Palestine Polytechnic University

College of Engineering

Study the Effect of Embedded Generation on the Medium Voltage Network: Bio-gas Case Study

By

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الإهداء

إلى ذلك الحضن الدافئ، إلى رائحة الجنة، أمي، من سهرت الليل حتى تراني في أجمل حلة، إليك أهدي هذا النجاح.

وإليك يا أبي، يا من كنت الشامخ رغم الملمات، كنت المتابع رغم بعد المكان والمسافات، إليك أهدي هذا النجاح.

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والتي لأجلها نثابر، ولنصرها نعمل ليل نهار، ولفجر عزها الذي اقترب على البزوغ.

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" أعَلِمتَ أشرفَ او أجل من الذي ... يبني ويُنشئُ أنفساً وعُقولا "

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ABSTRACT

The electrical power system of Adahiriya is a compact and integrated structure in hierarchical aspect. It works under medium voltage and supplied by 33KV delivered by Southern Electric Company. It plays an important role in the process of distribution of energy to the consumers.it is necessary to study and analysis the medium voltage network in order to estimate the power generation at this part of network for long term plans. The Object of this study is to investigate the effect of connect a generator on medium voltage networks and its effect on the power factor, voltage profile, total harmonic distortion, current fault, and losses. In order to emphasize the importance of the connections of synchronous generators in medium voltage level. The analysis of the Adahiriya electrical power system as performed by means of ETAP 12.6 software, whereas the connection of the embedded generation on medium voltage network increases the voltage profile and reduce the losses on destitution lines, its effect includes reducing the total harmonic distortion of voltage and current, also improves the power factor, slightly increases the fault current.

الملخص

تعتبر شبكة الظاهرية شبكة متكاملة مبنية بشكل شعاعي وتعمل على الضغط المتوسط ومغذية بجهد 33 كيلو فولت بالإضافة الى انها مزودة عن طريق شركة كهرباء الجنوب والتي بدورها تقوم بدور مهم في عملية توزيع الطاقة الى المستهلكين. بناءً على هذه الأهمية من الضروري العمل على تحليل شبكة الضغط المتوسط لتقدير خطط طويلة الأمد لبناء وتطوير محطات انتاج الطاقة. الهدف من هذا المشروع هو دراسة تأثير ربط مولد على شبكة الضغط المتوسط وتأثيره على معامل القدرة و مستوى الفولتية وتسريب التيار وتشوه الموجة الكلي (التوافقي) والخسائر، وذلك للتأكيد على اهمية عمل المحطات وربطها على شبكة الضغط المتوسط حيث ان الدراسة ستتم باستخدام برنامج الـ ETAP 12.6 على الحاسوب، حيث وجد أن إضافة مولد على الشبكة يعمل على تحسين مستوى الجهد ويقلل من الخسائر في خطوط التوزيع، ويشمل تأثيره على تقليل نسبة تشوه موجة التيار والجهد، ويحسن معامل القدرة على الشبكة، ويعمل على زيادة تيار الخطأ في حدوثه.

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LIST OF ABBREVIATION

ABBREVIATION	Meaning
EG	**Embedded Generation**
VP	**Voltage Profile**
THD	**Total Harmonic Distortion**
PF	**Power Factor**
ETAP	**Electrical Transient Analysis Program**
PWS	**Power World Simulator**
SElCo	**Southern Electrical Company**
DG	**Distribution Generation**
IEC	**Israel Electrical company**
TDD	**Total Demand Distortion**
MV	**Medium Voltage**
GVR	**Gas Filled Vacuum Recloser**

Chapter One

Introduction

1.1 Overview

1.2 Objective

1.3 Challenges

1.4 Methodology

1.5 Importance and motivation

1.6 Time schedule

Chapter One

Introduction

1.1 Overview

The fundamental concept of this project is to study and analysis the medium voltage electrical power network of Adahiriya city, and the effect of Embedded Generation on the network, whereas the study will concern on the voltage profile, power factor, unbalance of the load, current fault and total harmonic distortion on the network with and without EG, which will be studied by using a numerical method such as ETAP.

1.2 Objectives

- Study and analysis the medium voltage network: Adahiriya case study.
- Study the load profile -achieved by using Fluke 435 Power Quality Analyzer-.
- Study the effect of EG on medium voltage network, which will be concerned on THD, unbalance of the load, VP, PF and current fault.
- Suggest solutions and recommendations for problems as mention above of the network, if it exist.

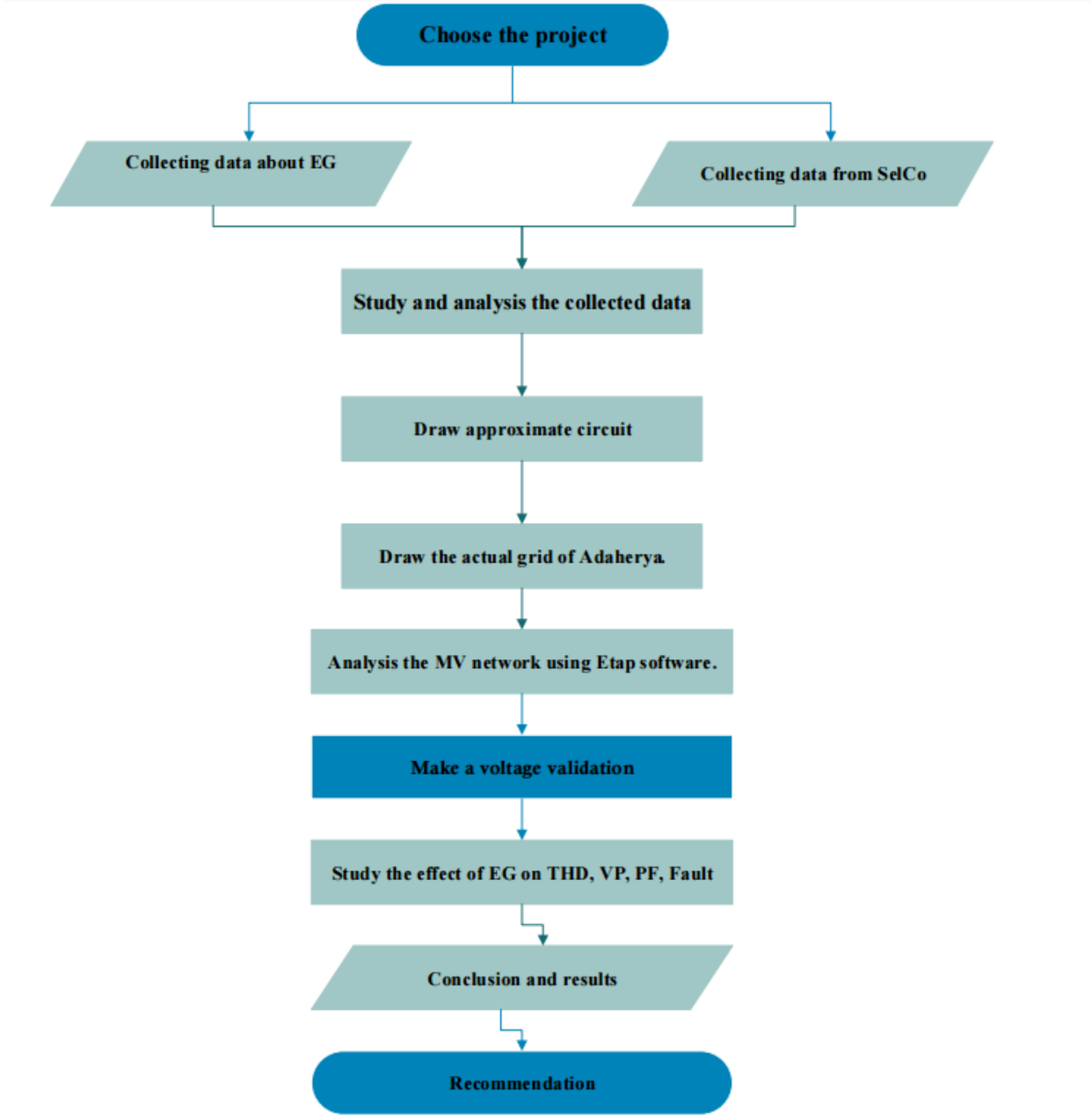
1.3 Challenges

This study has faced many challenges, main challenges represented as:

1. The access for data and data collection:
    - There is no collected data about Adahiriya network.
    - To collect the load profile data to the network which needs a very long time - 24 hour for each substation.

2. Power world Simulator software demo version 15, work only for 40 bus and number of buses in the network much higher.
3. Al-Jebrini's EG does not work continuously on the grid, just for limited time.
4. Because of political matters, there is no available data about tie point.

1.4 Methodology



1.5 Importance and motivation

Adahiriya is one of the most important citties in Hebron, it's load classified as residential, industrial and commercial, that make the reliability and security in the system are more important.

This research give the information about Adahiriya network to operate it at reliability case moreover helps to know what are the risks and weaknesses in the network with and without EG and how to solve it, in addition to suggest how to reduce the losses on the grid which leads to get higher rate of efficiency and finally knowing the capability of the system

1.6 Time schedule

First semester																
Week / Work	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Choosing project																
Determine required software																
Collecting data																
Data analysis																
filed tour & single line building																
Preparing the final report																

Second semester																
Week / Work	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Collecting data																
Data analysis																
Building the network on the Etap																
Analysis the Etap circuit to get results																
Editing for the introduction of project																
Preparing the final report																

Chapter Two

Literature Review

2.1 Scientific paper

2.2 Summary

Chapter Two

Literature Review

2.1 Scientific paper

Shaqiri at all [1] studied the effects of the hydropower generation plant on the medium voltage level of dragash. He developed a numerical model using ETAP 12.6, software the study investigates the effect of 6 MW generation on the network during the maximum and minimum generation of plant. The important of the generation on the voltage profile, short circuit current, stability, voltage deviation, voltage symmetry and power factor was descripted in details.

A. Bonhomme, D. Cortinas, and F.Boulanger at all [2] Study the impact of dispersed generation on the distribution network, and suggests a technical solution which would permit to connect more generators on the network in good conditions. It improves the network voltage, costs and the quality of supply. To improve the voltage in the network through several techniques including tap changers and dispersed generator.

Lombard at all [3] The harmonics in power systems causes abnormal operation and aging for the devices, also causes a high level of losses in the networks, so it's affecting on the planning and design a future network, especially on the price of electrical services. The study interested in estimating the losses includes both active and apparent power in this domain depends on the actual data was measured on a MV network of South Africa, the objective is to create a module to rate local networks to estimate the losses and its impact on future planning and revenues from decreasing the THD levels on the MV network. The most important challenge faced this project no permanent information about the harmonics in distribution networks.

Lucian Dulau at all [4] Analysis the main effect of the DG on the power system such as: increasing the level of the short circuit, reduce the power losses in the network, change the voltage profile of the network and the voltage transients will appear because of connection and disconnection of the DG on the network. Finally, the DG is a clean recourse that is reduce the greenhouse gas emissions.

Muhammad Javed and Mohsan Islam at all [5] The electrical energy demand is increasing day by day, that is need to discover new recourse to cover the increasing of the demand, in new days DG using to cover the increase the demand in the power system. The DG are located in near to user site or load which can be operated in grid or isolated plant. ETAP program using to analysis the main effect of the DG on improve the voltage profile, reduce the power losses in the network and improve the reliability of the system.

H.Shateri , M.Ghorbani and N.Eskandari alt all [6] Methods used in power flow calculation in transmission lines should not be used in distribution systems because of distribution systems owns special characteristics. Typically, distribution networks have one source for feeding loads - radial system-, sometimes there will be a DG feeding the loads directly and it’s the different between the distribution system and the transmission system. so, this paper study the power flow methods in distribution network in unbalance condition, to reduce the losses caused by the unbalance load by connect DG on the network in many configurations such as constant and balanced generation for both active and reactive power, constant generation for active power and variable generation for reactive power in one of the phases, constant generation for active power and variable generation for each phase, and variable generation for active and reactive power.

2.2 Summary

1. The main effect of the DG on the medium voltage network on the voltage profile, short circuit current, stability of the system, voltage deviation, voltage symmetry and power factor.

2. Suggest the technical solution to determine the number of the generator can connect to the network, whereas the THD does not exceed 20% in network which affect on mal operation of the relay and relays in the protection system becomes under reach or over reach.

3. Estimate the losses in the network caused by the harmonic and create module to estimate the losses and the impact of it in the future network.

4. To reduce the losses caused by the unbalance system should be connect the DG to the network.

Chapter Three

Adahiriya City Networks (Substations)

3.1 Introduction

3.2 Medium voltage network description

3.3 Component of the network

Chapter Three

Adahiriya City Network (Substations)

3.1 Introduction

Adahiriya is a Palestinian city in the Hebron Governorate, 23 km southwest of the city of Hebron in the Palestine. The population of Adahiriya is about 36000. The area of Adahiriya is 120854 acres [7].

SelCo is a power distribution company works at medium voltage level (33KV), it takes its energy from the Israeli Electricity Company IEC to supply three municipalities Adahiriya, Yatta, and Dura, in this project Adahiriya grid will be taken into account.

The electrical power system of Adahiriya is compact and integrated structure in hierarchical (radial) aspect, it acts as a good role in the distribution of the energy to the consumers, and mainly it satisfies the main factors that ensure the continuity in the power flow to the consumers [8].

3.2 Medium voltage network description.

The electric power company provided the project an air map for Adahiriya, Which contains transformers locations, underground cables, overhead lines types and main disconnect switch. The air photography of Adahiriya is shown in **Appendix A**. Adahiriya electric power network has one tie point that connected it with the Israel electrical Company.

3.3 Component of the network

SelCo has all required component to keep the system operate at security and reliable case, which are explained below.

3.3.1 Distribution lines

Two classifications of distribution lines in the network, underground and overhead line, also there are one type of underground cables and three types of overhead lines are used -Coyote, Dog and Rabbit- as mention in table 3.1. The Distribution line parameters are shown at **Appendix B1**.

Table 3.1: Distribution line

Line Type	Distance (km)
Coyote	7.3
Dog	3.934
Rabbit	10.01
Nexans, single core XLPE 95 mm^2	24.322

3.3.2 Distribution Transformers:

Distribution Transformers are one of the most important equipment in power system network, it transfers the voltage from medium voltage level to the low voltage level, Adahiriya network includes number of transformers around 54 Distribution transformers, and these transformers have a wide rating range from (160-630) kVA. The transformer technology is ARDAN, MACE, and ABB Electrical industries "oil distribution transformer" is shown in **Appendix B2,** the transformers can be shown as follow in Table (3.2)

Table 3.2: Distribution Transformers Substation

Transformers Ratings Network (kVA) (33KV/0.4KV)	Number of Transformers
630	6
400	14
250	29
160	7

3.3.3 GVR Auto Recloser

The GVR provides intelligent control and protection on power distribution networks, there are three GVR Reclosers connected at 33kV side divided the network for three protected areas, controlled by (POLARR) programmable relay. GVR Auto Recloser's data sheet is shown in **Appendix B3**.

3.3.4 Towers

Towers are using to transfer the electrical current from one place to another through the overhead lines and towers designed to carry the lines on a high distance enough from the ground to keep in the safety. There are many different designs of the towers in Adahiriya network such as lattice steel and truss tower.

3.3.5 Disconnector switch

Outdoor switch disconnector is used, it located at the head of the tower and switch off/on manually, however it used in the network and operate with rating of 24/36 kV. Disconnector switch data sheet is shown in **Appendix B4**.

3.3.6 Surge Arresters

This device is used to protect from overvoltage external -Lighting- Internal Switching- by breaking the insulation down, due to that the high current will pass to the earth instead of equipment, at Adahiriya network has Surge Arresters with rated voltage 5KV-36KV. Data sheet is shown in **Appendix B5**.

3.3.7 Insulators

To prevent touching between live lines and other equipment -Transformers, Towers, etc. two classifications used to insure a good insulation which are Vertical Connection and Horizontal Connection.

- Vertical Connection: Made by porcelain and used to isolate between equipment and live lines.
- Horizontal Connection: Made by glasses and used to tensile the live lines.

Chapter Four

Embedded Generator (Al-Jebrini case study)

4.1 Introduction

4.2 General discussion of synchronous generator

4.3 Connection the Distribution Generator to the power system

4.4 Al-Jebrini Embedded Generator

4.5 Modeling of the Embedded Generation on the power system

Chapter Four

Embedded Generator (Al-Jebrini case study)

4.1 Introduction

Renewable energy is the energy that came from natural resources such as wind, sunlight, waves, biomass and geothermal energy that resources using to production the electricity in specific area, the process using to produce the electricity is called Distributed Generation. DG is using to cancel the traditional centralized system on the network, where can using more than one of the power sources on the network.

The main advantages of the DG have small size that is can be placed close to the load where that characteristic provide better voltage and improving the power quality of the network, reduce the transmission losses and improve reliability of the system, in addition the DG reduce the greenhouse gas emission because the source of it is clean and efficient energy.

4.2 General discussion of synchronous generator

4.2.1 Power system stability

The power system stability refers to the machine in the system remains in synchronism with the system in the case of occur a disturbance in the power system.to keep the generator in synchronism with the power system, this process depends on the excitation system in the generator, the excitation system must provide the energy for the magnetic field to maintain it in synchronism with the power system. In addition, the excitation system also affect on the amount of reactive power that the generator may absorb or produce to maintain it with synchronism of the power system. Increasing the excitation current leads to increase the reactive power output and decreasing the excitation current the reactive power output will be decreased; this operation affect on the synchronism of the generator with the power system[9].

4.2.2 Capability curve of a Synchronous Generator

The Capability Curve of a Synchronous Generator is defines the limits within which the machine can operate normally and safely.

The allowable region of operation is bounded to the following points:

1. The stator winding limit is a long-term condition relative to the generator winding current carrying capability.
2. The rotor heating limit is relative to the rotor's current carrying capability. It is also associated with longer time conditions.
3. The stator end iron limit is a relatively short time condition, caused by a reduction in the field current to the point where a significant portion of the excitation is being supplied from the system to the generator.

The capability curve is based in the phasor diagram of the synchronous machine [9].

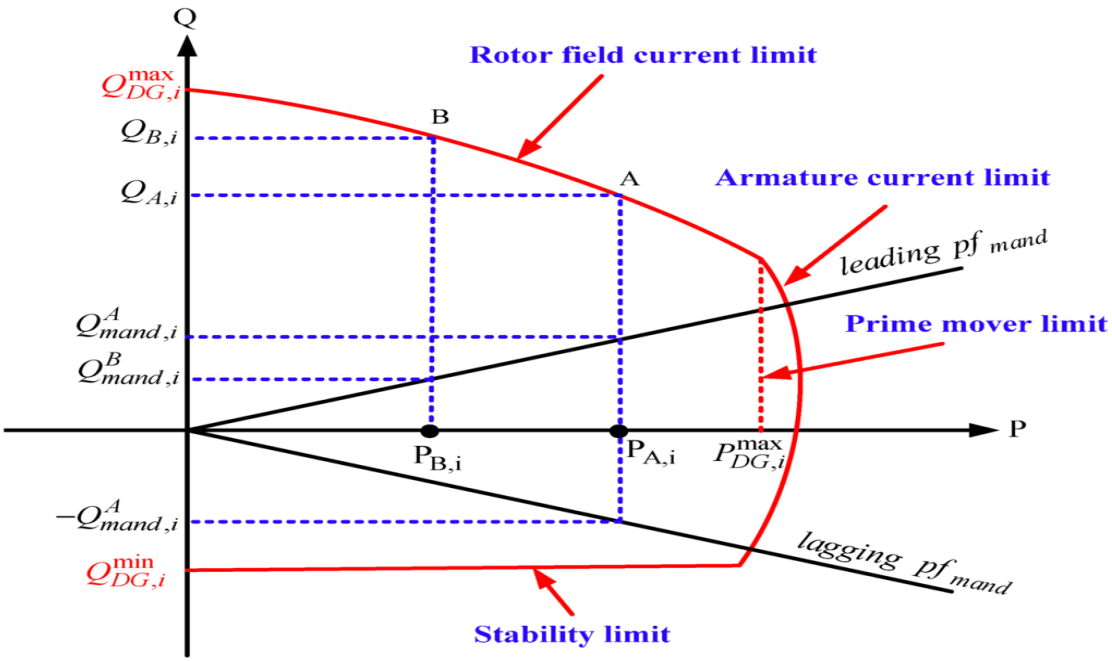


Figure (4.1): Capability Curve of a Synchronous Generator

4.2.3 Protection System Requirements for Synchronous Generator

Protection of the Synchronous Generator depending on the characteristics of it such as rated power, technology used and the mode of operation. If a fault occurs, the standards of interconnection require that the protection system of SG must be disconnected from the network. The protection system of SG working to detect the fault using intelligent relay control a motorized circuit breaker for rapidly disconnect and isolate the SG from the network, but in the normal operation of the system, the protection system of the SG will not interfere.

4.3 Conditions of connection the Distribution Generator to the power system

In order to synchronize a generator to the power system there four conditions must be met:

1. Phase Sequence

   The phase sequence of the three phases of the generator must be the same as the phase sequence of the three phases of the electrical system.

2. Voltage Magnitude

   The magnitude of the voltage of the grid must be equal to the magnitude of the voltage produced by the generator. If the grid voltage is less than the generator voltage, when it is connected to the grid the generator will be overexcited to solve this problem the generator will produce Kvar. If the grid voltage is more than the generator voltage, when it is connected to the grid the generator will be underexcited to solve this problem the generator will absorb Kvar.

3. Frequency

   The frequency of the voltage produced by the grid must be equal to the frequency of the voltage produced by the generator

4. Phase Angle

   The phase angle between the voltage produced by the generator and the voltage produced by the grid must be zero.

4.4 Al-Jebrini Embedded Generator

Al-Jebrini Company in Adahiriya city have biogas Embedded Generator in this project will be taken into account as a case study. See Al-Jibrini site in **Appendix A.**

The synchronous generator-directly coupled- was designed to provide electrical power reach to 380 Kw on the efficiency 96.4% by Leroy Somer, the rated voltage of the generator 400 ± 10% at frequency 50 Hz and the power factor of the generator within the range from 0.9 leading to 0.9 lagging, it also coupled with a voltage regulator (AVR) work to maintain the voltage within the range, and it is proved with control and monitoring system can remotely control by using SCADA system, however synchronous generator is not a source of harmonics on the network. Datasheet is shown in **Appendix C**.

4.5 Modeling of the Embedded Generation on the power system

To connect the DG to the network with 33KV it will be connected to a step-up transformer, in addition the connection of transformer at high voltage (33KV) side should be delta, and the low voltage (0.4KV) side is wye to ensure the isolation of the triplen harmonic.

The connection of EG to the network by step up transformer can be modeled as a simplified electrical system building in Etap.

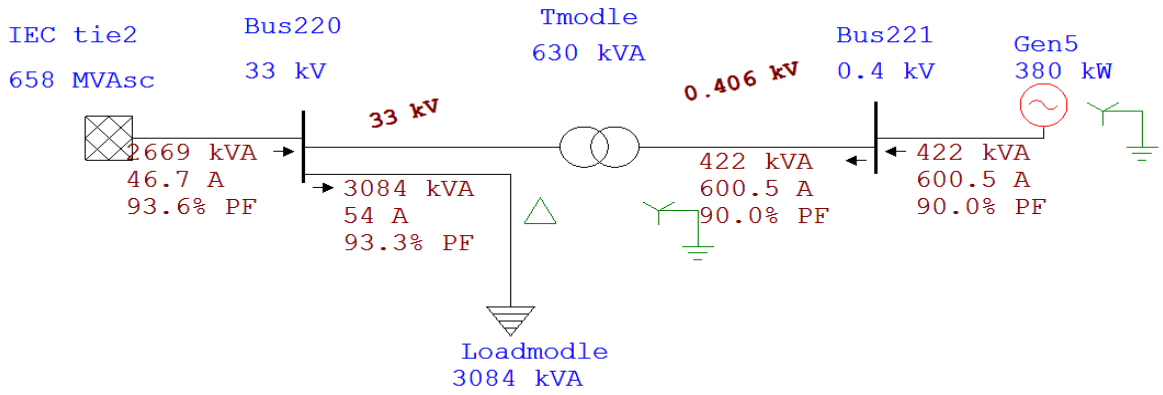


Figure (4.2): Modeling of the Embedded Generation on the power system

Chapter Five

Collecting data and analysis

5.1 Power quality analyzer

5.2 Data collection

5.3 Data analysis

Chapter Five

Collecting data and analysis

5.1 Power Quality Analyzers

Power Quality Analyzers is a device used to analyze the power on lines and substation. The Analyzer offers an extensive and powerful set of measurements to check power distribution systems. By using Fluke 435 the standard IEC61000-4-30 2003 Class A, It is used to obtain data in the form of values and curves such as: voltage, current, Frequency, power, energy, power PF and THD.

Figure (5.1): Power Quality Analyzers

5.1.1 Examination and installation steps

1. Configuration and programming the device through the substation in terms of voltage, current and the method of connection of the current transformer inside the station

2. Selecting the scan duration and determine the period between each reading, and select the period 24-hour divided into 5 minutes to read the data

3. Connect the device to the substation and start recording readings
4. disconnect the device after finish of the examination period
5. collect the readings from the device and transfer to the computer
6. analysis the readings data

5.2 Data collection

After recording readings from the device and transfer it to the computer, to obtain the required data in this study such as Voltage, current, Frequency, power, energy, power and total harmonic distortion. Adahiriya contains 54 electrical Transformer, it takes 24 hour for each substation as in **Appendix D**, and the following table (5.1) can show these Transformer.

Table 5.1: Transformer rating and loading level

No.	Name	Rating KVA	Percentage of average loading %	Percentage of maximum loading	No.	Name	Rating KVA	Percentage of average loading	Percentage of maximum loading %
1	Al-masjid Al_kaber	630	30.3	42.8	2	Mothalath Al_borg	630	30.3	42.8
3	Maskaneh	630	30.3	42.8	4	Bear mtawi'	630	22.7	31.5
5	Wad algamary 1	400	26.5	48	6	Wad algamary 2	250	10.4	28.9
7	Al_deir 1	400	32.7	55	8	Karam al_ashqar	400	17.3	28.1
9	Abu al_humas	400	32.7	55	10	Meqtaa' duma	400	22.9	40.5
11	Wad ali	400	24.2	40.3	12	Aqabit gharrarah	400	24.5	40.9
13	Qata't al_jamal	400	12	21	14	Al_markaz	400	18	23.4
15	Abu hashim	400	31.1	51.2	16	Sa'ada	400	14.5	24.3
17	Al_baladiya	400	14.5	24.3	18	Al_sheehk	400	31.1	51.2
19	Al-marj 1	250	17.3	29	20	Aqabit al_tarsha	250	30.4	48.9
21	Al_mustashfah	250	19.2	33.7	22	Da'na	250	10.6	36.6
23	Kurza	250	30.4	48.9	24	Al-deire 2	250	19.2	33.7
25	Rasmi wahab	250	10.6	36.6	26	Baten alqar'	250	25.8	39.6

27	Al_munta zah	250	13.1	21.6	28	Domet al_wridat	250	28.4	45.3
29	Juret al_dama	250	28.2	53.3	30	Kafar joul	250	17	30.5
31	Sam'a	250	6.2	12.9	32	Khalet al_ayaseh	250	10.2	20.2
33	Al_mizra b	250	6.8	14.2	34	Al_shada qa	250	10.2	14.2
35	Al_shuqf an	250	17	32.5	36	Al_estad	250	6.8	14.2
37	Eshreeteh	250	21.7	36.7	38	Al_muhta sib	250	16.2	23.4
39	Jammoq	250	22.6	43.5	40	Al_helal	630	1	1.9
41	Al_munta zah 2	250	13.1	21.6	42	Abu njeem 2	250	13.1	21.6
43	Al jame'a	250	13.9	23.6	44	Alghwla	250	4.9	9.5
45	Masafi	250	20	39.4	46	Al_jebren i	250	32	48
47	Abu_njee m 1	160	10.6	22.2	48	Inab al_kabeer	160	9.7	20.1
49	Shweki	160	9.7	20.1	50	Al-baha	160	35.3	68
51	Inab al_sagher	160	35.3	55.8	52	Bank al_eskan	160	6.8	22.2
53	Al_tork	630	16.1	19.5	54	Wad algamary 3	160	10.6	22.2
55	Mana'	250	8	20.9	56	Al jebreny step up	630	96.8	96.8

5.3 Data analysis

After collected the data that it need to analysis this data used to build the medium voltage network in the Etap software to discover the problems in the network that include unbalance in the system, harmonic and PF problem.

The results obtained from the readings that have been measured on Khalet al_ayaseh Transformer.

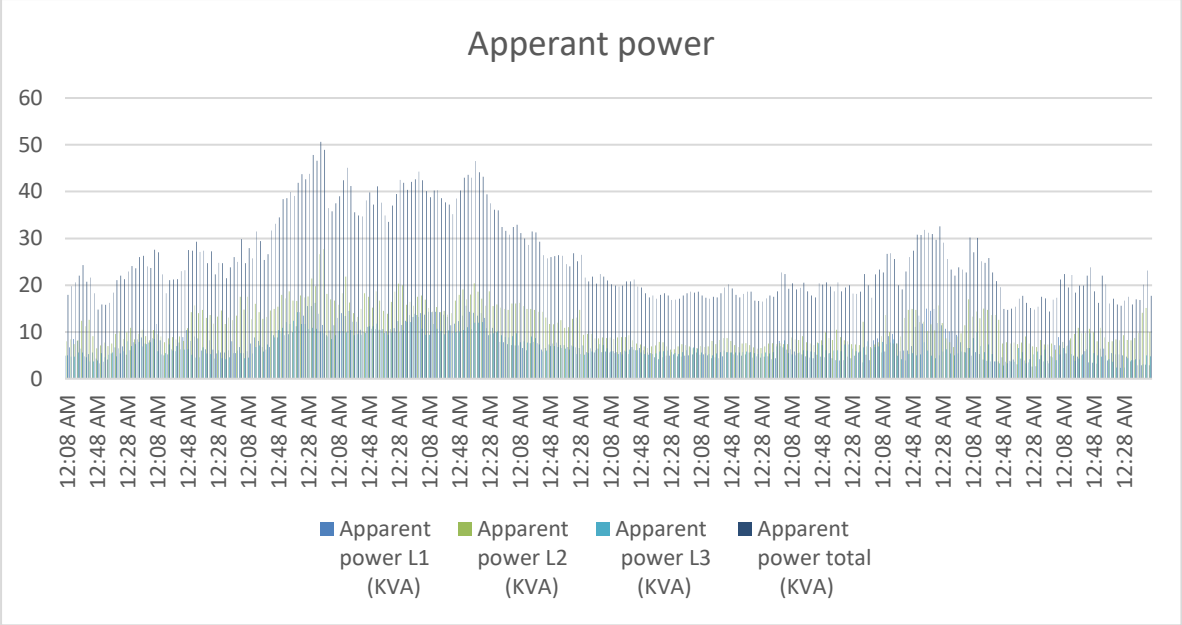


Figure (5.2): Apparent power in Khalet al_ayaseh Substation.

Table 5.2: Apparent power in Khalet al_ayaseh Substation.

Phase / load KVA	L1	L2	L3	Total
Minimum load	2.6	6.2	2.3	14.4
Maximum load	16.2	7	14.2	50.6
Average load	7.4	11.4	6.8	25.6

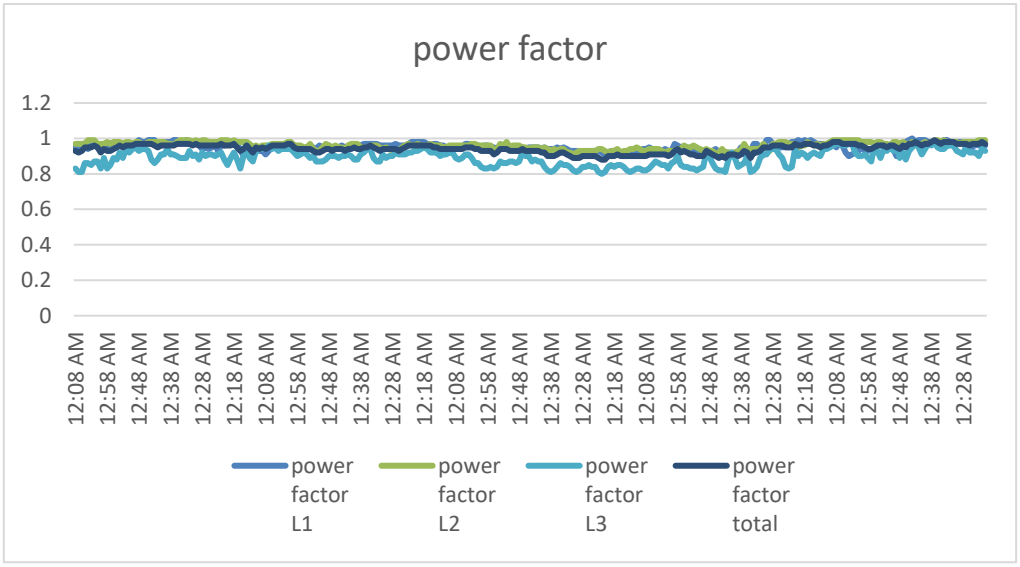


Figure (5.3): power factor in Khalet al_ayaseh Substation.

Table 5.3: Power Factor in Khalet al_ayaseh Substation.

Phase / PF	L1	L2	L3	Average
Minimum PF	0.9	0.91	0.8	0.88
Maximum PF	0.99	0.99	0.98	0.99
Average PF	0.953	0.96	0.89	0.94

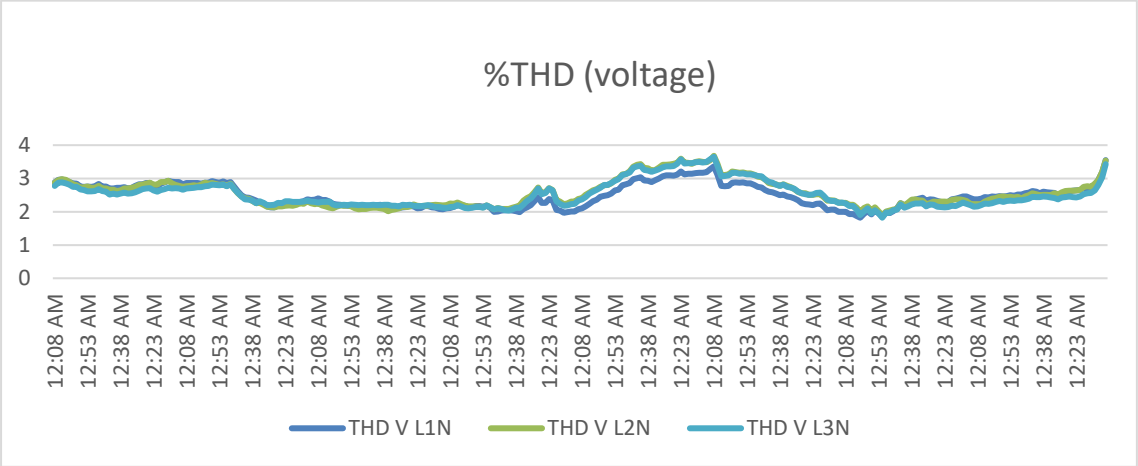


Figure (5.4): Percentage THD (voltage) in Khalet al_ayaseh Substation.

Table 5.4: Percentage THD (voltage) in Khalet al_ayaseh Substation.

Phase / THD%(voltage)	L1	L2	L3
Minimum THD	1.82	1.89	1.82
Maximum THD	3.55	3.68	3.65
Average	2.47	2.56	2.15

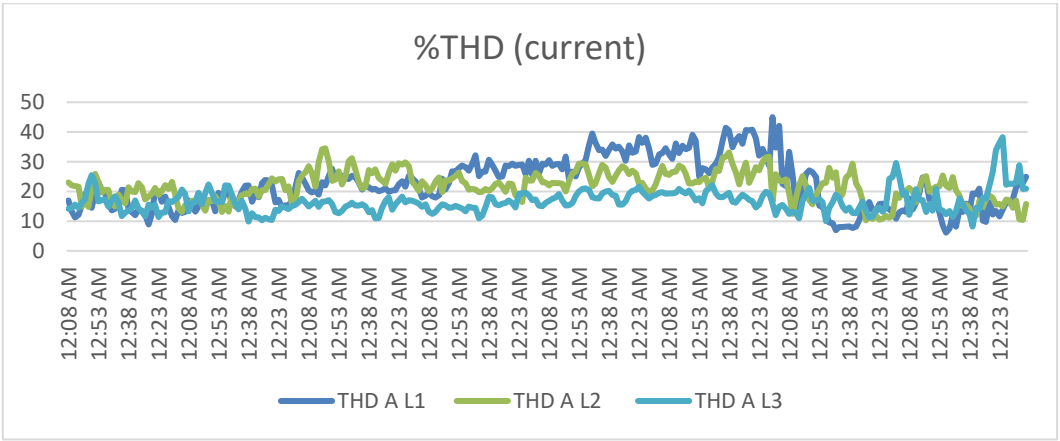


Figure (5.5): Percentage THD (current) in Khalet al_ayaseh Substation.

Table 5.5: Percentage THD (current) in Khalet al_ayaseh Substation.

Phase / THD%(current)	L1	L2	L3
Minimum THD	6.15	11.3	8.2
Maximum THD	45	34.5	38.2
Average	22.4	21.8	16.7

The Total Harmonic Distortion When applied the sinusoidal wave (voltage or current) to a nonlinear system that will produce an output wave with the same fundamental frequency as of the sinusoidal input wave but will also generate harmonics at multiples of the fundamental frequency. The total harmonic distortion (THD) using to measure the harmonic distortion present in the signal caused by a nonlinear system, that is defined as the ratio of the equivalent root mean square (RMS) (voltage or current) of all the harmonic frequencies (from the 2nd harmonic) over the (RMS) (voltage or current) of the fundamental frequency (the fundamental frequency is the main frequency of the signal).

The Global ratios are allowed as specified in IEEE 519-2014 depends on the bus voltage for THD_v and I_{SC} for THD_I which defined in IEEE's standard as TDD [10].

$$THD_V = \frac{\sqrt{V_{2,rms}^2 + V_{3,rms}^2 + V_{4,rms}^2 + \ldots + V_{n,rms}^2}}{V_{1.rms}} . 100\% \quad (5.1)$$

THD_V : Total Harmonic Distortion of the voltage

$V_{1.rms}$: rms value of the fundamental voltage

$V_{n.rms}$: rms value of the n^{th} harmonic

$$THD_I = \frac{\sqrt{I_{2,rms}^2 + I_{3,rms}^2 + I_{4,rms}^2 + \ldots + I_{n,rms}^2}}{I_{1.rms}} 100\% \quad (5.2)$$

THD_I : Total Harmonic Distortion of the current

$I_{1.rms}$: rms value of the fundamental current

$I_{n.rms}$: rms value of the harmonic n

$$TDD_I = \frac{\sqrt{I_{2,rms}^2 + I_{3,rms}^2 + I_{4,rms}^2 + \cdots + I_{n,rms}^2}}{I_{L.rms}} 100\% \quad (5.3)$$

TDD_I : Total Demand Distortion of the current

$I_{L.rms}$: Is the maximum demand load current in rms amps.

$$TDD = THD_I * \frac{I_{1.rms}}{I_{L.rms}} \quad (5.4)$$

To determine the maximum allowable TDD from IEEE 519-2014 standard table:

$$MVA_{sc} = \frac{MVArated}{Zsc} \quad (5.5)$$

MVA: The MVA of transformer

$$Isc = \frac{1000xMVA}{\sqrt{3}xKV}\ A \quad (5.6)$$

Isc: The short circuit current.

$$I_L = \frac{KW}{PFx\sqrt{3}xKV}\ A \quad (5.7)$$

I_L: The average demand current.

$$short\ circuit\ ratio = \frac{Isc}{I_L} \quad (5.8)$$

In this project find two Point of Common Coupling (PCC), the first PCC near the EG at medium voltage network:

$$MVA = \frac{MVArated}{Zsc} = \frac{0.630}{0.044} = 14.32$$

$$Isc = \frac{1000xMVA}{\sqrt{3}xKV} = \frac{1000x14.32}{\sqrt{3}x33} = 250\ A$$

$I_L = 6.4A$ The EG generate fixed current over the year

$$short\ circuit\ ratio = \frac{Isc}{I_L} = \frac{250}{6.4} = 39.06$$

Regarded to the table (5.6) 20 < 39.06 < 50 which means maximum allowable TDD = 8%.

The second PCC near the tie point at medium voltage network

$Isc = 10\ KA$ the short circuit current of PCC tie point find by datasheet of GVR

$I_L = 53.9A$ the average demand current find by ETAP analysis network

$$\frac{I_{SC}}{I_L} = \frac{10KA}{53.9A} = 185.5$$

Regarded to the table (5.6) $100 < 185.5 < 1000$ which means maximum allowable $TDD = 15\ \%$.

Table 5.6: IEEE standards 519-2014 harmonic current limit.

Maximum harmonic current distortion in percent of IL						
Individual harmonic order (odd harmonics)						
Isc/IL	**3≤ h < 11**	**11≤ h < 17**	**17≤ h < 23**	**23 ≤ h < 35**	**35≤ h ≤50**	**TDD**
< 20	4	2	1.5	0.6	0.3	5
20 < 50	7	3.5	2.5	1	0.5	8
50 < 100	10	4.5	4	1.5	0.7	12
100 < 1000	12	5.5	5	2	1	15
> 1000	15	7	6	2.5	1.4	20

Table 5.7: IEEE standards 519-2014 harmonic voltage limit.

Bus voltage V at PCC	**Individual harmonic (%)**	**Total harmonic distortion THD (%)**
V ≤ 1.0 kV	5	8
1 kV < V ≤ 69 kV	3	5
69 kV < V ≤ 161 kV	1.5	2.5
161 kV < V 1.0 1.5	1	1.5

The data of transformers analysis are shown in **Appendix D.**

Chapter Six

Software (ETAP)

6.1 Introduction

6.2 Modeling the network

6.3 Etap circuit analysis

Chapter Six

Software (Etap)

6.1 Introduction

In recent days, the using of software for analyze the network with a numerical method became more commonly, because of its simplicity, Accuracy of measurements, helps for planning and forecasting, and its ability to solve the problems, one of these software programs is Etap 12.6. Etap the most comprehensive software used to design the integrated electrical systems, which can provide many analysis types such as the power flow analysis in the two conditions (balanced load, unbalance load), In addition used to analyze industrial circuits, faults, THD, short circuit analysis … etc.

6.2 Modeling the network

The design of the Adahiriya network needs a large amount of data represented as 56 substations, and the length of the cables and overhead lines, also needs a long time for drawing the circuit -approximately two months-. The details of the distribution network are shown in **Appendix E1** for balanced loads and in **Appendix E2** for unbalanced loads.

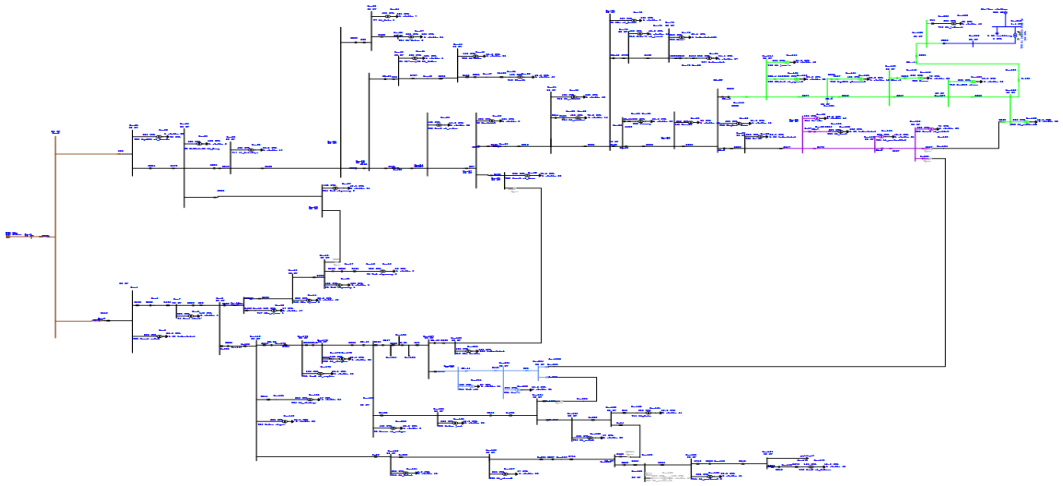


Figure (6.1): The distribution network (33/0.4) KV of Adahiriya city.

6.2.1 Cables and overhead lines

Adahiriya network has a large number on cables and overhead with a different manufacturer, which has an impedance value effect on the system, the library at the software does not has the suitable type of these conductors, so it's important to calculate the resistance and reactance regarded to the length as its written for each type in **Appendix E3** and all the data of distribution line analysis in Etap in **Appendix E4**.

Table 6.1: Cables and overhead lines data

Line Type	Resistance (Ω/Km)	Reactance (Ω/Km)	Admittance (Ω^{-1} /Km)
Coyote	0.216	0.318	0
Dog	0.269	0.326	0
Rabbit	0.529	0.347	0
Nexans, single core XLPE, 95 mm^2	0.321	0.22	$5.2*10^{-5}$

6.2.2 Transformers

The most important parameters should be taken into account to represent the transformers in Etap software are the KVA rating, positive and negative impedances, and X/R ratio.

Adahiriya network has a (160, 250, 400, 630) ratings with a different manufacturer, the calculation of X/R is attached in **Appendix E3** and show transformers data in Etap in **Appendix E5**.

Table 6.2: Transformer data

Transformer rating (KVA)	X/R	Z %
160	1.6	4.4
250	2.5	4.4
400	4	4.4
630	6.3	4.4

2.2.3 Loads

In Etap software there are two type of loads can be used which are (Lumped load, Static load), the first one is using for unbalanced load analysis, whereas the second one helps to analyze the harmonics.

This project includes two circuits with the both types of loads -Lumped, Static- to analyze more than one of important parameters and to get closer as possible as to the actual network.

However, to use static load to design an electrical system the average power for three phases should be calculated to ensure the accuracy, the harmonic for domestic loads was chosen from library as fluorescent harmonic, and then harmonic for industrial was designed regarded to harmonic data from the power analyzer.

Table 6.3: Data of the individual harmonic on the loads

Loads	Current							Voltage						
	H3	H5	H7	H9	H11	H13	H15	H3	H5	H7	H9	H11	H13	H15
Industrial loads	3.6	4.1	4.1	0.9	0.8	7.8	0.9	0.12	2.5	0.9	0.06	0.53	0.6	0.06
domestic loads	16	6	1	0	0	0	0	0.35	2.31	0.35	0.05	0.95	0.39	0.02

2.2.4 Generator

The EG of Al-Jebrini connected to the network has a rating with 380KVA and 0.4KV connected to step up transformer, to insert the generator to the network it's important to specify the limits of active and reactive power minimum and maximum the limit for reactive power in the EG is 183 Kvar and -183 Kvar respectively also the active power limit from 0 to 380 KW.

6.3 Etap circuit analysis and result

The connection of the DG on the electricity network has impact on the operation and performance of the network, and there are some changes to the characteristics of the network such as the voltage profile, harmonic and the power factor. The output result from the ETAP in **Appendix F.**

6.3.1 Voltage Validation

Firstly, to ensure the result gained from the ETAP program are approximately closed to the real data were collected from the network by power quality analyzer voltage validation should be checked to verify the result and to build accurate rule to analyze the network. In the Figure (6.2) note the real voltage versus the simulation voltage are approximately the same with a small different.

Table 6.4: comparison between the simulation and real voltage

Transformer	simulation voltage	real voltage	percentage of error
T 38	235.3	236.8	-0.633445946
T 3	241.3	241.4	-0.041425021
T 9	240.9	241.1	-0.082953131
T 11	235.2	236.9	-0.717602364
T 26	240.9	241.8	-0.372208437
T 32	229.8	231.6	-0.777202073
T 43	229.5	230.8	-0.563258232
T 12	234.9	236.1	-0.508259212
T 18	240.6	241.4	-0.331400166
T 45	229.2	229.3	-0.04361099

Where

$$percentage\ of\ error\ = \frac{simulation\ voltage - real\ voltage}{real\ voltage} \quad (6.1)$$

Refers to the Table (6.4) and Figure (6.3) note the extent to which the real values of the voltage are taken by the power quality analyzer match in approximately 99 % with the simulation values of the voltage in ETAP program.

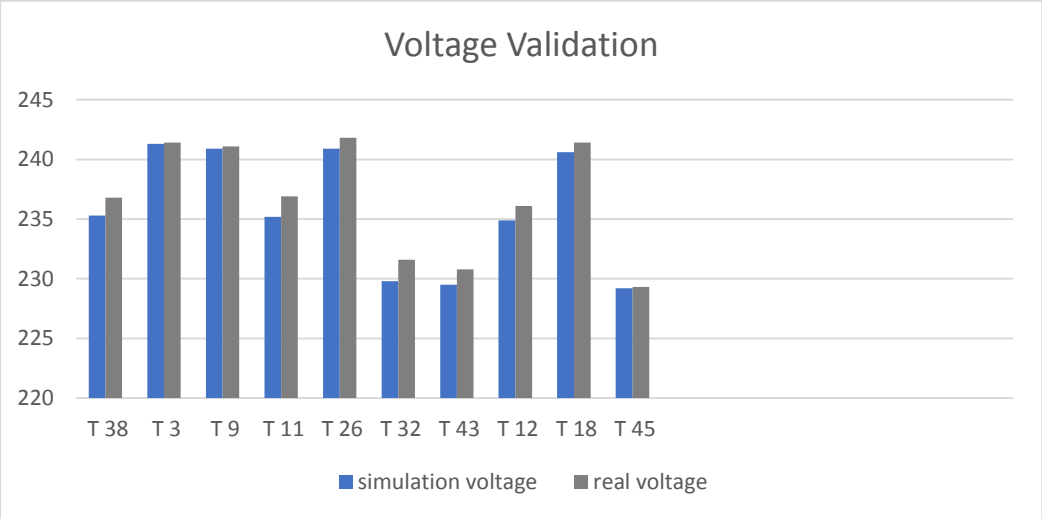


Figure (6.2): Comparison between the simulation and real voltage

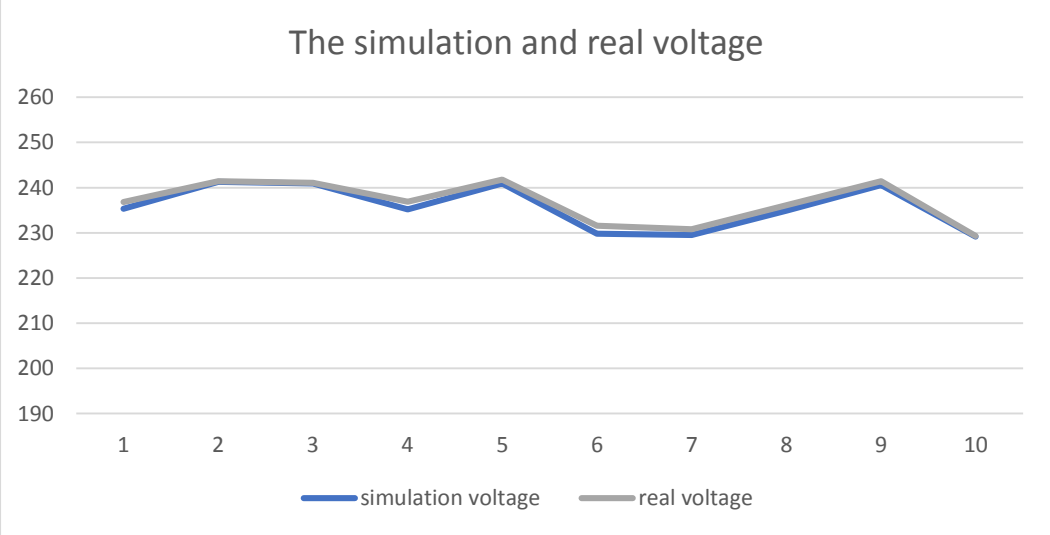


Figure (6.3): The simulation and real voltage

6.3.2 Voltage Profile

The impedance is causing the voltage drop and voltage loss, the equivalent circuit of distribution lines are shown in Figure (6.4) [12].

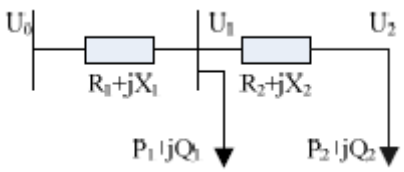


Figure (6.4): Equivalent circuit of distribution lines

$$U_2 = U_0 - \Delta U = U_0 - \frac{(P_1 - P_{DG})R_1 + (Q_1 - Q_{DG})X_1}{U_N} - \frac{(P_2 R_R + Q_2 X_2)}{U_N} \quad (6.2)$$

The connection of DG change the voltage profile by changing the direction and magnitude of real and reactive power flows, however providing the reactive power to the network leads to increase the voltage on the network and then the one of advantages of DG is to improve the voltage profile. As shown in the Figure (6.5) the voltage at Bus 138 increase from 32.932 KV to 32.968 KV as well the Bus 132 and Bus 127 the voltage increases from 32.933 KV to 32.963 KV and from 32.934 KV to 32.96 KV respectively.

After adding the DG to the network this lead to reduce the voltage drop on the resistance then the losses are decreasing on the distribution line.

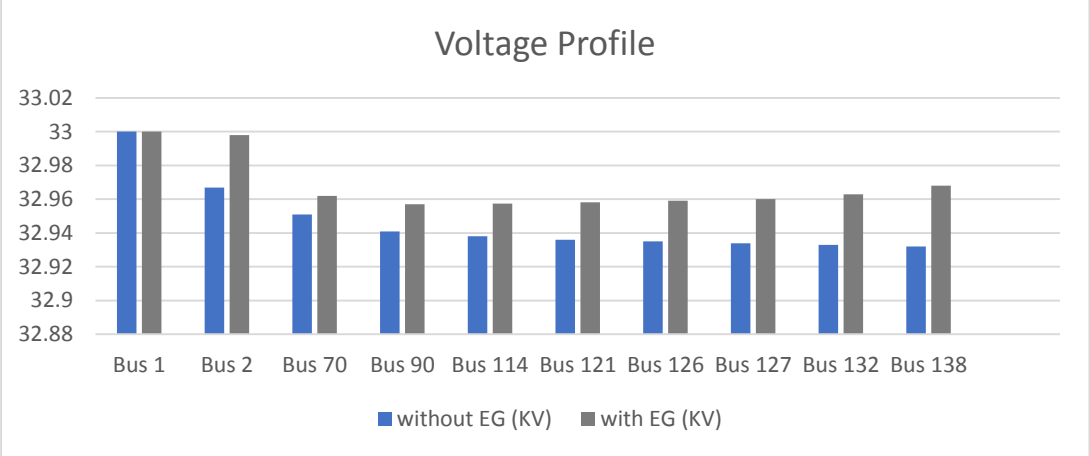


Figure (6.5): Voltage Profile with and without DG for the average load

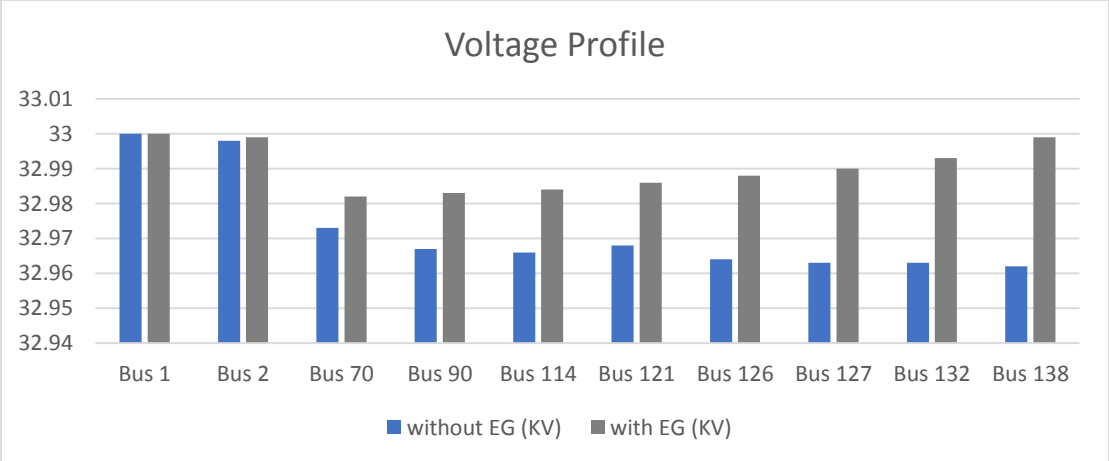


Figure (6.6): Voltage Profile with and without DG for the minimum load at maximum generation

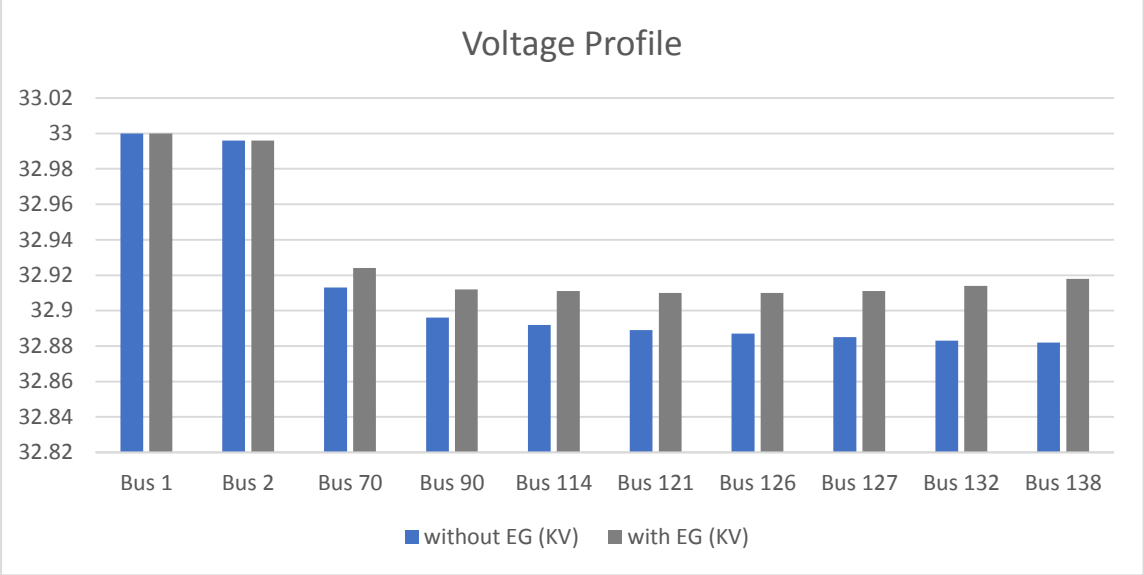


Figure (6.7): Voltage Profile with and without DG for the maximum load at minimum generation

6.3.3 Harmonic

One of the advantages of DG is to reduce the harmonic in the network by adding pure sinusoidal wave which leads to improve the voltage and current wave of the network then reduces the harmonic of the system, whereas the harmonic for current will be increased in remote buses, due to the increasing of the impedance that the generator see as illustrate in the Figure (6.8) the THD current at the Bus 70 increase from 6.1% to 8.17% unlike the buses close to the EG such as Bus 138 decrease from 7% to 1.35% and the Bus 132 decrease from 6.46% to 1.35% as well the Bus 127 and Bus126 the THD current decrease from 5.84% to 2.61% and from 5.28% to 2.61% respectively.

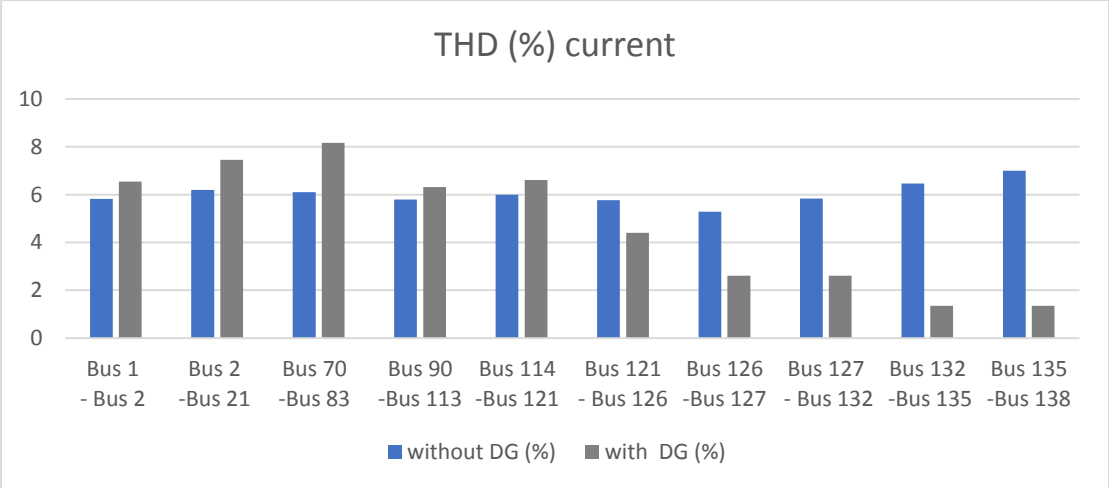


Figure (6.8): THD (%) current with and without DG for average load

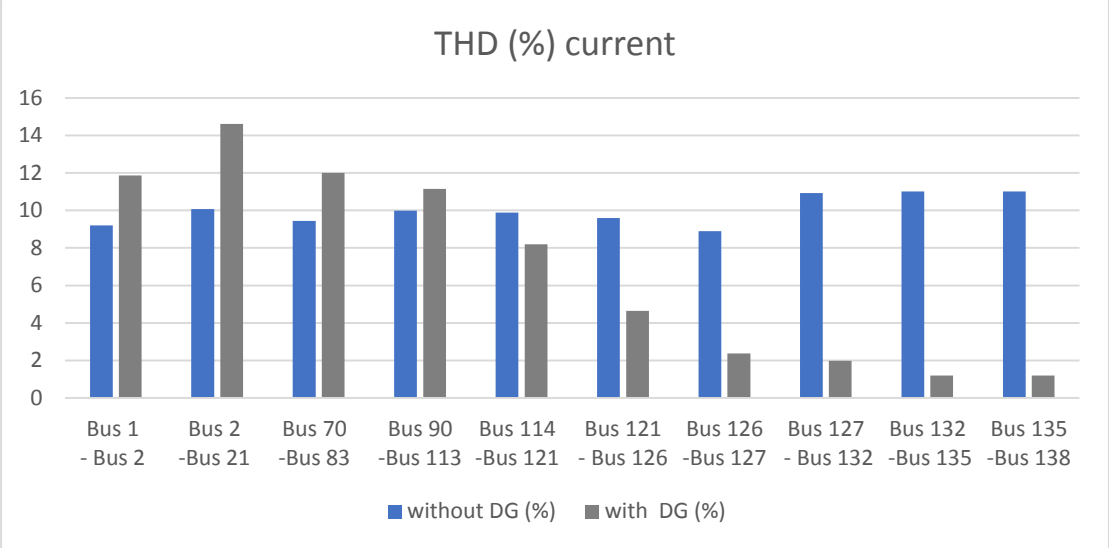


Figure (6.9): THD (%) current with and without DG for minimum load at maximum generation

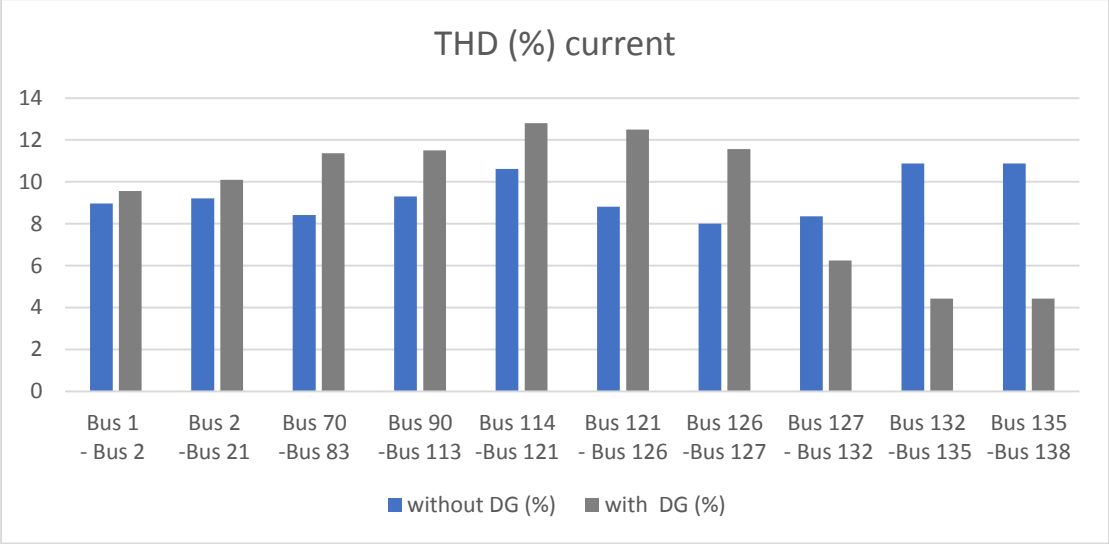


Figure (6.10): THD (%) current with and without DG for maximum load at minimum generation

In the same way, as shown in the Figure (6.11) the TDD current at Bus 138 decrease from 6.89% to 1.33% and the Bus 132 decrease from 6.66% to 1.33% as well the Bus 127 and Bus 126 the TDD current decrease from 5.65% to 2.57% and from 5.01% to 2.53% respectively. Unlike the buses remote from the EG like the Bus 70 increase from 5.59% to 7.88%.

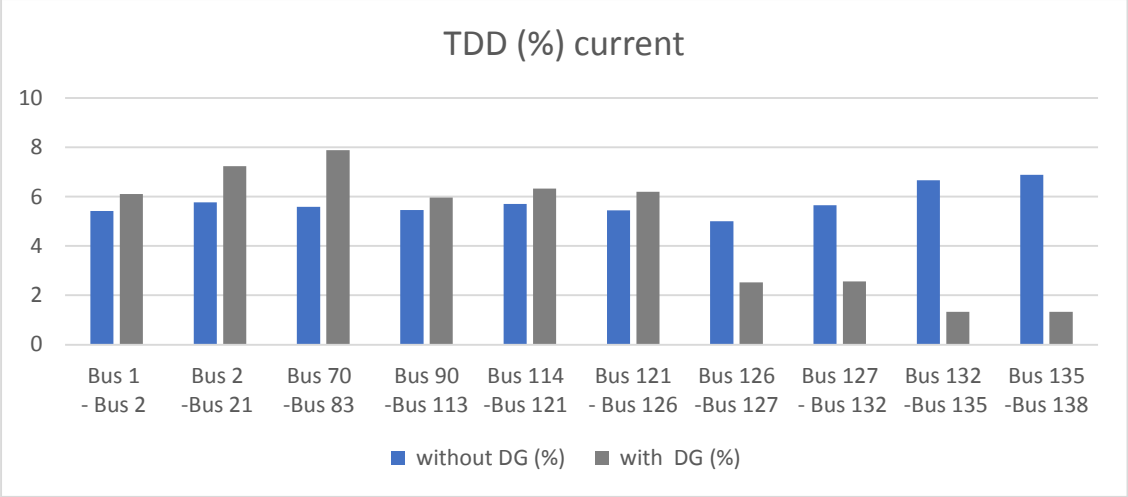


Figure (6.11): TDD (%) current with and without DG for average load

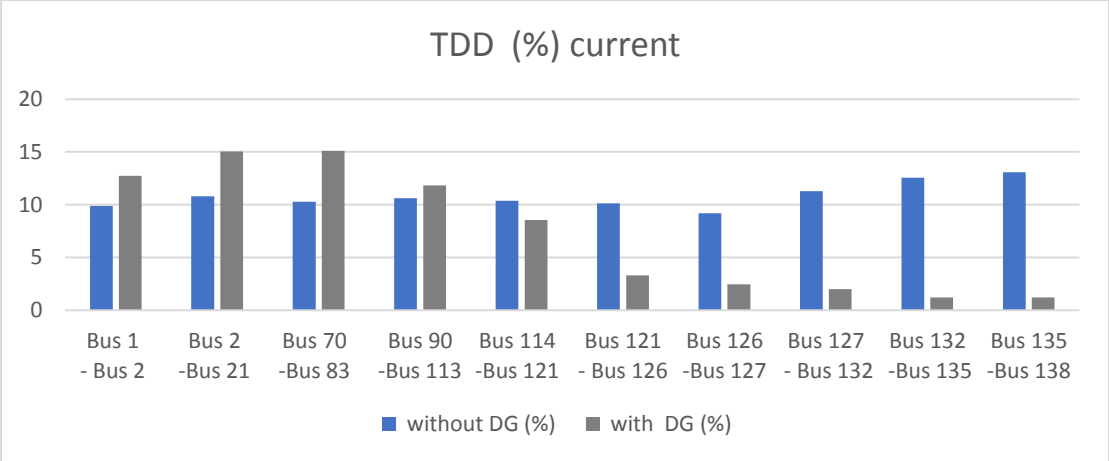


Figure (6.12): TDD (%) current with and without DG for minimum load at maximum generation

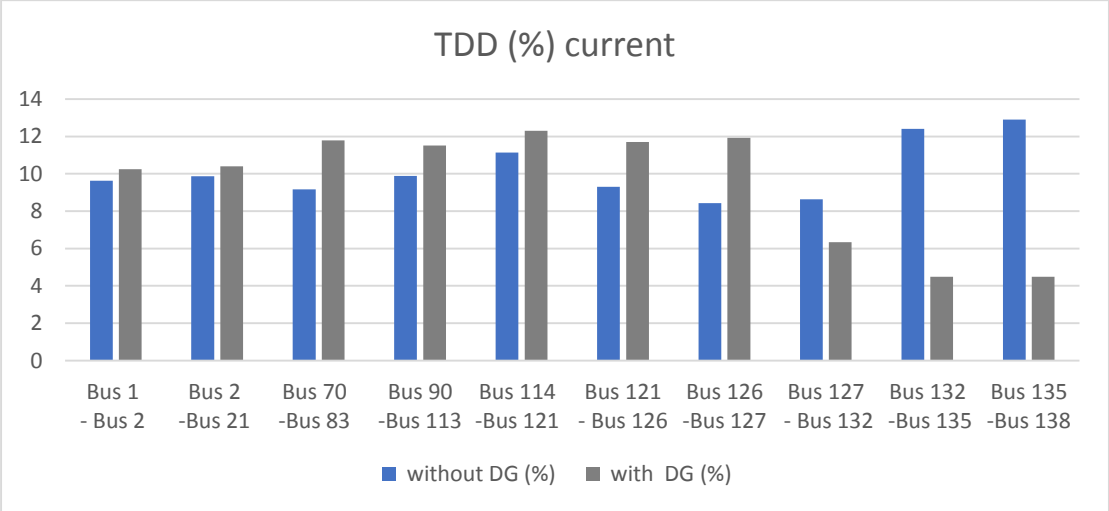


Figure (6.13): TDD (%) current with and without DG for maximum load at minimum generation

As shown in the Figure (6.14) the THD voltage at Bus 138 decrease from 1.7% to 1.51% also the Bus 126 decrease from 1.69% to 1.55% as well the Bus 114 and Bus 90 the THD voltage decrease from 1.68% to 1.56% and from 1.67% to 1.56% respectively.

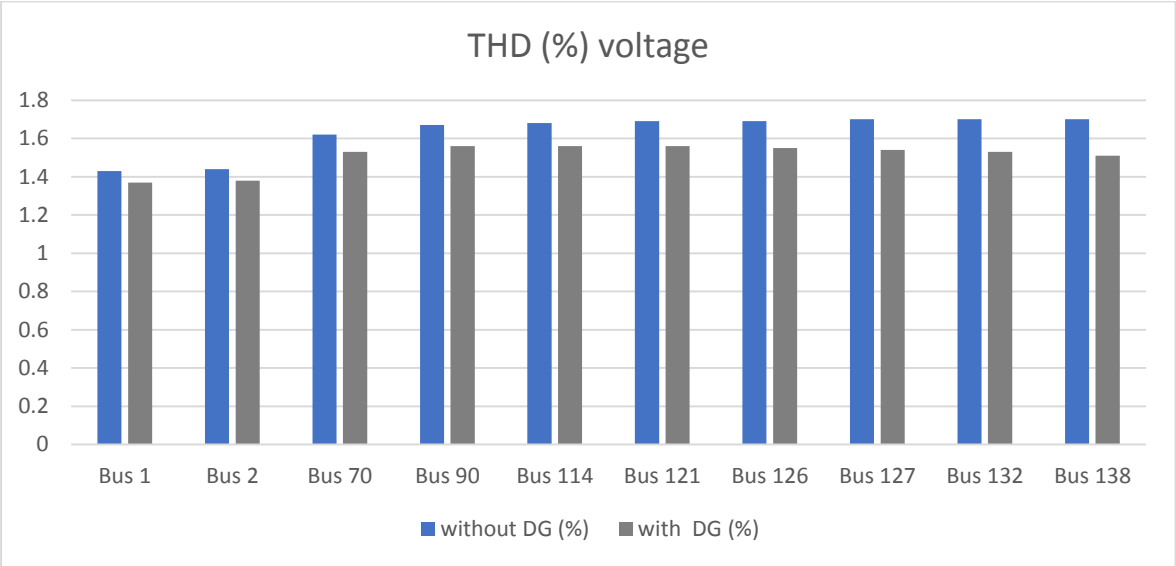


Figure (6.14): THD (%) voltage with and without DG for average load

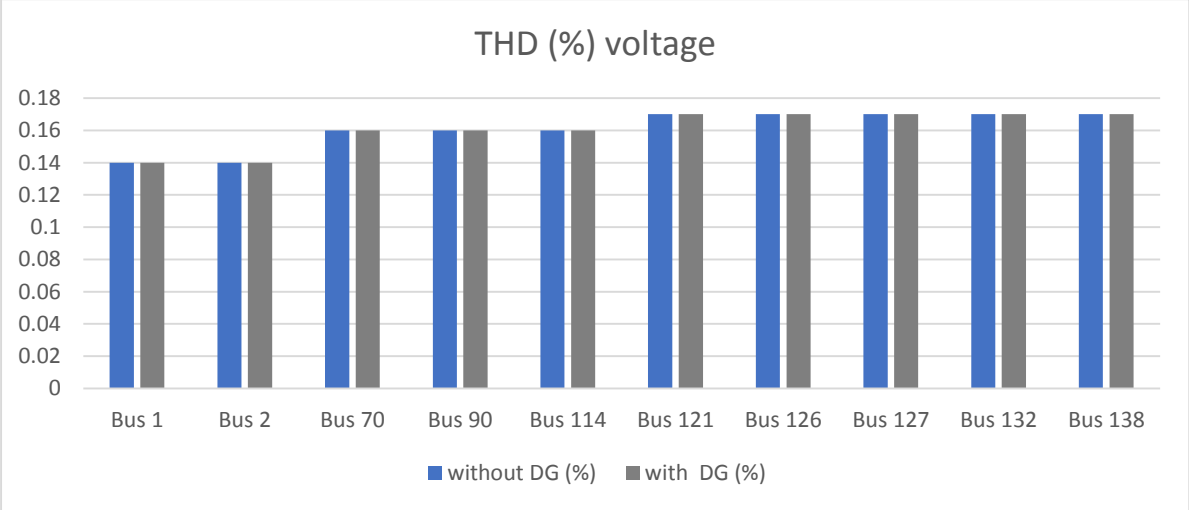


Figure (6.15): THD (%) voltage with and without DG for minimum load at maximum generation

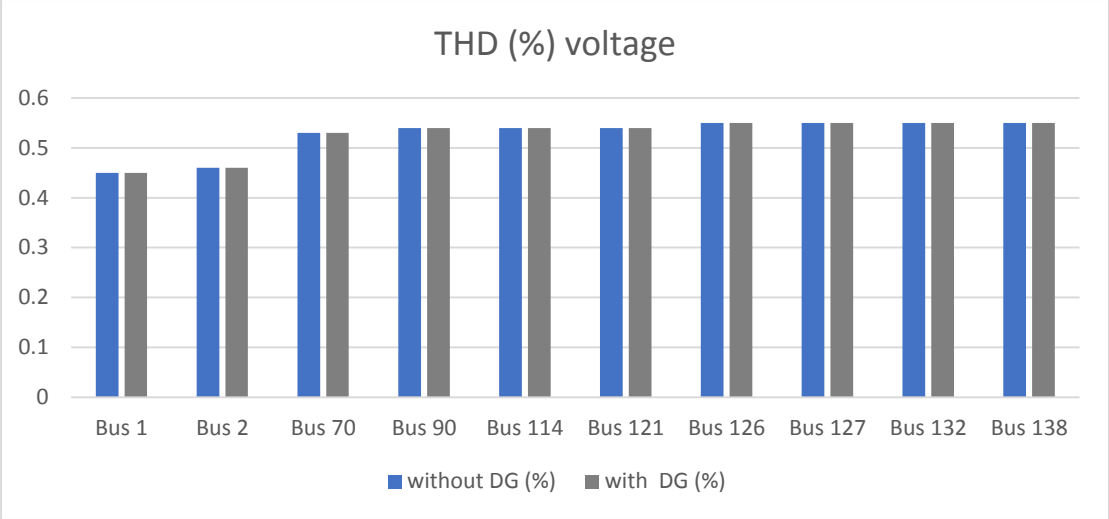


Figure (6.16): THD (%) voltage with and without DG for maximum load minimum at generation

The TDD and the THD voltage in the network within the limit according to the IEEE 519-2014 standard the percentage allowable for the TDD is 15% and in the network not exceeded to 9 % when adding the DG to the system. Also, the percentage allowable for the THD voltage is 5% and in the network not exceeded to 2% after connected the DG to the network.

6.3.4 Power Factor

The connection of DG is improving the power factor by adding the reactive power to the network as shown in the Figure (6.17) the power factor at Bus 138 increase from 89.9 lag to 90.8 lead and the Bus 132 increase from 89.9 lag to 90.8 lead as well the Bus 127 and Bus 126 the power factor increase from 91.5 lag to 92.1 lead and from 93.7 lag to 94.5 lead respectively.at the buses remote from the EG like the Bus 2 increase from 93 lag to 93.3 lag.

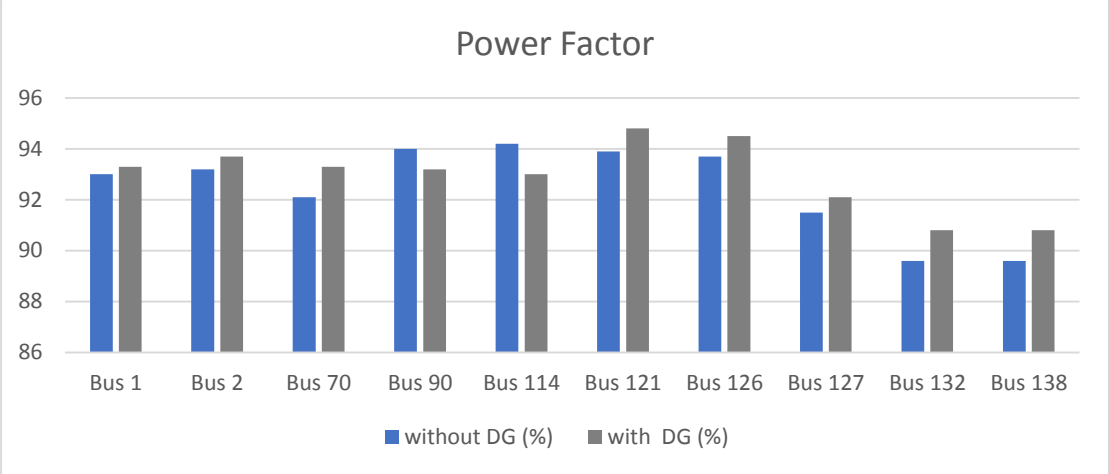


Figure (6.17): Power Factor with and without DG for average load

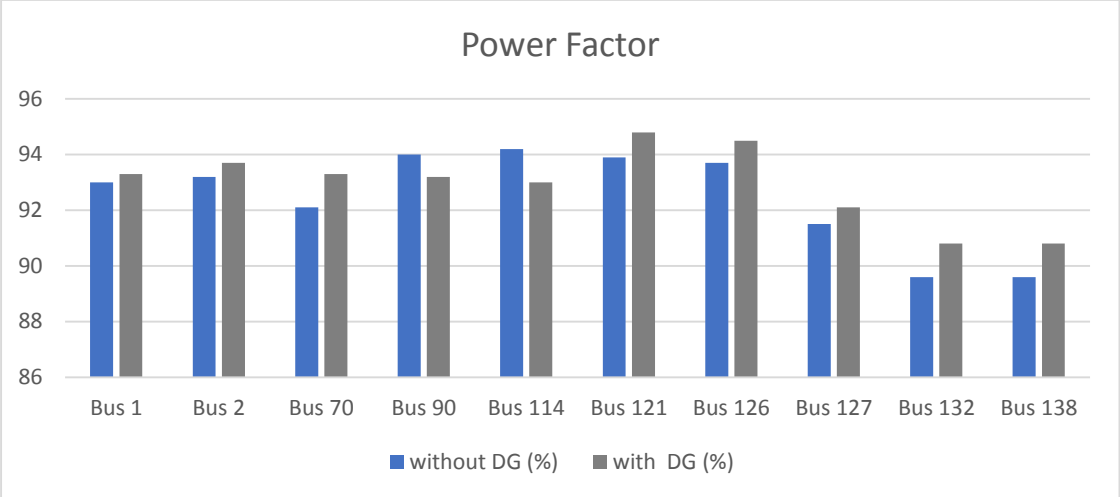


Figure (6.18): Power Factor with and without DG for minimum load at maximum generation

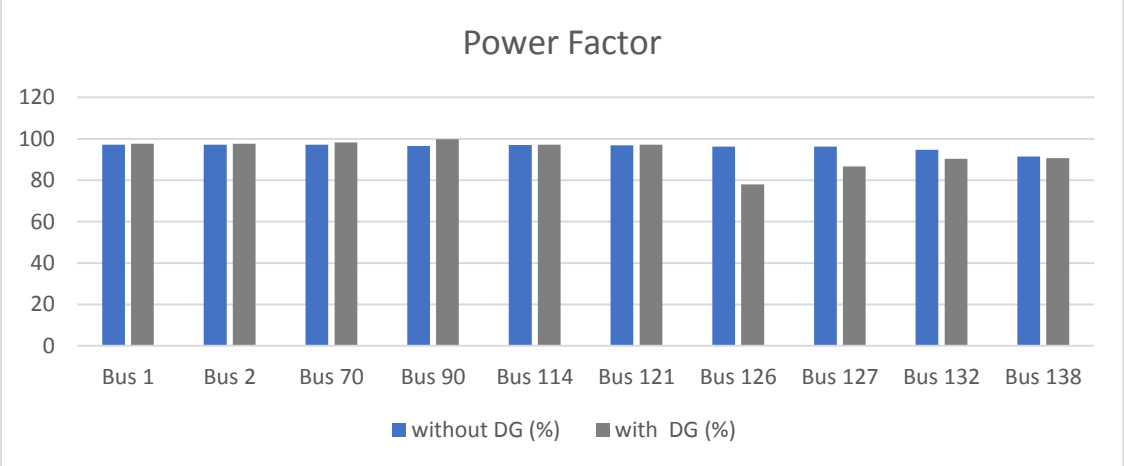


Figure (6.19): Power Factor with and without DG for maximum load at minimum generation

6.3.5 Unbalance System

The main characteristic of the DG is reducing the losses on conductors caused by the unbalance system on the network, the losses depends on the current passes through the resistance. For example, in the path of current closed to the DG the current flow through the resistance increases and that leads to increasing the losses. Unlike the remote buses from the DG, the current decreases and the losses also will be decreased, however the increment equals to decrement value and will they cancel each other.

As shown in the Figure (6.20) the losses at Bus 138 increase from 0.47 to 9.78 and the Bus 135 increase from 0.24 to 5.01 as well the Bus 132 and Bus 127 the losses increase from 1.04 to 4.37 and from 1.11 to 3.34 respectively. Unlike the buses remote from the EG like the Bus 1 decrease from 54.17 to 40.73. In the same way, the results were analyzed on the losses in L2 and L3.

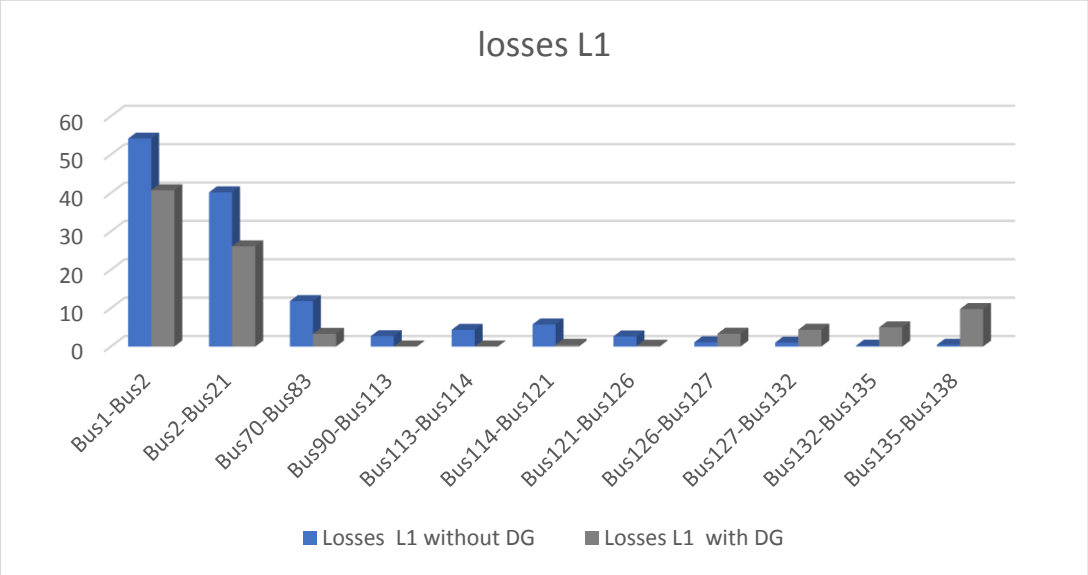


Figure (6.20): the losses in L1 with and without DG.

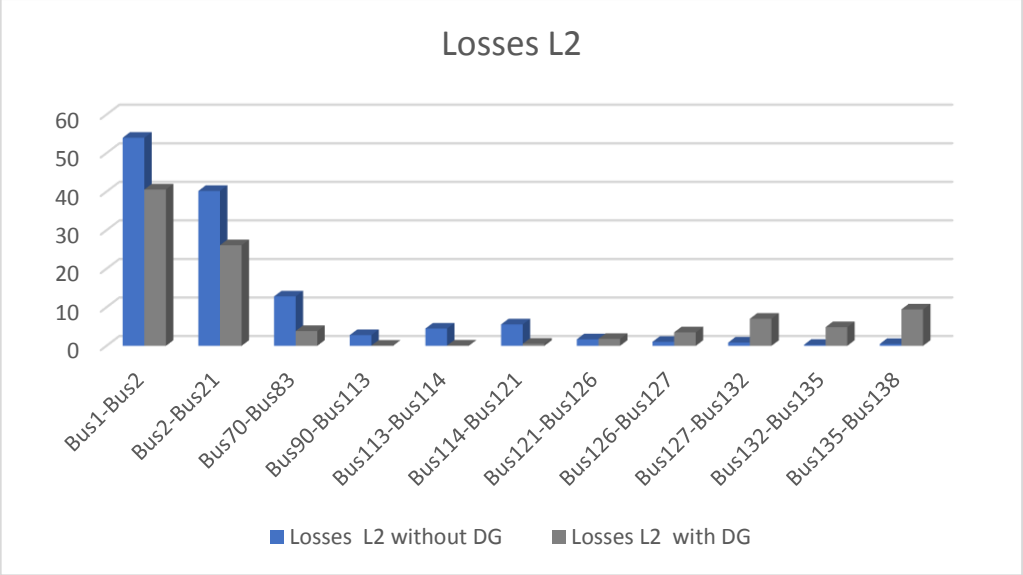


Figure (6.21): the losses in L2 with and without DG.

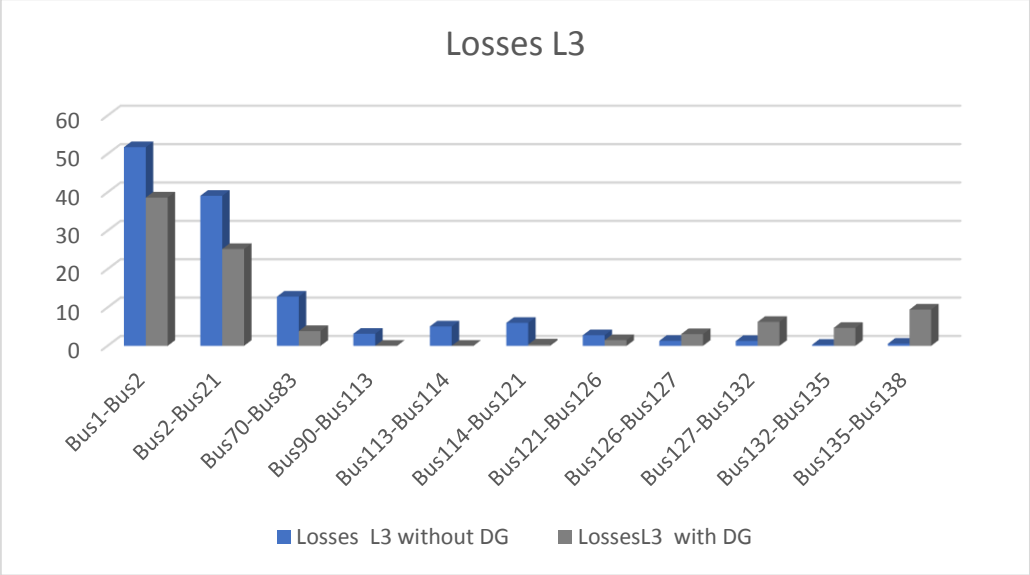


Figure (6.22): the losses in L3 with and without DG.

On another hand, the DG does not effect on the losses that causes due to the transformers as shown in table (6.5).

Table 6.5: The losses of transformers for three phases

No.	Name	Losses	No.	Name	Losses
1	Al-masjid Al_kaber	0.3	2	Mothalath Al_borg	0.3
3	Maskaneh	2.6	4	Bear mtawi’	0.9
5	Wad algamary 1	0.8	6	Wad algamary 2	0.4
7	Al_deir 1	0.9	8	Karam al_ashqar	0.7
9	Abu al_humas	0.9	10	Meqtaa’ duma	1.7

11	Wad ali	0.8	12	Aqabit gharrarah	0.9
13	Qata’t al_jamal	0.6	14	Al_markaz	0.6
15	Abu hashim	0.9	16	Sa’ada	0.7
17	Al_baladiya	0.9	18	Al_sheehk	0.7
19	Al-marj 1	0.7	20	Aqabit al_tarsha	0.8
21	Al_mustashfah	0.9	22	Da’na	0.3
23	Kurza	0.8	24	Al-deire 2	0.3
25	Rasmi wahab	0.3	26	Baten alqar’	0.6
27	Al_muntazah	0.4	28	Domet al_wridat	0.7
29	Juret al_dama	0.8	30	Kafar joul	0.5
31	Sam’a	0.3	32	Khalet al_ayaseh	0.3
33	Al_mizrab	0.3	34	Al_shadaqa	0.3
35	Al_shuqfan	0.4	36	Al_estad	0.3
37	Eshreeteh	1.1	38	Al_muhtasib	0.4
39	Jammoq	0.6	40	Al_helal	0.3
41	Al_muntazah 2	0.3	42	Abu njeem 2	0.3
43	Al jame’a	0.4	44	Alghwla	0.3
45	Masafi	0.5	46	Al_jebreni	0.7
47	Abu_njeem 1	0.3	48	Inab al_kabeer	0.1
49	Shweki	0.1	50	Al-baha	0.7
51	Inab al_sagher	0.7	52	Bank al_eskan	0.3
53	Al_tork	1.4	54	Wad algamary 3	0.3
55	Mana’	0.3			

6.3.6 Fault current

When the DG is connected to the network it effects on the fault current leads to slightly change -increase- , as shown the figure (6.23) note the fault current at Bus 2 increased from 11.009 KA to 11.054 KA and at Bus 126 increase from 5.748 KA to 5.79. The fault current increase by 46A that the DG is adding to network after the fault occurred.

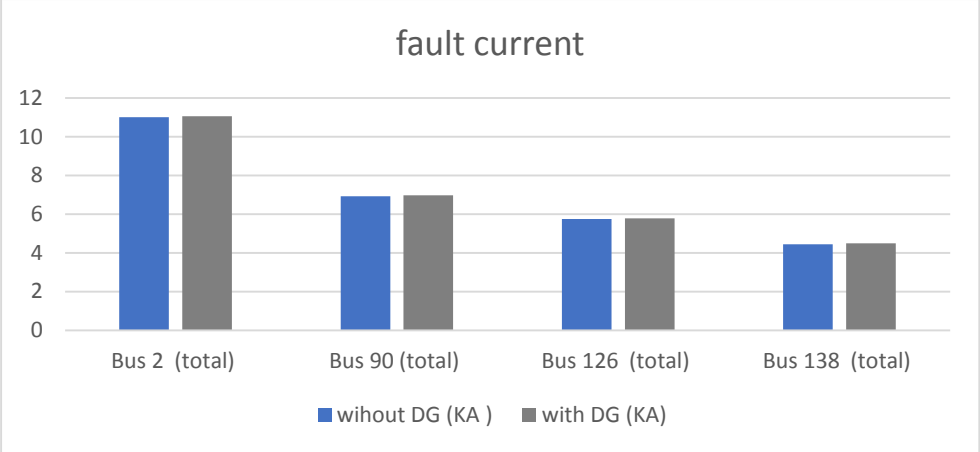


Figure (6.23): Fault current with and without DG for average load.

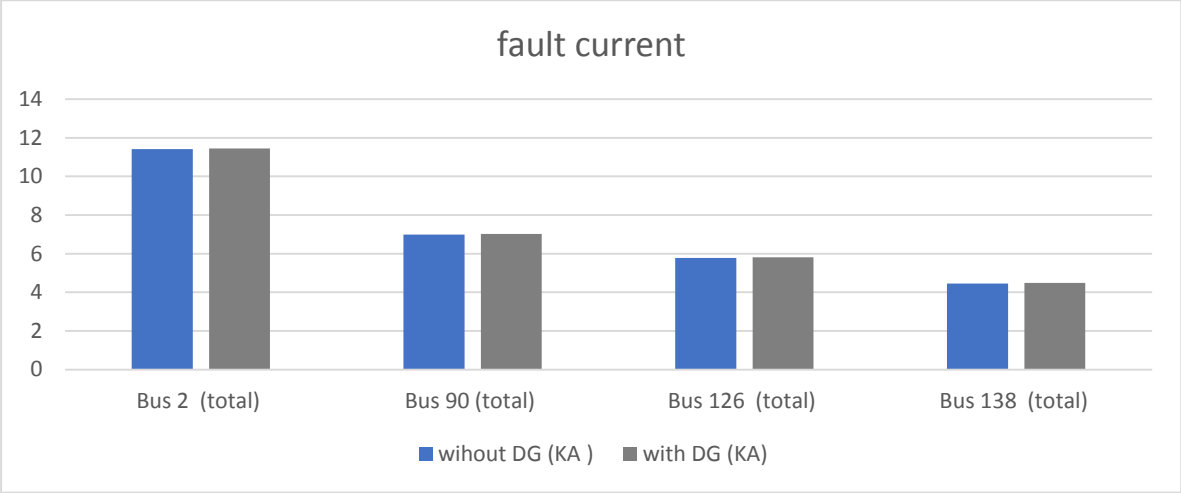


Figure (6.24): Fault current with and without DG for minimum load at maximum generation.

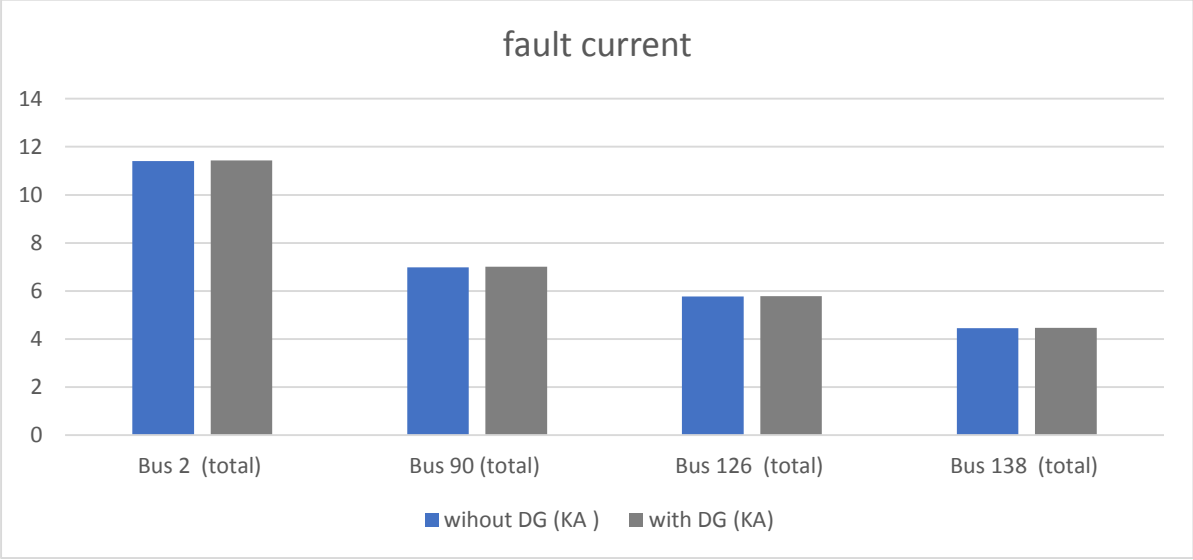


Figure (6.25): Fault current with and without DG for maximum load at minimum generation.

Chapter Seven

Conclusions and Recommendations

7.1 Conclusions

7.2 Recommendations

Chapter Seven

Recommendations and Conclusions

7.1 Conclusions

In this project, many conclusions achieved which must be taken into account to improve Adahiriya network and connecting EG on any MV network, those conclusions represents as:

1. Etap software can design the power system precisely as it exists in the real world, and gives the measurement accurately matching the practical system.
2. Installation the EG on MV increases the voltage profile of the network, that's because the EG considered as reactive power resource which will improve the voltage.
3. THD_v - decreased after connect EG at the system on the closed and remote buses from the EG.
4. THD_I -TDD- reduced extremely on the buses closed to EG, and increased in remote buses because of the effect of conductor's impedance.
5. TDD at the buses of Adahirya network does not beyond the limits of maximum allowable TDD of IEEE-519-2014 standard, which is a good indication about the network.
6. EG generates active and reactive power to the network, so it improves the power factor, but it will be highly noticeable in the buses closed to EG.
7. The EG does not effect on the losses of transformers in the unbalanced system.
8. After connect the EG on the network, the losses on the conductor's which are close to EG increased and decreased on the remote conductors due to the impedance that seen by the generator.
9. Connection the DG to the network slightly increases the fault current of the network and this increase does not effect on the protection system of the network.

7.2 Recommendations

7.2.1 Scientific Recommendations

- Make a mathematical module to calculate the effect of EG on the MV network regarded to the results from this project.
- Study and analyze the K-Factor for the transformers at Adahiriya network, which is an important factor to protect the network.
- Study the best location for the EG where should be connected to the network to guarantee the lowest power losses.
- Study the sag and swell voltage for the network, which may be occurred due to the connection of motors, generators, or trip a part of the network

7.2.2 Technical Recommendations

- Design a SCADA to a supervision on the network, and it's simplicity in collecting the data.
- Strict procedures to improve the power factor on the industrial loads to reduce the losses in the network.
- Connect harmonics filters to limit the effect of harmonics in the grid.
- Apply GIS system to find out loads for each customer and on which phase was connected.

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Appendices

Appendix A

Appendix B

Appendix C

Appendix D

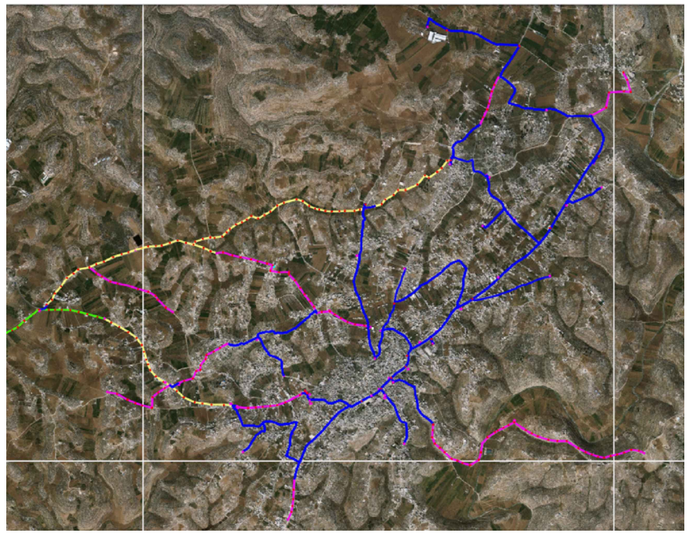
Appendix E

Appendix F

Appendix A

Air photograph Of Medium Voltage network

For Adahiriya city



Map Key

MEDIUM VOLTAGE

Description	Simple
Transformer	
Connection Point from IEC.	
Truss 12M	
Lattic Pole 12M	
over head line-RABBIT	
over head line-COYTE	
over head line-DOG	
undergraund cable-95mm2	
Auto Recloser GVR	Auto Recloser

Appendix B

Datasheet for component of the network

Appendix B1

Appendix B2

Appendix B3

Appendix B4

Appendix B5

Appendix B1

PRODUCT CATALOG – ACSR (Aluminum Conductor, Steel Reinforced)

BRITISH CONDUCTOR SIZES

Code Name	Total Area mm²	Total Area inch²	Aluminum Kg/km	Aluminum Lb/M ft	Weight[1] Steel Kg/km	Weight[1] Steel Lb/M ft	Total Kg/km	Total lb/M ft	Rated StrengtW N	Rated StrengtW kgf	Rated StrengtW lbf	Maximum dc Resistance at 20 °C Ohm/km	Maximum dc Resistance at 20 °C Ohm/M ft	Current Rating[4] Temperate Amp	Current Rating[4] Tropical Amp
Mole	12.39	0.0192	29.1	19.6	13.8	9.25	42.9	28.9	4270	435	960	2.63	0.803	92	75
Squirrel	24.43	0.0379	57.4	38.6	27.1	18.2	84.6	56.8	8184	835	1840	1.34	0.407	140	114
Gopher	30.62	0.0475	72.0	48.4	34.0	22.9	106.0	71.2	10052	1025	2260	1.07	0.325	160	130
Weasel	36.88	0.0572	86.8	58.3	41.0	27.6	127.8	85.9	11876	1211	2670	0.885	0.270	179	146
Fox	42.77	0.0663	100.5	67.6	47.5	31.9	148.0	99.5	13789	1406	3100	0.763	0.233	196	159
Ferret	49.48	0.0767	116.3	78.2	55.0	36.9	171.3	115.1	15790	1610	3550	0.660	0.201	213	173
Rabbit	61.70	0.0956	145.1	97.5	68.6	46.1	213.6	143.6	19260	1964	4330	0.529	0.161	243	297
Mink	73,71	0.1142	173.4	116.5	81.9	55.1	255.3	171.6	22107	2254	4970	0.443	0.135	370	218
Skunk	100.50	0.1558	175.9	118.2	289.5	194.6	465.5	312.8	56490	5761	12700	0.422	0.129	268	223
Beaver	87.29	0.1353	205.3	138.0	97.0	65.2	302.3	203.2	25932	2644	5830	0.374	0.114	297	240
Horse	116.20	0.1800	203.1	136.5	334.2	224.6	537.3	361.1	64941	6622	14600	0.365	0.111	289	241
Racoon	92.40	0.1433	217.3	146.0	102.6	69.0	319.9	215.0	27444	2799	6170	0.353	0.108	307	247
Otter	97.86	0.1517	230.1	154.6	108.7	73.1	338.8	227.7	29045	2962	6530	0.334	0.102	317	255
Cat	111.30	0.1726	261.6	175.8	123.6	83.1	385.2	258.8	33049	3370	7430	0.293	0.0894	341	274
Hare	122.50	0.1899	287.9	193.5	136.0	91.4	423.9	284.9	36340	3706	8170	0.267	0.0812	359	288
Dog	118.5	0.1837	287.9	193.5	106.2	71.4	394.1	264.9	33760	3443	7590	0.268	0.0816	390	312
Hyena	126.2	0.1956	290.2	195.0	159.7	107.3	449.9	302.3	42478	4332	9550	0.264	0.0830	397	316
Leopard	148.1	0.2296	360.1	242.0	133.1	89.46	493.2	331.5	42256	4309	9500	0.214	0.0653	449	358
Coyote	152.2	0.2359	365.7	245.8	155.8	104.7	521.5	350.4	47149	4808	10600	0.214	0.0653	450	358
Cougar	137.5	0.2131	359.0	241.3	56.3	37.8	415.3	279.1	30157	3075	6780	0.219	0.0667	440	351
Tiger	161.7	0.2506	364.3	244.8	239.2	160.8	603.5	405.6	60048	6123	13500	0.214	0.0653	455	361
Wolf	194.9	0.3021	439.2	295.1	288.4	193.8	727.6	489.0	71613	7303	16100	0.178	0.0542	512	406

18/30 (36) KV - SINGLE CORE, XLPE INSULATED, PVC SHEATHED, SCREENED, UNARMOURED CABLES.

Type M6N, M6A

Conforming to IEC 60502-2

ELECTRICAL CHARACTERISTICS

Nominal cross section	DC Resistance at 20°C*		Nominal inductance		Nominal capacity	Current carrying capacity **					
						Underground Cable		Cables in air		Cables in duct	
	Copper	Alu	Trefoil formation	Flat formation		Copper	Alu	Copper	Alu	Copper	Alu
mm²	Ω/Km	Ω/Km	mH/Km	mH/Km	µF/Km	Amp	Amp	Amp	Amp	Amp	Amp
50	0.387	0.641	0.464	0.649	0.136	230	180	245	190	205	160
70	0.268	0.443	0.439	0.623	0.151	280	220	305	235	255	200
95	0.193	0.320	0.417	0.601	0.166	335	260	375	290	310	245
120	0.153	0.253	0.398	0.583	0.179	385	300	425	330	355	280
150	0.124	0.206	0.387	0.572	0.191	430	335	485	375	410	320
185	0.0991	0.164	0.375	0.559	0.205	490	380	560	430	465	365
240	0.0754	0.125	0.359	0.544	0.223	560	440	660	510	555	435
300	0.0601	0.100	0.351	0.535	0.244	640	500	750	590	640	500
400	0.0470	0.0778	0.330	0.515	0.267	720	570	870	680	740	580
500	0.0366	0.0605	0.317	0.502	0.293	810	640	1000	790	855	670
630	0.0283	0.0469	0.307	0.491	0.326	910	740	1150	930	1010	790
800	0.0221	0.0367	0.291	0.476	0.375	1015	830	1290	1060	1155	900
1000	0.0176	0.0291	0.284	0.468	0.411	1110	935	1465	1230	1340	1090

* At different operating T(°C) : $R = R20°C \{1+ \alpha (T°C - 20)\}$

α : Temperature coefficient at 20°C = 0.00393 for copper & 0.00403 for aluminium

** Laying conditions : - Underground : Temperature of the soil 20°C - Thermal resistivity 100°C cm/w
- In air : Ambient temperature 30°C

*** Greater sizes are also available

Appendix B2

ARDAN
Ardan Electrical Industries (1993) Ltd

NISKO ARDAN GROUP

Oil Distribution Transformer

Transformer: Oil transformer 630/33/0.4C **Type:** 239

Electrical Data	Data	Units
Rated Power	630	kVA
Rated Primary Voltage	33	kV
Rated Secondary Voltage	0.4	kV
Rated Frequency	50	Hz
Number of phases	3	
Group of connection	Dyn11	
Short-circuit impedance	4.4	%
No-load losses	950	W
Load losses	5780	W
LV,HV Winding	Copper	

Technical Data		
Design version	Conservator	
HV bushings	30Nf250-990	
LV bushings	DT1000	
Rating of the tap-change	-3+3x2.5%	
Temperature rise limit	60/65	
Cooling method	ONAN	
Noise level (1 m)	<=50	dB(A)
Installation	Indoor/Outdoor	
Insulation class		
Insulation level:		
1.2/50 us	170	kV
50Hz, 1min	70	kV

ARDAN
Ardan Electrical Industries (1993) Ltd

NISKO ARDAN GROUP

Oil Distribution Transformer

Transformer: Oil transformer 400/33/0.4C **Type:** 204

Electrical Data	Data	Units
Rated Power	400	kVA
Rated Primary Voltage	33	kV
Rated Secondary Voltage	0.4	kV
Rated Frequency	50	Hz
Number of phases	3	
Group of connection	Dyn11	
Short-circuit impedance	4.4	%
No-load losses	650	W
Load losses	4830	W
LV,HV Winding	Copper	

Technical Data		
Design version	Conservator	
HV bushings	30Nf250-990	
LV bushings	DT630	
Rating of the tap-change	-3+3x2.5%	
Temperature rise limit	60/65	
Cooling method	ONAN	
Noise level (1 m)	<=50	dB(A)
Installation	Indoor/Outdoor	
Insulation class		
Insulation level:		
1.2/50 us	170	kV
50Hz, 1min	70	kV

ARDAN
Ardan Electrical Industries (1933) Ltd

NISKO ARDAN GROUP

Oil Distribution Transformer

Transformer: Oil transformer 250/33/0.4C Type: 171

Electrical Data	Data	Units
Rated Power	250	kVA
Rated Primary Voltage	33	kV
Rated Secondary Voltage	0.4	kV
Rated Frequency	50	Hz
Number of phases	3	
Group of connection	Dyn11	
Short-circuit impedance	4.4	%
No-load losses	450	W
Load losses	3150	W
LV,HV Winding	Copper	

Technical Data		
Design version	Conservator	
HV bushings	30Nf250-990	
LV bushings	DT630	
Rating of the tap-change	-3+3x2.5%	
Temperature rise limit	60/65	
Cooling method	ONAN	
Noise level (1 m)	<=50	dB(A)
Installation	Indoor/Outdoor	
Insulation class		
Insulation level:		
1.2/50 us	170	kV
50Hz, 1min	70	kV

ARDAN
Ardan Electrical Industries (1933) Ltd

NISKO ARDAN GROUP

Oil Distribution Transformer

Transformer: Oil transformer 160/33/0.4C Type: 114

Electrical Data	Data	Units
Rated Power	160	kVA
Rated Primary Voltage	33	kV
Rated Secondary Voltage	0.4	kV
Rated Frequency	50	Hz
Number of phases	3	
Group of connection	Dyn11	
Short-circuit impedance	4.4	%
No-load losses	300	W
Load losses	2450	W
LV,HV Winding	Copper	

Technical Data		
Design version	Conservator	
HV bushings	30Nf250-990	
LV bushings	1/630	
Rating of the tap-change	-3+3x2.5%	
Temperature rise limit	60/65	
Cooling method	ONAN	
Noise level (1 m)	<=50	dB(A)
Installation	Indoor/Outdoor	
Insulation class		
Insulation level:		
1.2/50 us	170	kV
50Hz, 1min	70	kV

Appendix B3

GVR Recloser

For Pole Mounting and Substation Applications

RATINGS

		GVR 15	GVR 27	GVR 38
Maximum System Voltage	kVrms	15.5	27	38
Continuous Current	A	630	630	630
Interrupting Current	kA	12.5/16	12.5	10
Impulse Voltage Withstand	kV peak	110	125/150	150 (internal) 170 (external)
Power Frequency Withstand Dry	kVrms for 60secs	50	60	70
Power Frequency Withstand Wet	kVrms for 60secs	50	50	60
Rated Gas Pressure for above		Atmospheric	Atmospheric/0.3 bar*	0.3 bar (gauge)
Number of Operations with no Maintenance		10,000	10,000	10,000
Weight	Kg	145	145/155*	155

* Ratings for 150kV impulse version

Appendix B4


KATZENSTEIN ADLER
ELCO Energy & Infrastructure Group
LOAD DISCONNECTOR
24/36 KV
IEC-60265-1
TYPE:TRLF1/24/36/400/MR
NO. 53172
pr. year 2014
Ur 24/36 kV
Uw 125/170 kV
fr 50 Hz
Ir 400 A
Ik 12.5/8 kA

Appendix B5

TRIDELTA Parafoudres S.A.

Miembro del grupo TRIDELTA

VARISIL™ HE PARARRAYOS DE OXIDO DE ZINC CON ENVOLVENTE POLIMERICA desde 5 kV hasta 36 kV

VARISIL™ HE POLYMER HOUSED GAPLESS METAL OXIDE TYPE from 5 kV up to 36 kV

Designación del pararrayos / Surge arrester designation

Modelo Type	Unidad Unit	HE05	HE06	HE09	HE10	HE12	HE12/R	HE15	HE18	HE21	HE24	HE24/R	HE24/2R	HE27	HE30	HE33	HE36	HE36/R
Tensión asignada Rated voltage Ur	kV eff kV rms	5	6	9	10	12	12	15	18	21	24	24	24	27	30	33	36	36
Tensión de servicio permanente Continuous operating voltage Uc	kV eff kV rms	4.25	5.1	7.65	8.4	10.2	10.2	12.7	15.3	17.5	20.0	20.0	20.0	22.5	25	27.5	30	30
Tensión residual máxima Maximum residual voltage - à 5kA 8/20 _ at 5 kA 8/20 - à 10kA 8/20 _at 10kA 8/20 - à 20kA 8/20_at 20kA 8/20	kV crête peak	 14.3 15.2 16.8	 15.4 16.4 18.1	 26.4 28.1 31.1	 27.5 29.3 32.4	 30.8 32.8 36.2	 30.8 32.8 36.2	 40.7 43.3 47.8	 46.2 49.1 54.3	 56.1 59.7 66.0	 61.2 65.1 71.9	 61.2 65.1 71.9	 61.2 65.1 71.9	 72.2 76.8 84.9	 76.2 81.1 89.6	 87.2 92.8 102.5	 91.7 97.5 107.5	 91.7 97.5 107.7
Tensión residual con onda de maniobra 500A-30/80 Switching residual voltage at 500- 30/80	kV crête peak	12.1	13.0	22.3	23.3	26.1	26.1	34.4	39.0	47.5	51.8	51.8	51.8	61.1	64.5	73.8	77.5	77.5
Tensión residual con impulso escarpado 10kA-1/2.5 Steep current impulse residual voltage at 10kA-1/2.5	kV crête peak	16.4	17.7	30.3	31.6	35.4	35.4	46.8	53.0	64.5	70.3	70.3	70.3	82.9	87.6	100.2	105.3	105.3
Capacidad dieléctrica del envolvente Lighning impulse withstand level of the housing	kV 1.2/50	95					110			125		170	200	170				200
Linea de fuga Creepage distance	mm	480					650			800		1200	1360	1200				1360
Altura/Height	mm	165					205			245		325	365	325				365
Diámetro/Diameter	mm	104					109					114						
Peso (opción S3D2) Weight (S3D2 option)	kg	1.5	1.5	1.7	1.7	1.7	1.9	2.1	2.1	2.5	2.5	2.9	3.1	3.1	3.1	3,3	3,3	3,5

Appendix C

Embedded generator

Technical specification

patruus 370 BG

(ehemals 2G-KWK-370 BG)

Design:

370 kW el.

400 V / 50 Hz

biogas (60% CH4, 40% CO2)

Hi = 5,98 kWh/Nm³

NOx < 500 mg/Nm³

Exhaust cooling to 180 °C

1.2 Generator (EVU planning data)

Manufacturer	Leroy Somer	
Type	LSA 47.2 L9	
Generator type	Synchronous, directly coupled	
Voltage regualtor (AVR)	D510C	
Rated speed	1500	1/min
Frequency	50	Hz
Effective electrical power	370	kW
Apparent electrical power (cos φ 0.9)	411	kVA
Apparent electrical power (cos φ 1.0)	370	kVA
Rated generator current (cos φ 0.9)	593	A
Rated generator current (cos φ 1.0)	534	A
Rated generator voltage (± 10 %)	400	V
Subtransient reactance X"d	12,6	%
Short-circuit current Ik"3	6,74	kA
Power factor cos φ (inductive / capacitive)	0,9 / 0,9	
Generator circuit breaker	800	A
Additional section switch (VDE-AR-N 4105)	800	A
Efficiency (full load) at Cos φ = 1	96,4	%
Mass moment of inertia	8,32	kg · m²
Ambient air temperature	40	°C
Stator circuit	star	
Protection class	IP 23	
Generator weight	1392	kg
Compensation	not available	
Engine startup	not available	

1. Genset

	50 %	75 %	100 %	Load
Electrical power	185	278	370	kW (5)
Useful thermal power	252	343	431	kW (2)
nominal power	519	739	953	kW (1)
Efficiencies electrical	35,6	37,6	38,8	% (1)
Efficiencies thermal	48,6	46,4	45,2	% (1), (2)
Efficiencies total (el. + th.)	84,2	84,0	84,0	% (1), (2)
CHP coefficient	0,73	0,81	0,86	(1), (2)

	NOx	CO	HCHO	
Exhaust emissions without catalytic converter	< 500	< 1000	< 60	mg/Nm³ (4), (6)
Exhaust emissions with catalytic converter	< 500	< 300	< 40	mg/Nm³ (4), (6)

Engine surface noise *	105	dB(A) (7)
Engine surface noise with sound reducing encapsulation (optional) **	70	dB(A) (7)

Low Voltage Alternators - 4 pole

LSA 47.2 - 365 to 600 kVA - 50 Hz / 456 to 750 kVA - 60 Hz

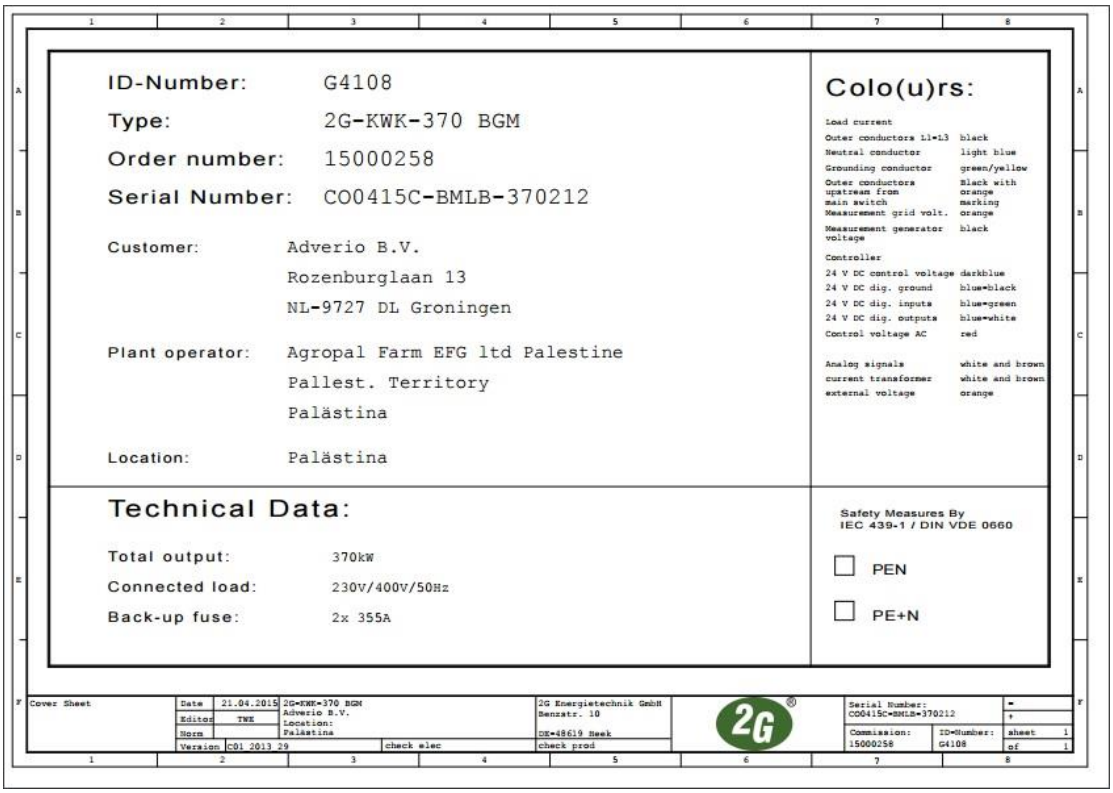
General characteristics

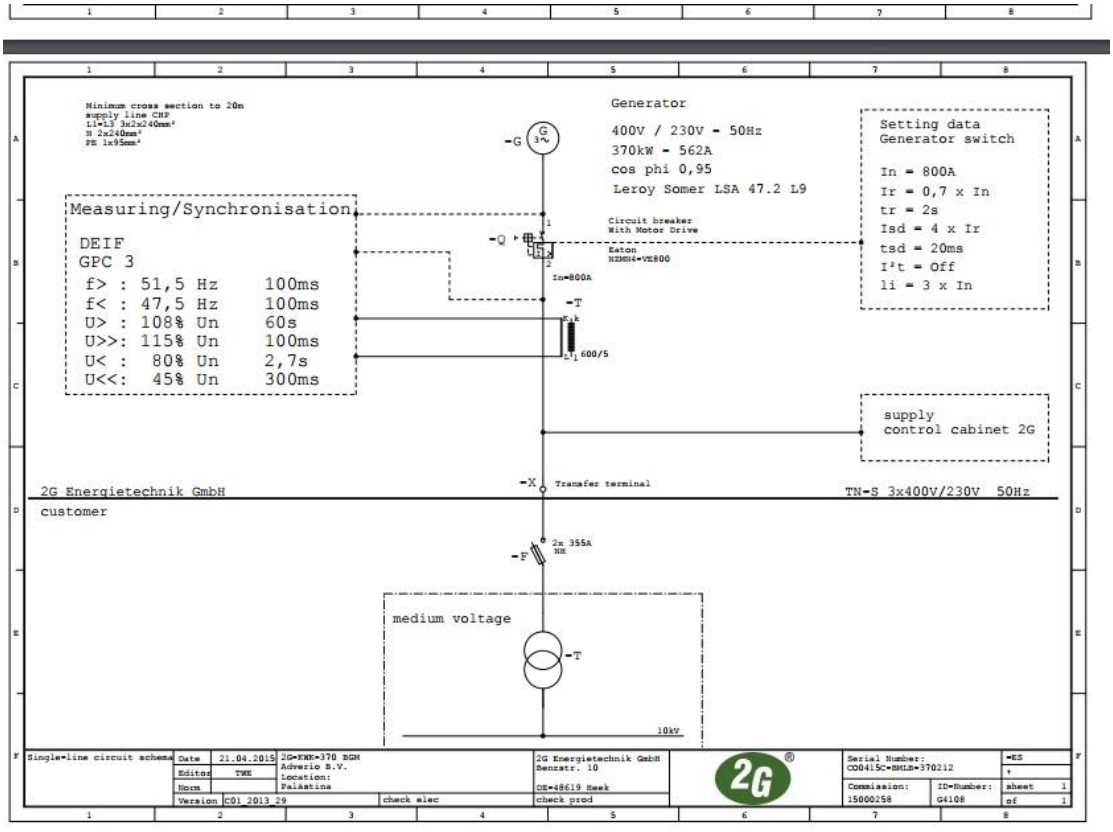
Insulation class	H	Excitation system	SHUNT (12 wire)	AREP or PMG
Winding pitch	2/3 (N° 6 or N° 6S)	AVR type	R 250	R 450
Number of wires	12 (N° 6) / 6 (N° 6S)	Voltage regulation (*)	± 0.5 %	± 0.5 %
Protection	IP 23	Short-circuit current	-	300% (3 IN) : 10s
Altitude	≤ 1000 m	Totale Harmonic distortion THD (**)	no load < 1.5%	
Overspeed	2250 min^{-1}	Waveform: NEMA = TIF (**)	< 50	
Air flow	0.9 m^3/s (50Hz) / 1.1 (60Hz)			

(*) Steady state. (**) Total harmonic distortion between phases, no-load or on-load (non-distorting)

Reactances (%). Time constants (ms) - Class H / 400 V

		VS2 (12w)	S4 (12w)	S5 (12w)	M7 (12w)	M8 (12w)	L9 (12w)	L9 (6w)
Kcc	Short-circuit ratio	0.38	0.37	0.33	0.41	0.32	0.37	0.38
Xd	Direct-axis synchro. reactance unsaturated	336	322	357	307	360	330	325
Xq	Quadrature-axis synchro. reactance unsaturated	201	193	214	184	216	198	195
T'do	No-load transient time constant	1738	1855	1855	1930	1958	1997	1997
X'd	Direct-axis transient reactance saturated	19.3	17.3	19.2	15.9	18.3	16.5	16.2
T'd	Short-circuit transient time constant	100	100	100	100	100	100	100
X"d	Direct-axis subtransient reactance saturated	13.5	12.1	13.5	11.1	12.9	11.4	11.6
T"d	Subtransient time constant	10	10	10	10	10	10	10
X"q	Quadrature-axis subtransient reactance saturated	18.4	16.3	18	14.7	17	15	15.2
Xo	Zero sequence reactance unsaturated	0.9	0.9	0.9	0.7	0.6	0.9	0.2
X2	Negative sequence reactance saturated	16	14.2	15.8	13	15	13.2	13.4
Ta	Armature time constant	15	15	15	15	15	15	15
Other class H/400 V data								
io (A)	No-load excitation current	1	0.9	0.9	1	0.9	0.9	0.9
ic (A)	On-load excitation current	3.8	3.5	3.8	3.6	3.7	3.7	3.7
uc (V)	On-load excitation voltage	39	35	38	36	37	36	36
ms	Response time (ΔU = 20% transient)	500	500	500	500	500	500	500
kVA	Start (ΔU = 20% cont. or 50% trans.) SHUNT	722	928	928	1073	1159	1258	1258
kVA	Start (ΔU = 20% cont. or 50% trans.) AREP	805	1035	1035	1195	1294	1400	1400
%	Transient ΔU (on-load 4/4) SHUNT - P.F.: 0.8 $_{LAG}$	16.8	15.5	16.7	14.6	16.2	15	14.8
%	Transient ΔU (on-load 4/4) AREP - P.F.: 0.8 $_{LAG}$	13.7	12.7	13.6	11.9	13.2	12.2	12.1
W	No-load losses	5440	5690	5690	6540	6120	6780	6880
W	Heat dissipation	20780	20470	23780	23040	26020	27490	26720


ID-Number: G4108
Type: 2G-KWK-370 BGM
Order number: 15000258
Serial Number: CO0415C-BMLB-370212
Customer: Adverio B.V.
Rozenburglaan 13
NL-9727 DL Groningen
Plant operator: Agropal Farm EFG ltd Palestine
Pallest. Territory
Palästina
Location: Palästina
Colo(u)rs:
Load current
Outer conductors L1-L3 black
Neutral conductor light blue
Grounding conductor green/yellow
Outer conductors upstream from main switch Black with orange marking
Measurement grid volt. orange
Measurement generator voltage black
Controller
24 V DC control voltage darkblue
24 V DC dig. ground blue-black
24 V DC dig. inputs blue-green
24 V DC dig. outputs blue-white
Control voltage AC red
Analog signals white and brown
current transformer white and brown
external voltage orange
Technical Data:
Total output: 370kW
Connected load: 230V/400V/50Hz
Back-up fuse: 2x 355A
Safety Measures By IEC 439-1 / DIN VDE 0660
PEN
PE+N
Cover Sheet
Date 21.04.2015
Editor TWE
Norm
Version C01 2013 29
2G-KWK-370 BGM
Adverio B.V.
Location:
Palästina
check elec
2G Energietechnik GmbH
Benzstr. 10
DE-48619 Heek
check prod
Serial Number:
CO0415C-BMLB-370212
Commission: 15000258
ID-Number: G4108
sheet 1
of 1


Minimum cross section to 20m
supply line CHP
L1-L3 3x2x240mm²
N 2x240mm²
PE 1x95mm²
Generator
400V / 230V - 50Hz
370kW - 562A
cos phi 0,95
Leroy Somer LSA 47.2 L9
Setting data
Generator switch
In = 800A
Ir = 0,7 x In
tr = 2s
Isd = 4 x Ir
tsd = 20ms
I²t = Off
Ii = 3 x In
Measuring/Synchronisation
DEIF
GPC 3
f> : 51,5 Hz 100ms
f< : 47,5 Hz 100ms
U> : 108% Un 60s
U>>: 115% Un 100ms
U< : 80% Un 2,7s
U<<: 45% Un 300ms
-G
-Q
Circuit breaker
With Motor Drive
Eaton
NZMN4-VE800
In=800A
-T
600/5
supply
control cabinet 2G
-X
Transfer terminal
2G Energietechnik GmbH
customer
TN-S 3x400V/230V 50Hz
-F
2x 355A
NH
medium voltage
-T
10kV
Single-line circuit scheme
Date 21.04.2015
Editor TWE
Norm
Version C01 2013 29
2G-KWK-370 BGM
Adverio B.V.
Location:
Palästina
check elec
2G Energietechnik GmbH
Benzstr. 10
DE-48619 Heek
check prod
Serial Number:
CO0415C-BMLB-370212
Commission: 15000258
ID-Number: G4108
-ES
sheet 1
of 1

Appendix D

Analysis of Substations

Apparent power analysis in all substation

Number	Name of substation	Minimum load				Maximum load				Average load			
		L1	L2	L3	Total	L1	L2	L3	Total	L1	L2	L3	Total
1	Al-masjid Al_kaber	34.5	26	29.3	94.1	105.8	78.9	101.8	270.1	73.1	51.9	66	191
2	Mothalath Al_borg	34.5	26	29.3	94.1	105.8	78.9	101.8	270.1	73.1	51.9	66	191
3	Maskaneh	34.5	26	29.3	94.1	105.8	78.9	101.8	270.1	73.1	51.9	66	191
4	Bear mtawi’	19.4	19.1	23.7	62.2	66.8	63.6	87.9	198.9	45	41.7	56.3	143.1
5	Wad algamary 1	17	13.2	9.7	45.3	68	60.8	66.7	192.3	37	34.9	33.9	106
6	Wad algamary 2	2.4	1.3	2.8	8.1	21.2	23.6	27.7	72.3	7.98	7.5	10.5	26
7	Al_deir 1	22.4	22	20.6	72.1	91.8	68.7	68.9	220.1	49	39.5	42.5	131.1
8	Karam al_ashqar	14.3	9.6	8.9	36.8	44.2	44.4	33	112.5	25.7	23.5	10.2	69.3
9	Abu al_humas	22.4	22	20.6	72.1	91.8	68.7	68.9	220.1	49	39.5	42.5	131.1
10	Meqtaa’ duma	14.2	19.6	16.7	60.8	52.7	58	63.6	162.3	29.12	33.56	28.9	91.6
11	Wad ali	15.2	16.9	20.4	58.5	56.4	50.6	69.5	161.5	30.42	28.4	38.1	97
12	Aqabit gharrarah	12.6	14.5	14.6	49.6	61	53.8	57	163.9	29.7	31.2	28.3	89.26
13	Qata’t al_jamal	11.6	9.7	6.1	30.8	40.2	32.4	21.9	84.3	22.1	16.2	12.2	48.2
14	Al_markaz	17.3	20.7	14.8	56.3	34.5	33.6	30.3	93.9	24.4	26.8	21.1	72.3

15	Abu hashim	22.8	20.9	18.4	67.8	80.8	62.1	70.3	205	44.3	38.6	41.6	124.5
16	Sa’ada	12.7	11.3	10.2	35.7	39.5	36.1	27	97.5	22	19.1	17.1	58.2
17	Al_baladiya	12.7	11.3	10.2	35.7	39.5	36.1	27	97.5	22	19.1	17.1	58.2
18	Al_sheehk	22.8	20.9	18.4	67.8	80.8	62.1	70.3	205	44.3	38.6	41.6	124.5
19	Al-marj 1	4	11.1	5.2	24.4	17.9	33.3	26.9	72.7	10.1	19.3	13.7	43.3
20	Aqabit al_tarsha	14.4	13.9	12.3	47.1	45.6	40.2	31.1	122.3	25.2	24.9	25.8	76
21	Al_mustashfah	11.6	9.7	6.1	30.8	40.2	32.4	21.9	84.3	22.1	16.2	12.2	48.2
22	Da’na	0	0	0	100	30.5	31.9	29	91.5	8.7	9.4	8.4	26.5
23	Kurza	14.4	13.9	12.3	47.1	45.6	40.2	31.1	122.3	25.2	24.9	25.8	76
24	Al-deire 2	11.6	9.7	6.1	30.8	40.2	32.4	21.9	84.3	22.1	16.2	12.2	48.2
25	Rasmi wahab	0	0	0	100	30.5	31.9	29	91.5	8.7	9.4	8.4	26.5
26	Baten alqar’	10.8	11.9	9.3	38.8	35.4	37.5	37.7	99	20.7	22.5	21.2	64.5
27	Al_muntazah	6.8	4.9	5.8	19	24.5	14.4	22.4	54.1	13	8	11.7	32.8
28	Domet al_wridat	15.3	11.7	15.3	48	36.5	42	43.8	113.6	23.1	21.7	26.2	71
29	Juret al_dama	7.9	8.9	16.2	36.3	41.9	46.4	49.8	133.4	20.9	19.9	29.6	70.5
30	Kafar joul	5.5	5.9	11.7	22	27.2	21.6	44	76.4	13.9	13.7	24	42.5
31	Sam’a	1.5	3.4	1.5	8.3	13.4	12.3	9.8	32.2	4.3	6.4	4.7	15.6
32	Khalet al_ayaseh	2.6	6.2	2.3	14.4	16.2	27	14.2	50.6	7.4	11.4	6.8	25.6

33	Al_mizrab	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
34	Al_shadaqa	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
35	Al_shuqfan	7.7	6.7	8	25.9	28.3	27.2	30.8	81.3	14.6	13.5	14.4	42.6
36	Al_estad	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
37	Eshreeteh	7.4	5.9	10	27.4	35.5	33.2	37.7	91.8	18.9	14.4	20.7	54.4
38	Al_muhtasib	5.9	5.4	7.9	21	16.2	21	26.6	58.6	10.5	13.4	16.4	40.5
39	Jammoq	9.5	8.4	7.2	31.7	38.5	40.2	38.3	108.8	19.3	18.6	17.6	56.6
40	Al_helal	0.2	0.2	0.2	0.6	4.7	3.8	5.1	12	2.1	1.7	3.1	6.9
41	Al_muntazah 2	6.8	4.9	5.8	19	24.5	14.4	22.4	54.1	13	8	11.7	32.8
42	Abu njeem 2	6.8	4.9	5.8	19	24.5	14.4	22.4	54.1	13	8	11.7	32.8
43	Al jame’a	2.3	5.7	6.5	15.9	17.4	23	27.1	59	7	12.8	14.9	34.8
44	Alghwla	2.4	0.9	2	6.3	12.9	11.2	10.8	23.9	5.2	2.5	4.5	12.3
45	Masafi	8	4.4	5.6	14.8	43	30.9	36.9	98.7	20.1	13.4	15.6	50
46	Al_jebreni	12	13.5	14.5	41.5	44	40.5	35.5	120	28	27	25	80
47	Abu_njeem 1	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
48	Inab al_kabeer	1.5	3.4	1.5	8.3	13.4	12.3	9.8	32.2	4.3	6.4	4.7	15.6
49	Shweki	1.5	3.4	1.5	8.3	13.4	12.3	9.8	32.2	4.3	6.4	4.7	15.6
50	Al-baha	9.5	8.4	7.2	31.7	38.5	40.2	38.3	108.8	19.3	18.6	17.6	56.6

51	Inab al_sagher	12.1	10.9	10.9	39.7	35.1	29.4	33.2	89.3	20.3	16.8	19.5	56.5
52	Bank al_eskan	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
53	Al_tork	12.5	14.7	12.8	39	37.8	44.6	40.8	123.2	31	37.1	33.5	101.8
54	Wad algamary 3	3.7	1.1	2.4	8.6	12.7	12.6	15.8	35.6	6.2	4.9	5.8	17
55	Mana’	1	0.7	1	3.2	21.4	15	17.5	52.4	7.9	5.5	6.73	20.1

Power Factor analysis in all substation

Number	Name of substation	Minimum PF				Maximum PF				Average PF			
		L1	L2	L3	Total	L1	L2	L3	total	L1	L2	L3	Total
1	Al-masjid Al_kaber	0.89	0.93	0.91	0.91	0.96	0.99	0.98	0.97	0.92	0.96	0.95	0.94
2	Mothalath Al_borg	0.89	0.93	0.91	0.91	0.96	0.99	0.98	0.97	0.92	0.96	0.95	0.94
3	Maskaneh	0.89	0.93	0.91	0.91	0.96	0.99	0.98	0.97	0.92	0.96	0.95	0.94
4	Bear mtawi’	0.60	0.72	0.85	0.75	0.97	0.98	0.99	0.98	0.82	0.80	0.94	0.89
5	Wad algamary 1	0.82	0.83	0.54	0.77	0.99	0.98	0.99	0.98	0.92	0.91	0.90	0.91
6	Wad algamary 2	0.34	0.59	0.65	0.63	0.99	0.99	0.99	0.99	0.86	0.90	0.88	0.88
7	Al_deir 1	0.91	0.92	0.91	0.93	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95
8	Karam al_ashqar	0.88	0.92	0.91	0.92	0.99	0.99	0.99	0.99	0.94	0.96	0.95	0.95
9	Abu al_humas	0.91	0.92	0.91	0.93	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95
10	Meqtaa’ duma	0.92	0.84	0.86	0.9	0.99	0.98	0.98	0.98	0.96	0.92	0.91	0.93
11	Wad ali	0.92	0.92	0.92	0.92	0.99	0.99	0.99	0.98	0.96	0.96	0.95	0.96
12	Aqabit gharrarah	0.92	0.88	0.90	0.90	0.99	0.99	0.98	0.98	0.97	0.93	0.94	0.95
13	Qata’t al_jamal	0.84	0.9	0.86	0.89	0.98	0.99	0.98	0.98	0.92	0.94	0.92	0.93
14	Al_markaz	0.86	0.93	0.92	0.92	0.98	0.99	0.99	0.99	0.93	0.97	0.96	0.95
15	Abu hashim	0.86	0.87	0.83	0.87	0.98	0.98	0.97	0.97	0.91	0.93	0.90	0.91
16	Sa’ada	0.93	0.93	0.89	0.94	0.99	0.99	0.99	0.99	0.96	0.97	0.95	0.96
17	Al_baladiya	0.93	0.93	0.89	0.94	0.99	0.99	0.99	0.99	0.96	0.97	0.95	0.96
18	Al_sheehk	0.86	0.87	0.83	0.87	0.98	0.98	0.97	0.97	0.91	0.93	0.90	0.91
19	Al-marj 1	0.93	0.97	0.94	0.96	0.99	1	1	0.99	0.96	0.98	0.98	0.98

20	Aqabit al_tarsha	0.88	0.88	0.91	0.99	0.98	0.99	0.98	0.97	0.94	0.94	0.94	0.94
21	Al_mustashfah	0.84	0.9	0.86	0.89	0.98	0.99	0.98	0.98	0.92	0.94	0.92	0.93
22	Da’na	0.24	0.26	0.03	0.21	0.96	0.95	0.94	0.95	0.92	0.91	0.88	0.89
23	Kurza	0.88	0.88	0.91	0.99	0.98	0.99	0.98	0.97	0.94	0.94	0.94	0.94
24	Al-deire 2	0.84	0.9	0.86	0.89	0.98	0.99	0.98	0.98	0.92	0.94	0.92	0.93
25	Rasmi wahab	0.24	0.26	0.03	0.21	0.96	0.95	0.94	0.95	0.92	0.91	0.88	0.89
26	Baten alqar’	0.83	0.84	0.83	0.85	0.96	0.98	0.97	0.96	0.90	0.83	0.91	0.91
27	Al_muntazah	0.89	0.87	0.94	0.92	0.99	0.99	0.99	0.99	0.95	0.93	0.97	0.95
28	Domet al_wridat	0.89	0.87	0.94	0.92	0.99	0.99	0.99	0.99	0.95	0.93	0.97	0.95
29	Juret al_dama	0.81	0.93	0.96	0.92	1	1	1	0.99	0.94	0.97	0.97	0.95
30	Kafar joul	0.73	0.80	0.95	0.86	0.98	0.98	1	0.99	0.88	0.86	0.98	0.94
31	Sam’a	0.86	0.87	0.77	0.88	0.99	0.99	0.99	0.99	0.95	0.92	0.89	0.92
32	Khalet al_ayaseh	0.90	0.91	0.80	0.88	0.99	0.99	0.98	0.99	0.95	0.96	0.89	0.94
33	Al_mizrab	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
34	Al_shadaqa	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
35	Al_shuqfan	0.92	0.89	0.87	0.90	0.99	0.99	0.99	0.99	0.95	0.94	0.94	0.94
36	Al_estad	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
37	Eshreeteh	0.93	0.97	0.93	0.95	0.99	1	0.99	0.99	0.97	0.98	0.96	0.97
38	Al_muhtasib	0.85	0.82	0.88	0.86	0.99	0.99	0.99	0.99	0.92	0.96	0.95	0.95
39	Jammoq	0.85	0.93	0.93	0.92	1	1	0.99	0.99	0.95	0.97	0.98	0.96
40	Al_helal	0.72	0.74	0.95	0.92	0.99	0.99	0.99	0.98	0.91	0.93	0.97	0.95
41	Al_muntazah 2	0.86	0.87	0.91	0.9	0.98	0.99	0.99	0.98	0.93	0.92	0.95	0.94
42	Abu njeem 2	0.86	0.87	0.91	0.9	0.98	0.99	0.99	0.98	0.93	0.92	0.95	0.94
43	Al jame’a	0.85	0.83	0.77	0.85	0.99	0.98	0.98	0.97	0.92	0.93	0.92	0.93

44	Alghwla	0.88	0.78	0.81	0.87	1	1	0.99	0.99	0.94	0.91	0.91	0.93
45	Masafi	0.86	0.88	0.86	0.88	0.99	0.99	0.98	0.98	0.94	0.95	0.93	0.94
46	Al_jebreni	0.85	0.83	0.88	0.85	0.91	0.95	0.90	0.92	0.88	0.89	0.89	0.90
47	Abu_njeem 1	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
48	Inab al_kabeer	0.86	0.87	0.77	0.88	0.99	0.99	0.99	0.99	0.95	0.92	0.89	0.92
49	Shweki	0.86	0.87	0.77	0.88	0.99	0.99	0.99	0.99	0.95	0.92	0.89	0.92
50	Al-baha	0.72	0.74	0.95	0.92	0.99	0.99	0.99	0.98	0.91	0.93	0.97	0.95
51	Inab al_sagher	0.93	0.87	0.90	0.92	0.99	0.97	0.99	0.98	0.96	0.92	0.95	0.95
52	Bank al_eskan	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
53	Al_tork	0.65	0.67	0.52	0.62	0.86	0.81	0.78	0.82	0.71	0.70	0.60	0.67
54	Wad algamary 3	0.88	0.88	0.90	0.89	0.99	1	0.99	0.99	0.92	0.94	0.95	0.94
55	Mana’	0.49	0.43	0.47	0.52	0.99	0.99	0.99	0.99	0.80	0.78	0.79	0.80

Percentage THD (voltage) analysis in all substation

N0.	Name of substation	Minimum			Maximum			Average		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
1	Al-masjid Al_kaber	2	2.1	2.1	2.9	2.9	2.9	2.4	2.5	2.5
2	Mothalath Al_borg	2	2.1	2.1	2.9	2.9	2.9	2.4	2.5	2.5
3	Maskaneh	2	2.1	2.1	2.9	2.9	2.9	2.4	2.5	2.5
4	Bear mtawi’	2.5	2.4	2.5	3.9	3.8	3.8	3.1	3	3.1
5	Wad algamary 1	2	1.84	1.8	3.07	3	2.8	2.5	2.3	2.2
6	Wad algamary 2	1.86	1.66	1.8	3.07	3.04	2.96	2.4	2.33	2.29
7	Al_deir 1	1.9	1.9	1.7	3.7	3.4	3.2	2.4	2.3	2.2
8	Karam al_ashqar	1.8	1.7	1.9	3	3.1	3.1	2.4	2.4	2.6
9	Abu al_humas	1.9	1.9	1.7	3.7	3.4	3.2	2.4	2.3	2.2
10	Meqtaa’ duma	2	1.9	2.2	18.1	4.8	3.7	4.1	2.8	2.7
11	Wad ali	1.6	1.5	1.8	3	3.1	3.3	2.3	2.4	2.5
12	Aqabit gharrarah	1	1.1	0.94	3.5	4.1	3.5	2	2.4	2.1
13	Qata’t al_jamal	1.7	2.1	2.1	3.2	3.7	3.5	2.4	2.6	2.6
14	Al_markaz	1.4	1.5	1.4	3.2	3.1	3	2.1	2.2	2.2
15	Abu hashim	2.0	1.9	2.1	3.1	3	3.1	2.5	2.4	2.5
16	Sa’ada	1.8	1.8	2	3.5	3.3	3.5	2.4	2.4	2.6
17	Al_baladiya	1.8	1.8	2	3.5	3.3	3.5	2.4	2.4	2.6
18	Al_sheehk	2.0	1.9	2.1	3.1	3	3.1	2.5	2.4	2.5
19	Al-marj 1	1.6	1.4	1.3	2.3	2.1	1.9	1.9	1.8	1.7
20	Aqabit al_tarsha	1.4	1.5	1.6	3	3.2	3.1	2.2	2.4	2.3
21	Al_mustashfah	1.7	2.1	2.1	3.2	3.7	3.5	2.4	2.6	2.6

22	Da’na	1.7	1.8	1.9	3	3.1	3.2	2.4	2.4	2.6
23	Kurza	1.4	1.5	1.6	3	3.2	3.1	2.2	2.4	2.3
24	Al-deire 2	1.7	2.1	2.1	3.2	3.7	3.5	2.4	2.6	2.6
25	Rasmi wahab	1.7	1.8	1.9	3	3.1	3.2	2.4	2.4	2.6
26	Baten alqar’	1.9	1.7	2	2.9	2.7	3.1	2.4	2.3	2.4
27	Al_muntazah	1.8	1.9	2.19	3.29	3.67	3.64	2.64	2.62	2.93
28	Domet al_wridat	1.8	1.9	2.19	3.29	3.67	3.64	2.64	2.62	2.93
29	Juret al_dama	1.6	1.7	1.9	3	3.3	3.4	2.2	2.3	2.5
30	Kafar joul	1.6	4.2	1.7	2.8	39.2	3	2.1	11.9	2.3
31	Sam’a	1.6	1.6	1.7	3.3	3.4	3.26	2.5	2.5	2.4
32	Khalet al_ayaseh	1.8	1.89	1.82	3.55	3.68	3.65	2.47	2.56	2.15
33	Al_mizrab	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
34	Al_shadaqa	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
35	Al_shuqfan	1.8	1.9	1.6	3.2	3.4	3.3	2.4	2.5	2.3
36	Al_estad	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
37	Eshreeteh	2	1.8	1.9	3.8	3.7	3.5	2.5	2.4	2.5
38	Al_muhtasib	1.7	1.9	1.5	3.4	3.3	3.2	2.3	2.4	2.2
39	Jammoq	2	1.7	2	4.1	3.5	3.9	2.6	2.4	2.6
40	Al_helal	1.8	1.8	2	3.2	3	3.3	2.5	2.4	2.6
41	Al_muntazah 2	1.7	1.9	2	3.2	3.1	3.3	2.4	2.4	2.5
42	Abu njeem 2	1.7	1.9	2	3.2	3.1	3.3	2.4	2.4	2.5
43	Al jame’a	1.9	1.9	2	3.2	3.2	3.2	2.5	2.5	2.6
44	Alghwla	1.9	1.9	1.7	3.8	3.5	3.8	2.7	2.6	2.6
45	Masafi	1.6	1.5	1.7	2.9	2.7	2.8	2.1	2	2.2
46	Al_jebreni	1.4	1.5	1.6	3	3.2	3.1	2.2	2.4	2.3

47	Abu_njeem 1	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
48	Inab al_kabeer	1.6	1.6	1.7	3.3	3.4	3.26	2.5	2.5	2.4
49	Shweki	1.6	1.6	1.7	3.3	3.4	3.26	2.5	2.5	2.4
50	Al-baha	2	1.7	2	4.1	3.5	3.9	2.6	2.4	2.6
51	Inab al_sagher	1.9	1.8	1.9	3.2	3	3.1	2.7	2.4	2.6
52	Bank al_eskan	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
53	Al_tork	1.8	1.7	1.8	3.4	3.6	3.6	2.3	2.3	2.4
54	Wad algamary 3	1.5	1.6	1.7	2.7	2.5	2.7	2	2.1	2.2
55	Mana’	1.7	1.6	1.8	3.2	2.9	3.2	2.2	2.2	2.3

Percentage THD (current) analysis in all substation

Number	Name of substation	Minimum load			Maximum load			Average		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
1	Al-masjid Al_kaber	7.8	9.3	9.3	14.9	19.3	18.5	11.4	14.5	13.2
2	Mothalath Al_borg	7.8	9.3	9.3	14.9	19.3	18.5	11.4	14.5	13.2
3	Maskaneh	7.8	9.3	9.3	14.9	19.3	18.5	11.4	14.5	13.2
4	Bear mtawi’	11.5	10.5	11.4	30	27	25	20.6	19	17.9
5	Wad algamary 1	5.91	6.9	6.56	18.13	23.8	33.57	11.05	12.8	17.7
6	Wad algamary 2	4.08	5.86	6.55	24.8	35.8	35.9	12.9	15.8	16.8
7	Al_deir 1	8.1	7.2	7.9	23.1	17.5	17.8	14.7	11.9	12.2
8	Karam al_ashqar	9.3	8.6	8.9	19.3	213	24.8	13.7	15.1	16.5
9	Abu al_humas	8.1	7.2	7.9	23.1	17.5	17.8	14.7	11.9	12.2
10	Meqtaa’ duma	7.6	8	7.63	25.64	18.36	18.02	14.5	12.94	13.13
11	Wad ali	7.1	8.6	8.7	29.5	23.4	20.2	18.1	15.8	14.1
12	Aqabit gharrarah	7.7	6.5	9.3	28.7	20	30.6	14.7	13.3	16.2
13	Qata’t al_jamal	5	6.3	6.3	25.8	18.2	26.6	14.7	13.1	14.1
14	Al_markaz	2	3.6	3.3	9.2	10	10.3	4.8	6.1	6
15	Abu hashim	4.82	7.18	6.93	13.9	16.6	17.27	9.28	12.3	11.7
16	Sa’ada	6.3	7.5	5.6	21.7	29	17.5	15.4	16.6	12.6
17	Al_baladiya	6.3	7.5	5.6	21.7	29	17.5	15.4	16.6	12.6
18	Al_sheehk	4.82	7.18	6.93	13.9	16.6	17.27	9.28	12.3	11.7
19	Al-marj 1	4.8	6.8	5.6	24.1	25	25.4	14.6	15.3	11.3

20	Aqabit al_tarsha	8.3	6.6	9	22.3	20.5	25.2	14.4	12.3	15.4
21	Al_mustashfah	5	6.3	6.3	25.8	18.2	26.6	14.7	13.1	14.1
22	Da'na	7.5	8.3	8.1	56.8	327.6	327.6	26.4	55.1	44.1
23	Kurza	8.3	6.6	9	22.3	20.5	25.2	14.4	12.3	15.4
24	Al-deire 2	5	6.3	6.3	25.8	18.2	26.6	14.7	13.1	14.1
25	Rasmi wahab	7.5	8.3	8.1	56.8	327.6	327.6	26.4	55.1	44.1
26	Baten alqar'	6.7	8.9	7.8	20.7	27.2	23.5	13.8	19.1	15.2
27	Al_muntazah	3.7	7	5.3	27.6	23.6	16.6	14	14.6	10.4
28	Domet al_wridat	3.7	7	5.3	27.6	23.6	16.6	14	14.6	10.4
29	Juret al_dama	6.9	5.5	6.9	27	25.1	28.8	14	15.1	14.4
30	Kafar joul	5.6	8.08	8.1	31.8	46.9	49.2	16.5	26.7	21.5
31	Sam'a	6.15	11.3	8.2	45	34.5	38.2	22.4	21.8	16.7
32	Khalet al_ayaseh	8.8	4.9	10.4	35.7	52.3	41.2	20.2	23.7	25.9
33	Al_mizrab	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
34	Al_shadaqa	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
35	Al_shuqfan	3.5	3.6	3.9	24.3	17.1	18.8	11.7	10.1	10
36	Al_estad	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
37	Eshreeteh	6.9	6.7	10.5	30.3	27.9	33.6	19.5	15.3	20.4
38	Al_muhtasib	5.8	5.2	8.2	21.1	26	32.8	12	13.3	15.1
39	Jammoq	7.5	3.8	14.7	22.4	28	24.6	16	17	20.5
40	Al_helal	8.43	8.81	8.06	27.24	30.43	26.1	17.04	18.7	15.18

41	Al_muntazah 2	4.7	3.6	3.8	36.6	21.7	17.9	16.8	10.5	11
42	Abu njeem 2	4.7	3.6	3.8	36.6	21.7	17.9	16.8	10.5	11
43	Al jame'a	4.6	5.91	6.43	34.15	54.54	42.53	18.7	25.4	20.8
44	Alghwla	5.8	6.6	4.6	22.9	41.1	30	15.3	20	15.6
45	Masafi	8.1	6.9	4.9	22.5	17.8	18.7	14.6	13.6	11.9
46	Al_jebreni	8.3	6.6	9	22.3	20.5	25.2	14.4	12.3	15.4
47	Abu_njeem 1	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
48	Inab al_kabeer	6.15	11.3	8.2	45	34.5	38.2	22.4	21.8	16.7
49	Shweki	6.15	11.3	8.2	45	34.5	38.2	22.4	21.8	16.7
50	Al-baha	7.5	3.8	14.7	22.4	28	24.6	16	17	20.5
51	Inab al_sagher	3.4	4.9	4	161.2	71.3	327.6	82.9	27.4	46.7
52	Bank al_eskan	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
53	Al_tork	3.3	5.6	7.2	41	79.9	58.4	16.1	79.9	58.4
54	Wad algamary 3	8	7	8.6	29.8	28.9	24.2	18.3	16.6	16.7
55	Mana'	3.3	5.6	7.2	41	79.9	58.4	16.1	28.5	26.1

Appendix E

Etap circuit analysis

Appendix E1

Appendix E2

Appendix E3

Appendix E4

Appendix E5

Appendix E1

Appendix E2

Appendix E3

Mathematical Model:

Cables and overhead lines Calculations:

- $R_{ac} = R_{dc}(1 + y_s + y_p)$

$$y_s = \frac{{X_s}^4}{192 + 0.8{X_s}^4}$$

$${X_s}^4 = (\frac{8\pi f}{R_{dc}} K_s * 10^{-7})^2$$

$$y_p = \frac{{X_p}^4}{192 + 0.8{X_p}^4} (\frac{d_c}{S})^2 \left[0.312(\frac{d_c}{S})^2 + \frac{1.18}{\frac{{X_p}^4}{192 + 0.8{X_p}^4} + 0.27} \right]$$

$${X_p}^4 = (\frac{8\pi f}{R_{dc}} K_p * 10^{-7})^2$$

Where:

$\boldsymbol{R_{dc}}$ is the dc resistance at the conductor operating temperature θ (Ω / m)

$\boldsymbol{f}$ is the supply frequency (Hz)

$\boldsymbol{d_c}$ is the diameter of the conductor (mm)

$\boldsymbol{S}$ is the distance between conductor axes, and $S = d_c + t$ where t is the thickness of the insulation between conductors (mm)

$\boldsymbol{K_s}$ is a constant.

$\boldsymbol{K_p}$ is a constant.

Type of Conductor	Dried and Impregnated?	k_s	k_p
Aluminium			
Round, stranded	Either	1	1

- $Xc = 2\pi f \left[K + 0.2 \ln \frac{2S}{d_c}\right] * 10^{-3}$

Where:

$\boldsymbol{Xc}$ is the conductor inductive reactance (Ω / km)

$\boldsymbol{f}$ is the supply frequency (Hz)

$\boldsymbol{S}$ is the axial spacing between conductors (mm)

$\boldsymbol{d_c}$ is the diameter of the conductor, or for shaped conductors, the diameter of an equivalent circular conductor of equal cross-sectional area and degree of compaction (mm)

$\boldsymbol{K}$ is a constant factor pertaining to conductor formation, for 3 wires strand in conductor $K\ equals\ 0.0778$

$\boldsymbol{Y}$ is an electrical conductance (Ω^{-1}/km)

Rabbit:

$\text{Area} = 61.70\ mm^2$

$\text{Area} = \pi r^2 = 61.70\ mm^2$

$r = 4.432\ mm$

$d_c = 2r = 8.864\ mm$

$S = d_c + t \cong\ d_c =\ 8.864\ mm$

$R_{dc} = 0.529 \frac{\Omega}{\text{km}}$

$X_s{}^4 = (\frac{8 * 3.14 * 50}{0.529 * 10^{-3}} * 1 * 10^{-7})^2 = 0.05637$

$y_s = \frac{0.05637}{192 + 0.8 * 0.05637} = 2.9 * 10^{-4}$

$X_s{}^4 = X_p{}^4 = 0.05637$

$$y_p = \frac{0.05637}{192 + 0.8 * 0.05637}\left(\frac{8.864}{8.864}\right)^2 \left[0.312\left(\frac{8.864}{8.864}\right)^2 + \frac{1.18}{\frac{0.05637}{192 + 0.8 * 0.05637} + 0.27}\right] = 1.356 * 10^{-3}$$

$$R_{ac} = 0.529(1 + 2.9 * 10^{-4} + 1.356 * 10^{-3}) = 0.529 \frac{\Omega}{\text{km}}$$

$S = 1.26 * A = 1.26 * 600 = 756\ mm$

- $Xc = 2 * 3.14 * 50 \left[0.0778 + 0.2 \ln \frac{2*765}{8.864}\right] * 10^{-3} = 0.347\ \frac{\Omega}{\text{km}}$

Dog:

$\text{Area} = 118.5\ mm^2$

$\text{Area} = \pi r^2 = 118.5\ mm^2$

$r = 6.143\ mm$

$d_c = 2r = 12.286\ mm$

$S = d_c + t \cong\ d_c =\ 12.286\ mm$

$R_{dc} = 0.268 \frac{\Omega}{\text{km}}$

$X_s{}^4 = (\frac{8 * 3.14 * 50}{0.268 * 10^{-3}} * 1 * 10^{-7})^2 = 0.2196$

$y_s = \frac{0.2196}{192 + 0.8 * 0.2196} = 1.142 * 10^{-3}$

$X_s{}^4 = X_p{}^4 = 0.2196$

$$y_p = \frac{0.2196}{192 + 0.8 * 0.2196}\left(\frac{12.286}{12.286}\right)^2 \left[0.312\left(\frac{12.286}{12.286}\right)^2 + \frac{1.18}{\frac{0.2196}{192 + 0.8 * 0.2196} + 0.27}\right] = 5.326 * 10^{-3}$$

$$R_{ac} = 0.268(1 + 1.142 * 10^{-3} + 5.326 * 10^{-3}) = 0.2697\ \frac{\Omega}{\text{km}}$$

$S = 1.26 * A = 1.26 * 600 = 756\ mm$

- $-Xc = 2 * 3.14 * 50\left[0.0778 + 0.2 \ln \frac{2*765}{12.286}\right] * 10^{-3} = 0.326\ \frac{\Omega}{\text{km}}$

Coyote:

$\text{Area} = 152.2\ mm^2$

$\text{Area} = \pi r^2 = 152.2\ mm^2$

$r = 6.962\ mm$

$d_c = 2r = 13.924\ mm$

$S = d_c + t \cong\ d_c =\ 13.924\ mm$

$R_{dc} = 0.214 \frac{\Omega}{\text{km}}$

$X_s{}^4 = (\frac{8 * 3.14 * 50}{0.214 * 10^{-3}} * 1 * 10^{-7})^2 = 0.344$

$y_s = \frac{0.344}{192 + 0.8 * 0.344} = 1.789 * 10^{-3}$

$X_s{}^4 = X_p{}^4 = 0.344$

$$y_p = \frac{0.344}{192 + 0.8 * 0.344}\left(\frac{13.924}{13.924}\right)^2\left[0.312\left(\frac{13.924}{13.924}\right)^2 + \frac{1.18}{\frac{0.344}{192 + 0.8 * 0.344} + 0.27}\right]$$

$$= 8.325 * 10^{-3}$$

$$R_{ac} = 0.214(1 + 1.789 * 10^{-3} + 8.325 * 10^{-3}) = 0.2161\frac{\Omega}{\text{km}}$$

$$S = 1.26 * A = 1.26 * 600 = 756\ mm$$

- $Xc = 2 * 3.14 * 50\left[0.0778 + 0.2\ln\frac{2*765}{13.924}\right] * 10^{-3} = 0.318\ \frac{\Omega}{\text{km}}$

Underground Cable:

$\text{Area} = 95\ mm^2$

$\text{Area} = \pi r^2 = 95\ mm^2$

$r = 5.5\ mm$

$d_c = 2r = 11\ mm$

$S = d_c + t \cong\ d_c = 11\ mm$

$R_{dc} = 0.320\frac{\Omega}{\text{km}}$

$X_s{}^4 = (\frac{8 * 3.14 * 50}{0.320 * 10^{-3}} * 1 * 10^{-7})^2 = 0.154$

$y_s = \frac{0.154}{192 + 0.8 * 0.154} = 8.015 * 10^{-4}$

$X_s{}^4 = X_p{}^4 = 0.154$

$$y_p = \frac{0.154}{192 + 0.8 * 0.154}\left(\frac{11}{11}\right)^2\left[0.312\left(\frac{11}{11}\right)^2 + \frac{1.18}{\frac{0.154}{192 + 0.8 * 0.154} + 0.27}\right]$$

$$= 3.742 * 10^{-3}$$

$$R_{ac} = 0.320(1 + 8.015 * 10^{-4} + 3.742 * 10^{-3}) = 0.321\frac{\Omega}{\text{km}}$$

$$Y = \frac{1}{Xc} = 2\ x\ pi\ x\ f\ x\ c = 2\ x\ 3.14\ x\ 50\ x\ 0.166\ x\ 10^{-6} = \ 5.2 * 10^{-5}\ \frac{\Omega^{-1}}{\text{Km}}$$

Transformer impedance calculation:

The transformers impedance varies 2-6 % for distribution transformers. The %R varies from 1.5 % (100 kVA) to 0.10 % (500,000 kVA) .and the %X varies from 1.5% (100 kVA) to 25 % (500,000 kVA). to calculate the value of X/R divided the X over R. [11]

For transformer rating 100 KVA:

$$\frac{X}{R} = \frac{1.5\%}{1.5\%} = 1$$

And for transformer rating 500000 KVA:

$$\frac{X}{R} = \frac{25\%}{0.1\%} = 250$$

To calculate transformer rating from 100 KVA to 500000 KVA by using this method:

transformer rating ⟶ X/R

If 100 KVA ⟶ 1

160 KVA ⟶ X/R

Then X/R for 160 KVA = $\frac{160*1}{100} = 1.6$

To find the X/R for other transformer in the same way:

transformer rating 250 KVA, X/R = 2.5.

transformer rating 400 KVA, X/R = 4.

transformer rating 630 KVA, X/R = 6.3.

Appendix E4

Line/Cable Input Data

Line/Cable			Ohms or Siemens/1000 ft per Conductor (Cable) or per Phase (Line)						
			Length						
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R	X	Y
C.20			65.6	0.0	1	75	0.097536	0.067056	0.0000159
C56			183.7	0.0	1	75	0.097536	0.067056	0.0000159
C59			193.6	0.0	1	75	0.097841	0.067361	0.0000159
C60			1207.3	0.0	1	75	0.097536	0.067056	0.0000159
C61			200.1	0.0	1	75	0.097841	0.067361	0.0000159
C80			262.5	0.0	1	75	0.097536	0.067056	0.0000159
C96			315.0	0.0	1	75	0.097536	0.067056	0.0000159
C97			318.2	0.0	1	75	0.097536	0.067056	0.0000159
C100			328.1	0.0	1	75	0.097536	0.067056	0.0000159
C107			347.8	0.0	1	75	0.097536	0.067056	0.0000159
C117			383.9	0.0	1	75	0.097536	0.067056	0.0000159
C120			393.7	0.0	1	75	0.097536	0.067056	0.0000159
C128			419.9	0.0	1	75	0.097536	0.067056	0.0000159
C160			524.9	0.0	1	75	0.097536	0.067056	0.0000159
C162			531.5	0.0	1	75	0.097536	0.067056	0.0000159
C163			534.8	0.0	1	75	0.097536	0.067056	0.0000159
C191			623.4	0.0	1	75	0.097536	0.067056	0.0000159
C193			633.2	0.0	1	75	0.097536	0.067056	0.0000159
C203			666.0	0.0	1	75	0.092937	0.057549	0.0000159
C216			708.7	0.0	1	75	0.097536	0.067056	0.0000159
C246			807.1	0.0	1	75	0.097536	0.067056	0.0000159
C280			918.6	0.0	1	75	0.097536	0.067056	0.0000159
C319			1046.6	0.0	1	75	0.097536	0.067056	0.0000159
C322			1056.4	0.0	1	75	0.092937	0.057549	0.0000464
C330			1082.7	0.0	1	75	0.097536	0.067056	0.0000159
C352			1154.9	0.0	1	75	0.097536	0.067056	0.0000159
C361			1181.1	0.0	1	75	0.097536	0.067056	0.0000159
C365			1181.1	0.0	1	75	0.097536	0.067056	0.0000159
C368			1207.3	0.0	1	75	0.097536	0.067056	0.0000159
C409			1509.2	0.0	1	75	0.097536	0.067056	0.0000159
C419			1374.7	0.0	1	75	0.097536	0.067056	0.0000159
C422			1384.5	0.0	1	75	0.097536	0.067056	0.0000159
C440			1443.6	0.0	1	75	0.097536	0.067056	0.0000159
C450			1476.4	0.0	1	75	0.097536	0.067056	0.0000159

Appendix E4

Line/Cable			Ohms or Siemens/1000 ft per Conductor (Cable) or per Phase (Line)						
			Length						
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R	X	Y
C.450			1476.4	0.0	1	75	0.097536	0.067056	0.0000159
C461			1515.7	0.0	1	75	0.097536	0.067056	0.0000159
C462			1509.2	0.0	1	75	0.097536	0.067056	0.0000159
C463			1519.0	0.0	1	75	0.097841	0.067056	0.0000159
C473			1551.8	0.0	1	75	0.097536	0.067056	0.0000159
C476			1561.7	0.0	1	75	0.097536	0.067056	0.0000159
C514			1686.4	0.0	1	75	0.097536	0.067056	0.0000159
C517			1696.2	0.0	1	75	0.097536	0.067056	0.0000159
C518			1699.5	0.0	1	75	0.097536	0.067056	0.0000159
C526			1725.7	0.0	1	75	0.097536	0.067056	0.0000159
C558			1830.7	0.0	1	75	0.097536	0.067056	0.0000159
C577			1889.8	0.0	1	75	0.097536	0.067056	0.0000159
C587			1925.9	0.0	1	75	0.097536	0.067056	0.0000159
C603			1978.3	0.0	1	75	0.097536	0.067056	0.0000159
C622			2040.7	0.0	1	75	0.097536	0.067056	0.0000159
C727			2385.2	0.0	1	75	0.097536	0.067056	0.0000159
C728			2388.5	0.0	1	75	0.097536	0.067056	0.0000159
C806			2644.4	0.0	1	75	0.097536	0.067056	0.0000159
C811			2660.8	0.0	1	75	0.097536	0.067056	0.0000159
C815			2673.9	0.0	1	75	0.097536	0.067056	0.0000159
C880			2887.1	0.0	1	75	0.097536	0.067056	0.0000159
C399			1309.1	0.0	1	75	0.097536	0.067056	0.0000159
C567			1860.2	0.0	1	75	0.097536	0.067056	0.0000159
C122			400.3	0.0	1	75	0.097536	0.067056	0.0000159

Line / Cable resistances are listed at the specified temperatures.

Appendix E4

Impedance Input Data

Impedance	Positive Sequence Impedanc			
ID	R	X	Y	Unit
Co14	0.138	0.203	0	Ohm
Co57	0.0123	0.0181	0	Ohm
Co58	0.0123	0.0181	0	Ohm
Co130	0.028	0.0413	0	Ohm
Co260	0.0561	0.0826	0	Ohm
Co261	0.056	0.082	0	Ohm
Co294	0.057	0.084	0	Ohm
Co528	0.114	0.167	0	Ohm
Co600	0.129	0.1908	0	Ohm
Co645	0.139	0.205	0	Ohm
Co999	0.215	0.317	0	Ohm
Co.1032	0.223	0.328	0	Ohm
D240	0.0647	0.0782	0	Ohm
D256	0.0647	0.0782	0	Ohm
D276	0.18	0.2184	0	Ohm
D634	0.171	0.2067	0	Ohm
D655	0.1766	0.2135	0	Ohm
D711	0.191	0.231	0	Ohm
D718	0.193	0.234	0	Ohm
R10	0.216	0.142	0	Ohm
R36	0.019	0.012	0	Ohm
R45	0.0238	0.0156	0	Ohm
R106	0.056	0.036	0	Ohm
R150	0.079	0.051	0	Ohm
R164	0.0772	0.0506	0	Ohm
R190	0.10051	0.065	0	Ohm
R380	0.20102	0.1318	0	Ohm
R410	0.216	0.142	0	Ohm
R436	0.23	0.151	0	Ohm
R455	0.24	0.157	0	Ohm
R560	0.296	0.194	0	Ohm
R734	0.388	0.254	0	Ohm
R803	0.424	0.278	0	Ohm
R844	0.4464	0.292	0	Ohm
R950	0.502	0.329	0	Ohm

Project: Study the effect of EG on MV

Location: Adahiriya MV network

Contract: SELCo

Engineer: Jubeh,Natsheh and Jundi

Filename: unbalance

ETAP

12.6.0H

Study Case: ULF

Revision: Base

2-Winding Transformer Input Data

Transformer		Rating						Z	Phase Shift			
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	% Z0	X1/R1	X0/R0	% Z 1	% Z 0	Type	Angle
T1 Al-masjid Al_kaber	3-Phase	0.630	33.000	0.400	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T10 Meqtaa' duma	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T11 Wad ali	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T12 Aqabit gharrarah	3-Phase	0.400	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T13 Qata't al_jamal	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T14 Al_markaz	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T15 Abu hashim	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T16 Sa'ada	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T17 Al_baladiya	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T18 Al_sheehk	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T19 Kerbit alama	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T2 Mothalath Al_borg	3-Phase	0.630	33.000	0.400	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T20 Aqabit al_tarsha	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T21 Al_mustashfah	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T22 Da'na	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T23 Kurza	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T24 Al-deire 2	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T25 Rasmi wahab	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T26 Baten alqar'	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T27 Al_muntazah	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T28 Domet al_wridat	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T29 Juret al_dama	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T3 Maskaneh	3-Phase	0.630	33.000	0.400	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T30 Kafar joul	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T31 Sam'a	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T32 Khalet al_ayaseh	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T33 Al_mizrab	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T34 Al_shadaqa	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T35 Al_shuqfan	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T36 Al_estad	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T37 Eshreeteh	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T38 Al_muhtasib	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T39 Jammoq	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T4 Bear mtawi'	3-Phase	0.630	33.000	0.400	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T40 Al_helal	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T41 Al_muntazah 2	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T42 Abu njeem 2	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T43 Al jame'a	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T44 Alghwla	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T45 Masafi	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T46 Al_jebreni	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T47 Abu_njeem 1	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000

Transformer		Rating			Z				Phase Shift			
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	% Z0	X1/R1	X0/R0	% Z 1	% Z 0	Type	Angle
T48 Inab al_kabeer	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T49 Shweki	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T5 Wad algamary 1	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T50 Al-baha	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T51 Inab al_sagher	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T52 Bank al_eskan	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T53 Al_tork	3-Phase	0.630	33.000	0.400	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T54 Wad algamary 3	3-Phase	0.160	33.000	0.400	4.40	4.40	1.60	1.60	4.4000	4.4000	Dyn	-30.000
T55 Mana’	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T56 Al jebreny step up	3-Phase	0.630	0.400	33.000	4.40	4.40	6.30	6.30	4.4000	4.4000	Dyn	-30.000
T6 Wad algamary 2	3-Phase	0.250	33.000	0.400	4.40	4.40	2.50	2.50	4.4000	4.4000	Dyn	-30.000
T7 Al_deir 1	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T8 Karam al_ashqar	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000
T9 Abu al_humas	3-Phase	0.400	33.000	0.400	4.40	4.40	4.00	4.00	4.4000	4.4000	Dyn	-30.000

Appendix F

Output result from the Etap

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
Bus1	33.000	100.000	0.0	2.935	1.132	0	0	Bus2	2.935	1.132	55.0	93.3
Bus2	33.000	99.994	0.0	0	0	0	0	Bus3	0.957	0.392	18.1	92.5
								Bus21	1.978	0.740	36.9	93.7
								Bus1	-2.934	-1.132	55.0	93.3
Bus3	33.000	99.991	0.0	0	0	0	0	Bus2	-0.957	-0.392	18.1	92.5
								Bus4	0.957	0.392	18.1	92.5
Bus4	33.000	99.985	0.0	0	0	0	0	Bus3	-0.956	-0.392	18.1	92.5
								Bus6	0.935	0.376	17.6	92.8
								Bus5	0.021	0.016	0.5	80.8
Bus5	0.400	99.592	-0.1	0	0	0.021	0.015	Bus4	-0.021	-0.015	38.1	80.9
Bus6	33.000	99.974	0.0	0	0	0	0	Bus4	-0.935	-0.376	17.6	92.8
								Bus7	0.935	0.376	17.6	92.8
Bus7	33.000	99.949	0.0	0	0	0	0	Bus9	0.809	0.310	15.2	93.4
								Bus6	-0.935	-0.376	17.6	92.8
								Bus8	0.126	0.066	2.5	88.6
Bus8	0.400	99.361	-0.5	0	0	0.126	0.064	Bus7	-0.126	-0.064	205.1	89.0
Bus9	33.000	99.948	0.0	0	0	0	0	Bus7	-0.809	-0.310	15.2	93.4
								Bus10	0.165	0.072	3.2	91.7
								Bus145	0.644	0.239	12.0	93.8
Bus10	33.000	99.944	0.0	0	0	0	0	Bus11	0.016	0.006	0.3	94.5
								Bus9	-0.165	-0.072	3.2	91.7
								Bus13	0.149	0.066	2.9	91.4
Bus11	33.000	99.944	0.0	0	0	0	0	Bus10	-0.016	-0.006	0.3	94.5
								Bus12	0.016	0.006	0.3	94.5
Bus12	0.400	99.582	-0.2	0	0	0.016	0.005	Bus11	-0.016	-0.005	24.4	94.6
Bus13	33.000	99.941	0.0	0	0	0	0	Bus15	0.119	0.055	2.3	90.7
								Bus10	-0.149	-0.066	2.9	91.4
								Bus14	0.031	0.011	0.6	94.0
Bus14	0.400	99.559	-0.3	0	0	0.031	0.011	Bus13	-0.031	-0.011	47.1	94.1
Bus15	33.000	99.939	0.0	0	0	0	0	Bus17	0.023	0.012	0.5	88.6
								Bus13	-0.119	-0.055	2.3	90.7
								Bus20	0.096	0.043	1.8	91.2
Bus17	33.000	99.939	0.0	0	0	0	0	Bus15	-0.023	-0.012	0.5	88.6
								Bus18	0.023	0.012	0.5	88.6
Bus18	33.000	99.939	0.0	0	0	0	0	Bus17	-0.023	-0.012	0.5	88.6
								Bus19	0.023	0.012	0.5	88.6

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
Bus19	0.400	99.593	-0.2	0	0	0.023	0.012	Bus18	-0.023	-0.012	37.4	88.7
Bus20	0.400	99.228	-0.5	0	0	0.096	0.042	Bus15	-0.096	-0.042	151.8	91.6
Bus21	33.000	99.987	0.0	0	0	0	0	Bus2	-1.978	-0.740	36.9	93.7
								Bus24	1.888	0.708	35.3	93.6
								Bus22	0.090	0.031	1.7	94.4
Bus22	0.400	98.896	-0.7	0	0	0.089	0.030	Bus21	-0.089	-0.030	137.0	94.8
Bus24	33.000	99.954	0.0	0	0	0	0	Bus28	1.703	0.623	31.7	93.9
								Bus26	0.042	0.009	0.8	97.9
								Bus21	-1.888	-0.708	35.3	93.6
								Bus25	0.143	0.076	2.8	88.2
Bus25	0.400	99.275	-0.5	0	0	0.142	0.074	Bus24	-0.142	-0.074	233.6	88.6
Bus26	33.000	99.953	0.0	0	0	0	0	Bus24	-0.042	-0.009	0.8	97.9
								Bus27	0.042	0.009	0.8	97.9
Bus27	0.400	99.141	-0.5	0	0	0.042	0.008	Bus26	-0.042	-0.008	62.0	98.1
Bus28	33.000	99.938	0.0	0	0	0	0	Bus31	1.647	0.607	30.7	93.8
								Bus24	-1.703	-0.623	31.7	93.9
								Bus30	0.056	0.016	1.0	96.3
Bus30	0.400	99.623	-0.3	0	0	0.056	0.015	Bus28	-0.056	-0.015	83.7	96.4
Bus31	33.000	99.930	0.0	0	0	0	0	Bus32	0.236	0.089	4.4	93.5
								Bus28	-1.647	-0.607	30.7	93.8
								Bus38	1.411	0.518	26.3	93.9
Bus32	33.000	99.930	0.0	0	0	0	0	Bus31	-0.236	-0.089	4.4	93.5
								Bus35	0.112	0.051	2.2	91.1
								Bus34	0.124	0.039	2.3	95.4
Bus34	0.400	99.192	-0.7	0	0	0.123	0.037	Bus32	-0.123	-0.037	187.6	95.8
Bus35	33.000	99.927	0.0	0	0	0	0	Bus32	-0.112	-0.051	2.2	91.1
								Bus37	0.112	0.051	2.2	91.1
Bus37	0.400	98.377	-0.9	0	0	0.111	0.048	Bus35	-0.111	-0.048	177.5	91.7
Bus38	33.000	99.922	0.0	0	0	0	0	Bus42	0.246	0.086	4.6	94.4
								Bus31	-1.411	-0.517	26.3	93.9
								Bus53	1.165	0.431	21.7	93.8
Bus41	0.400	99.284	-0.7	0	0	0.178	0.063	Bus42	-0.178	-0.063	273.7	94.3
Bus42	33.000	99.921	0.0	0	0	0	0	Bus38	-0.246	-0.086	4.6	94.4
								Bus43	0.068	0.021	1.2	95.5
								Bus41	0.178	0.065	3.3	93.9
Bus43	33.000	99.920	0.0	0	0	0	0	Bus42	-0.068	-0.021	1.2	95.5
								Bus44	0.068	0.021	1.2	95.5
Bus44	33.000	99.916	0.0	0	0	0	0	Bus47	0.014	0.006	0.3	92.4
								Bus43	-0.068	-0.021	1.2	95.5

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
								Bus46	0.054	0.015	1.0	96.2
Bus46	0.400	98.782	-0.6	0	0	0.053	0.014	Bus44	-0.053	-0.014	80.7	96.5
Bus47	33.000	99.916	0.0	0	0	0	0	Bus44	-0.014	-0.006	0.3	92.4
								Bus51	0.014	0.006	0.3	92.4
Bus51	33.000	99.914	0.0	0	0	0	0	Bus47	-0.014	-0.006	0.3	92.4
								Bus52	0.014	0.006	0.3	92.4
Bus52	0.400	99.567	-0.2	0	0	0.014	0.006	Bus51	-0.014	-0.006	22.4	92.5
Bus53	33.000	99.914	0.0	0	0	0	0	Bus54	1.165	0.431	21.7	93.8
								Bus38	-1.165	-0.431	21.7	93.8
Bus54	33.000	99.907	0.0	0	0	0	0	Bus57	1.149	0.426	21.5	93.8
								Bus53	-1.165	-0.431	21.7	93.8
								Bus56	0.016	0.006	0.3	94.4
Bus56	0.400	99.547	-0.2	0	0	0.016	0.005	Bus54	-0.016	-0.005	24.3	94.5
Bus57	33.000	99.903	0.0	0	0	0	0	Bus54	-1.149	-0.425	21.5	93.8
								Bus63	0.885	0.333	16.6	93.6
								Bus60	0.067	0.021	1.2	95.5
								Bus59	0.197	0.072	3.7	93.9
Bus59	0.400	104.490	-0.7	0	0	0.197	0.069	Bus57	-0.197	-0.069	288.1	94.3
Bus60	33.000	99.902	0.0	0	0	0	0	Bus57	-0.067	-0.021	1.2	95.5
								Bus62	0.067	0.021	1.2	95.5
Bus62	0.400	99.132	-0.6	0	0	0.066	0.020	Bus60	-0.066	-0.020	100.9	95.8
Bus63	33.000	99.899	0.0	0	0	0	0	Bus57	-0.885	-0.333	16.6	93.6
								Bus64	0.885	0.333	16.6	93.6
Bus64	33.000	99.892	0.0	0	0	0	0	Bus69	0.069	0.021	1.3	95.6
								Bus63	-0.885	-0.333	16.6	93.6
								Bus70	0.691	0.256	12.9	93.8
								Bus66	0.125	0.056	2.4	91.3
Bus66	0.400	104.270	-0.6	0	0	0.125	0.054	Bus64	-0.125	-0.054	188.1	91.7
Bus68	0.400	99.485	-0.4	0	0	0.069	0.021	Bus69	-0.069	-0.021	103.8	95.8
Bus69	33.000	99.892	0.0	0	0	0	0	Bus64	-0.069	-0.021	1.3	95.6
								Bus68	0.069	0.021	1.3	95.6
Bus70	33.000	99.883	0.0	0	0	0	0	Bus83	0.441	0.170	8.3	93.3
								Bus64	-0.691	-0.255	12.9	93.8
								Bus73	0.113	0.042	2.1	93.6
								Bus72	0.137	0.043	2.5	95.4
Bus72	0.400	104.364	-0.7	0	0	0.137	0.041	Bus70	-0.137	-0.041	197.3	95.8
Bus73	33.000	99.880	0.0	0	0	0	0	Bus76	0.068	0.025	1.3	94.0
								Bus70	-0.113	-0.042	2.1	93.6
								Bus75	0.045	0.018	0.8	93.0

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
Bus75	0.400	99.574	-0.3	0	0	0.045	0.017	Bus73	-0.045	-0.017	69.3	93.2
Bus76	33.000	99.878	0.0	0	0	0	0	Bus79	0.052	0.013	0.9	97.0
								Bus73	-0.068	-0.025	1.3	94.0
								Bus78	0.016	0.012	0.4	80.6
Bus78	0.400	99.580	-0.1	0	0	0.016	0.012	Bus76	-0.016	-0.012	28.9	80.7
Bus79	33.000	99.878	0.0	0	0	0	0	Bus76	-0.052	-0.013	0.9	97.0
								Bus82	0.052	0.013	0.9	97.0
Bus81	0.400	99.323	-0.5	0	0	0.052	0.013	Bus82	-0.052	-0.013	78.0	97.2
Bus82	33.000	99.877	0.0	0	0	0	0	Bus79	-0.052	-0.013	0.9	97.0
								Bus81	0.052	0.013	0.9	97.0
Bus83	33.000	99.880	0.0	0	0	0	0	Bus70	-0.441	-0.170	8.3	93.3
								Bus87	0.387	0.155	7.3	92.8
								Bus86	0.054	0.015	1.0	96.3
Bus85	0.400	99.281	-0.5	0	0	0.054	0.015	Bus86	-0.054	-0.015	81.1	96.5
Bus86	33.000	99.879	0.0	0	0	0	0	Bus83	-0.054	-0.015	1.0	96.3
								Bus85	0.054	0.015	1.0	96.3
Bus87	33.000	99.875	0.0	0	0	0	0	Bus83	-0.387	-0.155	7.3	92.8
								Bus90	0.340	0.138	6.4	92.6
								Bus89	0.047	0.017	0.9	94.2
Bus89	0.400	99.299	-0.4	0	0	0.047	0.016	Bus87	-0.047	-0.016	71.7	94.4
Bus90	33.000	99.867	0.0	0	0	0	0	Bus113	-0.001	-0.040	0.7	2.7
								Bus93	0.256	0.145	5.2	87.0
								Bus87	-0.340	-0.138	6.4	92.6
								Bus92	0.085	0.033	1.6	93.2
Bus92	0.400	99.293	-0.5	0	0	0.084	0.032	Bus90	-0.084	-0.032	131.3	93.5
Bus93	33.000	99.863	0.0	0	0	0	0	Bus96	0.235	0.130	4.7	87.6
								Bus90	-0.256	-0.145	5.2	87.0
								Bus95	0.021	0.016	0.5	80.8
Bus95	0.400	99.470	-0.2	0	0	0.021	0.015	Bus93	-0.021	-0.015	38.0	80.9
Bus96	33.000	99.862	0.0	0	0	0	0	Bus93	-0.235	-0.130	4.7	87.6
								Bus103	0.111	0.039	2.1	94.3
								Bus99	0.068	0.075	1.8	67.5
								Bus98	0.056	0.016	1.0	96.3
Bus98	0.400	99.547	-0.3	0	0	0.056	0.015	Bus96	-0.056	-0.015	83.6	96.4
Bus99	33.000	99.862	0.0	0	0	0	0	Bus102	0.068	0.075	1.8	67.5
								Bus96	-0.068	-0.075	1.8	67.5
Bus101	0.400	99.271	-0.2	0	0	0.068	0.074	Bus102	-0.068	-0.074	146.2	67.8
Bus102	33.000	99.860	0.0	0	0	0	0	Bus99	-0.068	-0.075	1.8	67.5
								Bus101	0.068	0.075	1.8	67.5

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
Bus103	33.000	99.860	0.0	0	0	0	0	Bus96	-0.111	-0.039	2.1	94.3
								Bus106	0.067	0.022	1.2	95.1
								Bus105	0.044	0.018	0.8	93.0
Bus105	0.400	99.283	-0.4	0	0	0.044	0.017	Bus103	-0.044	-0.017	69.1	93.2
Bus106	33.000	99.858	0.0	0	0	0	0	Bus103	-0.067	-0.022	1.2	95.1
								Bus108	0.067	0.022	1.2	95.1
Bus108	0.400	99.071	-0.6	0	0	0.066	0.021	Bus106	-0.066	-0.021	101.5	95.4
Bus113	33.000	99.867	0.0	0	0	0	0	Bus90	0.001	0.040	0.7	2.7
								Bus114	-0.001	-0.040	0.7	2.7
Bus114	33.000	99.867	0.0	0	0	0	0	Bus113	0.001	0.040	0.7	2.7
								Bus120	0.024	0.009	0.4	94.0
								Bus121	-0.057	-0.061	1.5	68.3
								Bus116	0.032	0.013	0.6	92.9
Bus116	0.400	99.449	-0.3	0	0	0.032	0.013	Bus114	-0.032	-0.013	50.0	93.1
Bus119	0.400	99.569	-0.2	0	0	0.024	0.009	Bus120	-0.024	-0.009	36.8	94.1
Bus120	33.000	99.867	0.0	0	0	0	0	Bus114	-0.024	-0.009	0.4	94.0
								Bus119	0.024	0.009	0.4	94.0
Bus121	33.000	99.869	0.0	0	0	0	0	Bus124	0.088	0.030	1.6	94.8
								Bus126	-0.145	-0.091	3.0	84.8
								Bus114	0.057	0.061	1.5	68.3
Bus124	33.000	99.869	0.0	0	0	0	0	Bus121	-0.088	-0.030	1.6	94.8
								Bus125	0.088	0.030	1.6	94.8
Bus125	0.400	101.785	-0.4	0	0	0.088	0.029	Bus124	-0.088	-0.029	131.0	95.0
Bus126	33.000	99.872	0.0	0	0	0	0	Bus127	-0.216	-0.115	4.3	88.2
								Bus121	0.145	0.091	3.0	84.8
								Bus142	0.071	0.025	1.3	94.5
Bus127	33.000	99.877	0.0	0	0	0	0	Bus126	0.216	0.115	4.3	88.2
								Bus132	-0.258	-0.124	5.0	90.2
								Bus129	0.042	0.009	0.8	98.0
Bus129	0.400	99.462	-0.4	0	0	0.042	0.008	Bus127	-0.042	-0.008	62.2	98.1
Bus132	33.000	99.885	0.0	0	0	0	0	Bus135	-0.299	-0.137	5.8	90.8
								Bus127	0.258	0.124	5.0	90.2
								Bus134	0.000	0.000	0.0	0.0
								Bus133	0.040	0.013	0.7	94.8
Bus133	0.400	101.978	-0.3	0	0	0.040	0.013	Bus132	-0.040	-0.013	59.6	95.0
Bus134	33.000	99.885	0.0	0	0	0	0	Bus132	0.000	0.000	0.0	0.0
Bus135	33.000	99.890	0.0	0	0	0	0	Bus132	0.299	0.137	5.8	90.8
								Bus138	-0.299	-0.137	5.8	90.8
Bus138	33.000	99.900	0.0	0	0	0	0	Bus135	0.299	0.137	5.8	90.8

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
								Bus226	0.071	0.035	1.4	89.6
								Bus213	-0.369	-0.173	7.1	90.6
Bus139	0.400	98.867	-0.6	0	0	0.070	0.034	Bus226	-0.070	-0.034	114.2	90.0
Bus142	33.000	99.869	0.0	0	0	0	0	Bus126	-0.071	-0.025	1.3	94.5
								Bus143	0.071	0.025	1.3	94.5
Bus143	0.400	99.006	-0.6	0	0	0.071	0.024	Bus142	-0.071	-0.024	108.6	94.8
Bus145	33.000	99.936	0.0	0	0	0	0	Bus146	0.643	0.239	12.0	93.8
								Bus9	-0.643	-0.239	12.0	93.8
Bus146	33.000	99.933	0.0	0	0	0	0	Bus152	0.068	0.025	1.3	93.9
								Bus145	-0.643	-0.239	12.0	93.8
								Bus172	0.495	0.179	9.2	94.0
								Bus151	0.016	0.006	0.3	94.5
								Bus148	0.065	0.029	1.2	91.3
Bus148	0.400	104.345	-0.5	0	0	0.064	0.028	Bus146	-0.064	-0.028	97.1	91.6
Bus150	0.400	99.737	-0.1	0	0	0.016	0.005	Bus151	-0.016	-0.005	24.5	94.6
Bus151	33.000	99.932	0.0	0	0	0	0	Bus146	-0.016	-0.006	0.3	94.5
								Bus150	0.016	0.006	0.3	94.5
Bus152	33.000	99.933	0.0	0	0	0	0	Bus146	-0.068	-0.025	1.3	93.9
								Bus155	0.061	0.023	1.1	93.8
								Bus154	0.007	0.002	0.1	95.5
Bus154	0.400	99.857	-0.1	0	0	0.007	0.002	Bus152	-0.007	-0.002	9.9	95.5
Bus155	33.000	99.931	0.0	0	0	0	0	Bus158	0.045	0.017	0.8	93.5
								Bus152	-0.061	-0.023	1.1	93.8
								Bus157	0.016	0.006	0.3	94.5
Bus157	0.400	99.736	-0.1	0	0	0.016	0.005	Bus155	-0.016	-0.005	24.5	94.6
Bus158	33.000	99.931	0.0	0	0	0	0	Bus155	-0.045	-0.017	0.8	93.5
								Bus159	0.045	0.017	0.8	93.5
Bus159	33.000	99.930	0.0	0	0	0	0	Bus160	0.045	0.017	0.8	93.5
								Bus158	-0.045	-0.017	0.8	93.5
Bus160	33.000	99.929	0.0	0	0	0	0	Bus163	0.045	0.017	0.8	93.5
								Bus159	-0.045	-0.017	0.8	93.5
Bus163	33.000	99.928	0.0	0	0	0	0	Bus160	-0.045	-0.017	0.8	93.5
								Bus166	0.014	0.006	0.3	92.4
								Bus165	0.031	0.011	0.6	94.0
Bus165	0.400	99.545	-0.3	0	0	0.031	0.011	Bus163	-0.031	-0.011	47.1	94.1
Bus166	33.000	99.927	0.0	0	0	0	0	Bus167	0.014	0.006	0.3	92.4
								Bus163	-0.014	-0.006	0.3	92.4
Bus167	33.000	99.927	0.0	0	0	0	0	Bus166	-0.014	-0.006	0.3	92.4
								Bus168	0.014	0.006	0.3	92.4

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
Bus168	33.000	99.927	0.0	0	0	0	0	Bus167	-0.014	-0.006	0.3	92.4
								Bus171	0.014	0.006	0.3	92.4
Bus170	0.400	99.579	-0.2	0	0	0.014	0.006	Bus171	-0.014	-0.006	22.4	92.5
Bus171	33.000	99.927	0.0	0	0	0	0	Bus168	-0.014	-0.006	0.3	92.4
								Bus170	0.014	0.006	0.3	92.4
Bus172	33.000	99.929	0.0	0	0	0	0	Bus146	-0.495	-0.179	9.2	94.0
								Bus173	0.495	0.179	9.2	94.0
Bus173	33.000	99.907	0.0	0	0	0	0	Bus176	0.442	0.161	8.2	93.9
								Bus172	-0.495	-0.179	9.2	94.0
								Bus175	0.053	0.018	1.0	94.7
Bus175	0.400	98.724	-0.6	0	0	0.052	0.017	Bus173	-0.052	-0.017	80.5	95.0
Bus176	33.000	99.901	0.0	0	0	0	0	Bus173	-0.442	-0.161	8.2	93.9
								Bus179	0.086	0.030	1.6	94.4
								Bus180	0.357	0.131	6.7	93.8
Bus178	0.400	97.965	-0.9	0	0	0.084	0.028	Bus179	-0.084	-0.028	130.9	94.9
Bus179	33.000	99.900	0.0	0	0	0	0	Bus176	-0.086	-0.030	1.6	94.4
								Bus178	0.086	0.030	1.6	94.4
Bus180	33.000	99.891	0.0	0	0	0	0	Bus176	-0.357	-0.131	6.7	93.8
								Bus194	0.224	0.086	4.2	93.4
								Bus181	0.067	0.025	1.3	93.9
								Bus208	0.066	0.021	1.2	95.2
Bus181	33.000	99.888	0.0	0	0	0	0	Bus184	0.027	0.010	0.5	94.0
								Bus180	-0.067	-0.025	1.3	93.9
								Bus183	0.040	0.015	0.7	93.8
Bus183	0.400	99.391	-0.3	0	0	0.039	0.014	Bus181	-0.039	-0.014	61.0	94.0
Bus184	33.000	99.888	0.0	0	0	0	0	Bus181	-0.027	-0.010	0.5	94.0
								Bus185	0.027	0.010	0.5	94.0
Bus185	33.000	99.887	0.0	0	0	0	0	Bus189	0.011	0.004	0.2	93.1
								Bus184	-0.027	-0.010	0.5	94.0
								Bus188	0.016	0.006	0.3	94.5
Bus188	0.400	99.692	-0.1	0	0	0.016	0.005	Bus185	-0.016	-0.005	24.5	94.6
Bus189	33.000	99.887	0.0	0	0	0	0	Bus193	0.000	0.000	0.0	0.0
								Bus185	-0.011	-0.004	0.2	93.1
								Bus192	0.011	0.004	0.2	93.1
Bus191	0.400	99.739	-0.1	0	0	0.011	0.004	Bus192	-0.011	-0.004	17.7	93.2
Bus192	33.000	99.886	0.0	0	0	0	0	Bus189	-0.011	-0.004	0.2	93.1
								Bus191	0.011	0.004	0.2	93.1
Bus193	33.000	99.887	0.0	0	0	0	0	Bus189	0.000	0.000	0.0	0.0
Bus194	33.000	99.889	0.0	0	0	0	0	Bus180	-0.224	-0.086	4.2	93.4

Bus		Voltage		Generation		Load		Load Flow				
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF
								Bus195	0.224	0.086	4.2	93.4
Bus195	33.000	99.883	0.0	0	0	0	0	Bus196	0.224	0.086	4.2	93.4
								Bus194	-0.224	-0.086	4.2	93.4
Bus196	33.000	99.883	0.0	0	0	0	0	Bus195	-0.224	-0.086	4.2	93.4
								Bus197	0.224	0.086	4.2	93.4
Bus197	33.000	99.883	0.0	0	0	0	0	Bus198	0.113	0.051	2.2	91.3
								Bus209	0.111	0.035	2.0	95.4
								Bus196	-0.224	-0.086	4.2	93.4
Bus198	33.000	99.881	0.0	0	0	0	0	Bus197	-0.113	-0.051	2.2	91.3
								Bus200	0.113	0.051	2.2	91.3
Bus200	0.400	99.045	-0.6	0	0	0.112	0.049	Bus198	-0.112	-0.049	178.7	91.7
Bus201	33.000	99.879	0.0	0	0	0	0	Bus204	0.000	0.000	0.0	0.0
								Bus209	-0.014	-0.006	0.3	92.4
								Bus203	0.014	0.006	0.3	92.4
Bus203	0.400	99.688	-0.1	0	0	0.014	0.006	Bus201	-0.014	-0.006	22.4	92.5
Bus204	33.000	99.879	0.0	0	0	0	0	Bus201	0.000	0.000	0.0	0.0
								Bus205	0.000	0.000	0.0	0.0
								Bus206	0.000	0.000	0.0	0.0
Bus205	33.000	99.879	0.0	0	0	0	0	Bus204	0.000	0.000	0.0	0.0
Bus206	33.000	99.879	0.0	0	0	0	0	Bus204	0.000	0.000	0.0	0.0
Bus208	0.400	99.493	-0.4	0	0	0.065	0.021	Bus180	-0.065	-0.021	99.5	95.4
Bus209	33.000	99.879	0.0	0	0	0	0	Bus201	0.014	0.006	0.3	92.4
								Bus197	-0.111	-0.035	2.0	95.4
								Bus211	0.097	0.029	1.8	95.7
Bus211	0.400	101.888	-0.5	0	0	0.097	0.028	Bus209	-0.097	-0.028	142.7	96.0
Bus212	0.400	99.744	0.8	0.380	0.184	0.004	0.002	Bus213	0.376	0.182	603.8	90.0
Bus213	33.000	99.900	0.0	0	0	0	0	Bus212	-0.369	-0.173	7.1	90.6
								Bus138	0.369	0.173	7.1	90.6
Bus226	33.000	99.900	0.0	0	0	0	0	Bus138	-0.071	-0.035	1.4	89.6
								Bus139	0.071	0.035	1.4	89.6

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

System Harmonics Bus Information

	Bus		Voltage Distortion								
	ID	kV	Fund. %	RMS %	ASUM %	THD %	TIF	TIHD %	TSHD %	THDG %	THDS %
	Bus1	33.000	100.00	100.01	102.48	1.37	8.55	0.00	0.00	1.37	1.37
	Bus2	33.000	99.99	100.00	102.49	1.38	8.61	0.00	0.00	1.38	1.38
	Bus3	33.000	99.99	100.00	102.49	1.38	8.63	0.00	0.00	1.38	1.38
	Bus4	33.000	99.99	100.00	102.50	1.39	8.70	0.00	0.00	1.39	1.39
#	Bus5	0.400	99.59	99.62	103.19	2.15	13.33	0.00	0.00	2.15	2.15
	Bus6	33.000	99.97	99.98	102.52	1.41	8.81	0.00	0.00	1.41	1.41
	Bus7	33.000	99.95	99.96	102.57	1.46	9.07	0.00	0.00	1.46	1.46
#	Bus8	0.400	99.36	99.38	102.99	2.17	13.47	0.00	0.00	2.17	2.17
	Bus9	33.000	99.95	99.96	102.57	1.46	9.09	0.00	0.00	1.46	1.46
	Bus10	33.000	99.95	99.96	102.58	1.47	9.13	0.00	0.00	1.47	1.47
	Bus11	33.000	99.94	99.96	102.58	1.47	9.13	0.00	0.00	1.47	1.47
#	Bus12	0.400	99.58	99.61	103.19	2.17	13.36	0.00	0.00	2.17	2.17
	Bus13	33.000	99.94	99.95	102.59	1.47	9.16	0.00	0.00	1.47	1.47
#	Bus14	0.400	99.56	99.58	103.18	2.17	13.41	0.00	0.00	2.17	2.17
	Bus15	33.000	99.94	99.95	102.59	1.48	9.18	0.00	0.00	1.48	1.48
	Bus17	33.000	99.94	99.95	102.59	1.48	9.18	0.00	0.00	1.48	1.48
	Bus18	33.000	99.94	99.95	102.59	1.48	9.19	0.00	0.00	1.48	1.48
#	Bus19	0.400	99.59	99.62	103.23	2.18	13.48	0.00	0.00	2.18	2.18
#	Bus20	0.400	99.23	99.25	102.85	2.17	13.38	0.00	0.00	2.17	2.17
	Bus21	33.000	99.99	100.00	102.50	1.39	8.67	0.00	0.00	1.39	1.39
#	Bus22	0.400	98.90	98.92	102.42	2.13	12.88	0.00	0.00	2.13	2.13
	Bus24	33.000	99.95	99.97	102.54	1.43	8.98	0.00	0.00	1.43	1.43
#	Bus25	0.400	99.28	99.30	102.89	2.16	13.43	0.00	0.00	2.16	2.16
	Bus26	33.000	99.95	99.96	102.54	1.43	8.99	0.00	0.00	1.43	1.43
#	Bus27	0.400	99.14	99.17	102.68	2.14	12.94	0.00	0.00	2.14	2.14
	Bus28	33.000	99.94	99.95	102.56	1.45	9.13	0.00	0.00	1.45	1.45
#	Bus30	0.400	99.62	99.65	103.25	2.17	13.46	0.00	0.00	2.17	2.17
	Bus31	33.000	99.93	99.94	102.57	1.46	9.21	0.00	0.00	1.46	1.46
	Bus32	33.000	99.93	99.94	102.57	1.46	9.21	0.00	0.00	1.46	1.46
#	Bus34	0.400	99.19	99.22	102.80	2.17	13.30	0.00	0.00	2.17	2.17
	Bus35	33.000	99.93	99.94	102.57	1.47	9.22	0.00	0.00	1.47	1.47
#	Bus37	0.400	98.38	98.40	101.91	2.15	12.92	0.00	0.00	2.15	2.15
	Bus38	33.000	99.92	99.94	102.58	1.47	9.29	0.00	0.00	1.47	1.47
#	Bus41	0.400	99.29	99.31	102.91	2.18	13.47	0.00	0.00	2.18	2.18
	Bus42	33.000	99.92	99.93	102.58	1.48	9.30	0.00	0.00	1.48	1.48
	Bus43	33.000	99.92	99.93	102.58	1.48	9.31	0.00	0.00	1.48	1.48
	Bus44	33.000	99.92	99.93	102.59	1.48	9.33	0.00	0.00	1.48	1.48
#	Bus46	0.400	98.78	98.81	102.32	2.15	12.89	0.00	0.00	2.15	2.15
	Bus47	33.000	99.92	99.93	102.59	1.48	9.34	0.00	0.00	1.48	1.48
	Bus51	33.000	99.92	99.93	102.59	1.49	9.36	0.00	0.00	1.49	1.49
#	Bus52	0.400	99.57	99.59	103.20	2.18	13.46	0.00	0.00	2.18	2.18

	Bus		Voltage Distortion								
	ID	kV	Fund. %	RMS %	ASUM %	THD %	TIF	TIHD %	TSHD %	THDG %	THDS %
	Bus53	33.000	99.92	99.93	102.59	1.49	9.38	0.00	0.00	1.49	1.49
	Bus54	33.000	99.91	99.92	102.60	1.50	9.46	0.00	0.00	1.50	1.50
#	Bus56	0.400	99.55	99.57	103.18	2.18	13.47	0.00	0.00	2.18	2.18
	Bus57	33.000	99.91	99.92	102.61	1.50	9.50	0.00	0.00	1.50	1.50
#	Bus59	0.400	99.27	99.29	102.91	2.18	13.54	0.00	0.00	2.18	2.18
	Bus60	33.000	99.90	99.92	102.61	1.50	9.51	0.00	0.00	1.50	1.50
#	Bus62	0.400	99.14	99.16	102.74	2.17	13.29	0.00	0.00	2.17	2.17
	Bus63	33.000	99.90	99.91	102.61	1.51	9.55	0.00	0.00	1.51	1.51
	Bus64	33.000	99.90	99.91	102.62	1.52	9.64	0.00	0.00	1.52	1.52
#	Bus66	0.400	99.06	99.08	102.69	2.19	13.48	0.00	0.00	2.19	2.19
#	Bus68	0.400	99.49	99.51	103.14	2.19	13.59	0.00	0.00	2.19	2.19
	Bus69	33.000	99.90	99.91	102.62	1.52	9.64	0.00	0.00	1.52	1.52
	Bus70	33.000	99.89	99.90	102.64	1.53	9.77	0.00	0.00	1.53	1.53
#	Bus72	0.400	99.15	99.17	102.79	2.19	13.48	0.00	0.00	2.19	2.19
	Bus73	33.000	99.88	99.90	102.65	1.54	9.81	0.00	0.00	1.54	1.54
#	Bus75	0.400	99.58	99.60	103.25	2.20	13.71	0.00	0.00	2.20	2.20
	Bus76	33.000	99.88	99.89	102.65	1.54	9.82	0.00	0.00	1.54	1.54
#	Bus78	0.400	99.58	99.61	103.26	2.20	13.73	0.00	0.00	2.20	2.20
	Bus79	33.000	99.88	99.89	102.65	1.55	9.83	0.00	0.00	1.55	1.55
#	Bus81	0.400	99.33	99.35	102.97	2.19	13.48	0.00	0.00	2.19	2.19
	Bus82	33.000	99.88	99.89	102.65	1.55	9.83	0.00	0.00	1.55	1.55
	Bus83	33.000	99.88	99.90	102.65	1.54	9.82	0.00	0.00	1.54	1.54
#	Bus85	0.400	99.28	99.31	102.92	2.19	13.46	0.00	0.00	2.19	2.19
	Bus86	33.000	99.88	99.89	102.65	1.54	9.82	0.00	0.00	1.54	1.54
	Bus87	33.000	99.88	99.89	102.66	1.55	9.91	0.00	0.00	1.55	1.55
#	Bus89	0.400	99.30	99.33	102.95	2.19	13.55	0.00	0.00	2.19	2.19
	Bus90	33.000	99.87	99.88	102.68	1.56	10.06	0.00	0.00	1.56	1.56
#	Bus92	0.400	99.30	99.32	102.97	2.20	13.68	0.00	0.00	2.20	2.20
	Bus93	33.000	99.87	99.88	102.68	1.57	10.10	0.00	0.00	1.57	1.57
#	Bus95	0.400	99.47	99.50	103.16	2.21	13.79	0.00	0.00	2.21	2.21
	Bus96	33.000	99.87	99.88	102.68	1.57	10.11	0.00	0.00	1.57	1.57
#	Bus98	0.400	99.55	99.57	103.24	2.20	13.77	0.00	0.00	2.20	2.20
	Bus99	33.000	99.87	99.88	102.69	1.57	10.12	0.00	0.00	1.57	1.57
#	Bus101	0.400	99.28	99.30	102.97	2.21	13.89	0.00	0.00	2.21	2.21
	Bus102	33.000	99.86	99.88	102.69	1.57	10.13	0.00	0.00	1.57	1.57
	Bus103	33.000	99.86	99.88	102.69	1.57	10.13	0.00	0.00	1.57	1.57
#	Bus105	0.400	99.29	99.31	102.95	2.20	13.63	0.00	0.00	2.20	2.20
	Bus106	33.000	99.86	99.87	102.69	1.58	10.13	0.00	0.00	1.58	1.58
#	Bus108	0.400	99.07	99.10	102.72	2.20	13.48	0.00	0.00	2.20	2.20
	Bus113	33.000	99.87	99.88	102.68	1.56	10.08	0.00	0.00	1.56	1.56
	Bus114	33.000	99.87	99.88	102.68	1.56	10.12	0.00	0.00	1.56	1.56
#	Bus116	0.400	99.45	99.48	103.13	2.20	13.71	0.00	0.00	2.20	2.20
#	Bus119	0.400	99.57	99.60	103.25	2.20	13.76	0.00	0.00	2.20	2.20

	Bus		Voltage Distortion								
	ID	kV	Fund. %	RMS %	ASUM %	THD %	TIF	TIHD %	TSHD %	THDG %	THDS %
	Bus120	33.000	99.87	99.88	102.68	1.56	10.13	0.00	0.00	1.56	1.56
	Bus121	33.000	99.87	99.89	102.68	1.56	10.18	0.00	0.00	1.56	1.56
	Bus124	33.000	99.87	99.89	102.68	1.56	10.18	0.00	0.00	1.56	1.56
#	Bus125	0.400	99.24	99.27	102.89	2.19	13.59	0.00	0.00	2.19	2.19
	Bus126	33.000	99.88	99.89	102.68	1.55	10.21	0.00	0.00	1.55	1.55
	Bus127	33.000	99.88	99.89	102.67	1.54	10.24	0.00	0.00	1.54	1.54
#	Bus129	0.400	99.47	99.49	103.12	2.19	13.67	0.00	0.00	2.19	2.19
	Bus132	33.000	99.89	99.90	102.67	1.53	10.28	0.00	0.00	1.53	1.53
#	Bus133	0.400	99.43	99.46	103.09	2.19	13.71	0.00	0.00	2.19	2.19
	Bus134	33.000	99.89	99.90	102.67	1.53	10.28	0.00	0.00	1.53	1.53
	Bus135	33.000	99.89	99.91	102.66	1.52	10.29	0.00	0.00	1.52	1.52
	Bus138	33.000	99.90	99.92	102.65	1.51	10.32	0.00	0.00	1.50	1.50
#	Bus139	0.400	98.87	98.89	102.51	2.16	14.32	0.00	0.00	2.16	2.16
	Bus142	33.000	99.87	99.89	102.68	1.56	10.23	0.00	0.00	1.56	1.56
#	Bus143	0.400	99.01	99.03	102.64	2.19	13.48	0.00	0.00	2.19	2.19
	Bus145	33.000	99.94	99.95	102.62	1.50	9.31	0.00	0.00	1.50	1.50
	Bus146	33.000	99.93	99.95	102.63	1.51	9.36	0.00	0.00	1.51	1.51
#	Bus148	0.400	99.13	99.15	102.74	2.18	13.30	0.00	0.00	2.18	2.18
#	Bus150	0.400	99.74	99.76	103.40	2.19	13.58	0.00	0.00	2.19	2.19
	Bus151	33.000	99.93	99.94	102.64	1.51	9.38	0.00	0.00	1.51	1.51
	Bus152	33.000	99.93	99.95	102.63	1.51	9.37	0.00	0.00	1.51	1.51
#	Bus154	0.400	99.86	99.88	103.53	2.19	13.63	0.00	0.00	2.19	2.19
	Bus155	33.000	99.93	99.94	102.65	1.52	9.43	0.00	0.00	1.52	1.52
#	Bus157	0.400	99.74	99.76	103.40	2.19	13.59	0.00	0.00	2.19	2.19
	Bus158	33.000	99.93	99.94	102.65	1.52	9.43	0.00	0.00	1.52	1.52
	Bus159	33.000	99.93	99.94	102.66	1.53	9.46	0.00	0.00	1.53	1.53
	Bus160	33.000	99.93	99.94	102.66	1.53	9.49	0.00	0.00	1.53	1.53
	Bus163	33.000	99.93	99.94	102.67	1.54	9.51	0.00	0.00	1.54	1.54
#	Bus165	0.400	99.55	99.57	103.20	2.19	13.52	0.00	0.00	2.19	2.19
	Bus166	33.000	99.93	99.94	102.67	1.54	9.52	0.00	0.00	1.54	1.54
	Bus167	33.000	99.93	99.94	102.67	1.54	9.52	0.00	0.00	1.54	1.54
	Bus168	33.000	99.93	99.94	102.67	1.54	9.52	0.00	0.00	1.54	1.54
#	Bus170	0.400	99.58	99.60	103.23	2.19	13.52	0.00	0.00	2.19	2.19
	Bus171	33.000	99.93	99.94	102.68	1.54	9.53	0.00	0.00	1.54	1.54
	Bus172	33.000	99.93	99.94	102.64	1.51	9.40	0.00	0.00	1.51	1.51
	Bus173	33.000	99.91	99.92	102.67	1.55	9.59	0.00	0.00	1.55	1.55
#	Bus175	0.400	98.72	98.75	102.29	2.17	12.98	0.00	0.00	2.17	2.17
	Bus176	33.000	99.90	99.91	102.68	1.56	9.64	0.00	0.00	1.56	1.56
#	Bus178	0.400	97.97	97.99	101.47	2.16	12.56	0.00	0.00	2.16	2.16
	Bus179	33.000	99.90	99.91	102.68	1.56	9.65	0.00	0.00	1.56	1.56
	Bus180	33.000	99.89	99.90	102.70	1.58	9.75	0.00	0.00	1.58	1.58
	Bus181	33.000	99.89	99.90	102.71	1.59	9.80	0.00	0.00	1.59	1.59
#	Bus183	0.400	99.39	99.42	103.06	2.21	13.56	0.00	0.00	2.21	2.21

	Bus		Voltage Distortion								
	ID	kV	Fund. %	RMS %	ASUM %	THD %	TIF	TIHD %	TSHD %	THDG %	THDS %
	Bus184	33.000	99.89	99.90	102.71	1.59	9.82	0.00	0.00	1.59	1.59
	Bus185	33.000	99.89	99.90	102.72	1.59	9.85	0.00	0.00	1.59	1.59
#	Bus188	0.400	99.69	99.72	103.39	2.21	13.73	0.00	0.00	2.21	2.21
	Bus189	33.000	99.89	99.90	102.72	1.59	9.86	0.00	0.00	1.59	1.59
#	Bus191	0.400	99.74	99.76	103.45	2.22	13.77	0.00	0.00	2.22	2.22
	Bus192	33.000	99.89	99.90	102.72	1.60	9.87	0.00	0.00	1.60	1.60
	Bus193	33.000	99.89	99.90	102.72	1.59	9.86	0.00	0.00	1.59	1.59
	Bus194	33.000	99.89	99.90	102.70	1.58	9.77	0.00	0.00	1.58	1.58
	Bus195	33.000	99.88	99.90	102.70	1.59	9.81	0.00	0.00	1.59	1.59
	Bus196	33.000	99.88	99.90	102.70	1.59	9.81	0.00	0.00	1.59	1.59
	Bus197	33.000	99.88	99.90	102.71	1.59	9.82	0.00	0.00	1.59	1.59
	Bus198	33.000	99.88	99.90	102.71	1.59	9.83	0.00	0.00	1.59	1.59
#	Bus200	0.400	99.05	99.07	102.71	2.21	13.54	0.00	0.00	2.21	2.21
	Bus201	33.000	99.88	99.89	102.71	1.59	9.85	0.00	0.00	1.59	1.59
#	Bus203	0.400	99.69	99.71	103.39	2.21	13.75	0.00	0.00	2.21	2.21
	Bus204	33.000	99.88	99.89	102.71	1.59	9.85	0.00	0.00	1.59	1.59
	Bus205	33.000	99.88	99.89	102.71	1.59	9.85	0.00	0.00	1.59	1.59
	Bus206	33.000	99.88	99.89	102.71	1.59	9.85	0.00	0.00	1.59	1.59
#	Bus208	0.400	99.49	99.52	103.17	2.21	13.63	0.00	0.00	2.21	2.21
	Bus209	33.000	99.88	99.89	102.71	1.59	9.85	0.00	0.00	1.59	1.59
#	Bus211	0.400	99.34	99.37	103.02	2.21	13.59	0.00	0.00	2.21	2.21
	Bus212	0.400	99.75	99.76	102.38	1.43	13.47	0.00	0.00	1.43	1.43
	Bus213	33.000	99.90	99.92	102.65	1.51	10.32	0.00	0.00	1.50	1.50
	Bus220	33.000	100.00	100.00	100.00	0	0.42	0.00	0.00	0.00	0.00
	Bus222	0.400	99.74	99.74	99.74	0.02	0.42	0.00	0.00	0.00	0.00
	Bus224	0.400	99.74	99.74	99.74	0	0.42	0.00	0.00	0.00	0.00
	Bus225	33.000	100.00	100.00	100.00	0	0.42	0.00	0.00	0.00	0.00

* IndicatesTHD (Total Harmonic Distortion) Exceeds the Limit.
\# Indicates IHD (Individual Harmonic Distortion) Exceeds the Limit.

System Harmonics Branch Information

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus1	Bus2	50.37	50.48	54.15	6.55	8.97	452.73	452.73	0.00	0.00	0.00	6.55	6.55
Bus2	Bus3	21.05	21.08	22.32	5.22	7.17	151.25	151.25	0.00	0.00	0.00	5.22	5.22
	Bus21	29.49	29.57	32.01	7.46	10.21	301.90	301.90	0.00	0.00	0.00	7.46	7.46
	Bus1	50.37	50.48	54.15	6.55	8.97	452.73	452.73	0.00	0.00	0.00	6.55	6.55
Bus3	Bus2	21.06	21.08	22.32	5.21	7.17	151.18	151.18	0.00	0.00	0.00	5.21	5.21
	Bus4	21.06	21.08	22.32	5.21	7.17	151.18	151.18	0.00	0.00	0.00	5.21	5.21
Bus4	Bus3	21.06	21.08	22.32	5.21	7.17	151.18	151.18	0.00	0.00	0.00	5.21	5.21
	Bus6	20.67	20.70	21.93	5.31	7.30	151.18	151.18	0.00	0.00	0.00	5.31	5.31
	Bus5	0.46	0.46	0.46	0.12	0.53	0.24	0.24	0.00	0.00	0.00	0.12	0.12
Bus5	Bus4	38.09	38.09	38.15	0.12	0.53	20.12	20.12	0.00	0.00	0.00	0.12	0.12
Bus6	Bus4	20.67	20.70	21.93	5.31	7.30	151.18	151.18	0.00	0.00	0.00	5.31	5.31
	Bus7	20.67	20.70	21.93	5.31	7.30	151.18	151.18	0.00	0.00	0.00	5.31	5.31
Bus7	Bus9	18.47	18.49	19.59	5.27	7.28	134.69	134.69	0.00	0.00	0.00	5.27	5.27
	Bus6	20.67	20.70	21.93	5.31	7.30	151.18	151.18	0.00	0.00	0.00	5.31	5.31
	Bus8	2.49	2.49	2.66	6.06	8.33	20.75	20.75	0.00	0.00	0.00	6.06	6.06
Bus8	Bus7	205.08	205.46	219.38	6.06	8.33	1711.89	1711.89	0.00	0.00	0.00	6.06	6.06
Bus9	Bus7	18.46	18.49	19.59	5.27	7.28	134.62	134.62	0.00	0.00	0.00	5.27	5.27
	Bus10	3.02	3.02	3.25	6.62	9.16	27.69	27.69	0.00	0.00	0.00	6.62	6.62
	Bus145	15.57	15.59	16.47	5.03	6.95	108.32	108.32	0.00	0.00	0.00	5.03	5.03
Bus10	Bus11	0.46	0.46	0.48	4.60	6.49	2.98	2.98	0.00	0.00	0.00	4.60	4.60
	Bus9	2.92	2.92	3.14	6.72	9.27	27.09	27.09	0.00	0.00	0.00	6.72	6.72
	Bus13	2.62	2.62	2.82	6.74	9.29	24.36	24.36	0.00	0.00	0.00	6.74	6.74
Bus11	Bus10	0.30	0.30	0.32	5.95	8.16	2.42	2.42	0.00	0.00	0.00	5.95	5.95
	Bus12	0.30	0.30	0.32	5.95	8.16	2.42	2.42	0.00	0.00	0.00	5.95	5.95
Bus12	Bus11	24.44	24.48	26.11	5.95	8.16	199.86	199.86	0.00	0.00	0.00	5.95	5.95
Bus13	Bus15	2.11	2.11	2.27	6.68	9.21	19.47	19.47	0.00	0.00	0.00	6.68	6.68
	Bus10	2.67	2.68	2.87	6.45	8.87	23.76	23.76	0.00	0.00	0.00	6.45	6.45
	Bus14	0.57	0.57	0.61	5.97	8.19	4.69	4.69	0.00	0.00	0.00	5.97	5.97
Bus14	Bus13	47.13	47.22	50.37	5.97	8.19	386.89	386.89	0.00	0.00	0.00	5.97	5.97
Bus15	Bus17	0.40	0.40	0.43	7.16	9.88	3.98	3.98	0.00	0.00	0.00	7.16	7.16
	Bus13	2.22	2.22	2.38	6.22	8.55	19.01	19.01	0.00	0.00	0.00	6.22	6.22
	Bus20	1.84	1.84	1.97	5.97	8.21	15.13	15.13	0.00	0.00	0.00	5.97	5.97
Bus17	Bus15	0.45	0.45	0.48	6.07	8.35	3.79	3.79	0.00	0.00	0.00	6.07	6.07
	Bus18	0.45	0.45	0.48	6.07	8.35	3.79	3.79	0.00	0.00	0.00	6.07	6.07
Bus18	Bus17	0.45	0.45	0.48	6.07	8.35	3.79	3.79	0.00	0.00	0.00	6.07	6.07
	Bus19	0.45	0.45	0.48	6.07	8.35	3.79	3.79	0.00	0.00	0.00	6.07	6.07
Bus19	Bus18	37.38	37.44	39.99	6.07	8.35	312.82	312.82	0.00	0.00	0.00	6.07	6.07
Bus20	Bus15	151.82	152.09	162.25	5.97	8.21	1248.39	1248.39	0.00	0.00	0.00	5.97	5.97
Bus21	Bus2	29.48	29.56	32.00	7.47	10.21	301.79	301.79	0.00	0.00	0.00	7.47	7.47
	Bus24	28.00	28.08	30.41	7.52	10.28	288.62	288.62	0.00	0.00	0.00	7.52	7.52
	Bus22	1.66	1.66	1.77	5.80	7.94	13.21	13.21	0.00	0.00	0.00	5.80	5.80

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus22	Bus21	137.04	137.27	146.15	5.80	7.94	1089.51	1089.51	0.00	0.00	0.00	5.80	5.80
Bus24	Bus28	24.93	25.01	27.16	7.77	10.66	266.65	266.65	0.00	0.00	0.00	7.77	7.77
	Bus26	0.76	0.76	0.81	5.92	8.11	6.15	6.15	0.00	0.00	0.00	5.92	5.92
	Bus21	27.93	28.01	30.34	7.52	10.28	288.07	288.07	0.00	0.00	0.00	7.52	7.52
	Bus25	2.83	2.84	3.03	6.05	8.32	23.61	23.61	0.00	0.00	0.00	6.05	6.05
Bus25	Bus24	233.61	234.03	249.87	6.05	8.32	1947.47	1947.47	0.00	0.00	0.00	6.05	6.05
Bus26	Bus24	0.75	0.75	0.80	5.74	7.84	5.90	5.90	0.00	0.00	0.00	5.74	5.74
	Bus27	0.75	0.75	0.80	5.74	7.84	5.90	5.90	0.00	0.00	0.00	5.74	5.74
Bus27	Bus26	61.97	62.07	66.05	5.74	7.84	486.81	486.81	0.00	0.00	0.00	5.74	5.74
Bus28	Bus31	23.98	24.06	26.15	7.84	10.76	258.75	258.75	0.00	0.00	0.00	7.84	7.84
	Bus24	24.89	24.96	27.11	7.78	10.67	266.36	266.36	0.00	0.00	0.00	7.78	7.78
	Bus30	1.01	1.02	1.08	5.94	8.15	8.28	8.28	0.00	0.00	0.00	5.94	5.94
Bus30	Bus28	83.71	83.86	89.42	5.94	8.15	683.09	683.09	0.00	0.00	0.00	5.94	5.94
Bus31	Bus32	4.22	4.23	4.51	5.92	8.08	34.15	34.15	0.00	0.00	0.00	5.92	5.92
	Bus28	23.96	24.03	26.12	7.84	10.76	258.60	258.60	0.00	0.00	0.00	7.84	7.84
	Bus38	20.16	20.22	22.03	8.09	11.11	224.73	224.73	0.00	0.00	0.00	8.09	8.09
Bus32	Bus31	4.24	4.25	4.52	5.89	8.02	34.06	34.06	0.00	0.00	0.00	5.89	5.89
	Bus35	1.98	1.98	2.13	6.51	8.95	17.75	17.75	0.00	0.00	0.00	6.51	6.51
	Bus34	2.27	2.28	2.43	5.87	8.04	18.32	18.32	0.00	0.00	0.00	5.87	5.87
Bus34	Bus32	187.61	187.93	200.24	5.87	8.04	1511.00	1511.00	0.00	0.00	0.00	5.87	5.87
Bus35	Bus32	2.15	2.16	2.29	5.78	7.91	17.05	17.05	0.00	0.00	0.00	5.78	5.78
	Bus37	2.15	2.16	2.29	5.78	7.91	17.05	17.05	0.00	0.00	0.00	5.78	5.78
Bus37	Bus35	177.54	177.84	189.31	5.78	7.91	1406.82	1406.82	0.00	0.00	0.00	5.78	5.78
Bus38	Bus42	4.37	4.38	4.68	6.22	8.53	37.38	37.38	0.00	0.00	0.00	6.22	6.22
	Bus31	20.11	20.18	21.99	8.10	11.13	224.53	224.53	0.00	0.00	0.00	8.10	8.10
	Bus53	16.28	16.33	17.84	8.34	11.46	187.17	187.17	0.00	0.00	0.00	8.34	8.34
Bus41	Bus42	273.80	274.28	292.50	5.95	8.16	2238.62	2238.62	0.00	0.00	0.00	5.95	5.95
Bus42	Bus38	4.38	4.39	4.69	6.19	8.50	37.31	37.31	0.00	0.00	0.00	6.19	6.19
	Bus43	1.24	1.25	1.33	6.08	8.36	10.42	10.42	0.00	0.00	0.00	6.08	6.08
	Bus41	3.32	3.32	3.55	5.95	8.16	27.13	27.13	0.00	0.00	0.00	5.95	5.95
Bus43	Bus42	1.25	1.25	1.33	5.62	7.66	9.58	9.58	0.00	0.00	0.00	5.62	5.62
	Bus44	1.25	1.25	1.33	5.62	7.66	9.58	9.58	0.00	0.00	0.00	5.62	5.62
Bus44	Bus47	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus43	1.25	1.25	1.33	5.62	7.66	9.58	9.58	0.00	0.00	0.00	5.62	5.62
	Bus46	0.98	0.98	1.04	5.70	7.79	7.63	7.63	0.00	0.00	0.00	5.70	5.70
Bus46	Bus44	80.73	80.86	86.00	5.70	7.79	629.63	629.63	0.00	0.00	0.00	5.70	5.70
Bus47	Bus44	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus51	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus51	Bus47	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus52	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus52	Bus51	22.43	22.47	23.97	6.00	8.24	185.12	185.12	0.00	0.00	0.00	6.00	6.00
Bus53	Bus54	16.21	16.26	17.77	8.37	11.49	186.94	186.94	0.00	0.00	0.00	8.37	8.37
	Bus38	16.21	16.26	17.77	8.37	11.49	186.94	186.94	0.00	0.00	0.00	8.37	8.37

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus54	Bus57	15.93	15.98	17.47	8.40	11.53	184.34	184.34	0.00	0.00	0.00	8.40	8.40
	Bus53	16.15	16.20	17.71	8.39	11.52	186.74	186.74	0.00	0.00	0.00	8.39	8.39
	Bus56	0.29	0.29	0.31	5.95	8.17	2.41	2.41	0.00	0.00	0.00	5.95	5.95
Bus56	Bus54	24.29	24.34	25.95	5.95	8.17	198.71	198.71	0.00	0.00	0.00	5.95	5.95
Bus57	Bus54	15.89	15.95	17.43	8.41	11.55	184.22	184.22	0.00	0.00	0.00	8.41	8.41
	Bus63	12.57	12.61	13.80	8.49	11.66	147.07	147.07	0.00	0.00	0.00	8.49	8.49
	Bus60	1.17	1.17	1.26	6.38	8.79	10.32	10.32	0.00	0.00	0.00	6.38	6.38
	Bus59	3.32	3.32	3.55	5.94	8.16	27.13	27.13	0.00	0.00	0.00	5.94	5.94
Bus59	Bus57	273.78	274.26	292.48	5.94	8.16	2238.00	2238.00	0.00	0.00	0.00	5.94	5.94
Bus60	Bus57	1.22	1.23	1.31	5.84	7.99	9.79	9.79	0.00	0.00	0.00	5.84	5.84
	Bus62	1.22	1.23	1.31	5.84	7.99	9.79	9.79	0.00	0.00	0.00	5.84	5.84
Bus62	Bus60	100.92	101.09	107.67	5.84	7.99	807.74	807.74	0.00	0.00	0.00	5.84	5.84
Bus63	Bus57	12.50	12.55	13.73	8.52	11.71	146.92	146.92	0.00	0.00	0.00	8.52	8.52
	Bus64	12.50	12.55	13.73	8.52	11.71	146.92	146.92	0.00	0.00	0.00	8.52	8.52
Bus64	Bus69	1.23	1.24	1.32	6.11	8.40	10.38	10.38	0.00	0.00	0.00	6.11	6.11
	Bus63	12.39	12.43	13.61	8.59	11.79	146.65	146.65	0.00	0.00	0.00	8.59	8.59
	Bus70	10.66	10.70	11.67	8.19	11.28	120.66	120.66	0.00	0.00	0.00	8.19	8.19
	Bus66	2.17	2.17	2.32	5.95	8.17	17.75	17.75	0.00	0.00	0.00	5.95	5.95
Bus66	Bus64	178.81	179.13	191.04	5.95	8.17	1464.00	1464.00	0.00	0.00	0.00	5.95	5.95
Bus68	Bus69	103.87	104.05	110.95	5.93	8.14	846.57	846.57	0.00	0.00	0.00	5.93	5.93
Bus69	Bus64	1.26	1.26	1.34	5.93	8.14	10.26	10.26	0.00	0.00	0.00	5.93	5.93
	Bus68	1.26	1.26	1.34	5.93	8.14	10.26	10.26	0.00	0.00	0.00	5.93	5.93
Bus70	Bus83	7.65	7.67	8.37	8.17	11.27	86.47	86.47	0.00	0.00	0.00	8.17	8.17
	Bus64	10.40	10.44	11.41	8.36	11.51	120.20	120.20	0.00	0.00	0.00	8.36	8.36
	Bus73	2.28	2.28	2.41	5.03	6.99	15.96	15.96	0.00	0.00	0.00	5.03	5.03
	Bus72	2.27	2.28	2.43	5.86	8.03	18.30	18.30	0.00	0.00	0.00	5.86	5.86
Bus72	Bus70	187.58	187.90	200.20	5.86	8.03	1509.47	1509.47	0.00	0.00	0.00	5.86	5.86
Bus73	Bus76	1.40	1.40	1.47	4.50	6.27	8.75	8.75	0.00	0.00	0.00	4.50	4.50
	Bus70	2.02	2.03	2.15	5.39	7.43	15.06	15.06	0.00	0.00	0.00	5.39	5.39
	Bus75	0.84	0.84	0.90	6.01	8.26	6.96	6.96	0.00	0.00	0.00	6.01	6.01
Bus75	Bus73	69.32	69.44	74.11	6.01	8.26	573.80	573.80	0.00	0.00	0.00	6.01	6.01
Bus76	Bus79	1.03	1.03	1.10	5.83	8.05	8.29	8.29	0.00	0.00	0.00	5.83	5.83
	Bus73	1.23	1.23	1.30	4.86	6.72	8.25	8.25	0.00	0.00	0.00	4.86	4.86
	Bus78	0.35	0.35	0.35	0.13	0.54	0.19	0.19	0.00	0.00	0.00	0.13	0.13
Bus78	Bus76	28.91	28.91	28.95	0.13	0.54	15.49	15.49	0.00	0.00	0.00	0.13	0.13
Bus79	Bus76	0.94	0.94	1.00	6.20	8.53	8.00	8.00	0.00	0.00	0.00	6.20	6.20
	Bus82	0.94	0.94	1.00	6.20	8.53	8.00	8.00	0.00	0.00	0.00	6.20	6.20
Bus81	Bus82	78.04	78.17	83.26	5.84	8.00	625.10	625.10	0.00	0.00	0.00	5.84	5.84
Bus82	Bus79	0.95	0.95	1.01	5.84	8.00	7.58	7.58	0.00	0.00	0.00	5.84	5.84
	Bus81	0.95	0.95	1.01	5.84	8.00	7.58	7.58	0.00	0.00	0.00	5.84	5.84
Bus83	Bus70	7.50	7.53	8.22	8.32	11.46	86.26	86.26	0.00	0.00	0.00	8.32	8.32
	Bus87	6.98	7.00	7.63	8.13	11.21	78.47	78.47	0.00	0.00	0.00	8.13	8.13
	Bus86	0.97	0.97	1.04	6.30	8.69	8.41	8.41	0.00	0.00	0.00	6.30	6.30

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus85	Bus86	81.16	81.30	86.61	5.85	8.01	651.50	651.50	0.00	0.00	0.00	5.85	5.85
Bus86	Bus83	0.98	0.99	1.05	5.85	8.01	7.90	7.90	0.00	0.00	0.00	5.85	5.85
	Bus85	0.98	0.99	1.05	5.85	8.01	7.90	7.90	0.00	0.00	0.00	5.85	5.85
Bus87	Bus83	6.64	6.66	7.29	8.50	11.71	78.00	78.00	0.00	0.00	0.00	8.50	8.50
	Bus90	6.70	6.72	7.29	7.65	10.56	70.98	70.98	0.00	0.00	0.00	7.65	7.65
	Bus89	0.87	0.87	0.93	5.92	8.11	7.06	7.06	0.00	0.00	0.00	5.92	5.92
Bus89	Bus87	71.71	71.84	76.58	5.92	8.11	582.83	582.83	0.00	0.00	0.00	5.92	5.92
Bus90	Bus113	6.54	6.55	7.02	6.32	8.74	57.25	57.25	0.00	0.00	0.00	6.32	6.32
	Bus87	6.12	6.14	6.70	8.30	11.44	70.18	70.18	0.00	0.00	0.00	8.30	8.30
	Bus92	1.59	1.60	1.70	5.96	8.18	13.05	13.05	0.00	0.00	0.00	5.96	5.96
Bus92	Bus90	131.38	131.61	140.38	5.96	8.18	1076.39	1076.39	0.00	0.00	0.00	5.96	5.96
Bus93	Bus96	0.39	0.39	0.40	0.88	1.53	0.60	0.60	0.00	0.00	0.00	0.88	0.88
	C399~	0.40	0.40	0.40	0.88	1.53	0.61	0.61	0.00	0.00	0.00	0.88	0.88
	Bus95	0.46	0.46	0.46	0.14	0.54	0.25	0.25	0.00	0.00	0.00	0.14	0.14
Bus95	Bus93	38.04	38.04	38.10	0.14	0.54	20.55	20.55	0.00	0.00	0.00	0.14	0.14
Bus96	Bus93	0.44	0.44	0.45	1.00	1.73	0.77	0.77	0.00	0.00	0.00	1.00	1.00
	Bus103	2.74	2.74	2.82	2.37	3.32	9.11	9.11	0.00	0.00	0.00	2.37	2.37
	Bus99	1.55	1.55	1.56	0.20	0.59	0.92	0.92	0.00	0.00	0.00	0.20	0.20
	Bus98	1.01	1.02	1.08	5.93	8.13	8.25	8.25	0.00	0.00	0.00	5.93	5.93
Bus98	Bus96	83.60	83.75	89.30	5.93	8.13	680.87	680.87	0.00	0.00	0.00	5.93	5.93
Bus99	Bus102	1.55	1.55	1.56	0.20	0.59	0.92	0.92	0.00	0.00	0.00	0.20	0.20
	Bus96	1.55	1.55	1.56	0.20	0.59	0.92	0.92	0.00	0.00	0.00	0.20	0.20
Bus101	Bus102	146.12	146.12	146.32	0.12	0.53	77.37	77.37	0.00	0.00	0.00	0.12	0.12
Bus102	Bus99	1.77	1.77	1.77	0.12	0.53	0.94	0.94	0.00	0.00	0.00	0.12	0.12
	Bus101	1.77	1.77	1.77	0.12	0.53	0.94	0.94	0.00	0.00	0.00	0.12	0.12
Bus103	Bus96	2.60	2.60	2.68	2.64	3.73	9.70	9.70	0.00	0.00	0.00	2.64	2.64
	Bus106	3.43	3.43	3.57	3.38	4.70	16.14	16.14	0.00	0.00	0.00	3.38	3.38
	Bus105	0.84	0.84	0.89	5.95	8.16	6.84	6.84	0.00	0.00	0.00	5.95	5.95
Bus105	Bus103	69.06	69.18	73.78	5.95	8.16	564.64	564.64	0.00	0.00	0.00	5.95	5.95
Bus106	Bus103	3.33	3.34	3.47	3.63	5.07	16.92	16.92	0.00	0.00	0.00	3.63	3.63
	C567~	0.56	0.56	0.57	0.88	1.53	0.86	0.86	0.00	0.00	0.00	0.88	0.88
	Bus206	4.49	4.50	4.72	4.39	6.12	27.51	27.51	0.00	0.00	0.00	4.39	4.39
	Bus108	1.23	1.23	1.31	5.84	8.00	9.86	9.86	0.00	0.00	0.00	5.84	5.84
Bus108	Bus106	101.51	101.69	108.31	5.84	8.00	813.16	813.16	0.00	0.00	0.00	5.84	5.84
Bus113	Bus90	5.95	5.97	6.42	6.86	9.46	56.45	56.45	0.00	0.00	0.00	6.86	6.86
	Bus114	5.95	5.97	6.42	6.86	9.46	56.45	56.45	0.00	0.00	0.00	6.86	6.86
Bus114	Bus113	5.02	5.03	5.48	7.98	10.96	55.20	55.20	0.00	0.00	0.00	7.98	7.98
	Bus120	0.52	0.52	0.55	5.88	8.24	4.28	4.28	0.00	0.00	0.00	5.88	5.88
	Bus121	5.06	5.07	5.44	6.61	9.08	46.01	46.01	0.00	0.00	0.00	6.61	6.61
	Bus116	0.61	0.61	0.65	5.98	8.21	4.99	4.99	0.00	0.00	0.00	5.98	5.98
Bus116	Bus114	49.99	50.08	53.43	5.98	8.21	411.32	411.32	0.00	0.00	0.00	5.98	5.98
Bus119	Bus120	36.82	36.89	39.35	5.98	8.21	302.99	302.99	0.00	0.00	0.00	5.98	5.98

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus120	Bus114	0.45	0.45	0.48	5.98	8.21	3.67	3.67	0.00	0.00	0.00	5.98	5.98
	Bus119	0.45	0.45	0.48	5.98	8.21	3.67	3.67	0.00	0.00	0.00	5.98	5.98
Bus121	Bus124	1.52	1.52	1.63	6.06	8.32	12.66	12.66	0.00	0.00	0.00	6.06	6.06
	Bus126	5.40	5.41	5.68	4.40	6.06	32.78	32.78	0.00	0.00	0.00	4.40	4.40
	Bus114	4.50	4.51	4.88	7.32	10.03	45.24	45.24	0.00	0.00	0.00	7.32	7.32
Bus124	Bus121	1.55	1.55	1.65	5.89	8.07	12.53	12.53	0.00	0.00	0.00	5.89	5.89
	Bus125	1.55	1.55	1.65	5.89	8.07	12.53	12.53	0.00	0.00	0.00	5.89	5.89
Bus125	Bus124	127.88	128.10	136.52	5.89	8.07	1033.48	1033.48	0.00	0.00	0.00	5.89	5.89
Bus126	Bus127	6.03	6.03	6.21	2.61	3.60	21.74	21.74	0.00	0.00	0.00	2.61	2.61
	Bus121	4.96	4.96	5.23	4.71	6.46	32.08	32.08	0.00	0.00	0.00	4.71	4.71
	Bus142	1.32	1.32	1.41	5.84	8.00	10.56	10.56	0.00	0.00	0.00	5.84	5.84
Bus127	Bus126	5.64	5.65	5.82	2.71	3.73	21.04	21.04	0.00	0.00	0.00	2.71	2.71
	Bus132	6.27	6.27	6.42	2.04	2.87	18.02	18.02	0.00	0.00	0.00	2.04	2.04
	Bus129	0.75	0.76	0.80	5.84	8.00	6.04	6.04	0.00	0.00	0.00	5.84	5.84
Bus129	Bus127	62.22	62.32	66.38	5.84	8.00	498.55	498.55	0.00	0.00	0.00	5.84	5.84
Bus132	Bus135	6.41	6.41	6.51	1.35	1.95	12.49	12.49	0.00	0.00	0.00	1.35	1.35
	Bus127	5.74	5.74	5.88	2.11	2.95	16.94	16.94	0.00	0.00	0.00	2.11	2.11
	Bus134	0	0	0	0	0	0.00	16.94	0.00	0.00	0.00	0.00	0.00
	Bus133	0.71	0.71	0.75	5.92	8.12	5.74	5.74	0.00	0.00	0.00	5.92	5.92
Bus133	Bus132	58.17	58.28	62.13	5.92	8.12	473.42	473.42	0.00	0.00	0.00	5.92	5.92
Bus134	Bus132	0	0	0	0	0	0.00	473.42	0.00	0.00	0.00	0.00	0.00
Bus135	Bus132	6.17	6.17	6.26	1.35	1.94	11.95	11.95	0.00	0.00	0.00	1.35	1.35
	Bus138	6.17	6.17	6.26	1.35	1.94	11.95	11.95	0.00	0.00	0.00	1.35	1.35
Bus138	Bus135	5.75	5.75	5.84	1.33	1.90	10.94	10.94	0.00	0.00	0.00	1.33	1.33
	Bus226	1.39	1.39	1.48	5.92	8.13	11.28	11.28	0.00	0.00	0.00	5.92	5.92
	Bus213	7.13	7.13	7.14	0.11	0.52	3.72	3.72	0.00	0.00	0.00	0.11	0.11
Bus139	Bus226	114.26	114.47	122.04	5.92	8.13	930.19	930.19	0.00	0.00	0.00	5.92	5.92
Bus142	Bus126	1.32	1.32	1.41	5.84	8.00	10.56	10.56	0.00	0.00	0.00	5.84	5.84
	Bus143	1.32	1.32	1.41	5.84	8.00	10.56	10.56	0.00	0.00	0.00	5.84	5.84
Bus143	Bus142	108.70	108.88	115.98	5.84	8.00	870.83	870.83	0.00	0.00	0.00	5.84	5.84
Bus145	Bus146	15.57	15.59	16.47	5.03	6.95	108.32	108.32	0.00	0.00	0.00	5.03	5.03
	Bus9	15.57	15.59	16.47	5.03	6.95	108.32	108.32	0.00	0.00	0.00	5.03	5.03
Bus146	Bus152	1.22	1.23	1.31	6.19	8.50	10.42	10.42	0.00	0.00	0.00	6.19	6.19
	Bus145	15.57	15.59	16.47	5.03	6.95	108.32	108.32	0.00	0.00	0.00	5.03	5.03
	Bus172	13.09	13.10	13.81	4.81	6.67	87.34	87.34	0.00	0.00	0.00	4.81	4.81
	Bus151	0.30	0.30	0.32	6.00	8.24	2.45	2.45	0.00	0.00	0.00	6.00	6.00
	Bus148	1.12	1.12	1.19	5.93	8.15	9.13	9.13	0.00	0.00	0.00	5.93	5.93
Bus148	Bus146	92.29	92.45	98.58	5.93	8.15	753.09	753.09	0.00	0.00	0.00	5.93	5.93
Bus150	Bus151	24.47	24.52	26.16	6.00	8.24	201.94	201.94	0.00	0.00	0.00	6.00	6.00
Bus151	Bus146	0.30	0.30	0.32	6.00	8.24	2.45	2.45	0.00	0.00	0.00	6.00	6.00
	Bus150	0.30	0.30	0.32	6.00	8.24	2.45	2.45	0.00	0.00	0.00	6.00	6.00

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus152	Bus146	1.22	1.23	1.31	6.19	8.50	10.42	10.42	0.00	0.00	0.00	6.19	6.19
	Bus155	1.10	1.11	1.18	6.23	8.56	9.46	9.46	0.00	0.00	0.00	6.23	6.23
	Bus154	0.12	0.12	0.13	6.00	8.24	1.00	1.00	0.00	0.00	0.00	6.00	6.00
Bus154	Bus152	9.95	9.96	10.63	6.00	8.24	82.13	82.13	0.00	0.00	0.00	6.00	6.00
Bus155	Bus158	0.81	0.81	0.87	6.33	8.70	7.04	7.04	0.00	0.00	0.00	6.33	6.33
	Bus152	1.10	1.11	1.18	6.23	8.56	9.46	9.46	0.00	0.00	0.00	6.23	6.23
	Bus157	0.30	0.30	0.32	6.00	8.24	2.45	2.45	0.00	0.00	0.00	6.00	6.00
Bus157	Bus155	24.47	24.52	26.16	6.00	8.24	201.93	201.93	0.00	0.00	0.00	6.00	6.00
Bus158	Bus155	0.81	0.81	0.87	6.33	8.70	7.04	7.04	0.00	0.00	0.00	6.33	6.33
	Bus159	0.81	0.81	0.87	6.33	8.70	7.04	7.04	0.00	0.00	0.00	6.33	6.33
Bus159	C122~	0.12	0.12	0.12	0.80	1.40	0.17	0.17	0.00	0.00	0.00	0.80	0.80
	Bus160	0.84	0.84	0.90	5.95	8.17	6.89	6.89	0.00	0.00	0.00	5.95	5.95
	Bus158	0.81	0.81	0.87	6.33	8.70	7.04	7.04	0.00	0.00	0.00	6.33	6.33
Bus160	Bus163	0.84	0.84	0.90	5.95	8.17	6.89	6.89	0.00	0.00	0.00	5.95	5.95
	Bus159	0.84	0.84	0.90	5.95	8.17	6.89	6.89	0.00	0.00	0.00	5.95	5.95
Bus163	Bus160	0.84	0.84	0.90	5.95	8.17	6.89	6.89	0.00	0.00	0.00	5.95	5.95
	Bus166	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus165	0.57	0.57	0.61	5.97	8.19	4.69	4.69	0.00	0.00	0.00	5.97	5.97
Bus165	Bus163	47.13	47.21	50.36	5.97	8.19	386.81	386.81	0.00	0.00	0.00	5.97	5.97
Bus166	Bus167	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus163	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus167	Bus166	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus168	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus168	Bus167	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus171	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus170	Bus171	22.42	22.46	23.97	6.00	8.24	185.10	185.10	0.00	0.00	0.00	6.00	6.00
Bus171	Bus168	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
	Bus170	0.27	0.27	0.29	6.00	8.24	2.24	2.24	0.00	0.00	0.00	6.00	6.00
Bus172	Bus146	13.09	13.10	13.81	4.81	6.67	87.34	87.34	0.00	0.00	0.00	4.81	4.81
	Bus173	13.09	13.10	13.81	4.81	6.67	87.34	87.34	0.00	0.00	0.00	4.81	4.81
Bus173	Bus176	12.18	12.19	12.84	4.71	6.54	79.69	79.69	0.00	0.00	0.00	4.71	4.71
	Bus172	13.09	13.10	13.81	4.81	6.67	87.34	87.34	0.00	0.00	0.00	4.81	4.81
	Bus175	0.98	0.98	1.04	5.74	7.84	7.66	7.66	0.00	0.00	0.00	5.74	5.74
Bus175	Bus173	80.51	80.64	85.80	5.74	7.84	632.12	632.12	0.00	0.00	0.00	5.74	5.74
Bus176	Bus173	12.16	12.17	12.82	4.69	6.51	79.24	79.24	0.00	0.00	0.00	4.69	4.69
	Bus179	1.50	1.50	1.60	6.19	8.49	12.74	12.74	0.00	0.00	0.00	6.19	6.19
	Bus180	10.66	10.67	11.22	4.49	6.24	66.58	66.58	0.00	0.00	0.00	4.49	4.49
Bus178	Bus179	130.93	131.13	139.24	5.56	7.57	992.91	992.91	0.00	0.00	0.00	5.56	5.56
Bus179	Bus176	1.59	1.59	1.69	5.56	7.57	12.04	12.04	0.00	0.00	0.00	5.56	5.56
	Bus178	1.59	1.59	1.69	5.56	7.57	12.04	12.04	0.00	0.00	0.00	5.56	5.56

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus180	Bus176	10.66	10.67	11.21	4.43	6.14	65.56	65.56	0.00	0.00	0.00	4.43	4.43
	Bus194	8.34	8.35	8.72	3.91	5.46	45.60	45.60	0.00	0.00	0.00	3.91	3.91
	Bus181	1.25	1.25	1.34	5.96	8.18	10.24	10.24	0.00	0.00	0.00	5.96	5.96
	Bus208	1.21	1.21	1.29	5.94	8.15	9.85	9.85	0.00	0.00	0.00	5.94	5.94
Bus181	Bus184	0.51	0.51	0.55	5.98	8.21	4.21	4.21	0.00	0.00	0.00	5.98	5.98
	Bus180	1.25	1.25	1.34	5.96	8.18	10.24	10.24	0.00	0.00	0.00	5.96	5.96
	Bus183	0.74	0.74	0.79	5.94	8.16	6.04	6.04	0.00	0.00	0.00	5.94	5.94
Bus183	Bus181	60.96	61.07	65.13	5.94	8.16	498.17	498.17	0.00	0.00	0.00	5.94	5.94
Bus184	Bus181	0.51	0.51	0.55	5.98	8.21	4.21	4.21	0.00	0.00	0.00	5.98	5.98
	Bus185	0.51	0.51	0.55	5.98	8.21	4.21	4.21	0.00	0.00	0.00	5.98	5.98
Bus185	Bus189	0.21	0.22	0.23	6.04	8.30	1.78	1.78	0.00	0.00	0.00	6.04	6.04
	Bus184	0.51	0.51	0.55	5.98	8.21	4.21	4.21	0.00	0.00	0.00	5.98	5.98
	Bus188	0.30	0.30	0.32	5.99	8.23	2.45	2.45	0.00	0.00	0.00	5.99	5.99
Bus188	Bus185	24.46	24.50	26.15	5.99	8.23	201.72	201.72	0.00	0.00	0.00	5.99	5.99
Bus189	Bus193	0	0	0	0	0	0.00	201.72	0.00	0.00	0.00	0.00	0.00
	Bus185	0.21	0.22	0.23	6.04	8.30	1.78	1.78	0.00	0.00	0.00	6.04	6.04
	Bus192	0.21	0.22	0.23	6.04	8.30	1.78	1.78	0.00	0.00	0.00	6.04	6.04
Bus191	Bus192	17.71	17.74	18.94	6.04	8.30	147.18	147.18	0.00	0.00	0.00	6.04	6.04
Bus192	Bus189	0.21	0.22	0.23	6.04	8.30	1.78	1.78	0.00	0.00	0.00	6.04	6.04
	Bus191	0.21	0.22	0.23	6.04	8.30	1.78	1.78	0.00	0.00	0.00	6.04	6.04
Bus193	Bus189	0	0	0	0	0	0.00	1.78	0.00	0.00	0.00	0.00	0.00
Bus194	Bus180	8.34	8.35	8.72	3.91	5.46	45.60	45.60	0.00	0.00	0.00	3.91	3.91
	Bus195	8.34	8.35	8.72	3.91	5.46	45.60	45.60	0.00	0.00	0.00	3.91	3.91
Bus195	Bus196	8.34	8.35	8.72	3.91	5.46	45.60	45.60	0.00	0.00	0.00	3.91	3.91
	Bus194	8.34	8.35	8.72	3.91	5.46	45.60	45.60	0.00	0.00	0.00	3.91	3.91
Bus196	Bus195	8.34	8.35	8.72	3.91	5.46	45.58	45.58	0.00	0.00	0.00	3.91	3.91
	Bus197	8.34	8.35	8.72	3.91	5.46	45.58	45.58	0.00	0.00	0.00	3.91	3.91
Bus197	Bus198	2.04	2.04	2.05	0.20	0.59	1.21	1.21	0.00	0.00	0.00	0.20	0.20
	Bus209	6.42	6.43	6.80	5.05	7.03	45.20	45.20	0.00	0.00	0.00	5.05	5.05
	Bus196	8.34	8.35	8.72	3.91	5.46	45.58	45.58	0.00	0.00	0.00	3.91	3.91
Bus198	Bus197	2.17	2.17	2.17	0.15	0.55	1.18	1.18	0.00	0.00	0.00	0.15	0.15
	Bus200	2.17	2.17	2.17	0.15	0.55	1.18	1.18	0.00	0.00	0.00	0.15	0.15
Bus200	Bus198	178.68	178.68	179.00	0.15	0.55	97.57	97.57	0.00	0.00	0.00	0.15	0.15
Bus201	Bus204	4.50	4.50	4.73	4.45	6.21	27.99	27.99	0.00	0.00	0.00	4.45	4.45
	Bus209	4.75	4.75	5.00	4.56	6.34	30.14	30.14	0.00	0.00	0.00	4.56	4.56
	Bus203	0.27	0.27	0.29	6.04	8.31	2.26	2.26	0.00	0.00	0.00	6.04	6.04
Bus203	Bus201	22.44	22.48	24.00	6.04	8.31	186.76	186.76	0.00	0.00	0.00	6.04	6.04
Bus204	Bus201	4.49	4.50	4.72	4.39	6.12	27.51	27.51	0.00	0.00	0.00	4.39	4.39
	Bus205	0	0	0	0	0	0.00	27.51	0.00	0.00	0.00	0.00	0.00
	Bus206	4.49	4.50	4.72	4.39	6.12	27.51	27.51	0.00	0.00	0.00	4.39	4.39
Bus205	Bus204	0	0	0	0	0	0.00	27.51	0.00	0.00	0.00	0.00	0.00
Bus206	Bus106	4.49	4.50	4.72	4.39	6.12	27.51	27.51	0.00	0.00	0.00	4.39	4.39
	Bus204	4.49	4.50	4.72	4.39	6.12	27.51	27.51	0.00	0.00	0.00	4.39	4.39

Bus		Current Distortion											
From Bus ID	To Bus ID	Fund. Amp	RMS Amp	ASUM Amp	THD %	TIF	IT Amp	ITB Amp	ITR Amp	TIHD %	TSHD %	THDG %	THDS %
Bus208	Bus180	99.51	99.69	106.30	5.94	8.15	812.85	812.85	0.00	0.00	0.00	5.94	5.94
Bus209	Bus201	4.78	4.79	5.04	4.60	6.42	30.72	30.72	0.00	0.00	0.00	4.60	4.60
	Bus197	6.36	6.37	6.73	5.00	6.94	44.15	44.15	0.00	0.00	0.00	5.00	5.00
	Bus211	1.69	1.69	1.80	5.90	8.08	13.65	13.65	0.00	0.00	0.00	5.90	5.90
Bus211	Bus209	139.06	139.30	148.47	5.90	8.08	1125.97	1125.97	0.00	0.00	0.00	5.90	5.90
Bus212	Bus213	603.24	603.24	603.97	0.11	0.52	314.17	314.17	0.00	0.00	0.00	0.11	0.11
Bus213	Bus212	7.13	7.13	7.14	0.11	0.52	3.72	3.72	0.00	0.00	0.00	0.11	0.11
	Bus138	7.13	7.13	7.14	0.11	0.52	3.72	3.72	0.00	0.00	0.00	0.11	0.11
Bus226	Bus138	1.39	1.39	1.48	5.92	8.13	11.28	11.28	0.00	0.00	0.00	5.92	5.92
	Bus139	1.39	1.39	1.48	5.92	8.13	11.28	11.28	0.00	0.00	0.00	5.92	5.92
C399~	Bus93	0	0	0	0	0	0.00	11.28	0.00	0.00	0.00	0.00	0.00
C567~	Bus106	0	0	0	0	0	0.00	11.28	0.00	0.00	0.00	0.00	0.00
C122~	Bus159	0	0	0	0	0	0.00	11.28	0.00	0.00	0.00	0.00	0.00

Unbalanced Load Flow Report

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
* Bus1	33.000	A	100.003	0.0	0.815	0.334	0	0	Bus2	A	0.815	0.334	46.2	92.5	
		B	99.993	-120.0	0.804	0.357	0	0		B	0.804	0.357	46.2	91.4	
		C	100.004	120.0	0.790	0.337	0	0		C	0.790	0.337	45.0	92.0	
										N			0.0		
Bus2	33.000	A	99.997	0.0	0	0	0	0	Bus3	A	0.295	0.123	16.8	92.3	
		B	99.988	-120.0	0	0	0	0		B	0.288	0.136	16.7	90.4	
		C	99.999	120.0	0	0	0	0		C	0.280	0.123	16.1	91.5	
										N			0.0		
									Bus21	A	0.520	0.211	29.5	92.6	
										B	0.516	0.221	29.5	91.9	
										C	0.509	0.213	29.0	92.2	
										N			0.0		
									Bus1	A	-0.815	-0.334	46.2	92.5	
										B	-0.804	-0.357	46.2	91.4	
										C	-0.790	-0.336	45.0	92.0	
										N			0.0		
Bus3	33.000	A	99.995	0.0	0	0	0	0	Bus2	A	-0.295	-0.123	16.8	92.3	
		B	99.986	-120.0	0	0	0	0		B	-0.288	-0.136	16.7	90.4	
		C	99.997	120.0	0	0	0	0		C	-0.280	-0.123	16.1	91.5	
										N			0.0		
									Bus4	A	0.295	0.123	16.8	92.3	
										B	0.288	0.136	16.7	90.4	
										C	0.280	0.123	16.1	91.5	
										N			0.0		
Bus4	33.000	A	99.989	0.0	0	0	0	0	Bus3	A	-0.295	-0.123	16.8	92.3	
		B	99.980	-120.0	0	0	0	0		B	-0.288	-0.136	16.7	90.4	
		C	99.992	120.0	0	0	0	0		C	-0.280	-0.123	16.1	91.5	
										N			0.0		
									Bus6	A	0.288	0.118	16.3	92.5	
										B	0.280	0.131	16.2	90.5	
										C	0.273	0.117	15.6	91.8	
										N			0.0		
									Bus5	A	0.007	0.005	0.4	82.7	
										B	0.008	0.005	0.5	86.4	
										C	0.008	0.006	0.5	80.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus5	0.400	A	99.616	29.8	0	0	0.008	0.004	Bus4	A	-0.008	-0.004	37.8	87.7	
		B	99.581	-90.2	0	0	0.008	0.005		B	-0.008	-0.005	40.8	86.5	
		C	99.603	149.9	0	0	0.007	0.005		C	-0.007	-0.005	36.5	80.0	
										N			3.1		
Bus6	33.000	A	99.979	0.0	0	0	0	0	Bus4	A	-0.288	-0.118	16.3	92.5	
		B	99.970	-120.0	0	0	0	0		B	-0.280	-0.131	16.2	90.5	
		C	99.982	120.0	0	0	0	0		C	-0.273	-0.117	15.6	91.8	
										N			0.0		
									Bus7	A	0.288	0.118	16.3	92.5	
										B	0.280	0.131	16.2	90.5	
										C	0.273	0.117	15.6	91.8	
										N			0.0		
Bus7	33.000	A	99.956	0.0	0	0	0	0	Bus9	A	0.269	0.106	15.2	93.0	
		B	99.947	-120.0	0	0	0	0		B	0.262	0.122	15.2	90.7	
		C	99.960	120.0	0	0	0	0		C	0.252	0.108	14.4	91.9	
										N			0.0		
									Bus6	A	-0.288	-0.118	16.3	92.5	
										B	-0.279	-0.131	16.2	90.5	
										C	-0.273	-0.117	15.6	91.8	
										N			0.0		
									Bus8	A	0.019	0.012	1.2	84.8	
										B	0.018	0.009	1.0	88.3	
										C	0.020	0.009	1.2	90.8	
										N			0.0		
Bus8	0.400	A	99.705	29.8	0	0	0.017	0.008	Bus7	A	-0.017	-0.008	84.2	90.0	
		B	99.719	-90.2	0	0	0.017	0.008		B	-0.017	-0.008	82.8	91.0	
		C	99.657	149.8	0	0	0.021	0.011		C	-0.021	-0.011	102.8	89.0	
										N			18.2		
Bus9	33.000	A	99.954	0.0	0	0	0	0	Bus7	A	-0.269	-0.106	15.2	93.0	
		B	99.945	-120.0	0	0	0	0		B	-0.262	-0.122	15.2	90.7	
		C	99.958	120.0	0	0	0	0		C	-0.252	-0.108	14.4	91.9	
										N			0.0		
									Bus10	A	0.057	0.025	3.3	91.8	
										B	0.056	0.028	3.3	89.6	
										C	0.054	0.025	3.1	90.6	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus145	A	0.211	0.082	11.9	93.3	
										B	0.206	0.094	11.9	91.0	
										C	0.198	0.083	11.3	92.3	
										N			0.0		
Bus10	33.000	A	99.951	0.0	0	0	0	0	Bus11	A	0.006	0.002	0.3	93.7	
		B	99.942	-120.0	0	0	0	0		B	0.005	0.003	0.3	89.5	
		C	99.955	120.0	0	0	0	0		C	0.005	0.002	0.3	95.6	
										N			0.0		
									Bus9	A	-0.057	-0.025	3.3	91.8	
										B	-0.056	-0.028	3.3	89.6	
										C	-0.054	-0.025	3.1	90.6	
										N			0.0		
									Bus13	A	0.052	0.023	3.0	91.5	
										B	0.051	0.025	3.0	89.6	
										C	0.049	0.024	2.9	90.0	
										N			0.0		
Bus11	33.000	A	99.951	0.0	0	0	0	0	Bus10	A	-0.006	-0.002	0.3	93.7	
		B	99.941	-120.0	0	0	0	0		B	-0.005	-0.003	0.3	89.5	
		C	99.955	120.0	0	0	0	0		C	-0.005	-0.002	0.3	95.6	
										N			0.0		
									Bus12	A	0.006	0.002	0.3	93.7	
										B	0.005	0.003	0.3	89.5	
										C	0.005	0.002	0.3	95.6	
										N			0.0		
Bus12	0.400	A	99.518	29.8	0	0	0.006	0.002	Bus11	A	-0.006	-0.002	26.9	92.8	
		B	99.623	-90.1	0	0	0.005	0.002		B	-0.005	-0.002	21.3	94.9	
		C	99.587	149.8	0	0	0.006	0.002		C	-0.006	-0.002	25.2	95.9	
										N			3.2		
Bus13	33.000	A	99.948	0.0	0	0	0	0	Bus15	A	0.040	0.020	2.4	89.6	
		B	99.938	-120.0	0	0	0	0		B	0.040	0.020	2.3	89.7	
		C	99.952	120.0	0	0	0	0		C	0.040	0.020	2.4	90.0	
										N			0.0		
									Bus10	A	-0.052	-0.023	3.0	91.5	
										B	-0.051	-0.025	3.0	89.6	
										C	-0.049	-0.024	2.9	90.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus14	A	0.011	0.003	0.6	97.2	
										B	0.011	0.006	0.7	89.1	
										C	0.009	0.004	0.5	90.4	
										N			0.0		
Bus14	0.400	A	99.509	29.7	0	0	0.012	0.004	Bus13	A	-0.012	-0.004	54.4	95.4	
		B	99.494	-90.2	0	0	0.009	0.005		B	-0.009	-0.005	46.3	87.5	
		C	99.648	149.8	0	0	0.009	0.002		C	-0.009	-0.002	42.1	97.4	
										N			0.0		
Bus15	33.000	A	99.946	0.0	0	0	0	0	Bus17	A	0.008	0.006	0.5	81.6	
		B	99.936	-120.0	0	0	0	0		B	0.007	0.004	0.4	85.6	
		C	99.950	120.0	0	0	0	0		C	0.009	0.004	0.5	91.4	
										N			0.0		
									Bus13	A	-0.040	-0.020	2.4	89.6	
										B	-0.040	-0.020	2.3	89.7	
										C	-0.040	-0.020	2.4	90.0	
										N			0.0		
									Bus20	A	0.032	0.014	1.9	91.4	
										B	0.033	0.016	1.9	90.5	
										C	0.032	0.016	1.9	89.6	
										N			0.0		
Bus17	33.000	A	99.946	0.0	0	0	0	0	Bus15	A	-0.008	-0.006	0.5	81.6	
		B	99.936	-120.0	0	0	0	0		B	-0.007	-0.004	0.4	85.6	
		C	99.950	120.0	0	0	0	0		C	-0.009	-0.004	0.5	91.4	
										N			0.0		
									Bus18	A	0.008	0.006	0.5	81.6	
										B	0.007	0.004	0.4	85.6	
										C	0.009	0.004	0.5	91.4	
										N			0.0		
Bus18	33.000	A	99.945	0.0	0	0	0	0	Bus17	A	-0.008	-0.006	0.5	81.6	
		B	99.936	-120.0	0	0	0	0		B	-0.007	-0.004	0.4	85.6	
		C	99.949	120.0	0	0	0	0		C	-0.009	-0.004	0.5	91.4	
										N			0.0		
									Bus19	A	0.008	0.006	0.5	81.6	
										B	0.007	0.004	0.4	85.6	
										C	0.009	0.004	0.5	91.4	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus19	0.400	A	99.595	29.8	0	0	0.007	0.004	Bus18	A	-0.007	-0.004	34.7	86.7	
		B	99.638	-90.2	0	0	0.007	0.003		B	-0.007	-0.003	32.5	90.3	
		C	99.512	149.8	0	0	0.009	0.005		C	-0.009	-0.005	45.6	88.0	
										N			10.0		
Bus20	0.400	A	99.196	29.4	0	0	0.034	0.014	Bus15	A	-0.034	-0.014	161.0	92.5	
		B	99.223	-90.5	0	0	0.032	0.014		B	-0.032	-0.014	151.8	91.8	
		C	99.217	149.5	0	0	0.030	0.015		C	-0.030	-0.015	147.5	90.0	
										N			17.0		
Bus21	33.000	A	99.992	0.0	0	0	0	0	Bus2	A	-0.520	-0.211	29.5	92.6	
		B	99.982	-120.0	0	0	0	0		B	-0.516	-0.221	29.5	91.9	
		C	99.993	120.0	0	0	0	0		C	-0.509	-0.213	29.0	92.2	
										N			0.0		
									Bus24	A	0.494	0.203	28.1	92.5	
										B	0.492	0.212	28.1	91.8	
										C	0.486	0.206	27.7	92.1	
										N			0.0		
									Bus22	A	0.025	0.008	1.4	95.4	
										B	0.024	0.009	1.3	93.4	
										C	0.024	0.007	1.3	95.5	
										N			0.0		
Bus22	0.400	A	99.100	29.4	0	0	0.024	0.008	Bus21	A	-0.024	-0.008	109.7	94.7	
		B	99.090	-90.6	0	0	0.023	0.008		B	-0.023	-0.008	108.4	94.0	
		C	99.201	149.4	0	0	0.025	0.006		C	-0.025	-0.006	112.3	97.5	
										N			12.3		
Bus24	33.000	A	99.965	0.0	0	0	0	0	Bus28	A	0.458	0.187	26.0	92.6	
		B	99.956	-120.0	0	0	0	0		B	0.461	0.194	26.3	92.2	
		C	99.967	120.0	0	0	0	0		C	0.454	0.193	25.9	92.0	
										N			0.0		
									Bus26	A	0.006	0.002	0.3	93.7	
										B	0.005	0.003	0.3	89.5	
										C	0.005	0.002	0.3	95.6	
										N			0.0		
									Bus21	A	-0.494	-0.203	28.1	92.5	
										B	-0.492	-0.212	28.1	91.8	
										C	-0.486	-0.206	27.7	92.1	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus25	A	0.030	0.014	1.7	90.6	
										B	0.026	0.016	1.6	85.5	
										C	0.026	0.011	1.5	92.0	
										N			0.0		
Bus25	0.400	A	99.518	29.7	0	0	0.031	0.016	Bus24	A	-0.031	-0.016	149.8	89.0	
		B	99.670	-90.3	0	0	0.024	0.010		B	-0.024	-0.010	112.8	93.0	
		C	99.618	149.7	0	0	0.027	0.012		C	-0.027	-0.012	127.2	91.0	
										N			34.9		
Bus26	33.000	A	99.965	0.0	0	0	0	0	Bus24	A	-0.006	-0.002	0.3	93.7	
		B	99.955	-120.0	0	0	0	0		B	-0.005	-0.003	0.3	89.5	
		C	99.967	120.0	0	0	0	0		C	-0.005	-0.002	0.3	95.6	
										N			0.0		
									Bus27	A	0.006	0.002	0.3	93.7	
										B	0.005	0.003	0.3	89.5	
										C	0.005	0.002	0.3	95.6	
										N			0.0		
Bus27	0.400	A	99.533	29.8	0	0	0.006	0.002	Bus26	A	-0.006	-0.002	26.9	92.8	
		B	99.636	-90.1	0	0	0.005	0.002		B	-0.005	-0.002	21.3	94.9	
		C	99.600	149.8	0	0	0.006	0.002		C	-0.006	-0.002	25.2	95.9	
										N			3.2		
Bus28	33.000	A	99.952	0.0	0	0	0	0	Bus31	A	0.439	0.182	25.0	92.4	
		B	99.943	-120.0	0	0	0	0		B	0.441	0.187	25.2	92.1	
		C	99.955	120.0	0	0	0	0		C	0.436	0.187	24.9	91.9	
										N			0.0		
									Bus24	A	-0.458	-0.187	26.0	92.6	
										B	-0.461	-0.194	26.3	92.2	
										C	-0.454	-0.193	25.9	92.0	
										N			0.0		
									Bus30	A	0.019	0.005	1.0	96.9	
										B	0.020	0.007	1.1	94.8	
										C	0.018	0.006	1.0	94.4	
										N			0.0		
Bus30	0.400	A	99.577	29.6	0	0	0.021	0.006	Bus28	A	-0.021	-0.006	95.5	96.5	
		B	99.646	-90.3	0	0	0.019	0.004		B	-0.019	-0.004	82.9	97.4	
		C	99.644	149.7	0	0	0.016	0.005		C	-0.016	-0.005	74.2	95.0	
										N			24.1		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus31	33.000	A	99.946	0.0	0	0	0	0	Bus32	A	0.046	0.018	2.6	92.9	
		B	99.936	-120.0	0	0	0	0		B	0.046	0.017	2.6	93.7	
		C	99.948	120.0	0	0	0	0		C	0.047	0.018	2.7	93.5	
										N			0.0		
									Bus28	A	-0.439	-0.182	25.0	92.4	
										B	-0.441	-0.187	25.2	92.1	
										C	-0.436	-0.187	24.9	91.9	
										N			0.0		
									Bus38	A	0.393	0.164	22.4	92.3	
										B	0.395	0.170	22.6	91.8	
										C	0.389	0.169	22.2	91.7	
										N			0.0		
Bus32	33.000	A	99.946	0.0	0	0	0	0	Bus31	A	-0.046	-0.018	2.6	92.9	
		B	99.936	-120.0	0	0	0	0		B	-0.046	-0.017	2.6	93.7	
		C	99.948	120.0	0	0	0	0		C	-0.047	-0.018	2.7	93.5	
										N			0.0		
									Bus35	A	0.007	0.005	0.4	82.7	
										B	0.008	0.005	0.5	86.4	
										C	0.008	0.006	0.5	80.0	
										N			0.0		
									Bus34	A	0.039	0.014	2.2	94.4	
										B	0.038	0.013	2.1	95.0	
										C	0.040	0.012	2.2	95.5	
										N			0.0		
Bus34	0.400	A	99.253	29.3	0	0	0.038	0.011	Bus32	A	-0.038	-0.011	174.0	96.0	
		B	99.254	-90.6	0	0	0.038	0.011		B	-0.038	-0.011	171.8	95.8	
		C	99.200	149.3	0	0	0.040	0.013		C	-0.040	-0.013	184.9	95.5	
										N			13.8		
Bus35	33.000	A	99.945	0.0	0	0	0	0	Bus32	A	-0.007	-0.005	0.4	82.7	
		B	99.935	-120.0	0	0	0	0		B	-0.008	-0.005	0.5	86.4	
		C	99.947	120.0	0	0	0	0		C	-0.008	-0.006	0.5	80.0	
										N			0.0		
									Bus37	A	0.007	0.005	0.4	82.7	
										B	0.008	0.005	0.5	86.4	
										C	0.008	0.006	0.5	80.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus37	0.400	A	99.572	29.8	0	0	0.008	0.004	Bus35	A	-0.008	-0.004	37.8	87.7	
		B	99.536	-90.2	0	0	0.008	0.005		B	-0.008	-0.005	40.8	86.5	
		C	99.559	149.9	0	0	0.007	0.005		C	-0.007	-0.005	36.5	80.0	
										N			3.1		
Bus38	33.000	A	99.939	0.0	0	0	0	0	Bus42	A	0.053	0.021	3.0	93.1	
		B	99.929	-120.0	0	0	0	0		B	0.050	0.023	2.9	91.0	
		C	99.941	120.0	0	0	0	0		C	0.050	0.019	2.8	93.2	
										N			0.0		
									Bus31	A	-0.393	-0.164	22.4	92.3	
										B	-0.395	-0.170	22.6	91.8	
										C	-0.389	-0.169	22.2	91.7	
										N			0.0		
									Bus53	A	0.340	0.143	19.4	92.2	
										B	0.345	0.147	19.7	92.0	
										C	0.339	0.149	19.5	91.5	
										N			0.0		
Bus41	0.400	A	99.491	29.7	0	0	0.031	0.016	Bus42	A	-0.031	-0.016	149.8	89.0	
		B	99.643	-90.3	0	0	0.024	0.010		B	-0.024	-0.010	112.8	93.0	
		C	99.591	149.7	0	0	0.027	0.012		C	-0.027	-0.012	127.2	91.0	
										N			34.9		
Bus42	33.000	A	99.938	0.0	0	0	0	0	Bus38	A	-0.053	-0.021	3.0	93.1	
		B	99.929	-120.0	0	0	0	0		B	-0.050	-0.023	2.9	91.0	
		C	99.941	120.0	0	0	0	0		C	-0.050	-0.019	2.8	93.2	
										N			0.0		
									Bus43	A	0.023	0.007	1.2	95.9	
										B	0.024	0.007	1.3	96.1	
										C	0.023	0.008	1.3	94.6	
										N			0.0		
									Bus41	A	0.030	0.014	1.7	90.6	
										B	0.026	0.016	1.6	85.5	
										C	0.026	0.011	1.5	92.0	
										N			0.0		
Bus43	33.000	A	99.937	0.0	0	0	0	0	Bus42	A	-0.023	-0.007	1.2	95.9	
		B	99.927	-120.0	0	0	0	0		B	-0.024	-0.007	1.3	96.1	
		C	99.939	120.0	0	0	0	0		C	-0.023	-0.008	1.3	94.6	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus44	A	0.023	0.007	1.2	95.9	
										B	0.024	0.007	1.3	96.1	
										C	0.023	0.008	1.3	94.6	
										N			0.0		
Bus44	33.000	A	99.933	0.0	0	0	0	0	Bus47	A	0.004	0.002	0.2	89.5	
		B	99.923	-120.0	0	0	0	0		B	0.005	0.002	0.3	95.9	
		C	99.935	120.0	0	0	0	0		C	0.005	0.003	0.3	85.3	
										N			0.0		
									Bus43	A	-0.023	-0.007	1.2	95.9	
										B	-0.024	-0.007	1.3	96.1	
										C	-0.023	-0.008	1.3	94.6	
										N			0.0		
									Bus46	A	0.019	0.005	1.0	96.9	
										B	0.018	0.005	1.0	96.1	
										C	0.018	0.005	1.0	96.6	
										N			0.0		
Bus46	0.400	A	98.691	29.4	0	0	0.018	0.006	Bus44	A	-0.018	-0.006	84.2	95.4	
		B	98.766	-90.7	0	0	0.019	0.004		B	-0.019	-0.004	85.5	97.6	
		C	98.921	149.4	0	0	0.017	0.003		C	-0.017	-0.003	76.7	98.1	
										N			15.7		
Bus47	33.000	A	99.933	0.0	0	0	0	0	Bus44	A	-0.004	-0.002	0.2	89.5	
		B	99.922	-120.0	0	0	0	0		B	-0.005	-0.002	0.3	95.9	
		C	99.935	120.0	0	0	0	0		C	-0.005	-0.003	0.3	85.3	
										N			0.0		
									Bus51	A	0.004	0.002	0.2	89.5	
										B	0.005	0.002	0.3	95.9	
										C	0.005	0.003	0.3	85.3	
										N			0.0		
Bus51	33.000	A	99.931	0.0	0	0	0	0	Bus47	A	-0.004	-0.002	0.2	89.5	
		B	99.921	-120.0	0	0	0	0		B	-0.005	-0.002	0.3	95.9	
		C	99.933	120.0	0	0	0	0		C	-0.005	-0.003	0.3	85.3	
										N			0.0		
									Bus52	A	0.004	0.002	0.2	89.5	
										B	0.005	0.002	0.3	95.9	
										C	0.005	0.003	0.3	85.3	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus52	0.400	A	99.647	29.9	0	0	0.004	0.001	Bus51	A	-0.004	-0.001	18.7	95.8	
		B	99.482	-90.2	0	0	0.006	0.002		B	-0.006	-0.002	27.8	92.3	
		C	99.592	149.9	0	0	0.004	0.002		C	-0.004	-0.002	20.4	89.0	
										N			5.6		
Bus53	33.000	A	99.931	0.0	0	0	0	0	Bus54	A	0.340	0.143	19.4	92.2	
		B	99.921	-120.0	0	0	0	0		B	0.345	0.147	19.7	92.0	
		C	99.934	120.0	0	0	0	0		C	0.339	0.149	19.5	91.5	
										N			0.0		
									Bus38	A	-0.340	-0.143	19.4	92.2	
										B	-0.345	-0.147	19.7	92.0	
										C	-0.339	-0.149	19.5	91.5	
										N			0.0		
Bus54	33.000	A	99.925	0.0	0	0	0	0	Bus57	A	0.334	0.141	19.1	92.2	
		B	99.915	-120.0	0	0	0	0		B	0.340	0.145	19.4	92.0	
		C	99.927	120.0	0	0	0	0		C	0.334	0.148	19.2	91.4	
										N			0.0		
									Bus53	A	-0.340	-0.143	19.4	92.2	
										B	-0.345	-0.147	19.7	92.0	
										C	-0.339	-0.149	19.5	91.5	
										N			0.0		
									Bus56	A	0.006	0.002	0.3	93.7	
										B	0.005	0.003	0.3	89.5	
										C	0.005	0.002	0.3	95.6	
										N			0.0		
Bus56	0.400	A	99.493	29.8	0	0	0.006	0.002	Bus54	A	-0.006	-0.002	26.9	92.8	
		B	99.596	-90.2	0	0	0.005	0.002		B	-0.005	-0.002	21.3	94.9	
		C	99.560	149.8	0	0	0.006	0.002		C	-0.006	-0.002	25.2	95.9	
										N			3.2		
Bus57	33.000	A	99.922	0.0	0	0	0	0	Bus54	A	-0.334	-0.141	19.1	92.2	
		B	99.911	-120.0	0	0	0	0		B	-0.340	-0.145	19.4	92.0	
		C	99.924	120.0	0	0	0	0		C	-0.334	-0.148	19.2	91.4	
										N			0.0		
									Bus63	A	0.282	0.115	16.0	92.6	
										B	0.289	0.118	16.4	92.6	
										C	0.283	0.122	16.2	91.8	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus60	A	0.022	0.012	1.3	88.5	
										B	0.026	0.011	1.5	91.8	
										C	0.025	0.014	1.5	86.7	
										N			0.0		
									Bus59	A	0.030	0.014	1.7	90.6	
										B	0.026	0.016	1.6	85.5	
										C	0.026	0.011	1.5	92.0	
										N			0.0		
Bus59	0.400	A	99.474	29.7	0	0	0.031	0.016	Bus57	A	-0.031	-0.016	149.9	89.0	
		B	99.625	-90.3	0	0	0.024	0.010		B	-0.024	-0.010	112.8	93.0	
		C	99.574	149.7	0	0	0.027	0.012		C	-0.027	-0.012	127.2	91.0	
										N			34.9		
Bus60	33.000	A	99.920	0.0	0	0	0	0	Bus57	A	-0.022	-0.012	1.3	88.5	
		B	99.910	-120.0	0	0	0	0		B	-0.026	-0.011	1.5	91.8	
		C	99.922	120.0	0	0	0	0		C	-0.025	-0.014	1.5	86.7	
										N			0.0		
									Bus62	A	0.022	0.012	1.3	88.5	
										B	0.026	0.011	1.5	91.8	
										C	0.025	0.014	1.5	86.7	
										N			0.0		
Bus62	0.400	A	98.917	29.5	0	0	0.022	0.011	Bus60	A	-0.022	-0.011	109.0	90.0	
		B	98.743	-90.6	0	0	0.027	0.012		B	-0.027	-0.012	130.9	91.0	
		C	98.909	149.5	0	0	0.022	0.011		C	-0.022	-0.011	109.0	89.0	
										N			20.2		
Bus63	33.000	A	99.918	0.0	0	0	0	0	Bus57	A	-0.282	-0.115	16.0	92.6	
		B	99.907	-120.0	0	0	0	0		B	-0.289	-0.118	16.4	92.6	
		C	99.920	120.0	0	0	0	0		C	-0.283	-0.122	16.2	91.8	
										N			0.0		
									Bus64	A	0.282	0.115	16.0	92.6	
										B	0.289	0.118	16.4	92.6	
										C	0.283	0.122	16.2	91.8	
										N			0.0		
Bus64	33.000	A	99.911	0.0	0	0	0	0	Bus69	A	0.023	0.007	1.3	95.5	
		B	99.900	-120.0	0	0	0	0		B	0.024	0.007	1.3	95.5	
		C	99.913	120.0	0	0	0	0		C	0.023	0.008	1.3	94.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus63	A	-0.282	-0.115	16.0	92.6	
										B	-0.289	-0.118	16.4	92.6	
										C	-0.283	-0.122	16.2	91.8	
										N			0.0		
									Bus70	A	0.220	0.090	12.5	92.6	
										B	0.227	0.092	12.9	92.7	
										C	0.222	0.097	12.7	91.6	
										N			0.0		
									Bus66	A	0.039	0.018	2.3	90.9	
										B	0.037	0.019	2.2	89.6	
										C	0.038	0.016	2.2	91.7	
										N			0.0		
Bus66	0.400	A	98.984	29.3	0	0	0.040	0.018	Bus64	A	-0.040	-0.018	193.0	91.5	
		B	99.143	-90.6	0	0	0.036	0.014		B	-0.036	-0.014	168.0	93.0	
		C	99.029	149.4	0	0	0.038	0.018		C	-0.038	-0.018	181.2	90.6	
										N			29.4		
Bus68	0.400	A	99.431	29.6	0	0	0.023	0.009	Bus69	A	-0.023	-0.009	106.0	93.6	
		B	99.472	-90.5	0	0	0.026	0.007		B	-0.026	-0.007	116.4	97.0	
		C	99.569	149.6	0	0	0.020	0.005		C	-0.020	-0.005	91.6	96.8	
										N			33.2		
Bus69	33.000	A	99.911	0.0	0	0	0	0	Bus64	A	-0.023	-0.007	1.3	95.5	
		B	99.900	-120.0	0	0	0	0		B	-0.024	-0.007	1.3	95.5	
		C	99.913	120.0	0	0	0	0		C	-0.023	-0.008	1.3	94.0	
										N			0.0		
									Bus68	A	0.023	0.007	1.3	95.5	
										B	0.024	0.007	1.3	95.5	
										C	0.023	0.008	1.3	94.0	
										N			0.0		
Bus70	33.000	A	99.902	0.0	0	0	0	0	Bus83	A	0.138	0.061	7.9	91.5	
		B	99.891	-120.0	0	0	0	0		B	0.151	0.060	8.5	92.9	
		C	99.904	120.0	0	0	0	0		C	0.146	0.071	8.5	89.8	
										N			0.0		
									Bus64	A	-0.220	-0.090	12.5	92.6	
										B	-0.227	-0.092	12.9	92.7	
										C	-0.222	-0.097	12.7	91.6	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus73	A	0.042	0.015	2.4	94.0	
										B	0.038	0.020	2.2	88.9	
										C	0.036	0.014	2.0	93.6	
										N			0.0		
									Bus72	A	0.039	0.014	2.2	94.4	
										B	0.038	0.013	2.1	95.0	
										C	0.040	0.012	2.2	95.5	
										N			0.0		
Bus72	0.400	A	99.208	29.3	0	0	0.038	0.011	Bus70	A	-0.038	-0.011	174.0	96.0	
		B	99.209	-90.7	0	0	0.038	0.011		B	-0.038	-0.011	171.9	95.8	
		C	99.156	149.3	0	0	0.040	0.013		C	-0.040	-0.013	185.0	95.5	
										N			13.8		
Bus73	33.000	A	99.898	0.0	0	0	0	0	Bus76	A	0.025	0.011	1.4	92.0	
		B	99.888	-120.0	0	0	0	0		B	0.021	0.010	1.2	89.6	
		C	99.901	120.0	0	0	0	0		C	0.023	0.007	1.3	96.0	
										N			0.0		
									Bus70	A	-0.042	-0.015	2.4	94.0	
										B	-0.038	-0.020	2.2	88.9	
										C	-0.036	-0.014	2.0	93.6	
										N			0.0		
									Bus75	A	0.017	0.005	0.9	96.5	
										B	0.017	0.009	1.0	88.0	
										C	0.013	0.007	0.8	88.5	
										N			0.0		
Bus75	0.400	A	99.443	29.6	0	0	0.020	0.008	Bus73	A	-0.020	-0.008	96.0	92.4	
		B	99.580	-90.3	0	0	0.015	0.006		B	-0.015	-0.006	70.3	94.0	
		C	99.653	149.8	0	0	0.011	0.005		C	-0.011	-0.005	52.9	92.5	
										N			40.6		
Bus76	33.000	A	99.897	0.0	0	0	0	0	Bus79	A	0.019	0.006	1.0	95.2	
		B	99.887	-120.0	0	0	0	0		B	0.016	0.005	0.9	94.8	
		C	99.900	120.0	0	0	0	0		C	0.018	0.003	1.0	98.7	
										N			0.0		
									Bus73	A	-0.025	-0.011	1.4	92.0	
										B	-0.021	-0.010	1.2	89.6	
										C	-0.023	-0.007	1.3	96.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus78	A	0.006	0.005	0.4	80.3	
										B	0.005	0.005	0.4	70.6	
										C	0.005	0.004	0.3	79.9	
										N			0.0		
Bus78	0.400	A	99.522	29.9	0	0	0.006	0.005	Bus76	A	-0.006	-0.005	34.3	80.0	
		B	99.628	-90.1	0	0	0.004	0.003		B	-0.004	-0.003	23.9	78.8	
		C	99.586	149.9	0	0	0.005	0.004		C	-0.005	-0.004	29.1	79.3	
										N			9.2		
Bus79	33.000	A	99.897	0.0	0	0	0	0	Bus76	A	-0.019	-0.006	1.0	95.2	
		B	99.886	-120.0	0	0	0	0		B	-0.016	-0.005	0.9	94.8	
		C	99.899	120.0	0	0	0	0		C	-0.018	-0.003	1.0	98.7	
										N			0.0		
									Bus82	A	0.019	0.006	1.0	95.2	
										B	0.016	0.005	0.9	94.8	
										C	0.018	0.003	1.0	98.7	
										N			0.0		
Bus81	0.400	A	99.287	29.5	0	0	0.018	0.005	Bus82	A	-0.018	-0.005	82.2	97.0	
		B	99.476	-90.4	0	0	0.014	0.002		B	-0.014	-0.002	62.6	98.5	
		C	99.219	149.5	0	0	0.020	0.006		C	-0.020	-0.006	90.1	96.3	
										N			25.9		
Bus82	33.000	A	99.896	0.0	0	0	0	0	Bus79	A	-0.019	-0.006	1.0	95.2	
		B	99.886	-120.0	0	0	0	0		B	-0.016	-0.005	0.9	94.8	
		C	99.898	120.0	0	0	0	0		C	-0.018	-0.003	1.0	98.7	
										N			0.0		
									Bus81	A	0.019	0.006	1.0	95.2	
										B	0.016	0.005	0.9	94.8	
										C	0.018	0.003	1.0	98.7	
										N			0.0		
Bus83	33.000	A	99.899	0.0	0	0	0	0	Bus70	A	-0.138	-0.061	7.9	91.5	
		B	99.888	-120.0	0	0	0	0		B	-0.151	-0.060	8.5	92.9	
		C	99.901	120.0	0	0	0	0		C	-0.146	-0.071	8.5	89.8	
										N			0.0		
									Bus87	A	0.120	0.056	6.9	90.6	
										B	0.133	0.054	7.5	92.5	
										C	0.128	0.066	7.6	88.7	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus86	A	0.019	0.005	1.0	96.8	
										B	0.018	0.005	1.0	95.9	
										C	0.018	0.005	1.0	96.3	
										N			0.0		
Bus85	0.400	A	99.230	29.5	0	0	0.018	0.006	Bus86	A	-0.018	-0.006	84.0	95.4	
		B	99.282	-90.5	0	0	0.019	0.004		B	-0.019	-0.004	85.2	97.4	
		C	99.381	149.5	0	0	0.017	0.003		C	-0.017	-0.003	76.5	98.1	
										N			15.3		
Bus86	33.000	A	99.898	0.0	0	0	0	0	Bus83	A	-0.019	-0.005	1.0	96.8	
		B	99.888	-120.0	0	0	0	0		B	-0.018	-0.005	1.0	95.9	
		C	99.900	120.0	0	0	0	0		C	-0.018	-0.005	1.0	96.3	
										N			0.0		
									Bus85	A	0.019	0.005	1.0	96.8	
										B	0.018	0.005	1.0	95.9	
										C	0.018	0.005	1.0	96.3	
										N			0.0		
Bus87	33.000	A	99.894	0.0	0	0	0	0	Bus83	A	-0.120	-0.056	6.9	90.6	
		B	99.883	-120.0	0	0	0	0		B	-0.133	-0.054	7.5	92.5	
		C	99.895	120.0	0	0	0	0		C	-0.128	-0.066	7.6	88.7	
										N			0.0		
									Bus90	A	0.103	0.051	6.0	89.6	
										B	0.117	0.047	6.6	92.9	
										C	0.113	0.062	6.8	87.9	
										N			0.0		
									Bus89	A	0.017	0.005	0.9	95.5	
										B	0.015	0.008	0.9	89.4	
										C	0.014	0.005	0.8	94.8	
										N			0.0		
Bus89	0.400	A	99.175	29.5	0	0	0.019	0.007	Bus87	A	-0.019	-0.007	87.5	94.5	
		B	99.423	-90.3	0	0	0.013	0.004		B	-0.013	-0.004	58.2	95.3	
		C	99.325	149.6	0	0	0.015	0.006		C	-0.015	-0.006	67.8	93.4	
										N			28.9		
Bus90	33.000	A	99.887	0.0	0	0	0	0	Bus113	A	-0.011	-0.007	0.7	85.6	
		B	99.875	-120.0	0	0	0	0		B	-0.006	-0.016	0.9	34.6	
		C	99.887	120.0	0	0	0	0		C	0.000	-0.007	0.4	3.8	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus93	A	0.087	0.047	5.2	87.9	
										B	0.092	0.053	5.6	86.7	
										C	0.085	0.054	5.3	84.3	
										N			0.0		
									Bus87	A	-0.103	-0.051	6.0	89.6	
										B	-0.117	-0.047	6.6	92.9	
										C	-0.113	-0.062	6.8	87.9	
										N			0.0		
									Bus92	A	0.026	0.010	1.5	93.4	
										B	0.031	0.010	1.7	95.0	
										C	0.029	0.014	1.7	89.3	
										N			0.0		
Bus92	0.400	A	99.394	29.5	0	0	0.028	0.008	Bus90	A	-0.028	-0.008	126.5	96.5	
		B	99.205	-90.5	0	0	0.031	0.013		B	-0.031	-0.013	146.2	92.6	
		C	99.290	149.6	0	0	0.026	0.012		C	-0.026	-0.012	125.7	91.5	
										N			7.5		
Bus93	33.000	A	99.883	0.0	0	0	0	0	Bus96	A	0.080	0.043	4.8	88.4	
		B	99.871	-120.0	0	0	0	0		B	0.084	0.048	5.1	86.8	
		C	99.883	120.0	0	0	0	0		C	0.077	0.048	4.8	84.8	
										N			0.0		
									Bus90	A	-0.087	-0.047	5.2	87.9	
										B	-0.092	-0.053	5.6	86.7	
										C	-0.085	-0.054	5.3	84.3	
										N			0.0		
									Bus95	A	0.007	0.005	0.4	82.7	
										B	0.008	0.005	0.5	86.4	
										C	0.008	0.006	0.5	80.0	
										N			0.0		
Bus95	0.400	A	99.508	29.8	0	0	0.008	0.004	Bus93	A	-0.008	-0.004	37.8	87.7	
		B	99.470	-90.2	0	0	0.008	0.005		B	-0.008	-0.005	40.8	86.5	
		C	99.496	149.9	0	0	0.007	0.005		C	-0.007	-0.005	36.5	80.0	
										N			3.1		
Bus96	33.000	A	99.882	0.0	0	0	0	0	Bus93	A	-0.080	-0.043	4.8	88.4	
		B	99.869	-120.0	0	0	0	0		B	-0.084	-0.048	5.1	86.8	
		C	99.882	120.0	0	0	0	0		C	-0.077	-0.048	4.8	84.8	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus103	A	0.041	0.013	2.3	95.4	
										B	0.038	0.018	2.2	91.0	
										C	0.036	0.013	2.0	94.1	
										N			0.0		
									Bus99	A	0.020	0.025	1.7	63.1	
										B	0.026	0.024	1.8	73.3	
										C	0.024	0.029	2.0	62.9	
										N			0.0		
									Bus98	A	0.019	0.005	1.0	96.9	
										B	0.020	0.007	1.1	94.8	
										C	0.018	0.006	1.0	94.4	
										N			0.0		
Bus98	0.400	A	99.505	29.6	0	0	0.021	0.006	Bus96	A	-0.021	-0.006	95.5	96.5	
		B	99.572	-90.3	0	0	0.019	0.004		B	-0.019	-0.004	82.9	97.4	
		C	99.572	149.7	0	0	0.016	0.005		C	-0.016	-0.005	74.2	95.0	
										N			24.1		
Bus99	33.000	A	99.881	0.0	0	0	0	0	Bus102	A	0.020	0.025	1.7	63.1	
		B	99.869	-120.0	0	0	0	0		B	0.026	0.024	1.8	73.3	
		C	99.881	120.0	0	0	0	0		C	0.024	0.029	2.0	62.9	
										N			0.0		
									Bus96	A	-0.020	-0.025	1.7	63.1	
										B	-0.026	-0.024	1.8	73.3	
										C	-0.024	-0.029	2.0	62.9	
										N			0.0		
Bus101	0.400	A	99.338	29.8	0	0	0.022	0.022	Bus102	A	-0.022	-0.022	134.8	71.6	
		B	99.228	-90.3	0	0	0.026	0.026		B	-0.026	-0.026	161.4	70.8	
		C	99.253	149.8	0	0	0.020	0.026		C	-0.020	-0.026	145.7	60.9	
										N			4.0		
Bus102	33.000	A	99.880	0.0	0	0	0	0	Bus99	A	-0.020	-0.025	1.7	63.1	
		B	99.868	-120.0	0	0	0	0		B	-0.026	-0.024	1.8	73.3	
		C	99.880	120.0	0	0	0	0		C	-0.024	-0.029	2.0	62.9	
										N			0.0		
									Bus101	A	0.020	0.025	1.7	63.1	
										B	0.026	0.024	1.8	73.3	
										C	0.024	0.029	2.0	62.9	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus103	33.000	A	99.879	0.0	0	0	0	0	Bus96	A	-0.041	-0.013	2.3	95.4	
		B	99.867	-120.0	0	0	0	0		B	-0.038	-0.018	2.2	91.0	
		C	99.880	120.0	0	0	0	0		C	-0.036	-0.013	2.0	94.1	
										N			0.0		
									Bus106	A	0.024	0.008	1.3	94.3	
										B	0.021	0.008	1.2	92.9	
										C	0.023	0.006	1.2	96.5	
										N			0.0		
									Bus105	A	0.017	0.004	0.9	96.8	
										B	0.017	0.009	1.0	88.3	
										C	0.013	0.007	0.8	89.0	
										N			0.0		
Bus105	0.400	A	99.038	29.5	0	0	0.020	0.008	Bus103	A	-0.020	-0.008	96.3	92.4	
		B	99.286	-90.4	0	0	0.015	0.006		B	-0.015	-0.006	70.5	94.0	
		C	99.422	149.7	0	0	0.011	0.005		C	-0.011	-0.005	53.0	92.5	
										N			40.7		
Bus106	33.000	A	99.878	0.0	0	0	0	0	Bus103	A	-0.024	-0.008	1.3	94.3	
		B	99.866	-120.0	0	0	0	0		B	-0.021	-0.008	1.2	92.9	
		C	99.878	120.0	0	0	0	0		C	-0.023	-0.006	1.2	96.5	
										N			0.0		
									Bus108	A	0.024	0.008	1.3	94.3	
										B	0.021	0.008	1.2	92.9	
										C	0.023	0.006	1.2	96.5	
										N			0.0		
Bus108	0.400	A	99.067	29.4	0	0	0.022	0.007	Bus106	A	-0.022	-0.007	100.6	95.0	
		B	99.080	-90.5	0	0	0.020	0.008		B	-0.020	-0.008	94.5	93.7	
		C	99.050	149.3	0	0	0.025	0.006		C	-0.025	-0.006	114.1	97.0	
										N			20.0		
Bus113	33.000	A	99.887	0.0	0	0	0	0	Bus90	A	0.011	0.007	0.7	85.6	
		B	99.875	-120.0	0	0	0	0		B	0.006	0.016	0.9	34.6	
		C	99.887	120.0	0	0	0	0		C	0.000	0.007	0.4	3.8	
										N			0.0		
									Bus114	A	-0.011	-0.007	0.7	85.6	
										B	-0.006	-0.016	0.9	34.6	
										C	0.000	-0.007	0.4	3.8	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus114	33.000	A	99.888	0.0	0	0	0	0	Bus113	A	0.011	0.007	0.7	85.6	
		B	99.876	-120.0	0	0	0	0		B	0.006	0.016	0.9	34.6	
		C	99.887	120.0	0	0	0	0		C	0.000	0.007	0.4	3.8	
										N			0.0		
									Bus120	A	0.006	0.003	0.4	91.6	
										B	0.009	0.002	0.5	98.7	
										C	0.009	0.005	0.5	88.9	
										N			0.0		
									Bus121	A	-0.027	-0.016	1.6	85.7	
										B	-0.025	-0.020	1.7	78.0	
										C	-0.022	-0.017	1.5	80.3	
										N			0.0		
									Bus116	A	0.009	0.007	0.6	81.5	
										B	0.010	0.002	0.5	97.0	
										C	0.013	0.005	0.7	93.5	
										N			0.0		
Bus116	0.400	A	99.613	29.8	0	0	0.006	0.003	Bus114	A	-0.006	-0.003	30.4	92.8	
		B	99.405	-90.3	0	0	0.012	0.005		B	-0.012	-0.005	55.6	93.3	
		C	99.332	149.7	0	0	0.014	0.006		C	-0.014	-0.006	64.8	92.7	
										N			30.0		
Bus119	0.400	A	99.620	29.8	0	0	0.007	0.002	Bus120	A	-0.007	-0.002	32.1	95.3	
		B	99.535	-90.3	0	0	0.011	0.002		B	-0.011	-0.002	49.5	98.0	
		C	99.609	149.9	0	0	0.006	0.003		C	-0.006	-0.003	29.5	89.0	
										N			17.7		
Bus120	33.000	A	99.887	0.0	0	0	0	0	Bus114	A	-0.006	-0.003	0.4	91.6	
		B	99.875	-120.0	0	0	0	0		B	-0.009	-0.002	0.5	98.7	
		C	99.887	120.0	0	0	0	0		C	-0.009	-0.005	0.5	88.9	
										N			0.0		
									Bus119	A	0.006	0.003	0.4	91.6	
										B	0.009	0.002	0.5	98.7	
										C	0.009	0.005	0.5	88.9	
										N			0.0		
Bus121	33.000	A	99.890	0.0	0	0	0	0	Bus124	A	0.027	0.009	1.5	95.4	
		B	99.878	-120.0	0	0	0	0		B	0.030	0.010	1.7	95.1	
		C	99.889	120.0	0	0	0	0		C	0.028	0.012	1.6	91.6	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus126	A	-0.054	-0.025	3.1	91.0	
										B	-0.056	-0.030	3.3	87.9	
										C	-0.050	-0.029	3.0	86.7	
										N			0.0		
									Bus114	A	0.027	0.016	1.6	85.7	
										B	0.025	0.020	1.7	78.0	
										C	0.022	0.017	1.5	80.3	
										N			0.0		
Bus124	33.000	A	99.889	0.0	0	0	0	0	Bus121	A	-0.027	-0.009	1.5	95.4	
		B	99.877	-120.0	0	0	0	0		B	-0.030	-0.010	1.7	95.1	
		C	99.889	120.0	0	0	0	0		C	-0.028	-0.012	1.6	91.6	
										N			0.0		
									Bus125	A	0.027	0.009	1.5	95.4	
										B	0.030	0.010	1.7	95.1	
										C	0.028	0.012	1.6	91.6	
										N			0.0		
Bus125	0.400	A	99.298	29.5	0	0	0.029	0.007	Bus124	A	-0.029	-0.007	129.2	97.2	
		B	99.162	-90.4	0	0	0.029	0.011		B	-0.029	-0.011	135.8	93.3	
		C	99.255	149.6	0	0	0.027	0.010		C	-0.027	-0.010	123.1	94.0	
										N			5.7		
Bus126	33.000	A	99.893	0.0	0	0	0	0	Bus127	A	-0.079	-0.033	4.5	92.5	
		B	99.881	-120.0	0	0	0	0		B	-0.079	-0.039	4.7	89.7	
		C	99.892	120.0	0	0	0	0		C	-0.074	-0.036	4.3	89.8	
										N			0.0		
									Bus121	A	0.054	0.025	3.1	91.0	
										B	0.056	0.030	3.3	87.9	
										C	0.050	0.029	3.0	86.7	
										N			0.0		
									Bus142	A	0.025	0.008	1.4	95.4	
										B	0.024	0.009	1.3	93.4	
										C	0.024	0.007	1.3	95.5	
										N			0.0		
Bus127	33.000	A	99.897	0.0	0	0	0	0	Bus126	A	0.079	0.033	4.5	92.5	
		B	99.886	-120.0	0	0	0	0		B	0.079	0.039	4.7	89.7	
		C	99.897	120.0	0	0	0	0		C	0.074	0.036	4.3	89.8	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
									Bus132	A	-0.091	-0.036	5.2	92.9	
										B	-0.091	-0.042	5.2	90.9	
										C	-0.086	-0.039	5.0	91.3	
										N			0.0		
									Bus129	A	0.012	0.004	0.6	95.3	
										B	0.011	0.002	0.6	98.0	
										C	0.013	0.003	0.7	98.1	
										N			0.0		
Bus129	0.400	A	99.540	29.7	0	0	0.010	0.003	Bus127	A	-0.010	-0.003	46.5	96.6	
		B	99.537	-90.3	0	0	0.012	0.002		B	-0.012	-0.002	53.8	98.7	
		C	99.520	149.7	0	0	0.013	0.002		C	-0.013	-0.002	56.5	98.3	
										N			7.9		
Bus132	33.000	A	99.906	0.0	0	0	0	0	Bus135	A	-0.104	-0.043	5.9	92.3	
		B	99.895	-120.0	0	0	0	0		B	-0.102	-0.045	5.8	91.5	
		C	99.905	120.0	0	0	0	0		C	-0.101	-0.043	5.8	92.2	
										N			0.0		
									Bus127	A	0.091	0.036	5.2	92.9	
										B	0.091	0.042	5.2	90.9	
										C	0.086	0.039	5.0	91.3	
										N			0.0		
									Bus134	A	0.000	0.000	0.0	0.0	
										B	0.000	0.000	0.0	0.0	
										C	0.000	0.000	0.0	0.0	
										N			0.0		
									Bus133	A	0.013	0.007	0.7	88.2	
										B	0.011	0.003	0.6	95.7	
										C	0.015	0.004	0.8	96.6	
										N			0.0		
Bus133	0.400	A	99.496	29.8	0	0	0.010	0.004	Bus132	A	-0.010	-0.004	45.6	92.1	
		B	99.451	-90.3	0	0	0.013	0.004		B	-0.013	-0.004	58.2	96.2	
		C	99.348	149.6	0	0	0.016	0.005		C	-0.016	-0.005	71.3	95.5	
										N			19.1		
Bus134	33.000	A	99.906	0.0	0	0	0	0	Bus132	A	0.000	0.000	0.0	0.0	
		B	99.895	-120.0	0	0	0	0		B	0.000	0.000	0.0	0.0	
		C	99.905	120.0	0	0	0	0		C	0.000	0.000	0.0	0.0	
										N			0.0		

Bus			Voltage		Generation		Load		Load Flow						XFMR
ID	kV	Phase	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	Phase	MW	Mvar	Amp	% PF	% Tap
Bus135	33.000	A	99.911	0.0	0	0	0	0	Bus132	A	0.104	0.043	5.9	92.3	
		B	99.900	-120.0	0	0	0	0		B	0.102	0.045	5.8	91.5	
		C	99.910	120.0	0	0	0	0		C	0.101	0.043	5.8	92.2	
										N			0.0		
									Bus138	A	-0.104	-0.043	5.9	92.3	
										B	-0.102	-0.045	5.8	91.5	
										C	-0.101	-0.043	5.8	92.2	
										N			0.0		
Bus138	33.000	A	99.921	0.0	0	0	0	0	Bus213	A	-0.124	-0.056	7.2	91.3	
		B	99.910	-120.0	0	0	0	0		B	-0.124	-0.056	7.2	91.3	
		C	99.920	120.0	0	0	0	0		C	-0.124	-0.056	7.1	91.3	
										N			0.0		
									Bus135	A	0.104	0.043	5.9	92.3	
										B	0.102	0.045	5.8	91.5	
										C	0.101	0.043	5.8	92.2	
										N			0.0		
									Bus139	A	0.021	0.012	1.3	85.7	
										B	0.022	0.011	1.3	90.3	
										C	0.023	0.013	1.4	87.0	
										N			0.0		
Bus139	0.400	A	99.004	29.6	0	0	0.019	0.010	Bus138	A	-0.019	-0.010	95.8	88.0	
		B	98.814	-90.5	0	0	0.024	0.012		B	-0.024	-0.012	117.8	89.0	
		C	98.908	149.5	0	0	0.022	0.011		C	-0.022	-0.011	109.0	89.0	
										N			20.0		
Bus142	33.000	A	99.889	0.0	0	0	0	0	Bus126	A	-0.025	-0.008	1.4	95.4	
		B	99.878	-120.0	0	0	0	0		B	-0.024	-0.009	1.3	93.4	
		C	99.889	120.0	0	0	0	0		C	-0.024	-0.007	1.3	95.5	
										N			0.0		
									Bus143	A	0.025	0.008	1.4	95.4	
										B	0.024	0.009	1.3	93.4	
										C	0.024	0.007	1.3	95.5	
										N			0.0		
Bus143	0.400	A	98.996	29.4	0	0	0.024	0.008	Bus142	A	-0.024	-0.008	109.8	94.7	
		B	98.984	-90.6	0	0	0.023	0.008		B	-0.023	-0.008	108.5	94.0	
		C	99.097	149.3	0	0	0.025	0.006		C	-0.025	-0.006	112.3	97.5	
										N			12.3		

SHORT-CIRCUIT REPORT

3-phase fault at bus: **Bus138**

Prefault voltage = 33.000 = 100.00 % of nominal bus kV (33.000 kV)
= 100.00 % of base (33.000 kV)

Contribution		1/2 Cycle					1.5 to 4 Cycle				
From Bus ID	To Bus ID	% V From Bus	kA Real	kA Imaginary	Imag. /Real	kA Symm. Magnitude	% V From Bus	kA Real	kA Imaginary	Imag. /Real	kA Symm. Magnitude
Bus138	Total	0.00	2.732	-3.562	1.3	4.489	0.00	2.707	-3.544	1.3	4.459
Bus213	Bus138	0.03	0.007	-0.046	6.9	0.046	0.03	0.007	-0.046	6.9	0.046
Bus135	Bus138	7.97	2.723	-3.512	1.3	4.444	7.92	2.699	-3.496	1.3	4.417
Bus139	Bus138	4.58	0.002	-0.004	2.4	0.005	1.88	0.001	-0.002	2.4	0.002

NACD Ratio = 0.99

\# Indicates a fault current contribution from a three-winding transformer
* Indicates a fault current through a tie circuit breaker
If faulted bus is involved in loops formed by protection devices, the short-circuit contributions through these PDs will not be reported.

SHORT-CIRCUIT REPORT

3-phase fault at bus: **Bus138**

Prefault voltage = 33.000 = 100.00 % of nominal bus kV (33.000 kV)
= 100.00 % of base (33.000 kV)

Contribution		1/2 Cycle					1.5 to 4 Cycle				
From Bus ID	To Bus ID	% V From Bus	kA Real	kA Imaginary	Imag. /Real	kA Symm. Magnitude	% V From Bus	kA Real	kA Imaginary	Imag. /Real	kA Symm. Magnitude
Bus138	Total	0.00	2.725	-3.517	1.3	4.449	0.00	2.700	-3.498	1.3	4.419
Bus135	Bus138	7.97	2.723	-3.512	1.3	4.444	7.92	2.699	-3.496	1.3	4.417
Bus139	Bus138	4.58	0.002	-0.004	2.4	0.005	1.88	0.001	-0.002	2.4	0.002

NACD Ratio = 1.00

\# Indicates a fault current contribution from a three-winding transformer
* Indicates a fault current through a tie circuit breaker
If faulted bus is involved in loops formed by protection devices, the short-circuit contributions through these PDs will not be reported.