CHAPTER ONE

INTERODUCTION

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1.1 Background

Calculations of losses in power systems have been paid attention by many researchers. Earlier efforts concentrated on energy loss estimation on a yearly basis and power loss estimations for maximum load situations. The estimated losses were important data when calculating the energy losses and planning grids. After the global deregulation of electricity markets, the situation has completely changed. Knowledge of the magnitude of losses with high accuracy is crucial for fair competition in deregulated markets. Correct value of losses is necessary for correct evaluation of loss cost.

To be able to calculate losses with high accuracy, accurate data on power input and output is required. There are several ongoing projects dedicated to improve the data accuracy. One example is to install meters at the incomers on substations and feeders. Recently, in 2010SEDC started to install energy meters. This work will be completed in 2014.

There are certain losses which affect the economy of the power system. It is a well-known fact that all energy supplied to a distribution utility does not reach the end consumer. The term “distribution losses” refers to the difference between the amount of energy delivered to the distribution system and the amount of energy customers is billed.

In SEDC Sudan distribution network the percentage distribution losses has been quite high, from table table.1.1[9]losses percentage is (16.61%) for year 2013.

Table.1.1: SEDC losses report 2013

.	Month	Losses %
1	JAN	16.7
2	FEB	16.2
3	MAR	19.7
4	APR	17.7

5	MAY	22.3
6	JUN	19.9
7	JUL	19.6
8	AUG	12.4
9	SEB	19.4
10	OCT	12.9
11	NOV	8.7
12	DEC	13.9
Average		16.61

Electric power transmission and distribution losses (% of output) in Sudan was last measured at year 2012, according to the World Bank. Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and the distribution to consumers, including pilferage. From (fig 1.1) illustrate losses for Electric power transmission and distribution losses (% of output) in Sudan since 1998 according to world bank [9].

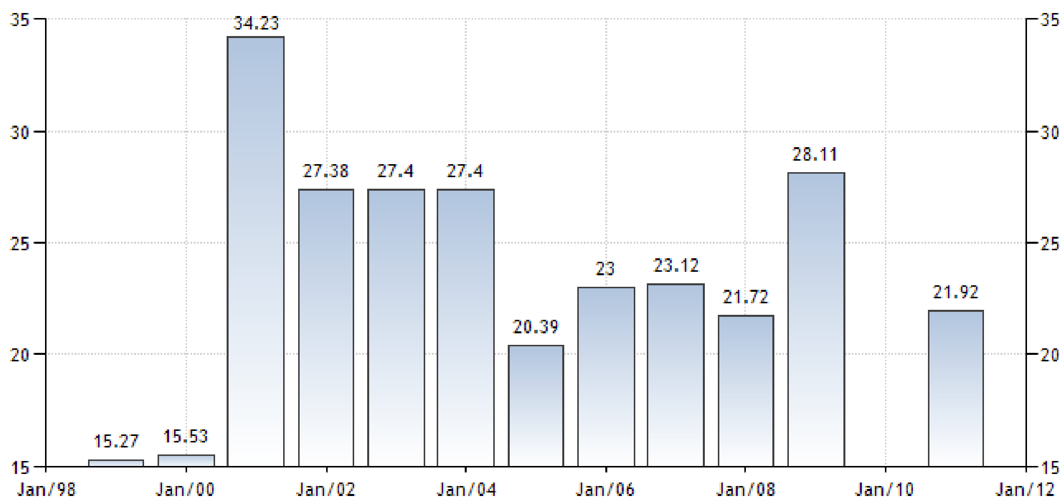


Fig.1.1 :World Bank Indicators - Sudan - Energy losses

SEDC desires to improve its knowledge on the level of reasonable losses to obtain better reference values to the results of grid settlement. Since losses vary, knowledge on how losses vary within SEDC network during different times of the year, different load conditions etc., would be valuable. If the normal loss variations were known, errors in the metering, reporting and grid settlement would be much easier to detect.

The Transmission and Distribution losses in the advanced Countries of the world ranging from (4-12) %. However, the transmission and distribution losses in Sudan are not comparable with advanced countries as the system operating conditions are. Table 1.2 shows the losses percentage in selected countries [2].

Table.1.2: Transmission and distribution losses in selected countries

Country	1980	1990	1999	2000
Finland	6.2	4.8	3.6	3.7
Netherlands	4.7	4.2	4.2	4.2
Belgium	6.5	6	5.5	4.8
Germany	5.3	5.2	5	5.1
Italy	10.4	7.5	7.1	5.1
Denmark	9.3	8.8	59	7.1
United States	10.5	10.5	5.7	17.1
Switzerland	9.1	7	7.5	7.4
France	6.9	9	8	7.8
Austria	7.9	6.9	7.9	7.8
Sweden	9.8	7.6	8.4	9.1
Australia	11.6	8.4	9.2	9.1
United Kingdom	9.2	8.9	9.2	9.4
Portugal	13.3	9.8	10	9.4
Norway	9.5	7.1	8.2	9.8
Ireland	12.8	10.9	9.6	9.9
Canada	10.6	8.2	9.2	9.9
Spain	11.1	11.1	11.2	10.6
New Zealand	14.4	13.3	13.1	11.5

1.2 Objective

The aim of this thesis is to investigate and analysis the technical losses of Distribution grid by using simulation tools known NEPLAN , used extensively for the Power Systems the main capabilities, features and benefits of using this professional software for planning .

1.3 Case Study

The research area has been chosen due to the highly consumption in Khartoum north industrial area. Khalil Osman is a distribution substation (33/11) KV considered as main power source for the most factories in Khartoum North industrial area. It supplied from Kuku and El-Izba transmission substation via 33KV overhead cable XLPE3*300mm2 as a follows:

- (Khalilosman 1 izb l4) incoming line connected to (TR1) via (KHALIL OSAMAN) 33 KV busbar. (TR1) has capacity of 20 MVA. (TR 1) is connected to the following outgoing loads :
    - ELMASRA outgoing.

    i. SAFA OIL outgoing.

    ii. SHAMBT outgoing.

    iii. COLA outgoing.
- (Z605 KUKU L10) incoming line connected to (TR2) via (KHALIL OSAMAN B32)33 KV busbar.(TR2) has capacity of 20 MVA. (TR 2) is connected to the following outgoing loads :

    i. CAPO out-going.

    ii. SIGA/SAIFONAT outgoing.

    iii. SAFIA outgoing.

1.4 Thesis Layout

Chapter one gives an introduction to the research, Including the methods and analysis tools, chapter two discusses the general equation of losses calculation and losses terms ,chapter three describes the experience of NEPLAN software used extensively for the Power Systems the main capabilities, features and benefits of using this professional software for planning . In chapter four simulations and analysis the NEPLAN results of Khalil Osman feeders. Finally, chapter five represents conclusion and recommendation.

CHAPTER TWO ELECTRICAL LOSSES LITERATURE

CHAPTER TWO
ELECTRICAL LOSSES LITERATURE

2.1 INTRODUCTION

Due to the expansion in Sudanese national grid, limitation of generation and continuous increasing in demand. As results the network becomes overloaded, energy transmission and distribution is accompanied with losses, It is very important for electric power utility to consider these losses and reduce them wherever practical. Cost of procedures to improve and reduce the loss is less than the cost of the establishment of a new distribution substations and consuming time as well.

This chapter is intended to discuss the losses terms and general equation of losses calculation.

2.2 Electrical system loss

Total electric energy losses in the electric system, consists of transmission , transformer , and distribution losses between the supply and receiving points.

The average power loss can be expressed as

$$P_{loss} = P_{source} - P_{load} \quad \text{------------------------------} (2.1)$$

where P_{source} means the average power that the source is injecting into the transmission line and P_{load} is the power consumed by the load at the end. This is a simple enough calculation, except that power and current are both time dependent functions and that energy .Energy is power accumulated over time, or

$$W_{loss} = \int_a^b P_{loss}(t)\, dt \quad \text{------------------------------} (2.2)$$

with and bas the starting and ending points of the time interval being evaluated.

2.3 The allowable volt drop

The acceptable percentage volt drop ± 6% , is international standard for distribution grid.

2.4 Losses study

It is common practice to divide losses into categories:

- Technical losses:

  Technical losses are losses that occur in electrical equipment, especially cables, overhead lines and power transformers.

- Non-technical losses:

  consists of losses not related to the physical power system but rather to loss sources like electricity thefts and errors in billing and meter reading.

2.5 Technical Losses

Technical losses in power system are caused by the physical properties components of the power system. The most obvious example the power dissipation in transmission lines and transformers due to internal electrical resistance .Following table showing reason of losses at the transmission and distribution grid

Table.2.1:losses factors in grid of transmission and distribution network

Grid	Resistance loss	Corona loss	Dielectric loss	Copper & iron loss transformer
Transmission	√	√	√	√
Distribution	√	×	√	√

Technical losses are possible to compute and control , its occur during transmission and distribution and involve substation, transformer, and line. These include resistive losses of the primary feeders, the distribution transformer losses (resistive loses in windings and the core losses), resistive losses in secondary network, resistive losses in service drops and losses in meter. Losses are inherent to the distribution of electricity and cannot be eliminated.

Technical losses can classify into two type:

1. Load losses: include I^2R load in the winding due to load and eddy current , stray loss due to leaking fluxes in the winding , core clamps , and other parts.load losses are caused primarily by resistance of the winding conducting to the current that flows through them.
2. No- load losses : No load losses include core losses and dielectric losses .Transformer losses are generally no load losses .

2.6 Transformer Losses

Transformer losses are generally classified into no load or core losses and load losses , Fig.2.1 showing the total transformer losses , [2]

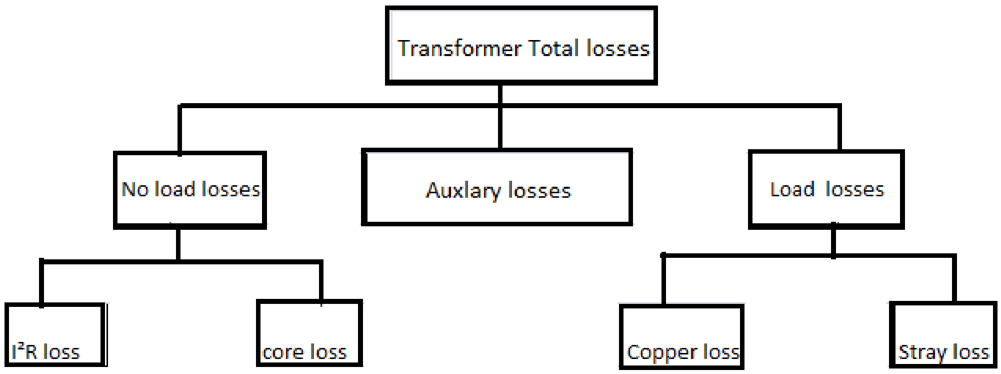


Fig.2.1: Transformer losses

Transformer components definitions

- Core Losses :Losses that are mainly caused by the resistance of the iron core to the magnetic flux magnetizing it .
- Eddy current losses : are losses caused by the current induced in the iron by the alternating magnetic field . As the magnetic flux changes with the alternating current in the coil , a current is induced in the iron that flows at right angles or cross - sectionally to the magnetic flux .[2]

$$Pe = Ke\,\frac{(\mathrm{tfBm})^2}{\rho} \quad \text{---------------------------------} \quad (2.3)$$

where :

F : frequency

B_m: maximum magnetic flux density

P_e : Eddy current losses

ρ : Resistivity magnetic material

t : Thickness off iron plate

K_e : Proportional constant

- Stray Load loss (synchronous machines) : The losses due to eddy currents in copper and additional core losses in the iron, produced by distortion of the magnetic flux by the load current, and including that portion the core loss associated with the resistance drop.
- Hysteresis loss (power and distribution transformers): The energy loss in magnetic material that results from an alternating magnetic field as the elementary magnets within the material seek to align themselves with the reversing magnetic field..

$$P_h = K_h f B_m^{1.6} \text{-------------------------------------}(2.4)$$

where

f_h : Hysteresis Loss

F : Frequency

Bm : Maximum Magnetic Flux Density

Kh : Proportional Constant

- Auxiliary losses: are losses caused by the use of cooling equipment such as fans and pumps to increase the loading capability of substation transformers.

2.7 Reasons of technical losses:

They are major reasons in transmission and distribution grid can cause obvious losses , due to material parameters of power system component quality and right network planning. Following are some of the major reasons of power system grid:

1. The volt drops.
2. Low load power factor
3. Improper earthing at consumer end.
4. Long single phase lines.
5. Unbalanced loading.
6. Losses due to overloading.
7. Losses due to poor standard of equipments.
8. Harmonics distortion.

2.8 Non-Technical Losses (Commercial Losses)

Non-technical losses, sometimes called “commercial losses”, are very important because they often contribute to a large extent to the power that the utility is not paid for.

it's related to metering errors, inaccurate meters, improperly read meters and estimated consumption due to lack of meters. Unauthorized connections as well as administrative errors are other possible sources of non-technical losses. From the examples above it is clear that most non-technical losses are associated with low voltage distribution networks. At medium voltage distribution level, non-technical losses are primarily caused by inaccurate meters and tampering with measurement transformers .At transmission voltage level non-technical losses are often related to metering errors at nodes. On transmission level, nontechnical losses are rare and can be neglected .

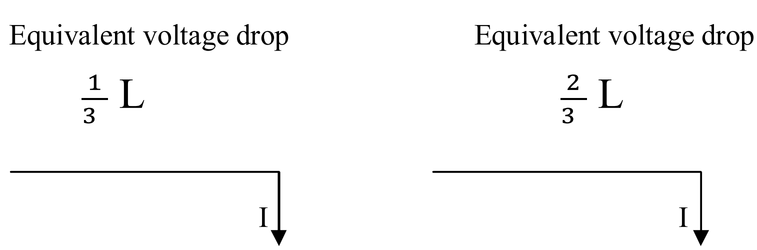
2.9 Line Losses and Voltage Drop Relationship

Line losses are from the line current flowing through the resistance of the conductors. After distribution transformer losses, primary line losses are the largest cause of losses on the distribution system. Like any resistive losses, line losses are a function of the current squared multiplied by the resistance (I^2R).

Because losses are a function of the current squared, most losses occur on the primary near the substation. Losses occur regardless of the power factor of the circuit

Approximations method are the common way for calculate drop. A uniformly distributed load along a circuit of length (L) has the same losses as a single lumped load placed at a length of (l/3) from the source end. For voltage drop, the equivalent circuits are different: a uniformly distributed load along a circuit of length(L) has the same voltage drop as a single lumped load placed at a length of (l/2) from the source end. This (1/2) rule for voltage drop and the (1/3) rule for losses are helpful approximations when doing hand calculations or when making simplifications to enter in a load-flow program.

Losses, voltage drop, and capacity are all interrelated. Three-phase circuits have the highest power transfer capacity, the lowest voltage drop, and the lowest losses.



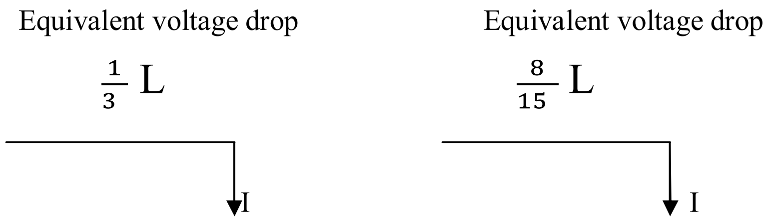


fig.2.2: Load Distribution and Dispersal Loss Factor

Table 2.2 Load Distribution and Dispersal Loss Factor

Model of dispersal load	
Concentrating on the end of line	
Distributing equally on the line	
Increasing, so that it goes to the end of line	
Becoming the maximum in the middle of line	
Decreasing, so that it goes to the end of line	

2.10 Losses factors

Utilities consider both peak losses and energy losses. Peak losses are important because they compose a portion of the peak demand; energy losses are the total kilowatt-hours wasted as heat in the conductors. The peak losses are more easily estimated from measurements and models. The average losses can be found from the peak losses using the loss factor F_l:

$$F_l = \frac{\text{Average losses}}{\text{Peak losses}} \quad (2.5)$$

Losses factor use to measure energy losses if the value of losses is known.

Load factor is the ratio between average load and maximum load through cretin period , and calculated from the following equations

$$\text{Average load} = \frac{\text{Energy during period in KWH}}{\text{House during Period}} \text{-----------------------(2.6),}$$

$$\text{load factor} = \frac{\text{EnergAverge load in Kwh}}{\text{Peak load in kw}} = \frac{\text{Averge load KWH}}{\text{Maximum load Kwh}} \text{--------------(2.7)}$$

Normally there is no enough information to directly measure the loss factor. For find the load factor (the average demand over the peak demand). The loss factor is some function of the load factor squared. The most common approximation is this is often used for evaluating line losses and transformer load losses (which are also a function of I^2R). Load factors closer to one result in loss factors closer to one.

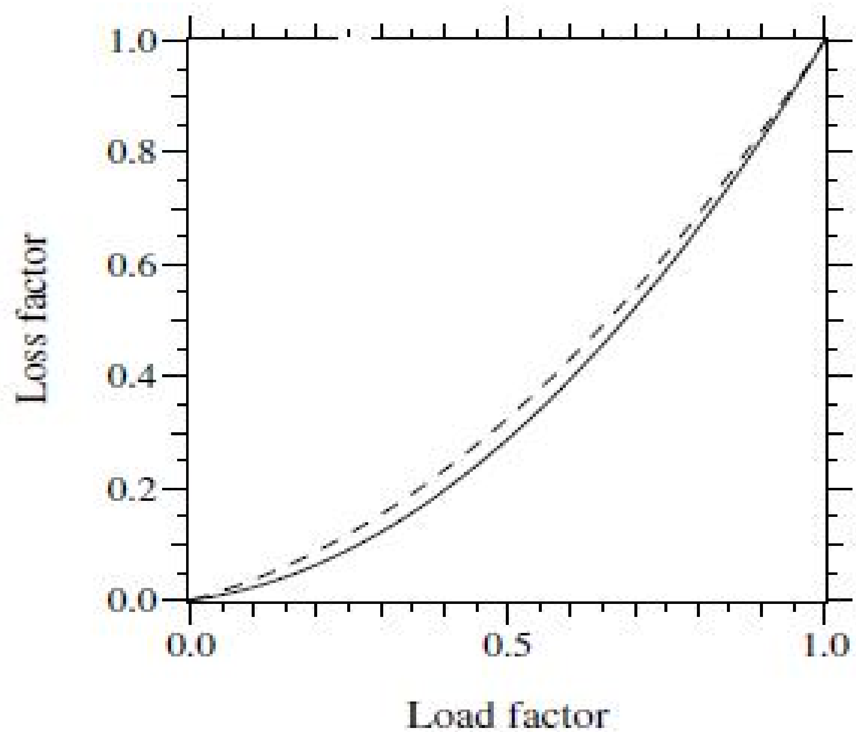


fig.2.3 : Relation between load and loss factor

CHAPTRE THREE
METHODOLOGY AND MODELING BY NEPLAN

CHAPTRE THREE

METHODOLOGY AND MODELING BY NEPLAN

3.1 INTRODUCTION

Many of electrical and power systems engineering laboratories must be realistic because cannot be performed practical experiences on a HV transmission system and some of equipments is often expensive. This chapter describes the experience of NEPLAN software used extensively for the Power Systems the main capabilities, features and benefits of using this professional software for planning .

The importance of simulation in power system engineering can be seen in the variety of simulation tools there are available in various forms and brands around the power engineering academic/research centers, electrical utilities, industries and companies. Software packages for power system analysis can be divided into two classes of tools:

- Commercial software. These tools represent a conventional and an attractive option for education process due the many advantages of using. These software packages are created and developed by important research or electric utilities companies, are well-known in a concurrent market, typically well-tested and computationally efficient. For students, represents a favorable opportunity to meet and use these well-known packages. there is an extended presentation of most illustrative power engineering software (EDSA, EUROSTAG, CYME, ETAP, NEPLAN).
- Educational/research software are created and used mainly in universities or research institutions. For educational activities, the flexibility and open-source characteristics are more important aspects than computational efficiency. These aspects corresponds to the main advantages of these tools which can be a valid alternative to commercial software for power engineering education. In the last decade, several high-scientific languages, such as MATLAB, have become very popular for research and educational purpose. At this aim, there is a variety of open source educational tools. Most of them are oriented to a specific aspect (application) of power system analysis .

3.2 DEFENTION

NEPLAN is a power system software applied worldwide for network planning, modeling and analysis. NEPLAN is used in more than 80 countries by more than 600 companies, such as small and large electrical utilities, industries and universities. NEPLAN focuses on modeling and simulation an analysis on computers, which represent a very efficient method for obtaining experience and enhance skills with power system. The software has plenty possibilities to entered graphically all the power systems elements, various analysis tools and flexibility.

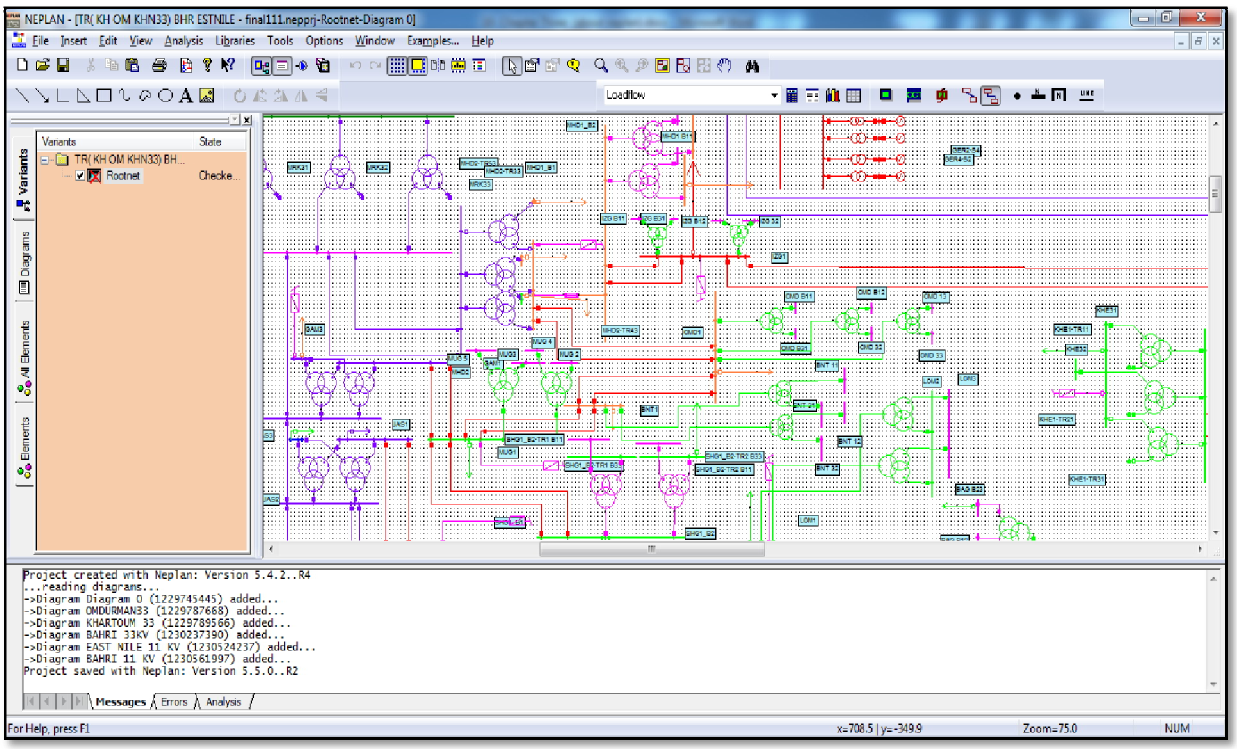


Fig. 3.1 NEPLAN Graphic User Interface

NEPLAN is a very user friendly planning and information system for electrical-,gas- and water- networks and one of the most complete planning, optimization and simulation tool for transmission, distribution, generation and industrial networks. The power system analysis software NEPLAN consists of several modules, The modules can be grouped as follows:

I. General :

- Load Flow .
- Short Circuit Analysis.
- Reliability Analysis.

II. Distribution

- Load Flow with Load profiles .
- Optimization of Distribution Network .
- Optimal separation point .
- Optimal Feeder Reinforcement .
- Low-voltage calculation .
- Capacitor Placement.

III. Transmission

- Contingency Analysis .
- Optimal power flow .
- Voltage stability .
- Small signal stability.
- Transient stability .
- Dynamic Transient stability.
- Net transfer capacity.

IV. Industrial

- Harmonic Analysis .
- Motor starting..
- Cable dimensioning.

V. Protection

- Fault finding analysis.
- Over current protection .
- Distance protection .
- Investment analysis.

3.3 Design in NEPLAN

NEPLAN permits to define, develop and manage the power systems elements, data, library and graphics. The main elements used for network design and applications are:

- Transmission network elements: AC and DC transmission lines, two, three or four windings transformers, buses

- Classic compensating and Voltage Control devices: shunt capacitors, series capacitors, shunt reactors, synchronous condensers, regulating transformers such as tap-changing transformers.
- FACTS devices: Controlled static VAR compensators SVC, Static Compensators STATCOM, Thyristor Controlled Series Capacitors TCSC, United Power Flow Controller UPFC, Phase Shift Transformer PST.
- Generating Units Controls devices: Generators, Excitation system, Automatic Voltage Regulator AVR, Power System Stabilizer PSS.
- Power System Loads: static loads, induction motors and load models parameters.

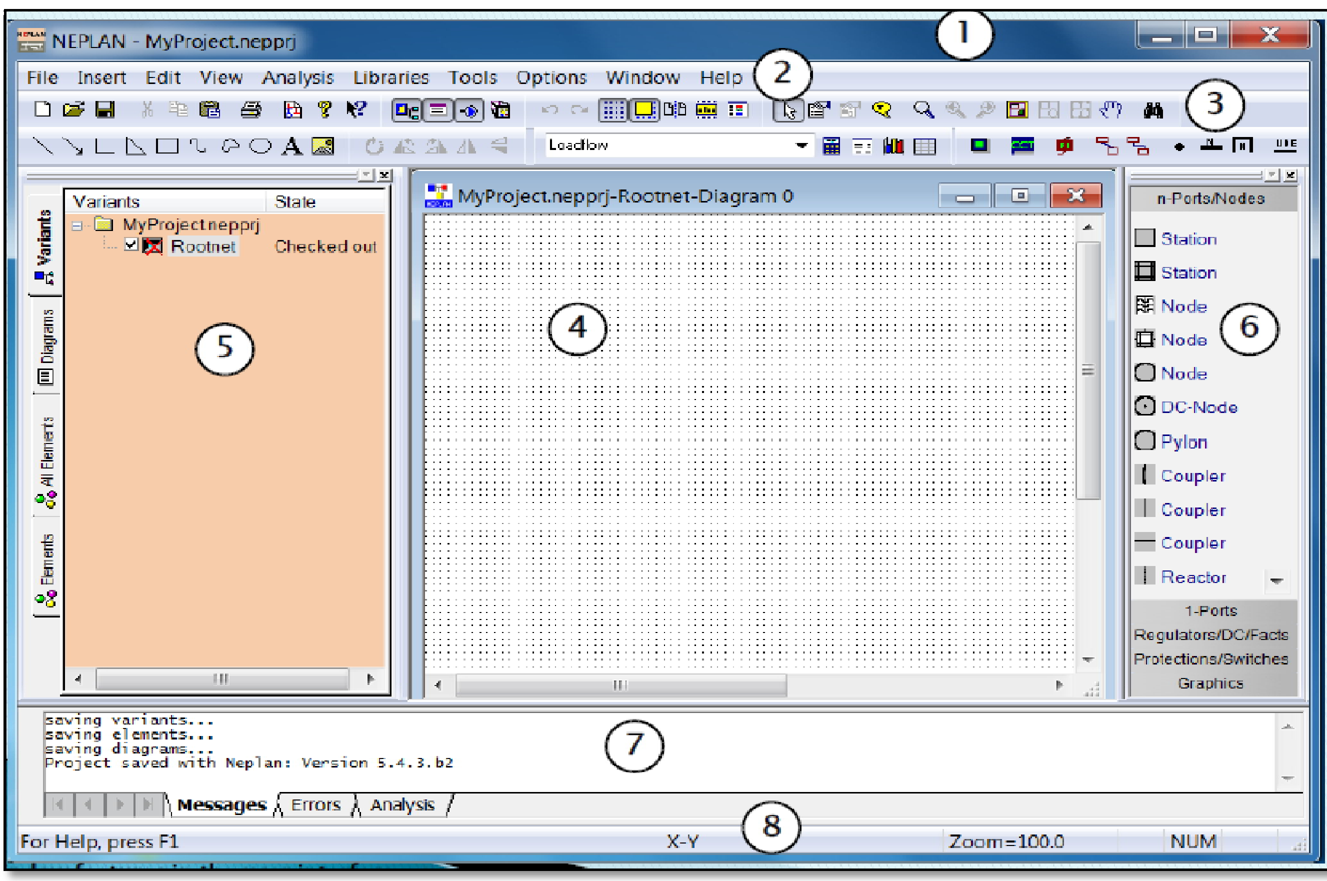


Fig. 3.2 NEPLAN User Interface

From fig .3.2 ,numbers indicate the following window features:

1. Title bar .
2. Menu option bar
3. Toolbar .
4. Workspace with diagrams and data tables.
5. Variant Manager .
6. Symbol Window.
7. Message Window .
8. Status bar.

3.4 The Basic Elements of NEPLAN

To understand the NEPLAN environment, it is essential that certain concepts used in the system are described

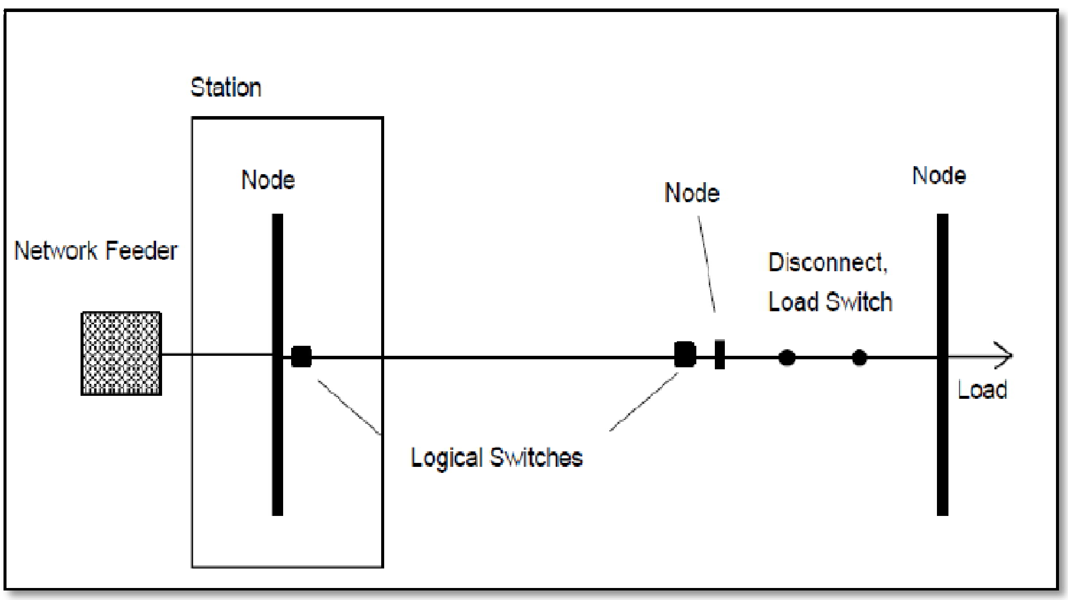


fig.3.3 :One line diagram with network components

The following are Elements of NEPLAN :

1. Notes : A node is the connection point of two elements or a location, where electrical energy will be produced or consumed (generator, load). A node is described by:
   - Name,
   - nominal system voltage in kV,

- zone and area,
- type of node (main bus bar, bus bar, sleeve, special node),
- description,

2. Elements: An element corresponds to a network component, like e.g. line, transformer or electrical machine. An element is described topological by a starting and an ending node. The elements will be described electrical by the rated current, rated power and rated voltage and its parameters, such as losses, reactance,

3.5 Procedure of NEPLAN implementation in this thesis

For study and analysis any cases, all elements parameters and data sheets of lines and transformers must be known and Inserting into the software .see fig.3.4 , for this thesis information's have been taken from SEDC distribution Control Center.

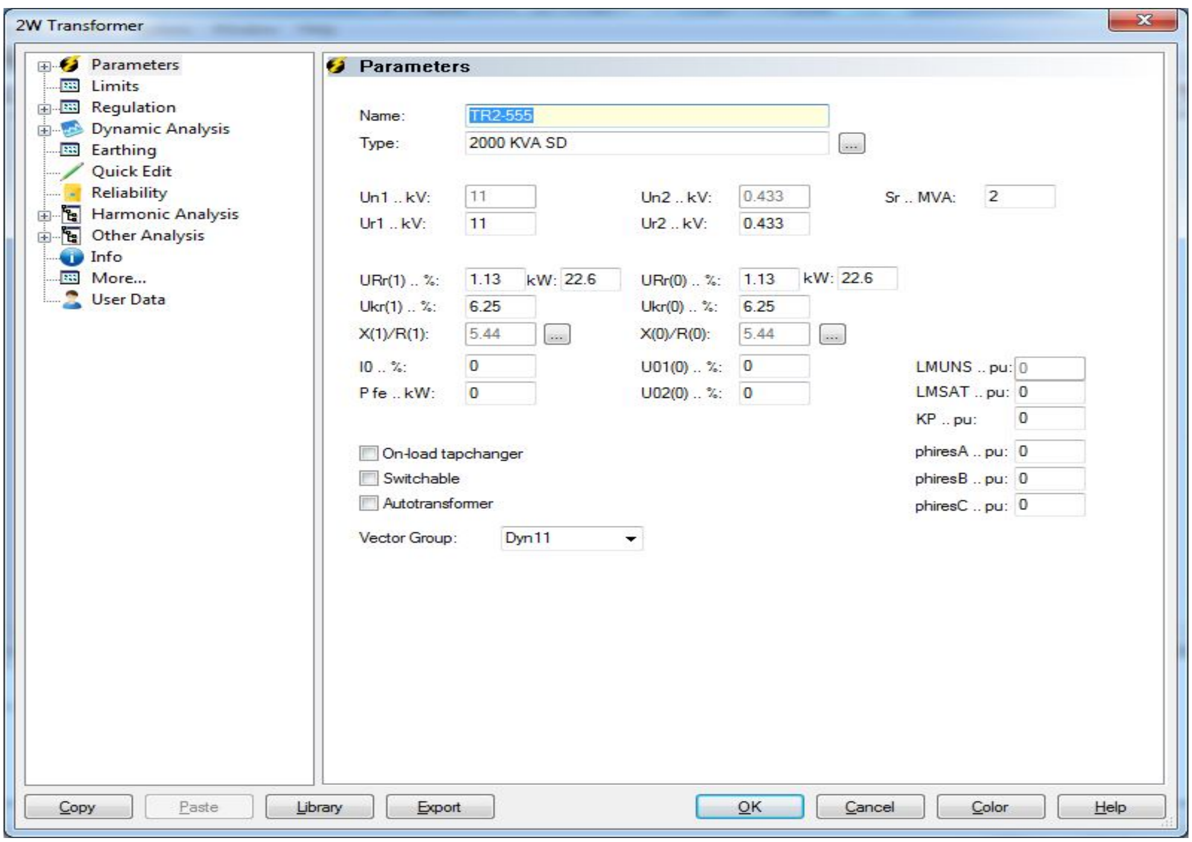


fig.3.4 :Element parameters Data insertion

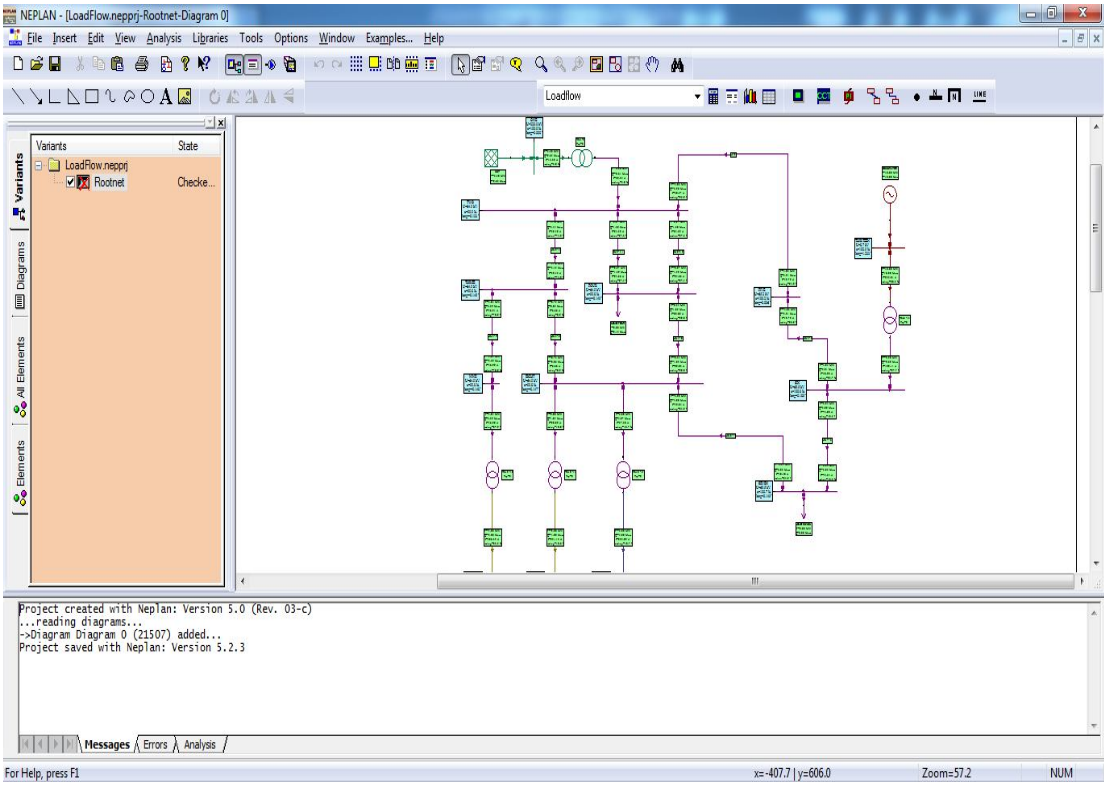


fig.3.5 :Creation grid

3.6 Input data

all element have data and its import to fill all items for items:

3.6.1 network feeder

Table 3. 1:network parameters

Name	SK max	IK max	R(1)/X(1) max	Z(0)/Z(1) max	R(0)/X(0) max	C1	SK min	IK min	R(1)/X(1) min	Z(0)/Z(1) min	R(0)/X(0) min	LF-type	U oper %
sd	1250	3.28	0.1	1.667	0	0	1250	3.28	0	0	0	SL	100

3.6.2 loads

Table 3. 2:loads parameters

Name	LF Type	P	Q	Units
IZB	PQ	34.85	12.3	HV

3.6.3 lines

Table 3. 3:loads parameters

Name	Length	Number	Units	R(1)	X(1)	C(1)	B(1)	R(0)	X(0)	C(0)	B(0)	G(0)	I max
KU	12	1	km	0.067	0.302	0.013	4.103	0.262	1.2	0.005	1.50	0	1250

3.6.4 transformers

Table 3. 4:transformer parameters

Name	Conn 1	Con 2	Conn 3	Vector group	Sr MVA	V 1 KV	V 2 KV
IZ	KU	MAN	PA	YNyn0d11	100	33	11

3.7 MODELING

3.7.1 Introduction

Sudanese Distribution Electricity Company (SEDC) for last years has experienced a significant increase in the loads. This results in heavily loaded lines in distribution network due to the limited capacity of substations. Distribution of electric power is accompanied with losses, it is very important for electric power suppliers to consider these losses and reduce them wherever practical .Cost of procedures to improve and reduce the loss is less than the cost of the establishment of a new distribution substations and consuming time as well.

This thesis, represent investigation and analysis the technical losses which occurs in numerous small components in the distribution system, such as transformers and distribution lines. While each of these components may have relatively small losses, the large number of components involved makes it important to examine the losses in the distribution system.

3.7.2 Case study

The research area has been chosen due to the highly consumption in Khartoum north industrial area.

Khalil Osman is a distribution substation (33/11) KV considered as main power source for the most factories in Khartoum North industrial area. It supplied from Kuku and El-Izba transmission substation via 33KV overhead cable XLPE3*300mm^2 as a follows:

- (Khalilosman 1 izb l4) incoming line connected to (TR1) via (KHALIL OSAMAN) 33 KV busbar. (TR1) has capacity of 20 MVA. (TR 1) is connected to the following outgoing loads :
  - ELMASRA outgoing.

- SAFA OIL outgoing.
- SHAMBT outgoing.
- COLA outgoing.

- (Z605 KUKU L10) incoming line connected to (TR2) via (KHALIL OSAMAN B32)33 KV busbar.(TR2) has capacity of 20 MVA. (TR 2) is connected to the following outgoing loads :
  - CAPO out-going.
  - SIGA/SAIFONAT outgoing.
  - SAFIA outgoing.

Table 4.1 illustrate the total actual load by transformer, meanwhile the capacities of the substation are 40 MVA.

Table 3.5: distribution by transformer

Description	TR 1	TR 2
Number of feeder	4	3
Number of customer	50	33
Total capacity (KVA)	27900	21450

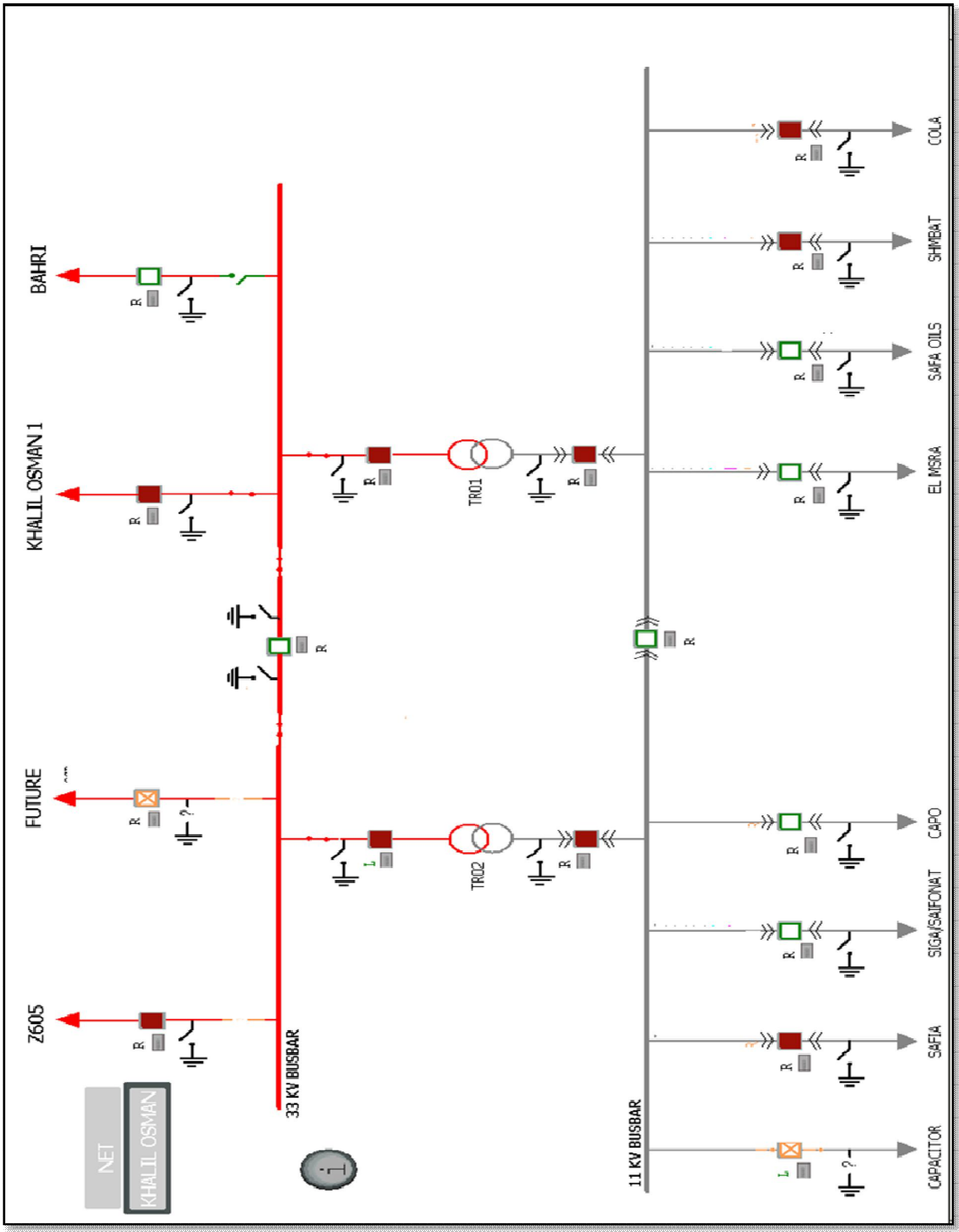


Fig 3.6: Khalil Osman distribution substation Single line diagram

Khalil Osman area contains a large number of factories and loads of different capacities distributed unevenly on different distribution lines putting strain resulting in losses power. Following tables gives an idea of transformer capacities. The total real demand is 49.35MVA while the capacities of two substation transformer are 40 MVA.

Table 3.6: Transformers (1) loads capacities

Transformer	Outgoing name	Load capacity KVA
TR (1)	ELMASRA	4350
	SAFA OIL	16350
	COLA	7000
	SHAMBAT	200
TAOTAL		27900

Table 3.7 : Transformers (2) loads capacities

Transformer	Outgoing name	Load capacity KVA
TR (2)	CAPO	5500
	SIGA/SAIFONAT	8750
	SAFIA	7200
TOTAL		21450

3.7.3 Modeling and simulation

The link between substation and customers is made up of several cable sections and transformer. The information of component, such as cable, cable length and transformer data is typically stored in a Geographic Information System (GIS).for this research data was collected in Khartoum grid control center.

When building a network model, the first step is to extract the information for Simulation by NEPLAN software. Second step is to simulate the area. Then All actual data of network component (line and transformer parameters) implemented into the simulation, fig (3.7 , 3.8 , 3.9) : illustrates Single line diagram of case area) the load flow run to determine the following items:

1. Line voltage drop.

2. Line and transformer loss.
3. Load power factor.
4. Line loading.
5. Phase angle.
6. P & Q for grid elements.
7. Losses.

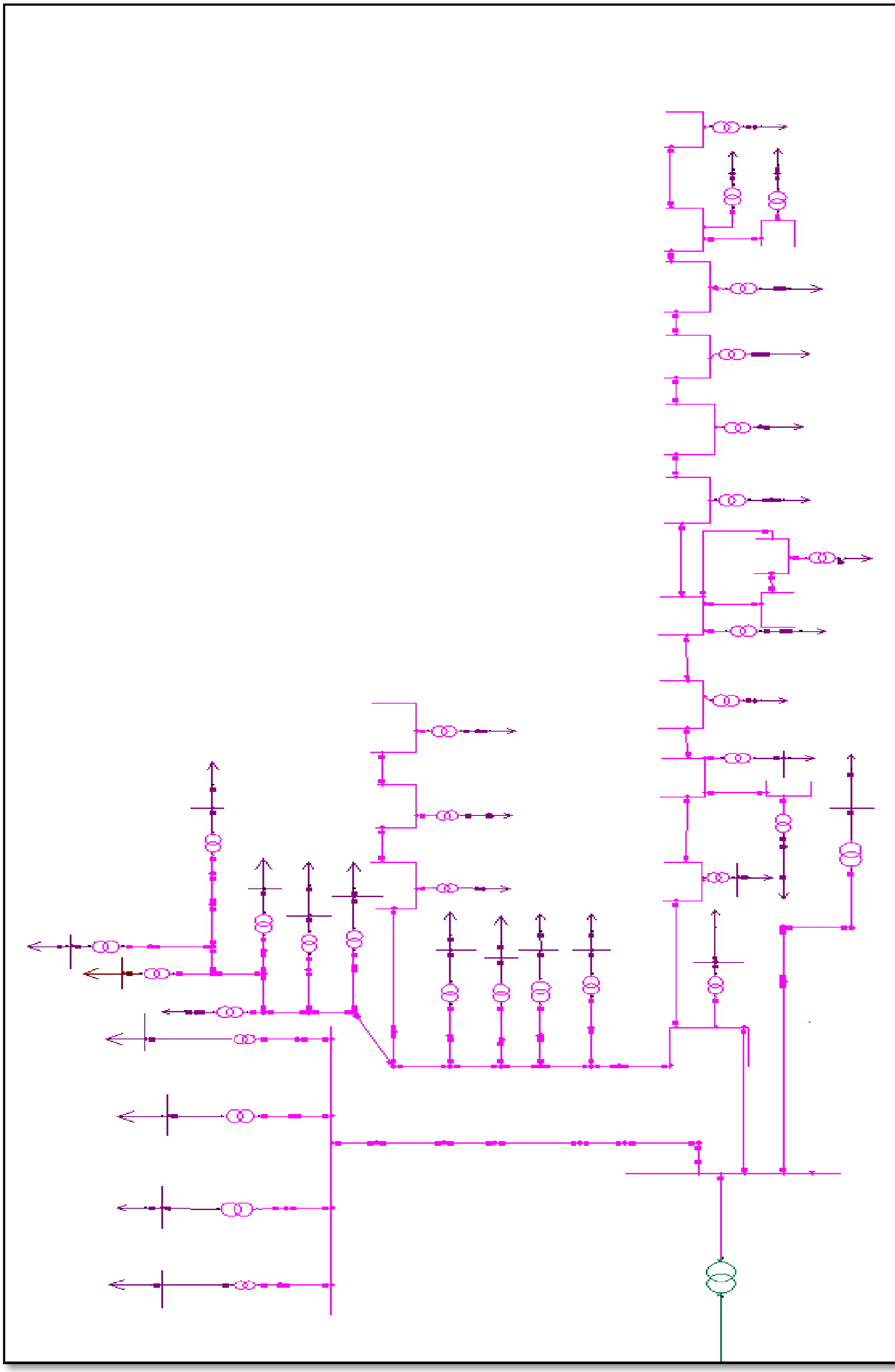


fig3.7 :Single line diagram for CAPO, SIGA/ SAIFONAT and SAFIA

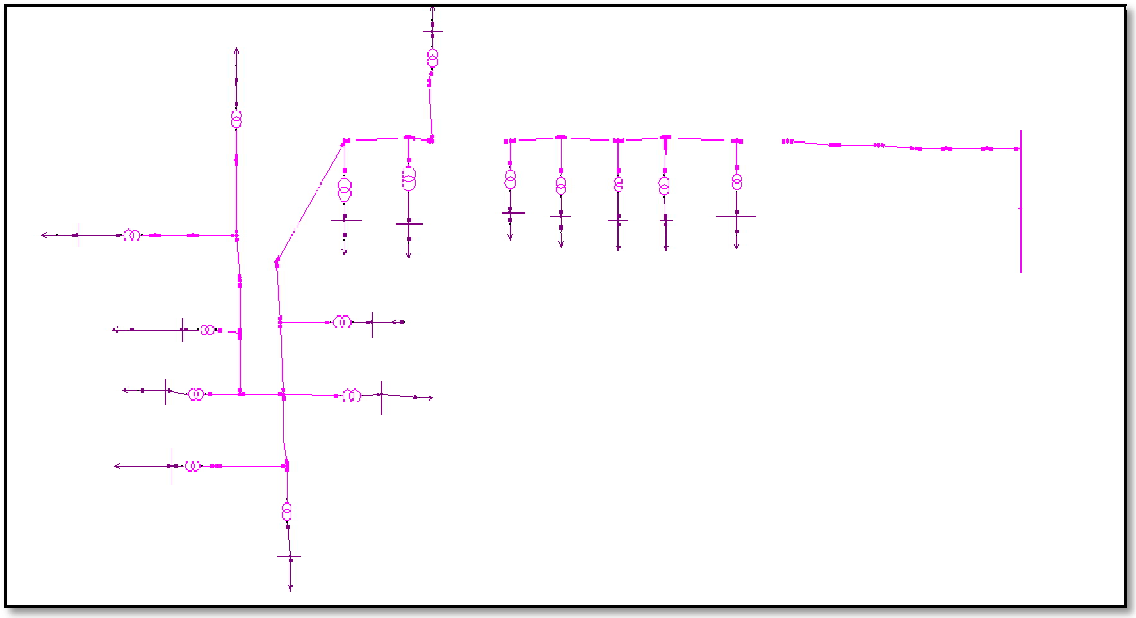


fig3.8 :Single line diagram for ELMASRA

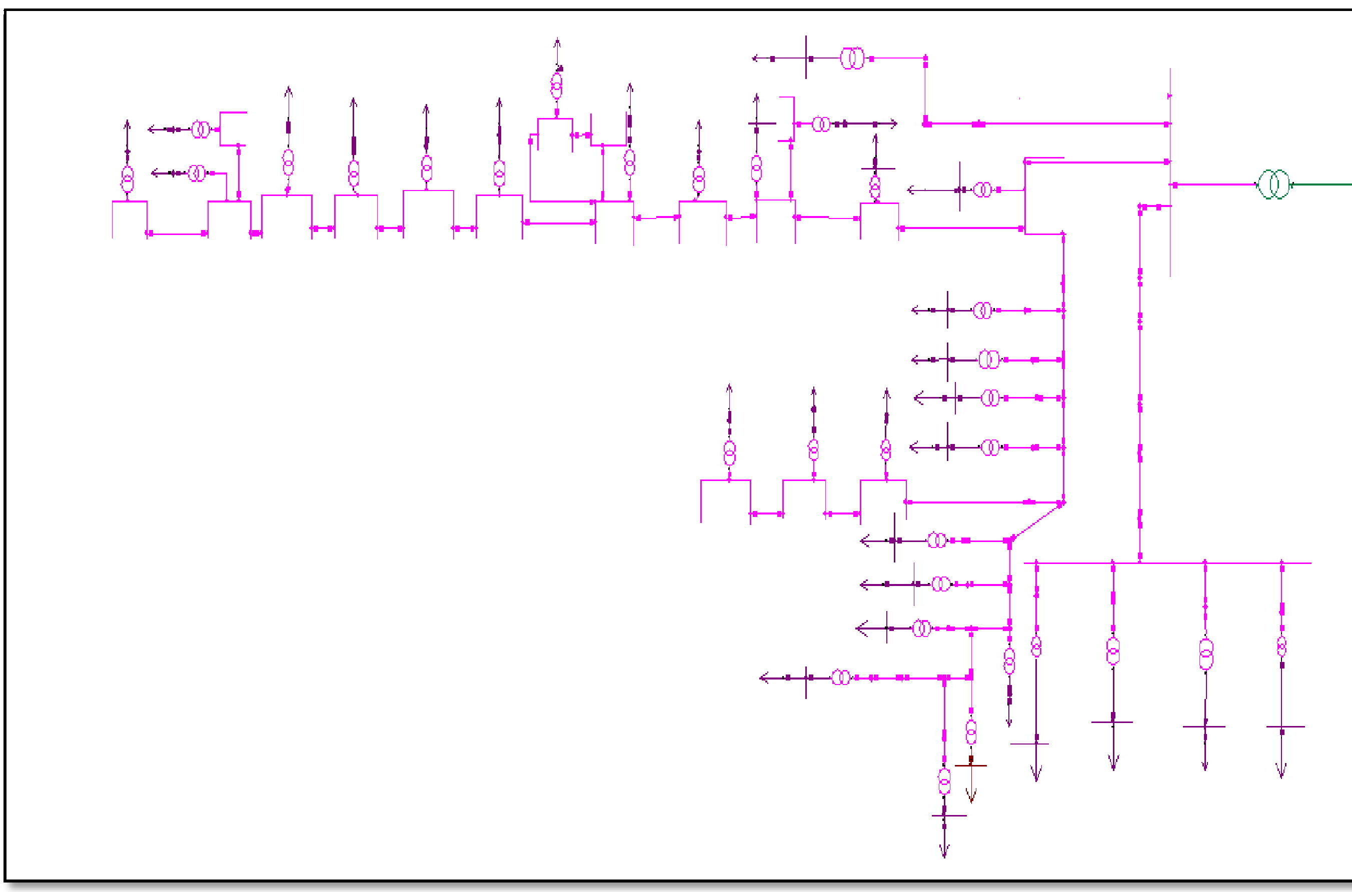


fig 3.9 :Single line diagram for COLA and SHMABT and SAFA oil

3.7.3.1 SIGA/SAIFONAT outgoing losses detail

The feeder length is 9.271 Km connecting with five customers with overhead line XLPE3*185mm^2 .The voltage drop is acceptable and within the standard, maximum percentage voltage drop value is 1.4 %. Table 3.8 :illustrate Voltage drop of SIGA/SAIFONAT feeder

Table 3.8 :Voltage drop of SIGA/SAIFONAT feeder

	Load Name	nominal voltage KV	calculated voltage	D V %	Distance from substation (Km)
1	ALSARF ALSHEE	11	10.912	0.8	2.365
2	SIGA1	11	10.866	1.218182	4.753
3	SIGA2	11	10.847	1.390909	6.683
4	SIGA5	11	10.854	1.327273	7.522
5	SIGA6	11	10.852	1.345455	9.655

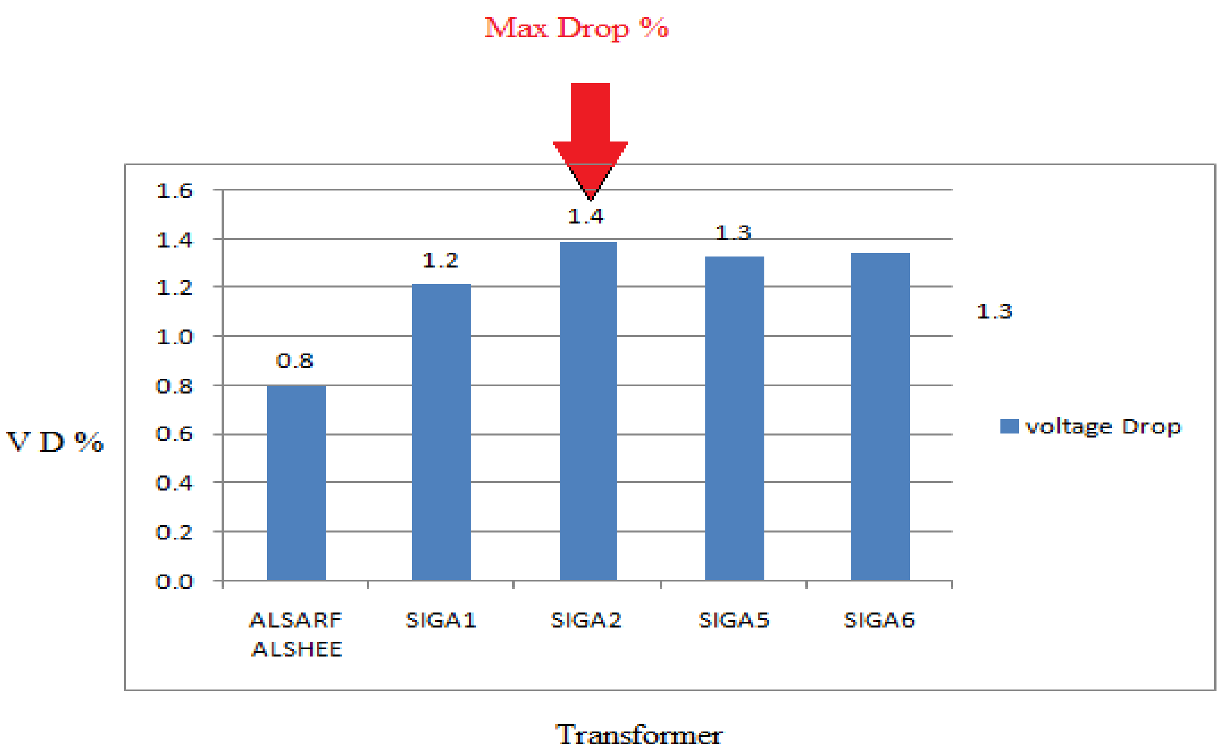


fig3.10 : voltage drop of SIGA/SAIFONAT feeder at the customer transformer

Analysis software display a values of line losses for each items in the SIGA/SAIFONAT feeder ,the highest losses value at Node 3275 (marked in red color) item name SIGA/SAIFONAT KHO L4,Table 3.9 : illustrates line losses of

SIGA/SAIFONAT feeder, the conductor size of this line is (35 mm^2) with length 1.344 km , this feeder feeds two loads with capacity of 4000 KVA. The standard request for all medium voltage line to use 185 mm^2.

Table 3.9: line losses of SIGA/SAIFONAT feeder

ID	Node	Element name	Losses P %	P Losses	Q Losses
3259	KHALIL OSMAN B12	SIGA/SAIFONAT KHO L1	4.15%	0.096	-7.79
3220	N3204	SIGA/SAIFONAT KHO L2	12.58%	0.291	0.212
3228	N3225	L1229799101	0.91%	0.021	-15.11
3267	N3264	SIGA/SAIFONAT KHO L3	10.59%	0.245	0.066
3275	N3272	SIGA/SAIFONAT KHO L4	44.64%	1.033	-12.79
3288	N3285	SIGA/SAIFONAT KHO L5	9.90%	0.229	0.076
3296	N3293	L1229799126	0.22%	0.005	-0.28
3340	N3329	SIGA/SAIFONAT KHO L6	9.77%	0.226	-9.87
3374	N3332	L1229799136	7.00%	0.162	-8.9
3394	N3391	SIGA/SAIFONAT KHO L7	0.04%	0.001	-0.44
3402	N3399	SIGA/SAIFONAT KHO L8	0.13%	0.003	-6.18
3410	N3407	L1229799156	0.00%	0	-0.24
3441	N3438	SIGA/SAIFONAT KHO L9	0.04%	0.001	-10.66
3450	N3447	L1229799166	0.04%	0.001	-9.86

Table 3.10 :Transformer Losses of SIGA/SAIFONAT feeder

ID	Node	Element name	Losses P %	P Losses	Q Losses
3236	N3225	TR2-3236	17.66%	0.101	0.375
3304	N3293	TR2-3304	40.73%	0.233	1.268
3382	N3332	TR2-3382	40.91%	0.234	1.272
3418	N3407	TR2-3418	0.35%	0.002	0.012
3458	N3447	TR2-3458	0.35%	0.002	0.012

Total feeder losses is 2.886 KW

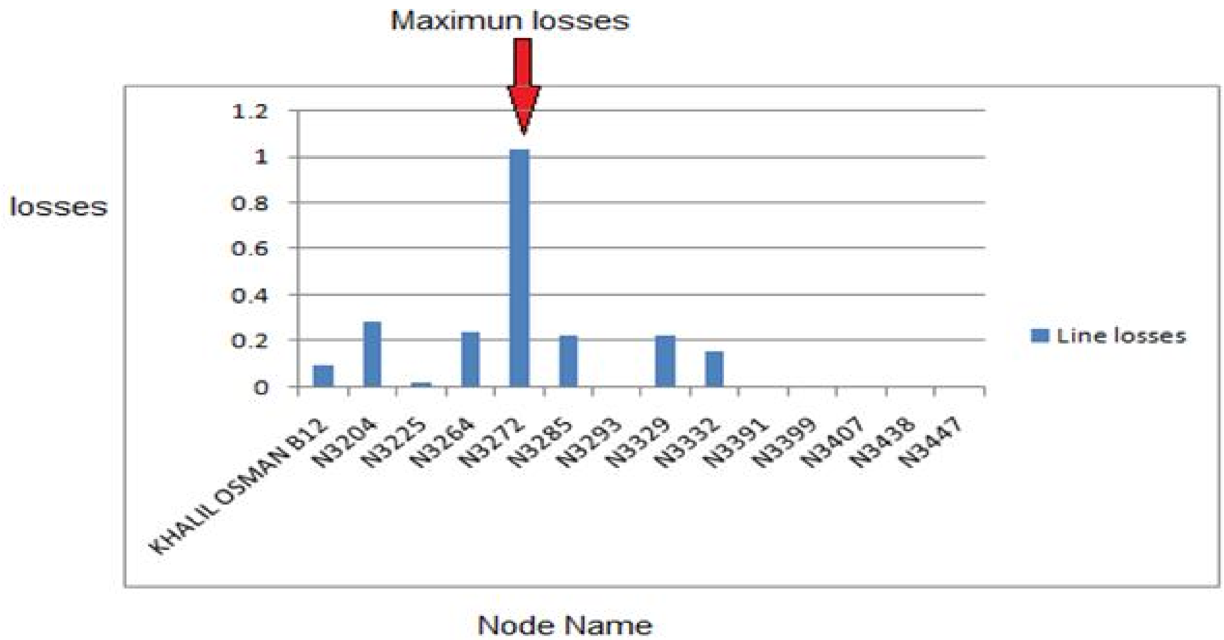


fig 3.11 :line loss condition of SIGA/SAIFONAT

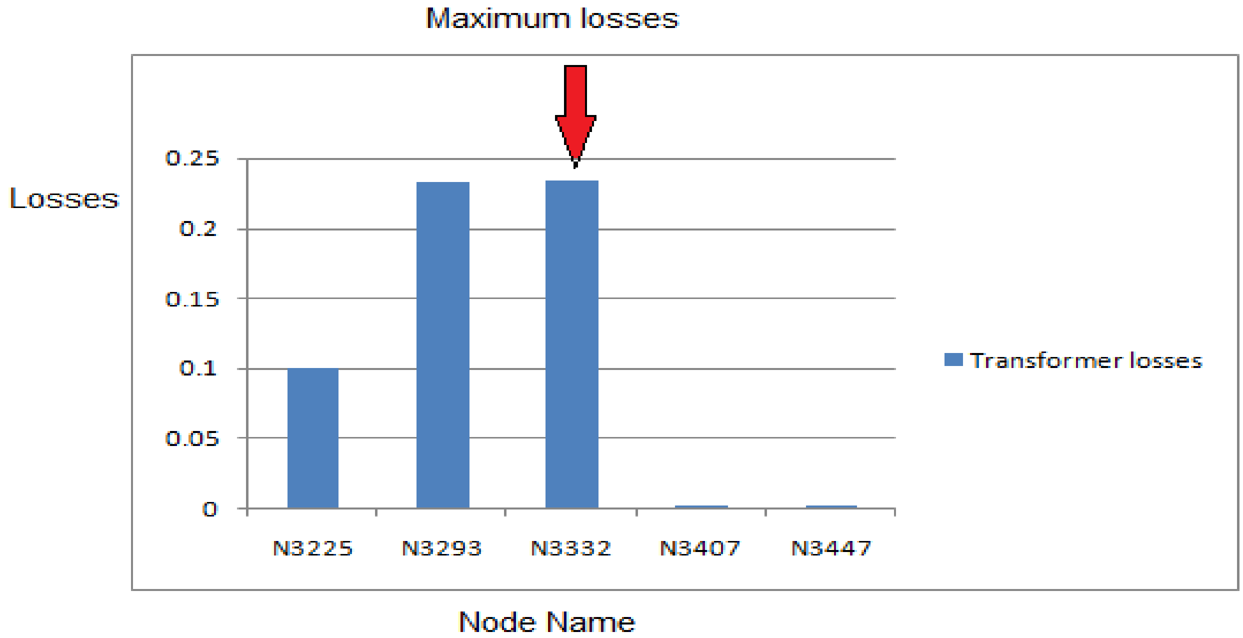


fig3.12 :Transformer loss condition of SIGA/SAIFONAT

3.7.3.2 SAFIA outgoing losses detail

Safia feeder consider as main problem with length 23.8684 Km connecting with 24 customers by overhead line XLPE3*185mm^2 , all customer connect from main to transformer by cable size 35 mm^2.Element (ID: 4355) has conductor size 35mm^{2}this element connect 6 transformer with 3450 KVA capacity . The voltage drop is out of distribution standard (6 %) in the end of feeder , maximum percentage voltage drop value is 6.36% (marked in red) . Table 3.11: illustrate Voltage drop of Safia feeder

Table 3.11: Voltage drop of Safia feeder

	Load Name	nominal voltage KV	calculated voltage	D V %	Distance from substation (Km)
1	SPESTIAL	11	10.752	2.25	8.364
2	KHAS	11	10.64	3.27	9.916
3	ALSHRG ALAWST LLTAGLIF	11	10.593	3.70	11.028
4	DAR ALADOWA LLNSHER	11	10.581	3.81	11.708
5	DUBI 2	11	10.572	3.89	11.706
6	SAEED LLMOAD ALGZAYA	11	10.564	3.96	12.709
7	DUBI	11	10.544	4.15	13.741

8	SELIDOR	11	10.556	4.04	14.811
9	DANFODEW	11	10.563	3.97	14.642
10	ZEWT ALWAHA	11	10.562	3.98	12.825
11	SABOON SATEE	11	10.561	3.99	14.879
12	SAEED ALGZAEAA	11	10.563	3.97	16.496
13	CRYSTAL	11	10.479	4.74	12.131
14	CRYSTAL 2	11	10.479	4.74	15.173
15	CRYSTAL 3	11	10.479	4.74	15.173
16	PEPSI 2	11	10.465	4.86	15.173
17	PEPSI 1	11	10.465	4.86	15.545
18	Load	11	10.44	5.09	15.545
19	PEPSI 4	11	10.429	5.19	18.3116
20	KELOBATRA	11	10.425	5.23	16.7766
21	ALHYAH ALGOMEA LLABHATH ALGELOGY	11	10.409	5.37	17.9286
22	ALBALAT ALMZAYKO	11	10.411	5.35	20.3936
23	ALKEBREET ALHADETH	11	10.3	6.36	20.6316
24	ALADADAT	11	10.3	6.36	20.7166

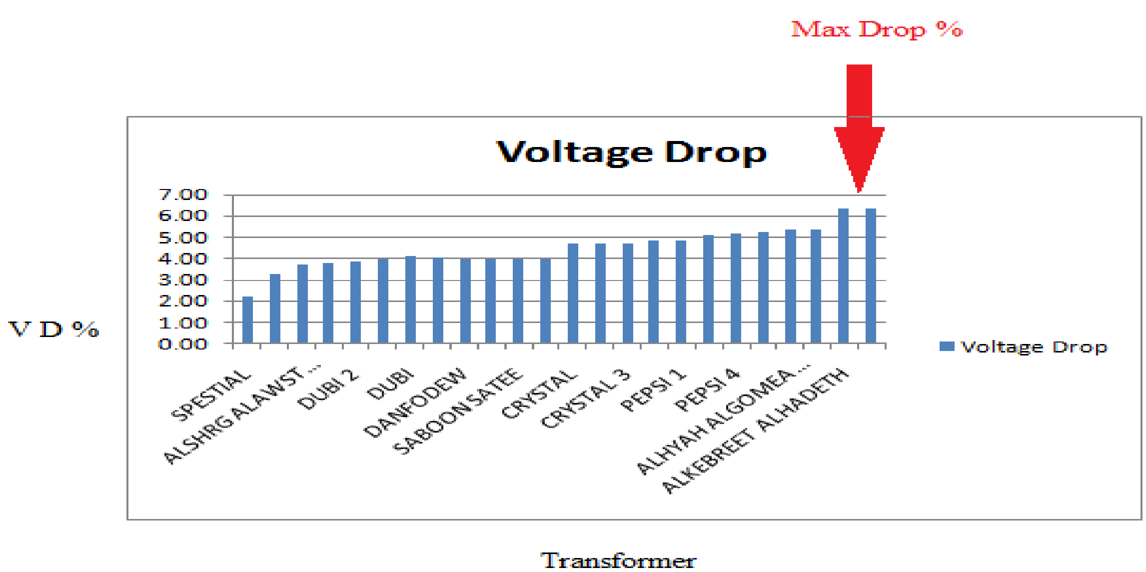


fig3.13 :voltage drop of Safia feeder at the customer transformer

Neplan analysis software display a values of line losses for each items in the Safia feeder . This feeder has highest losses in the whole area . The highest losses value at element NO : 4518,item name L1229799633(marked in red) (Table 3.12: illustrates line losses of Safia feeder, the length of this line is (0.529) km with cable size 35 mm^2this represent30.02 % of this feeder losses. The second lower losses value at element NO 3840 the length of this line is (0.052) km losses of this line 18.15% . with cable size 35 mm^2, element NO 4549,length (0.497)km ,losses of this line 18.15%.

Table 3.12: line losses of Safia feeder

ID	Node	Element name	Losses P %	P Losses	Q Losses
3627	N3616	SAFIA KHO L1	0.80%	9.232	-70.81
3622	N3619	L..1229800340	3.36%	5.581	10.528
3692	N3619	L1229797068	0.74%	2.753	5.197
3656	N3632	L1229797269	0.02%	0	-10.85
3661	N3640	L1229799284	0.73%	0	-0.34
3723	N3720	L1229799273	0.53%	3.384	6.386
3754	N3720	L1229797078	0.00%	0.179	0.096
3762	N3751	L1229797083	0.01%	0.038	-7.79
3793	N3751	L1229797088	0.00%	0.167	-0.07
3832	N3790	L1229797098	0.00%	0.113	-0.34
3801	N3798	L1229797093	0.00%	0.023	-4.68
3871	N3829	L1229797108	30.02%	0.026	-0.36
3840	N3837	L1229797103	18.15%	0.002	-0.47
3921	N3868	L1229797118	8.95%	0.011	-0.34
3882	N3876	L1229797113	0.00%	0.158	-0.38
3952	N3949	L1229800119	0.00%	1.36	2.378
4133	N3957	L1229800151	11.00%	0	-0.31

3965	N3957	L..1229800014	0.58%	0.162	0.275
4000	N3970	L1229799986	0.12%	0	-0.36
3973	N3986	L1229800367	0.54%	0.011	-0.37
4044	N4041	L..1229799999	0.37%	0.005	-0.31
4052	N4049	L1229800141	0.07%	0.001	-0.94
4169	N4080	L1229800354	0.08%	0	-0.31
4094	N4088	L1229800146	0.01%	0.002	-7.13
4164	N4161	L..1229800017	0.04%	0.047	0.078
4188	N4177	L1229797173	0.51%	2.2	3.65
4180	N4177	L1229800008	4.42%	1.412	-9.15
4196	N4185	L1229799735	0.00%	0.424	-8.77
4282	N4185	L1229799718	0.53%	0.401	0.472
4290	N4279	L1229799740	0.00%	0.091	-4.27
4344	N4279	L1229799723	0.80%	0.196	0
4355	N4341	L1229797228	3.36%	0.453	-6.62
4366	N4352	L1229797233	0.74%	0	-0.53
4405	N4352	L1229799550	0.02%	0.147	-0.02
4374	N4363	L1229800302	0.73%	0.001	-8.64
4444	N4402	L1229799555	0.53%	0.076	-0.17
4452	N4441	L1229797259	0.00%	0.004	-0.41
4486	N4441	L1229797243	0.01%	0.053	-0.25
4494	N4483	L1229799617	0.00%	0.043	-0.2
4502	N4491	L1229799622	0.00%	0.038	-0.18
4510	N4499	L1229797338	0.00%	0.008	-0.22

4518	N4507	L1229799633	30.02%	0.014	-4.67
4549	N4507	L1229797348	18.15%	0	-0.18
4580	N4577	L1229797294	8.95%	0.007	-0.17
4588	N4698	L1229797299	0.00%	0.023	-4.32

Table 3.13: Transformer losses of Safia feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
3236	N3225	TR2-3236	4.60%	0.101	0.375
3304	N3293	TR2-3304	10.62%	0.233	1.268
3382	N3332	TR2-3382	10.67%	0.234	1.272
3418	N3407	TR2-3418	0.09%	0.002	0.012
3458	N3447	TR2-3458	0.09%	0.002	0.012
3669	N3643	TR2-3669	0.87%	0.019	0.04
3700	N3689	TR2-3700	0.87%	0.019	0.041
3731	N3720	TR2-3731	1.64%	0.036	0.081
3770	N3759	TR2-3770	5.79%	0.127	0.531
3809	N3798	TR2-3809	5.83%	0.128	0.532
3848	N3837	TR2-3848	5.83%	0.128	0.532
3898	N3879	TR2-3898	5.83%	0.128	0.535
3932	N3918	TR2-3932	2.19%	0.048	0.119
4021	N3994	TR2-4021	1.64%	0.036	0.081
4060	N4049	TR2-4060	3.10%	0.068	0.209
4102	N4088	TR2-4102	2.19%	0.048	0.118
4141	N4130	TR2-4141	3.10%	0.068	0.209
4235	N4193	TR2-4235	5.93%	0.13	0.543

4224	N4193	TR2-4224	5.93%	0.13	0.543
4213	N4193	TR2-4213	5.93%	0.13	0.543
4304	N4287	TR2-4304	5.93%	0.13	0.543
4382	N4371	TR2-4382	0.09%	0.002	0.014
4460	N4449	TR2-4460	3.19%	0.07	0.215
4557	N4546	TR2-4557	1.69%	0.037	0.084
4702	N4698	TR2-4599	3.19%	0.07	0.215
4711	N4698	TR2-4622	3.19%	0.07	0.215

Total feeder losses is 32.946 KW

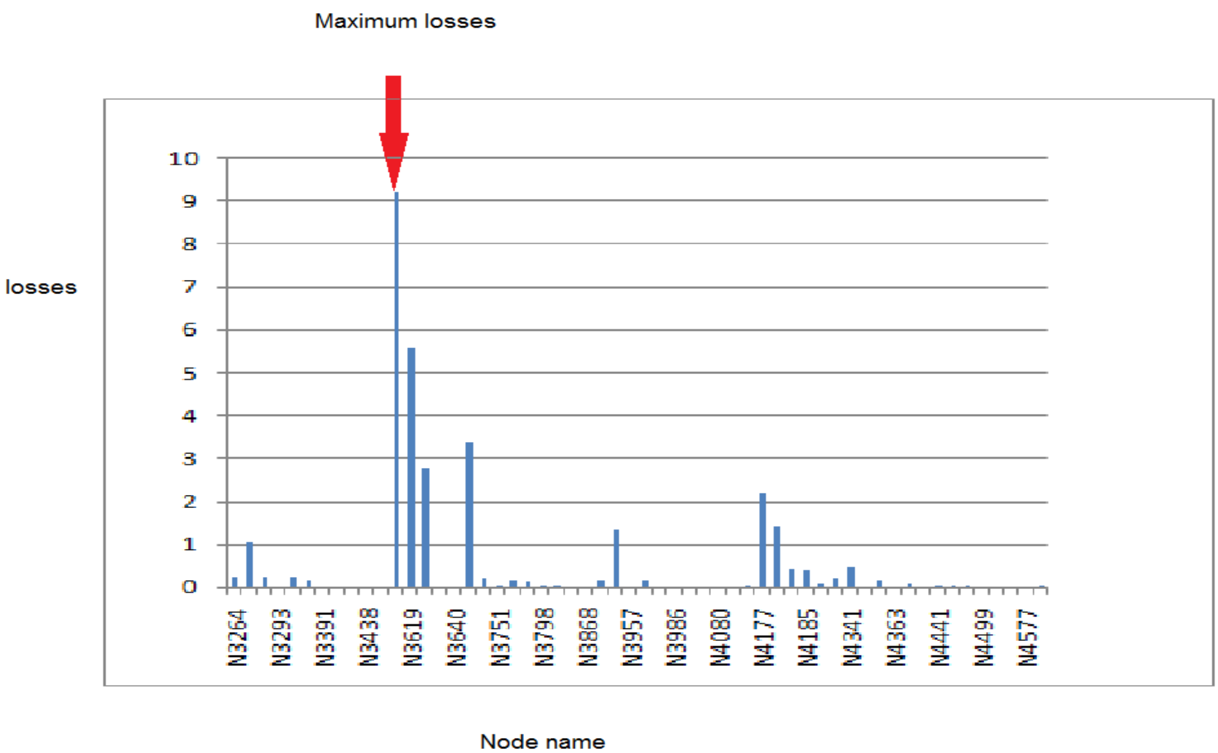


fig3.14 :lines loss condition of Safia

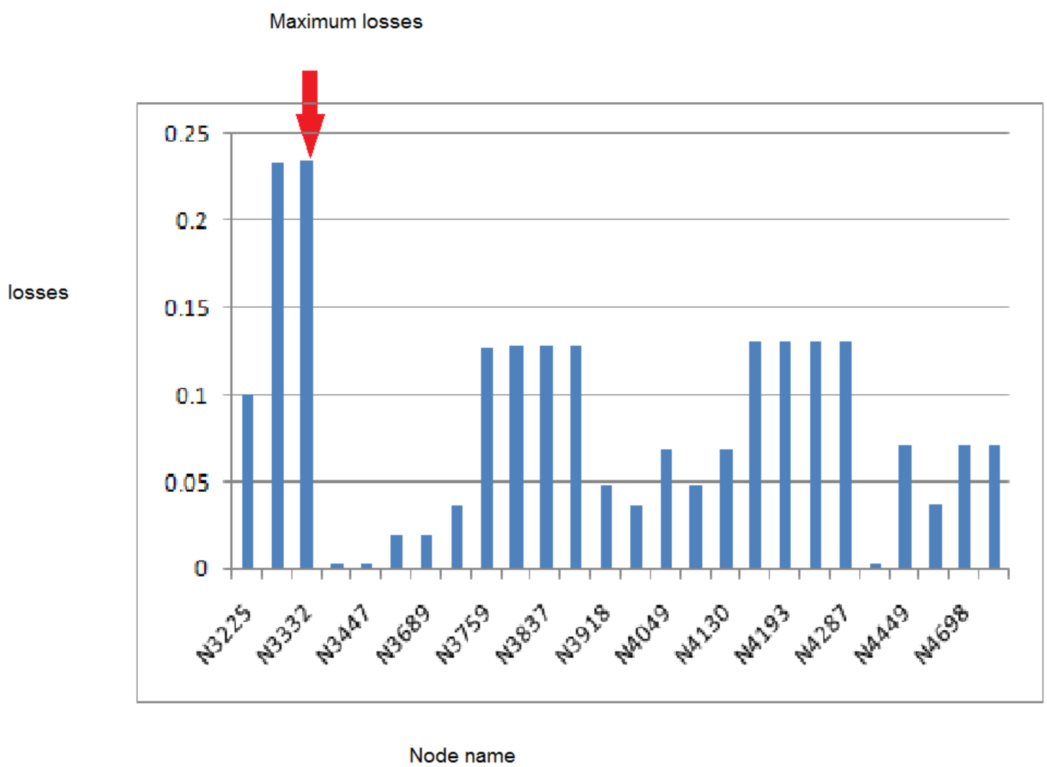


fig3.15 :Transformer loss condition of Safia

3.7.3.3 SHAMBT outgoing losses detail

Shambat feeder is short line with length 0.977Km connecting with one customer by overhead line XLPE3*185mm^2 , this feeder connected as standby with other feeder from OLD FADUL substation to serving that loads . The voltage drop is acceptable and within the standard the maximum percentage voltage drop value is 0.7 %. Table 3.14:illustrateVoltage drop of Shambat feeder.

Table 3.14:Voltage drop of Shambat feeder

	Load Name	nominal voltage KV	calculated voltage	V D %	Distance from substation (Km)
1	Load	11	10.922	0.7	0.977

Analysis software display losses values of each item , loses in this feeder is neglected, illustration from table 3.15 : line losses and table 3.15 :transformer losses . when connect this feeder with OLD FADUL substation loads losses calculation results will be change .

Table 3.14: line losses of Shambat feeder

ID	Node	Element name	Line losses	P Losses	Q Losses
1292	KHALIL OSMAN B11	SHAMBT KHO	---	0	-0.18
1300	N1289	SHAMBT KHO L3	---	0	-0.04
1316	N1308	SHAMBT KHO L2	---	0	-8.26

Table 3.16: transformer losses of Shambat feeder

ID	Node	Element name	Losses	P Losses	Q Losses
1324	N1308	ELHUSAYNI SHAMBT TR	100 %	0.034	0.076

Total losses is 0.034 KW

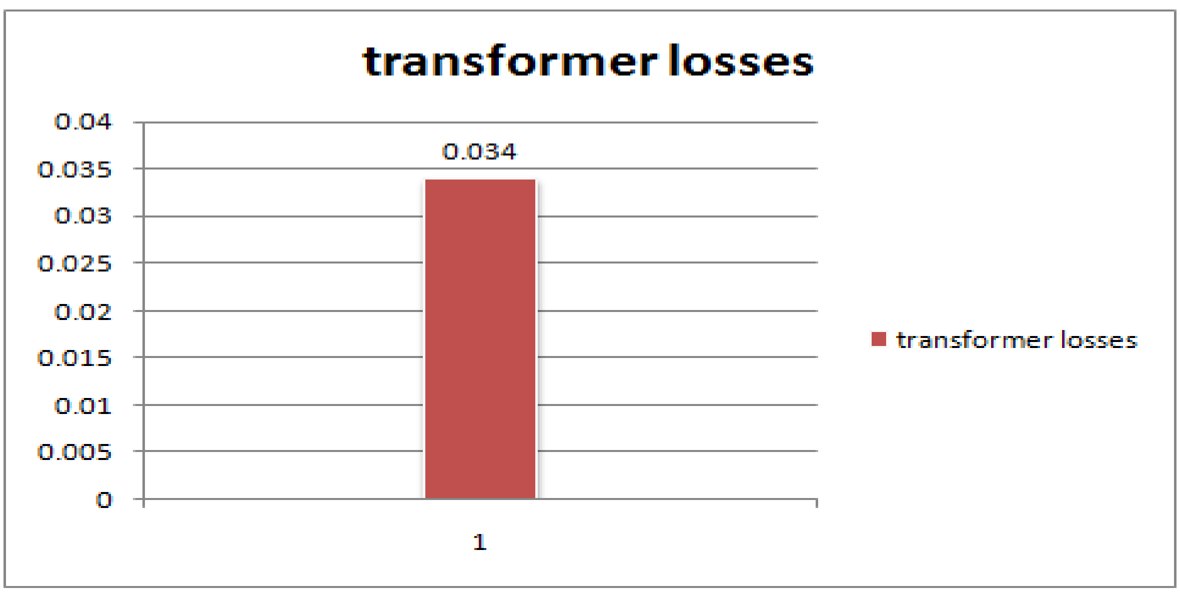


fig 3.16 :Transformer loss condition of shambat

3.7.3.4 COLA outgoing losses detail

The feeder length is 2.535Km connecting with four customers by overhead line XLPE3*185mm2 .The voltage drop is acceptable and within the standard the maximum percentage voltage drop value is 0.9727 % . Table 3.17:illustrateVoltage drop of COLA feeder.

Table 3.17:Voltage drop of COLA feeder

	Load Name	nominal voltage KV	calculated voltage	V D %	Distance from substation (Km)
1	ALCOLA1	11	10.893	0.9727	2.365
2	ALCOLA2	11	10.893	0.9727	4.753
3	ALCOLA3	11	10.893	0.9727	6.683
4	ALCOLA4	11	10.893	0.9727	7.522

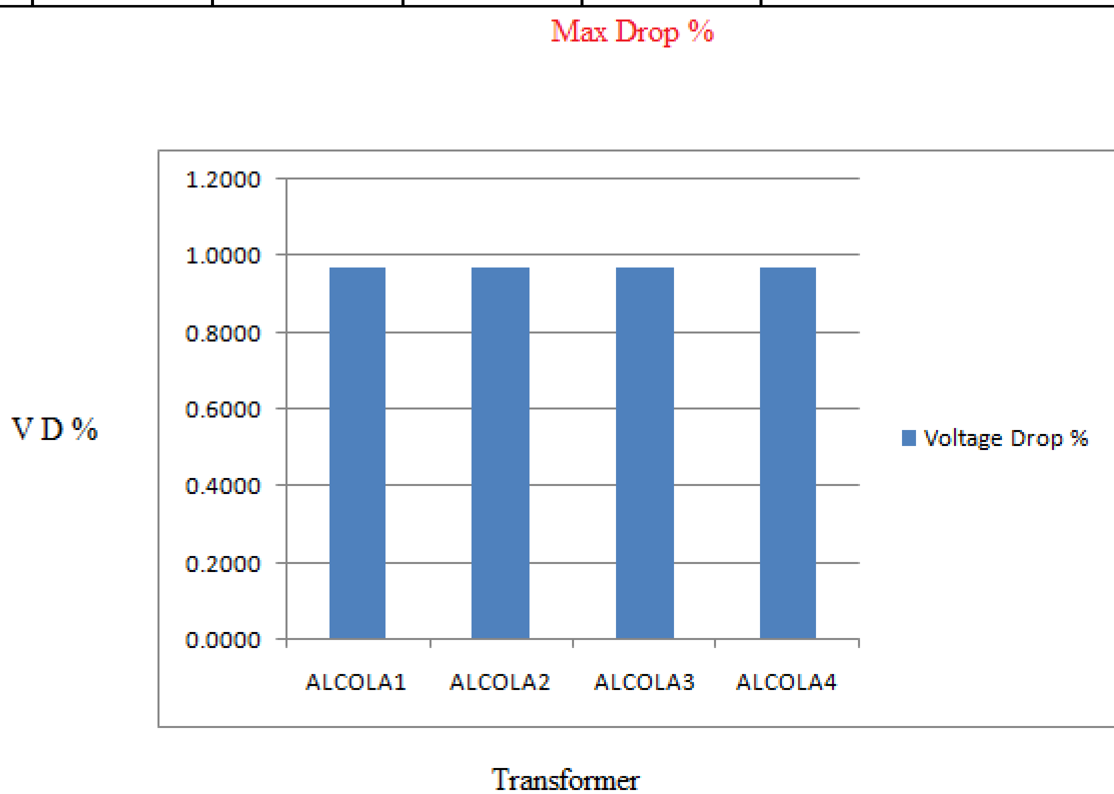


fig3.17 :voltage drop of COLA feeder at the customer transformer

Neplan analysis software display losses for each items in the COLA feeder, illustration from table (3.18) ,this feeder has the lowest losses value in the case area .

Table 3.18: line losses of COLA feeder

ID	Node	Element name	Type	P Losses	Q Losses
281	N273	COLA KHO L5	39.18%	0.286	-14.78
276	N273	COLA KHO L6	17.81%	0.13	0.152
289	COLA KHO N4	COLA KHO L11	0.00%	0	-1.01
362	COLA KHO N4	L362	0.00%	0	-0.31
372	COLA KHO N4	L372	0.00%	0	-0.31
367	N303	L367	0.00%	0	-0.31
218	KHALIL OSMAN B11	COLA KHO L1	3.01%	0.022	-1.19
252	N224	COLA KHO L3	2.47%	0.018	-0.95
241	N238	COLA KHO L4	28.63%	0.209	0.231
268	N257	COLA KHO L7	8.90%	0.065	-3.45

Table 3.19: transformer losses of COLA feeder

ID	Node	Element name	Type	P Losses	Q Losses
555	N294	TR2-555	9.03%	0.058	0.315
330	N286	TR2-330	18.69%	0.12	0.501
501	N303	TR2-501	36.14%	0.232	1.262
519	N306	TR2-519	36.14%	0.232	1.262

Total feeder losses is 1.372 KW

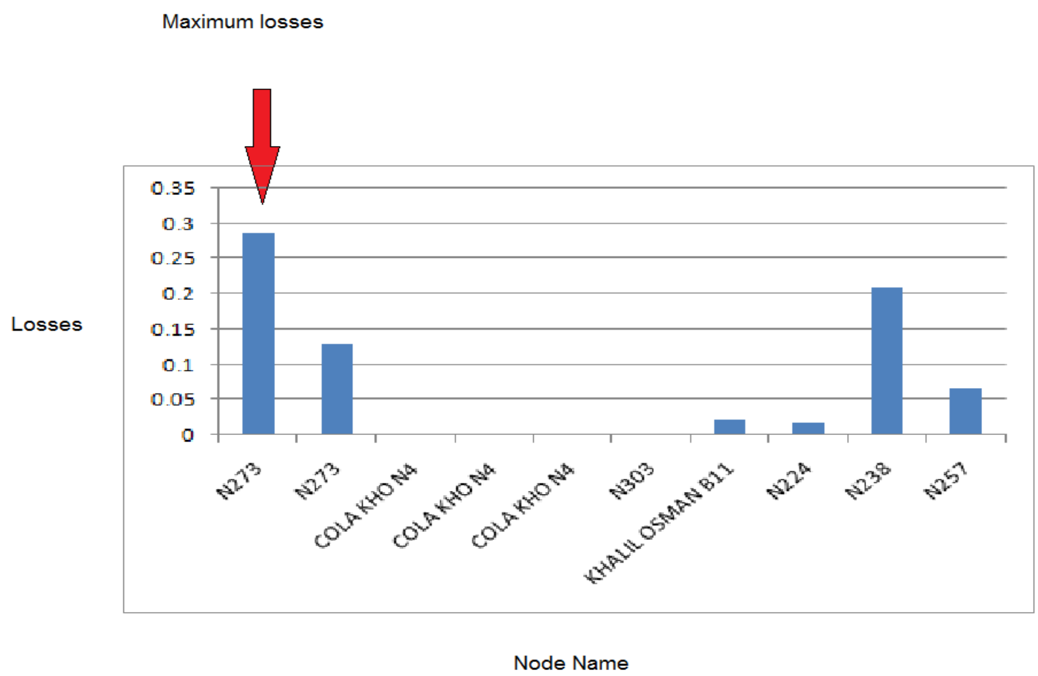


fig (3.18) : line condition COLA outgoing

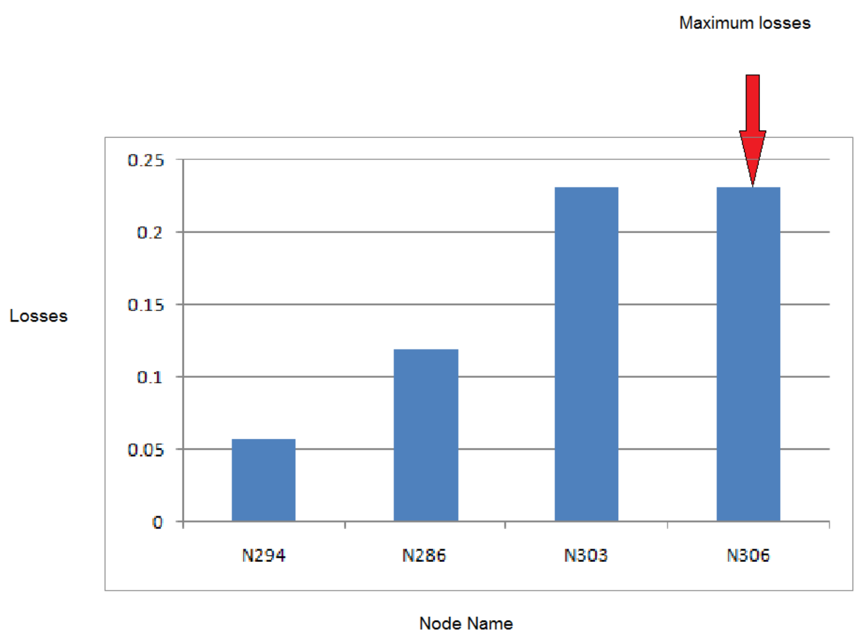


fig (3.19) : Transformer condition COLA outgoing

3.7.3.5 CAPO OUTGOING losses detail

The feeder length is 7.686 Km connecting with four customers by overhead line XLPE3*185mm2 .The voltage drop is acceptable and within the standard the maximum percentage voltage drop value is 0.9364% . Table 3.20 :illustrate Voltage drop of COLA feeder.

Table 3.20:Voltage drop of CAPO feeder

	Load Name	nominal voltage KV	calculated voltage	VD %	Distance from substation (Km)
1	CAPO	11	10.901	0.9000	5.216
2	CAPO	11	10.899	0.9182	5.514
3	CAPO	11	10.896	0.9455	5.613
4	CAPO	11	10.897	0.9364	5.413

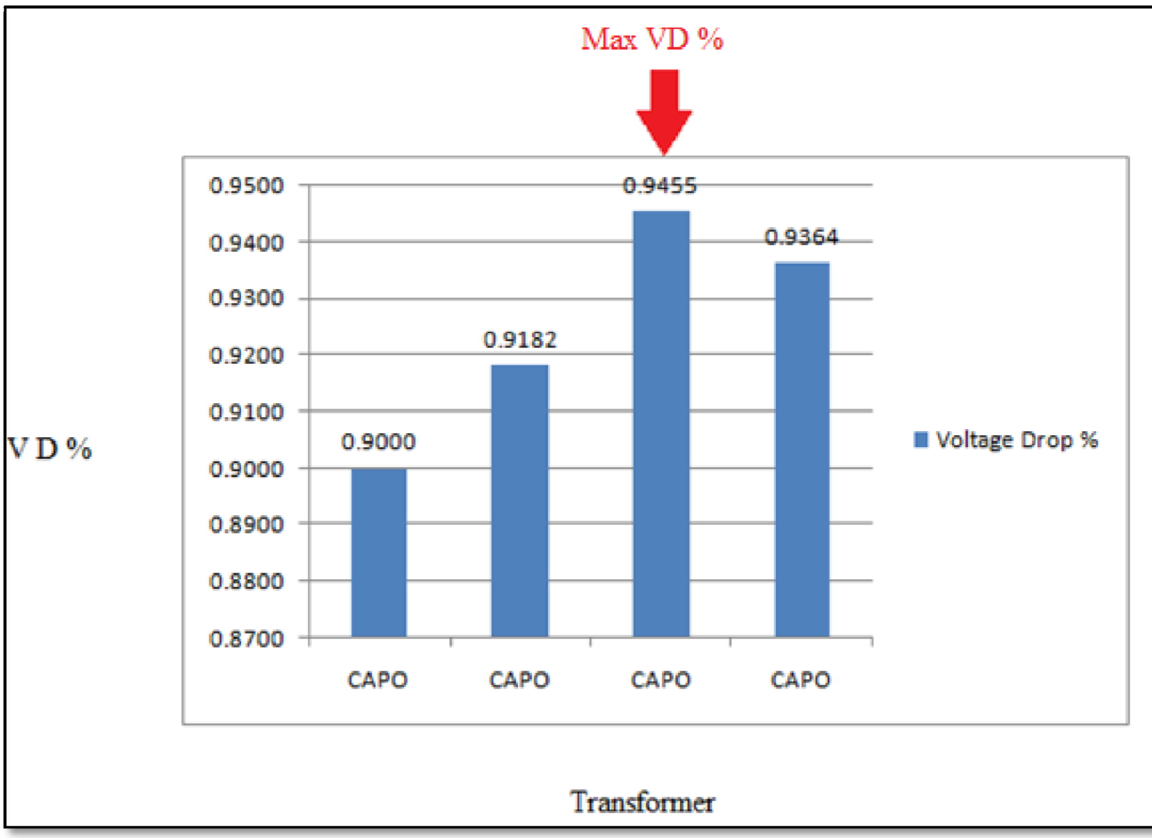


fig3.20 :voltage drop of CAPO feeder at the customer transformer

Neplan analysis software display losses of each items in the CAPO feeder . The highest losses value at element NO 3515 which is represent item name CAPO KHO L1(marked in red)Table 3.21 illustrate line losses of CAPO feeder) the length of this line is (4.69)km with cable size 185 mm^2.

Table 3.21: line losses of CAPO feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
3539	N3536	CAPO KHO L5	5.27%	0.065	0.025
3515	KHALIL OSMAN B12	CAPO KHO L1	86.62%	1.068	-72.78
3510	N3493	CAPO KHO L2	0.16%	0.002	-5.69
3531	N3528	CAPO KHO L4	6.57%	0.081	-9.95
3523	N3520	CAPO KHO L3	1.38%	0.017	-8.91

Table 3.22:Transformer losses of CAPO feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
3547	N3520	TR2-3547	18.58%	0.12	0.5
3579	N3528	TR2-3579	35.76%	0.231	1.261
3599	N3536	TR2-3599	35.76%	0.231	1.261
3487	N3493	TR2-3487	9.91%	0.064	0.196

Total feeder losses is 1.879 KW

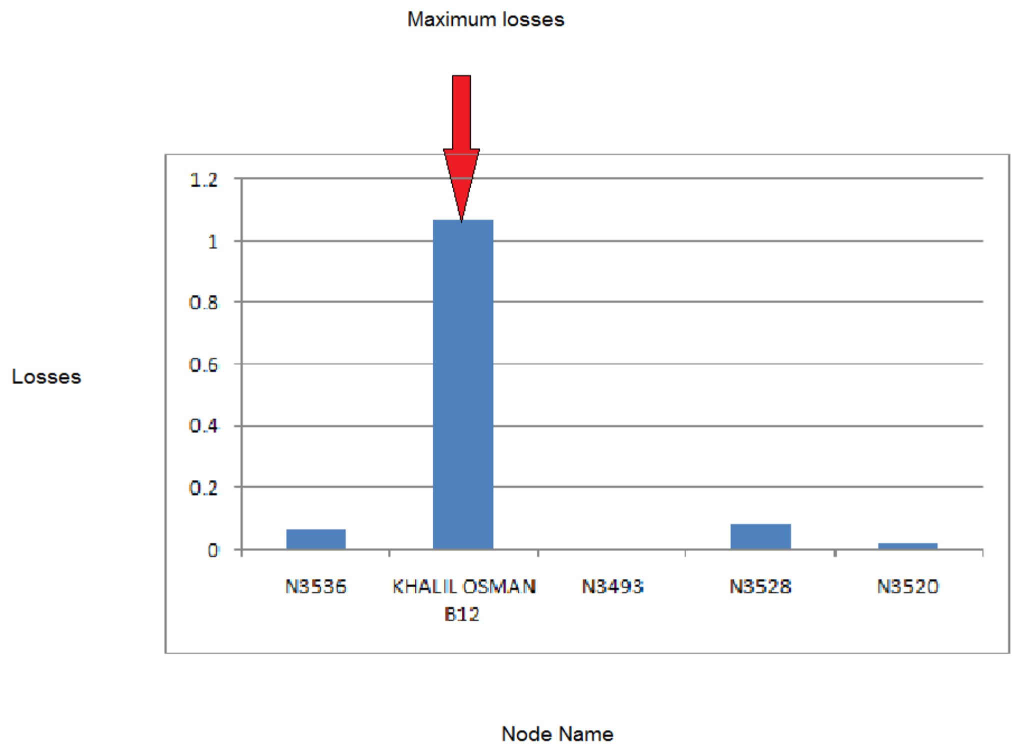


fig (3.21)   : line loss condition CAPO outgoing

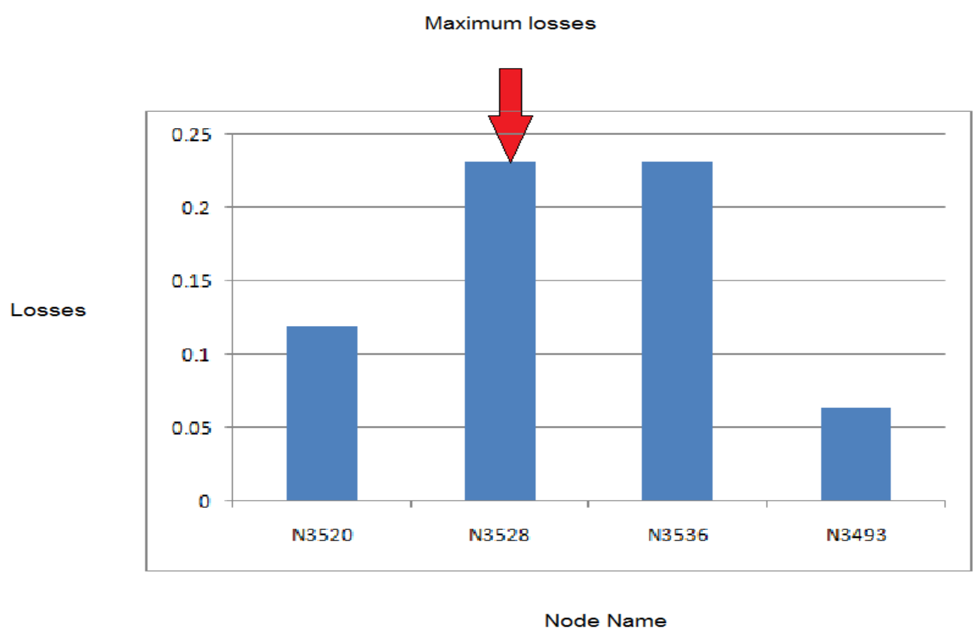


fig (3.22)   : Transformer loss condition CAPO outgoing

3.7.3.6 ELMASRA losses detail

The feeder length 18.549 Km connecting with 16 customers by overhead line XLPE3*185mm^2 , The voltage drop is acceptable and within the standard the maximum percentage voltage drop value is 1.72% . Table 3.23 :illustrate Voltage drop of ELMASRA feeder, this line not short but the voltage drop in the range of the standard.

Table 3.23:Voltage drop of ELMASRA feeder

	Load Name	nominal voltage KV	calculated voltage	VD %	Distance from substation (Km)
1	TLMAS TARK	11	10.867	1.21	5.469
2	ALCOLA	11	10.865	1.23	5.966
3	TRANS50	11	10.859	1.28	6.095
4	TRANCE200	11	10.858	1.29	6.177
5	TRANSE200 1	11	10.856	1.31	6.959
6	TRANSE 200 2	11	10.846	1.40	7.801
7	TESHOP	11	10.84	1.45	8.284
8	BIZYANOSE	11	10.836	1.49	8.317
9	ALSAFEEH	11	10.821	1.63	8.724
10	AAM	11	10.82	1.64	9.541
11	MKHAZEN ALCOLA	11	10.819	1.65	10.465
12	NASEG BAHRI	11	10.819	1.65	10.543
13	ZEOWT THANI	11	10.819	1.65	11.306
14	ALEZDEHAR LLAHZA	11	10.816	1.67	12.275
15	HANA LLIBASKAWET	11	10.811	1.72	11.202
16	DAL	11	10.811	1.72	12.04

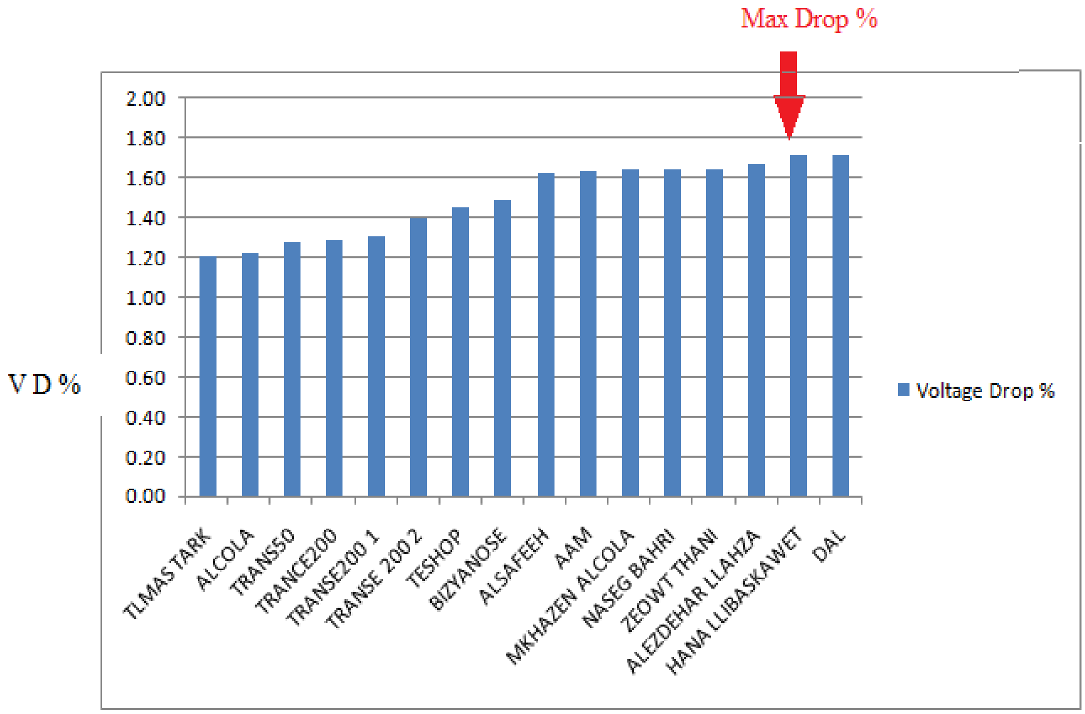


fig (3.23) : voltage drop of ELMASRA feeder at the customer transformer

Neplan analysis software display a values of line losses for each items in the ELMASRA feeder .The highest losses value at element NO : 680 ,item name ELMASRA KHO L7 (marked in red) Table 4.20: illustrate line losses of ELMASRA feeder) the length of this line is (0.94) km with cable size 185mm^{2}this represent 13. 25 % of this feeder losses see Table 3.24

Table 3.24: line losses of ELMASRA feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
1094	N1060	L1229798094	0.00%	0	-0.39
3832	N3790	L1229797098	5.13%	0.113	-0.34
606	N603	ELMASRA KHO L2	9.89%	0.218	0.135
595	KHALIL OSMAN B11	ELMASRA KHO L1	7.03%	0.155	-13.65
3871	N3829	L1229797108	1.18%	0.026	-0.36

1695	N1684	SAFA OILS KHO L11	0.82%	0.018	-0.03
1156	N1153	L1229798141	0.82%	0.018	-0.3
879	N876	L1229798049	0.00%	0	-0.19
622	N611	ELMASRA KHO L4	11.84%	0.261	0.171
614	N611	ELMASRA KHO L3	5.44%	0.12	-10.28
638	N627	ELMASRA KHO L6	9.44%	0.208	0.144
630	N627	ELMASRA KHO L5	6.08%	0.134	-11.21
1192	N1184	L1229798151	0.27%	0.006	-0.34
1208	N1205	L1229798161	0.09%	0.002	-6.49
1200	N1184	L1229798156	0.32%	0.007	-0.34
938	N863	L1229798039	4.85%	0.107	0.005
669	N635	ELMASRA KHO L8	1.50%	0.033	0.047
949	N907	L1229798044	2.90%	0.064	-0.03
680	N674	ELMASRA KHO L7	13.25%	0.292	0.203
688	N652	L1229798004	0.00%	0	-0.15
1261	N1253	L1229798171	0.18%	0.004	-4.04
1248	N1197	L1229798166	0.05%	0.001	-0.21
988	N977	L1229798064	5.85%	0.129	-0.11
980	N946	L1229798059	5.17%	0.114	-0.12
1032	N985	L1229798074	0.32%	0.007	-0.01
755	N752	L1229798014	6.62%	0.146	0.084
1063	N1029	L1229798084	0.05%	0.001	-0.3
798	N795	L1229798540	0.91%	0.02	0.012

Table 3.25: transformer losses of ELMASRA feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
840	N829	TRANSE200 1 KHO TR	5.11%	0.034	0.077
1133	N1122	ZEOWT THANI KHO TR	9.76%	0.065	0.199
1164	N1153	ALEZDEHAR LLAHZA KHO TR	9.76%	0.065	0.199
887	N876	TRANSE 200 2 KHO TR	5.11%	0.034	0.077
646	N635	TLMAS TARK KHO TR	2.70%	0.018	0.039
918	N907	TESHOP KHO TR	9.76%	0.065	0.198
1219	N1205	HANA LLIBASKAWET HKO TR	6.76%	0.045	0.113
957	N946	BAHRI 11 KV	5.11%	0.034	0.077
997	N985	MKHAZEN ALCOLA KHO TR	9.76%	0.065	0.199
763	N752	TRANS50 KHO	1.35%	0.009	0.018
1040	N1029	NASEG BAHRI KHO TR	9.76%	0.065	0.199
1071	N1060	ALSAFEEH KHO TR	5.11%	0.034	0.077
806	N795	TRANCE200 KHO TR	5.11%	0.034	0.077
1102	N1091	AAM KHO TR	5.11%	0.034	0.077
1269	N1253	DAL KHO TR	9.76%	0.065	0.199

Total feeder losses is 2.87 KW

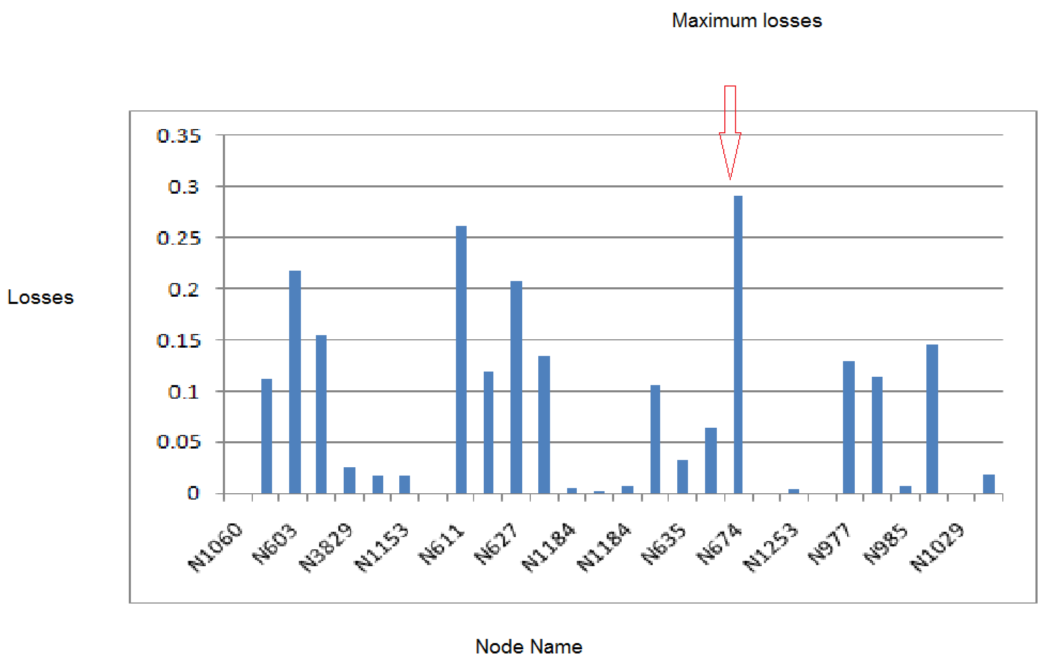


fig (3.24) : line loss condition ELMASRA outgoing

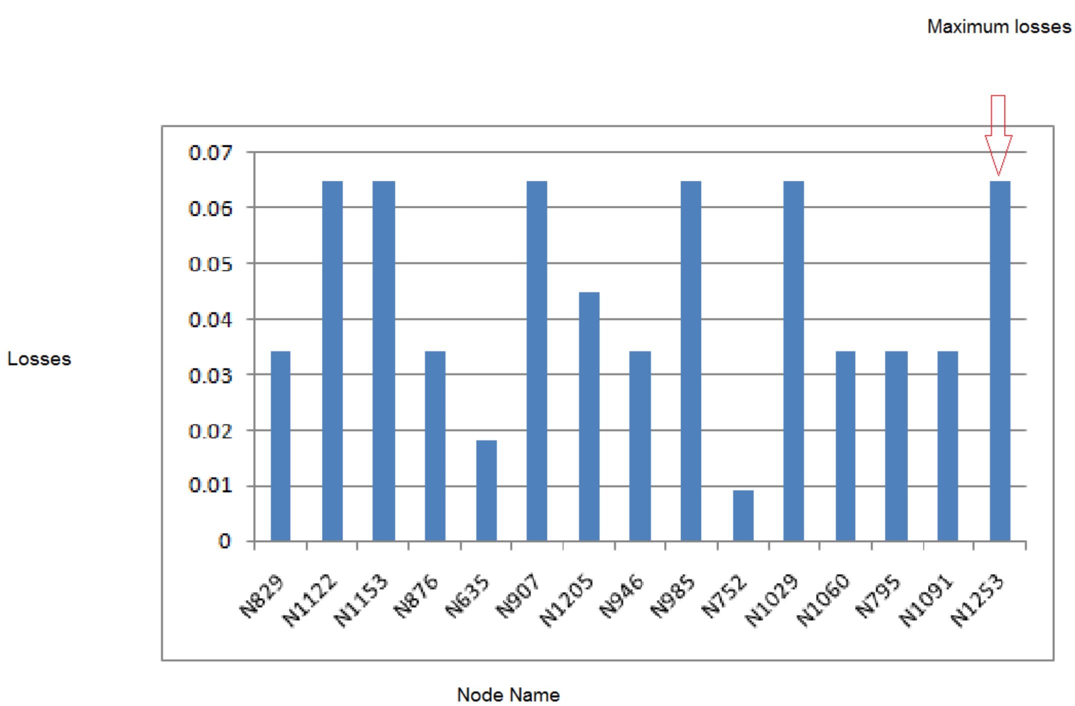


fig (3.25) : Transformer loss condition ELMASRA outgoing

3.7.3.7 SAFA OIL

The feeder length is 24.08 Km connecting with 28 customers by overhead line XLPE3*185mm2 and XLPE 70 mm^2. The voltage drop is acceptable and within the standard the maximum voltage drop value is 1.3 % Table 3.25: display Voltage drop SAFA OIL feeder

Table 3.25 Voltage drop of SAFA OIL feeder

	Load Name	nominal voltage KV	calculated voltage	VD %	Distance from substation (Km)
1	Load	11	10.899	0.92	1.326
2	Load	11	10.898	0.93	1.361
3	Load	11	10.898	0.93	1.627
4	Load	11	10.898	0.93	1.442
5	Load	11	10.897	0.94	1.655
6	Load	11	10.897	0.94	1.747
7	Load	11	10.897	0.94	1.844
8	Load	11	10.896	0.95	2.301
9	Load	11	10.895	0.95	1.893
10	Load	11	10.895	0.95	2.06
11	Load	11	10.895	0.95	2.198
12	Load	11	10.895	0.95	2.405
13	Load	11	10.892	0.98	2.495
14	Load	11	10.885	1.05	2.523
15	Load	11	10.878	1.11	2.776
16	Load	11	10.866	1.22	1.499
17	Load	11	10.857	1.30	1.709
18	Load	11	10.861	1.26	2.113
19	Load	11	10.86	1.27	2.548
20	Load	11	10.857	1.30	2.588
21	Load	11	10.857	1.30	2.623
22	Load	11	10.857	1.30	2.609
23	Load	11	10.86	1.27	2.648
24	Load	11	10.86	1.27	2.693
25	Load	11	10.86	1.27	2.806
26	Load	11	10.86	1.27	2.786
27	Load	11	10.86	1.27	2.905
28	Load	11	10.86	1.27	2.917

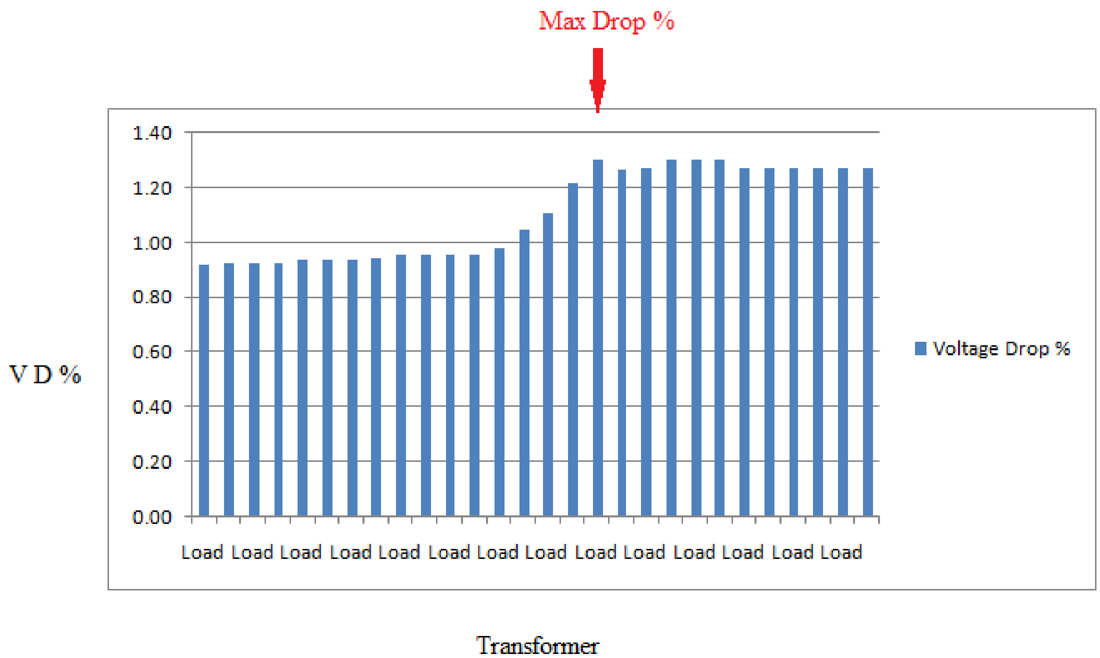


fig (3.26) : voltage drop of SAFA OIL feeder at the customer transformer

Neplan analysis software display a values of line losses for each items in the SAFA OIL feeder . The highest losses value at element NO 3093 which is represent item name SAFA OILS KHO L1(marked in red) (see Table 3.27: line losses of SAFA OIL feeder) the length of this line is (1.326)km with cable size 185 mm^2 , the line represent 55.48 % of total this line losses.

Table 3.27 line losses of SAFA OIL feeder

ID	Node	Element name	Losses %	P Losses	Q Losses
3005	N2994	SAFA OILS KHO L39	0.00%	0	-3.96
2719	N3149	SAFA OILS KHO L31	0.16%	0.007	-0.43
1385	N1374	SAFA OILS KHO L4	4.19%	0.183	0.122
1656	N1645	SAFA OILS KHO L16	0.05%	0.002	-0.02
1648	N1470	SAFA OILS KHO L7	11.03%	0.482	0.255
2762	N3152	SAFA OILS KHO L32	0.43%	0.019	-1.42
1393	N1382	SAFA OILS KHO L13	0.02%	0.001	-0.24

1687	N1645	SAFA OILS KHO L6	3.25%	0.142	0.056
3059	N3164	SAFA OILS KHO L42	0.00%	0	-0.43
1424	N1382	SAFA OILS KHO L3	8.38%	0.366	0.227
1703	N1692	SAFA OILS KHO L24	0.00%	0	-0.43
1695	N1684	SAFA OILS KHO L11	0.41%	0.018	-0.03
2799	N3155	SAFA OILS KHO L35	0.00%	0	-1.51
1996	N1848	SAFA OILS KHO L19	0.00%	0	-0.01
1442	N1421	SAFA OILS KHO L14	0.00%	0	-0.24
362	COLA KHO	L362	0.00%	0	-0.31
3098	N3087	SAFA OILS KHO L2	0.27%	0.012	-0.53
3093	N3087	SAFA OILS KHO L1	55.48%	2.424	-18.67
2553	N1684	SAFA OILS KHO L20	2.47%	0.108	-0.03
2004	N1993	SAFA OILS KHO L28	0.00%	0	-0.38
1742	N1731	SAFA OILS KHO L25	0.00%	0	-0.33
1734	N1692	SAFA OILS KHO L10	0.11%	0.005	-0.01
2836	N3161	SAFA OILS KHO L33	0.00%	0	-97.14
3103	N3087	SAFA OILS KHO L5	4.19%	0.183	0.122
2831	N3158	SAFA OILS KHO L34	0.00%	0	0
1473	N1421	SAFA OILS KHO L8	7.80%	0.341	0.195
3130	N3119	SAFA OILS KHO L22	0.02%	0.001	-0.62
3125	N3122	SAFA OILS KHO L21	0.00%	0	-0.54
1773	N1731	SAFA OILS KHO L9	0.07%	0.003	-0.01
3135	N2499	SAFA OILS KHO L23	0.05%	0.002	-0.46
2867	N3155	L2867SAFA OILS KHO	0.32%	0.014	-2.27

3179	N4674	SAFA OILS KHO L29	0.00%	0	-2.89
2898	N2864	SAFA OILS KHO L37	0.32%	0.014	-2.6
1812	N1770	SAFA OILS KHO L18	0.00%	0	-0.01
2640	N3146	SAFA OILS KHO L30	0.64%	0.028	-1.24
2929	N2895	SAFA OILS KHO L38	0.14%	0.006	-2.15
1851	N1809	SAFA OILS KHO L17	0.00%	0	-0.03
1862	N1848	SAFA OILS KHO L27	0.00%	0	-0.01
2960	N2926	SAFA OILS KHO L41	0.18%	0.008	-3.23

table 3.28transformer losses of SAFA OIL

ID	Node	Element name	Losses %	P Losses	Q Losses
2727	N3152	TR2-2727	3.68%	0.064	0.196
3013	N2997	TR2-3013	3.68%	0.064	0.196
3036	N2994	TR2-3036	3.68%	0.064	0.196
1945	N1939	TR2-1945	1.96%	0.034	0.077
2690	N4674	TR2-2690	3.68%	0.064	0.196
3067	N3164	TR2-3067	1.96%	0.034	0.076
1976	N1809	TR2-1976	1.04%	0.018	0.039
1711	N1700	TR2-1711	1.96%	0.034	0.077
2574	N3087	TR2-2574	1.04%	0.018	0.039
2012	N2001	TR2-2012	0.52%	0.009	0.018
2492	N3108	TR2-2492	6.96%	0.121	0.504
2844	N3161	TR2-2844	6.90%	0.12	0.5
1750	N1739	TR2-1750	1.96%	0.034	0.077
2480	N3122	TR2-2480	6.96%	0.121	0.504
2468	N3119	TR2-2468	6.96%	0.121	0.504

2875	N2864	TR2-2875	2.59%	0.045	0.111
1512	N1390	MTBA KHAR. UNIV.	6.90%	0.12	0.501
2611	N3146	TR2-2611	1.04%	0.018	0.039
1524	N1429	TOMAS	5.87%	0.102	0.377
2906	N2895	TR2-2906	5.87%	0.102	0.376
2770	N3155	TR2-2770	6.90%	0.12	0.5
2937	N2926	TR2-2937	2.59%	0.045	0.111
1870	N1859	TR2-1870	1.04%	0.018	0.039
1625	N1478	TR2-1625	3.68%	0.064	0.197
1789	N1778	TR2-1789	6.96%	0.121	0.504
2648	N3149	TR2-2648	3.68%	0.064	0.196

Total feeder losses is 6.108 KW

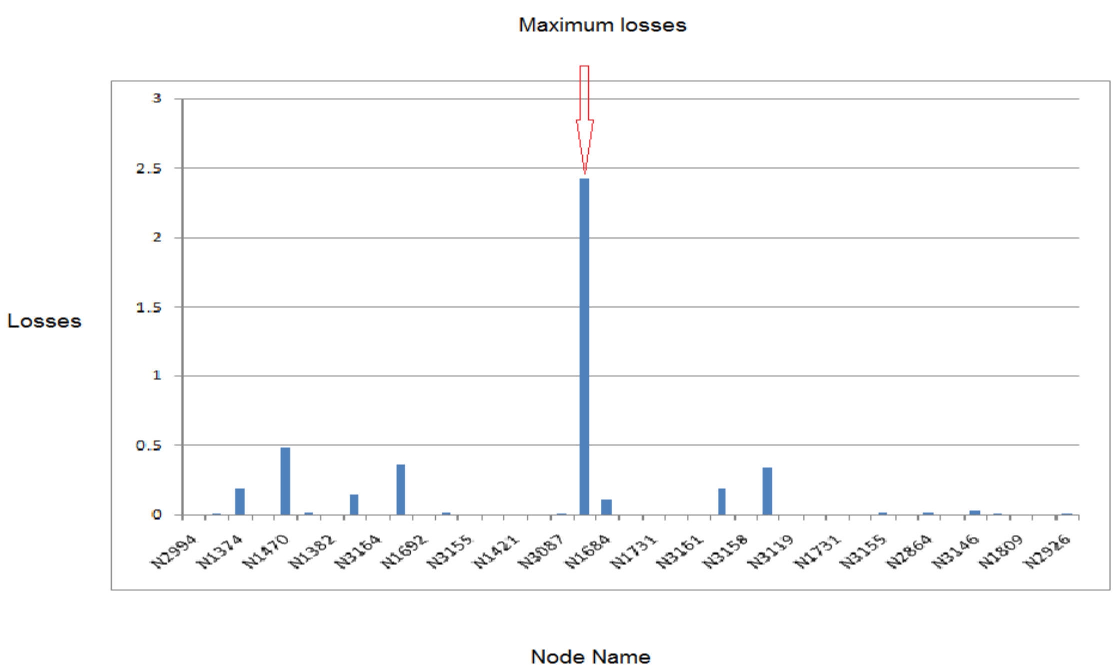


fig. 3.27 Line condition SAFA OIL outgoing

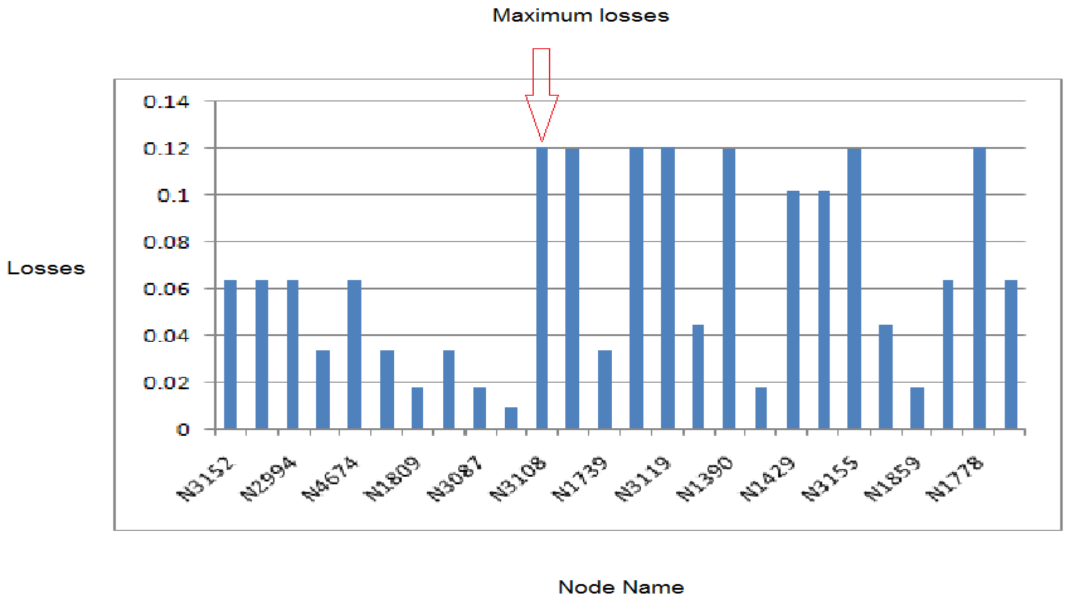


fig. 3.28 Transformer losses condition

CHAPTER FOUR

RESULTS AND DISCUSSION

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

Through the extracted results mentioned in the third chapter turned out that there is a clear defect in multiple parts of the substation feeders . Results will be discussed extensively in this chapter and puts up solutions to minimized losses in the region.

After reviewing the table results of each component of grid elements , problem found in one feeder (Safia feeder) consist of 24 customers with 23.8684 Km length and the majority of transformer feed residential costumer not connected with capacitor bank as the rest of substation feeder feed industrial customers with capacitor bank in their location. Fig.4.1 : illustrate the losses per feeders , it's clearly Safia outgoing has the biggest losses value .

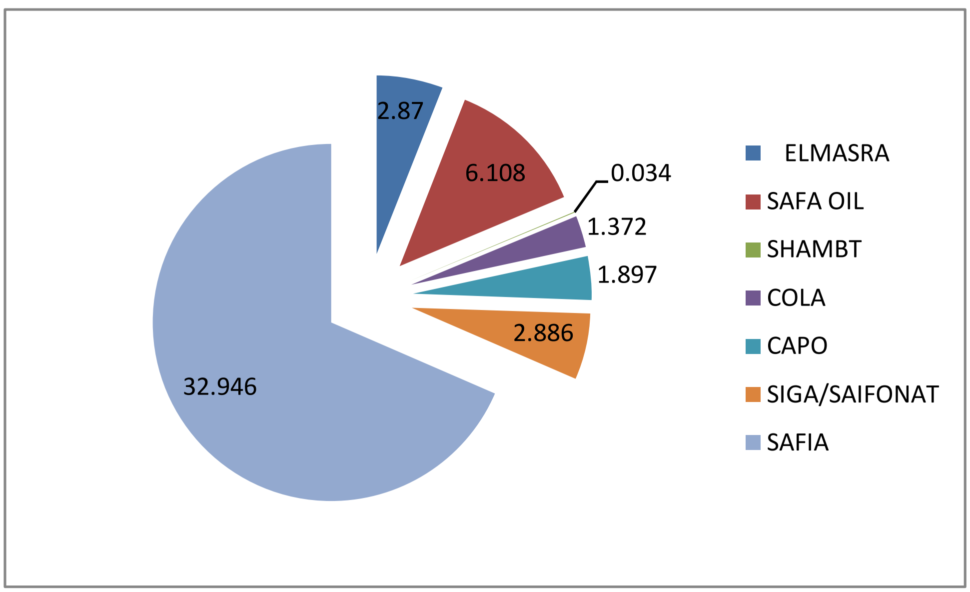
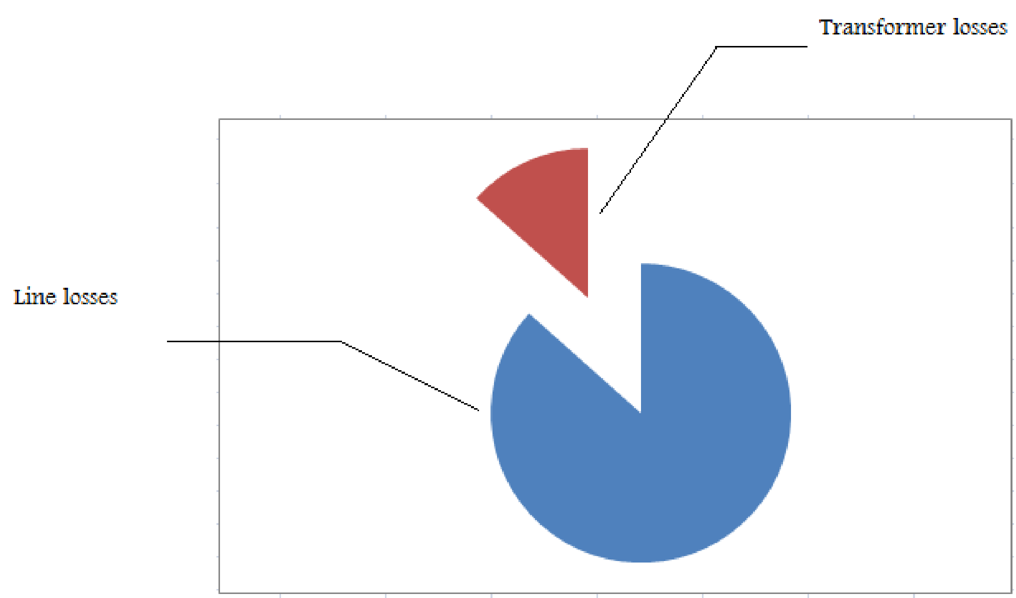


fig.4.1 : losses per feeder

From The data in the tables.4.1 , represent the whole details losses in lines and transformer which shows the contrast of the line loss associated with each feeder pair line and transformer loss. From fig 3. XX It can be concluded that the lines is significantly greater than the transformer loss

Table . 4.1 losses precentage per feeder

	Feeder name	Losses %
1	ELMASRA	5.97%
2	SAFA OIL	12.70%
3	SHAMBT	0.07%
4	COLA	2.85%
5	CAPO	3.94%
6	SIGA/SAIFONAT	6.00%
7	SAFIA	68.48%



F.4.2: Loss distribution between lines and transformers.

Table .4.18 , illustrate the total losses found by NEPLAN software for the feeders include transformer is 0.053 MW

Table 4.2: Total losses

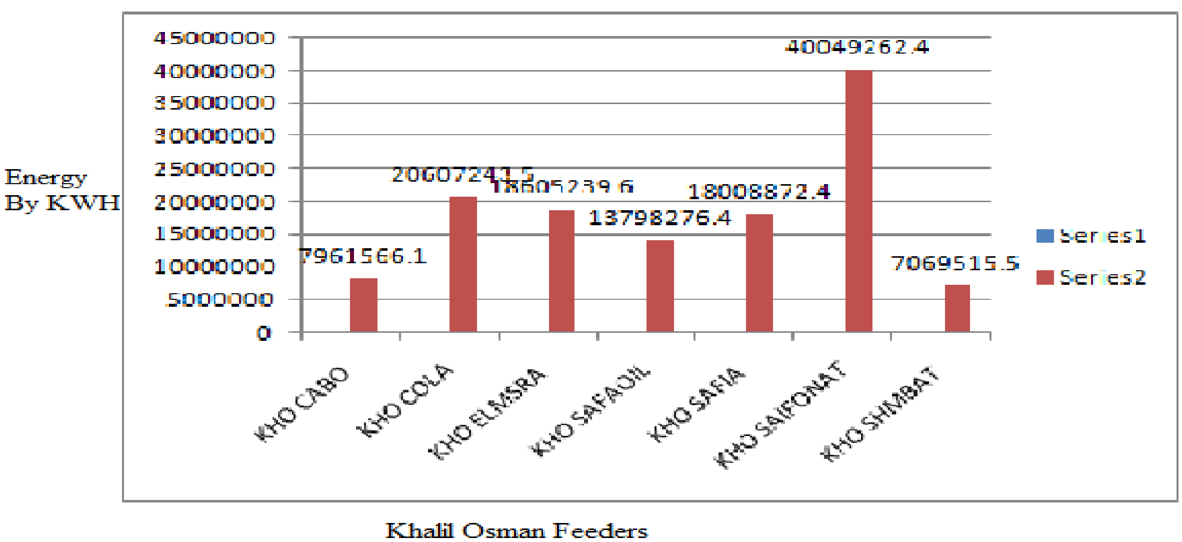
P :Losses MW	Q : losses Mvar
0.053	-0.422

4.2 Annual Technical Losses Percentage

For determination losses percentage , Annual energy sent must be known .khalil Osman annually deliver 126099975.9 KWH for 2013 , Table 4.3 shows the feeder energy sent by detail and month .

Table 4.3: Khalil Osman total energy 2013 profile

Month	CAPO	COLA	ELMASRA	SAFA OIL	SAFIA	SIGA /SAIFONAT	SHAMBT
JAN	834806	2226637	1542382	1299440	2090524	3345608.7	804139.5
FEB	769254	1856749	1409859	1217577	1865111	3273919.7	836061.1
MAR	812563	1549390	1185897	887901	1391167	3057445.9	589453.7
APR	886618	1754937	1421345	1252709	1583650	3342843.8	697328
MAY	798131	1942213	1310197	1040861	1445408	3430255.2	380665.1
JUN	770042	1580170	1287296	939534	1337475	3270365.4	349881.2
JUL	753234	1379254	1285335	1075082	755961	3245173.3	420658.4
AUG	742405	1151629	1183714	1139566	1009546	3068616.9	446761.2
SEB	390850	1290741	1416910	1003853	1133374	2988348	430382.8
OCT	389711	1848548	2135067	1277797	1609113	3585994.1	674150.2
NOV	415358	2004177	2127219	1345182	1896368	3591849.9	733910.2
DEC	398594	2022799	2300018	1318774	1891178	3848841.5	706124.1



F.4.3:: Khalil Osman total energy 2013 profile

The loaded feeder SIGA/SAIFONAT with 40049262 KWH demand for 2013 is not the highest losses value due to the capacitor bank in factories and the line length is 9.27 Km connected with 5 transformers by over head line 185mm^2 .

By multiplying the losses of each feeder by 8760 , the annual losses can be determine which already found by NEPLAN . Table 4.4 illustrate all feeders annual losses

Table 4.4 : Khalil Osman feeders annual losses

Feeder name	Annual losses	Losses %
SIGA/SAIFONAT	25281.36	0.06
SAFIA	288606.96	1.6
CAPO	16460.04	0.2
COLA	12018.72	0.06
SHAMBT	297.84	0.004
SAFA OIL	53506.08	0.4
ELMASRA	25141.2	0.14
Total	421312.2	

4.3 Problems and Solutions

To reduce the feeders losses there many solution depend on the feeder situation , next table show action for weak point in the grid and correction action

Table 4.5 : Problems and Solutions losses

NO	Feeder Name	Component ID	Problem	Correction Action
1	SIGA/SAIFONAT	3275	Component has conductor cross 35mm and feed 4000 KVA with 0.529 m length with losses : P_{Loss} = 1.033 KWH Q_{Losses} = -12.79 KVAR	Change the cross section from 35mm^2 to 185 mm^2 will reduce the losses to P_{Losses}=0.327 KWH Q_{Losses}=0.104 KVAR for this element
2	SAFIA	4355	Component has conductor cross 35mm and feed 6 transformers with 0.754 m length with losses : P_{Loss} = 0.453 KWH Q_{Losses} = -6.62 KVAR	Change the cross section from 35mm^2 to 185 mm^2 will reduce the losses to P_{Losses}=0.142KWH Q_{Losses}=-0.001 KVAR for this element

			Danfodu low power factor Alwaha oil low power factor Sati factory low power factor Dubai low power factor	Install Capacitor bank

4.4 Customer Transformer Reactive Power

Customer load nature may cause reactive energy , that reflect as drop voltage and reduce the grid capacity . regarding to the thesis consideration of reactive must studied. following tables display in detail the 2013 load profile , clearly the low power factor and reactive energy transformer need to connect with shunt capacitors

Table 4.6 : Danfodu2013 load profile

Month	KWH	KVAR	KVA	P.F
Dec	1434	1434	2027.982248	0.7071
Nov	1878	1878	2655.89307	0.7071
Oct	2040	2040	2884.995667	0.7071
Sep	2348	2348	3320.573444	0.7071
Aug	2166	2166	3063.186576	0.7071
Jul	2752	2752	3891.915724	0.7071
Jun	2302	2302	3255.519621	0.7071
May	2391	2391	3381.384628	0.7071
Apr	1944	1944	2749.231165	0.7071
Mar	1795	3271	3731.148081	0.4811
Feb	1476	2190	2640.961189	0.5589
Jan	1565	2190	2691.714138	0.5814

Table 4.7: Alwaha oil factory2013 load profile

Month	KWH	KVAR	KVA	P.F
Dec	15948	19375	25094.40832	0.6355
Nov	14301	17668	22730.52628	0.6292
Oct	5103	7770	9295.886671	0.5490
Sep	3042	5025	5874.043667	0.5179
Aug	508	714	876.2762122	0.5797
Jul	3277	3389	4714.239069	0.6951
Jun	5768	6932	9017.895985	0.6396
May	5693	7060	9069.390773	0.6277
Apr	6402	7448	9821.319056	0.6518
Mar	6886	7270	10013.48571	0.6877
Feb	8096	10018	12880.43245	0.6286
Jan	5622	6474	8574.354786	0.6557

Table 4.8 : Sati factory2013 load profile

Month	KWH	KVAR	KVA	P.F
Dec	1443	468	1516.994726	0.9512
Nov	793	404	889.9803369	0.8910
Oct	3037	2433	3891.382531	0.7804
Sep	7067	7011	9954.728022	0.7099
Aug	1088	750	1321.455258	0.8233
Jul	1588	1145	1957.745898	0.8111
Jun	1516	1567	2180.308464	0.6953
May	836	887	1218.878583	0.6859
Apr	432	435	613.0652494	0.7047
Mar	403	331	521.5074304	0.7728

Feb	526	422	674.3589549	0.7800
Jan	5622	6474	8574.354786	0.6557

Table 4.9 : Dubai factory2013 load profile

Month	KWH	KVAR	KVA	P.F
Dec	1870	1376	2321.696793	0.8054
Nov	3299	1868	3791.150881	0.8702
Oct	4412	2029	4856.190379	0.9085
Sep	12201	10300	15967.2916	0.7641
Aug	5057	3241	6006.44071	0.8419
Jul	5405	1759	5684.021992	0.9509
Jun	6289	2106	6632.251277	0.9482
May	10356	7381	12717.14972	0.8143
Apr	7069	4258	8252.352695	0.8566
Mar	3574	1059	3727.593996	0.9588
Feb	7004	4046	8088.64216	0.8659
Jan	5188	3569	6297.071145	0.8239

CHAPTER FIVE

RESULTS AND RECOMONDATION

CHAPTER FIVE

RESULTS AND RECOMONDATION

Results of NEPLAN software is use for investigation and analysis Khalil Osman substation feeders, The weak elements displayed and voltage drop as well. To reach the optimum losses, the following proposed corrective action must follow. By using a network software simulator, losses can be calculated rapidly. By trial and error, it is possible to quickly find the best solution by comparing simulated scenarios against actual situations.

5.1 Conclusions

Khalil Osman outgoings have many factors can raise the losses and voltage drop , First factor if the length of the 11 KV from this expressed in ELMASRA,SAFA OIL and SAFIA feeders. The second factor is the conductor size of 11 KV specially, SAFIA has size in many parts 35mm^2. Third factor is load are concentrated in three feeders (ELMASRA, SAFA OIL and SAFIA), while four feeders connected with a few loads.

5.2 Recommendations

For optimization technical losses for Khalil Osman outgoing , the recommendations corrective action must followed:

1. Load Transfer

   Load transfer can provide a fast long-term and generally low-cost solution to overload and under voltage problems. ELMASRA, SAFA OIL and SAFIA loads can distributed in CAPO , COLA , SHAMBAT and SIGA/SAIFONAT with consideration the following account constraints:

   - Capacity of the receiving feeder or substation
   - Localization of the load breaker and switch
   - Limitations and risks associated with the network protection.

- load transfer can also affect other measures such as load unbalance correction or adding shunt capacitors.

2. Line conductor replacement

   Conductor overloads appear when the current in a conductor exceeds the conductor's allowable limit. SAFIA feeder has many conductor size 35mm^2 need to replace with 185 mm^2 size.

3. Shunt capacitor installation

   Customer transformer due to the nature of their loads need to use shunt capacitors , for example danfodu transformer, alwaha oil factory, sati factory and Dubai factory.
4. Use of custom power device such as D-statcom.

Appendix A

Khalil Osman outgoing transformer capacities details

Outgoing name	Load name	Load capacity KVA
ELMASRA	TLMAS TARK	100
	ALCOLA	100
	TRANS50	50
	TRANCE200	200
	TRANSE200 1	200
	TRANSE 200 2	200
	TESHOP	500
	BIZYANOSE	200
	ALSAFEEH	200
	AAM	200
	MKHAZEN ALCOLA	500
	NASEG BAHRI	500
	ZEOWT THANI	500
	ALEZDEHAR LLAHZA	500
	HANA LLIBASKAWET	300
	DAL	100
SAFA OIL	Public transformer	100
	Public transformer	100
	Public transformer	500
	Public transformer	500
	Public transformer	500
	Public transformer	1000
	Public transformer	1000
	Public transformer	300
	Public transformer	750
	Public transformer	300

	Public transformer	1000
	Public transformer	500
	Public transformer	200
	Public transformer	500
	Public transformer	1000
	Public transformer	1000
	Public transformer	750
	Public transformer	500
	Public transformer	1000
	Public transformer	1000
	Public transformer	1000
	Public transformer	1000
	Public transformer	200
	Public transformer	200
	Public transformer	200
	Public transformer	1000
	Public transformer	100
	Public transformer	100
	Public transformer	50
SHAMBT	Public transformer	200
COLA	Alcola1	1000
	Alcola2	2000
	Alcola3	2000
	Alcola4	2000
Total Capacity		27900

Outgoing name	Load name	Load capacity KVA
CAPO	Capo	500
	Capo	1000
	Capo	2000
	Capo	2000
SIGA/SAIFONAT	SARF ALSHEE1	750
	SIGA1	2000
	SIGA2	2000
	SIGA5	2000
	SIGA6	2000
SAFIA	SPESTIAL	100
	KHAS	100
	ALSHRGALAWST LLTAGLIF	200
	DAR ALADOWA LLNSHER	1000
	DUBI 2	1000
	SAEED LLMOAD ALGZAYA	1000
	DUBI	1000
	SELIDOR	300
	DANFODEW	200
	ZEWT ALWAHA	500
	SABOON SATEE	300
	SAEED ALGZAEAA	500
	CRYSTAL	1000
	CRYSTAL 2	1000
	CRYSTAL 3	1000
	PEPSI 2	1000
	PEPSI 1	1000

	Load	2000
	PEPSI 4	1000
	KELOBATRA	500
	ALHYAH ALGOMEA LLABHATH ALGELOGY	750
	ALBALAT W ALMZAYKO	300
	ALKEBREET ALHADETH	500
	ALADADAT	500
Total Capacity		27400

Appendix B

Data Parameters

COLA Line

From NODE	To NODE	Line Size mm²	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
108	238	185	0.077	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
238	224	185	0.435	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
224	246	185	0.62	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
246	257	185	0.269	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
257	165	185	0.224	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
265	273	185	0.269	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
273	210	185	0.69	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
210	265	185	0.065	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
210	294	185	0.02	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
210	303	185	0.02	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
210	306	185	0.02	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315

SAFA OILS Line

From NODE	To NODE	Line Size mm²	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
108	3087	185	1.326	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3087	3146	185	0.035	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3146	3149	185	0.081	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3149	4674	185	0.081	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3149	3152	185	0.028	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3152	3155	185	0.92	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3155	3158	185	0.097	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3158	3161	185	0.457	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3161	3155	185	0.062	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3155	2864	185	0.146	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2864	2895	185	0.167	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2864	2926	185	0.138	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2926	2957	185	0.207	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2957	2994	185	0.09	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2994	3164	185	0.028	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
2994	2997	185	0.253	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3087	1374	70	0.074	0.443	0.362291	0.010065	1.329	1.449162	0.168	315
1374	1382	70	0.074	0.443	0.362291	0.010065	1.329	1.449162	0.168	315

1382	1390	35	0.025	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1382	1421	70	0.192	0.443	0.362291	0.010065	1.329	1.449162	0.168	315
1421	1429	35	0.025	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1421	1470	70	0.224	0.443	0.362291	0.010065	1.329	1.449162	0.168	315
1470	1478	35	0.43	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1470	1645	70	376	0.443	0.362291	0.010065	1.329	1.449162	0.168	315
1645	1653	70	0.075	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1645	1684	70	0.16	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1684	2499	70	0.32	0.443	0.362291	0.010065	1.329	1.449162	0.168	315
2499	3119	185	0.03	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3119	3122	185	0.02	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3122	3108	185	0.035	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
1684	1692	70	0.142	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1692	1700	35	0.045	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1692	1731	70	0.049	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1731	1739	35	0.035	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1731	1939	70	0.045	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1939	1770	70	0.063	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1770	1778	35	0.05	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
1770	1809	70	0.03	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1809	1848	70	0.088	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1848	1859	70	0.031	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1848	1993	70	0.043	0.44	0.362291	0.010066	1.329	1.449162	0.004027	270
1993	2001	35	0.04	0.524	0.11618	0.259999	1.572	0.46472	0.104	145

SHAMBAT Line

From NODE	To NODE	Line Size mm^2	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
108	1289	185	0.446	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1289	1297	95	0.117	0.32	0.35261	0.010356	0.7168	1.41044	0.004142	400
1297	1308	185	0.525	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315

ELMASRA Line

From NODE	To NODE	Line Size mm^2	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
108	592	185	0.877	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
592	603	185	0.735	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
603	611	185	0.662	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315

611	619	185	0.862	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
619	627	185	0.724	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
627	674	185	69	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
674	635	185	0.94	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
635	652	185	0.111	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
652	685	185	0.385	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
625	752	185	0.515	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
752	795	185	0.082	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
795	829	185	0.182	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
829	863	185	0.842	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
863	876	185	0.48	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
863	907	185	0.516	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
907	946	185	0.407	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
946	977	185	0.817	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
977	985	185	0.924	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
985	1029	185	0.078	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1029	1060	185	0.763	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1060	1091	185	0.969	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1029	1122	185	0.659	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1122	1153	185	0.838	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1153	1184	185	0.889	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1184	1197	185	0.889	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1197	1245	185	0.538	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
1245	1353	35	0.424	0.524	0.11618	0.259999	1.572	0.46472	0.104	145

SIGA/SAIFONAT Line

From NODE	To NODE	Line Size mm²	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
83	3204	185	0.5	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315
3204	3212	185	0.903	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3212	3225	35	0.962	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3212	3264	185	1.035	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3264	3272	35	1.344	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3272	3285	185	0.941	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3285	3293	35	0.03	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3285	3329	185	1.03	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3329	3332	35	0.93	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3329	3391	185	1.101	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3391	3399	35	0.643	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3399	3407	35	0.025	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3407	3438	35	1.108	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3438	3447	35	1.025	0.524	0.11618	0.259999	1.572	0.46472	0.104	145

CAPO Line

From NODE	To NODE	Line Size mm²	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
83	3481	185	4.69	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315

SAFIA Line

From NODE	To NODE	Line Size mm²	Length km	R(1) ohm/km	X(1) ohm/km	C(1) uf/km	R(0) ohm/km	X(0) ohm/km	C(0) uf/km	Ir max Amp
83	3616	185	5.053	0.0991	0.08783	0.42	0.2973	0.35168	0.168	315

3616	3632	185	2.162	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3632	3640	35	1.149	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3640	3643	185	0.857	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3632	3619	185	1.809	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3619	3689	185	0.892	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3689	3720	185	1.112	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3720	3751	185	0.68	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3751	3759	35	0.853	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3751	3790	185	1.06	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3790	3798	35	0.514	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3790	3829	185	1.465	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3829	3837	35	0.052	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3829	3868	185	1.084	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3868	3918	185	0.901	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3720	3949	185	0.934	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3949	3986	185	1.027	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3986	3970	35	0.035	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3970	3994	185	0.948	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3970	4041	185	0.85	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4041	4049	35	0.104	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4041	4080	185	0.938	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4080	4088	35	0.783	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4080	4161	185	0.815	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
3949	3957	185	0.134	0.164	0.330604	0.01108	0.367	1.46	0.01108	400

3957	4130	35	0.035	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
3957	4161	185	0.044	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4161	4177	185	1.321	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4177	4185	185	2.034	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4185	4193	35	0.99	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4185	4279	185	0.882	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4279	4287	35	0.48	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4279	4341	185	1.056	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4341	4352	35	0.754	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4352	4363	185	1.416	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4163	4371	35	0.971	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4352	4402	185	0.852	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4402	4410	35	0.752	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4402	4441	185	0.871	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4441	4449	185	1.133	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4441	4483	185	0.964	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4483	4491	185	0.776	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4491	4499	185	0.696	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4499	4507	185	0.633	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4507	4515	35	0.529	0.524	0.11618	0.259999	1.572	0.46472	0.104	145
4507	4546	185	0.497	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4499	4477	185	0.499	0.164	0.330604	0.01108	0.367	1.46	0.01108	400
4477	4698	35	0.489	0.524	0.11618	0.259999	1.572	0.46472	0.104	145

SAFIA Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.3	1.5	4	1.5	4	Dyn11
11	0.433	0.3	1.5	5	1.5	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.75	1.31	5	1.31	5	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.1	1.173	4	1.73	4	Dyn11

11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11

SAFA OILS Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.3	1.5	4	1.5	4	Dyn11
11	0.433	0.75	1.31	5	1.31	5	Dyn11
11	0.433	0.3	1.5	5	1.5	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.75	1.31	5	1.31	5	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.05	1.81	4	1.81	4	Dyn11

SHAMBAT Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	0.2	1.63	4	1.63	4	Dyn11

ELMASRA Transformer

Voltage	Voltage	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group

1(KV)	2(KV)						
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.1	1.173	4	1.73	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.3	1.5	4	1.5	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.05	1.81	4	1.81	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.3	1.5	4	1.5	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11
11	0.433	0.2	1.63	4	1.63	4	Dyn11

11	0.433	0.5	1.25	4	1.25	4	Dyn11

SIGA/SAIFONAT Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	0.75	1.31	5	1.31	5	Dyn11

CAPO Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11
11	0.433	0.5	1.25	4	1.25	4	Dyn11

COLA Transformer

Voltage 1(KV)	Voltage 2(KV)	S(MVA)	UrRr(1)%	uKr(1)%	UrRr(0)%	uKr(0)%	Vector group
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	2	1.13	6.25	1.13	6.25	Dyn11
11	0.433	1	1.17	5	1.17	5	Dyn11

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