA	96	SC	0.331238	0.029200	0.984638	0.086800	3.481788	0.364000	2.486991	0.260000
21	KADUNA - JOS	197	SC	0.331122	0.059900	0.983970	0.178000	3.486643	0.748000	2.489128	0.534000
	JOS - KADUNA	197	SC	0.331122	0.059900	0.983970	0.178000	3.486643	0.748000	2.489128	0.534000
22	KADUNA - KANO*	230	SC	0.331000	0.069908	0.985000	0.208035	3.490000	0.874140	2.490000	0.623670
	KANO - KADUNA*	230	SC	0.331000	0.069908	0.985000	0.208035	3.490000	0.874140	2.490000	0.623670
23	JOS - GOMBE	265	SC	0.332864	0.081000	0.986264	0.240000	3.499835	1.010000	2.491467	0.719000
	GOMBE - JOS	265	SC	0.332864	0.081000	0.986264	0.240000	3.499835	1.010000	2.491467	0.719000
24	SHIRORO - KATAMPE*	144	DC	0.303000	0.040066	0.997000	0.131835	3.812000	0.597783	2.295000	0.359893
	KATAMPE - SHIRORO*	144	DC	0.303000	0.040066	0.997000	0.131835	3.812000	0.597783	2.295000	0.359893

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
25	SHIRORO - JEBBA*	244	SC	0.331000	0.074163	0.985000	0.220698	3.490000	0.927349	2.490000	0.661633
	JEBBA - SHIRORO*	244	SC	0.331000	0.074163	0.985000	0.220698	3.490000	0.927349	2.490000	0.661633
	SHIRORO - JEBBA*	244	SC	0.331000	0.074163	0.985000	0.220698	3.490000	0.927349	2.490000	0.661633
	JEBBA - SHIRORO*	244	SC	0.331000	0.074163	0.985000	0.220698	3.490000	0.927349	2.490000	0.661633
26	BIRNIN KEBBI - KAINJI	310	SC	0.330915	0.094200	0.983613	0.280000	3.489440	1.178000	2.488225	0.840000
	KAINJI - BIRNIN KEBBI	310	SC	0.330915	0.094200	0.983613	0.280000	3.489440	1.178000	2.488225	0.840000
27	JEBBA GS - JEBBA TS	8	DC	0.299475	0.002200	0.993713	0.007300	3.810836	0.033200	2.295684	0.020000
	JEBBA TS - JEBBA GS	8	DC	0.299475	0.002200	0.993713	0.007300	3.810836	0.033200	2.295684	0.020000
28	KAINJI - JEBBA	81	SC	0.330733	0.024600	0.985478	0.073300	3.491707	0.308000	2.494077	0.220000
	JEBBA - KAINJI	81	SC	0.330733	0.024600	0.985478	0.073300	3.491707	0.308000	2.494077	0.220000
	KAINJI - JEBBA	81	SC	0.330733	0.024600	0.985478	0.073300	3.491707	0.308000	2.494077	0.220000
	JEBBA - KAINJI	81	SC	0.330733	0.024600	0.985478	0.073300	3.491707	0.308000	2.494077	0.220000
	AFAM - PORT HARCOURT (ONNE)	45	DC	0.303000	0.012521	0.997000	0.041198	3.812000	0.186807	2.295000	0.112466
	PORT HARCOURT (ONNE) - AFAM	45	DC	0.303000	0.012521	0.997000	0.041198	3.812000	0.186807	2.295000	0.112466
	ALAOJI - IKOT EKPENE	38	DC	0.303000	0.010573	0.997000	0.034790	3.812000	0.157748	2.295000	0.094972
	IKOT EKPENE - ALAOJI	38	DC	0.303000	0.010573	0.997000	0.034790	3.812000	0.157748	2.295000	0.094972
	IKOT EKPENE - CALABAR	72	DC	0.303000	0.020033	0.997000	0.065917	3.812000	0.298891	2.295000	0.179946
	CALABAR - IKOT EKPENE	72	DC	0.303000	0.020033	0.997000	0.065917	3.812000	0.298891	2.295000	0.179946
	2ND BENIN - ONITSHA	137	SC	0.331000	0.041641	0.985000	0.123916	3.490000	0.520684	2.490000	0.371491
	ONITSHA - BENIN	137	SC	0.331000	0.041641	0.985000	0.123916	3.490000	0.520684	2.490000	0.371491
	IKEJA WEST - EGBIN	62	SC	0.331000	0.018845	0.985000	0.056079	3.490000	0.235638	2.490000	0.168120
	EGBIN - IKEJA WEST	62	SC	0.331000	0.018845	0.985000	0.056079	3.490000	0.235638	2.490000	0.168120
	BENIN - EGBIN	218	SC	0.331000	0.066261	0.985000	0.197181	3.490000	0.828533	2.490000	0.591131
	EGBIN - BENIN	218	SC	0.331000	0.066261	0.985000	0.197181	3.490000	0.828533	2.490000	0.591131
	GOMBE - YOLA	217	SC	0.331000	0.065957	0.985000	0.196276	3.490000	0.824732	2.490000	0.588419
	YOLA - GOMBE	217	SC	0.331000	0.065957	0.985000	0.196276	3.490000	0.824732	2.490000	0.588419
	YOLA - JALINGO	132	SC	0.331000	0.040121	0.985000	0.119394	3.490000	0.501681	2.490000	0.357933
	JALINGO - YOLA	132	SC	0.331000	0.040121	0.985000	0.119394	3.490000	0.501681	2.490000	0.357933
	AYEDE - PAPALANTO	60	SC	0.331000	0.018237	0.985000	0.054270	3.490000	0.228037	2.490000	0.162697
	PAPALANTO - AYEDE	60	SC	0.331000	0.018237	0.985000	0.054270	3.490000	0.228037	2.490000	0.162697

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
	IKEJA WEST - PAPALANTO	30	SC	0.331000	0.009118	0.985000	0.027135	3.490000	0.114018	2.490000	0.081348
	PAPALANTO - IKEJA WEST	30	SC	0.331000	0.009118	0.985000	0.027135	3.490000	0.114018	2.490000	0.081348
	IKEJA WEST - OMOTOSO	160	SC	0.331000	0.048632	0.985000	0.144720	3.490000	0.608098	2.490000	0.433858
	OMOTOSO - IKEJA WEST	160	SC	0.331000	0.048632	0.985000	0.144720	3.490000	0.608098	2.490000	0.433858
	BENIN - OMOTOSO	120	SC	0.331000	0.036474	0.985000	0.108540	3.490000	0.456073	2.490000	0.325393
	OMOTOSHO - BENIN	120	SC	0.331000	0.036474	0.985000	0.108540	3.490000	0.456073	2.490000	0.325393
	GEREGU - AJAOKUTA	5	DC	0.331000	0.001520	0.985000	0.004522	3.490000	0.019003	2.490000	0.013558
	AJAOKUTA - GEREGU	5	DC	0.303000	0.001391	0.997000	0.004578	3.812000	0.020756	2.295000	0.012496
	GOMBE - DAMATURU	135	SC	0.331000	0.041033	0.985000	0.122107	3.490000	0.513082	2.490000	0.366067
	DAMATURU - GOMBE	135	SC	0.331000	0.041033	0.985000	0.122107	3.490000	0.513082	2.490000	0.366067
	DAMATURU - MAIDUGURI	140	SC	0.331000	0.042553	0.985000	0.126630	3.490000	0.532085	2.490000	0.379625
	MAIDUGURI - DAMATURU	140	SC	0.331000	0.042553	0.985000	0.126630	3.490000	0.532085	2.490000	0.379625
	IKEJA WEST - SAKETE	70	SC	0.331000	0.021276	0.985000	0.063315	3.490000	0.266043	2.490000	0.189813
	SAKETE - IKEJA WEST	70	SC	0.331000	0.021276	0.985000	0.063315	3.490000	0.266043	2.490000	0.189813
	JOS - MAKURDI	230	DC	0.303000	0.063994	0.997000	0.210569	3.812000	0.954792	2.295000	0.574829
	MAKURDI - JOS	230	DC	0.303000	0.063994	0.997000	0.210569	3.812000	0.954792	2.295000	0.574829
	MAKURDI - ALIADE	50	DC	0.303000	0.013912	0.997000	0.045776	3.812000	0.207563	2.295000	0.124963
	ALIADE - MAKURDI	50	DC	0.303000	0.013912	0.997000	0.045776	3.812000	0.207563	2.295000	0.124963
	NEW HAVEN SOUTH - ALIADE	150	DC	0.303000	0.041736	0.997000	0.137328	3.812000	0.622690	2.295000	0.374888
	ALIADE - NEW HAVEN SOUTH	150	DC	0.303000	0.041736	0.997000	0.137328	3.812000	0.622690	2.295000	0.374888
	IKOT EKPENE - NEW HAVEN SOUTH	143	DC	0.303000	0.039788	0.997000	0.130919	3.812000	0.593631	2.295000	0.357393
	NEW HAVEN SOUTH - IKOT EKPENE	143	DC	0.303000	0.039788	0.997000	0.130919	3.812000	0.593631	2.295000	0.357393
	IKOT EKPENE - NEW HAVEN SOUTH	143	DC	0.303000	0.039788	0.997000	0.130919	3.812000	0.593631	2.295000	0.357393
	NEW HAVEN SOUTH - IKOT EKPENE	143	DC	0.303000	0.039788	0.997000	0.130919	3.812000	0.593631	2.295000	0.357393
	NEW HAVEN SOUTH - NEW HAVEN	5	DC	0.303000	0.001391	0.997000	0.004578	3.812000	0.020756	2.295000	0.012496
	NEW HAVEN - NEW HAVEN SOUTH	5	DC	0.303000	0.001391	0.997000	0.004578	3.812000	0.020756	2.295000	0.012496
	AFAM - IKOT EKPENE	90	DC	0.303000	0.025041	0.997000	0.082397	3.812000	0.373614	2.295000	0.224933
	IKOT EKPENE - AFAM	90	DC	0.303000	0.025041	0.997000	0.082397	3.812000	0.373614	2.295000	0.224933
	OWERRI - ALAOJI	60	DC	0.303000	0.016694	0.997000	0.054931	3.812000	0.249076	2.295000	0.149955
	ALAOJI - OWERRI	60	DC	0.303000	0.016694	0.997000	0.054931	3.812000	0.249076	2.295000	0.149955

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
	OWERRI - ONITSHA	75	DC	0.303000	0.020868	0.997000	0.068664	3.812000	0.311345	2.295000	0.187444
	ONITSHA - OWERRI	75	DC	0.303000	0.020868	0.997000	0.068664	3.812000	0.311345	2.295000	0.187444
	EGBEMA - OMOKU	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	OMOKU - EGBEMA	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	OWERRI - EGBEMA	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	EGBEMA - OWERRI	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	OSOGBO - GANMO	87	SC	0.331000	0.026444	0.985000	0.078691	3.490000	0.330653	2.490000	0.235910
	GANMO - OSOGBO	87	SC	0.331000	0.026444	0.985000	0.078691	3.490000	0.330653	2.490000	0.235910
	JEBBA - GANMO	70	SC	0.331000	0.021276	0.985000	0.063315	3.490000	0.266043	2.490000	0.189813
	GANMO - JEBBA	70	SC	0.331000	0.021276	0.985000	0.063315	3.490000	0.266043	2.490000	0.189813
	AJAOKUTA - LOKOJA	38	DC	0.303000	0.010573	0.997000	0.034790	3.812000	0.157748	2.295000	0.094972
	LOKOJA - AJAOKUTA	38	DC	0.303000	0.010573	0.997000	0.034790	3.812000	0.157748	2.295000	0.094972
	LOKOJA - GWAGWALADA	140	DC	0.303000	0.038953	0.997000	0.128173	3.812000	0.581178	2.295000	0.349896
	GWAGWALADA - LOKOJA	140	DC	0.303000	0.038953	0.997000	0.128173	3.812000	0.581178	2.295000	0.349896
	IKEJA WEST - ERUNKAN	32	SC	0.331000	0.009726	0.985000	0.028944	3.490000	0.121620	2.490000	0.086772
	ERUNKAN - IKEJA WEST	32	SC	0.331000	0.009726	0.985000	0.028944	3.490000	0.121620	2.490000	0.086772
	EGBIN - ERUNKAN	30	SC	0.331000	0.009118	0.985000	0.027135	3.490000	0.114018	2.490000	0.081348
	ERUNKAN - EGBIN	30	SC	0.331000	0.009118	0.985000	0.027135	3.490000	0.114018	2.490000	0.081348
	IKOT ABASI - IKOT EKPENE	75	DC	0.303000	0.020868	0.997000	0.068664	3.812000	0.311345	2.295000	0.187444
	IKOT EKPENE - IKOT ABASI	75	DC	0.303000	0.020868	0.997000	0.068664	3.812000	0.311345	2.295000	0.187444
	BENIN - BENIN NORTH	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN NORTH - BENIN	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN - BENIN NORTH	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN NORTH - BENIN	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN - BENIN NORTH	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN NORTH - BENIN	20	SC	0.331000	0.006079	0.985000	0.018090	3.490000	0.076012	2.490000	0.054232
	BENIN NORTH - AJAOKUTA	195	SC	0.331000	0.059270	0.985000	0.176377	3.490000	0.741119	2.490000	0.528764
	AJAOKUTA - BENIN NORTH	195	SC	0.331000	0.059270	0.985000	0.176377	3.490000	0.741119	2.490000	0.528764
	BENIN NORTH - AJAOKUTA	195	SC	0.331000	0.059270	0.985000	0.176377	3.490000	0.741119	2.490000	0.528764
	AJAOKUTA - BENIN NORTH	195	SC	0.331000	0.059270	0.985000	0.176377	3.490000	0.741119	2.490000	0.528764

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	R_1		R_0		X_1		X_0	
				(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu	(Ω/km)	pu
	BENIN NORTH - EYAEN	5	DC	0.303000	0.001391	0.997000	0.004578	3.812000	0.020756	2.295000	0.012496
	EYAEN - BENIN NORTH	5	DC	0.303000	0.001391	0.997000	0.004578	3.812000	0.020756	2.295000	0.012496
	AJA - ALAGBON	26	DC	0.303000	0.007234	0.997000	0.023803	3.812000	0.107933	2.295000	0.064981
	ALAGBON - AJA	26	DC	0.303000	0.007234	0.997000	0.023803	3.812000	0.107933	2.295000	0.064981
	SHIRORO - GWAGWALADA	114	DC	0.303000	0.031719	0.997000	0.104369	3.812000	0.473245	2.295000	0.284915
	GWAGWALADA - SHIRORO	114	DC	0.303000	0.031719	0.997000	0.104369	3.812000	0.473245	2.295000	0.284915
	GWAGWALADA - KATAMPE	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	KATAMPE - GWAGWALADA	30	DC	0.303000	0.008347	0.997000	0.027466	3.812000	0.124538	2.295000	0.074978
	OWERRI - AHOADA	73	DC	0.392000	0.026277	1.349000	0.090429	2.933000	0.233165	1.790000	0.142300
	AHOADA - OWERRI	73	DC	0.392000	0.026277	1.349000	0.090429	2.933000	0.233165	1.790000	0.142300
	AHOADA - YENAGOA	46	DC	0.392000	0.016558	1.349000	0.056983	2.933000	0.146926	1.790000	0.089668
	YENAGOA - AHOADA	46	DC	0.392000	0.016558	1.349000	0.056983	2.933000	0.146926	1.790000	0.089668
	YENAGOA - GBARAN-UBIE	5	DC	0.392000	0.001800	1.349000	0.006194	2.933000	0.015970	1.790000	0.009747
	GBARAN-UBIE - YENAGOA	5	DC	0.392000	0.001800	1.349000	0.006194	2.933000	0.015970	1.790000	0.009747
		Lines in yellow will cease to exist during scenarios after the Basecase.				**– Owerri - Ahoada - Yenagoa - Gbaran Ubie are 132 kV Lines with BEAR conductor. – The rest are 330 kV lines with twin BISON conductor.**					

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (µF/km)	C_0 (µF/km)
				(µS/km)	pu	(µS/km)	pu	(µS/km)	pu	(µS/km)	pu		
1	ALAOJI - ONITSHA	138	SC	3.486778	0.524000	2.488655	0.374000	0.011099	0.007922	2.488655	0.374000	0.011099	0.007922
	ONITSHA - ALAOJI	138	SC	3.486778	0.524000	2.488655	0.374000	0.011099	0.007922	2.488655	0.374000	0.011099	0.007922
2	ALAOOJI - AFAM*	25	DC	3.812000	0.103782	2.295000	0.062481	0.012134	0.007305	2.295000	0.062481	0.012134	0.007305
	AFAM - ALAOJI*	25	DC	3.812000	0.103782	2.295000	0.062481	0.012134	0.007305	2.295000	0.062481	0.012134	0.007305
3	NEW HAVEN - ONITSHA	96	SC	3.491353	0.365000	2.486991	0.260000	0.011113	0.007916	2.486991	0.260000	0.011113	0.007916
	ONITSHA - NEW HAVEN	96	SC	3.491353	0.365000	2.486991	0.260000	0.011113	0.007916	2.486991	0.260000	0.011113	0.007916
4	ONITSHA - OKPAI*	80	DC	3.812000	0.332101	2.295000	0.199940	0.012134	0.007305	2.295000	0.199940	0.012134	0.007305
	OKPAI - ONITSHA *	80	DC	3.812000	0.332101	2.295000	0.199940	0.012134	0.007305	2.295000	0.199940	0.012134	0.007305
5	BENIN - OSOGBO	251	SC	3.490172	0.954000	2.487753	0.680000	0.011110	0.007919	2.487753	0.680000	0.011110	0.007919
	OSOGB - BENIN	251	SC	3.490172	0.954000	2.487753	0.680000	0.011110	0.007919	2.487753	0.680000	0.011110	0.007919
6	BENIN - ONITSHA	137	SC	3.492121	0.521000	2.486712	0.371000	0.011116	0.007915	2.486712	0.371000	0.011116	0.007915
	ONITSHA - BENIN	137	SC	3.492121	0.521000	2.486712	0.371000	0.011116	0.007915	2.486712	0.371000	0.011116	0.007915
7	BENIN - SAPELE	50	DC	3.820018	0.208000	2.295684	0.125000	0.012160	0.007307	2.295684	0.125000	0.012160	0.007307
	SAPELE - BENIN	50	DC	3.820018	0.208000	2.295684	0.125000	0.012160	0.007307	2.295684	0.125000	0.012160	0.007307
	BENIN - SAPELE	50	SC	3.820018	0.208000	2.295684	0.125000	0.012160	0.007307	2.295684	0.125000	0.012160	0.007307
	SAPELE - BENIN	50	SC	3.820018	0.208000	2.295684	0.125000	0.012160	0.007307	2.295684	0.125000	0.012160	0.007307
8	BENIN - DELTA*	107	SC	3.490000	0.406665	2.490000	0.290142	0.011109	0.007926	2.490000	0.290142	0.011109	0.007926
	DELTA - BENIN*	107	SC	3.490000	0.406665	2.490000	0.290142	0.011109	0.007926	2.490000	0.290142	0.011109	0.007926
9	BENIN - AJAOKUTA	195	SC	3.508276	0.745000	2.500530	0.531000	0.011167	0.007959	2.500530	0.531000	0.011167	0.007959
	AJAOOKUTA - BENIN	195	SC	3.508276	0.745000	2.500530	0.531000	0.011167	0.007959	2.500530	0.531000	0.011167	0.007959
	BENIN - AJAOKUTA	195	SC	3.508276	0.745000	2.500530	0.531000	0.011167	0.007959	2.500530	0.531000	0.011167	0.007959
	AJAOKUTA - BENIN	195	SC	3.508276	0.745000	2.500530	0.531000	0.011167	0.007959	2.500530	0.531000	0.011167	0.007959
10	SAPELE - ALADJA	63	SC	3.483610	0.239000	2.492457	0.171000	0.011089	0.007934	2.492457	0.171000	0.011089	0.007934
	ALADJA - SAPELE	63	SC	3.483610	0.239000	2.492457	0.171000	0.011089	0.007934	2.492457	0.171000	0.011089	0.007934
11	DELTA - ALADJA*	32	SC	3.490000	0.121620	2.490000	0.086772	0.011109	0.007926	2.490000	0.086772	0.011109	0.007926
	ALADJA - DELTA*	32	SC	3.490000	0.121620	2.490000	0.086772	0.011109	0.007926	2.490000	0.086772	0.011109	0.007926
12	IKEJA WEST - BENIN	280	DC	3.810836	1.162000	2.295684	0.700000	0.012130	0.007307	2.295684	0.700000	0.012130	0.007307
	BENIN - IKEJA WEST	280	DC	3.810836	1.162000	2.295684	0.700000	0.012130	0.007307	2.295684	0.700000	0.012130	0.007307
13	IKEJA WEST - EGBIN	62	DC	3.806392	0.257000	2.280873	0.154000	0.012116	0.007260	2.280873	0.154000	0.012116	0.007260

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (µF/km)	C_0 (µF/km)
				(µS/km)	pu	(µS/km)	pu	(µS/km)	pu	(µS/km)	pu		
	EGBIN - IKEJA WEST	62	DC	3.806392	0.257000	2.280873	0.154000	0.012116	0.007260	2.280873	0.154000	0.012116	0.007260
14	IKEJA WEST - OSOGBO*	252	SC	3.490000	0.957754	2.490000	0.683326	0.011109	0.007926	2.490000	0.683326	0.011109	0.007926
	OSOGB - IKEJA WEST*	252	SC	3.490000	0.957754	2.490000	0.683326	0.011109	0.007926	2.490000	0.683326	0.011109	0.007926
15	IKEJA WEST - AYEDE*	137	SC	3.490000	0.520684	2.490000	0.371491	0.011109	0.007926	2.490000	0.371491	0.011109	0.007926
	AYEDE - IKEJA WEST*	137	SC	3.490000	0.520684	2.490000	0.371491	0.011109	0.007926	2.490000	0.371491	0.011109	0.007926
16	IKEJA WEST - AKANGBA*	18	SC	3.490000	0.068411	2.490000	0.048809	0.011109	0.007926	2.490000	0.048809	0.011109	0.007926
	AKANGBA - IKEJA WEST*	18	SC	3.490000	0.068411	2.490000	0.048809	0.011109	0.007926	2.490000	0.048809	0.011109	0.007926
	IKEJA WEST - AKANGBA*	18	SC	3.490000	0.068411	2.490000	0.048809	0.011109	0.007926	2.490000	0.048809	0.011109	0.007926
	AKANGBA - IKEJA WEST*	18	SC	3.490000	0.068411	2.490000	0.048809	0.011109	0.007926	2.490000	0.048809	0.011109	0.007926
17	EGBIN - AJA*	14	DC	3.812000	0.058118	2.295000	0.034990	0.012134	0.007305	2.295000	0.034990	0.012134	0.007305
	AJA - EGBIN*	14	DC	3.812000	0.058118	2.295000	0.034990	0.012134	0.007305	2.295000	0.034990	0.012134	0.007305
18	OSOGBO - JEBBA	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
	JEBBA - OSOGBO	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
	OSOGBO - JEBBA	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
	JEBBA - OSOGBO	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
	OSOGBO - JEBBA	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
	JEBBA - OSOGBO	157	SC	3.491779	0.597000	2.491621	0.426000	0.011115	0.007931	2.491621	0.426000	0.011115	0.007931
19	OSOGBO - AYEDE	115	SC	3.489440	0.437000	2.491316	0.312000	0.011107	0.007930	2.491316	0.312000	0.011107	0.007930
	AYEDE - OSOGBO	115	SC	3.489440	0.437000	2.491316	0.312000	0.011107	0.007930	2.491316	0.312000	0.011107	0.007930
20	KADUNA - SHIRORO	96	SC	3.481788	0.364000	2.486991	0.260000	0.011083	0.007916	2.486991	0.260000	0.011083	0.007916
	SHIRORO - KADUNA	96	SC	3.481788	0.364000	2.486991	0.260000	0.011083	0.007916	2.486991	0.260000	0.011083	0.007916
	KADUNA - SHIRORO	96	SC	3.481788	0.364000	2.486991	0.260000	0.011083	0.007916	2.486991	0.260000	0.011083	0.007916
	SHIRORO - KADUNA	96	SC	3.481788	0.364000	2.486991	0.260000	0.011083	0.007916	2.486991	0.260000	0.011083	0.007916
21	KADUNA - JOS	197	SC	3.486643	0.748000	2.489128	0.534000	0.011098	0.007923	2.489128	0.534000	0.011098	0.007923
	JOS - KADUNA	197	SC	3.486643	0.748000	2.489128	0.534000	0.011098	0.007923	2.489128	0.534000	0.011098	0.007923
22	KADUNA - KANO*	230	SC	3.490000	0.874140	2.490000	0.623670	0.011109	0.007926	2.490000	0.623670	0.011109	0.007926
	KANO - KADUNA*	230	SC	3.490000	0.874140	2.490000	0.623670	0.011109	0.007926	2.490000	0.623670	0.011109	0.007926
23	JOS - GOMBE	265	SC	3.499835	1.010000	2.491467	0.719000	0.011140	0.007931	2.491467	0.719000	0.011140	0.007931
	GOMBE - JOS	265	SC	3.499835	1.010000	2.491467	0.719000	0.011140	0.007931	2.491467	0.719000	0.011140	0.007931
24	SHIRORO - KATAMPE*	144	DC	3.812000	0.597783	2.295000	0.359893	0.012134	0.007305	2.295000	0.359893	0.012134	0.007305

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (µF/km)	C_0 (µF/km)
				(µS/km)	pu	(µS/km)	pu	(µS/km)	pu	(µS/km)	pu		
	KATAMPE - SHIRORO*	144	DC	3.812000	0.597783	2.295000	0.359893	0.012134	0.007305	2.295000	0.359893	0.012134	0.007305
25	SHIRORO - JEBBA*	244	SC	3.490000	0.927349	2.490000	0.661633	0.011109	0.007926	2.490000	0.661633	0.011109	0.007926
	JEBBA - SHIRORO*	244	SC	3.490000	0.927349	2.490000	0.661633	0.011109	0.007926	2.490000	0.661633	0.011109	0.007926
	SHIRORO - JEBBA*	244	SC	3.490000	0.927349	2.490000	0.661633	0.011109	0.007926	2.490000	0.661633	0.011109	0.007926
	JEBBA - SHIRORO*	244	SC	3.490000	0.927349	2.490000	0.661633	0.011109	0.007926	2.490000	0.661633	0.011109	0.007926
26	BIRNIN KEBBI - KAINJI	310	SC	3.489440	1.178000	2.488225	0.840000	0.011107	0.007920	2.488225	0.840000	0.011107	0.007920
	KAINJI - BIRNIN KEBBI	310	SC	3.489440	1.178000	2.488225	0.840000	0.011107	0.007920	2.488225	0.840000	0.011107	0.007920
27	JEBBA GS - JEBBA TS	8	DC	3.810836	0.033200	2.295684	0.020000	0.012130	0.007307	2.295684	0.020000	0.012130	0.007307
	JEBBA TS - JEBBA GS	8	DC	3.810836	0.033200	2.295684	0.020000	0.012130	0.007307	2.295684	0.020000	0.012130	0.007307
28	KAINJI - JEBBA	81	SC	3.491707	0.308000	2.494077	0.220000	0.011114	0.007939	2.494077	0.220000	0.011114	0.007939
	JEBBA - KAINJI	81	SC	3.491707	0.308000	2.494077	0.220000	0.011114	0.007939	2.494077	0.220000	0.011114	0.007939
	KAINJI - JEBBA	81	SC	3.491707	0.308000	2.494077	0.220000	0.011114	0.007939	2.494077	0.220000	0.011114	0.007939
	JEBBA - KAINJI	81	SC	3.491707	0.308000	2.494077	0.220000	0.011114	0.007939	2.494077	0.220000	0.011114	0.007939
	AFAM - PORT HARCOURT (ONNE)	45	DC	3.812000	0.186807	2.295000	0.112466	0.012134	0.007305	2.295000	0.112466	0.012134	0.007305
	PORT HARCOURT (ONNE) - AFAM	45	DC	3.812000	0.186807	2.295000	0.112466	0.012134	0.007305	2.295000	0.112466	0.012134	0.007305
	ALAOJI - IKOT EKPENE	38	DC	3.812000	0.157748	2.295000	0.094972	0.012134	0.007305	2.295000	0.094972	0.012134	0.007305
	IKOT EKPENE - ALAOJI	38	DC	3.812000	0.157748	2.295000	0.094972	0.012134	0.007305	2.295000	0.094972	0.012134	0.007305
	IKOT EKPENE - CALABAR	72	DC	3.812000	0.298891	2.295000	0.179946	0.012134	0.007305	2.295000	0.179946	0.012134	0.007305
	CALABAR - IKOT EKPENE	72	DC	3.812000	0.298891	2.295000	0.179946	0.012134	0.007305	2.295000	0.179946	0.012134	0.007305
	2ND BENIN - ONITSHA	137	SC	3.490000	0.520684	2.490000	0.371491	0.011109	0.007926	2.490000	0.371491	0.011109	0.007926
	ONITSHA - BENIN	137	SC	3.490000	0.520684	2.490000	0.371491	0.011109	0.007926	2.490000	0.371491	0.011109	0.007926
	IKEJA WEST - EGBIN	62	SC	3.490000	0.235638	2.490000	0.168120	0.011109	0.007926	2.490000	0.168120	0.011109	0.007926
	EGBIN - IKEJA WEST	62	SC	3.490000	0.235638	2.490000	0.168120	0.011109	0.007926	2.490000	0.168120	0.011109	0.007926
	BENIN - EGBIN	218	SC	3.490000	0.828533	2.490000	0.591131	0.011109	0.007926	2.490000	0.591131	0.011109	0.007926
	EGBIN - BENIN	218	SC	3.490000	0.828533	2.490000	0.591131	0.011109	0.007926	2.490000	0.591131	0.011109	0.007926
	GOMBE - YOLA	217	SC	3.490000	0.824732	2.490000	0.588419	0.011109	0.007926	2.490000	0.588419	0.011109	0.007926
	YOLA - GOMBE	217	SC	3.490000	0.824732	2.490000	0.588419	0.011109	0.007926	2.490000	0.588419	0.011109	0.007926
	YOLA - JALINGO	132	SC	3.490000	0.501681	2.490000	0.357933	0.011109	0.007926	2.490000	0.357933	0.011109	0.007926
	JALINGO - YOLA	132	SC	3.490000	0.501681	2.490000	0.357933	0.011109	0.007926	2.490000	0.357933	0.011109	0.007926
	AYEDE - PAPALANTO	60	SC	3.490000	0.228037	2.490000	0.162697	0.011109	0.007926	2.490000	0.162697	0.011109	0.007926

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (μF/km)	C_0 (μF/km)
				(μS/km)	pu	(μS/km)	pu	(μS/km)	pu	(μS/km)	pu		
	PAPALANTO - AYEDE	60	SC	3.490000	0.228037	2.490000	0.162697	0.011109	0.007926	2.490000	0.162697	0.011109	0.007926
	IKEJA WEST - PAPALANTO	30	SC	3.490000	0.114018	2.490000	0.081348	0.011109	0.007926	2.490000	0.081348	0.011109	0.007926
	PAPALANTO - IKEJA WEST	30	SC	3.490000	0.114018	2.490000	0.081348	0.011109	0.007926	2.490000	0.081348	0.011109	0.007926
	IKEJA WEST - OMOTOSO	160	SC	3.490000	0.608098	2.490000	0.433858	0.011109	0.007926	2.490000	0.433858	0.011109	0.007926
	OMOTOSO - IKEJA WEST	160	SC	3.490000	0.608098	2.490000	0.433858	0.011109	0.007926	2.490000	0.433858	0.011109	0.007926
	BENIN - OMOTOSO	120	SC	3.490000	0.456073	2.490000	0.325393	0.011109	0.007926	2.490000	0.325393	0.011109	0.007926
	OMOTOSHO - BENIN	120	SC	3.490000	0.456073	2.490000	0.325393	0.011109	0.007926	2.490000	0.325393	0.011109	0.007926
	GEREGU - AJAOKUTA	5	DC	3.490000	0.019003	2.490000	0.013558	0.011109	0.007926	2.490000	0.013558	0.011109	0.007926
	AJAOKUTA - GEREGU	5	DC	3.812000	0.020756	2.295000	0.012496	0.012134	0.007305	2.295000	0.012496	0.012134	0.007305
	GOMBE - DAMATURU	135	SC	3.490000	0.513082	2.490000	0.366067	0.011109	0.007926	2.490000	0.366067	0.011109	0.007926
	DAMATURU - GOMBE	135	SC	3.490000	0.513082	2.490000	0.366067	0.011109	0.007926	2.490000	0.366067	0.011109	0.007926
	DAMATURU - MAIDUGURI	140	SC	3.490000	0.532085	2.490000	0.379625	0.011109	0.007926	2.490000	0.379625	0.011109	0.007926
	MAIDUGURI - DAMATURU	140	SC	3.490000	0.532085	2.490000	0.379625	0.011109	0.007926	2.490000	0.379625	0.011109	0.007926
	IKEJA WEST - SAKETE	70	SC	3.490000	0.266043	2.490000	0.189813	0.011109	0.007926	2.490000	0.189813	0.011109	0.007926
	SAKETE - IKEJA WEST	70	SC	3.490000	0.266043	2.490000	0.189813	0.011109	0.007926	2.490000	0.189813	0.011109	0.007926
	JOS - MAKURDI	230	DC	3.812000	0.954792	2.295000	0.574829	0.012134	0.007305	2.295000	0.574829	0.012134	0.007305
	MAKURDI - JOS	230	DC	3.812000	0.954792	2.295000	0.574829	0.012134	0.007305	2.295000	0.574829	0.012134	0.007305
	MAKURDI - ALIADE	50	DC	3.812000	0.207563	2.295000	0.124963	0.012134	0.007305	2.295000	0.124963	0.012134	0.007305
	ALIADE - MAKURDI	50	DC	3.812000	0.207563	2.295000	0.124963	0.012134	0.007305	2.295000	0.124963	0.012134	0.007305
	NEW HAVEN SOUTH - ALIADE	150	DC	3.812000	0.622690	2.295000	0.374888	0.012134	0.007305	2.295000	0.374888	0.012134	0.007305
	ALIADE - NEW HAVEN SOUTH	150	DC	3.812000	0.622690	2.295000	0.374888	0.012134	0.007305	2.295000	0.374888	0.012134	0.007305
	IKOT EKPENE - NEW HAVEN SOUTH	143	DC	3.812000	0.593631	2.295000	0.357393	0.012134	0.007305	2.295000	0.357393	0.012134	0.007305
	NEW HAVEN SOUTH - IKOT EKPENE	143	DC	3.812000	0.593631	2.295000	0.357393	0.012134	0.007305	2.295000	0.357393	0.012134	0.007305
	IKOT EKPENE - NEW HAVEN SOUTH	143	DC	3.812000	0.593631	2.295000	0.357393	0.012134	0.007305	2.295000	0.357393	0.012134	0.007305
	NEW HAVEN SOUTH - IKOT EKPENE	143	DC	3.812000	0.593631	2.295000	0.357393	0.012134	0.007305	2.295000	0.357393	0.012134	0.007305
	NEW HAVEN SOUTH - NEW HAVEN	5	DC	3.812000	0.020756	2.295000	0.012496	0.012134	0.007305	2.295000	0.012496	0.012134	0.007305
	NEW HAVEN - NEW HAVEN SOUTH	5	DC	3.812000	0.020756	2.295000	0.012496	0.012134	0.007305	2.295000	0.012496	0.012134	0.007305

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (μF/km)	C_0 (μF/km)
				(μS/km)	pu	(μS/km)	pu	(μS/km)	pu	(μS/km)	pu		
	AFAM - IKOT EKPENE	90	DC	3.812000	0.373614	2.295000	0.224933	0.012134	0.007305	2.295000	0.224933	0.012134	0.007305
	IKOT EKPENE - AFAM	90	DC	3.812000	0.373614	2.295000	0.224933	0.012134	0.007305	2.295000	0.224933	0.012134	0.007305
	OWERRI - ALAOJI	60	DC	3.812000	0.249076	2.295000	0.149955	0.012134	0.007305	2.295000	0.149955	0.012134	0.007305
	ALAOJI - OWERRI	60	DC	3.812000	0.249076	2.295000	0.149955	0.012134	0.007305	2.295000	0.149955	0.012134	0.007305
	OWERRI - ONITSHA	75	DC	3.812000	0.311345	2.295000	0.187444	0.012134	0.007305	2.295000	0.187444	0.012134	0.007305
	ONITSHA - OWERRI	75	DC	3.812000	0.311345	2.295000	0.187444	0.012134	0.007305	2.295000	0.187444	0.012134	0.007305
	EGBEMA - OMOKU	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	OMOKU - EGBEMA	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	OWERRI - EGBEMA	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	EGBEMA - OWERRI	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	OSOGBO - GANMO	87	SC	3.490000	0.330653	2.490000	0.235910	0.011109	0.007926	2.490000	0.235910	0.011109	0.007926
	GANMO - OSOGBO	87	SC	3.490000	0.330653	2.490000	0.235910	0.011109	0.007926	2.490000	0.235910	0.011109	0.007926
	JEBBA - GANMO	70	SC	3.490000	0.266043	2.490000	0.189813	0.011109	0.007926	2.490000	0.189813	0.011109	0.007926
	GANMO - JEBBA	70	SC	3.490000	0.266043	2.490000	0.189813	0.011109	0.007926	2.490000	0.189813	0.011109	0.007926
	AJAOKUTA - LOKOJA	38	DC	3.812000	0.157748	2.295000	0.094972	0.012134	0.007305	2.295000	0.094972	0.012134	0.007305
	LOKOJA - AJAOKUTA	38	DC	3.812000	0.157748	2.295000	0.094972	0.012134	0.007305	2.295000	0.094972	0.012134	0.007305
	LOKOJA - GWAGWALADA	140	DC	3.812000	0.581178	2.295000	0.349896	0.012134	0.007305	2.295000	0.349896	0.012134	0.007305
	GWAGWALADA - LOKOJA	140	DC	3.812000	0.581178	2.295000	0.349896	0.012134	0.007305	2.295000	0.349896	0.012134	0.007305
	IKEJA WEST - ERUNKAN	32	SC	3.490000	0.121620	2.490000	0.086772	0.011109	0.007926	2.490000	0.086772	0.011109	0.007926
	ERUNKAN - IKEJA WEST	32	SC	3.490000	0.121620	2.490000	0.086772	0.011109	0.007926	2.490000	0.086772	0.011109	0.007926
	EGBIN - ERUNKAN	30	SC	3.490000	0.114018	2.490000	0.081348	0.011109	0.007926	2.490000	0.081348	0.011109	0.007926
	ERUNKAN - EGBIN	30	SC	3.490000	0.114018	2.490000	0.081348	0.011109	0.007926	2.490000	0.081348	0.011109	0.007926
	IKOT ABASI - IKOT EKPENE	75	DC	3.812000	0.311345	2.295000	0.187444	0.012134	0.007305	2.295000	0.187444	0.012134	0.007305
	IKOT EKPENE - IKOT ABASI	75	DC	3.812000	0.311345	2.295000	0.187444	0.012134	0.007305	2.295000	0.187444	0.012134	0.007305
	BENIN - BENIN NORTH	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926
	BENIN NORTH - BENIN	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926
	BENIN - BENIN NORTH	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926
	BENIN NORTH - BENIN	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926
	BENIN - BENIN NORTH	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926
	BENIN NORTH - BENIN	20	SC	3.490000	0.076012	2.490000	0.054232	0.011109	0.007926	2.490000	0.054232	0.011109	0.007926

S/N	NAME	LENGTH (km)	TYPE (DC/SC)	B_1		B_0		Y_1		Y_0		C_1 (µF/km)	C_0 (µF/km)
				(µS/km)	pu	(µS/km)	pu	(µS/km)	pu	(µS/km)	pu		
	BENIN NORTH - AJAOKUTA	195	SC	3.490000	0.741119	2.490000	0.528764	0.011109	0.007926	2.490000	0.528764	0.011109	0.007926
	AJAOKUTA - BENIN NORTH	195	SC	3.490000	0.741119	2.490000	0.528764	0.011109	0.007926	2.490000	0.528764	0.011109	0.007926
	BENIN NORTH - AJAOKUTA	195	SC	3.490000	0.741119	2.490000	0.528764	0.011109	0.007926	2.490000	0.528764	0.011109	0.007926
	AJAOKUTA - BENIN NORTH	195	SC	3.490000	0.741119	2.490000	0.528764	0.011109	0.007926	2.490000	0.528764	0.011109	0.007926
	BENIN NORTH - EYAEN	5	DC	3.812000	0.020756	2.295000	0.012496	0.012134	0.007305	2.295000	0.012496	0.012134	0.007305
	EYAEN - BENIN NORTH	5	DC	3.812000	0.020756	2.295000	0.012496	0.012134	0.007305	2.295000	0.012496	0.012134	0.007305
	AJA - ALAGBON	26	DC	3.812000	0.107933	2.295000	0.064981	0.012134	0.007305	2.295000	0.064981	0.012134	0.007305
	ALAGBON - AJA	26	DC	3.812000	0.107933	2.295000	0.064981	0.012134	0.007305	2.295000	0.064981	0.012134	0.007305
	SHIRORO - GWAGWALADA	114	DC	3.812000	0.473245	2.295000	0.284915	0.012134	0.007305	2.295000	0.284915	0.012134	0.007305
	GWAGWALADA - SHIRORO	114	DC	3.812000	0.473245	2.295000	0.284915	0.012134	0.007305	2.295000	0.284915	0.012134	0.007305
	GWAGWALADA - KATAMPE	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	KATAMPE - GWAGWALADA	30	DC	3.812000	0.124538	2.295000	0.074978	0.012134	0.007305	2.295000	0.074978	0.012134	0.007305
	OWERRI – AHOADA	73	DC	2.933000	0.233165	1.790000	0.142300	0.009336	0.005698	1.790000	0.142300	0.009336	0.005698
	AHOADA – OWERRI	73	DC	2.933000	0.233165	1.790000	0.142300	0.009336	0.005698	1.790000	0.142300	0.009336	0.005698
	AHOADA – YENAGOA	46	DC	2.933000	0.146926	1.790000	0.089668	0.009336	0.005698	1.790000	0.089668	0.009336	0.005698
	YENAGOA - AHOADA	46	DC	2.933000	0.146926	1.790000	0.089668	0.009336	0.005698	1.790000	0.089668	0.009336	0.005698
	YENAGOA - GBARAN-UBIE	5	DC	2.933000	0.015970	1.790000	0.009747	0.009336	0.005698	1.790000	0.009747	0.009336	0.005698
	GBARAN-UBIE - YENAGOA	5	DC	2.933000	0.015970	1.790000	0.009747	0.009336	0.005698	1.790000	0.009747	0.009336	0.005698

Lines in yellow will cease to exist during scenarios after the Basecase.

- **Owerri - Ahoada - Yenagoa - Gbaran Ubie are 132 kV Lines with BEAR conductor.**
- **The rest are 330 kV lines with twin BISON conductor.**

Table of Figures

Figure 1: Locations of the NIPP

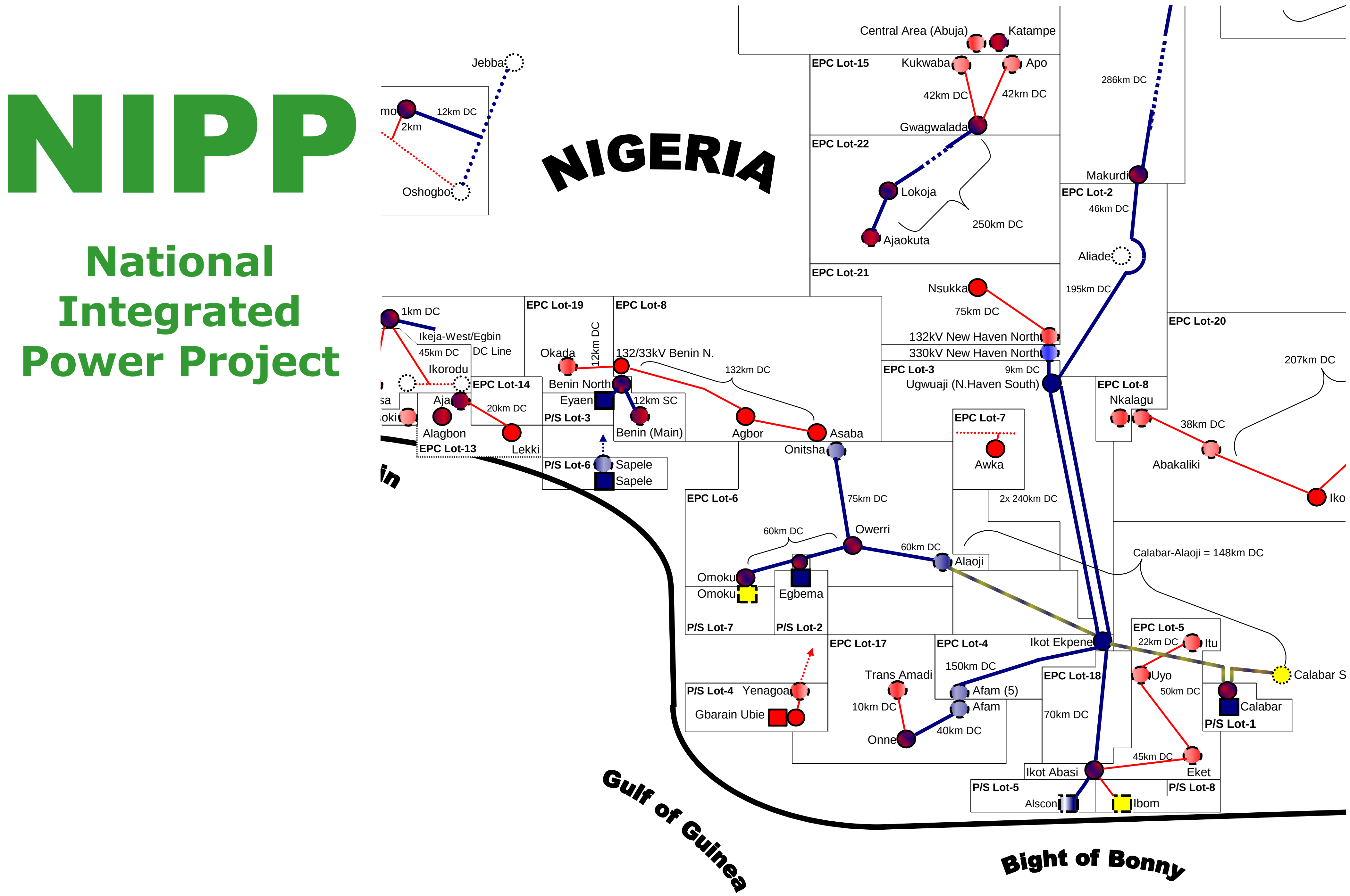


Figure 2: PHCN Grid Circuit Diagram

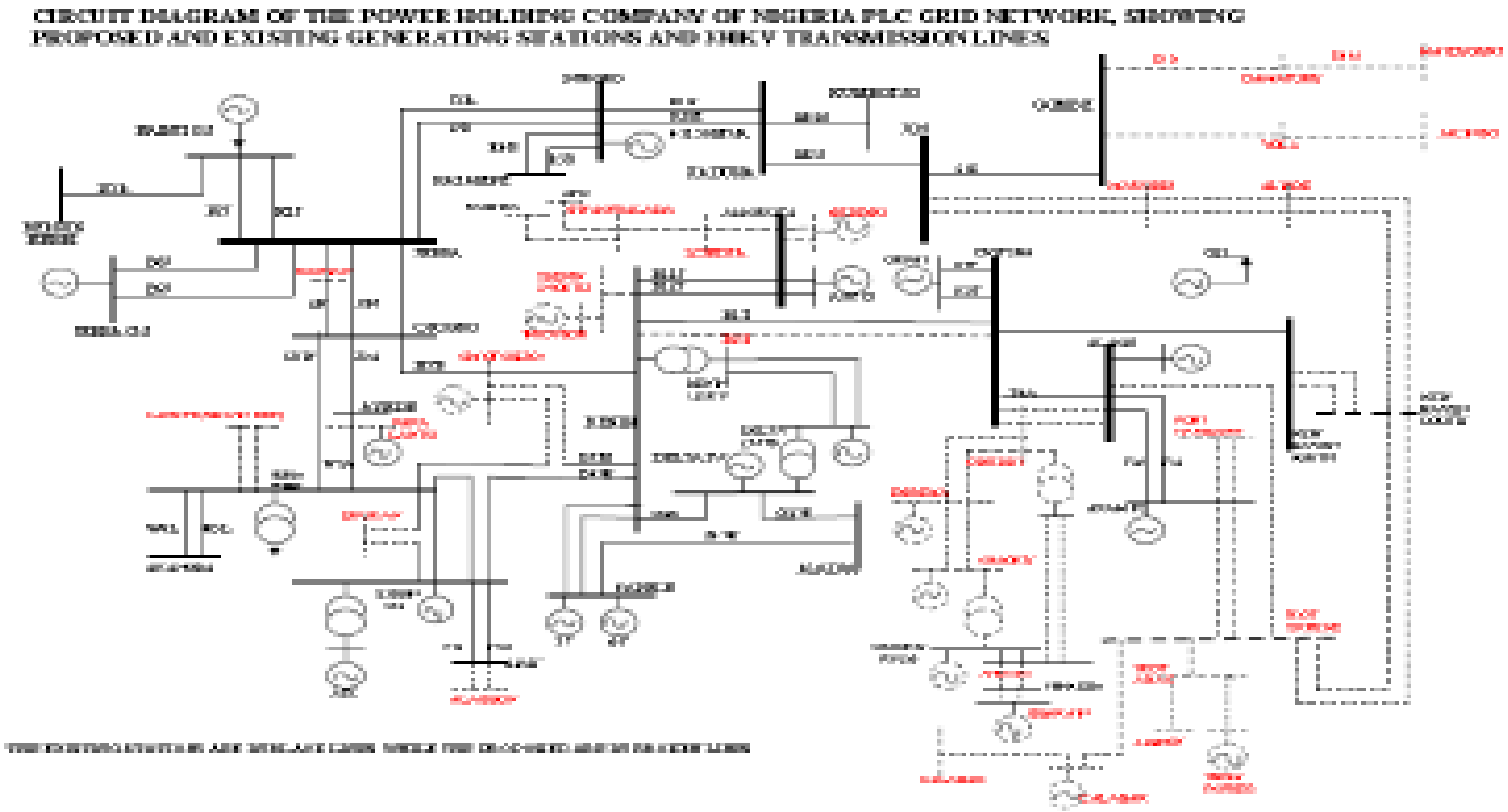


Figure 3: Base Case Network

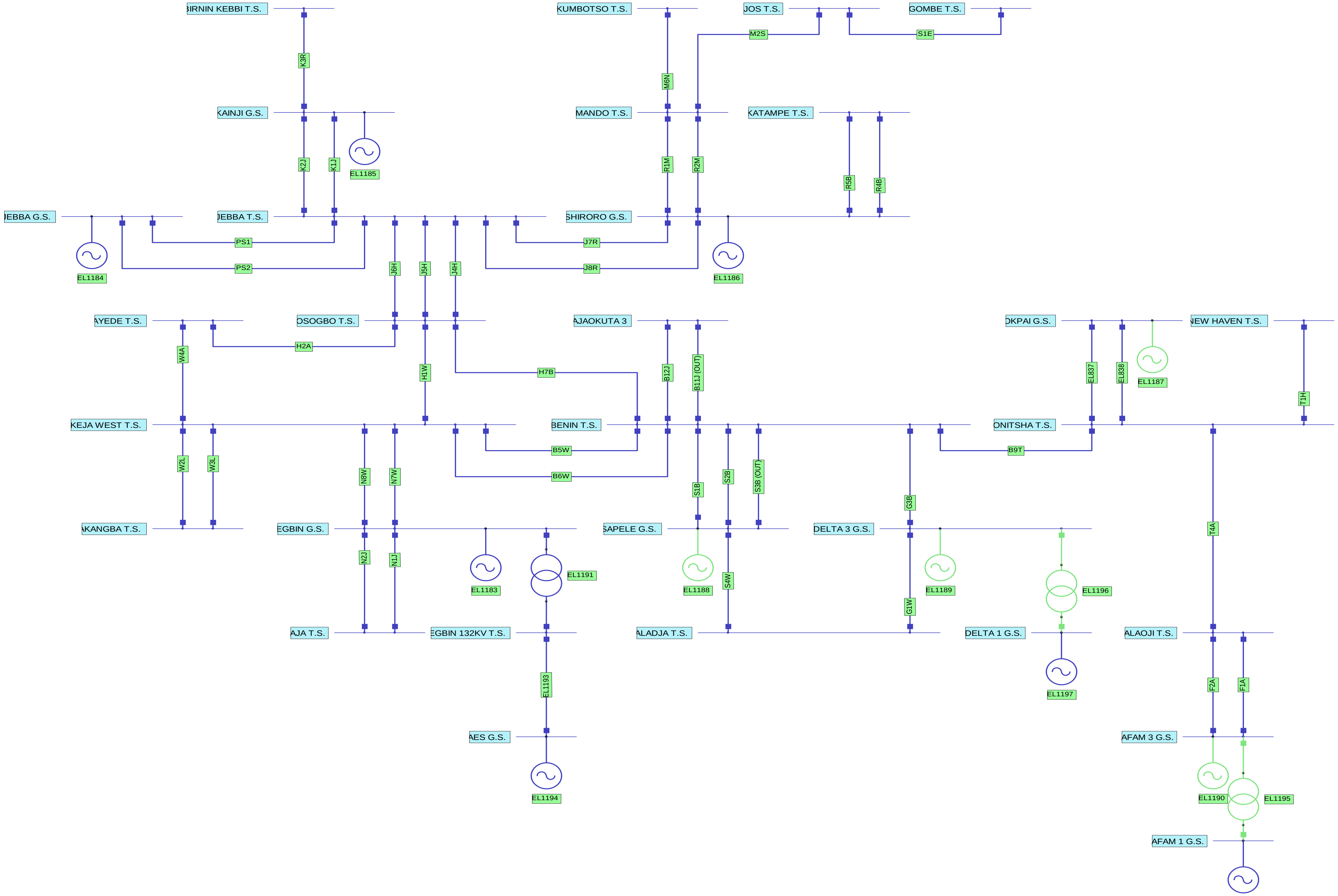
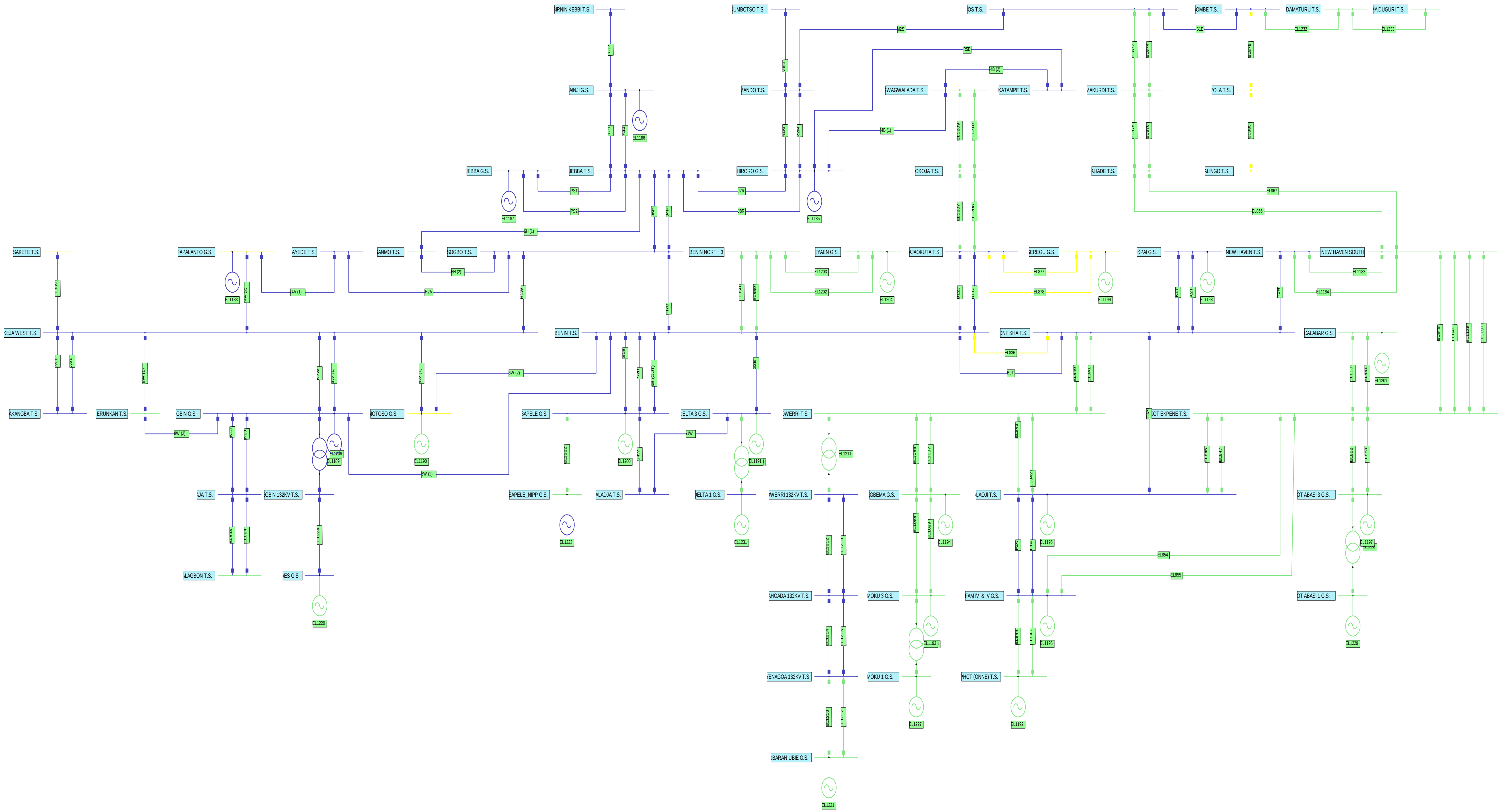


Figure 4: Base Case + 4 FGN + 7 NIPP Network



International Workshop on NIPP Grid Study

1.0 INTRODUCTION

An international workshop to present the results of the NIPP Grid Study for peer review held from 22 to 24 March 2007 in Abuja.

Senior Special Assistant to the President on Power Sector Reform (SSAP-P), Engr. F. A. Somolu, who is also the NIPP Grid Study Team leader, chaired the proceedings.

Participants were drawn from the academia and electricity industry practitioners from ECOWAS countries.

Opening remarks were given by Engr. J. O. Ayodele, Ag. Executive Director Technical Services, Power Holding Company of Nigeria (PHCN), Mr. J. A. Olotu, Managing Director / Chief Executive Officer, Niger Delta Power Holding Company, and Mr. B. O. Adeyemo, Director, West Africa Power Pool (WAPP), while SSAP-P declared the workshop open on behalf of Minister for Energy, Dr. Edmund Daukoru.

2.0 COMMENTS FROM PARTICIPANTS

2.1 Prof. Aliyu – Abubakar Tafawa Balewa University, Bauchi

In-house service team should be commended with PHCN having a competent team. They have been able to utilize and prove the use of software tools.

There is the need for a study group like this, which could be likened to the American research team (EPRI) to look into operational details when the need arises not to system fault and analysis/solution.

The Operational staff - gives the problem to this team to evaluate.

The final report format should take the format below.

Vol. 1 - Executive summary

Vol. 2 - Power flow

Vol. 3 - Short circuit

Vol. 4 - Stability

VOL 1: Executive Summary

This should contain the summary of the Project and there should be graphical drawings as well as maps of Nigeria showing the location of Federal Government of Nigeria and NIPP Plants.

Date lines should also be indicated for the completion of these plants if available.

VOL 2: Power Flow Studies

Provide single line diagram topology include all station step-up transformers.

Transmission line parameters as well as transformers parameter should be included or listed.

State Clearly type of Busbar Arrangements

The report should state clearly whether single or distributed slack bus was used – Please indicate it.

Use bar chart for voltage distribution, voltage profile.

Use actual power factors

Justify typical data used.

Reactive VAR limit to be specified.

Extend the result with variety in power factor.

Compare NEPLAN result with daily operation report.

Use modern Technologies.

Compare NEPLAN result with another good software tools using SCADA results i.e. Eurostag. PSS/E etc.

Extend the study to cover typically other former studies carried out with respect to correct the parameter used e.g. the pf. In addition, to include changes made on previous study.

VOL 3: Short Circuit Studies

On the short circuit studies.

Justify the data used for this short circuit. e.g. why we selected the typical values. e.g. using Ad" reactance behind the voltage.

Explain with sufficient detail with respect to the use of lumped parameters e.g. finding the equivalent unit for the X-generator unit.

We should put the unit MVA of Generator.

Perform N-1 or N-2 contingency and see the result

Explain values or state if we actually used solid grounding in the report for our transformers and or generator.

Explain Value for the unbalanced fault

VOL 4: Transient Stability

We need to modernize it; there are certain new definitions that have come in from IEEE.

Use standard definition.

Voltage or angle stability has standard definition. We should be able to know the difference and focus on the target we wish.

The fault swing instability is what we are concerned.
For subsequent swing could be a cascaded effect, but our interest is the angle swing and its critical nature.

The generating unit and its modeling need to be talked about in details i.e. Modeling of all generating unit should be stated clearly.

Use a conservative model for the electrical generators.

The higher models, 3rd, 4th, 5th or 6th etc. are used. Constant voltage behind the sub-transient reactance Xd, Xd', Xd", td, t"d.

Do not include the Xd" sub-transient' analysis because they die off early.

Modeling of the governors, we never looked at the hydro-units may be they are far from where the fault are applied.

Proper modeling of Governors

Take max advantage unit has been submitted to PHCN on transient stability study by consultants. This will give us the details of practical/application or theoretical report.

On the Tables

We may have to split it on regions and the table becomes compact. It is very long to follow:

There are some units with zero unit values; there is no need to include then in the report even when there are different scenarios.

They are not in the base case or scenarios we should remove then or bring them in when necessary.

Please provide references and Acknowledgement for this report.

The equipment has a standard range that Xd" - 0.6 pg of a generator will fall into similarly the Transformer should not be more than 10%.

The header row of tables should be repeated at every page for easier reference.

Other comments

You must have adequate reserve for stability and maintenance

The parameters Xd, Xd", td, td" doubt change.

Parameter changes when we come to economic aspect i.e. fuel usage.

Observed the possibility of the system frequency to be 50Hz is very small.

For transmission line, the parameters can change if there is change in configuration but it doest change. We may use stochastic method.

Did you discover any difference between the designed parameter and derived parameters?

The social aspect was not considered. Development and line clearance are no longer only the capacitance of the line will be affected because of the built up area.

The reaction of the rotor after a fault scenario.

Energo told us about the new equipment used to measure reactances of the line.

2.1 Prof. Katende – Covenant University, Otta

He re-echoed Prof. Aliyu's appreciation on the study team. His presentation is on

He was happy that the team that did the work is African.

He shared his experiences with the power system operation in Nigerian – Happy that Nigerian Engineer has come of age.

A system can only be useful if it is stable.

Stability Aspect

Derived some confidence that something right has been done.

We should have the right model of the different system and subsystem available.

The reports should be in volumes.

There should be a version of the Volume meant for expert to be able to

Evaluate and tell the people that yes you know what you are doing.

The stability result depends on the generator loading, event though we are operating on a region of softest load.

The reactances we are using in the M/C are still the same, the reactances of these lines and M/C must have changed both at the receiving and sending end.

We need to carry out study on parameter to find out the changes recorded on these elements.

We need to check the parameters changes over time.

Analysis for the need of PSS, stability study: voltage, Transient and long term stability should be considered

Stability result depends on generator load. So, scenario should be used

Clearance Time

The circuit breaker used shows that they are still 330kV, may require between 8-12 cycles as recommended by IEE.
We need to increase the clearance time, it is too short - 200 seconds.

The type of stabilizers determine how stable should be, are they design for our type of network, since generation is more from the south.

There is need to do this type of analysis in order to know the type of Stabilizer.

The method used in carrying out the study is quite in order.

Most 330kV CBs require 6-8 cycles. Therefore, increase clearing time to see what happens.

Finally

The issue of the definitions in the sense that we talk of Angle, stability, voltage stability and voltage collapses, or long term and mid term stability.

Solution proposed for one, should not be used for others so that we do not solve one and leave others.

IEEE - Records discontinuity of Dynamic stability definition should be of standard.

IEEE standard should be followed.

2.3 Mr. Ntsin – Volta River Authority, Accra

Commends the team.

Operation Department commends what the Planning Division is doing.

Every collapse must be investigated to find out the problem, the way the unit went down, record it the process and eventually simulate it before we can conclude and know what happen to avoid future occurrences.

Planning Engineers should send out reports for operators to use/study.

After witnessing two collapses in VRA, a study was carried out that revealed the cause to be aging lines, after this study the system has improved with little or no collapse recorded.

Harmonize load shedding, by running dynamic stability – they shed load instead of system collapse.

Frequency Studies

Frequency problem should be considered because of frequency problem, we should carryout further study on how we can synchronize the frequency for WAPP project.

Dynamic analysis to determine setting limit of relays, line capability

Getting the models right is the beginning of getting the study right.

2.4 Mr.Kuevidjen – Communaute Electricite du Benin, Lome

Commended PHCN team.

Dynamic study

The models used by PB Power.

Did they consider the actual value of these governors i.e. by PB Power?

Because the parameters of these machines are not the same due to ageing.

Frequency control.

Please send us more power from SAKETE! but our problem is frequency instability, will you take care of this problem if the system is increasing, the system frequency is swing too much from $48H_2 – 51H_2$.

Explained the present difficulty to tie Nigerian Network to VRA and CIE due to frequency swing and requested dedicated study to address it.

We need to validate the PB Power parameters even though most of the data presented/used are typical values.

2.5 Engr. Zaccheaus – Power Holding Company of Nigeria, Abuja

Generator pulling out - did you consider it?

Post fault was considered. Aliyu said such that pre-fault and post fault are same.

Making use of a large unit equivalent to the largest unit in the system

Egbin the largest single unit 220 MW.

PHCN has a reserve margin of 15% - wide implication. Maintenance scheduling becomes difficult. so the reserve margins should be there for maintenance to be done. It must be there.

This study will go to reliability.

Frequency continue - Based on our collaboration, we have received a frequency disturbance recorder, we have been able to monitor PHCN frequently. It gives us the time lag and GPS.

Most of the governors are not working.

2.6 Engr. Somolu – Presidency, Abuja

The only way to remove a fault is to remove the bus connecting the generator to the line.

2.7 Dr. Akinbulire – University of Lagos, Lagos

Supported the Predecessor – on appreciating the study team.

The need to have efficient and reliable databank.

Power Flow Analysis:

i- Clearance should be made.

Kainji is selected as slack bus, from the flow result page 82., are they separated units or lumped (units at Afam)

Data collected should show substation voltages.

Is the analysis extended to voltage level less than 330kV - Yes?

Graphical method of representation of the results of the report to be able to identify the overloaded lines etc.

The line type is not indicated in the report. (Bison, Bear and Wolf). The P/P of the power flow analysis should be of high quality from the 2006 network should have been verified from the actual values obtained from the site to give good comparison with the other software tool.

The thermal unit of the lines was stated, the limits are not likely to be more than 60% design value due to the wears and tears it was subjected to and should be swing another look.

The valuable part of the network should be indicated. The progressive side moves from radical to ring/mesh network.

The analysis of course is done after the generating station location has been finalized and thus we would want to see the effect of the generator on the network.

The analysis of course is done after the generating station location has been finalized and thus we would want to see the effect of the generator on the network.

2.8 Dr. Okafor – Presidency, Abuja

The 2006 result as the base case. i.e. the last peak of 3774.4 of August S/2005.

The result collected from the field is comparable with that obtained result from NEPLAN.

2.9 Mr. Kendadusi – Communaute Electricite du Benin, Lome

Power flow - Is it possible to extend the year of study because we have stopped at 2008.

Because Nigeria has a large power to deliver to WAPP 25MW.

Bottleneck at Benin - It is possible to create more substation in this area.

Frequency control needed to be considered the frequency fluctuation should be considered.

2.10 Dr. Okafor – Federal University of Technology, Owerri

Commend the Chairman and team of the study for picking quality people.

Formation of Research and Development in PHCN.

More challenge to develop software in Nigeria that can solve the flow.

Jiyoda's report compared with ours.

The contingencies report of Jiyoda and other.

Result of the analysis must be consider for (n-1)

The min ad max demand of load to carry, there are no re-enforcement on expansion of transmission lines.

Contingencies

1. - (n-o) – whatever the generation is including NIPP our power could be whether to the load centers.

But the (n-1) states that if we lose a line, the system will be unable to wheel the power to the load center. This is because of the radial system, but if we have a ring circuit the system stability is assured.

Prof. Aliyu - We should move away from n-1 to credible contingencies.

On Parameters - * You must start from the fundamentals * Conductance (g)

Temperature – Corona effect - we loose power if we can model if we represent it.

Variational analysis - increase/it by 1%, 10%, and see the effect of these changes.

2.11 Engr. Anumaka – Transmission Company of Nigeria, Abuja

Derating of equipment and line.

The capacity of a generator can be reduced, if the cooling of the transmission is not working, we cannot push more power than the transmission can take.

3.0 RESPONSE TO PARTICIPANTS' COMMENTS

Most of the comments from participants have been incorporated into this Final Report. Others will be addressed in follow-up in-house studies.

4.0 LIST OF PARTICIPANTS

S/N	Name	Affiliation	Address
1	Egr. F. A. Somolu	NIPP	27, Mississippi Str. Maitama Abuja
2	Ben K. Ntsin	VRA	Eng. Dept. VRA Box M77, Accra
3	Kindadoussi Norbert	CEB	Control Centre Manager
4	Kuevidjen Dosseh	CEB	CEB - BP 1368 Lome
5	Yaneogo Guy Marie	SONABEL	01BP 54 Ouga 01
6	Sanou Honore	WAPP	06BP 2907 Cotonou Benin
7	Okudo Ikechukwu J.	OTIS/NIPP	27, Mississippi Str. Maitama Abuja
8	Engr. C. A. Anyanwu	TCN/PHCN	Power System Planning , TCN Nigeria
9	Engr. Abuh Jeremiah Usman	NIPP/OTIS	Otis Engr. Maitama Abuja
10	Engr. Abutu E	TCN/PHCN	PSPD, CHQ Abuja
11	Ogunsina Ayodeji A	NIPP/Presidency	Office of SSAP, PHCN HQ Maitama Abuja
12	B. A Ishola	TCN/PHCN	NCC Oshogbo Osun State
13	E. A. Anumakka	PHCN	PSPD, CHQ Abuja
14	Kanayo Anyionwu	LI/OTIS	27 Mississippi St. Maitama Abuja
15	Adjekpiyede O. Ovie	NIPP/Presidency	Office of SSAP, PHCN HQ Maitama Abuja
16	Dr. E. N. C. Okafor	FUTO Owerri	Elect/Elect FUT Owerri
17	Dr. F. N. Okafor	UNILAG/ Presidency	Elect/Elect Dept. UNILAG, Lagos
18	Dr. T. A. Inugonum	PHCN/TCN	PHCN HQ Maitama Abuja
19	Engr. M. A. Ajibade	PHCN/TCN	PHCN HQ Maitama Abuja
20	L. O. Ejiofor	Energy	Fed. Ministry of Energy, Abuja
21	Dr T. O Akinbulire	UNILAG EEED	Elect/Elect Engr. UNILAG
22	Prof. U. O. Aliyu	ATBU Bauchi	School Of Eng. ATBU, Bauchi
23	Prof James Katende	Covenant University	College of Science & Technology, Covenant University, Ota

5.0 RAPPORTEURS

1. Engr. E. A. Anumaka – TCN, Abuja
2. Dr. T. A. Inugonum – TCN, Abuja
3. Engr. B. A. Ishola – NCC, Osogbo
4. Mr. A. Ogunsina – Presidency, Abuja
5. Mr. Ovie O. Adjekpiyede – Presidency, Abuja

NEPLAN Training

1.0 INTRODUCTION

A weeklong training on NEPLAN system analysis suite held from 26 to 30 March 2007 in Abuja.

The training was conducted by Dr. Luigi Busarello, one of the partners of Messrs BCP of Switzerland, the developers of NEPLAN software.

BCP kindly made extra NEPLAN licences available for the training with the result that each participant had the full latest version of the software (version 5.3.3) for a hands-on training programme.

2.0 TRAINING PROGRAMME

Monday 26.3.2007 – Friday 30.3.2007 (9:00 – 18:00)

1ST DAY (MONDAY 26.3.2007)

NEPLAN-BASICS
OVERVIEW, NETWORK MODELING, DIAGRAMS, AREA/ZONES, SCALING FACTORS, DATA MANAGEMENT, ELEMENT LIBRARIES, HELP, PRINTING

2ND DAY (TUESDAY 27.3.2007)

EXTENDED NETWORK MODELLING AND CALCULATION
TAP CHANGER, NON-LINEAR LOADS, SVC, COMPENSATION (REACTORS, CAPACITORS), DATA REQUIREMENTS FOR LOADFLOW AND OPTIMAL POWER FLOW, SHORT CIRCUIT, DYNAMIC ANALYSIS, SMALL SIGNAL STABILITY AND VOLTAGE STABILITY

3RD DAY (WEDNESDAY 28.3.2007)

SETTING UP AND MODELING OF CONTROLS FOR DYNAMIC ANALYSIS (AVR, GOV, PSS)
HOW TO BUILT-UP A CONTROL, FUNCTION BLOCKS, INITIALISATION OF CONTROLS, LIBRARY, COPY/PASTE, INPUT OF A CONTROL FROM SCRATCH

4TH DAY (THURSDAY 29.3.2007)

EVALUATING THE EXISTING NETWORK MODEL
NAMING OF ELEMENTS, CONTINGENCY ANALYSIS, SIMULATIONS AND IMPROVEMENTS

5TH DAY (FRIDAY 30.3.2007)

EVALUATING THE EXISTING NETWORK MODEL (CONTINUE)
SIMULATIONS AND IMPROVEMENTS

QUESTIONS AND ANSWERS
SOLVING SPECIFIC PROBLEMS ENCOUNTERED BY THE TRAINEES

3.0 LIST OF PARTICIPANTS

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