Palestine Polytechnic University

College of Engineering

Study, Analysis and Development of Bani Na'im Medium Voltage Electric Network

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كلية الهندسة

دائرة الهندسة الكهربائية

Study, Analysis and Development of Bani Na'im Medium Voltage Electric Network

فريق المشروع

بهاء أبو رعيه   قسام خضور

بناء على نظام كلية الهندسة وإشراف ومتابعة المشرف المباشر على المشروع وموافقة أعضاء اللجنة المناقشة ، تم تقديم هذا العمل إلى دائرة الهندسة الكهربائية وذلك للوفاء بمتطلبات درجة البكالوريوس في هندسة تكنولوجيا الطاقة الكهربائية.

توقيع المشرف

توقيع اللجنة المناقشة

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توقيع رئيس الدائرة

الإهداء

إلى وطننا فلسطين

إلى شهداء فلسطين

إلى الاسرى والمعتقلين

إلى ينبوع العطاء والحنان .. أباؤنا وأمهاتنا

إخواننا وأخواتنا

زملاؤنا وزميلاتنا

المعلمين والى كل من ساهم في انجاح هذا العمل

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The product of this research would not be possible without all of them.

الملخص:

هذا المشروع هو دراسة وتحليل لشبكة كهرباء الجهد المتوسط في بلدة بني نعيم – الخليل. تعتمد منهجية الدراسة على جمع البيانات والمعلومات اللازمة للعثور على المشاكل الموجودة في الشبكة والتوصل إلى حلول لهذه المشاكل سواء في مكونات الشبكة أو في عملية التوزيع والنقل واستخدام برنامج **E-TAP** للقيام بتحليل الشبكة وعمل التحسينات الضرورية للشبكة مثل الحد من الخسائر، وتحسين معامل القدرة، وتحقيق استقرار الشبكة وزيادة كفاءتها وعمل التعديلات اللازمة وتطوير الشبكة ، مع النظر في الدراسة الاقتصادية اللازمة لإصلاح المشكلة، وتحديد متطلبات تطوير الشبكة من المصدر والحمل.

Abstract:

The project is to present offer proposal complete study of the medium voltage electrical network in Bani Na'im town near Hebron.

The study methodology is to collecting data and information needed to discover the network problems using E-TAP program, and discuss the result of load flow.

That is made the essential developments and improvements on the network such as reducing the losses, improving the power factor, achieving the network stability and increasing its efficiency. In the other hand, the project finds solutions for the problems that exist such as, low power factor, losses in electrical network, and voltage drop. Work necessary adjustments and developing to the network with considering the economic study needed to solving problems, and identify network development requirements with respect to source side and load side.

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Chapter One

1.1 Introduction

The total area of Bani Na'im is 207 km^2, with total population of 26523. Bani Na'im is energized for electricity from Israel Electric Corporation (IEC). The power delivered through at the southern entrance to the town Yaken region (منطقة يقين) with 33 KV transmission line feeds the domestic and the industrial sector in Bani Na'im.

1.2 Literature Survey

This study for Bani Na'im Medium Voltage electrical network used numerical calculations at E-TAP program to investigate the power flow in the electrical network and find out the problems in the network such as losses in the grid, low power factor, then finding the solutions to problems.

1.3 Objectives

1- Reducing the losses in the electrical network.

2- Improving the power factor.

3- Increasing electrical network reliability.

4- Conducting load forecasting.

1.4 Approach

1- Collecting the needed data.

2- Building single line diagram by using related software packages such as E-TAP for analysis the electrical network.

3- Solving the problems in the electrical network.

4- Conducting load forecasting.

Chapter Two

Bani Na'im Medium Voltage Electric Network

2.1 Bani Na'im Location

Bani Na'im town locating of the east of Hebron city, from the north of the town there is 'Seer', from the south 'Yatta' and from the east the dead sea and Masafer Bani Na'im. The figure 2.1 explains that:

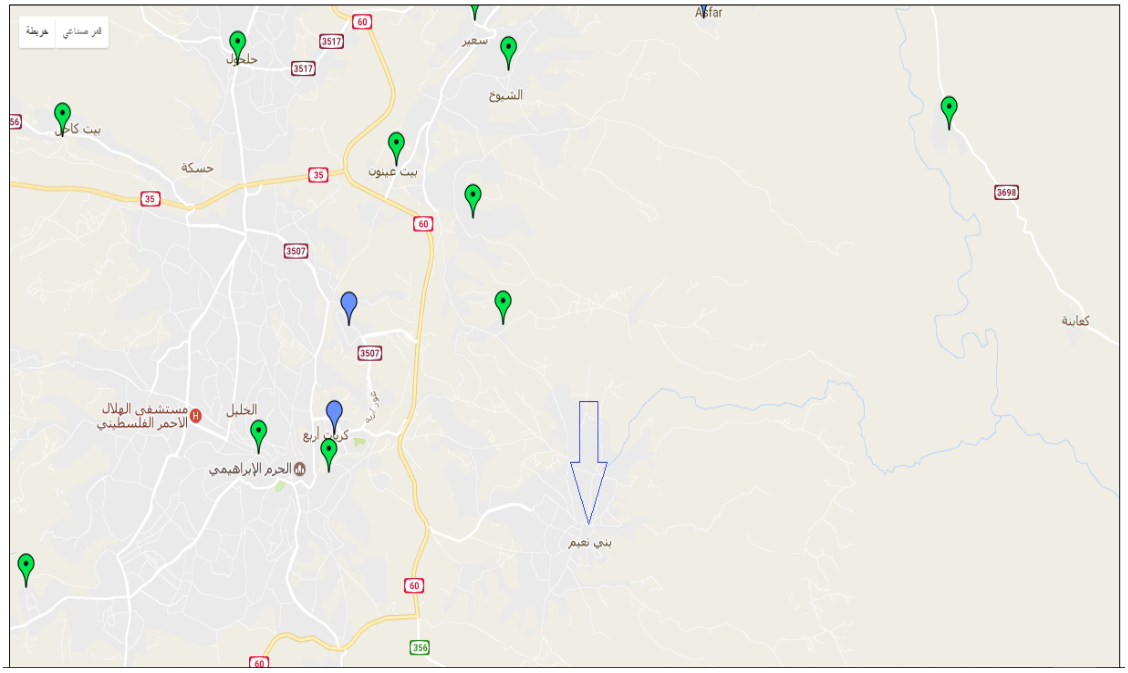


Figure 2. 1 Location of Bani Na'im on the map.

The figure 2.2 show an aerial photograph of Bani Na'im.

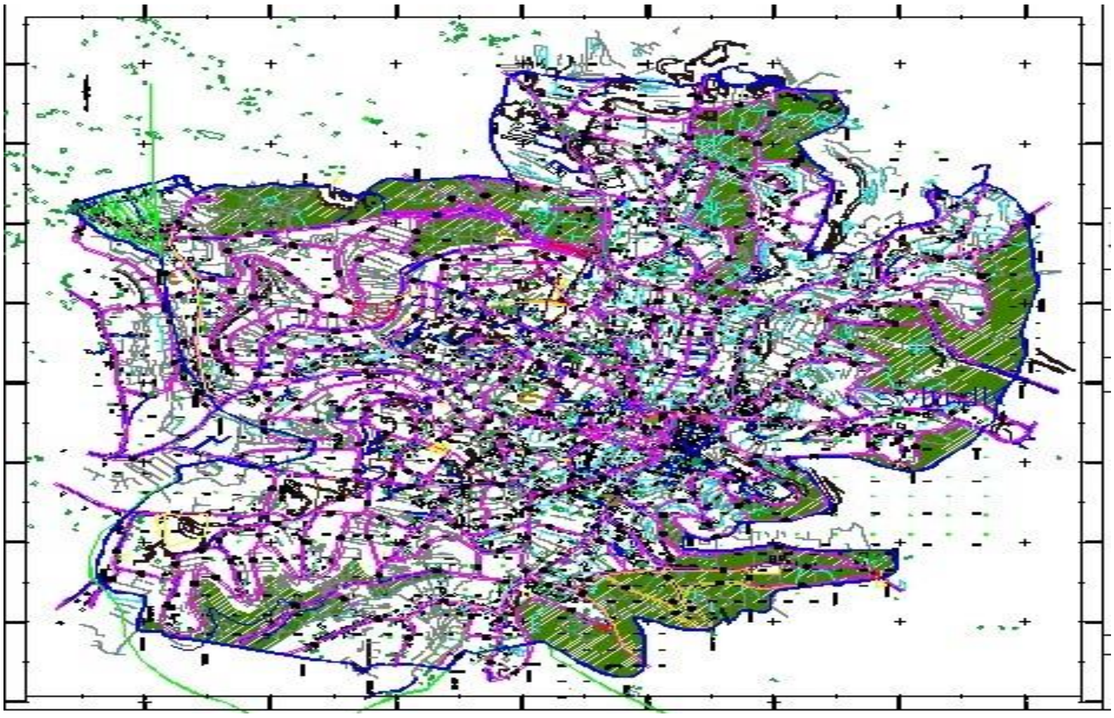


Figure 2. 2 Bani Na’im Aerial Photograph AutoCAD MAPS.

2.2 Medium Voltage Fed

Medium voltage network considered as a link between upcoming high-voltage network of the electricity company and the low voltage network that supplies domestic and industrial loads.

The network at town Bani Na'im was built in 1994, and the power delivered through at the southern entrance to the town (Yaken region) with 33 KV transmission line feeds the domestic and the industrial sector in Bani Na’im, the main circuit breaker is rated above (169.4 A). the max demand is reached (10 MVA).

2.3 Medium Voltage Network Components

Medium voltage network consists of the following parts:

1- Transmission lines and Cables.

2- Towers.

3- Transformers.

4- Protection devices.

4.1 Isolators.

4.2 Fuses.

4.3 circuit breakers.

4.4 Surge arresters.

5- Earthing System.

2.3.1 Transmission lines and Cables:

Transmission lines:

Transmission lines is one of the basic components of the power grid through which power transmission.

The main type of transmission line is aluminums conductors:

1- All Aluminums Conductors (A.A.C.)

2- All Aluminum Alloy Conductors (A.A.A.C.)

3- Aluminum Conductor Steel Reinforced (A.C.S.R)

Aluminum Conductor Steel Reinforced – A.C.S.R**:**

ACSR conductor consists of a solid or stranded steel core surrounded by strands of aluminum (E.C. GRADE). ACSR Conductor is available in a wide range of steel, containing carbon from 0.5% to 0.85 %. The higher strength ACSR Conductor are used for river crossings, overhead ground wires, installations involving extra-long spans etc. Against any given resistance of conductor, ACSR may be manufactured for having a wide range of tensile strength as per requirement. The principal advantage of these conductors is high tensile strength so that they are used for longer spans with less supports. Due to the greater diameter of ACSR Conductor a much higher corona limit can be obtained causing big advantages on high as well as extra high voltage Overhead lines. [1]

Key Benefits:

• ACSR Conductor has high Tensile Strength.

• Variable steel core stranding enables desired strength to be achieved without sacrificing ampacity.

• Additional corrosion protection is available through the application of grease to the core or infusion of the complete cable with grease.

The most important elements that must be considered in the transmission lines are:
R(ohm/km), X(ohm/km), Cross-section area, Length, Type.

- Bani Na'im network has (15174.15) meters of (A.C.S.R) transmission line and cross-sectional area ($50mm^2$).

Table2. 1 The resistance and reactance of the ACSR conductor.

A.C.S.R - Cable	R(Ohms/Km)	X(Ohms/Km)
50 mm2	0.543	0.333

Cables:

A cable is defined as a single conductor or an assembly of conductors covered by solid electrical insulation. Cable specifications generally start with the conductor and progress radially through the insulation and coverings. The following is a typical list of specifications: [2]

(a) Number of conductors in cable.

(b) Conductor size and material.

(c) Insulation type.

(d) Voltage rating.

(e) Shielding system.

(f) Outer finishes.

(g) Installation.

The underground cables have several advantages such as:

less liable to damage through storms or lightning, low maintenance cost, less chances of faults, smaller voltage drops and better general appearance. [3]

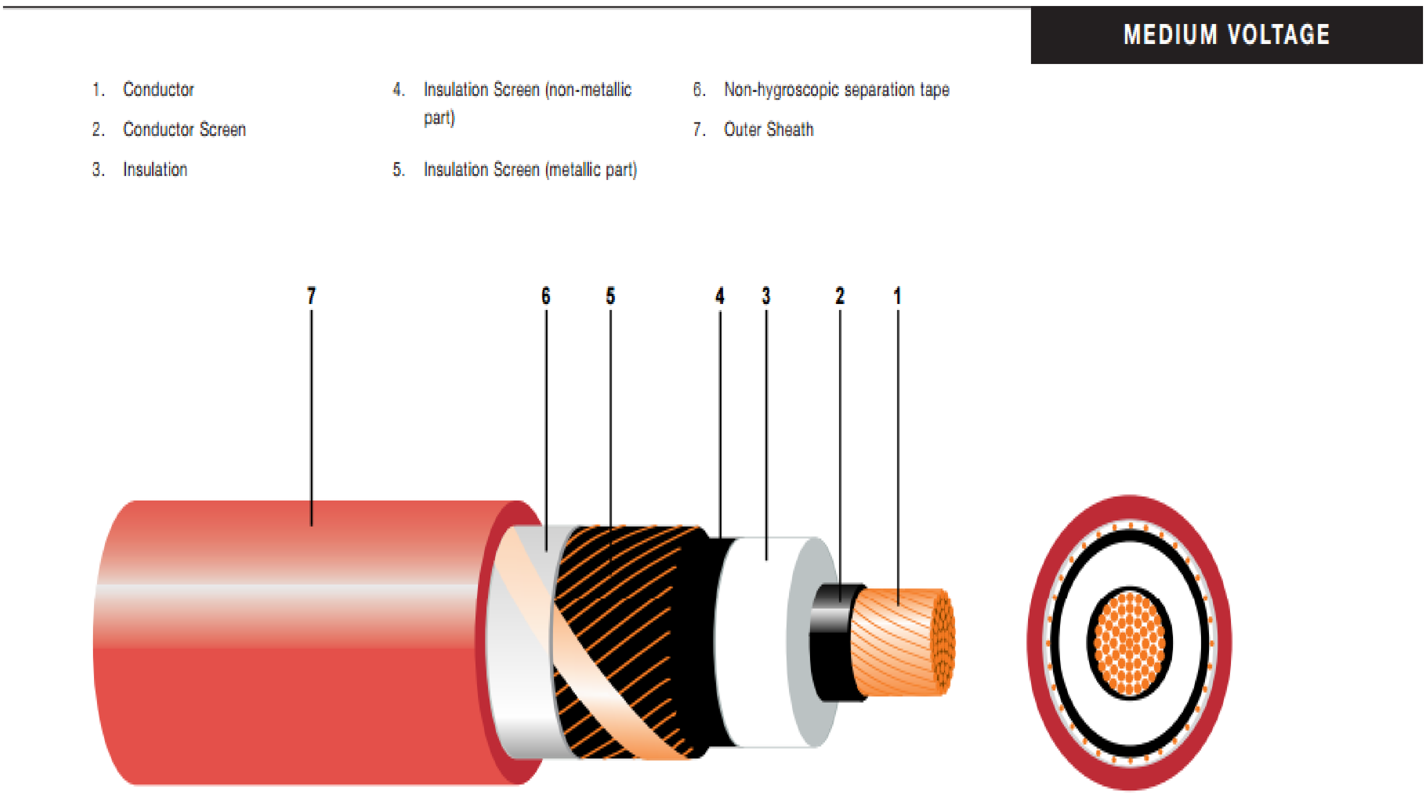


Figure 2. 3 Circular stranded compacted copper conductor, XLPE insulated, with copper wire or copper tape screen and PVC outer sheath. Complies with IEC 502.

* XLPE – Cross linked Polyethylene.

- Bani Na’im network has only 800 meters of 95 mm^2 medium voltage cable, Type of XLPE.

Table2. 2 The resistance and reactance of X.L.P.E

XLPE - Cable	R(Ohms/Km)	X(Ohms/Km)
95 mm2	0.41	0.121

2.3.2 Towers:

The main supporting unit of overhead transmission line is transmission tower. Transmission towers have to carry the heavy transmission conductor at a sufficient safe height from ground.

In addition to that all towers have to sustain all kinds of natural calamities.

Table2. 3: Safety Distance between conductor and ground.

Voltage (KV)	Distance (m)
≤33	5.8
33 to 66	6
66 to 132	6.7
132 to 273	7
275 to 400	7.3

- Bani Na’im network has 35 medium voltage towers and 44 medium voltage ladder towers.

Figure 2. 4 High voltage towers.

2.3.3 Transformers:

Transformers are an essential part of any electrical system. They come in various sizes and voltage ratings. Transformers are used for transforming power from one voltage level to another.

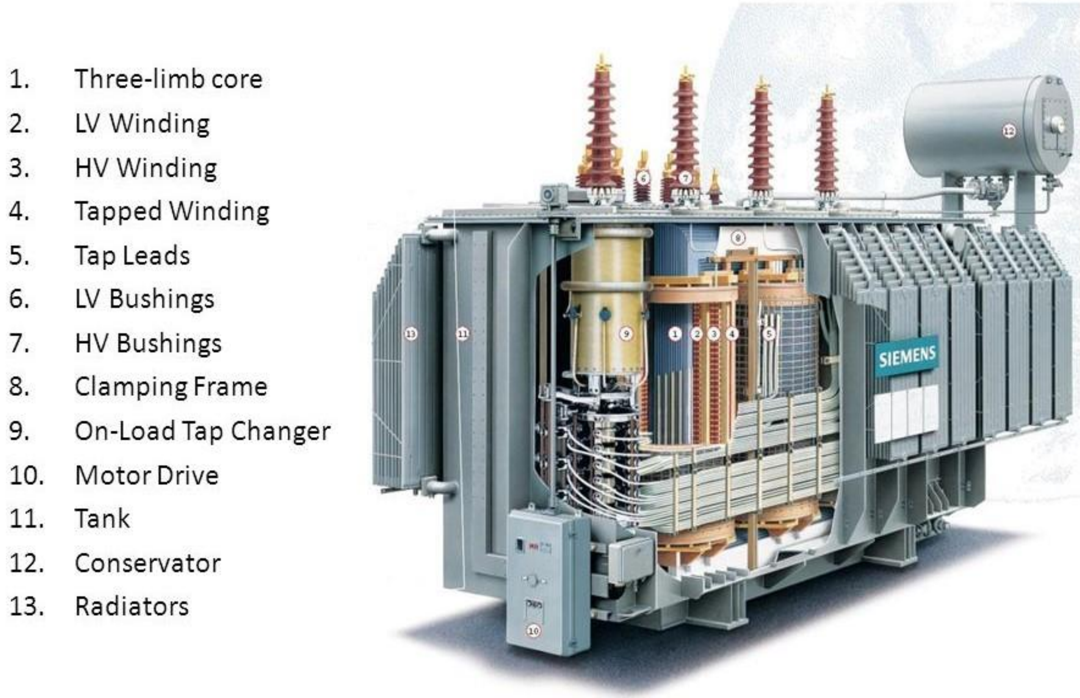


Figure 2. 5 Main parts of a transformer.

Cooling in Transformers:

Removal of heat caused by losses is necessary to prevent excessive internal temperature which would shorten the life of the insulation. The general classes of cooling are: self-cooled, forced-air or forced-oil-cooled, and water-cooled.

The basic types of cooling are referred to by standard designations. Show in the following table

Table2. 4 Transformer Cooling Designations.

Present Designation	Previous Designation	(Obsolete) Description.
ONAN	OA	Oil immersed, natural circulation, self-cooled
ONAF	FA	Oil-immersed, natural circulation, forced-air cooled
ONAN/ONAF/ONAF	OA/FA/FA	Oil-immersed, self-cooled, plus two stages of fan cooling
ONAN/ONAF/OFAF	OA/FA/FOA	Oil-immersed, self-cooled, plus one stage of fan and one stage with forced-air and forced-oil cooling
ONAN/ODAF	OA/FOA	Oil-immersed, self-cooled, plus one stage of directed fan cooling
OFAF	FOA	Oil-immersed, forced-oil, and forced-air cooled (pump and fans)
OFWF	FOW	Oil-immersed, forced-oil, and forced-water cooled
ODAF	FOA	Oil-immersed, directed forced oil, and forced-air cooled
ODWF	FOW	Oil-immersed, directed-forced oil, with forced-water cooling

- Bani Na'im installed transformers:

Bani Na'im electrical network has 37 transformers arranged for (250-630) kVA at the same rating voltage with (33/0.4) kV.

Table2.5: Transformers rating.

No.	Name of Tr.	Rating KVA	Voltage Ratio KV	Year of Operate	Type	Size of Loads
1	طلعة عمرو	400	33/0.4	1994	Domestic	Heavy
2	سنوت	400	33/0.4	1994	Domestic	Medium
3	مصنع المقالع	400	33/0.4	1996	Industrial	One Consumer
4	خلة الوردة	400	33/0.4	1999	Domestic	Medium
5	مصنع خليل خليل	400	33/0.4	1994	Industrial	One Consumer
6	خلة الشعرة	400	33/0.4	2004	Domestic	Light
7	مثلث أبو الهايل	400	33/0.4	1994	Domestic	Heavy
8	مسجد النبي لوط	400	33/0.4	1996	Domestic	Heavy
9	صورمعين	400	33/0.4	2007	Industrial	>3 Consumer
10	خلة أبو بيضة	400	33/0.4	1994	Domestic	Medium
11	الكوربة	400	33/0.4	1999	Domestic	Heavy
12	البريد	630	33/0.4	2008	Domestic	Heavy
13	مثلث عربية	400	33/0.4	2008	Domestic	Heavy
14	واد المغير	250	33/0.4	2010	Domestic	Heavy
15	الكسارة	400	33/0.4	2008	Industrial	One Consumer
16	حي وجا	400	33/0.4	2004	Domestic	Heavy
17	حي الزيدات	250	33/0.4	2010	Industrial	One Consumer
18	محاجر الزيدات	400	33/0.4	2014	Industrial	>3 Consumer
19	خلة اللوزة	250	33/0.4	2010	Industrial	One Consumer
20	مصنع خلة اللوزه	400	33/0.4	2014	Industrial	2-3 Consumer
21	مصنع الرافدين	630	33/0.4	1999	Industrial	One Consumer
22	منشار زكريا	400	33/0.4	2004	Industrial	One Consumer
23	مصنع البلاستيك	400	33/0.4	2000	Industrial	One Consumer
24	منشار أبو زايد	400	33/0.4	2006	Industrial	One Consumer
25	منشار الوسام	630	33/0.4	2004	Industrial	One Consumer
26	مصنع التحرير	400	33/0.4	2008	Industrial	One Consumer
27	حي عربية التحتا	400	33/0.4	2008	Domestic	Heavy
28	مصنع المناوس	630	33/0.4	2004	Industrial	One Consumer
29	منشار النبعة	630	33/0.4	2000	Industrial	One Consumer
30	مصنع رضوان	630	33/0.4	1999	Industrial	One Consumer
31	محاجر	400	33/0.4	2000	Industrial	One Consumer
32	منشار فؤاد	250	33/0.4	2006	Industrial	One Consumer
33	مصنع العويوي(1)	630	33/0.4	1999	Industrial	One Consumer
34	مصنع العويوي(2)	250	33/0.4	2015	Industrial	One Consumer
35	مصنع عودة	400	33/0.4	2000	Industrial	One Consumer
36	مصنع شحدة	630	33/0.4	2004	Industrial	One Consumer
37	منشار ياسين	630	33/0.4	2004	Industrial	One Consumer

Size of Loads	**Ratio loading**
Heavy	85 % - 100 % of Rating KVA
Medium	67 % - 84 % of Rating KVA
Light	20 % - 66 % of Rating KVA

Transformers classification According to the loading profile

The figure 2.6 show block diagram the classifications of electrical transformers on the medium voltage electrical network for the town of Bani Na'im where they were classified according to usage to electrical transformers industrial electrical transformers domestic and divided according to its capacity and determine the number of transformers depending on the loads on each transformer and divided industrial transformers based on the number of consumers on each transformer and domestic transformers Based on the size of the existing loads them.

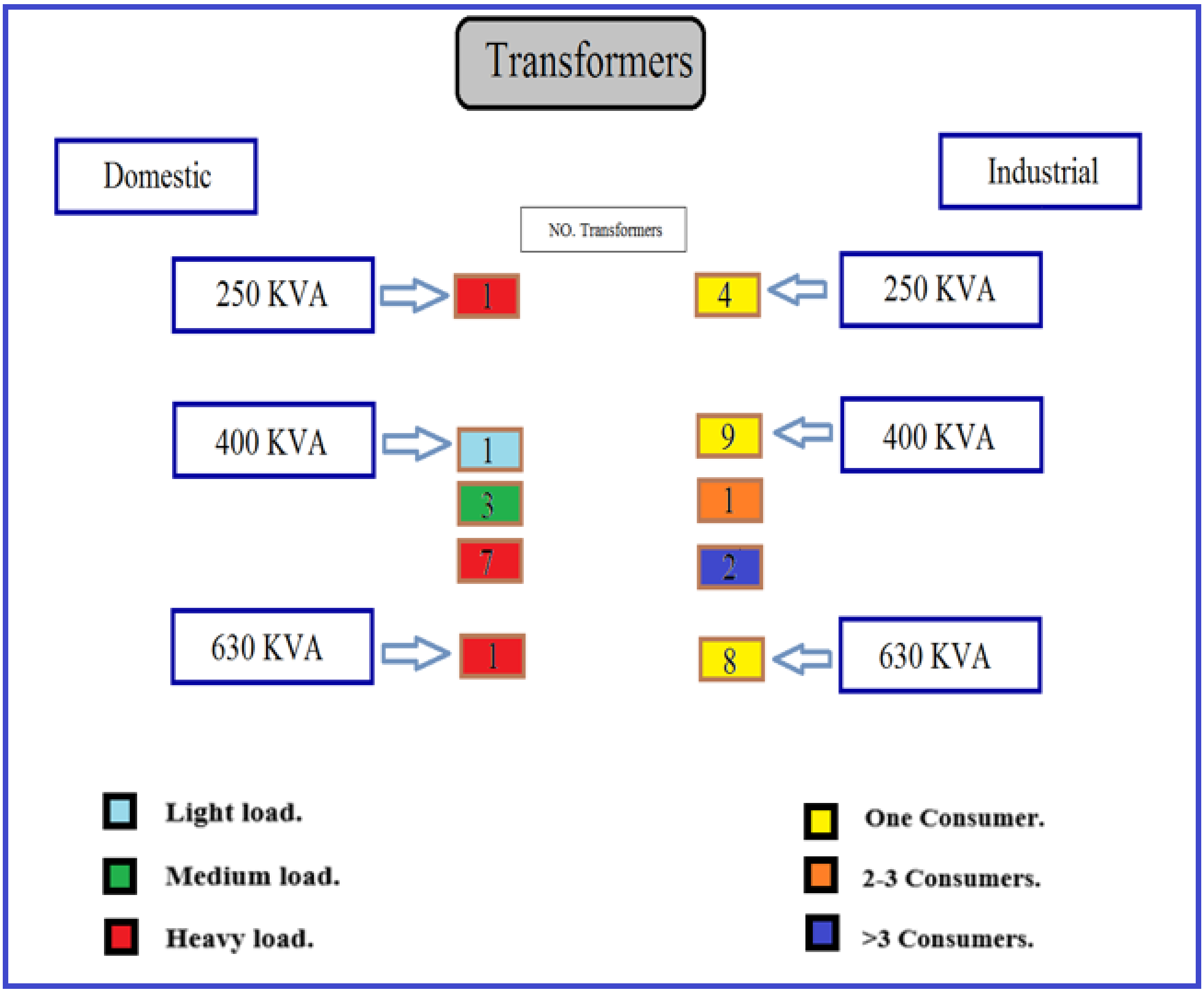


Figure 2. 6 Classify Transformers.

2.3.4 Protection devices:

Protective equipment of the important parts that must be available in every power grid, they limit the damage in the network components which may arise from increased loads or short Circuit or others of the errors that may damage the components of the network, A kind used for varies depending on network type and by application to be protected.

In the medium voltage network for the town of Bani Na'im there is the following equipment:

1- circuit breakers.

2- Fuses.

3- Isolators.

Isolators are used in addition to circuit breakers, and are provided on each side of every circuit breaker to provide isolation and enable maintenance.

Sequence of operation

While opening – Open circuit breaker first and then isolators.

While closing – Close isolators first and then close circuit breakers.

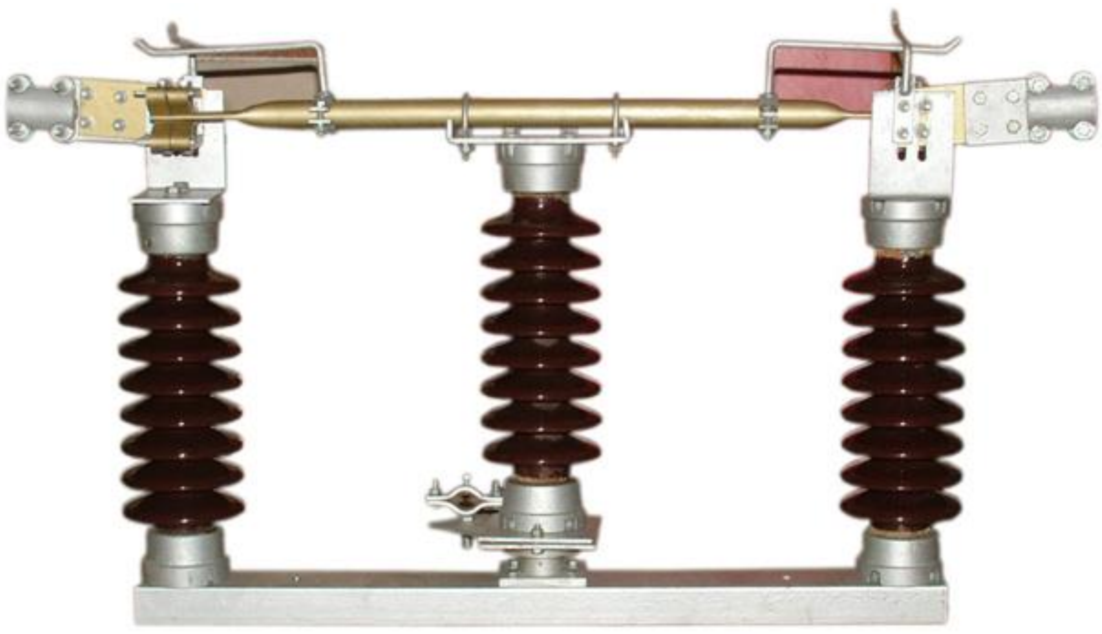


Figure 2. 7 Isolator (disconnecting switch).

4- Surge arresters.

A surge arrester is a device to protect electrical equipment from over-voltage transients caused by external (lightning) or internal (switching) events. This class of device is used to protect equipment in power transmission and distribution systems. The arrester provides a low-impedance path to ground for the current from a lightning strike or transient voltage and then restores to a normal operating condition. It will release high pressure until a normal operating condition is reached. When the pressure is returned to normal, the safety valve is ready for the next operation. When a high voltage (greater than the normal line voltage) exists on the line, the arrester immediately furnishes a path to ground and thus limits and drains of the excess voltage.

The arrester has two functions, it must provide a point in the circuit at which an over-voltage pulse can pass to ground and second, to prevent any follow-up current from owing to ground.

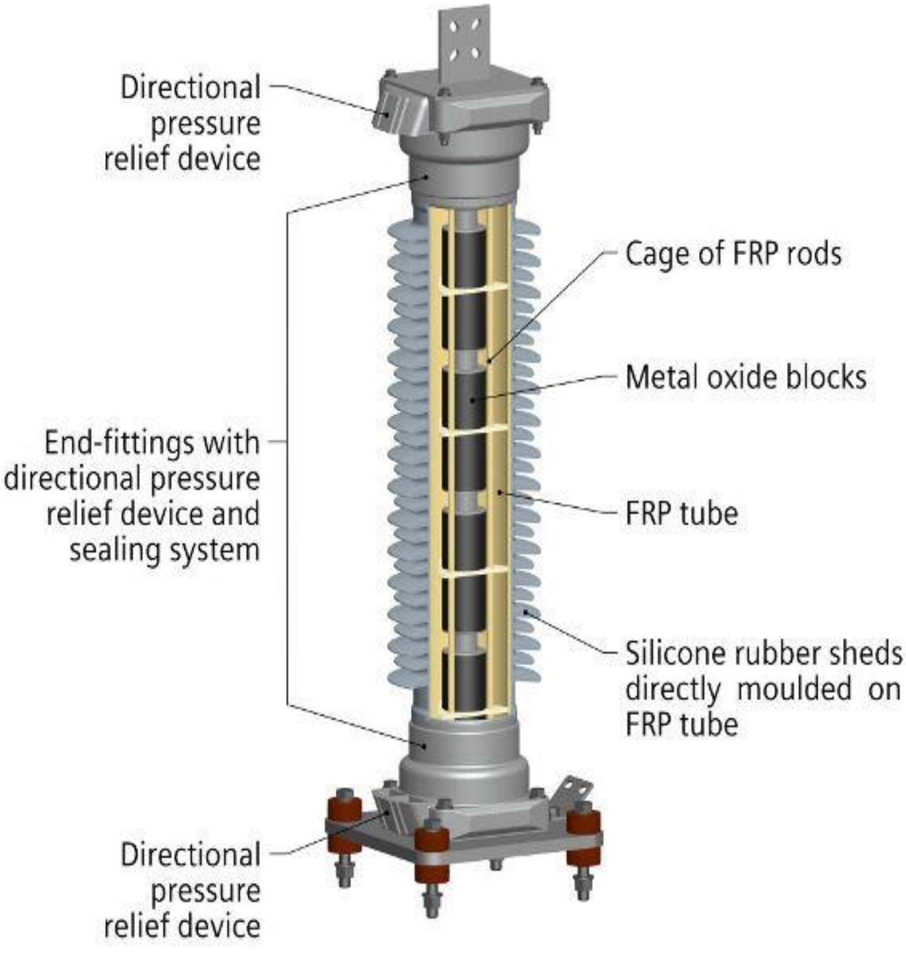


Figure 2. 8 Surge arresters.

2.3.5 Earthing System:

The topic of system grounding is extremely important, as it affects the susceptibility of the system to voltage transients, determines the types of loads the system can accommodate, and helps to determine the system protection requirements.

The system grounding arrangement is determined by the grounding of the power source. For commercial and industrial systems, the types of power sources generally fall into four broad categories:

1. Utility Service – The system grounding is usually determined by the secondary- winding configuration of the upstream utility substation transformer.

2. Generator – The system grounding is determined by the stator winding- configuration.

3. Transformer – The system grounding on the system fed by the transformer is determined by the transformer secondary winding configuration.

4. Static Power Converter – For devices such as rectifiers and inverters, the system grounding is determined by the grounding of the output stage of the converter.

Types of Earthling Systems:

There are three possible configurations:

1) **TT:** transformer neutral earthed and frame earthed.

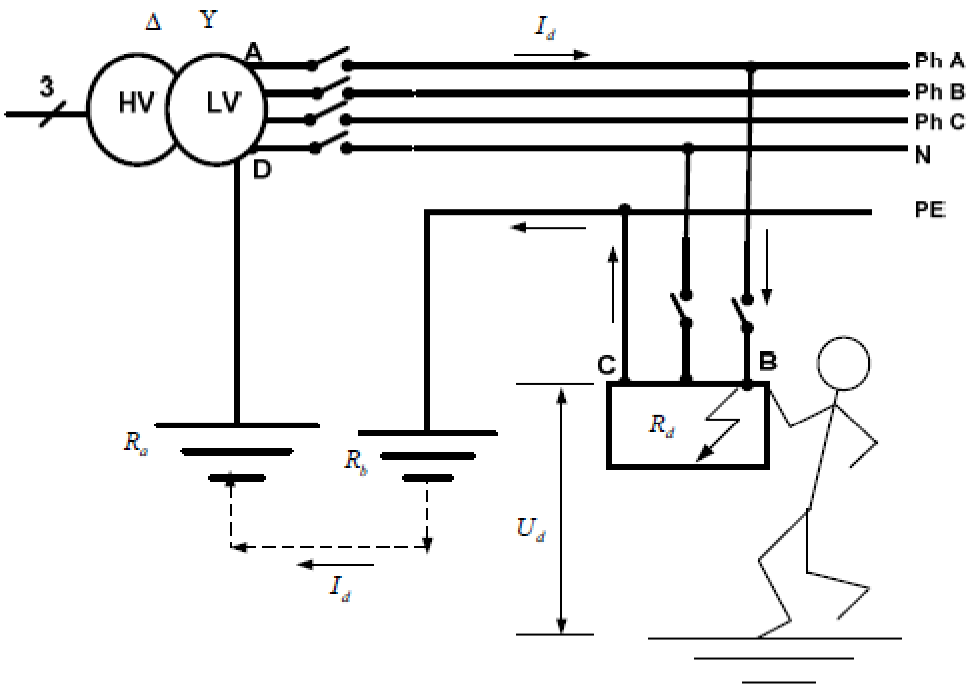


Figure 2. 9 The fault behavior in the TT earthing system.

2) **TN:** transformer neutral earthed, frame connected to neutral.

The TN system includes three sub-systems: TN-C, TN-S and TN-C-S.

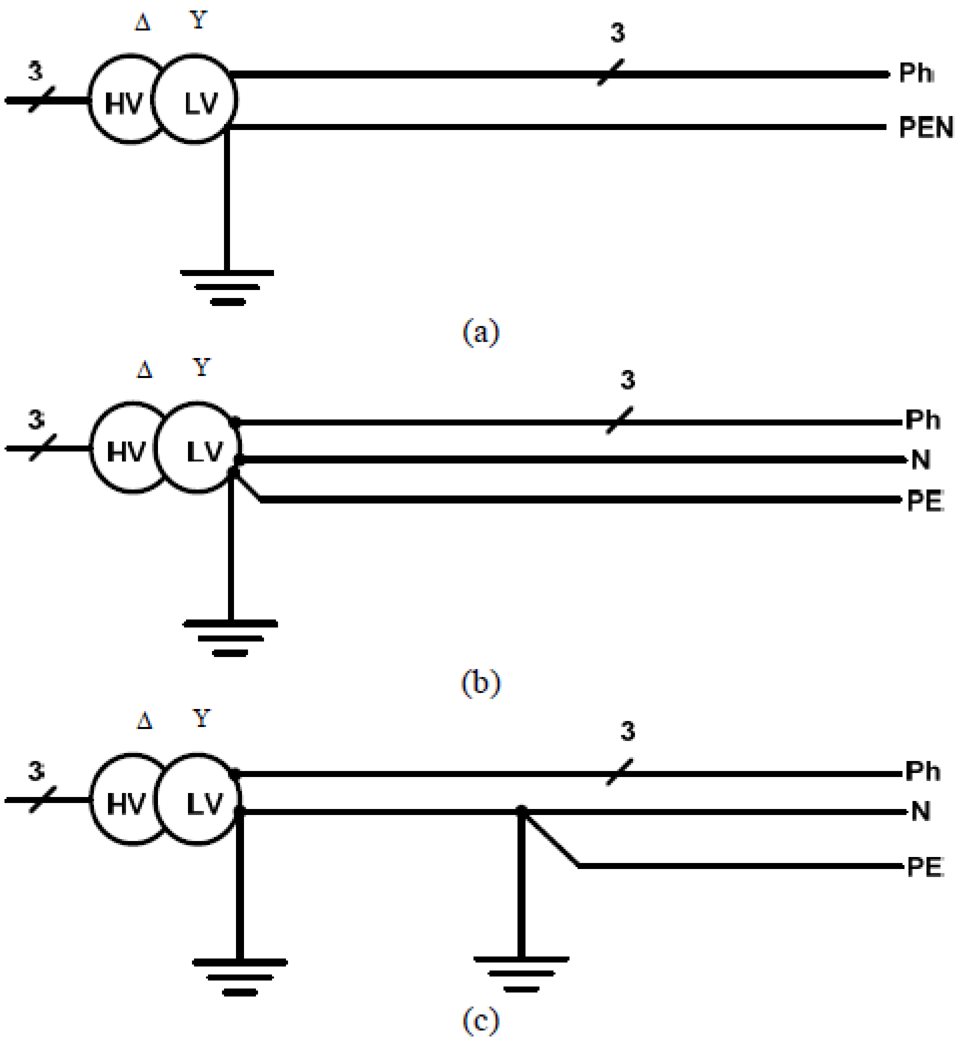


Figure 2. 10 (a): TN-C earthing system configuration; (b): TN-S earthing system configuration;

(c): TN-C-S earthing system.

3) **IT:** unearthed transformer neutral, earthed frame.

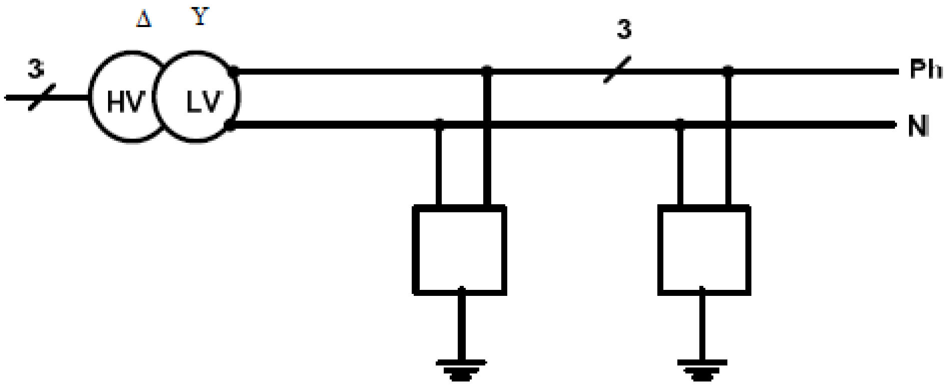


Figure 2.11. IT earthing system.

2.4 Distribution Configuration

The primary purpose of an electricity distribution system is to meet the customer's demands for energy after receiving the bulk electrical energy from transmission or sub transmission substation.

There are basically two major types of distribution substations:

Primary substation and Customer substation.

The primary substation serves as a load center and the customer substation interfaces to the low voltage (LV) network.

Customer substation is referred to a distribution room normally provided by the customer. The distribution room can accommodate a number of I-IV switchgear panel and the transformer to enable LV connection to the customer incoming switchboard.

Depending on the geographical location, the distribution network can be in the form of overhead lines or underground cables. Cables are commonly used in urban areas and overhead lines are adopted for rural areas. Different network configurations are possible in order to meet the required supply reliability. Protection, control and monitoring equipment are provided to enable effective operation of the distribution network. [4]

There's two configurations in distribution power system:

1. Radial Electrical Power Distribution System.

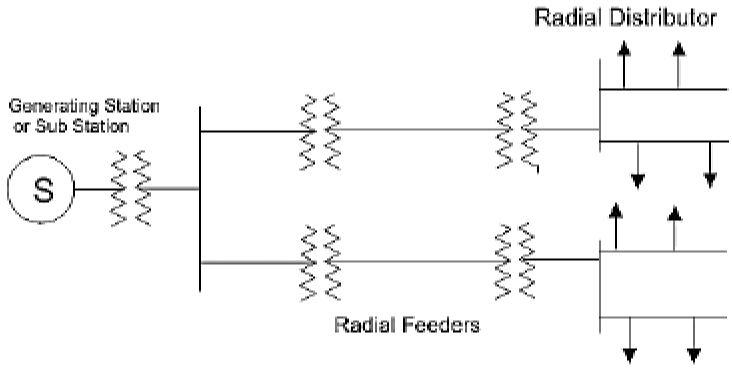


Figure 2. 12 Radial electrical power distribution system.

2. Ring Main Electrical Power Distribution System.

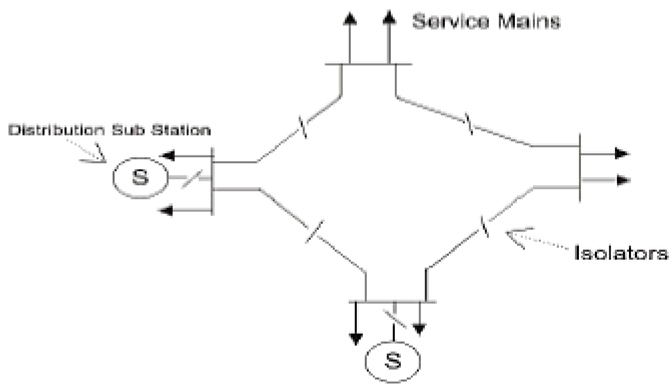


Figure 2. 13 Ring Main Electrical Power Distribution System.

- **Existing distribution configuration in Bani Na'im**

The distribution configuration used in Bani Na'im is Radial system so that the main high voltage feeder feeds industrial and domestic transformers through medium voltage transmission line and underground cable, also every transformer feeds some ABC distribution cable deliver 0.4 KV to the customers in domestic sector. That mean in case of transformer failure, the power interrupted. In other words, the consumer would be in darkness until the feeder or transformer was fixed again.

- The figure 2.14 explains distribution configuration Scheme in Bani Na'im.

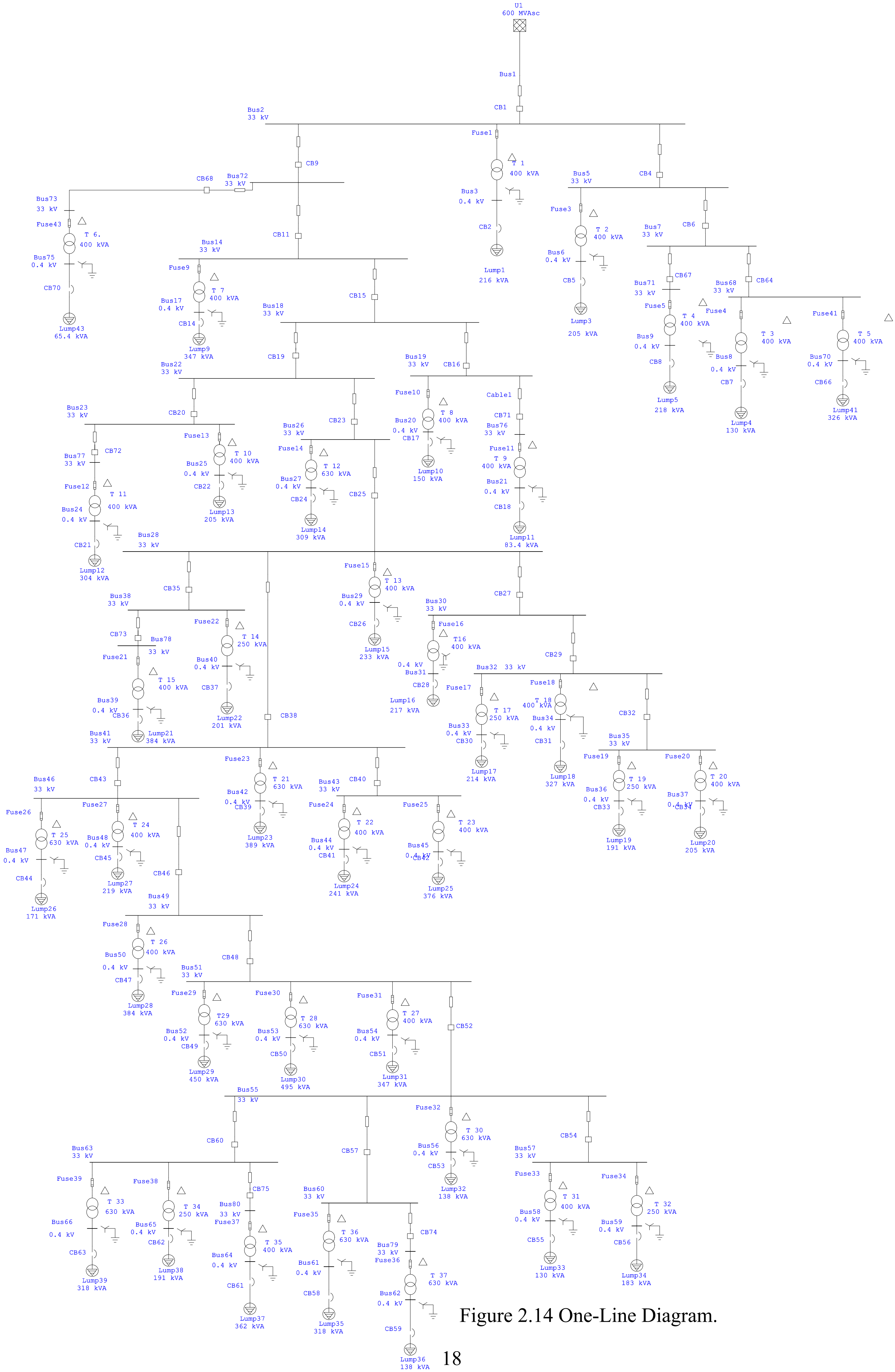


Figure 2.14 One-Line Diagram.

Chapter Three

3.1 Tools and Technologies Used

The electrical load of Bani Na'im has been measured and analyzed through a hardware device and software program.

For measuring the load, we use a device called “Vega 78 power quality analyzer “this device measures a wide range of power component and evaluate the power quality.[*]

Figure 3. 1 Vega 78 power quality analyzer device.

We use it for taking an instantaneous measuring to some of the transformers in the network then enter them to E-TAP software for data analysis.

The main software used in the project is E-TAP program witch a Power Station with fully graphical electrical transient analyzer program that can run under the Microsoft Windows.

E-TAP provide the highest performance level for demanding applications, such as large network analysis requiring intensive computation and online monitoring and control applications.

[*] For more information about device " Vega 78 power quality analyzer "See the device manual in the Appendix part 2.

3.2 Data from Vega 78 Power Quality Analyzer.

Based on the table 2.5 on page 10, the Bani Na'im network containing 37 transformers feeding the area with requirement power for domestic and industrial sectors. In our project, we decide to choose only twenty-seven transformers, ten of them is domestic transformers and seventeen industrial transformers.

As sample to make the nature of load calculation through take an approximation for diversified demand curve after recording values using "Vega 78".

We took the first reading on DEC/11/2016, then the second reading on APR/17-20/2017 three times a day, for domestic and industrial transformers

3.2.1 The following pictures show the values and waves that we measured for a simple transformer industrial transformer is the KHALAT LOZA.

1- The data of transformer consumption.

Table 3. 1: Consumption of KHALAT LOZA TRANSFORMER.

Phase 1		Phase 2		Phase 3	
Urms 242.2	S[kVA] 67.39	Urms 241.8	S[kVA] 68.19	Urms 241.7	S[kVA] 69.90
U12 419.28	P[kW] 54.85	U23 418.89	P[kW] 56.87	U13 418.97	P[kW] 58.60
Irms 278.2	Pf 1 i 0.81	Irms 282.0	Pf 2 i 0.83	Irms 289.2	Pf 3 i 0.84
Thd(I) 1.30	Q[kVAR] i 39.15	Thd(I) 1.28	Q[kVAR] i 37.62	Thd(I) 1.26	Q[kVAR] i 38.11
Thd(U) 0.41	dPf 0.81	Thd(U) 0.35	dPf 0.83	Thd(U) 0.43	dPf 0.84

Total

Stot [kVA]	Qtot [kVAR]	Ptot [kW]	PFftot	dPFtot	Ineutral	UN-PE	Freq.
205.45	114.88	170.33	0.83	0.83	14.12	0.0	50.01

2- Voltage of 3phase

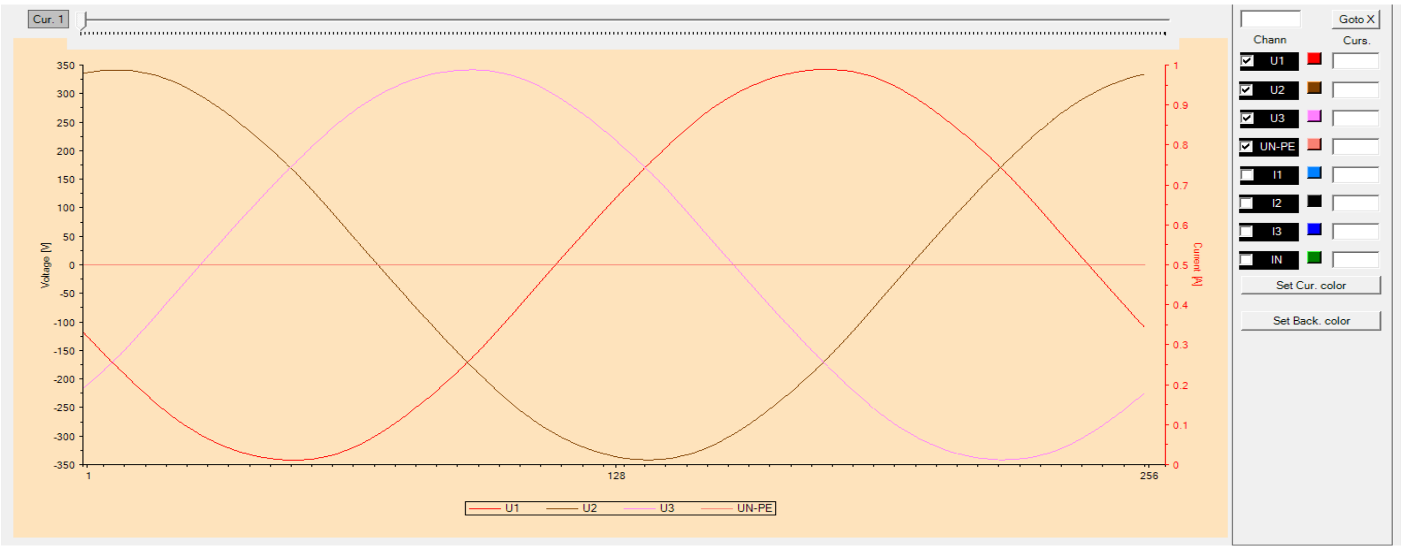


Figure 3. 2: Phase voltage of KHALAT LOZA TRANSFORMER.

3- Current of 3phase

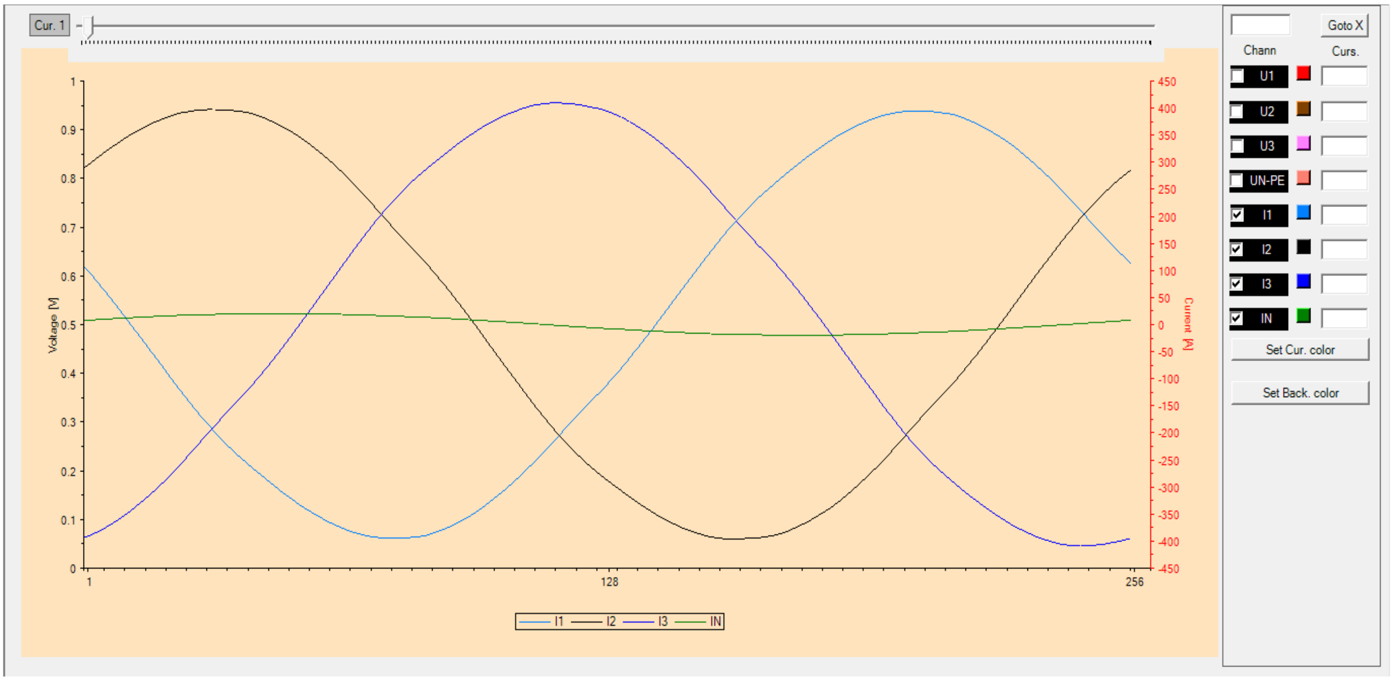


Figure 3. 3: Phase current of KHALAT LOZA TRANSFORMER.

4- Angle between phases

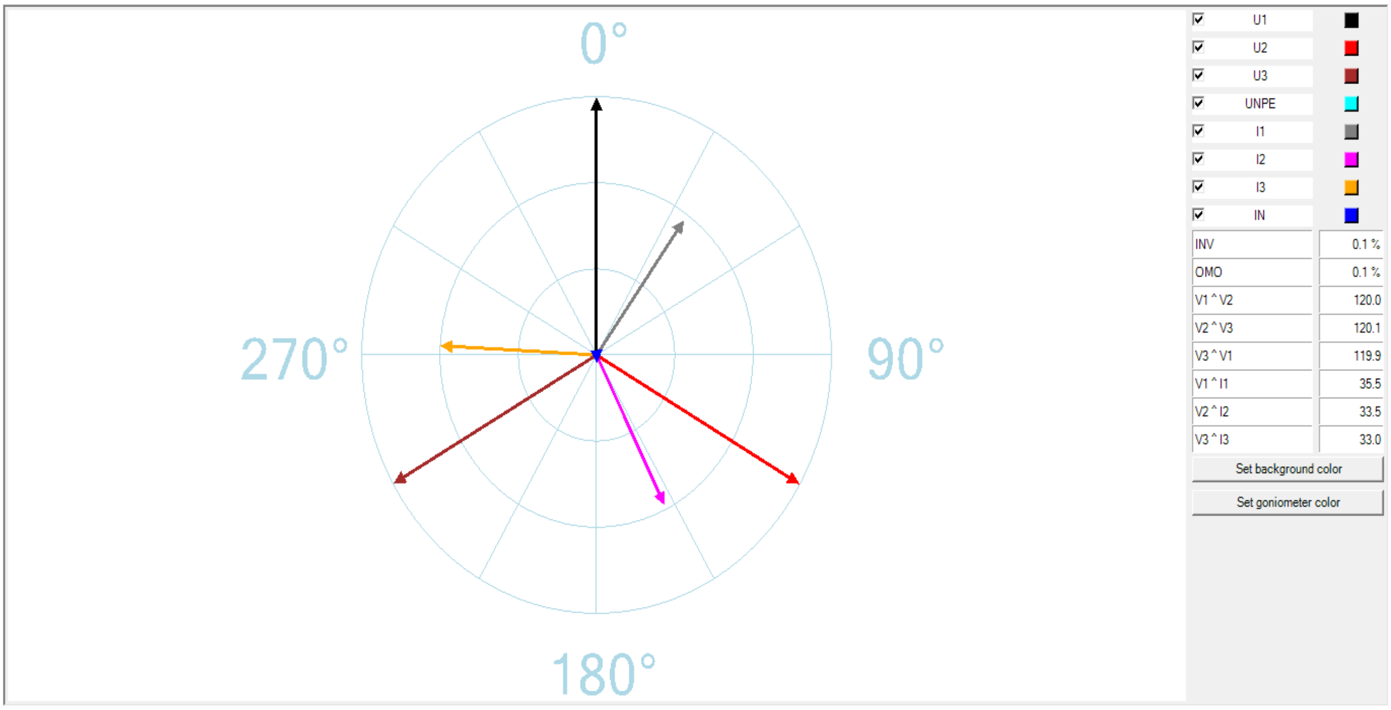


Figure 3. 4: Angles between phase's current and voltage of KHALAT LOZA TRANSFORMER.

5- Harmonic

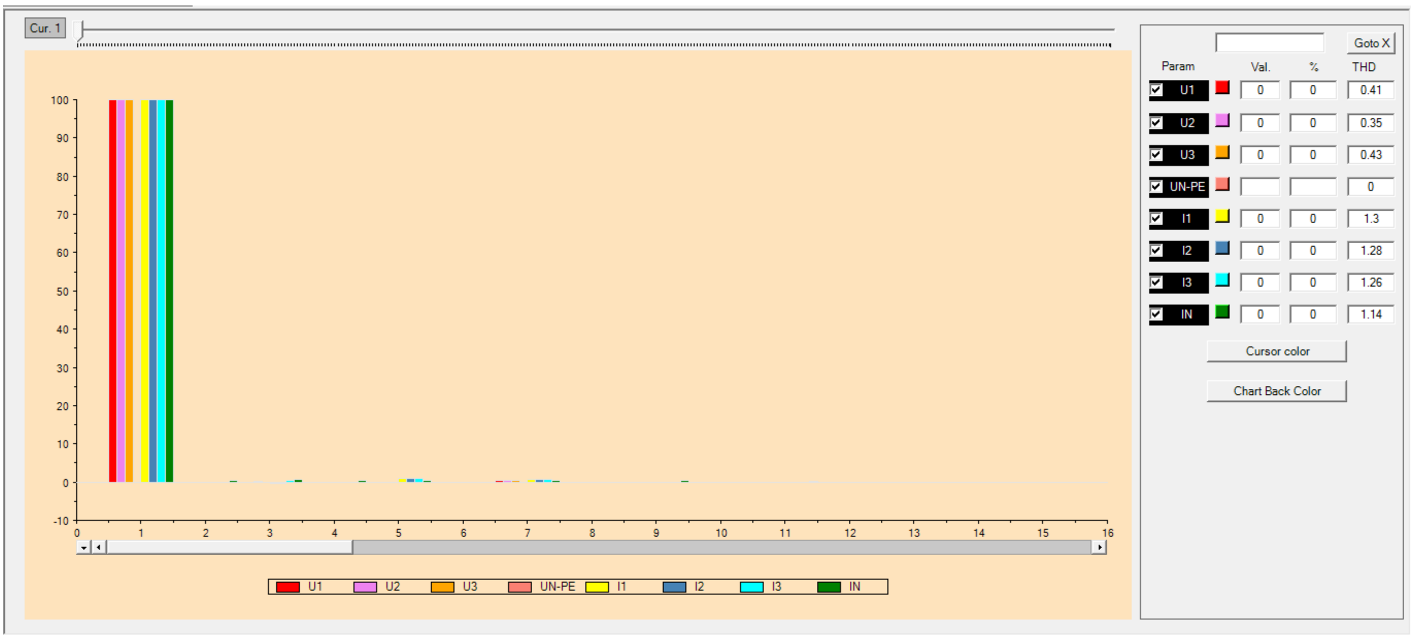
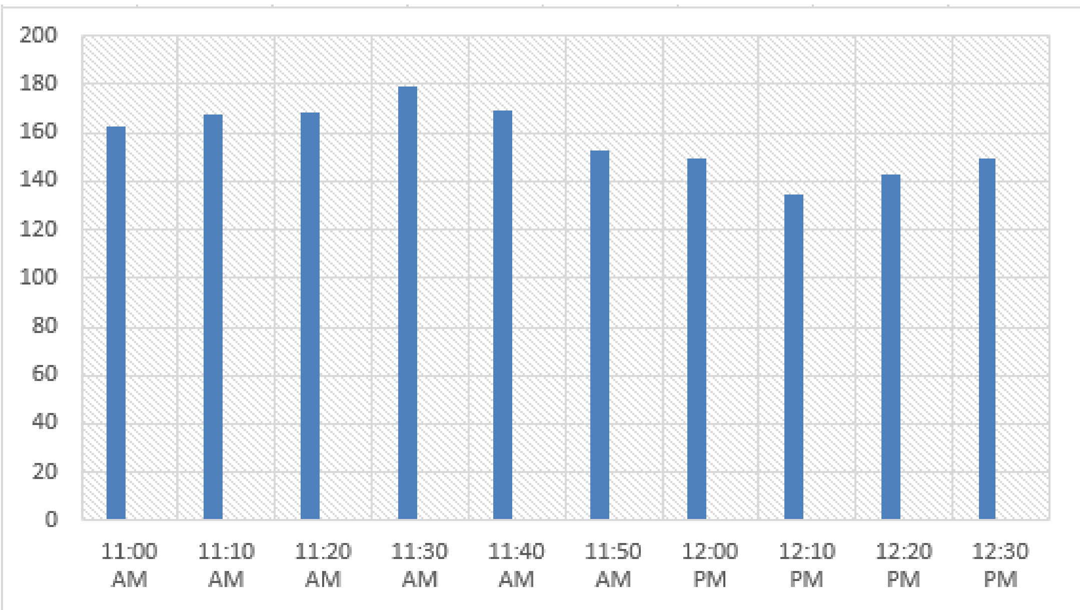


Figure 3. 5: Harmonic in current and voltage of KHALAT LOZA Transformer.

3.2.2 Table 3.2 show the values of voltage, current, power and power factor, Measured on the TALAT A'MOR domestic transformer 400 KVA, Heavy load. for an hour and a half at Morning.

Table 3. 2 : Values of TALAT A'MOR domestic transformer

Time	V1 (V)	V2 (V)	V3 (V)	V12 (V)	V23 (V)	V13 (V)	I1 (A)	I2 (A)	I3 (A)	P (KW)	Q (KVAR)	S (KVA)	PF
11:00	233.9	235.4	234.5	406.94	407.02	404.98	295.5	206.7	227.3	162.545	53.4259579	171.1	0.95
11:10	234	235.3	234.7	406.51	407.38	405.32	280.4	238	226.2	167.52	48.86	174.5	0.96
11:20	233.8	235.2	234.8	406.47	407.43	404.97	300.1	234.2	215.7	168.672	49.196	175.7	0.96
11:30	233.6	235.4	234.3	406.76	406.67	404.63	292.8	187.4	238.2	178.848	52.164	186.3	0.96
11:40	233.6	235.5	234.4	407	406.69	404.89	310.1	187.7	254.9	169.344	49.392	176.4	0.96
11:50	234.3	235.8	235.2	407.64	407.95	406.09	278.7	187	212.2	152.928	44.604	159.3	0.96
12:00	234.7	236.2	235.5	408.21	408.65	406.71	260.1	288.1	209.2	149.184	43.512	155.4	0.96
12:10	234.9	235.9	235.4	407.84	408.28	407.08	216.4	180.4	205.9	134.71	44.2770358	141.8	0.95
12:20	234.6	235.8	235.3	407.63	408.03	406.64	245.2	177.4	209.2	142.56	41.58	148.5	0.96
12:30	233.5	234.6	234.3	405.66	406.27	404.67	258.3	195.6	210.3	149.184	43.512	155.4	0.96
					avg. value		273.76	208.25	220.91	157.5495	47.0522994	164.44	0.958
					max. value		310.1	288.1	254.9	178.848	53.4259579	186.3	0.96



Time	P (KW)
11:00	162.545
11:10	167.52
11:20	168.672
11:30	178.848
11:40	169.344
11:50	152.928
12:00	149.184
12:10	134.71
12:20	142.56
12:30	149.184

Figure 3. 6: TALAT A'MOR domestic transformer.

3.3 Load Consumer Category

For domestic transformers, we found the minimum results at the morning, the average in evening, and the maximum was at night.

For industrial transformers, we found the maximum results in midday, and at night was the minimum.

See Table 3.3 & Table 3.4

Table 3. 3 : Load data from VEGA 78 of domestic transformer*

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
1	Name: طلعة عمرو Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	141.8	134.71	44.277	0.95
		MAX	322.5	309.6	90.3	0.96
		AVG	216.372	207.71	60.58	0.96
12	Name: البريد Rating-KVA: 630 Type Loads: Domestic Size of Loads: Heavy	MIN	186.13	135.88	127.21	0.73
		MAX	344.34	299.58	169.78	0.87
		AVG	308.98	256.45	172.34	0.83
14	Name: واد المغير Rating-KVA: 250 Type Loads: Domestic Size of Loads: Heavy	MIN	120.71	110.1	49.5	0.91
		MAX	223.31	198.76	101.82	0.89
		AVG	200.38	170.33	105.56	0.85

* **For load data from VEGA 78 of all domestic transformers see to Appendix part 3.**

Table 3. 4 Load data from VEGA 78 of industrial transformer[**]

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
9	Name: صورمعين Rating-KVA: 400 Type Loads: Industrial Size of Loads: >3 Consumer	MIN	34.11	31.72	12.53	0.93
		MAX	83.38	77.55	30.65	0.93
30	Name: مصنع رضوان Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	20.7	18.63	9.02	0.9
		MAX	138.035	126.99	54.09	0.92
32	Name: منشار فؤاد Rating-KVA: 250 Type Loads: Industrial Size of Loads: One Consumer	MIN	21.6	19.87	8.47	0.92
		MAX	183.2	152.1	102.18	0.83

We suffer from many barriers that we cannot connect Vega 78 during 24 hours, because the municipality staff did not cooperate enough with us, and we cannot open the transformer box all the time, see figure 3.7 which explain the reason it.

Figure 3. 7 Vega on transformer box.

[**] **For load data from VEGA 78 of all industrial transformers see to Appendix part 4.**

Chapter Four

4.1 E-TAP Program*

4.2 E-TAP Simulation and Result

4.2.1 E-TAP Simulation

In this part, we take of all transformers in the network. The simulation data of the all is cleared below for the present network before reconstruction, and the simulation data at maximum loads of industrial, and average loads of domestics.

4.2.2 One-Line diagram**

The main source of data for the system is the One-Line diagram; this data includes the series impedance and shunt admittances of the transmission line, other essential information includes transformer tap setting, data about the nominal voltages and the load power and the generated power.

Figure 4.1: Simulation.

*** For information about program the E-TAP see to appendix part 5.**
**** One-Line diagram at large scale of scheme in appendix part 6.**

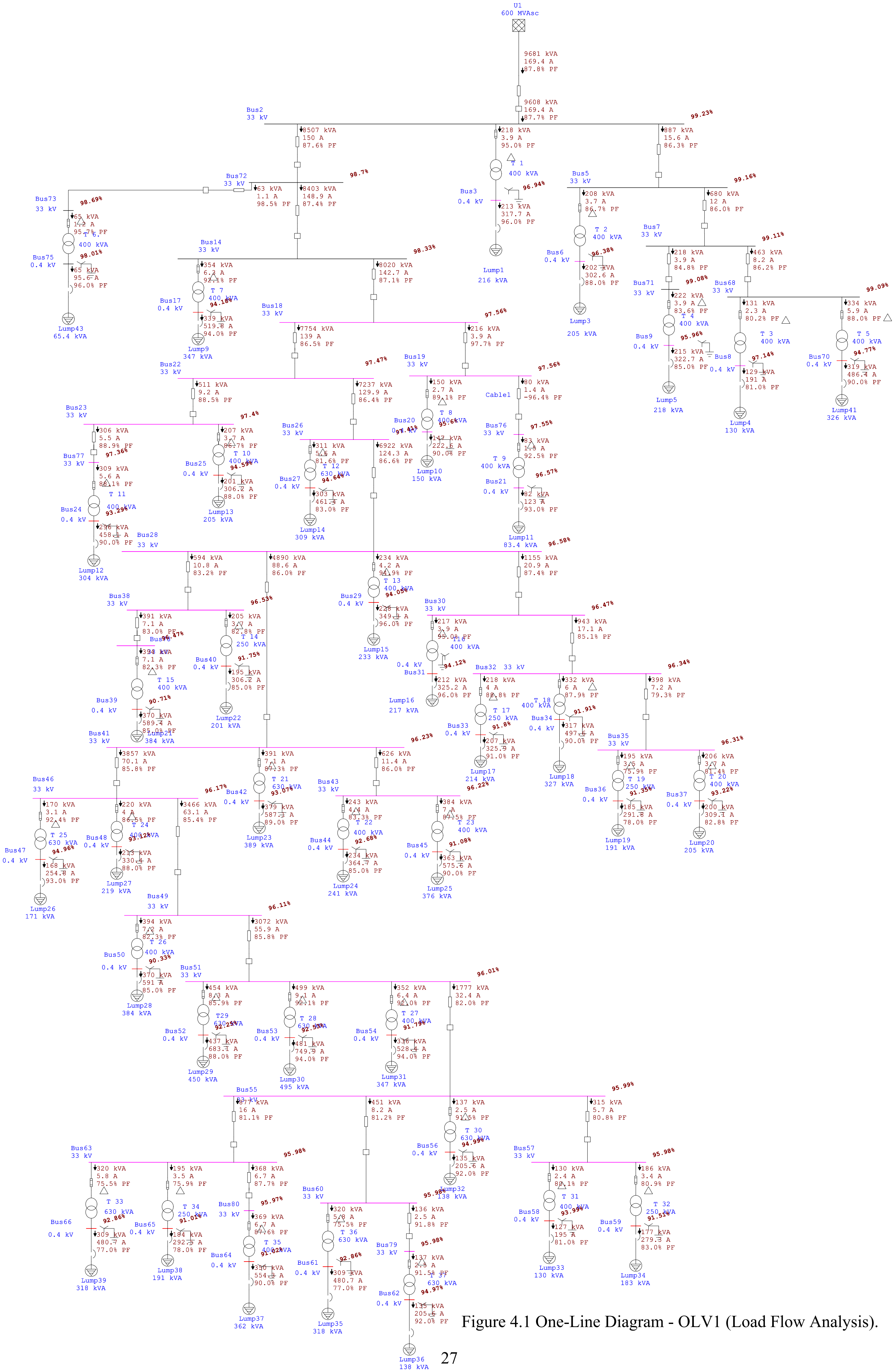


Figure 4.1 One-Line Diagram - OLV1 (Load Flow Analysis).

4.2.3 E-TAP data and result

4.2.3.1 Data:

We got the information and data from one-Line diagram on E-TAP, this data includes branches data Table4.1 and transformers data Table 4.2.

Table 4. 1 Branches data from E-TAP.

ID	Type	From	ToSec	R	X	Z	Y
Line6	Line	Bus72	Bus14	4.43481	1.186946	4.590901	0.00209
T 7	2W XFMR	Bus14	Bus17	558.073	1724.445	1812.5	0
Line8	Line	Bus14	Bus18	9.33043	2.497225	9.658832	0.00439
Line9	Line	Bus18	Bus19	2.82132	0.7551058	2.920618	0.00133
Line1	Line	Bus1	Bus2	7.8771	2.108253	8.154354	0.00371
T 8	2W XFMR	Bus19	Bus20	558.073	1724.445	1812.5	0
T 9	2W XFMR	Bus76	Bus21	558.073	1724.445	1812.5	0
Line10	Line	Bus18	Bus22	1.19601	0.320103	1.238103	0.00056
Line11	Line	Bus22	Bus23	12.2778	3.286063	12.70992	0.00578
T 11	2W XFMR	Bus77	Bus24	558.073	1724.445	1812.5	0
T 10	2W XFMR	Bus23	Bus25	558.073	1724.445	1812.5	0
Line12	Line	Bus22	Bus26	0.78771	0.2108253	0.8154354	0.00037
T 12	2W XFMR	Bus26	Bus27	281.76	1115.768	1150.794	0
Line13	Line	Bus26	Bus28	11.6502	3.118106	12.06029	0.00548
T 13	2W XFMR	Bus28	Bus29	558.073	1724.445	1812.5	0
T 1	2W XFMR	Bus2	Bus3	558.073	1724.445	1812.5	0
Line14	Line	Bus28	Bus30	9.33174	2.497576	9.660192	0.00439
T16	2W XFMR	Bus30	Bus31	558.073	1724.445	1812.5	0
Line15	Line	Bus30	Bus32	13.1285	3.513754	13.59059	0.00618
T 17	2W XFMR	Bus32	Bus33	892.917	2759.112	2900	0
T 18	2W XFMR	Bus32	Bus34	558.073	1724.445	1812.5	0
Line16	Line	Bus32	Bus35	8.92738	2.389353	9.241601	0.0042
T 19	2W XFMR	Bus35	Bus36	892.917	2759.112	2900	0
T 20	2W XFMR	Bus35	Bus37	558.073	1724.445	1812.5	0
Line17	Line	Bus28	Bus38	9.18995	2.459628	9.513412	0.00433
T 15	2W XFMR	Bus78	Bus39	558.073	1724.445	1812.5	0
T 14	2W XFMR	Bus38	Bus40	892.917	2759.112	2900	0
Line18	Line	Bus28	Bus41	7.01062	1.876345	7.257375	0.0033
T 21	2W XFMR	Bus41	Bus42	281.76	1115.768	1150.794	0
Line19	Line	Bus41	Bus43	1.57542	0.4216505	1.630871	0.00074
T 22	2W XFMR	Bus43	Bus44	558.073	1724.445	1812.5	0
T 23	2W XFMR	Bus43	Bus45	558.073	1724.445	1812.5	0
Line20	Line	Bus41	Bus46	1.57542	0.4216505	1.630871	0.00074
T 25	2W XFMR	Bus46	Bus47	281.76	1115.768	1150.794	0
T 24	2W XFMR	Bus46	Bus48	558.073	1724.445	1812.5	0
Line21	Line	Bus46	Bus49	1.54916	0.414623	1.60369	0.00073
Line2	Line	Bus2	Bus5	7.66875	2.052489	7.938671	0.00361
T 26	2W XFMR	Bus49	Bus50	558.073	1724.445	1812.5	0

Line22	Line	Bus49	Bus51	3.058942	0.8187048	3.166608	0.00144
T29	2W XFMR	Bus51	Bus52	281.7595	1115.768	1150.794	0
T 28	2W XFMR	Bus51	Bus53	281.7595	1115.768	1150.794	0
T 27	2W XFMR	Bus51	Bus54	558.0729	1724.445	1812.5	0
Line23	Line	Bus51	Bus55	1.312851	0.3513754	1.359059	0.000618
T 30	2W XFMR	Bus55	Bus56	281.7595	1115.768	1150.794	0
Line24	Line	Bus55	Bus57	2.704472	0.7238334	2.799661	0.001273
T 31	2W XFMR	Bus57	Bus58	558.0729	1724.445	1812.5	0
T 32	2W XFMR	Bus57	Bus59	892.9166	2759.112	2900	0
T 2	2W XFMR	Bus5	Bus6	558.0729	1724.445	1812.5	0
Line25	Line	Bus55	Bus60	2.025728	0.5421723	2.097028	0.000954
T 36	2W XFMR	Bus60	Bus61	281.7595	1115.768	1150.794	0
T 37	2W XFMR	Bus79	Bus62	281.7595	1115.768	1150.794	0
Line26	Line	Bus55	Bus63	1.553102	0.4156772	1.607767	0.000731
T 35	2W XFMR	Bus80	Bus64	558.0729	1724.445	1812.5	0
T 34	2W XFMR	Bus63	Bus65	892.9166	2759.112	2900	0
T 33	2W XFMR	Bus63	Bus66	281.7595	1115.768	1150.794	0
Line27	Line	Bus7	Bus68	4.594977	1.229814	4.756706	0.002163
Line3	Line	Bus5	Bus7	7.605343	2.035518	7.873029	0.00358
T 5	2W XFMR	Bus68	Bus70	558.0729	1724.445	1812.5	0
Line28	Line	Bus7	Bus71	12.89088	3.450155	13.3446	0.006069
Line4	Line	Bus2	Bus72	6.136264	1.642329	6.352242	0.002889
Line29	Line	Bus72	Bus73	17.3165	4.63452	17.92596	0.008155
T 6.	2W XFMR	Bus73	Bus75	558.0729	1724.445	1812.5	0
Cable1	Cable	Bus19	Bus76	1.73764	1.260606	2.146746	0.055513
Line30	Line	Bus23	Bus77	13.9556	3.735121	14.4468	0.00657
Line31	Line	Bus38	Bus78	13.12851	3.513754	13.59059	0.006181
Line32	Line	Bus60	Bus79	2.625701	0.7027509	2.718118	0.001236
T 3	2W XFMR	Bus68	Bus8	558.0729	1724.445	1812.5	0
Line33	Line	Bus63	Bus80	1.312851	0.3513754	1.359059	0.000618
T 4	2W XFMR	Bus71	Bus9	558.0729	1724.445	1812.5	0

Table 4. 2 Transformers data from E-TAP.

ID	From Bus	To Bus	Prim-kV	Prim %Tap	Sec-kV	Sec %Tap	Conn.	Sec.Grd.Type	MVA	Max-MVA	PosZ	PosX/R	ZeroZ	ZeroX/R
T 7	Bus14	Bus17	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 8	Bus19	Bus20	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 9	Bus76	Bus21	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 11	Bus77	Bus24	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 10	Bus23	Bus25	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 12	Bus26	Bus27	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 13	Bus28	Bus29	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 1	Bus2	Bus3	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T16	Bus30	Bus31	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 17	Bus32	Bus33	33	0	0.4	0	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 18	Bus32	Bus34	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 19	Bus35	Bus36	33	0	0.4	0	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 20	Bus35	Bus37	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 15	Bus78	Bus39	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 14	Bus38	Bus40	33	0	0.4	0	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 21	Bus41	Bus42	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 22	Bus43	Bus44	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 23	Bus43	Bus45	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 25	Bus46	Bus47	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 24	Bus46	Bus48	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 26	Bus49	Bus50	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T29	Bus51	Bus52	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 28	Bus51	Bus53	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 27	Bus51	Bus54	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 30	Bus55	Bus56	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 31	Bus57	Bus58	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 32	Bus57	Bus59	33	0	0.4	0	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 2	Bus5	Bus6	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 36	Bus60	Bus61	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 37	Bus79	Bus62	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 35	Bus80	Bus64	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 34	Bus63	Bus65	33	0	0.4	0	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 33	Bus63	Bus66	33	0	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 5	Bus68	Bus70	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 6.	Bus73	Bus75	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 3	Bus68	Bus8	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 4	Bus71	Bus9	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09

4.2.3.2 Result

The load flow study is very important in evaluating the operation of power systems. Controlling them, planning for the future expansion and solve the problem in network, the relating to a real power system can be carried out only with a digital computer. Because of the complexity of the calculation we use a computer program in our case we use the E-TAP.

4.2.3.2.1 Load flow *

We apply load flow test on the grid with balance load then record the result of our simulation for the existing transformers show in table 4.3.

* **see Appendix to the Complete report of Load Flow Analysis part 7.**

Table 4. 3 Load flow Source Load from E-TAP.

ID	IDTerm Bus	Rated-kV	KVA-HP	Amp Rating	PF	Operating-KW	Operating-Kvar	Operating-Amp
U1	Bus1	33	600000	0	0	8495.825	4640.382	169.3649
Lump9	Bus17	0.4	347	500.8513	94	318.8109	115.7129	519.7725
Lump10	Bus20	0.4	150	216.5063	90	132.6773	64.25854	222.57
Lump11	Bus21	0.4	83.3872	120.3591	92.99	76.50295	30.23617	122.9568
Lump12	Bus24	0.4	304	438.7862	90	266.5024	129.073	458.1474
Lump13	Bus25	0.4	205	295.892	88	176.5996	95.31837	306.2356
Lump14	Bus27	0.4	309	446.0031	83	251.1199	168.7536	461.4256
Lump15	Bus29	0.4	233	336.3065	96	218.5368	63.65764	349.3258
Lump1	Bus3	0.4	216	311.7691	96	204.8574	59.75009	317.7426
Lump16	Bus31	0.4	217	313.2125	96	203.5826	59.30164	325.1896
Lump17	Bus33	0.4	214	308.8824	91	188.6173	85.93655	325.8802
Lump18	Bus34	0.4	327	471.9839	90	285.1663	138.1124	497.5676
Lump19	Bus36	0.4	191	275.6848	78	144.0509	115.5694	291.7888
Lump20	Bus37	0.4	205	295.892	82.82	165.3484	111.8533	309.0992
Lump21	Bus39	0.4	384	554.2563	85	314.8337	195.1164	589.3717
Lump22	Bus40	0.4	201	290.1185	85	165.4452	102.5337	306.1987
Lump23	Bus42	0.4	389	561.4731	89	336.9513	172.6253	587.119
Lump24	Bus44	0.4	241	347.8535	85	199.0701	123.3726	364.745
Lump25	Bus45	0.4	376	542.7092	90	326.8596	158.3053	575.564
Lump26	Bus47	0.4	171	246.8172	93	155.9075	61.6186	254.8013
Lump27	Bus48	0.4	219	316.0993	88	187.6011	101.2564	330.4259
Lump28	Bus50	0.4	384	554.2563	85	314.383	194.8371	591.0128
Lump29	Bus52	0.4	450	649.519	88	384.1952	207.3666	683.1195
Lump30	Bus53	0.4	495	714.4709	94	451.9177	164.0242	749.9357
Lump31	Bus54	0.4	347	500.8513	94	315.9139	114.6614	528.447
Lump32	Bus56	0.4	138	199.1858	92	124.4784	53.02758	205.5973
Lump33	Bus58	0.4	130	187.6388	81	102.8457	74.45903	194.9783
Lump34	Bus59	0.4	183	264.1378	83	146.9487	98.75011	279.2649
Lump3	Bus6	0.4	205	295.892	88	177.837	95.98627	302.6352
Lump35	Bus61	0.4	318	458.9935	77	238.1162	197.3098	480.6736
Lump36	Bus62	0.4	138	199.1858	92	124.4721	53.02489	205.6152
Lump37	Bus64	0.4	362	522.502	90	314.6256	152.3802	554.3478
Lump38	Bus65	0.4	191	275.6848	78	143.8636	115.4191	292.5132
Lump39	Bus66	0.4	318	458.9935	77	238.112	197.3063	480.6891
Lump41	Bus70	0.4	326	470.5405	90	287.4197	139.2037	486.4009
Lump43	Bus75	0.4	65.4	94.39677	96	62.29008	18.16795	95.55226
Lump4	Bus8	0.4	130	187.6388	81	104.1146	75.37769	190.9791
Lump5	Bus9	0.4	218	314.6559	85	182.3647	113.0195	322.7152

4.2.3.2.2 Branch Losses

The table 4.4 indicate power losses in the network with the specific location of the losses.

Table 4. 4 Branch Losses.

ID-Branch	From	To	From To-MW	From To-MVar	To From-MW	ToFrom-Mvar	Loss-kW	Loss-kvar	% Bus Voltage From	% Bus Voltage To	Vd % Drop in Vmag	FromTo Amp	To From Amp
Line1	Bus1	Bus2	8.50	4.64	-8.42	-4.62	73.83	16.08	100.00	99.23	0.77	169.3649	169.396
Line2	Bus2	Bus5	0.77	0.45	-0.76	-0.45	0.61	-3.39	99.23	99.16	0.07	15.63249	15.66422
Line4	Bus2	Bus72	7.45	4.11	-7.40	-4.10	45.10	9.24	99.23	98.70	0.53	149.9838	150.008
T 1	Bus2	Bus3	0.21	0.07	-0.20	-0.06	2.70	8.36	99.23	96.94	2.30	3.851425	317.7425
Line3	Bus5	Bus7	0.58	0.35	-0.58	-0.35	0.36	-3.42	99.16	99.11	0.05	11.99622	12.02807
T 2	Bus5	Bus6	0.18	0.10	-0.18	-0.10	2.45	7.58	99.16	96.38	2.78	3.668305	302.6352
Line27	Bus7	Bus68	0.40	0.24	-0.40	-0.24	0.10	-2.10	99.11	99.09	0.02	8.174008	8.193114
Line28	Bus7	Bus71	0.19	0.12	-0.19	-0.12	0.06	-5.94	99.11	99.08	0.03	3.854934	3.9117
T 3	Bus8	Bus68	-0.10	-0.08	0.11	0.08	0.98	3.02	97.14	99.09	1.95	190.9791	2.314898
T 4	Bus9	Bus71	-0.18	-0.11	0.19	0.12	2.79	8.62	95.96	99.08	3.13	322.7152	3.9117
Line6	Bus14	Bus72	-7.31	-4.08	7.34	4.09	32.15	6.58	98.33	98.70	0.38	148.9618	148.9443
Line8	Bus14	Bus18	6.98	3.94	-6.92	-3.93	62.09	12.40	98.33	97.56	0.76	142.7004	142.7375
T 7	Bus14	Bus17	0.33	0.14	-0.32	-0.12	7.24	22.36	98.33	94.18	4.14	6.300273	519.7725
Line9	Bus18	Bus19	0.21	0.05	-0.21	-0.05	0.01	-1.26	97.56	97.56	0.01	3.870419	3.875288
Line10	Bus18	Bus22	6.71	3.89	-6.70	-3.88	7.55	1.49	97.56	97.47	0.10	139.0481	139.053
Cable1	Bus19	Bus76	0.08	-0.02	-0.08	-0.03	0.00	-52.83	97.56	97.55	0.00	1.431391	1.490386
T 8	Bus19	Bus20	0.13	0.07	-0.13	-0.06	1.33	4.10	97.56	95.60	1.95	2.697819	222.57
T 9	Bus21	Bus76	-0.08	-0.03	0.08	0.03	0.40	1.25	96.57	97.55	0.99	122.9568	1.490386
Line11	Bus22	Bus23	0.45	0.24	-0.45	-0.24	0.34	-5.40	97.47	97.40	0.07	9.164351	9.210691
Line12	Bus22	Bus26	6.25	3.65	-6.25	-3.65	4.34	0.81	97.47	97.41	0.06	129.8966	129.8998
Line30	Bus23	Bus77	0.27	0.14	-0.27	-0.15	0.14	-6.19	97.40	97.36	0.04	5.501144	5.553302
T 10	Bus23	Bus25	0.18	0.10	-0.18	-0.10	2.51	7.76	97.40	94.59	2.82	3.711946	306.2356
T 11	Bus24	Bus77	-0.27	-0.13	0.27	0.15	5.62	17.37	93.29	97.36	4.07	458.1474	5.553302
Line13	Bus26	Bus28	5.99	3.47	-5.93	-3.45	58.86	10.59	97.41	96.58	0.83	124.3297	124.3764
T 12	Bus26	Bus27	0.25	0.18	-0.25	-0.17	2.88	11.40	97.41	94.64	2.77	5.593038	461.4256
Line14	Bus28	Bus30	1.01	0.56	-1.01	-0.56	1.34	-3.74	96.58	96.47	0.11	20.91803	20.95413
Line17	Bus28	Bus38	0.49	0.33	-0.49	-0.33	0.35	-3.94	96.58	96.53	0.06	10.75591	10.79661
Line18	Bus28	Bus41	4.21	2.49	-4.19	-2.49	17.98	1.74	96.58	96.23	0.35	88.5844	88.61279
T 13	Bus28	Bus29	0.22	0.07	-0.22	-0.06	3.27	10.10	96.58	94.05	2.53	4.234252	349.3258
Line15	Bus30	Bus32	0.80	0.50	-0.80	-0.50	1.26	-5.41	96.47	96.34	0.13	17.10094	17.15602
T16	Bus30	Bus31	0.21	0.07	-0.20	-0.06	2.83	8.75	96.47	94.12	2.35	3.941693	325.1897
Line16	Bus32	Bus35	0.32	0.24	-0.32	-0.25	0.15	-3.86	96.34	96.31	0.04	7.232732	7.276122
T 17	Bus32	Bus33	0.19	0.10	-0.19	-0.09	4.55	14.06	96.34	91.80	4.54	3.950063	325.8802
T 18	Bus32	Bus34	0.29	0.16	-0.29	-0.14	6.63	20.49	96.34	91.91	4.43	6.031122	497.5676
T 19	Bus35	Bus36	0.15	0.13	-0.14	-0.12	3.65	11.28	96.31	91.35	4.95	3.536834	291.7888
T 20	Bus35	Bus37	0.17	0.12	-0.17	-0.11	2.56	7.91	96.31	93.22	3.09	3.746657	309.0992
Line31	Bus38	Bus78	0.32	0.22	-0.32	-0.22	0.22	-5.70	96.53	96.47	0.05	7.085127	7.143899
T 14	Bus38	Bus40	0.17	0.11	-0.17	-0.10	4.02	12.42	96.53	91.75	4.78	3.7115	306.1987
T 15	Bus39	Bus78	-0.31	-0.20	0.32	0.22	9.30	28.75	90.71	96.47	5.76	589.3717	7.143899
Line19	Bus41	Bus43	0.54	0.32	-0.54	-0.32	0.07	-0.67	96.23	96.22	0.01	11.38259	11.38896
Line20	Bus41	Bus46	3.31	1.98	-3.31	-1.98	2.53	-0.01	96.23	96.17	0.06	70.11632	70.12273

T 21	Bus41	Bus42	0.34	0.19	-0.34	-0.17	4.66	18.46	96.23	93.07	3.15	7.116593	587.1189
T 22	Bus43	Bus44	0.20	0.13	-0.20	-0.12	3.56	11.01	96.22	92.68	3.54	4.421152	364.745
T 23	Bus43	Bus45	0.34	0.19	-0.33	-0.16	8.87	27.42	96.22	91.08	5.14	6.976534	575.564
Line21	Bus46	Bus49	2.96	1.80	-2.96	-1.80	2.01	-0.14	96.17	96.11	0.06	63.06424	63.07063
T 24	Bus46	Bus48	0.19	0.11	-0.19	-0.10	2.92	9.04	96.17	93.12	3.04	4.005162	330.4258
T 25	Bus46	Bus47	0.16	0.07	-0.16	-0.06	0.88	3.48	96.17	94.96	1.20	3.088501	254.8013
Line22	Bus49	Bus51	2.63	1.58	-2.63	-1.58	3.13	-0.49	96.11	96.01	0.10	55.92003	55.93248
T 26	Bus49	Bus50	0.32	0.22	-0.31	-0.19	9.36	28.91	96.11	90.33	5.78	7.163792	591.0128
Line23	Bus51	Bus55	1.46	1.02	-1.46	-1.02	0.45	-0.45	96.01	95.99	0.02	32.38293	32.38887
T 27	Bus51	Bus54	0.32	0.14	-0.32	-0.11	7.48	23.11	96.01	91.79	4.22	6.405419	528.447
T 28	Bus51	Bus53	0.46	0.19	-0.45	-0.16	7.61	30.12	96.01	92.53	3.48	9.09013	749.9357
T29	Bus51	Bus52	0.39	0.23	-0.38	-0.21	6.31	24.99	96.01	92.25	3.77	8.280237	683.1195
Line24	Bus55	Bus57	0.25	0.19	-0.25	-0.19	0.03	-1.17	95.99	95.98	0.01	5.735637	5.748269
Line25	Bus55	Bus60	0.37	0.26	-0.37	-0.26	0.04	-0.87	95.99	95.98	0.01	8.219226	8.228576
Line26	Bus55	Bus63	0.71	0.51	-0.71	-0.51	0.13	-0.64	95.99	95.98	0.01	15.99206	15.99924
T 30	Bus55	Bus56	0.13	0.06	-0.12	-0.05	0.57	2.26	95.99	94.99	1.00	2.492088	205.5973
T 31	Bus57	Bus58	0.10	0.08	-0.10	-0.07	1.02	3.15	95.98	93.99	1.99	2.363374	194.9783
T 32	Bus57	Bus59	0.15	0.11	-0.15	-0.10	3.34	10.33	95.98	91.51	4.47	3.385029	279.2649
Line32	Bus60	Bus79	0.13	0.05	-0.13	-0.06	0.01	-1.14	95.98	95.98	0.00	2.483985	2.492306
T 36	Bus60	Bus61	0.24	0.21	-0.24	-0.20	3.12	12.37	95.98	92.86	3.12	5.826347	480.6736
T 37	Bus62	Bus79	-0.12	-0.05	0.13	0.06	0.57	2.26	94.97	95.98	1.00	205.6152	2.492306
Line33	Bus63	Bus80	0.32	0.18	-0.32	-0.18	0.02	-0.56	95.98	95.97	0.01	6.714368	6.719368
T 33	Bus63	Bus66	0.24	0.21	-0.24	-0.20	3.12	12.37	95.98	92.86	3.12	5.826534	480.6891
T 34	Bus63	Bus65	0.15	0.13	-0.14	-0.12	3.67	11.33	95.98	91.01	4.96	3.545615	292.5132
T 35	Bus64	Bus80	-0.31	-0.15	0.32	0.18	8.23	25.44	91.02	95.97	4.95	554.3479	6.719368
T 5	Bus68	Bus70	0.29	0.16	-0.29	-0.14	6.34	19.58	99.09	94.77	4.32	5.895769	486.4009
Line29	Bus72	Bus73	0.06	0.01	-0.06	-0.02	0.01	-7.94	98.70	98.69	0.01	1.125522	1.158209
T 6.	Bus73	Bus75	0.06	0.02	-0.06	-0.02	0.24	0.76	98.69	98.01	0.68	1.158209	95.55226
Total							**462.9**	**423.7**			**127.01**		

4.2.3.2.3 Alert Summary

The table 4.5 indicate voltage drop in the network with the specific location of all buses.

Table 4. 5 Alert results from E-TAP.

DeviceID	DeviceType	Unit	Rated	Calculated	Deviation	Condition	AlertType	Remarks
Bus3	Bus	kV	0.4	0.3877435	96.93587	Under Voltage	Marginal	3-Phase
Bus6	Bus	kV	0.4	0.3855312	96.3828	Under Voltage	Marginal	3-Phase
Bus8	Bus	kV	0.4	0.3885798	97.14495	Under Voltage	Marginal	3-Phase
Bus9	Bus	kV	0.4	0.3838325	95.95813	Under Voltage	Marginal	3-Phase
Bus17	Bus	kV	0.4	0.376731	94.18275	Under Voltage	Critical	3-Phase
Bus18	Bus	kV	33	32.19575	97.56287	Under Voltage	Marginal	3-Phase
Bus19	Bus	kV	33	32.19361	97.55641	Under Voltage	Marginal	3-Phase
Bus20	Bus	kV	0.4	0.3824078	95.60196	Under Voltage	Marginal	3-Phase
Bus21	Bus	kV	0.4	0.3862625	96.56563	Under Voltage	Marginal	3-Phase
Bus22	Bus	kV	33	32.16439	97.46786	Under Voltage	Marginal	3-Phase
Bus23	Bus	kV	33	32.14294	97.40285	Under Voltage	Marginal	3-Phase
Bus24	Bus	kV	0.4	0.3731581	93.28952	Under Voltage	Critical	3-Phase
Bus25	Bus	kV	0.4	0.3783475	94.58686	Under Voltage	Critical	3-Phase
Bus26	Bus	kV	33	32.14512	97.40946	Under Voltage	Marginal	3-Phase
Bus27	Bus	kV	0.4	0.3785653	94.64131	Under Voltage	Critical	3-Phase
Bus28	Bus	kV	33	31.87206	96.582	Under Voltage	Marginal	3-Phase
Bus29	Bus	kV	0.4	0.3761994	94.04985	Under Voltage	Critical	3-Phase
Bus30	Bus	kV	33	31.83507	96.4699	Under Voltage	Marginal	3-Phase
Bus31	Bus	kV	0.4	0.3764681	94.11703	Under Voltage	Critical	3-Phase
Bus32	Bus	kV	33	31.79306	96.34261	Under Voltage	Marginal	3-Phase
Bus33	Bus	kV	0.4	0.3672159	91.80398	Under Voltage	Critical	3-Phase
Bus34	Bus	kV	0.4	0.3676572	91.91428	Under Voltage	Critical	3-Phase
Bus35	Bus	kV	33	31.7814	96.30727	Under Voltage	Marginal	3-Phase
Bus36	Bus	kV	0.4	0.3654199	91.35498	Under Voltage	Critical	3-Phase
Bus37	Bus	kV	0.4	0.3728743	93.21857	Under Voltage	Critical	3-Phase
Bus38	Bus	kV	33	31.85376	96.52655	Under Voltage	Marginal	3-Phase
Bus39	Bus	kV	0.4	0.3628377	90.70942	Under Voltage	Critical	3-Phase
Bus40	Bus	kV	0.4	0.3670044	91.75111	Under Voltage	Critical	3-Phase
Bus41	Bus	kV	33	31.7553	96.22818	Under Voltage	Marginal	3-Phase
Bus42	Bus	kV	0.4	0.3722978	93.07444	Under Voltage	Critical	3-Phase
Bus43	Bus	kV	33	31.75193	96.21796	Under Voltage	Marginal	3-Phase
Bus44	Bus	kV	0.4	0.3707123	92.67809	Under Voltage	Critical	3-Phase
Bus45	Bus	kV	0.4	0.3643045	91.07611	Under Voltage	Critical	3-Phase
Bus46	Bus	kV	33	31.73455	96.16531	Under Voltage	Marginal	3-Phase

Bus47	Bus	kV	0.4	0.3798585	94.96462	Under Voltage	Critical	3-Phase
Bus48	Bus	kV	0.4	0.372493	93.12325	Under Voltage	Critical	3-Phase
Bus49	Bus	kV	33	31.71625	96.10986	Under Voltage	Marginal	3-Phase
Bus50	Bus	kV	0.4	0.3613122	90.32804	Under Voltage	Critical	3-Phase
Bus51	Bus	kV	33	31.68414	96.01254	Under Voltage	Marginal	3-Phase
Bus52	Bus	kV	0.4	0.3689878	92.24694	Under Voltage	Critical	3-Phase
Bus53	Bus	kV	0.4	0.3701236	92.53091	Under Voltage	Critical	3-Phase
Bus54	Bus	kV	0.4	0.3671798	91.79495	Under Voltage	Critical	3-Phase
Bus55	Bus	kV	33	31.67633	95.98889	Under Voltage	Marginal	3-Phase
Bus56	Bus	kV	0.4	0.3799516	94.9879	Under Voltage	Critical	3-Phase
Bus57	Bus	kV	33	31.67351	95.98032	Under Voltage	Marginal	3-Phase
Bus58	Bus	kV	0.4	0.375971	93.99274	Under Voltage	Critical	3-Phase
Bus59	Bus	kV	0.4	0.3660249	91.50623	Under Voltage	Critical	3-Phase
Bus60	Bus	kV	33	31.67329	95.97968	Under Voltage	Marginal	3-Phase
Bus61	Bus	kV	0.4	0.3714388	92.8597	Under Voltage	Critical	3-Phase
Bus62	Bus	kV	0.4	0.3798991	94.97477	Under Voltage	Critical	3-Phase
Bus63	Bus	kV	33	31.6718	95.97515	Under Voltage	Marginal	3-Phase
Bus64	Bus	kV	0.4	0.3640899	91.02247	Under Voltage	Critical	3-Phase
Bus65	Bus	kV	0.4	0.364041	91.01025	Under Voltage	Critical	3-Phase
Bus66	Bus	kV	0.4	0.3714203	92.85507	Under Voltage	Critical	3-Phase
Bus70	Bus	kV	0.4	0.3790697	94.76741	Under Voltage	Critical	3-Phase
Bus76	Bus	kV	33	32.19314	97.55498	Under Voltage	Marginal	3-Phase
Bus77	Bus	kV	33	32.12825	97.35835	Under Voltage	Marginal	3-Phase
Bus78	Bus	kV	33	31.83655	96.47439	Under Voltage	Marginal	3-Phase
Bus79	Bus	kV	33	31.67203	95.97585	Under Voltage	Marginal	3-Phase
Bus80	Bus	kV	33	31.67013	95.97009	Under Voltage	Marginal	3-Phase

Bus Voltage Alerts

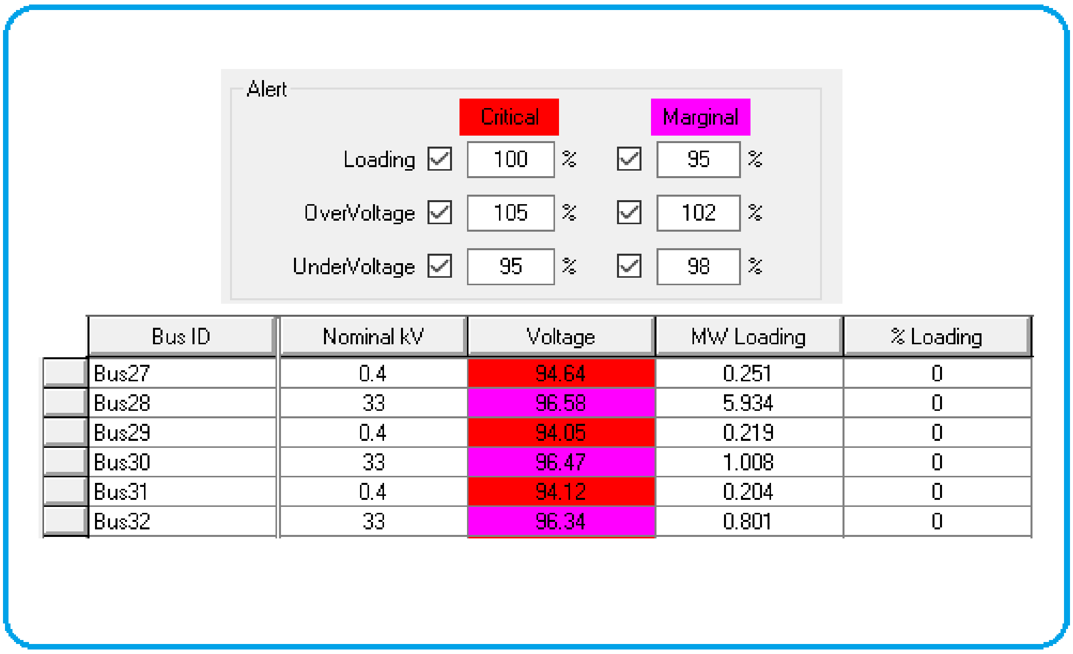
Bus Voltage Simulation Alerts generate alerts if the voltage magnitude percent results from the Load Flow calculation exceed or are below the specified nominal kV rating percent values Bus Voltage Alerts report over voltage and under voltage alerts. [5]

Critical and Marginal Alerts

There are two types of simulation alerts generated after a Load Flow study. The difference between Marginal and Critical Alerts is their use of different percent value conditions to determine if an alert should be generated. If a condition for a Critical alert is met, then an alert will be generated in the Alert View Window and the overloaded element will turn red in the one-line diagram. The same is true for Marginal Alerts, except that the overloaded component will be displayed in magenta color.

Also, the Marginal Alerts check box must be selected if the user desires to display the Marginal Alerts. If a device alert qualifies it for both Critical and Marginal alerts, only Critical Alerts are displayed. It should be noted that in order for E-TAP PowerStation to generate alerts for an element type, both the element rating and the percent value entered in this page must be non-zero. [5]

The figure 4.2 show the intended of Critical and Marginal Alerts.



Bus ID	Nominal kV	Voltage	MW Loading	% Loading
Bus27	0.4	94.64	0.251	0
Bus28	33	96.58	5.934	0
Bus29	0.4	94.05	0.219	0
Bus30	33	96.47	1.008	0
Bus31	0.4	94.12	0.204	0
Bus32	33	96.34	0.801	0

Figure 4.2: Critical and Marginal Alerts.

4.3 Protection analysis

E-TAP program can make protection and fault analysis for network shown in figure 4.3.

This figure show the Star Auto-Evaluation Viewer highlights detected violations and concerns of equipment protection and device coordination for possible correction and adjustment of protective device settings.

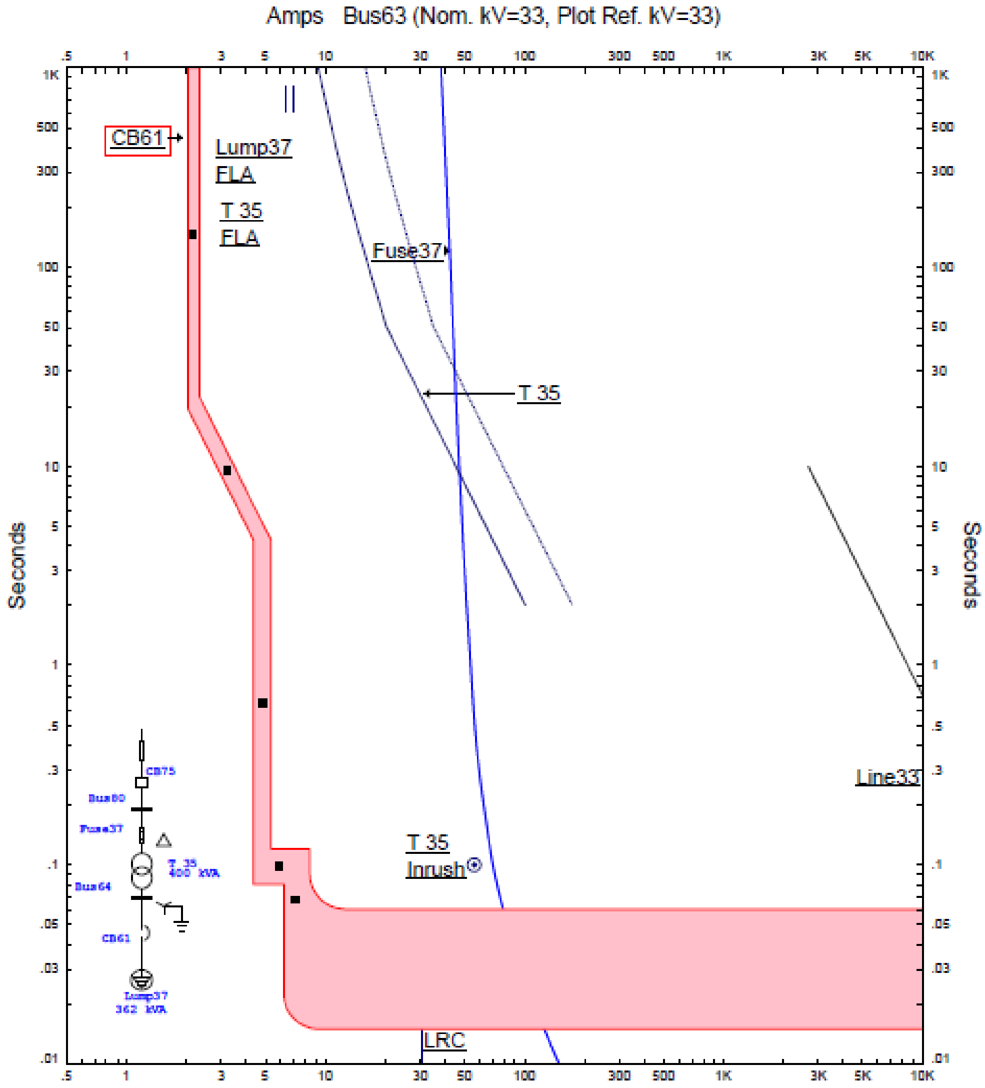


Figure 4.3 Simulation diagram.

This table shows the resulting values of the short-circuit applied at bus 55 in the electrical network.

Table 4. 6 Short-Circuit Summary Report.

Faulted Bus	Voltage kV		3-Phase Fault (kA)	
	Nominal	Base	Symm.3ph	Asymm.3ph
Bus55	33	33	2.893	2.893

Chapter Five

5.1 Problems and Solutions

This chapter discusses the result from data analysis chapter and detects the problem in the network to give Possible solutions to increase the network efficiency.

first part describes the problem and the other one contains a E-TAP data after reconstruction to improve the solution.

5.2 Problems

The project conclusion can be summarized network problems as follow:

1 - Bani Na'im electrical network has very low power factor range (0.70 – 0.91).

Which very low in industrial region and in range of domestic region.

2- Bani Na'im network has voltage drop.

The E-TAP simulation show that a high voltage drops on many branches in the network where the voltage on some branches is under nominal voltage and the ranges of voltage drop reach more than 5% as shown in previous Table 4.4 and Table 4.5.

3 – Bani Na'im network has high losses.

The branch losses table show that Bani Na'im has losses of 463 KW and 424 KVAR.

4- Problem in equipment.

Many equipment must be replaced because some of them are old and the other is fluty like law voltage circuit barker and some transformer silica gel was black.

5 – problem of Arabia transformer unbalanced.

The transformer returns the current on neutral line.

5.3 Solutions*

5.3.1 Solution the Problem of low power factor

Various inductive loads used in all industries deals with the problem of power factor improvement. Capacitor bank connected in shunt helps in maintaining the power factor closer to unity. They improve the electrical supply quality and increase the efficiency of the system. Also, the line losses are also reduced. Shunt capacitor banks are less costly and can be installed anywhere.

This section deals with shunt capacitor bank designing for power factor improvement considering overvoltage for substation installation.

Most Ac electric machines draw apparent power in terms of kilovolt amperes (KVA) which is in excess of the useful power, measured in kilowatts (KW), required by the machine.

The ratio of these quantities (KW/KVA) is called the power factor cos ϕ and is dependent on the type of machine in use.

Power factor (Cosθ) = $\frac{\mathbf{P(Kw)}}{\mathbf{S(KVA)}}$ ………….. Eq. (5.1)

P: Real power.

S: apparent power.

A large proportion of the electric machinery used in industry has an inherently low pf, which means that the supply authorities have to generate much more current than is theoretically required. In addition, the transformers and cables have to carry this high current. When the overall pf of a generating station's load is low, the system is inefficient and the cost of electricity corresponding high [6].

To overcome this, and at the same time ensure that the generators and cables are not loaded with the wattles current, the supply authorities often impulse penalties for low pf. [7] [8].

* see appendix to the one-Line Diagram - OLV 1 (Load Flow Analysis) part 8, and the Complete report of load flow analysis part 9, **after solve problems**.

Some of the machinery or equipment with low pf are listed below:

1. Induction motors of all types
2. Power thyristor installations
3. Welding machines
4. Electric arc and induction furnaces
5. Choke coils and induction furnaces
6. Neon signs and fluorescent lighting

The method employed to improve the pf involves introducing reactive (KVAR) into the system in phase opposition to the watt less or reactive current.

POWER FACTOR IMPROVEMENT:

The apparent power (KVA) in ac circuit can be resolved into two components, the in-phase component which supplies the useful power (KW), and the watt less component (KVAR) which does no useful work. The phasor sum of the two is the KVA drawn from the supply. The cosine of the phase angle between the KVA and the KW represents the power factor of the load. This is shown by the phasor diagram in Figure 5.1.

To improve the power factor, equipment drawing KVAR of approximately the same magnitude as the load KVAR but in phase opposition (leading), is connected in parallel with the load.

The resultant KVA is now smaller and the new power factor (cos ϕ2) is increased shown in figure 5.1.

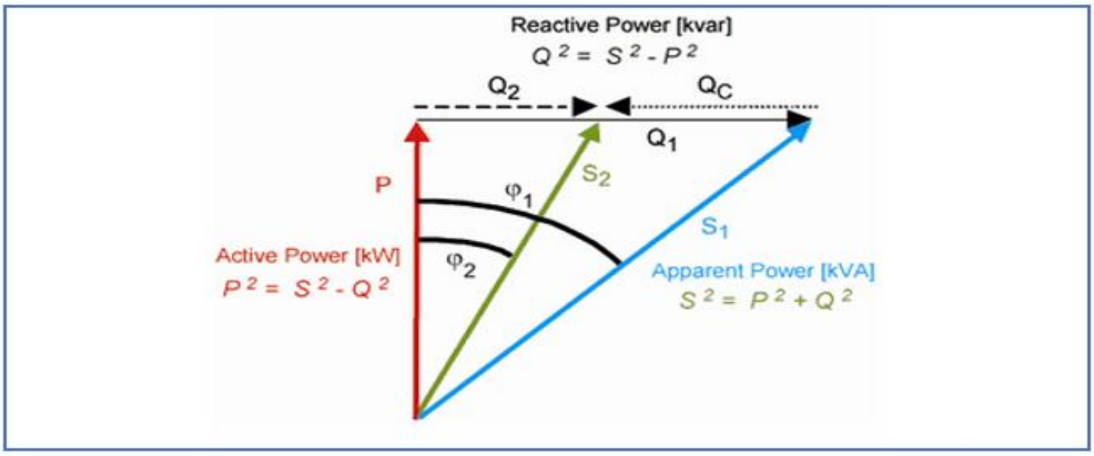


Figure 5.1: Phasor Diagram of a plant operation at lagging power factor, and Power factor correction by adding leading KVAR.

Cos ϕ2 is controlled by the magnitude of the KVAR added. Thus, any desired power factor can be obtained by varying the leading KVAR. A typical arrangement of shunt capacitor connected in parallel with a load is shown in figure 5.2.

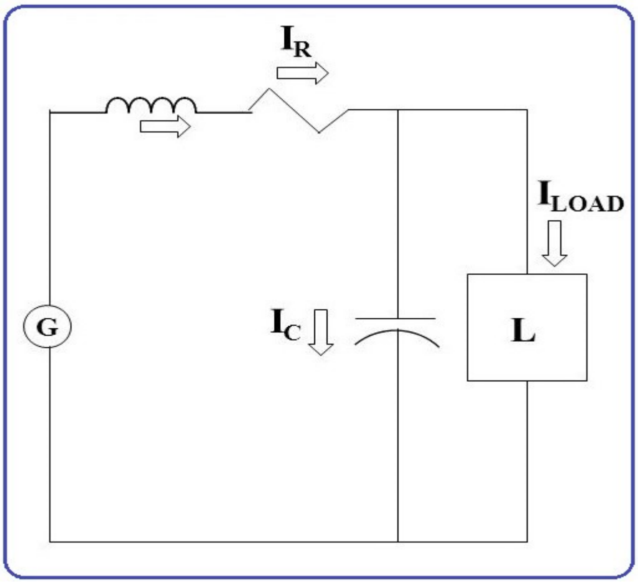


Figure 5.2: Capacitor connected in parallel with load.

The network has a low power factor in many transformers at low voltage side so the capacitor bank is solved this problem by add at load have low pf as shown in table 5.1.

Table 5.1: Capacitor bank correction

Name Of Tr.	Capacitor Bank	Selected (KVAR)	Number Of Unit	Number Of Bus	PF Before %	PF After %
T2 سنوت	40	40	1	6	88	95.3
T3 مصنع المقالع	40	40	1	8	81	95
T4 خلة الوردة	32	40	1	9	85	92.7
T5 مصنع خليل خليل	40	40	1	70	90	94.5
T8 مسجد النبي لوط	40	40	1	20	90	98.3
T10 خلة أبو بيضة	32	40	1	25	88	95.5
T11 الكوربة	40	40	1	24	90	94.8
T12 البريد	40	40	2	27	83	92
T14 واد المغير	32	40	1	40	85	93.3
T15 الكسارة	80	100	1	39	85	98
T18 محاجر الزيدات	40	40	1	34	90	94.4
T19 خلة اللوزة	100	100	1	36	78	99.3
T20 مصنع خلة اللوزة	40	40	1	37	82.8	91.7
T21 مصنع الرافدين	40	40	1	42	89	93
T22 منشار زركيا	40	40	1	44	85	92.1
T23 مصنع البلاستيك	40	40	1	45	90	94
T24 منشار أبو زايد	40	40	1	48	88	95
T26 مصنع التحرير	100	100	1	50	85	95.4
T29 منشار النبعة	100	100	1	52	88	96.2
T31 محاجر	40	40	2	58	81	94.5
T32 منشار فؤاد	40	40	2	59	83	99.1
T33 مصنع العويوي-1-	100	100	1	66	77	92.5
T34 مصنع العويوي-2-	100	100	1	65	78	99.3
T35 مصنع عودة	40	40	1	64	90	94.2
T36 مصنع شحدة	100	100	2	61	77	99

Advantages of Power Factor Improvement:

The benefits that can be achieved by applying the correct power factor correction are:

1- Reduction of power consumption due to improved energy efficiency. Reduced power consumption means less greenhouse gas emissions and fossil fuel depletion by power stations.

2- Reduction of electricity bills.

3- Extra kVA available from the existing supply.

4- Reduction of ($I^{2*}R$) losses in transformers and distribution equipment.

5- Reduction of voltage drops in long cables.

6- Reduced electrical burden on cables and electrical components.

After makes power factor correction the network be more stable as show in table 5.2.

Table 5.2: Result after power factor correction.

ID	Type	kV	MW-After	Mvar-After	MVA-After	PF-After	LoadAmp-After
Bus1	SWNG	33	8.412044	2.996592	8.92984	0.9420151	156.2317
Bus2	Load	33	8.394339	2.988478	8.910439	0.9420792	156.2566
Bus3	Load	0.4	0.2072698	0.06045372	0.2159061	0.96	311.9729
Bus5	Load	33	0.7769342	0.2925791	0.8301983	0.9358417	14.56825
Bus6	Load	0.4	0.1804403	0.05734669	0.1893339	0.9530267	273.1276
Bus7	Load	33	0.5940835	0.2322191	0.6378565	0.9313748	11.19867
Bus8	Load	0.4	0.1056593	0.03581357	0.1115639	0.9470744	159.6723
Bus9	Load	0.4	0.1850192	0.07496767	0.1996303	0.9268093	289.2393
Bus14	Load	33	7.325729	2.612379	7.777586	0.9419028	136.7677
Bus17	Load	0.4	0.3262674	0.1184193	0.347093	0.9400001	500.6503
Bus18	Load	33	6.977447	2.465861	7.400354	0.9428532	130.4361
Bus19	Load	33	0.2145202	0.02877023	0.2164409	0.9911262	3.81515
Bus20	Load	0.4	0.1351845	0.02519948	0.1375132	0.9830661	197.8084

Bus21	Load	0.4	0.0777748	0.03073884	0.08362892	0.9299988	119.8426
Bus22	Load	33	6.761142	2.460495	7.194934	0.9397087	126.8523
Bus23	Load	33	0.4633981	0.1644018	0.4916968	0.9424468	8.672134
Bus24	Load	0.4	0.2742646	0.09234659	0.2893941	0.94772	415.1907
Bus25	Load	0.4	0.1818282	0.0565571	0.1904211	0.9548741	269.5658
Bus26	Load	33	6.296568	2.301801	6.704107	0.9392105	118.2197
Bus27	Load	0.4	0.2560334	0.1125662	0.279686	0.9154316	405.4211
Bus28	Load	33	6.024448	2.176564	6.405576	0.9405006	113.241
Bus29	Load	0.4	0.2250603	0.06555788	0.2344141	0.9600971	333.3279
Bus30	Load	33	1.038689	0.3877256	1.108695	0.9368567	19.61233
Bus31	Load	0.4	0.2097025	0.06108431	0.218418	0.9600971	310.2318
Bus32	Load	33	0.8257071	0.3244592	0.8871673	0.930723	15.70467
Bus33	Load	0.4	0.1961146	0.08935246	0.2155106	0.91	305.7146
Bus34	Load	0.4	0.2941727	0.1025609	0.3115386	0.9442576	450.1543
Bus35	Load	33	0.3249127	0.1044826	0.3412988	0.9519889	6.043631
Bus36	Load	0.4	0.1499973	0.01692581	0.1509492	0.9936936	214.2496
Bus37	Load	0.4	0.1706665	0.07442798	0.1861897	0.9166273	265.3698
Bus38	Load	33	0.4345541	0.1388853	0.4562087	0.9525335	8.068656
Bus39	Load	0.4	0.2561574	0.05648271	0.2623107	0.9765419	374.3886
Bus40	Load	0.4	0.170908	0.06585138	0.1831555	0.9331304	264.1382
Bus41	Load	33	4.31399	1.582954	4.595243	0.9387949	81.3957
Bus42	Load	0.4	0.3482131	0.1372377	0.3742813	0.9303511	532.5799
Bus43	Load	33	0.557204	0.2437807	0.6081984	0.916155	10.77412
Bus44	Load	0.4	0.2054705	0.08673336	0.2230265	0.9212831	319.5006
Bus45	Load	0.4	0.3409175	0.123626	0.3626405	0.9400977	513.9549
Bus46	Load	33	3.404085	1.187868	3.605389	0.9441659	63.87469
Bus47	Load	0.4	0.1591087	0.06288379	0.1710847	0.93	246.6344
Bus48	Load	0.4	0.1938998	0.06343167	0.2040115	0.9504354	290.0596
Bus49	Load	33	3.046235	1.051247	3.222525	0.9452944	57.12192
Bus50	Load	0.4	0.3262057	0.1024618	0.341919	0.9540439	494.2537
Bus51	Load	33	2.710572	0.9282522	2.86511	0.9460623	50.83371
Bus52	Load	0.4	0.3977657	0.1124618	0.4133584	0.9622779	590.0901
Bus53	Load	0.4	0.4656615	0.1690126	0.4953846	0.94	713.6411
Bus54	Load	0.4	0.3286082	0.1192689	0.3495832	0.94	495.4434
Bus55	Load	33	1.498924	0.4574191	1.567165	0.9564559	27.80861
Bus56	Load	0.4	0.1269252	0.05406988	0.1379621	0.9200001	199.2679
Bus57	Load	33	0.2609066	0.06612121	0.2691548	0.9693555	4.776396
Bus58	Load	0.4	0.1051993	0.03635422	0.1113037	0.9451552	161.0385
Bus59	Load	0.4	0.1527015	0.02047895	0.1540686	0.9911267	219.4669
Bus60	Load	33	0.3743913	0.06496479	0.3799859	0.9852769	6.743223

Bus61	Load	0.4	0.2450159	0.002390538	0.2450275	0.9999524	353.1053
Bus62	Load	0.4	0.126919	0.05406724	0.1379554	0.92	199.2825
Bus63	Load	33	0.7359602	0.2727542	0.7848773	0.9376755	13.92908
Bus64	Load	0.4	0.3282298	0.1174774	0.3486198	0.9415123	494.0617
Bus65	Load	0.4	0.14985	0.01730192	0.1508456	0.9934002	214.616
Bus66	Load	0.4	0.2463391	0.1011033	0.2662796	0.9251145	378.6656
Bus68	Load	33	0.4065681	0.1581108	0.4362301	0.9320039	7.660364
Bus70	Load	0.4	0.2943142	0.1019197	0.3114618	0.9449447	446.095
Bus71	Load	33	0.1873737	0.08224301	0.2046285	0.9156775	3.59358
Bus72	Load	33	7.39613	2.626229	7.848555	0.9423556	137.8564
Bus73	Load	33	6.28E-02	0.0189806	0.06556353	0.9571782	1.151729
Bus75	Load	0.4	6.25E-02	0.01823329	0.06511889	0.9599999	95.01762
Bus76	Load	33	7.82E-02	0.03198784	0.08446999	0.9255241	1.488953
Bus77	Load	33	0.2793556	0.1080779	0.2995336	0.9326352	5.284245
Bus78	Load	33	0.260297	0.069274	0.2693574	0.9663628	4.764946
Bus79	Load	33	0.1275111	0.05641219	0.1394325	0.9145007	2.474462
Bus80	Load	33	0.3354388	0.1397531	0.363387	0.9230897	6.449291

5.3.2 Solution the Problem of voltage drop

Voltage drop is defined as the amount of voltage loss that occur through all or part of a network due to impedance Voltage drop becomes important when the length of power conductor becomes very long because increasing of its impedance.

Voltage drop can also occur when over load or short circuit cases. Excessive voltage drop can cause loss of efficiency in operation of light, motors and other load for different applications. Voltage drop is caused by resistance in the conductor or connections leading to the electrical load. There are many causes of resistance in the conductor path. There are four fundamental causes of voltage drop:

1- Material - Copper is a better conductor than aluminum and will have less voltage drop than aluminum for a given length and wire size.

2- Wire Size - Larger wire sizes (diameter) will have less voltage drop than smaller wire sizes (diameters) of the same length.

3- Wire Length - Shorter wires will have less voltage drop than longer wires for the same wire size (diameter).

4- Current Being Carried - Voltage drop increases on a wire with an increase in the current flowing through the wire.

We solve the under voltage on transformers by changing the tab changer at transformers as shown in table 5.3, and solve the under voltage on main buses by change the size of some transmission lines that feed it as shown in table 5.4.

Table 5.3: Transformers data with fixed tab changer.

ID	From Bus	To Bus	Prim kV	Prim%Tap	Sec kV	Sec%Tap	Conn.	Sec.Grd.Type	MVA	MaxMVA	PosZ	PosX/R	ZeroZ	ZeroX/R
T 7	Bus14	Bus17	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 8	Bus19	Bus20	33	2.5	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 9	Bus76	Bus21	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 11	Bus77	Bus24	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 10	Bus23	Bus25	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 12	Bus26	Bus27	33	0	0.4	2.5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 13	Bus28	Bus29	33	-2.5	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 1	Bus2	Bus3	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T16	Bus30	Bus31	33	-2.5	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 17	Bus32	Bus33	33	-2.5	0.4	5	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 18	Bus32	Bus34	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 19	Bus35	Bus36	33	0	0.4	5	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 20	Bus35	Bus37	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 15	Bus78	Bus39	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 14	Bus38	Bus40	33	0	0.4	5	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 21	Bus41	Bus42	33	-5	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 22	Bus43	Bus44	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 23	Bus43	Bus45	33	-2.5	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 25	Bus46	Bus47	33	-2.5	0.4	0	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 24	Bus46	Bus48	33	-2.5	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 26	Bus49	Bus50	33	-2.5	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T29	Bus51	Bus52	33	-2.5	0.4	2.5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 28	Bus51	Bus53	33	-2.5	0.4	2.5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 27	Bus51	Bus54	33	-2.5	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 30	Bus55	Bus56	33	2.5	0.4	5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 31	Bus57	Bus58	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 32	Bus57	Bus59	33	0	0.4	5	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 2	Bus5	Bus6	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 36	Bus60	Bus61	33	2.5	0.4	5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 37	Bus79	Bus62	33	2.5	0.4	5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 35	Bus80	Bus64	33	-2.5	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 34	Bus63	Bus65	33	0	0.4	5	D/Y	Solid	0.25	0.3	7.25	3.09	7.25	3.09
T 33	Bus63	Bus66	33	0	0.4	5	D/Y	Solid	0.63	0.7	7.25	3.96	7.25	3.96
T 5	Bus68	Bus70	33	0	0.4	5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 6.	Bus73	Bus75	33	0	0.4	0	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 3	Bus68	Bus8	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09
T 4	Bus71	Bus9	33	0	0.4	2.5	D/Y	Solid	0.4	0.45	7.25	3.09	7.25	3.09

Table 5.4: New sectional area of transmission lines.

ID	FromBus	ToBus	Size(mm2)-Before	Size(mm2)-After	Length (ft)
Cable1	Bus19	Bus76	95	95	2624.672
Line1	Bus1	Bus2	49.5	120	1968.504
Line10	Bus18	Bus22	49.5	120	298.8845
Line11	Bus22	Bus23	49.5	77.3	3068.241
Line12	Bus22	Bus26	49.5	120	196.8504
Line13	Bus26	Bus28	49.5	120	2911.417
Line14	Bus28	Bus30	49.5	77.3	2332.021
Line15	Bus30	Bus32	49.5	77.3	3280.84
Line16	Bus32	Bus35	49.5	49.5	2230.971
Line17	Bus28	Bus38	49.5	49.5	2296.588
Line18	Bus28	Bus41	49.5	77.3	1751.969
Line19	Bus41	Bus43	49.5	49.5	393.7008
Line2	Bus2	Bus5	49.5	49.5	1916.437
Line20	Bus41	Bus46	49.5	120	393.7008
Line21	Bus46	Bus49	49.5	49.5	387.1391
Line22	Bus49	Bus51	49.5	49.5	764.4357
Line23	Bus51	Bus55	49.5	77.3	328.084
Line24	Bus55	Bus57	49.5	49.5	675.853
Line25	Bus55	Bus60	49.5	49.5	506.2336
Line26	Bus55	Bus63	49.5	49.5	388.1234
Line27	Bus7	Bus68	49.5	49.5	1148.294
Line28	Bus7	Bus71	49.5	49.5	3221.457
Line29	Bus72	Bus73	49.5	49.5	4327.428
Line3	Bus5	Bus7	49.5	49.5	1900.591
Line30	Bus23	Bus77	49.5	77.3	3487.533
Line31	Bus38	Bus78	49.5	77.3	3280.84
Line32	Bus60	Bus79	49.5	49.5	656.168
Line33	Bus63	Bus80	49.5	49.5	328.084
Line4	Bus2	Bus72	49.5	120	1533.465
Line6	Bus72	Bus14	49.5	120	1108.268
Line8	Bus14	Bus18	49.5	120	2331.693
Line9	Bus18	Bus19	49.5	49.5	705.0525

5.3.3 Solution the Problem of the high losses.

Power distribution systems have tie and sectionalizing switches. The states of those switches determine the configuration of the network. Reconfiguration of distribution network is achieved through switching operation on switches of distribution network branches [9].

Power companies are interested in finding the most efficient configuration for minimization of real power losses and load balancing among distribution feeders. This will help to save energy and enhance the operation performance of distribution system.

To manage a loss reduction program in a transmission and distribution system, it is necessary to use efficient and effective computational tools like MATLAB that allow quantifying the loss in each different network element for system losses reduction.

Technical Losses:

Technical losses in power system are caused by the physical properties of the components of the power system. The most obvious example is the power dissipated in transmission lines and transformers due to internal electrical resistance. Technical losses are naturally occurring losses (caused by action internal to the power system) and consist mainly of power dissipation in electrical system component such as transmission lines, power transformers, measurement system, etc. Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads. Technical losses occur during transmission and distribution and involve substation, transformer, and line related losses. 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 kWh meter. Losses are inherent to the distribution of electricity and cannot be eliminated. Technical losses are due to current flowing in the electrical network and generate the following types of losses: [10]

1- Copper losses those are due to (I^2*R) losses that are inherent in all inductors because of the finite resistance of conductors.

2- Dielectric losses that are losses that result from the heating effect on the dielectric material between conductors

3- Induction and radiation losses that are produced by the electromagnetic fields surrounding conductors.

Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads. The following are the causes of technical losses:

1- Harmonics distortion

2- Improper earthing at consumer end

3- Long single-phase lines

4- Unbalanced loading

5- Losses due to overloading and low voltage

6- Losses due to poor standard of equipment's.

After solved problem at low power factor and voltage drop the losses is decreased, In the table 5.5 show the result Branch Losses of network after fixed the loses parameter's.

Table 5.5: Branch Losses.

IDBranch	From	To	FromToMW	FromToMVar	ToFromMW	ToFromMvar	LosskW	Loss kvar
Line1	Bus1	Bus2	8.412044	2.996592	-8.394339	-2.988478	17.70485	8.114142
Line2	Bus2	Bus5	0.7774652	0.28913	-0.7769342	-0.2925791	0.5309196	-3.449047
Line4	Bus2	Bus72	7.406865	2.63043	-7.39613	-2.626229	10.73533	4.200799
T 1	Bus2	Bus3	0.210009	6.89E-02	-0.2072698	-6.05E-02	2.739136	8.463928
Line3	Bus5	Bus7	0.5943945	0.228745	-0.5940835	-0.2322191	0.3109728	-3.474087
T 2	Bus5	Bus6	0.1825397	6.38E-02	-0.1804403	-5.73E-02	2.099477	6.487384
Line27	Bus7	Bus68	0.4066561	0.1559866	-0.4065681	-0.1581108	8.79E-02	-2.12419
Line28	Bus7	Bus71	0.1874274	7.62E-02	-0.1873737	-8.22E-02	5.38E-02	-6.010522
T 3	Bus8	Bus68	-0.1056593	-3.58E-02	0.1063768	3.80E-02	0.717528	2.217161
T 4	Bus9	Bus71	-0.1850192	-7.50E-02	0.1873737	8.22E-02	2.354478	7.275337
Line6	Bus14	Bus72	-7.325729	-2.612379	7.333366	2.615336	7.636872	2.957585
Line8	Bus14	Bus18	6.992059	2.471086	-6.977447	-2.465861	14.61231	5.224444
T 7	Bus14	Bus17	0.3336699	0.141293	-0.3262674	-0.1184193	7.402524	22.8738
Line9	Bus18	Bus19	0.2145334	4.77E-03	-0.2145202	-6.07E-03	1.32E-02	-1.30507
Line10	Bus18	Bus22	6.762914	2.461096	-6.761142	-2.460495	1.771884	0.6007479
Cable1	Bus19	Bus76	7.82E-02	-2.27E-02	-7.82E-02	-3.20E-02	1.08E-03	-54.68741
T 8	Bus19	Bus20	0.1363401	2.88E-02	-0.1351845	-2.52E-02	1.15558	3.570743
T 9	Bus21	Bus76	-0.0777748	-3.07E-02	7.82E-02	3.20E-02	0.4042054	1.248995
Line11	Bus22	Bus23	0.4635605	0.1584052	-0.4633981	-0.1644018	0.1623997	-5.996636
Line12	Bus22	Bus26	6.297581	2.30209	-6.296568	-2.301801	1.013573	0.2887967
Line30	Bus23	Bus77	0.2794239	0.1012134	-0.2793556	-0.1080779	6.83E-02	-6.864451
T 10	Bus23	Bus25	0.1839742	0.0631884	-0.1818282	-0.0565571	2.146052	6.6313
T 11	Bus24	Bus77	-0.2742646	-9.23E-02	0.2793556	0.1080779	5.091033	15.73129
Line13	Bus26	Bus28	6.038199	2.179986	-6.024448	-2.176564	13.7505	3.422503
T 12	Bus26	Bus27	0.2583689	0.1218148	-0.2560334	-0.1125662	2.335502	9.248587
Line14	Bus28	Bus30	1.039322	0.3834242	-1.038689	-0.3877256	0.6329759	-4.301433
Line17	Bus28	Bus38	0.434749	0.134702	-0.4345541	-0.1388853	0.1949151	-4.183316
Line18	Bus28	Bus41	4.322191	1.583218	-4.31399	-1.582954	8.2005	0.2635109
T 13	Bus28	Bus29	0.2281873	0.0752202	-0.2250603	-6.56E-02	3.126966	9.662324
Line15	Bus30	Bus32	0.8262774	0.3182715	-0.8257071	-0.3244592	0.5703175	-6.187635
T16	Bus30	Bus31	0.2124112	6.95E-02	-0.2097025	-6.11E-02	2.708648	8.369721
Line16	Bus32	Bus35	0.3250188	0.100407	-0.3249127	-0.1044826	0.1061412	-4.075622
T 17	Bus32	Bus33	0.200531	0.102999	-0.1961146	-8.94E-02	4.416346	13.64651
T 18	Bus32	Bus34	0.3001573	0.1210532	-0.2941727	-0.1025609	5.984578	18.49234
T 19	Bus35	Bus36	0.1521664	0.0236282	-0.1499973	-1.69E-02	2.169057	6.702386
T 20	Bus35	Bus37	0.1727463	8.09E-02	-0.1706665	-7.44E-02	2.079763	6.426469
Line31	Bus38	Bus78	0.2603493	6.28E-02	-0.260297	-0.069274	5.23E-02	-6.427233
T 14	Bus38	Bus40	0.1742048	7.60E-02	-0.170908	-6.59E-02	3.296805	10.18713
T 15	Bus39	Bus78	-0.2561574	-5.65E-02	0.260297	0.069274	4.139577	12.79129
Line19	Bus41	Bus43	0.5572637	0.2430732	-0.557204	-0.2437807	5.97E-02	-0.7075189
Line20	Bus41	Bus46	3.404677	1.187452	-3.404085	-1.187868	0.5917516	-0.416312

T 21	Bus41	Bus42	0.3520492	0.1524286	-0.3482131	-0.1372377	3.836096	15.19094
T 22	Bus43	Bus44	0.2084853	0.096049	-0.2054705	-8.67E-02	3.01477	9.315638
T 23	Bus43	Bus45	0.3487187	0.1477317	-0.3409175	-0.123626	7.801188	24.10567
Line21	Bus46	Bus49	3.047886	1.050979	-3.046235	-1.051247	1.65128	-0.268911
T 24	Bus46	Bus48	0.1962676	7.07E-02	-0.1938998	-6.34E-02	2.367851	7.31666
T 25	Bus46	Bus47	0.1599314	6.61E-02	-0.1591087	-6.29E-02	0.822673	3.257785
Line22	Bus49	Bus51	2.713154	0.9275416	-2.710572	-0.9282522	2.581994	-0.7105574
T 26	Bus49	Bus50	0.3330808	0.1237059	-0.3262057	-0.1024618	6.875111	21.24409
Line23	Bus51	Bus55	1.499103	0.4568591	-1.498924	-0.4574191	0.1792729	-0.560074
T 27	Bus51	Bus54	0.3358576	0.1416693	-0.3286082	-0.1192689	7.249347	22.40048
T 28	Bus51	Bus53	0.472898	0.197669	-0.4656615	-0.1690126	7.236478	28.65645
T29	Bus51	Bus52	0.4027134	0.1320547	-0.3977657	-0.1124618	4.94771	19.59293
Line24	Bus55	Bus57	0.2609268	6.49E-02	-0.2609066	-6.61E-02	2.01E-02	-1.232246
Line25	Bus55	Bus60	0.3744214	6.40E-02	-0.3743913	-6.50E-02	3.01E-02	-0.9189699
Line26	Bus55	Bus63	0.7360587	0.2720698	-0.7359602	-0.2727542	9.84E-02	-0.6843622
T 30	Bus55	Bus56	0.1275172	5.64E-02	-0.1269252	-5.41E-02	0.5920702	2.344598
T 31	Bus57	Bus58	0.1059292	3.86E-02	-0.1051993	-3.64E-02	0.7298599	2.255267
T 32	Bus57	Bus59	0.1549775	2.75E-02	-0.1527015	-2.05E-02	2.275981	7.032781
Line32	Bus60	Bus79	0.1275164	5.52E-02	-0.1275111	-5.64E-02	5.23E-03	-1.200037
T 36	Bus60	Bus61	0.246875	9.75E-03	-0.2450159	-2.39E-03	1.859118	7.362106
T 37	Bus62	Bus79	-0.126919	-5.41E-02	0.1275111	5.64E-02	0.5921571	2.344942
Line33	Bus63	Bus80	0.3354566	0.1391572	-0.3354388	-0.1397531	0.0178284	-0.595883
T 33	Bus63	Bus66	0.2484771	0.1095698	-0.2463391	-0.1011033	2.138012	8.466526
T 34	Bus63	Bus65	0.1520265	2.40E-02	-0.14985	-1.73E-02	2.176481	6.725327
T 35	Bus64	Bus80	-0.3282298	-0.1174774	0.3354388	0.1397531	7.20897	22.27572
T 5	Bus68	Bus70	0.3001913	0.12008	-0.2943142	-0.1019197	5.877131	18.16034
Line29	Bus72	Bus73	6.28E-02	1.09E-02	-6.28E-02	-0.0189806	7.26E-03	-8.087764
T 6.	Bus73	Bus75	6.28E-02	0.0189806	-6.25E-02	-1.82E-02	0.2418468	0.7473066
Total							205.7	299.4

5.3.4 Solution the Problem in equipment

The protection equipment is solved by calibration of circuit breakers and fuses by evaluate the maximum current using E-TAP to satisfy a good selectivity.

5.3.5 Solution the problem Arabia transformer unbalanced

A three-phase power system is called balanced or symmetrical if the three-phase voltages and currents have the same amplitude and are phase shifted by 120° with respect to each other. If either or both of these conditions are not met, the system is called unbalanced or asymmetrical. [11]

The figure 5.3 show the current in lines three phases and the existence of a current in the neutral line.

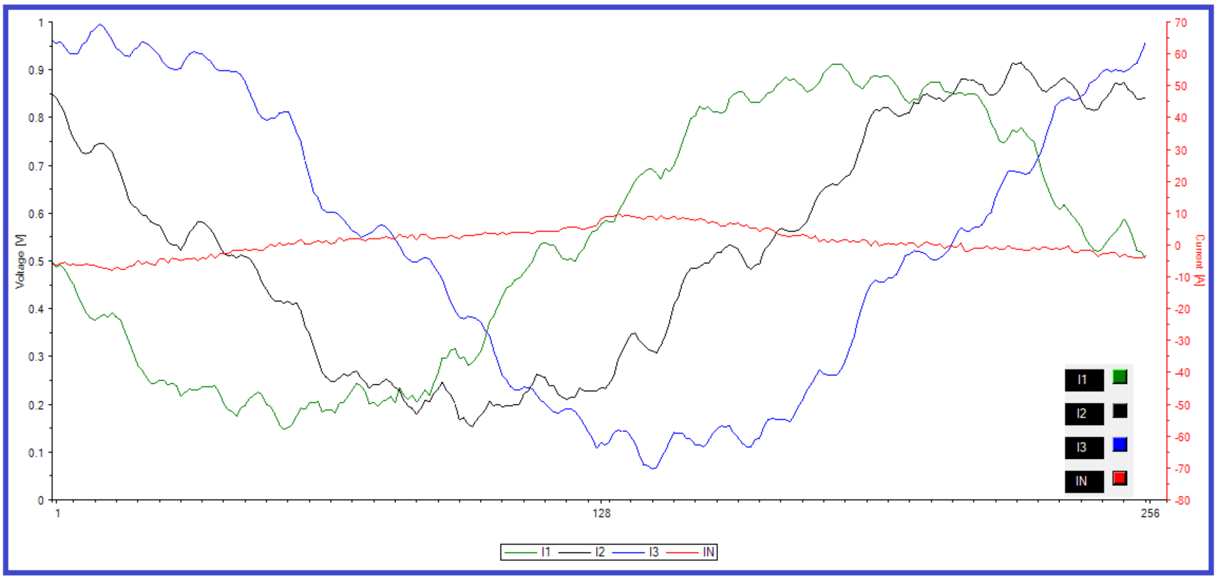


Figure 5.3 Phase current.

The transformer earthing system has been maintained to solve the unbalance problem.

Chapter Six

Load Growth and Economical Study

6.1 Introduction

This chapter talks about the Bani Na'im load growth and the future expected data for the maximum remaining year to reach the maximum load at transformer or reach the available age, in both conditions the transformer who reach its full capacity or maximum age must be replaced.

In the other hand chapter 6 contain an economic study for reconstruction to calculate the total money needed for problem solution.

6.2 load growth

This section talks about the future of electrical load that's occurred due to natural expansion which increases by 620188.8 W every year. the data needed is taken from Bani Na'im municipality from (2008 to December 2016) to decide which areas have a high demand for new electricity participation, build a scientific expectation time for transformer to reach a full load, and study the time needed for replace a transformer due its load and presumptive age at 30 years. for each. See table 6.1

Table 6.1 Power per year

Year	Power (MW)
2008	13.9506
2009	14.45021
2010	14.98195
2011	15.23154
2012	16.61064
2013	16.96662
2014	18.0306
2015	18.68898
2016	18.91211
2017	19.5322988
2018	20.1524876
2019	20.7726764
2020	21.3928652
2021	22.013054
2022	22.6332428
2023	23.2534316
2024	23.8736204
2025	24.4938092
2026	25.113998
2027	25.7341868
2028	26.3543756
2029	26.9745644
2030	27.5947532

In our study, we have been relying on load growth:

1- Population growth.

2- Increase the area of residential and industrial.

3- Increased loads.

4- The default network age.

See Figure 6.1

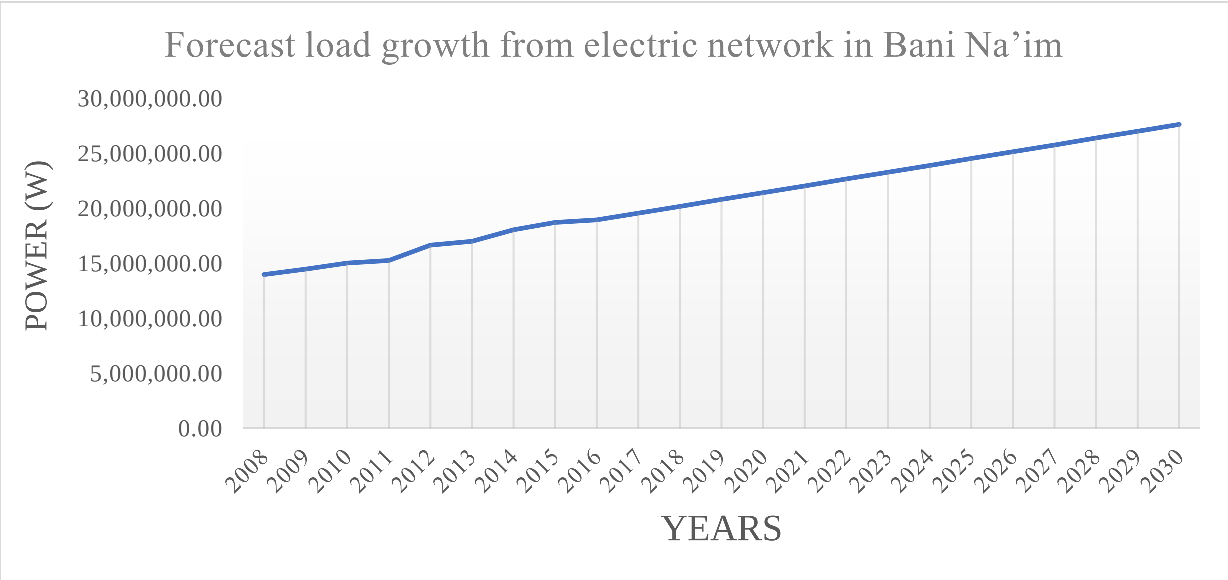


Figure 6.1 forecast load growth.

During (2016-2030) we must find a source load to feed the network, and the source is solar energy system with capacity 2 MVA, which put in Haret al-zeedat to feed another half from the network. See figure 6.2

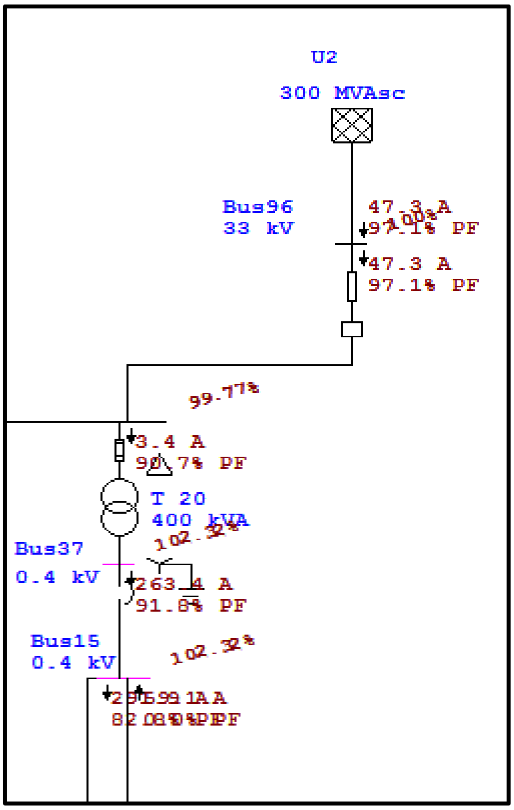


Figure 6.2 second source.

So, the solar energy system is in Msafer Bani Na'im which near from chosen region.

The reason for choose the place according:

1- Increase the population and the residential area.

2- Empty region in this place.

When the second source added, the power factor improves, and the losses decrease to 178 KW.

6.3 Economical study

Economic study:

Money is the Backbones for any project with its both types. The project also saves money, strengthening human safety, reduce electricity outage.

Profit is the different between cost and revenue If the profit is deserving the investment, the investors take a courage to Perform the project. The previous scenarios to solve Bani Na'im medium voltage network problem needs an economical study to decide if the project can be applied or not.

Running cost cannot be detected because there's no enough information for estimate the maintenance per year. so, depending on capital cost. witch the total amount of money that's the project require to start consist the equipment, salaries …etc. for the project we can Generalize That the capital cost is the equipment cost.

The project needs two kinds of equipment:

1- Transmission line section:

The Cost of wire change show in table 6.2

Table 6.2 Transmission line cost.

Type of wire	Length (ft)	Price ($/ft)	Price ($)	Company name
Pirelli/GZ ACSR 77.3 mm2	17530	2.47	43299.1	WALNUT
Pirelli/GZ ACSR 120 mm2	10743.5	3	51130.5	CHERRY
Total			94429.6	

2- Capacitor bank economy:

The capacitor bank price which chosen for power correction for areas with low power factor is clear in table 6.3.

Table 6.3: Capacitor bank price.

Name Of Tr.	Capacitor Bank	Selected (KVAR)	Number Of Unit	Price ($/unit)	Price ($)	Company name
T2 سنوت	40	40	1	132	132	ningbo quanhe electronics
T3 مصنع المقالع	40	40	1	132	132	ningbo quanhe electronics
T4 خلة الوردة	32	40	1	132	132	ningbo quanhe electronics
T5 مصنع خليل خليل	40	40	1	132	132	ningbo quanhe electronics
T8 مسجد النبي لوط	40	40	1	132	132	ningbo quanhe electronics
T10 خلة أبو بيضة	32	40	1	132	132	ningbo quanhe electronics
T11 الكوربة	40	40	1	132	132	ningbo quanhe electronics
T12 البريد	40	40	2	132	264	ningbo quanhe electronics
T14 واد المغير	32	40	1	132	132	ningbo quanhe electronics
T15 الكسارة	80	100	1	1200	1200	Zhejiang , China (Mainland)
T18 محاجر الزيدات	40	40	1	132	132	ningbo quanhe electronics
T19 خلة اللوزة	100	100	1	1200	1200	Zhejiang , China (Mainland)
T20 مصنع خلة اللوزة	40	40	1	132	132	ningbo quanhe electronics
T21 مصنع الرافدين	40	40	1	132	132	ningbo quanhe electronics
T22 منشار زركيا	40	40	1	132	132	ningbo quanhe electronics
T23 مصنع البلاستيك	40	40	1	132	132	ningbo quanhe electronics
T24 منشار أبو زايد	40	40	1	132	132	ningbo quanhe electronics
T26 مصنع التحرير	100	100	1	1200	1200	Zhejiang , China (Mainland)
T29 منشار النبعة	100	100	1	1200	1200	Zhejiang , China (Mainland)
T31 محاجر	40	40	2	132	264	ningbo quanhe electronics
T32 منشار فؤاد	40	40	2	132	264	ningbo quanhe electronics
T33 -1- مصنع العويوي	100	100	1	1200	1200	Zhejiang , China (Mainland)
T34 -2- مصنع العويوي	100	100	1	1200	1200	Zhejiang , China (Mainland)
T35 مصنع عودة	40	40	1	132	132	ningbo quanhe electronics
T36 مصنع شحدة	100	100	2	1200	2400	Zhejiang , China (Mainland)
Total					12372	

Capital Costs = capacitor bank price + Transmission line price …..… Eq. (6.1)

Capital Costs = 12372 $ + 94429.6 $

= 106801.6 $

Income:

In the other hand, power factor correction and reducing voltage drop level are decreasing the losses from 462.9 KW in to 206 KW, the 257 KW different will be provided so the money saved form reducing the losses as the flowing.

P annual = power * (hours /year) ……… Eq. (6.2)

P annual = 257(KW) * 8760(hour/year)

P annual = 2251320 (KW hour / year)

while taking the price of KWH is (0.157) $.

saving ($) = 2251320 (KW hour / year) * (0.157) $ / (KW hour) …...Eq. (6.3)

saving ($) = 353457.24 $/year

6.4 Conclusion

The profit of first year after applying the result as the flowing

Profit = Income – Cost … Eq. (6.4)

= 353457.24 $ - 106801.6 $

= 246655.64 $

The project will Provide 246655.64 $ for the municipality at the first year.

6.5 SCADA System

SCADA is Supervisory Control and Data Acquisition. The major function of SCADA is for acquiring data from remote devices such as valves, pumps, transmitters etc. and providing overall control remotely from a SCADA Host software platform. This provides process control locally so that these devices turn on at the right time, supporting your control strategy and a remote method of capturing data and events (alarms) for monitoring these processes. SCADA Host platforms also provide functions for graphical displays, alarming, trending and historical storage of data.

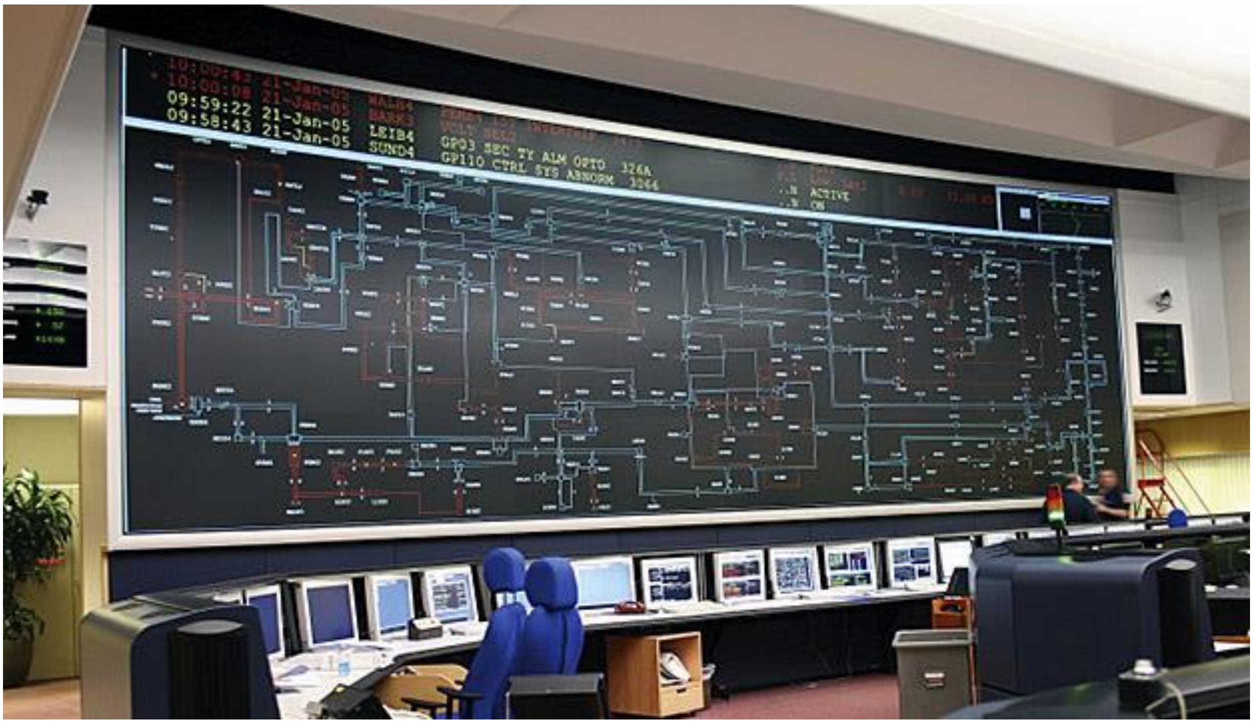


Figure 6.3: SCADA screen.

Looking at the overall structure of a SCADA system, there are many distinct levels within SCADA these being.

1- Field instrumentation.

2- PLCs and / or RTUs.

3- Communications networks

4- SCADA host software.

6.5.1 SCADA system Benefits for Electrical Distribution

1- Locate the problem in the network.

2- Network control.

3- Monitor the network.

4- Increases reliability through automation.

5- Eliminates the need for manual data collection.

6- Automation protects workers by enabling problem areas to be detected and addressed automatically.

6.5.2 How SCADA Works

A SCADA system for a power distribution application is a typically a PC-based software package. Data is collected from the electrical distribution system, with most of the data originating at substations. Depending on its size and complexity, a substation will have a varying number of controllers and operator interface points. In a typical configuration, a substation is controlled and monitored in real time by a Programmable Logic Controller (PLC) and by certain specialized devices such as circuit breakers and power monitors. Data from the PLC and the devices is then transmitted to a PC-based SCADA node located at the substation. One or more PCs are located at various centralized control and monitoring points. The links between the sub-station PCs and the central station PCs are generally Ethernet-based and are implemented via the Internet, an intranet and/or some version of cloud computing. In addition to data collection, SCADA systems typically allow commands to be issued from central control and monitoring points to substations. If desired and as circumstances allow, these commands can enable full remote control.

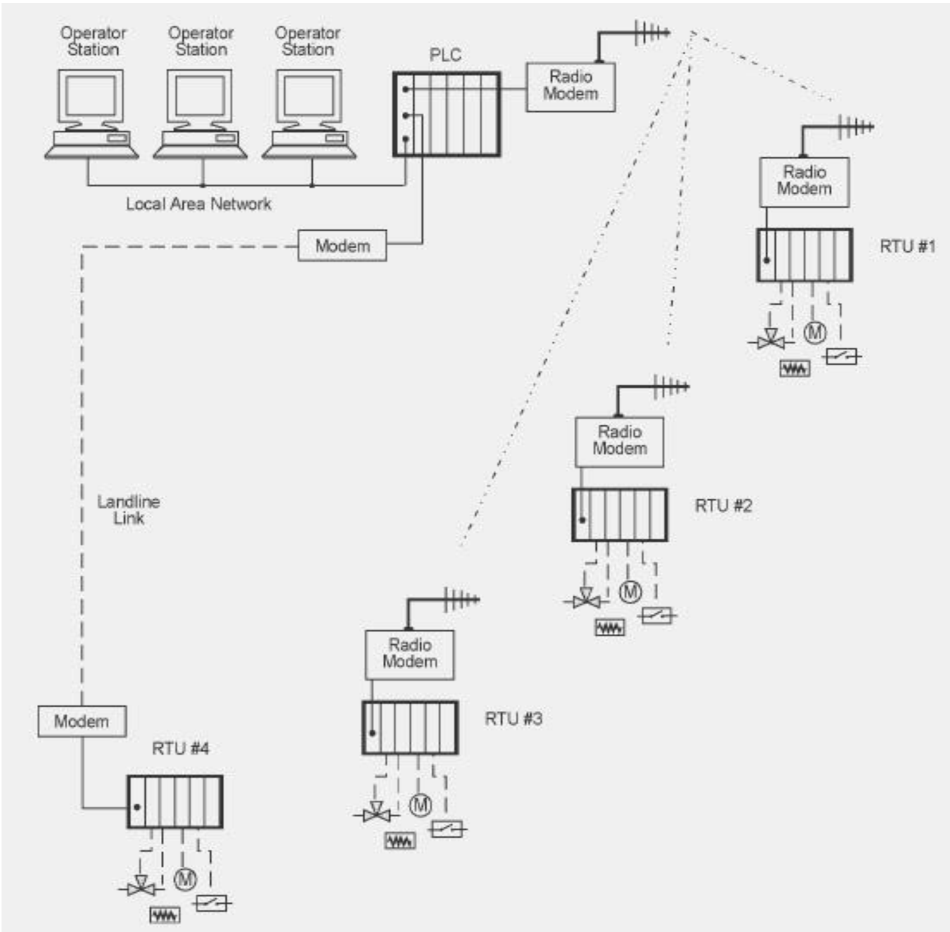


Figure 6.4: Control of SCADA.

We can apply SCADA system at any part of electricity network, because the importance for this system to monitor the network as we mentioned before, the figure 6.5 explain a part from the network can apply SCADA system on her.

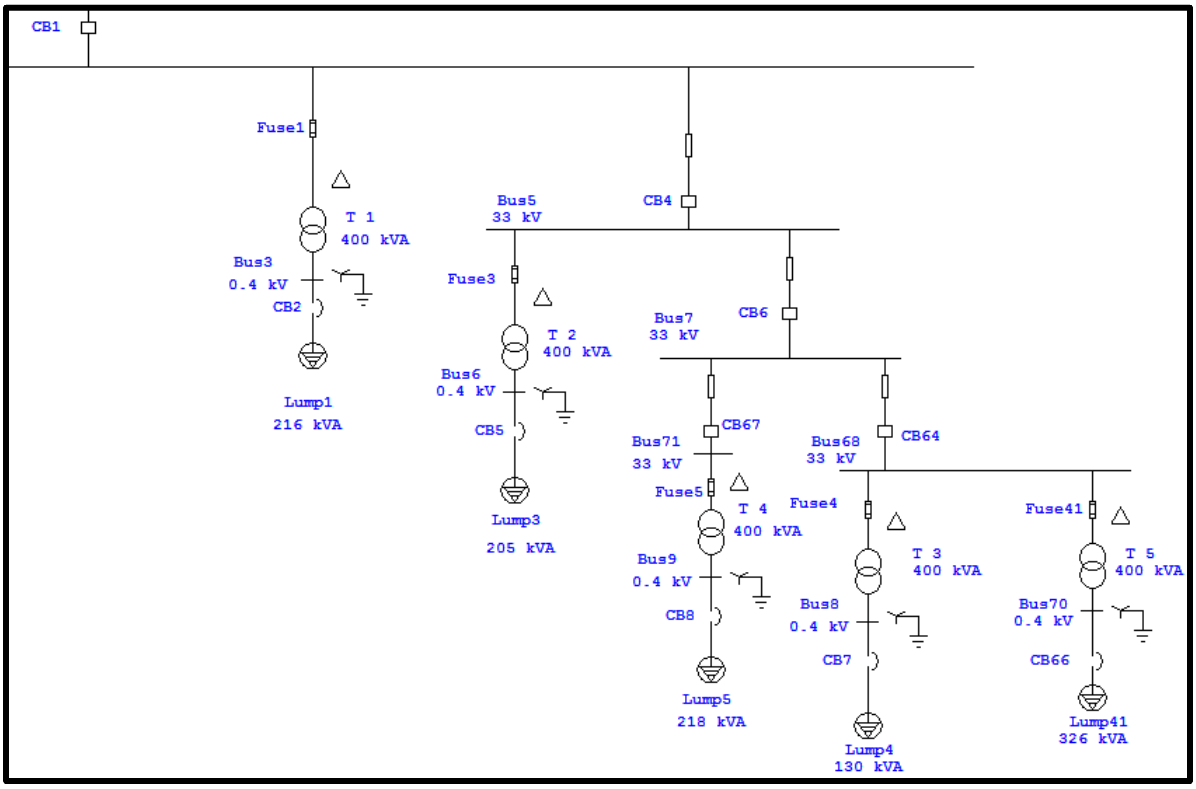


Figure 6.5 Part from the network can apply SCADA system on her.

The table 6.4 explain the part which monitored in the network, and we put this items by using unity pro programs.

Table 6.4: variables in unity pro programs.

Data Editor

Variables | DDT Types | Function Blocks | DFB Types

Filter — Name = * — ☑ EDT ☑ DDT ☑ IODDT ☑ Device DDT

Name	Type	Address	Value	Comment	Time stamping
CB1	BOOL				None
CB4	BOOL				None
CB6	BOOL				None
CB64	BOOL				None
CB67	BOOL				None
CB2	BOOL				None
CB5	BOOL				None
CB8	BOOL				None
CB7	BOOL				None
CB66	BOOL				None
I	INT				
V	INT				
P	INT				

Chapter Seven

Conclusions and Recommendations

This chapter divided in to two parts, the first part summarizing main problems and solutions for Bani Na'im medium voltage electric network. it's also contain the conclusions expected after applying the project. The other part is our recommendations for Bani Na'im municipality, Palestine polytechnic university and students of electric power engineering.

7.1 Conclusions

7.1.1 Problems:

1- Network has a Losses evaluated from the load flow results of Bani Na'im electric power network using E-TAP show that it has a level of power losses nearly of 462.9 KW.

2- Network has Unacceptable power factor value that of between (0.70-0.91) measured by Vega 78 power analyzer.

3- Network has a voltage drop reach more than 5%, that's drop affects the low voltage side.

4- Some protection and isolating equipment is very old with law readability and selectivity.

5- Arabi transformer unbalanced problem, the transformer returns the current on neutral line.

7.1.3 Solutions the problems

1- Losses is decreased after the previous scenarios to reach 206 KW.

2- Low power factor problem solved by Power Factor improvement using capacitor bank.

3- Voltage drop at medium voltage side is acceptable so its needn't to change conductor or redistribute load for a voltage drop of 3.27% at worst case. but the voltage drops at distribution side solved be changing the tab of transformer that's have an under voltage at the load.

4- The protection equipment is solved by calibration of circuit breakers and fuses by evaluate the maximum current using E-TAP to satisfy a good selectivity.

5- Arabi transformer unbalanced problem is solved by repair and delivery of earthing system.

The project describes the existing Bani Na'im medium voltage network and put a solution for existing problems. the project practically applying will solve those problems and get this advantages for the network:

1- Power factor will be rise to reach nearly unity power factor.

2- Voltage drop problem will be solved to reach acceptable range in low voltage side.

3- Network losses will be minimized as possible to get acceptable value.

4- Over load and under voltage problem will be solved.

5- Increasing the medium voltage network efficiency.

6- After problems solving, save a capacity of 1 MVA, where before the solving problems the capacity consumed was 9.68 MVA, then after solving problems the capacity has become 8.92 MVA.

7- The project will provide 246655.64 $ for the municipality at the first year.

7.2 Recommendations

7.2.1 Recommendations for Bani Na'im Municipality:

1- Hiring electric engineer in the Municipality.

2- Use "Vega 78 power analyzer" for measure the loads on the electrical network.

3- Use power measuring devices for each transformer.

4- Use E-TAP program for representation the electrical network and study it.

7.2.2 Recommendations for our university:

1- Build a new relationship between the university and the governmental or private power sector.

2- Change the Field Training system in the university to ensure that power student can deal with medium voltage in training sites.

3- help interested student in E-TAP to learn more about the program.

7.2.3 Recommendations for power engineering student:

1- Try to learn more about E-TAP program and use it for developing the power engineering in the university.

2- Decide your graduation project in distribution sector for medium and also for low voltage network in another region.

3- Make research's about SCADA system for applying it and applying new power method in all cities in Palestine.

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[1] Data sheet*

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* For a Data sheet see Appendix part 1.

Appendix

Part 1: **Data sheet of Transmission lines.**

Part 2: **Vega 78 power quality analyzer**.

Part 3: **load data from VEGA 78 of all domestic transformers.**

Part 4: **load data from VEGA 78 of all industrial transformers.**

Part 5: **E-TAP Program.**

Part 6: **One-Line Diagram - OLV1 (Load Flow Analysis <u>before</u> solve problems).**

Part 7: **Complete report of Load Flow Analysis <u>before</u> solve problems.**

Part 8: **One-Line Diagram - OLV1 (Load Flow Analysis <u>after</u> solve problems).**

Part 9: **Complete report of Load Flow Analysis <u>after</u> solve problems.**

Part 1

Data sheet of Transmission lines

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TECHNICAL DATA SHEET

- **AAAC- ALL ALUMINIUM ALLOY CONDUCTORS**
- **ACSR- ALUMINIUM CONDUCTOR STEEL REINFORCED**
- **AAC- ALL ALUMINIUM CONDUCTORS**

KJV ALLOY CONDUCTORS P. LTD. - *An ISO 9001:2008 Company*

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CONVERSION FACTORS AND FORMULAE

CONVERSION FACTORS TABLE

These units	Multiplied by	Equal
Amperes per sq. cm	6.452	Amperes per sq. in
Ampere-turns	1.257	Gilbert
Ampere-turns per cm	2.540	Ampere-turns per in
British thermal units	778.3	Foot pounds
	3.930×10^{-4}	Horsepower hours
	1.055	Joules
	2.931×10^{-4}	Kilowatt hours
B.t.u. per min	12.97	Foot-pounds per sec
	0.02357	Horsepower
	0.01758	Kilowatts
	17.58	Watts
Centimeters	3.281×10^{-2}	Feet
	0.3937	Inches
	6.214×10^{-6}	Miles
	393.7	Miles
	1.094×10^{-2}	Yards
Centimeter-dynes	7.376×10^{-8}	Pound-feet
Centimeter-grams	7.233×10^{-5}	Pound-feet
Centimeter per sec	1.969	Feet per minute
	0.03281	Feet per sec
	0.02237	Miles per hour
	3.728×10^{-4}	Miles per minute
Circular mils	7.854×10^{-7}	Sq. inches
	0.7854.	Sq. mils
Cms Per sec Per sec	0.03281	Feet per sec Per sec
Cubic Centimeters	3.531×10^{-5}	Cubic feet
	3.102×10^{-2}	Cubic inches
Cubic feet	7.481	Gallons U.S./6.228 imp. gal
	59.83	Pints (liquid) US
	29.92	Quarts (liquid) US
	49.83	Pints (imperial)
	24.915	Quarts (imperial)
Cubic meters	35.31	Cubic feet
	61.024×10^{3}	Cubic inches
	1.308	Cubic yards
	264.2	Gallons US
	2113	(1,759 imperial) pints (liquid)
	1057	(879 imperial) quarts (liquid)
Degrees (angle)	0.01745	Radians
Degrees per sec	0.1667	Revolutions per minute
Dynes	2.248×10^{-6}	Pounds
Ergs (dyne- Centimeters)	9.480×10^{-11}	British thermal units
	7.378×10^{-8}	Foot pounds
	10^{7}	Joules
Ergs per sec	5.688×10^{-9}	B.t. units per minute
	4.427×10^{-6}	Foot-pounds per minute
	7.378×10^{-8}	Foot-pounds per sec
	1.341×10^{-10}	Horsepower
	10^{-10}	Kilowatts
Feet of Water	62.43	Pounds per sq. foot
	0.4335	Pounds per sq. inch
Feet per minute	0.01667	Feet per seconds
	0.01136	Miles per hour
Feet per sec	0.5921	Knots
	0.6813	Miles per hour

These units	Multiplied by	Equal
Foot-pounds	1.285×10^{-3}	British thermal units
	1.356×10^{7}	Ergs
	5.050×10^{-7}	horsepower hours
	1.356	joules
	3.766×10^{-7}	kilowatt hours
Foot-pounds per sec	7.709×10^{-2}	B.t. units per minute
	1.818×10^{-3}	Horse power
	1.356×10^{-3}	Kilowatts
Gallons U S	0.1337	Cubic feet
	231	Cubic inches
Gallons per minute	2.228×10^{-3}	Cubic feet per sec
Gausses	6.452	Lines per sq. inch
Gilbert	0.7958	Ampere-turns
Gilbert per centimeter	2.021.	Ampere-turns per inch
Grams	980.7	Dynes
	15.43	Grains
	0.03527	Ounces
Grams	0.03215	Ounces (troy)
	2.205×10^{-3}	Pounds
Horsepower	42.42	B.t. units per minute
	33,000	Foot-pounds per minute
	550	Foot-pounds per second
	1.014	Horsepower (metric).
	0.7457	Kilowatts.
	745.7	Watts.
Horsepower (boiler)	33.250	B.t.u. per hour.
	9.804	Kilowatts.
Horsepower hours	2,545	B.t. units
	1.98×10^{6}	Foot-Pounds
	2.684×10^{6}	Joules.
Inches of water	0.5781	Ounce per sq. in.
	5.202	Pounds per sq. ft.
	0.03613	Pounds per sq. in.
Inches of water	0.5781	Ounces per sq. in.
	5.202	Pounds per sq. ft.
	0.03613	Pounds per sq. in.
Joules (Int.)	9.480×10^{-4}	B.t. Units
	10^{7}	Ergs
	0.7378	Foot-pounds.
	2.778×10^{-4}	Watt-hours.
Kilograms	980.665×10^{-3}	Dynes.
	2.205	Pounds
	1.102×10^{-3}	Tons (short)
Kilogram per sq. mm.	14.223	Pounds per sq. inch.
	0.0063497	Tons per sq. inch.
Kilogram per sq. mm.	1,422.3	Pounds per sq. inch.
Kilometer	0.62137	Miles.
	1,093.61	Yds
	3,280.84	Ft.
Kilolines	10^{3}	Maxwells
Kilowatts	56.88	B.t. units per min
	4.427×10^{4}	Foot-pounds per min.
	737.8	Foot pounds per sec.
	1,341	Horsepower
	10^{3}	Watts.

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These units	Multiplied by	Equal
Kilowatt-hours	3,413 2.656×10^{6} 1,341 3.6×10^{6}	B.t. units per min. Foot-pounds Horsepower hours. Joules.
Lumens per sq. ft.	1	Footcandles.
Megalines	106	Maxwells
Megohms	10^{6}	Ohms.
Metre	3.281 39.37 6.214×10^{-4}	Feet. Inches. Miles.
Metres per minute	0.05468 0.03728	Feet per second. Miles per hour.
Metres per sec.	196.8 3.281 2.237 0.03728	Feet per min. Feet per second. Miles per hour. Miles per min.
Microhms	10^{12} 10^{4}	Megohms. Ohms.
Mils	8.333×10^{-5} 10^{3}	Feet. Inches.
Mil-foot	9.425×10^{-6}	Cubic inches.
Millihenries	10^{3}	Henries.
Milimetres	3.281×10^{-3} 0.03937 6.214×10^{-7} 39.37	Feet. Inches. Miles. Mils.
Miles	1.6093 1,760 5,280 63,360	Kilometres. Yds. Ft. Inches.
Miles per hour	88 1.467	Feet per min. Feet per second.
Miles per hr. per sec.	1.467	Feet per sec. Per sec.
Miles per min.	88 52.10 60	Feet per second. Knots. Miles per hour.
Minutes (angle) Ohms	2.909×10^{-4} 10^{6} 10^{6}	Radians. Megohms. Microhms.
Ounces	0.0625	Pounds.
Ounces per sq. in.	0.0625	Pounds per sq. in.
Pounds	44.823 16	Dynes. Ounces.
Pounds (troy)	0.8229	Pounds (av.).
Pounds of water	0.01602 27.68 0.1198	Cubic feet Cubic inches. Gallons U.S.
Pounds per cubic foot	5.787×10^{-4} 5.456×10^{-9}	Pounds per cubic inch. Pounds per mil-foot.
Pounds per cubic inch	9.425×10^{-4}	Pounds per mil-foot.
Pounds per square foot	0.01602 6.944×10^{-3}	Feet of water. Pounds per sq. inch.
Pounds per square inch	2.307 144	Feet of water. Pounds per square foot.
Pounds of water per min.	2.669×10^{-4}	Cubic feet per sec.
Quadrants (angle)	90 5,400 1.571	Degrees. Minutes. Radians.

These units	Multiplied by	Equal
Quarts (dry)	67.20	Cubic inches.
Quarts (liq.) U.S.	3.342×10^{-2} 57.75	Cubic feet. Cubic inches.
Radians	57.30 3,438 0.6366	Degrees Minutes Quadrants.
Radians per sec.	57.30 9.549 0.1592	Degrees per second. Revolutions per min. Revolutions per sec.
Revolutions	360 6.283 4	Degrees Radians Quandrants.
Revolutions per minute	6 0.1047 0.01667	Degrees per second. Radians per second. Revolutions per sec.
Revs. Per sec. Per sec.	6.283 3,600 60	Radians per sec. Per sec. Revs. Per min. per min. Revs. Per min. per sec.
Seconds (angle)	4.8×10^{-6}	Radians
Square centimetres	1.973×10^{5} 1.076×10^{-3} 0.1550	Circular mils. Square feet. Square inches.
Square foot	2.296×10^{-5} 1.833×10^{-4} 144	Acres. Circular mils. Square inches.
Square inches	1.273×10^{6} 6.944×10^{3} 10^{6}	Circular mils. Square feet. Square mils.
Square metres	2.471×10^{-4} 10.76 1,550 3.861×10^{-7}	Acres Square feet Square inches. Square mils.
Square miles	640 27.88×10^{6} 3.098×10^{6}	Acres Square feet. Square yards.
Square millimetres	1.973×10^{3}	Circular mils.
Square mils	1.273 10^{6}	Circular mils. Square inches.
Temp. (degs. C.) + 273	1	Abs. Temp. (degs.).
Temp. (degs. C.) + 17.8	1.8	Temp. (degs.) Fahr.
Temp. (degs. Fahr.) -32	0.5556	Temp. (degs.) C.
Temp. (degs. Fahr.) + 460	1	Abs. Two (degs. Fahr.).
Tons (long)	2,240 1.01605	Pounds Tons (metric)
Tons (metric)	2,204.6 0.09842	Pounds. Tons (longs).
Tons (short)	2,000 0.90719	Pounds. Tons (metric).
Tons (short) per sq. ft.	13.89	Pounds per square inch.
Tons (short) per sq. in.	2,000	Pounds per square inch.
Tons (long) per sq. in.	157.488 1,574.88 0.157488	Kilogram per sq. cm. Kilogram per sq. cm. Tonnes per sq. mm.
Webers	10^{8}	Maxwells.
Yards	0.9144 0.000568	Metres. Miles.

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CONVERSION FORMULAE

To Convert	Multiply by
LENGTH	
Milli-inches into micrometers	25.4
inches into millimetres	25.4
Inches into centimetres	2.54
Inches into metres	0.0254
Feet into millimetres	304.8
Feet into centimetres	30.48
Feet into metres	0.3048
Yards into metres	0.9144
Fathoms into metres	1.8288
Chains into metres	20.1168
Furlongs into metres	201.168
Miles, statute into kilometres	1.609344
Miles, nautical into kilometres	1.852
VOLUME & CAPACITY	
Cubic inches into cubic centimetres	16.387064
Cubic inches into litres	0.016387
Cubic feet into cubic metres	0.0283168
Cubic feet into litres	28.316847
Pints into litres	0.5682613
Quarts into litres	1.1365225
Cubic yards into cubic metres	0.7645549
Gallons into litres	4.54609
Gallons into cubic metres	0.0045461
Fluid ounces into cubic centimetres	28.413063
AREA	
Square inches into square millimetres	645.16
Square inches into square centimetres	6.4516
Square feet into square centimetres	929.0304
Square feet into square metres	0.092903
Square yards into square metres	0.836123
Acres into ares	40.468564
Acres into hectares	0.4046856
Square miles into hectares	258.9988
Square miles into square kilometres	2.589988

To Convert	Multiply by
MASS	
Grains into milligrams	64.79891
Grains into metric carats	0.323995
Grains into grams	0.064799
Penny weights into grams	1.555174
Drams into grams	1.77185
Ounces into grams	28.349523
Ounces troy into grams	31.103477
Ounces troy into metric carats	155.5174
Ounces into kilograms	0.0283495
Pounds into kilograms	0.4535924
Stones into kilograms	6.3502932
Hundred weights into kilograms	50.802345
Tons into kilograms	1016.0469
Tons into metric tonnes	1.01604
Tahils into grams	37.799
Kati into kilograms	0.60479
POWER	
Foot pounds-force per second into watts	1.35582
Horsepower into watts	745.7
Foot pounds-force per second into kilowatts	0.001356
Horsepower into kilowatts	0.7457
Horsepower into metric horsepower	1.01387

1 Kgf = 9.81 N

1 N = 0.1019 kg

1 KN = 0.1019 X 1000

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ALL ALUMINIUM ALLOY CONDUCTOR – AAAC

AAAC conductor is made from aluminum-magnesium-silicon alloy of high electrical conductivity containing Magnesium (0.6-0.9%) & Silicon (0.5-0.9%) to give it better mechanical properties after treatment.

AAAC conductors are generally made out of aluminum alloy 6201 (Minimum Conductivity is 54%). AAAC Conductor has a better corrosion resistance and better strength to weight ratio and improved electrical conductivity than ACSR Conductor on equal diameter basis.

Key Benefits

- Higher Strength to weight ratio compared to ACSR Conductor.
- Better Corrosion resistant than ACSR Conductor.
- Better sag Characterstics

Please go through different sizes as per global standards in next page.

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ALL ALUMINUM ALLOY CONDUCTOR (IS:398 PART 4)

Serial No.	Actual Area mm²	Stranding & Wire Diameter mm	Approx. Overall Dia mm	Approx. Mass kg/km	Calculated Maximum Resistance at 20°C ohms/km	Approx. Calculated Breaking Load kN
1	15	3/2.50	5.39	40.150	2.3040	4.33
2	22	7/2.00	6.00	60.160	1.5410	6.45
3	34	7/2.50	7.50	94.000	0.9900	10.11
4	55	7/3.15	9.45	149.200	0.6210	16.03
5	80	7/3.81	11.43	218.260	0.4250	23.41
6	100	7/4.26	12.78	272.860	0.3390	29.26
7	125	19/2.89	14.45	342.510	0.2735	36.64
8	148	19/3.15	15.75	406.910	0.2290	43.50
9	173	19/3.40	17.00	474.020	0.1969	54.54
10	200	19/3.66	18.30	549.400	0.1710	58.66
11	232	19/3.94	19.70	636.670	0.1471	68.05
12	288	37/3.15	22.05	794.050	0.1182	84.71
13	346	37/3.45	24.15	952.560	0.0984	101.58
14	400	37/3.71	25.97	1101.630	0.0829	117.40
15	465	37/4.00	28.00	1280.500	0.0734	136.38
16	525	61/3.31	29.79	1448.390	0.0651	146.03
17	570	61/3.45	31.05	1573.710	0.0598	158.66
18	604	61/3.55	31.95	1666.000	0.0568	167.99
19	642	61/3.66	32.94	1771.360	0.0534	178.43
20	695	61/3.81	34.29	1919.130	0.0492	193.25
21	767	61/4.00	36.00	2115.540	0.0446	213.01

AAAC (ASTM B399)

CODE NAME	Conductor Size (MCM)	Number Of Wires & Diameter	Cross-sectional Area (mm²)	Overall Diameter (mm)	Weight (kg/km)	Calculated Breaking Load (kgf)	Calculated Breaking Load (kN)	Calculated DC Resistance at 20°C ohms/Km	Breaking Length (km)
	66.36	7/2.47	33.54	7.41	92	1087	10.66	0.99870	11.82
Ames	77.47	7/2.67	39.19	8.01	108	1270	12.45	0.85470	11.76
	105.60	7/3.12	53.52	9.36	148	1734	17.00	0.62590	11.72
Azusa	123.30	7/3.37	62.44	10.01	172	2023	19.84	0.53640	11.76
	133.10	7/3.50	67.35	10.50	186	2091	20.51	0.49730	11.24
Anaheim	155.40	7/3.78	78.55	11.34	217	2439	23.92	0.42640	11.24
	167.80	7/3.93	84.91	11.79	234	2636	25.85	0.39450	11.26
Amherst	195.70	7/4.25	99.30	12.75	274	3083	30.23	0.33730	11.25
	211.60	7/4.42	107.40	13.26	296	3335	32.71	0.31190	11.27
Alliance	246.90	7/4.77	125.10	14.31	345	3884	38.09	0.26780	11.26
Canton	394.50	19/3.66	199.90	18.30	551	6012	58.96	0.16760	10.91
	400.00	19/3.69	203.20	18.45	560	6112	59.94	0.16480	10.91
	450.00	19/3.91	228.10	19.55	629	6861	67.28	0.14680	10.91
Cairo	465.40	19/3.98	236.40	19.90	652	7110	69.73	0.14170	10.90
	500.00	19/4.12	253.30	20.60	698	7619	74.72	0.13220	10.92
	550.00	37/3.10	279.30	21.70	770	8577	84.11	0.11990	11.08
Darien	559.50	19/4.36	283.70	21.80	782	8533	83.68	0.11810	10.97
	600.00	37/3.23	303.20	22.61	836	9311	91.31	0.11050	11.14
	650.00	37/3.37	330.00	23.59	910	10134	99.38	0.10150	11.14
Elgin	652.40	19/4.71	331.00	23.55	913	9956	97.64	0.10120	10.90
	700.00	37/3.49	354.00	24.43	976	10418	102.20	0.09462	10.67
Flint	740.80	37/3.59	374.50	25.13	1033	11022	108.10	0.08944	10.67
	750.00	37/3.62	380.80	25.34	1050	11207	109.90	0.08796	10.67
	800.00	37/3.73	404.30	26.11	1115	11899	116.70	0.08285	10.67
	900.00	37/3.96	455.70	27.72	1256	13411	131.50	0.07350	10.68
Greeley	927.20	37/4.02	469.60	28.14	1295	13821	135.50	0.07133	10.67
	1000.00	37/4.18	507.70	29.26	1400	14942	146.50	0.06598	10.67

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AAAC (DIN:48201-6)								
Nominal Aluminum Area	Number & Diameter of Wires	Cross-sectional Area	Overall Diameter	Weight	Calculated Breaking Load		Calculated DC Resistance at 20°C	Breaking Length
(mm²)	(mm)	(mm²)	(mm)	(kg/km)	(kgf)	(kN)	(ohm / km)	(km)
16	7/1.70	15.89	5.10	43	453	4.44	2.09080	10.530
25	7/2.10	24.25	6.30	66	690	6.77	1.37000	10.450
35	7/2.50	34.36	7.50	94	979	9.6	0.96690	10.410
50	7/3.00	49.48	9.00	135	1409	13.82	0.67130	10.440
50	19/1.80	48.35	9.00	133	1377	13.5	0.69030	10.350
70	19/2.10	65.81	10.50	181	1874	18.38	0.50720	10.350
95	19/2.50	93.27	12.50	256	2656	26.05	0.35790	10.380
120	19/2.80	117.00	14.00	322	3332	32.68	0.28530	10.350
150	37/2.25	147.10	15.75	405	4190	41.09	0.22750	10.350
185	37/2.50	181.60	17.50	500	5172	50.73	0.18420	10.340
240	61/2.25	242.50	20.25	669	6906	67.74	0.13830	10.340
300	61/2.50	299.40	22.50	826	8527	83.63	0.11200	10.340
400	61/2.89	400.10	26.01	1104	11390	111.7	0.08381	10.330
500	61/3.23	499.80	29.07	1379	14235	139.6	0.06709	10.340
625	91/2.96	626.20	32.56	1733	17835	174.9	0.05367	10.290
800	91/3.35	802.10	36.85	2219	22852	224	0.04190	10.300
1000	91/3.74	999.70	41.14	2766	28470	279.2	0.03362	20.290

AAAC (BS 3242:1970)									
Code Name	Nominal Aluminum Area	Strands & Diameter of Wires	Cross-Sectional Area	Overall Diameter	Weight	Breaking Load		Calculated Resistance at 20°C Max	Breaking Length
	(mm²)	(mm)	(mm²)	(mm)	(kg)	kgf	kN	(ohm / km)	(km)
-	10	7/1.47	11.80	4.41	32	340	3.34	2.7710	10.63
Box	15	7/1.85	18.82	5.55	51	537	5.27	1.7490	10.53
Acacia	20	7/2.08	23.79	6.24	65	680	6.67	1.3840	10.46
Almond	25	7/2.34	30.10	7.02	82	861	8.45	1.0930	10.50
Cedar	30	7/2.54	35.47	7.62	97	1014	9.95	0.9281	10.45
-	35	7/2.77	42.18	8.31	115	1205	11.82	0.7804	10.48
Fir	40	7/2.95	47.84	8.85	131	1367	13.41	0.6881	10.44
Hazel	50	7/3.30	59.87	9.90	164	1711	16.78	0.5498	10.43
Pine	60	7/3.61	71.65	10.83	196	2048	20.09	0.4594	10.45
-	70	7/3.91	84.05	11.73	230	2402	23.56	0.3917	10.44
Willow	75	7/4.04	89.73	12.12	245	2565	25.16	0.3669	10.47
-	80	7/4.19	96.52	12.57	264	2758	27.06	0.3411	10.45
-	90	7/4.45	108.90	13.35	298	3112	30.53	0.3023	10.44
Oak	100	7/4.65	118.90	13.95	325	3398	33.33	0.2769	10.46
-	100	19/2.82	118.70	14.10	326	3393	33.29	0.2787	10.41
Mulberry	125	19/3.18	150.90	15.90	415	4312	42.30	0.2192	10.39
Ash	150	19/3.48	180.70	17.40	497	5164	50.66	0.1831	10.39
Elm	175	19/3.76	211.00	18.80	580	6030	59.15	0.1568	10.40
Poplar	200	37/2.87	239.40	20.09	659	6841	67.11	0.1385	10.38
-	225	37/3.05	270.30	21.35	744	7724	75.77	0.1227	10.38
Sycamore	250	37/3.23	303.20	22.61	835	8664	84.99	0.1093	10.38
Upas	300	37/3.53	362.10	24.71	997	10350	101.53	0.0916	10.38
Walnut	350	37/3.81	421.80	26.67	1162	12053	118.24	0.0786	10.37
Yew	400	37/4.06	479.00	28.43	1319	13685	134.25	0.0692	10.38
Totara	425	37/4.14	498.10	28.98	1372	14223	139.53	0.0666	10.37
Rubus	500	61/3.50	586.90	31.50	1620	16771	164.52	0.0566	10.35
Araucaria	700	61/4.14	821.10	37.26	2266	23450	230.04	0.0405	10.35

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ALL ALUMINIUM CONDUCTOR – AAC

AAC conductor is also known as aluminum stranded conductor. AAC conductor is manufactured from electrolytically refined (E.C.GRADE) aluminum, having purity of minimum 99.5% of aluminium (with minimum Conductivity of 61%). AAC conductor is used mainly in urban areas because the spacing is short and the supports are close.

All aluminum conductors are made up of one or more strands of aluminum wire depending on the end usage. AAC conductors are also used extensively in coastal areas because they have a very high degree of corrosion resistance.

Key Benefits

- Conductivity of AAC Conductor is high.
- AAC Conductor is corrosion resistant.

Please go through different sizes as per global standards in next page.

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ALL ALUMINUM CONDUCTORS (IS:398 PART 1)							
Code Word	Nominal Aluminium	Stranding & Wire Diameter	Sectional Area	Approximate Overall Diameter	Approximate Mass	Calculated Resistance at 20°C Max	Approximate Calculated Breaking Load
	mm²	mm	mm²	mm	kg/km	ohm/km	kN
GNAT	25	7/2.21	26.85	6.63	74	1.1	4.52
ANT	50	7/3.10	52.83	9.3	145	0.55	8.25
WASP	100	7/4.39	106	13.17	290	0.28	15.96
	150	19/3.18	150.9	15.9	415	0.19	23.28
Spider	240	19/3.99	237.6	19.95	654	0.12	35.74
Butter-Fly	300	19/4.65	322.7	23.25	888	0.09	48.74

AAC (BS 215 PART 1:1970)									
Code Name	Nominal Aluminum Area	Strands & Diameter of Wires	Cross-Sectional Area	Overall Diameter	Breaking Load		Weight	Calculated Resistance at 20°C Max	Breaking Length
	mm²	mm	mm²	mm	Kgf	KN	Kg/Km	Ohm/Km	Km
Midge	22	7/2.06	23.33	6.18	407	3.99	64	1.2270	6.36
Aphis	25	3/3.35	26.44	7.22	420	4.12	73	1.0830	5.68
Gnat	25	7/2.21	26.85	6.63	468	4.59	74	1.0660	6.32
Weevil	30	3/3.66	31.56	7.89	495	4.86	87	0.9070	5.63
Mosquito	35	7/2.59	36.88	7.77	614	6.02	101	0.7763	6.08
Ladybird	40	7/2.79	42.80	8.37	701	6.88	117	0.6689	5.99
Ant	50	7/3.10	52.83	9.30	844	8.28	145	0.5419	5.82
Fly	60	7/3.40	63.55	10.20	1010	9.91	174	0.4505	5.80
Bluebottle	70	7/3.66	73.65	10.98	1156	11.34	202	0.3887	5.72
Earwig	75	7/3.78	78.55	11.34	1217	11.94	215	0.3645	5.66
Grasshopper	80	7/3.91	84.05	11.73	1303	12.78	230	0.3406	5.67
Clegg	90	7/4.17	95.60	12.51	1482	14.54	262	0.2995	5.66
Wasp	100	7/4.39	106.00	13.17	1633	16.02	290	0.2702	5.63
Beetle	100	19/2.67	106.40	13.35	1773	17.39	293	0.2704	6.05
Bee	125	7/4.90	132.00	14.70	2033	19.94	361	0.2169	5.63
Cricket	150	7/5.36	157.90	16.08	2432	23.86	432	0.1813	5.63
Hornet	150	19/3.25	157.60	16.25	2519	24.71	434	0.1825	5.80
Caterpillar	175	19/3.53	185.90	17.65	2917	28.62	511	0.1547	5.71
Chafer	200	19/3.78	213.20	18.90	3305	32.42	587	0.1349	5.63
Spider	225	19/3.99	237.60	19.95	3683	36.13	654	0.1211	5.63
Cockroach	250	19/4.22	265.70	21.10	4118	40.40	731	0.1083	5.63
Butterfly	300	19/4.65	322.70	23.25	4970	48.76	888	0.0892	5.60
Moth	350	19/5.00	373.10	25.00	5746	56.37	1027	0.0771	5.59
Drone	350	37/3.58	372.40	25.06	5844	57.33	1027	0.0774	5.69
Locust	400	19/5.36	428.70	26.80	6603	64.78	1180	0.0671	5.60
Centipede	400	37/3.78	415.20	26.46	6435	63.13	1145	0.0694	5.62
Maybug	450	37/4.09	486.10	28.63	7535	73.92	1340	0.0593	5.62
Scorpion	500	37/4.27	529.80	29.89	8160	80.05	1461	0.0544	5.59
Cicada	600	37/4.65	628.30	32.55	9678	94.94	1732	0.0459	5.59
Tarantula	750	37/5.23	794.90	36.61	12244	120.11	2192	0.0363	5.59

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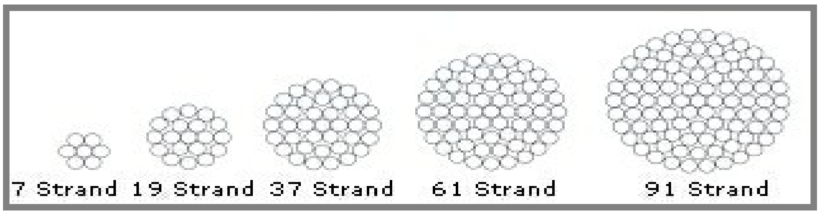
AAC (DIN 48201-5)								
Nominal aluminium area	Number and diameter	Cross-sectional	Overall diameter	Weight	Calculated Breaking Load		Calculated DC Resistance At 20°C	Breaking length
mm²	mm	mm²	mm	Kg/Km	kgf	kN	Ohms/Km	Km
16	7/1.70	15.89	5.10	43	290	2.84	1.80170	6.740
25	7/2.10	24.25	6.30	66	425	4.17	1.18060	6.440
35	7/2.50	34.36	7.50	94	589	5.78	0.83320	6.270
50	7/3.00	49.48	9.00	135	810	7.94	0.57860	6.000
50	19/1.80	48.35	9.00	133	862	8.45	0.59500	6.480
70	19/2.10	85.81	10.50	181	1154	11.32	0.43710	6.380
95	19/2.50	93.27	12.50	256	1599	15.68	0.30840	6.260
120	19/2.80	117.00	14.00	322	1915	18.78	0.24590	5.950
150	37/2.25	147.10	15.75	405	2580	25.30	0.19600	6.370
185	37/2.50	181.60	17.50	500	3114	30.54	0.15880	6.230
240	61/2.25	242.50	20.25	669	4029	39.51	0.11920	6.030
300	61/2.50	299.40	22.50	826	4864	47.70	0.09651	5.900
400	61/2.89	400.10	26.01	1104	6206	60.86	0.72220	5.630
500	61/3.23	499.80	29.07	1379	7614	74.67	0.05782	5.530
625	91/2.96	626.20	32.56	1733	9713	95.25	0.04625	5.600
800	91/3.35	802.10	36.85	2219	12072	118.39	0.03610	5.440
1000	91/3.74	999.70	41.14	2766	14863	145.76	0.02897	5.370

AAC (ASTM B231)									
Code name	Conductor Size	Number & Diameter of Wire	Cross-Sectional Area	Overall Diameter	Weight	Calculated Breaking Load		Calculated DC Resistance at 20OC	Breaking Length
	(MCM)	mm	mm²	mm	Kg/Km	(kgf)	(kN)	ohms/Km	Km
Peachbell	6.00	7/1.55	13.21	4.65	36	254	2.49	2.1750	7.06
Rose	4.00	7/1.96	21.12	5.88	58	399	3.91	1.3610	6.88
Iris	2.00	7/2.47	33.54	7.41	92	611	5.99	0.8568	6.64
Pansy	1.00	7/2.78	42.49	8.34	117	746	7.31	0.6763	6.38
Poppy	1/0	7/3.12	53.52	9.36	148	903	8.86	0.5369	6.10
Aster	2/0	7/3.50	67.35	10.50	186	1136	11.14	0.4267	6.11
Phlox	3/0	7/3.93	84.91	11.79	234	1375	13.48	0.3384	5.88
Oxlip	4/0	7/4.42	107.40	13.26	296	1740	17.06	0.2676	5.88
Sneezewort	250.00	7/4.80	126.70	14.40	349	2052	20.12	0.2268	5.88
Valerian	250.00	19/2.91	126.40	14.55	348	2107	20.66	0.2273	6.06
Daisy	266.80	7/4.96	135.30	14.88	373	2191	21.49	0.2124	5.87
Laurel	266.80	19/3.01	135.20	15.05	373	2254	22.10	0.2125	6.04
Peony	300.00	19/3.19	151.90	15.95	419	2482	24.34	0.1892	5.93
Tulip	336.40	19/3.38	170.50	16.90	470	2787	27.33	0.1685	5.93
Daffodil	350.00	19/3.45	177.60	17.25	490	2903	28.47	0.1618	5.93
Canna	397.50	19/3.68	202.10	18.40	557	3237	31.74	0.1422	5.81
Goldentuft	450.00	19/3.91	228.10	19.55	629	3580	35.11	0.1260	5.69
Cosmos	477.00	19/4.02	241.20	20.10	665	3784	37.11	0.1191	5.69
Syringa	477.00	37/2.88	241.00	20.16	664	3932	38.56	0.1192	5.92
Hyacinth	500.00	37/2.95	252.90	20.65	697	4126	40.46	0.1136	5.92
Zinnia	500.00	19/4.12	253.30	20.60	698	3975	38.98	0.1134	5.69
Dahlia	556.50	19/4.35	282.40	21.75	779	4431	43.45	0.1018	5.69
Mistletoe	556.50	37/3.11	181.10	21.77	775	4496	44.09	0.1022	5.80
Meadowsweet	600.00	37/3.23	303.20	22.61	836	4849	47.55	0.0948	5.80
Orchid	636.00	37/3.33	322.20	23.31	888	5154	50.54	0.0892	5.80
Heuchera	650.00	37/3.37	330.00	23.59	910	5279	51.77	0.0871	5.80
Verbena	700.00	37/3.49	354.00	24.43	976	5661	55.52	0.0812	5.80
Flag	700.00	61/2.72	354.50	24.48	977	5831	57.18	0.0811	5.97
Violet	715.50	37/3.53	362.10	24.71	998	5792	56.80	0.0794	5.80
Nasturtium	715.50	61/2.75	362.30	24.75	999	5961	58.46	0.0793	5.97
Petunia	750.00	37/3.62	380.80	25.34	1050	5969	58.54	0.0755	5.69
Cattail	750.00	61/2.82	381.00	25.38	1050	6147	60.28	0.0754	5.86
Arbutus	795.00	37/3.72	402.10	26.04	1109	6303	61.81	0.0715	5.69
Lilac	795.00	61/2.90	402.90	26.10	1111	6501	63.75	0.0713	5.85

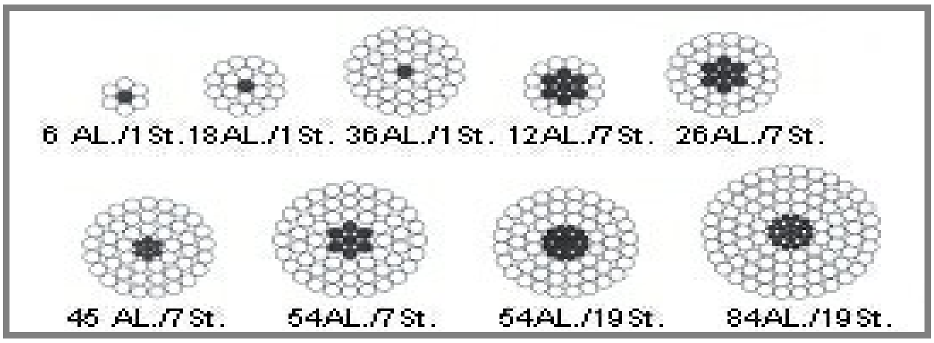
AAC (ASTM B231)

Code name	Conductor Size (MCM)	Number & Diameter of Wire mm	Cross-Sectional Area mm²	Overall Diameter mm	Weight Kg/Km	Calculated Breaking Load (kgf)	Calculated Breaking Load (kN)	Calculated DC Resistance at 20OC ohms/Km	Breaking Length Km
Cockscomb	900.00	37/3.96	455.70	27.72	1256	6997	68.62	0.06306	5.57
Snapdragon	900.00	61/3.09	457.40	27.81	1261	7236	70.96	0.06282	5.74
Magnolia	954.00	37/4.08	483.70	28.56	1334	7428	72.84	0.05941	5.57
Goldenrod	954.00	61/3.18	484.50	28.62	1336	7664	75.16	0.05931	5.74
Hawkweed	1000.00	37/4.18	507.70	29.26	1400	7796	76.45	0.05660	5.57
Camellia	1000.00	61/3.25	506.00	29.25	1395	8005	78.50	0.05679	5.74
Bluebell	1033.50	37/4.24	522.40	29.68	1440	8022	78.67	0.05501	5.57
Larkspur	1033.50	61/3.31	524.90	29.79	1447	8304	81.43	0.05474	5.74
Marigold	1113.00	61/3.43	563.60	30.87	1554	8917	87.45	0.05099	5.74
Hawthorn	1192.50	61/3.55	603.80	31.95	1665	9551	93.66	0.04759	5.74
Narcissus	1272.00	61/3.67	645.30	33.03	1779	10004	98.11	0.04453	5.63
Columbine	1351.50	61/3.78	684.50	34.02	1887	10612	104.10	0.04198	5.63
Carnation	1431.00	61/3.89	725.00	35.01	1999	11010	108.00	0.03964	5.51
Gladiolus	1510.50	61/4.00	766.50	36.00	2113	11641	114.20	0.03749	5.51
Coreopsis	1590.00	41/4.10	805.40	36.90	2221	12231	119.90	0.03568	5.51
Jessamine	1750.00	61/4.30	885.80	38.70	2442	13453	131.90	0.03244	5.51
Cowslip	2000.00	91/3.76	1010.00	41.36	2785	15490	151.90	0.02845	5.56
Sagebrush	2250.00	91/3.99	1138.00	43.89	3168	17088	167.60	0.02550	5.39
Lupine	2500.00	91/4.21	1267.00	46.31	3527	19024	186.60	0.02290	5.39
Bitterroot	2750.00	91/4.41	1390.00	48.51	3870	20875	204.70	0.02088	5.39
Trillium	3000.00	127/3.90	1517.00	50.70	4223	22784	223.40	0.01913	5.39
Bluebonnet	3500.00	127/4.22	1776.00	54.86	4993	26676	261.60	0.01650	5.34

Construction of AAC & AAAC Conductors



Construction of ACSR Conductors



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ALUMINIUM CONDUCTOR STEEL REINFORCED – ACSR

ACSR conductor consists of a solid or stranded steel core surrounded by strands of aluminum (E.C. GRADE). ACSR Conductor is available in a wide range of steel, containing carbon from 0.5% to 0.85 %. The higher strength ACSR Conductor are used for river crossings, overhead ground wires, installations involving extra long spans etc. Against any given resistance of conductor, ACSR may be manufactured for having a wide range of tensile strength as per requirement. The principal advantage of these conductors are high tensile strength so that they are used for longer spans with less supports. Due to the greater diameter of ACSR Conductor a much higher corona limit can be obtained causing big advantages on high as well as extra high voltage Overhead lines.

Key Benefits

- ACSR Conductor has high Tensile Strength.
- Variable steel core stranding enables desired strength to be achieved without sacrificing ampacity.
- Additional corrosion protection is available through the application of grease to the core or infusion of the complete cable with grease

Please go through different sizes as per global standards in next page.

ALUMINUM CONDUCTOR STEEL REINFORCED (IS:398 PART 2)

Nominal Aluminium	Stranding & Wire Diameter		Sectional Area of Aluminium	Total Sectional Area	Approximate Overall Diameter	Approximate Mass	Calculated Resistance at 20°C Max	Approximate Calculated Breaking Load
	Aluminium	Steel						
mm²	mm	mm	mm²	mm²	mm	kg/km	ohm/km	kN
10	6/1.50	1/1.50	10.6	12.37	4.5	43	2.78	3.97
18	6/1.96	1/1.96	18.1	21.12	5.88	73	1.62	6.74
20	6/2.11	1/2.11	20.98	24.48	6.33	85	1.39	7.61
30	6/2.59	1/2.59	31.61	36.88	7.77	128	0.93	11.12
50	6/3.35	1/3.35	52.88	61.7	10.05	214	0.55	18.25
80	6/4.09	1/4.09	78.83	91.97	12.27	319	0.37	26.91
100	6/4.72	7/1.57	105	118.5	14.15	394	0.28	32.41
150	30/2.59	7/2.59	158.1	194.9	18.13	726	0.19	67.34
200	30/3.00	7/3.00	212.1	261.5	21	974	0.14	89.67
400	42/3.50	7/1.96	404.1	425.2	26.88	1281	0.07	88.79
420	54/3.18	7/3.18	428.9	484.5	28.62	1621	0.07	130.32
520	54/3.53	7/3.53	528.5	597	31.77	1998	0.06	159.6
560	42/4.13	7/2.30	562.7	591.7	31.68	1781	0.05	120.16

ACSR (DIN 48204)

Nominal Cross Sections	Construction Number and diameter of wires		Cross-sectional area			Overall diameter	Weight			Calculated breaking load		Calculated D.C. resistance
	Al	S	AL	Steel	Total		Al	S	Total			at 20°C
(mm²)	(mm)	(mm)	(mm²)	(mm²)	(mm²)	mm	(kg/km)	(kg/km)	(kg/km)	(kgf)	(kN)	Ohms/Km
16/2.5	6/1.8	1/1.8	15.27	2.25	17.81	5.50	42	20	62	592	5.81	1.87900
25/4	6/2.25	1/2.25	23.86	3.98	27.84	6.75	65	31	96	920	9.02	1.20300
35/6	6/2.7	1/2.7	34.35	5.73	40.08	8.10	94	45	139	1295	12.70	0.83530
44/32	14/2.0	7/2.4	43.98	31.67	75.65	11.20	122	248	370	4636	45.46	0.65730
50/8	6/3.2	1/3.2	48.25	8.04	56.29	9.60	132	63	195	1752	17.18	0.59460
50/30	12/2.33	7/2.33	51.17	29.85	81.02	11.65	141	234	375	4515	44.28	0.56440
70/12	26/1.85	7/1.44	69.89	11.40	81.29	11.72	193	89	282	2683	26.31	0.41300
95/15	26/2.15	7/1.67	94.39	15.33	109.72	13.61	260	120	380	3586	35.17	0.30580
95/55	12/3.2	7/3.2	96.51	56.30	152.81	16.00	266	441	707	8178	80.20	0.29920
105/75	14/3.1	19/2.25	105.67	75.55	181.22	17.45	292	594	886	10879	106.69	0.27360
120/20	26/2.44	7/1.9	121.57	19.85	141.42	15.46	335	156	491	4583	44.94	0.23740
120/70	12/3.6	7/3.6	122.15	71.25	193.40	18.00	337	558	895	10009	98.16	0.23640
125/30	30/2.33	7/2.33	127.92	29.85	157.77	16.31	353	234	587	5900	57.86	0.22590
150/25	26/2.7	7/2.1	148.86	24.25	173.11	17.10	411	190	601	5544	54.37	0.19390
170/40	30/2.7	7/2.7	171.77	40.08	211.85	18.90	474	314	788	7853	77.01	0.16820
185/30	26/3.0	7/2.33	183.78	29.85	213.63	18.99	507	234	741	6759	66.28	0.15710
210/35	26/3.2	7/2.49	209.10	34.09	243.19	20.27	577	267	844	7642	74.94	0.13800
210/50	30/3.0	7/.3.0	212.06	49.48	261.54	21.00	585	388	973	9407	92.25	0.13630
230/30	24/3.5	7/2.33	230.90	29.85	260.75	20.99	636	234	870	7453	73.09	0.12490
240/40	26/3.45	7/2.68	243.05	39.49	282.54	21.84	670	309	979	8816	86.46	0.11880
265/35	24/3.74	7/2.49	236.66	34.09	293.75	22.43	727	267	994	8457	82.94	0.10940
300/50	26/3.86	7/3.0	304.26	49.48	353.74	24.44	839	388	1227	10716	105.09	0.09487
305/40	54/2.68	7/2.68	304.62	39.49	344.11	24.12	841	309	1150	10126	99.30	0.09490
340/30	48/3.0	7/2.33	339.29	29.85	369.14	24.99	936	234	1170	9438	92.56	0.08513
380/50	54/3.0	7/3.0	381.70	49.48	431.18	27.00	1054	388	1442	12329	120.91	0.07573
385/35	48/3.2	7/2.49	386.04	34.09	420.13	26.67	1065	267	1332	10637	104.31	0.07482
435/55	54/3.2	7/3.2	434.29	56.30	490.59	28.80	1199	441	1640	13896	136.27	0.06656
450/40	48/3.45	7/2.68	448.71	39.49	488.20	28.74	1238	309	1547	12256	120.19	0.06437
490/65	54/3.4	7/3.4	490.28	63.55	553.83	30.60	1354	498	1852	15586	152.85	0.05896
495/35	45/3.74	7/2.49	494.36	34.09	528.48	29.91	1364	267	1631	12268	120.31	0.05843
510/45	48/3.68	7/2.87	510.54	45.28	555.82	30.69	1409	355	1764	13698	134.33	0.05657
550/70	54/3.6	7/3.6	549.65	71.25	620.90	32.40	1518	558	2076	17072	167.42	0.05259
560/50	48/3.86	7/3.0	561.70	49.48	611.18	32.16	1550	388	1938	14916	146.28	0.05142
570/40	45/4.02	7/2.68	571.16	39.49	610.65	32.16	1576	309	1885	14070	137.98	0.05057
650/45	45/4.3	7/2.87	653.49	45.28	698.77	34.41	1803	355	2155	15859	155.52	0.04420
680/85	54/4.0	19/2.4	678.58	85.95	764.53	36.00	1874	676	2550	21413	209.99	0.04260
1045/45	72/4.3	7/2.87	1045.58	45.28	1090.86	43.01	2889	355	3244	22216	217.87	0.02766

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ACSR (BS 215 PART 2:1970)

Code Name	Nominal Aluminum Area	Strands & Diameter of Wires		Cross-Sectional Area		WEIGHT			Breaking Load		Calculated Resistance at 20°C Max
		Al	Steel	Al	Steel	Al	Steel	Total			
		mm	mm	mm^2	mm^2	Kg/Km	Kg/Km	Kg/Km	kgf	KN	Ohm/Km
Mole	10	6/1.50	1/1.50	10.60	1.77	29	14	43	421	4.13	2.7070
Squirrel	20	6/2.11	1/2.11	20.98	3.50	58	27	85	807	7.92	1.3680
Gopher	25	6/2.36	1/2.36	26.25	4.37	72	34	106	979	9.60	1.0930
Weasel	30	6/2.59	1/2.59	31.61	5.27	87	41	128	1167	11.45	0.9077
Fox	35	6/2.79	1/2.79	36.88	6.11	101	48	149	1342	13.17	0.7823
Ferret	40	6/3.00	1/3.00	42.41	7.07	116	55	171	1553	15.23	0.6766
Rabbit	50	6/3.35	1/3.35	52.88	8.81	145	69	214	1872	18.36	0.5426
Mink	60	6/3.66	1/3.66	63.13	10.52	173	82	255	2223	21.81	0.4545
Skunk	60	12/2.59	7/2.59	63.22	36.88	175	289	464	5396	52.93	0.4568
Beaver	70	6/3.99	1/3.99	75.02	12.50	205	98	303	2626	25.76	0.3825
Horse	70	12/2.79	7/2.79	73.36	42.80	203	335	538	6240	61.21	0.3936
Racoon	75	6/4.10	1/4.10	79.22	13.20	217	103	320	2774	27.21	0.3622
Otter	80	6/4.22	1/4.22	83.92	13.99	230	109	339	2939	28.83	0.3419
Cat	90	6/4.50	1/4.50	95.43	15.90	262	124	386	3330	32.67	0.3007
Hare	100	6/4.72	1/4.72	105.00	17.50	288	137	425	3666	35.96	0.2733
Dog	100	6/4.72	7/1.57	105.00	13.55	288	106	394	3332	32.69	0.2733
Hyena	100	7/4.39	7/1.93	106.00	20.48	293	160	453	4183	41.04	0.2728
Cougar	125	18/3.05	1/3.05	131.50	7.31	362	57	419	3062	30.04	0.2190
Leopard	125	6/5.28	7/1.75	131.40	16.84	361	132	493	4156	40.77	0.2184
Tiger	125	30/2.36	7/2.36	131.20	30.62	363	240	603	5914	58.02	0.2203
Dingo	150	18/3.35	1/3.35	158.70	8.81	437	69	506	3642	35.73	0.1814
Wolf	150	30/2.59	7/2.59	158.10	36.88	437	289	726	7061	69.27	0.1828
Caracal	175	18/3.61	1/3.61	184.20	10.24	507	80	587	4191	41.11	0.1563
Lynx	175	30/2.79	7/2.79	183.40	42.80	507	335	842	8136	79.81	0.1576
Jaguar	200	18/3.86	1/3.86	210.60	11.70	580	91	671	4749	46.59	0.1367
Panther	200	30/3.00	7/3.00	212.10	49.48	586	388	974	9407	92.28	0.1362
Lion	225	30/3.18	7/3.18	238.30	55.60	659	436	1095	10248	100.53	0.1213
Bear	250	30/3.35	7/3.35	264.40	61.70	731	483	1214	11339	111.24	0.1093
Goat	300	30/3.71	7/3.71	324.30	75.67	896	593	1489	13848	135.85	0.0891
Sheep	350	30/3.99	7/3.99	375.10	87.53	1037	686	1723	15938	156.35	0.0770
Antelope	350	54/2.97	7/2.97	374.10	48.50	1034	380	1414	12084	118.54	0.0773
Bison	350	54/3.00	7/3.00	381.70	49.48	1055	388	1443	12328	120.94	0.0757
Deer	400	30/4.27	7/4.27	429.60	100.20	1187	785	972	18202	178.56	0.0673
Zebra	400	54/3.18	7/3.18	428.90	55.60	1186	436	1622	13450	131.94	0.0674
Elk	450	30/4.50	7/4.50	477.10	113.30	1318	872	2190	20221	198.37	0.0606
Camel	450	54/3.35	7/3.35	476.00	61.70	1316	483	1799	14878	145.95	0.0607
Moose	500	54/3.53	7/3.53	528.50	68.51	1461	537	1998	16417	161.05	0.0547
Coyote	125	26/2.54	7/1.91	137.74	20.06	365	157	522	4820	47.30	0.3035

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ACSR (ASTM B232)

Code Name	Cond. Size		Number and Diameter of Wires		Cross-sectional area			Overall Diameter	Weight			Calculated Breaking Load		Calculated Resistance at 20°C Max
	AWG	MCM	Al mm	Steel mm	Al mm²	Steel mm²	Total mm²	mm	Al kg/km	Steel kg/km	Total kg/km	KgF	KN	
Turkey	6	26.24	6/1.68	1/1.68	13.30	2.22	15.52	5.04	37	17	54	540	5.29	2.1500
Thrush	5	33.22	6/1.89	1/1.89	16.83	2.81	19.64	5.67	46	22	68	678	6.65	1.6990
Swan	4	41.74	6/2.12	1/2.12	21.18	3.53	24.71	6.36	58	27	85	846	8.30	1.3500
Swanate	4	41.74	7/1.96	1/2.61	21.12	5.35	26.47	6.53	58	42	100	1067	10.46	1.3540
Swallow	3	52.68	6/2.38	1/2.38	26.69	4.45	31.14	7.14	73	35	108	1042	10.22	1.0710
Sparrow	2	66.36	6/2.67	1/2.67	33.59	5.60	39.19	8.01	92	44	136	1289	12.64	0.8513
Sparate	2	66.36	7/2.47	1/3.30	33.54	8.55	42.09	8.24	92	67	159	1650	16.18	0.8526
Robin	1	83.69	6/3.00	1/3.00	42.41	7.07	49.48	9.00	116	55	171	1612	15.81	0.6742
Raven	1/0	105.60	6/3.37	1/3.37	53.52	8.92	62.44	10.11	147	69	216	1987	19.49	0.5343
Quail	2/0	133.10	6/3.78	1/3.78	67.33	11.22	78.55	11.34	185	87	272	2401	23.55	0.4247
Pigeon	2/0	167.80	6/4.25	1/4.25	85.12	14.19	99.31	12.75	234	110	334	3006	29.48	0.3359
Penguin	4/0	211.60	6/4.77	1/4.77	107.20	17.87	125.10	14.31	294	139	433	3787	37.14	0.2667
Waxwing		266.80	18/3.09	1/3.09	135.00	7.50	142.50	15.45	372	58	430	3118	30.58	0.2129
Owl		266.80	6/5.36	7/1.79	135.40	17.62	153.00	16.09	371	138	509	4406	43.21	0.2112
Partridge		266.80	26/2.57	7/2.00	134.90	21.99	156.90	16.28	374	172	546	5113	50.14	0.2141
Ostrich		300.00	26/2.73	7/2.12	152.20	24.71	176.90	17.28	422	193	615	5756	56.45	0.1897
Merlin		336.40	18/3.47	1/3.47	170.20	9.46	179.70	17.35	469	74	543	3931	38.55	0.1688
Linnet		336.40	26/2.89	7/2.25	170.60	27.83	198.40	18.31	473	217	690	6413	62.89	0.1693
Oriole		336.40	30/2.69	7/2.69	170.50	39.78	210.30	18.83	474	311	785	7866	77.14	0.1698
Chickadee		397.50	18/3.77	1/3.77	200.90	11.16	212.10	18.85	554	87	641	4500	44.13	0.1430
Brant		397.50	24/3.27	7/2.18	201.60	26.13	227.70	19.62	559	204	763	6645	65.16	0.1432
Ibis		397.50	26/3.14	7/2.44	201.30	32.73	234.00	19.88	558	256	814	7378	72.35	0.1434
Lark		397.50	30/2.92	7/2.92	200.90	46.88	247.80	20.44	558	367	925	9203	90.25	0.1441
Pelican		477.00	18/4.14	1/4.14	242.30	13.46	255.80	20.7	668	105	773	5347	52.43	0.1186
Flicker		477.00	24/3.58	7/3.29	241.60	31.40	273.00	21.49	669	245	914	7791	76.40	0.1195
Hawk		477.00	26/3.44	7/2.67	241.60	39.19	280.80	21.77	669	306	975	8844	86.73	0.1195
Hen		477.00	30/3.20	7/3.20	241.30	56.30	297.60	22.4	670	440	1110	10784	105.75	0.1200
Osprey		556.50	18/4.47	1/4.47	282.50	15.69	298.20	22.35	779	112	891	6233	61.12	0.1017
Parakeet		556.50	24/3.87	7/2.58	282.30	36.60	318.90	23.22	782	286	1068	9000	88.26	0.1023
Dove		556.50	26/3.72	7/2.89	282.60	45.92	328.50	23.55	783	359	1142	10260	100.62	0.1022
Eagle		556.50	30/3.46	7/3.46	282.10	65.82	347.90	24.22	783	515	1298	12607	123.63	0.1026
Peacock		605.00	24/4.03	7/2.69	306.10	39.78	345.90	24.19	848	311	1159	9771	95.82	0.9434
Squab		605.00	26/3.87	7/3.01	305.80	49.81	355.60	24.51	847	389	1236	11019	108.06	0.09443
Wood Duck		605.00	30/3.61	7/3.61	307.10	71.65	378.80	25.27	853	560	1413	13140	128.86	0.09426
Teal		605.00	30/3.61	19/2.16	307.10	69.62	376.70	25.24	853	545	1398	13568	133.06	0.09426
Kingbird		636.00	18/4.78	1/4.78	323.00	17.95	341.00	23.90	891	140	1031	7128	69.90	0.08896
Swift		636.00	36/3.38	1/3.38	232.00	8.97	382.00	23.66	891	70	961	6253	61.32	0.08896
Rook		636.00	24/4.14	7/2.76	323.10	41.88	365.00	24.84	891	327	1218	10299	101.00	0.08937
Grosbeak		636.00	26/3.97	7/3.09	321.80	52.49	374.30	25.15	892	410	1302	11428	112.07	0.08973
Scoter		636.00	30/3.70	7/3.70	322.60	75.26	397.90	25.90	896	588	1484	13803	135.36	0.08973
Egret		636.00	30/3.70	19/2.22	322.60	73.54	596.10	25.90	896	576	1472	14304	140.27	0.08973
Flamingo		666.60	24/4.23	7/2.82	337.30	43.72	381.00	25.38	935	342	1277	10752	105.44	0.08561
Gannet		666.60	26/4.07	7/3.16	338.30	54.90	393.20	25.76	937	429	1366	11978	117.46	0.08536
Stilt		715.50	24/4.39	7/2.92	363.30	46.88	410.20	26.32	1007	366	1373	11554	113.31	0.07948
Starling		715.50	24/4.21	7/3.28	361.90	59.15	421.10	26.68	1003	462	1932	12865	126.16	0.07979
Crow		715.50	54/2.92	7/3.92	361.60	46.88	408.50	26.28	1002	366	1368	11753	115.26	0.07986
Redwing		715.50	30/3.92	19/2.35	362.10	82.41	444.50	27.43	1006	645	1651	15650	153.47	0.07994
Coot		795.00	36/3.77	1/3.77	401.90	11.16	413.10	26.39	1108	87	1195	7580	74.33	0.07150
Cuckoo		795.00	24/4.62	7/3.08	402.30	52.15	454.50	27.72	1115	407	1522	12650	124.05	0.07178
Drake		795.00	26/4.44	7/3.45	402.60	65.44	468.00	28.11	1115	511	1626	14267	139.91	0.07172
Tern		795.00	45/3.38	7/2.25	403.80	27.83	431.60	27.03	1119	217	1336	10027	98.33	0.07151
Condor		795.00	54/3.08	7/3.08	402.30	52.15	454.50	27.72	1115	407	1522	12771	125.24	0.07178
Mallard		795.00	30/4.14	19/2.48	403.80	91.78	495.60	28.96	1121	718	1839	17439	171.02	0.07169
Crane		874.50	54/3.23	7/3.23	442.50	57.36	499.90	29.07	1226	448	1674	14046	137.74	0.06526
Ruddy		900.00	45/3.59	7/2.40	455.50	31.67	487.20	28.74	1262	247	1509	11094	108.79	0.06339
Canary		900.00	54/3.88	7/3.28	456.30	59.15	515.50	29.52	1264	462	1726	14484	142.04	0.06328
Catbird		954.00	36/4.14	1/4.14	484.60	13.46	498.10	28.98	1336	105	1441	8986	88.12	0.05930
Rail		954.00	45/3.70	7/2.47	483.80	33.54	517.30	29.61	1340	262	1602	11772	115.44	0.05969
Cardinal		954.00	54/3.38	7/3.38	484.50	62.81	547.30	30.42	1342	490	1832	15381	150.84	0.05900
Tanager		1033.50	36/4.30	1/4.30	522.80	14.52	537.30	30.10	1441	113	1554	9694	95.06	0.05496
Ortian		1033.50	45/3.85	7/2.57	523.90	36.31	560.20	30.81	1452	284	1736	12578	123.35	0.05512
Curlew		1033.50	54/3.51	7/3.51	522.50	67.73	590.20	31.59	1448	529	1977	16586	162.65	0.05527
Bluejay		1133.00	45/4.00	7/2.66	565.50	38.90	604.40	31.98	1567	304	1871	13540	132.78	0.05106
Finch		1133.00	54/3.65	19/2.19	565.00	71.57	636.60	32.85	1573	560	2133	17748	174.05	0.05136

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ACSR (ASTM B232)

Code Name	Cond. Size		Number and Diameter of Wires		Cross-sectional area			Overall Diameter	Weight			Calculated Breaking Load		Calculated Resistance at 20°C Max
	AWG	MCM	Al mm	Steel mm	Al mm²	Steel mm²	Total mm²	mm	Al kg/km	Steel kg/km	Total kg/km	KgF	KN	
Grackle		1192.50	54/3.77	19/2.27	602.80	76.89	679.70	33.97	1678	602	2280	19001	186.34	0.05
Skylark		1272.00	36/4.78	1/4.78	646.00	17.95	664.00	33.46	1781	140	1921	11978	117.46	0.04
Bittern		1272.00	45/4.27	7/2.85	644.40	44.66	689.10	34.17	1785	349	2134	15471	151.72	0.04
Pheasant		1272.00	54/3.90	19/2.34	645.10	81.71	726.80	35.10	1796	640	2436	19789	194.06	0.04
Dipper		1351.50	45/3.40	7/2.93	684.20	47.20	731.40	35.15	1896	369	2265	16380	160.63	0.04220
Martin		1351.50	54/4.02	19/2.41	685.40	86.67	772.10	36.17	1908	678	2586	21008	206.02	0.04
Bobolink		1431.00	45/4.53	7/3.02	752.30	50.14	802.40	36.24	2084	392	2476	17398	170.62	0.04
Plover		1431.00	54/4.14	19/2.48	726.90	91.78	818.70	37.24	2024	718	2742	22264	218.33	0.04
Nuthatch		1510.50	45/4.65	7/3.10	764.20	52.83	817.00	37.20	2117	413	2530	18153	178.02	0.04
Parrot		1510.50	54/4.25	19/2.55	766.10	97.03	863.10	38.25	2133	759	2892	23500	230.46	0.04
Lapwing		1590.00	45/4.78	7/3.18	807.50	55.60	863.10	38.22	2237	434	2671	19154	187.84	0.04
Falcon		1590.00	54/4.36	19/2.62	806.20	102.40	908.60	39.26	2245	801	3046	24770	242.91	0.04
Chukar		1780.00	84/3.70	19/2.22	903.20	73.54	976.70	40.70	2515	576	3091	23138	226.91	0.03
Bluebird		2156.00	84/4.07	19/2.44	1093.00	88.84	1182.00	44.76	3043	695	3738	27343	268.14	0.03
Kiwi		2167.00	72/4.41	7/2.94	1100.00	47.52	1148.00	44.10	3062	371	3433	22635	221.97	0.03
Kiwi		2312.00	76/4.43	19/2.07	1171.00	63.94	1235.00	45.75	3260	500	3760	25733	252.35	0.02

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CONDUCTOR PACKING: DRUM DIMENSIONS TO IS 1778/1980

Drum Component (mm)	Constructional Details for Drum Components				
1	2	3	4	5	6
Flange diameter	965	1065	1195	1220	1345
Barrel diameter	585	600	600	600	600
Traverse	510	710	710	710	710
Flange thickness	2x 25	2x 32	2x 32	2x 32	2x 32
Bore Diameter	80	80	80	80	80
Nail Circle	3	5	5	5	5
Nail length	65	75	75	75	75
Nail Size (Min.)	3.25	3.25	3.25	3.25	3.25
Thickness of Barrel end supports	38	38	38	38	38
Thickness of Barrel end lagging	38	38	38	38	38
No. of stretchers	4	4	4	4	4
Stretchers size	100x 38	100x 38	100x 38	100x 38	100x 38
No. of Bolts	4	4	4	4	4
Diameter of bolts (Min.)	12	12	12	12	12
Size of square washer	50x 6	50x 6	50x 6	50x 6	50x 6
Size of spindle plate	150x 150x 6	150x 150x 6	150x 150x 6	150x 150x 6	150x 150x 6
Diameter of spindle plate hole	90	90	90	90	90
No. of Spindle plate bolt	4	4	4	4	4
Spindle plate bolt diameter	12	12	12	12	12
Thickness of external logging	38	38	38	38	38
No. of binders over external lagging	2	2	2	2	2

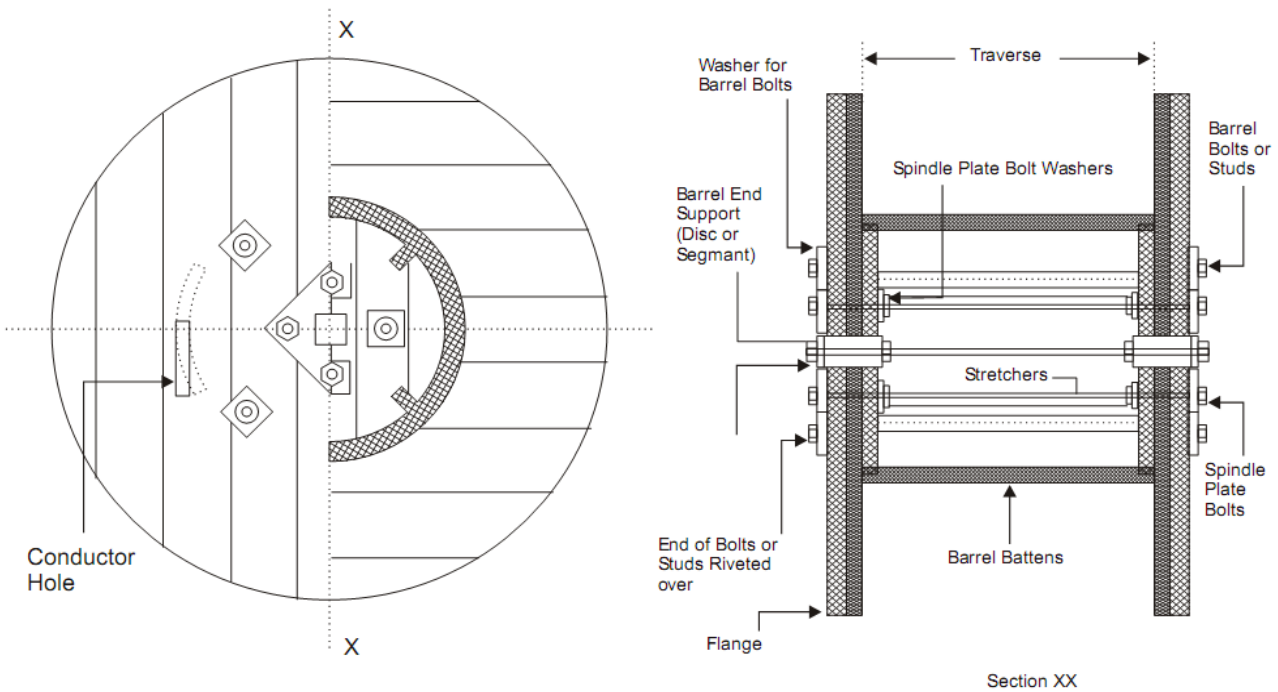

Fig.1 Drum Nomenclature

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CONDUCTOR PACKING: DRUM DIMENSIONS TO IS 1778/1980

Drum Component	Constructional Details for Drum Components					
1	7	8	9	10	11	12
Flange diameter	1370	1475	1615	1725	1100	1900
Barrel diameter	600	600	685	710	750	1500
Traverse	710	710	812	812	600	600
Flange thickness	2x 32	2x 32	2x 33	2x 33	2x 32	2x 33
Bore Diameter	80	80	100	100	54x 54	105x 105
Nail Circle	5	5	6	6	5	5
Nail length	75	75	89	89	75	75
Nail Size(Min.)	3.25	3.25	3.65	3.65	3.25	3.25
Thickness of barrel end supports	50	50	50	50	38	50
Thickness of barrel end lagging	38	50	50	50	38	50
No. of stretchers	6	6	6	6	4	4
Stretchers sizes	100x 33	100x 50	100x 50	100x 50	75x 50	75x 75
No. of bolts	6	6	6	6	4	4
Diameter of bolt (Min.)	12	19	19	19	19	22
Size of square washer	50x 6	50x 6	50x 63	50x 6	75x 6	100x 6
Size of spindle plate	230x 230x 6	230x 230x 6	230x 230x 6	230x 230x 6	230x 230x 6	380x 380x 6
Diameter of spindle plate hole	90	90	90	90	-	-
No. of spindle plate bolt	4	4	4	4	4	4
Spindle plate bolt diameter	12	12	12	12	16	16
Thickness of external lagging	38	50	50	50	38	50
No. of binders over external lagging	3	3	3	3	2	3

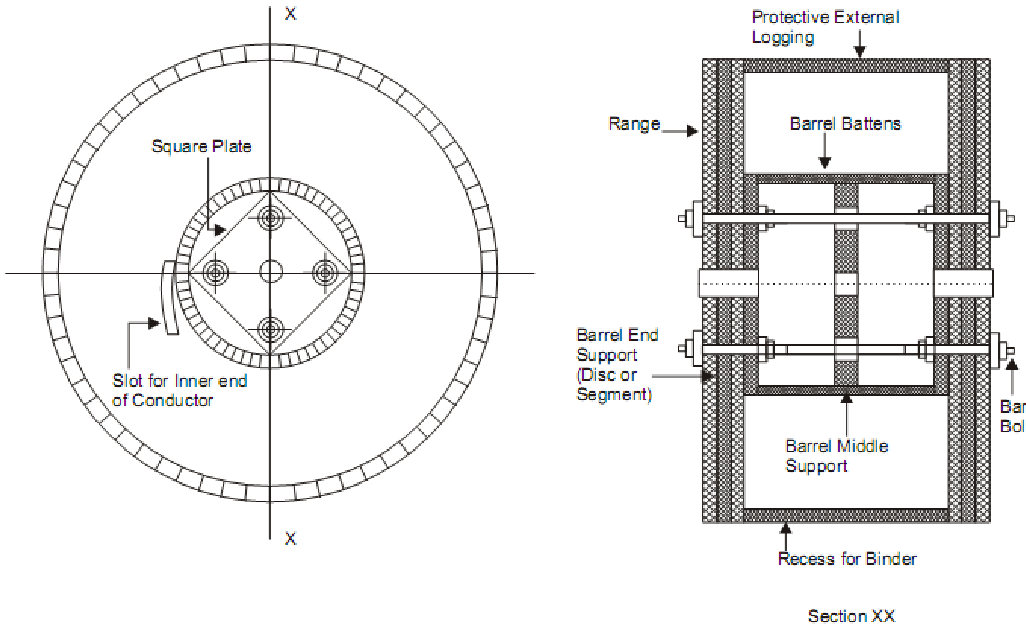


Fig. 2 Drum having 3 ply flange construction with barrel middle supports.

Part 2

Vega 78 power quality analyzer

POWER QUALITY ANALYZERS

PQA series and VEGA78 can record all parameters of voltage, current and power simultaneously in order to achieve an advanced mains monitoring as well as a full analysis of spikes and flickers in a simple and intuitive way.

HT®

Any company can be subject to a reduction in power quality or to an increase in management costs due to inner or external causes so bringing about damages to electrical equipment.

***PQA series** represents a prompt solution to meet engineers' requirements in every electrical field, as regards monitoring single- and three-phase networks with the aim of detecting and solving any problem in power supply systems.*

Disturbances are featured by one origin (or more than one) and by a series of events transferred to the users. The noise origin is not always or exclusively due to the mains supplier, more often than not it can be traced back to some consumers who, because of particularly adverse conditions on their installations, affect power supply quality of other users connected to the same network.
To avoid this, the power company puts contractual obligations about possible disturbances caused by individual users. When checking power quality control of users is to be taken into account checking their compliance with contractual and standard limits.

The following are the various types of disturbances which may occur.
Non-linear loads with current harmonics causing the following problems:

- High current on neutral
- Overheating of transformers, motors and cables
- Generation of voltage harmonics due to interaction with power system impedance
- Risk of paying extra costs due to low power factor
- Faults and possible resonances with power factor correction capacitors
- Flickering
- Failures on PC networks, 200KHZ spikes
- Engine start and inrush currents
- Voltage anomalies (breaks, peaks)
- RCDs trip out or fuse damage
- Voltage imbalance

These problems cause an excess of energy consumption and maintenance costs. To face these kind of problems HT power analyzers permit the user to analyse numberless data simply and quickly like no other system does. PQA testers, designed according to innovative design, are provided with touch-screen display enabling intuitive and fast work. The user interface is based on identification icons. On-line help is available on each screen and represents a valuable assistance for the user when operating the instrument. Each parameter can be traced through the typical tree structure.

It is possible to display **directly**:

- General information on recording (configuration, comments, etc.)
- To draw the graphic of all the recorded quantities. The graphic function "vector diagram" permits the user to assess the mutual phase shift between voltage

signals and input currents, so defining load nature.
- To display table of events related to voltage (voltage anomalies, fast transients) indicating number, date and time of occurrence as well as voltage limits
- To display table of events related to current (inrush currents) indicating number, date and time of occurrence as well as current limits
- To display analysis of power quality in the form of graphics and tables according to standards EN50160.

Functions:
- TRMS voltage measurement/ recording (5 inputs)
- TRMS current measurement/ recording (3 inputs + 1 neutral)
- Measurement/recording of active, reactive, apparent powers and energy
- Measurement/recording of power factor and frequency
- Analysis of voltage and current harmonics up to 49th
- Flicker analysis (Pst, Plt)
- Dissymmetry of input voltage signals
- Voltage anomalies (dips, swells) on 10ms
- Starting current of electrical machines (Inrush)
- Analysis of voltage quick transients (spikes) with resolution 5µs (PQA824)
- Simultaneous measurements (max 251 quantities)
- Integration period ranging from 1s to 60min
- Numerical/graphical display of parameters
- Histograms of the harmonic analysis
- Vector diagram of voltages and currents
- Automatic selection of parameters for default recordings
- Wide colour TFT display with "touch-screen"
- Contextual help on the active display of each screen
- Backlighting and contrast adjustment
- Internal memory
- Memory expansion through external compact flash
- USB pen drive for record transfer
- USB serial interface for PC connection
- Display virtual keyboard for quick data entry
- Windows software to analyse recorded data on PC
- Rechargeable LI-ION battery with power pack.

General Menu

General Setting permits to set the instrument system parameters such as auto power off, memory type where to save recorded data, date/time, language, display contrast, protection password.

Display of Measurements permits the user to display measurement results in real time.

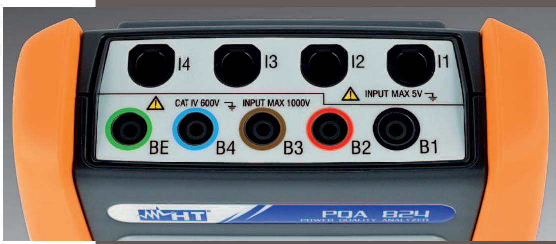
Analyser Setting permits the user to define simple and advanced configurations related to the connection of the instrument to the installation.

Recording Setting permits the user to select settings for each recording and get information on the instrument's operating autonomy.

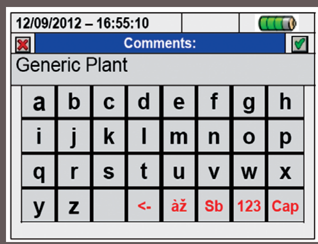
Management of stored data permits the user to display the list of all recordings as well as stored data.

Instrument details where general information concerning the instrument are reported.

Input terminals

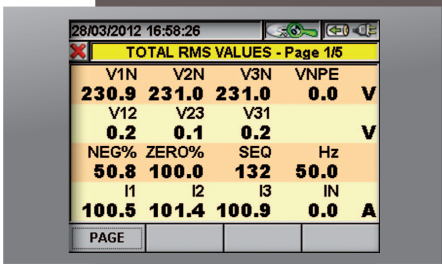


Configuration

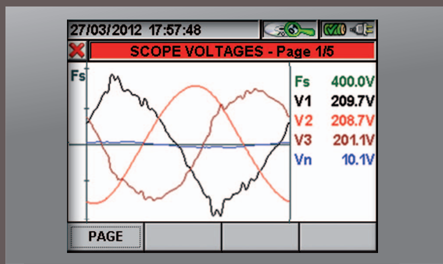


Display of measurements

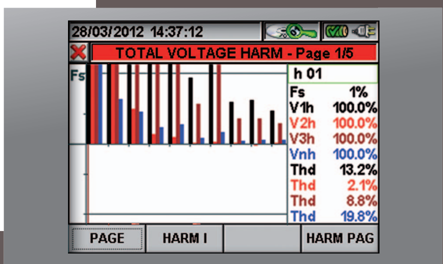
The instrument permits the user to carry out analysis of harmonics, cosphi, powers on all phases, display of waveforms and vector quantities providing the user with a section called oscilloscope.



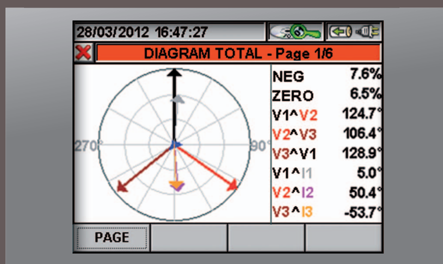
Measurement of voltages, AC TRMS currents as well as active, reactive and apparent powers, power factor for each single and total phase besides flicker values and voltage dissymetry.



Display of voltage and current waveforms for both single and total phase.



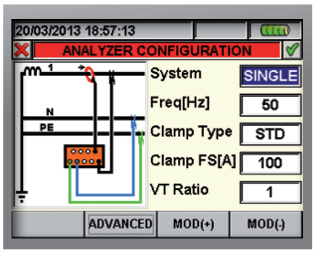
Display of voltage and current harmonics up to 49th component for both single and total phase both as table and as histogram plot. The THD% value is always present for each phase.

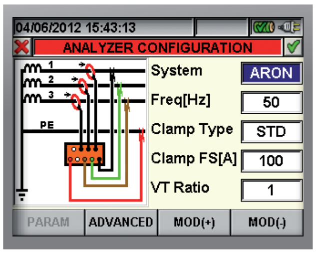


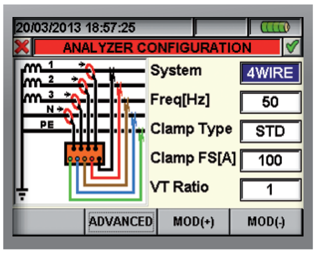
Display of vector diagram where voltages and currents with phase shift angles are drawn in order to define load nature.

Analyzer setting

Before starting a recording the instrument shows a series of system configurations: 4-wire, 3-wire, single, ARON so giving the user the opportunity to define clamp meter type STD or FLEX, clamp's full scale, system frequency as well as interface with voltage transformers (TV) of the installation under test displaying the value of voltages on the primary side of the transformers themselves.





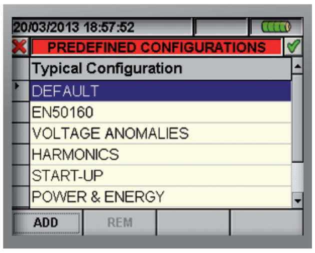


Recorder setting

Under this section the instrument permits the user to define any detail for activation of recordings, selection of parameters, type of analysis to be effected easily thanks to "touch-screen" display and special smart icons.

Default setting

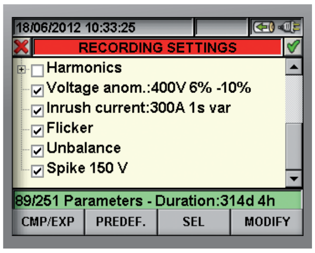
opens section of default configuration where the user can select the type of analysis to be carried out so letting the instrument automatically select the parameters suitable for that purpose. It is also possible to create and save up to 16 custom configurations.

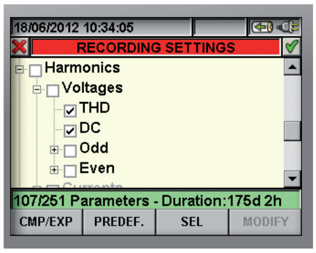


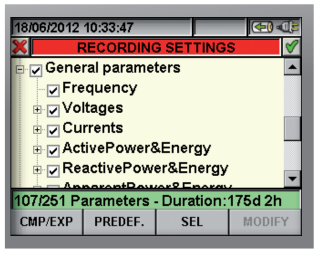
1. ***DEFAULT***: *setting of parameters when the instrument leaves factory.*
2. ***EN50160***: *setting of parameters for power quality according to standards EN50160 relative to voltage anomalies, harmonic analysis, flicker, dissymetry and detection of voltage spikes.*
3. ***VOLTAGE ANOMALIES***: *setting of parameters for power quality relative to voltage anomalies (breaks, peaks).*
4. ***HARMONICS***: *setting of parameters for voltage and current harmonic analysis.*
5. ***MACHINE START***: *setting of parameters relative to starting of motors and electrical machines.*
6. ***POWER & ENERGY***: *setting of parameters relative to power and energy measurements.*

Manual setting

permits selection of the required quantities for recording and analysis provided by the instrument (harmonics, voltage anomalies, dissymmetry, inrush currents, flicker with tree structure) and indication of recording autonomy changing dynamically depending on selection.

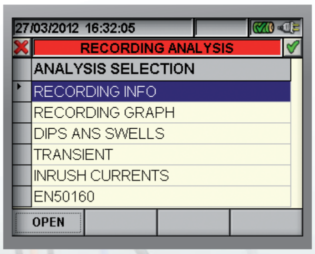


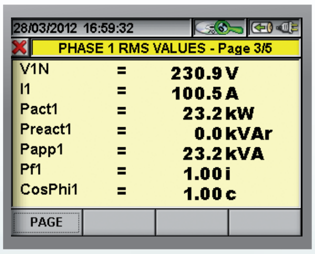


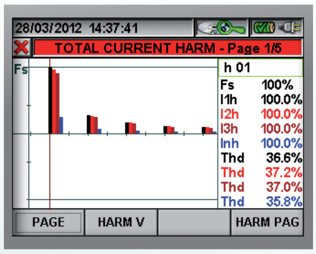


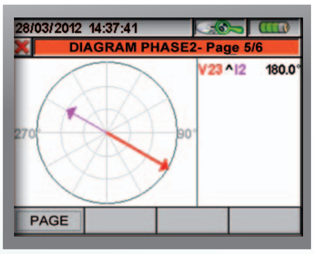
Recording outcome

Display of recording outcome is very easy thanks to table "RECORDING ANALYSIS" listing the measurements to analyse through EVENT tables such as inrush currents, anomalies , spike flicker as well as temporary harmonic/THD trends so getting an immediate analysis report according to EN50160. It is also possible to display waveforms, harmonics, power values, cosphi and vector diagrams relative to instantaneous measurements.



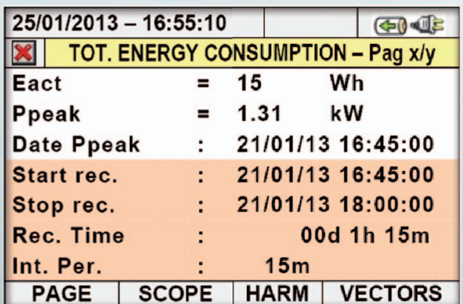






ANALYSIS OF CONSUMED ENERGY

This page shows the Energy and Peak power values consumed while recording

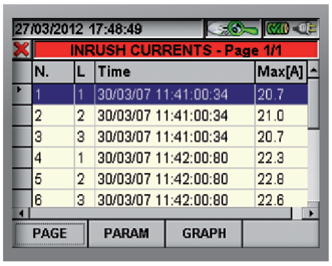


Eact	*Total active power consumed while Recording.*
Ppeak	*Max. active power peak (measured on 16 periods of mains frequency) consumed while recording*
Date Ppeak	*Date and time in which the power peak occurred*
Start rec.	*Starting date of the recording*
Stop rec.	*Stopping date of the recording*
Rec. Time	*Recording time expressed in days (d), hours (h) and minutes (m)*
Int. Per.	*Set integration period value*

Inrush currents

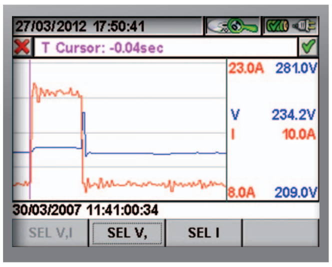
During a dynamic phase such as the start of motors as well as of uninterruptible power supplies or other applications, measurement of inrush currents aims at properly sizing the installation in order to estimate how other elements such as RCDs and fuses could be affected.
PQA models are capable of carrying out recordings of inrush currents with minimum resolution of 10ms whose data can be reported both numerically and graphically.
The results are as follows:

- *The number of detected events (max 1000 recordable events)*
- *Phase L1, L2, L3 corresponding to event occurrence*
- *Date/Time when event took place*
- *Maximum value of inrush current.*


27/03/2012 17:48:49
INRUSH CURRENTS - Page 1/1

N.	L	Time	Max[A]
1	1	30/03/07 11:41:00:34	20.7
2	2	30/03/07 11:41:00:34	21.0
3	3	30/03/07 11:41:00:34	20.7
4	1	30/03/07 11:42:00:80	22.3
5	2	30/03/07 11:42:00:80	22.8
6	3	30/03/07 11:42:00:80	22.6

PAGE PARAM GRAPH

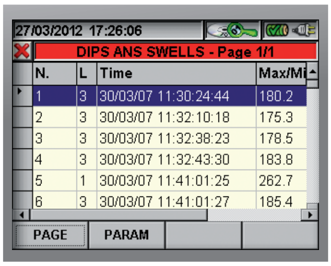


By means of cursor this graph shows maximum/minimum current and voltage values, value of current and voltage of the selected inrush current.

Voltage anomalies

Voltage anomalies (breaks, peaks) are due to connection/disconnection of high power loads as well as to network undersizing compared to the extent of loads.
For example a voltage break occurs when inrush current interacts with impedance of electrical circuit so causing current increase and voltage decrease along with tripping out of RCDs, malfunction/power off of equipment and sodium vapour lamps.

During recording phase PQA stores all EVENTS such as breaks/peaks. Thanks to an easy and intuitive report the user can immediately estimate the extent of the event.


27/03/2012 17:26:06
DIPS ANS SWELLS - Page 1/1

N.	L	Time	Max/Mi
1	3	30/03/07 11:30:24:44	180.2
2	3	30/03/07 11:32:10:18	175.3
3	3	30/03/07 11:32:38:23	178.5
4	3	30/03/07 11:32:43:30	183.8
5	1	30/03/07 11:41:01:25	262.7
6	3	30/03/07 11:41:01:27	185.4

PAGE PARAM

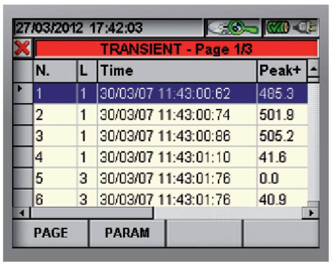
TABLE STRUCTURE

- *anomaly serial number;*
- *phase number on which anomaly occurred;*
- *date and time when anomaly occurred;*
- *anomaly max/min volt value;*
- *anomaly duration in seconds;*
- *anomaly type (up or down).*

Spikes

Pulses generated in one plant are often caused by switching power supplies, diagnostics electro medical equipment and switching on/off of loads as well as by lightning bringing about a fast increase of voltage. They can affect equipment logical circuits through capacitive couplings and burn out PCBs or damage electrical insulation.
Model PQA824 permits to detect rapid voltage transients (spikes) through high frequency sampling with minimum resolution 5μs (200kHz) storing them in a full report:

- *spike serial number;*
- *phase number on which spike occurred;*
- *date and time when spike occurred;*
- *Volt spike positive peak;*
- *Volt spike negative peak;*
- *Volt spike positive delta;*
- *Volt spike negative delta;*
- *type Up or Down (higher or lower than set threshold);*
- *phenomenon speed (Fast or Slow).*


27/03/2012 17:42:03
TRANSIENT - Page 1/3

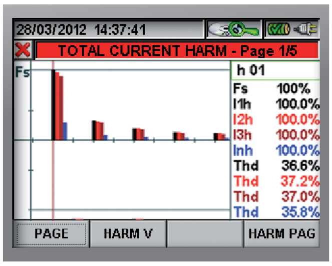
N.	L	Time	Peak+
1	1	30/03/07 11:43:00:62	485.3
2	1	30/03/07 11:43:00:74	501.9
3	1	30/03/07 11:43:00:86	505.2
4	1	30/03/07 11:43:01:10	41.6
5	3	30/03/07 11:43:01:76	0.0
6	3	30/03/07 11:43:01:76	40.9

PAGE PARAM

Harmonics

Harmonic distortion is caused by non linear loads where current does not change according to voltage. Some effects due to harmonics are:

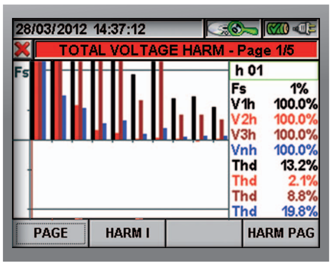
- *Overheating of transformers and motors*
- *Damage or false alarms on switches, fuses and relays*
- *Increase of parallel resonance in phase shift capacitors due to inductive loads*
- *Vibration on motors with possible deterioration.*



The graph shows the third current harmonic over time. A special effect is represented by neutral overload due to odd current harmonics multiple of THREE. These harmonics are added in the neutral conductor which shall be therefore suitably sized in order to get a current higher than the phase one circulating on it.
In the stator the windings of an asynchronous motor are fed with AC current and generate a rotating magnetic field moving the rotor. Some harmonics particularly the 5th, the 11th and the 17th create a negative sequence opposing the motion and generating an anti-torque so reducing the motor performance.

THD%

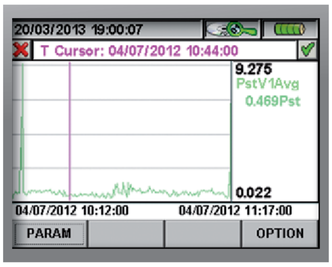
To assess the overall harmonic content of a waveform reference is made to the total harmonic distortion (THD%) which represents a kind of quadratic mean of the harmonics set. As for voltages this parameter shall comply with standards EN50160 with a value lower than 8%.



Flicker

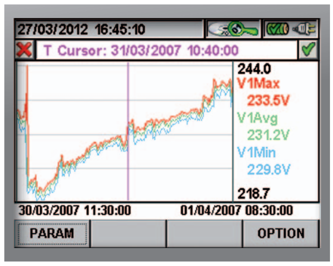
In the electro technical field **Flicker** is a visible change in brightness of an incandescent lamp due to rapid fluctuations in the voltage of the power supply. The source of this is the voltage drop generated over the source impedance of the grid by the changing load current of an equipment or facility. These fluctuations in time generate flicker. The effects can range from disturbance to epileptic attacks of photosensitive persons. Flicker may also affect sensitive electronic equipment such as television receivers or industrial processes relying on constant electrical power. The requirements of flicker measurement equipment are defined in the standards IEC/EN61000-4-15. Flicker may be produced, for example, if a steel mill uses large electric motors or arc furnaces on a distribution network, or frequent starting of an elevator motor in an office building, or if a rural residence has a large water pump starting regularly on a long feeder system. The likelihood of flicker increases as the size of the changing load becomes larger with respect to the prospective short circuit current available at the point of common connection. Electric utility companies shall keep to limitations as far as such a disturbance is concerned. Some testers called flicker meters can detect the distorted signal so starting a statistical analysis with the following quantities, whose value **shall always be <1**:

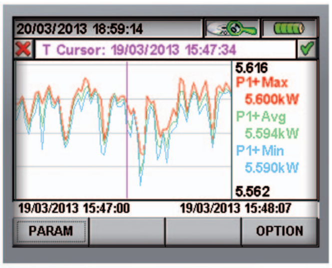
- **PPst** = Short-term flicker severity is calculated over an interval of 10 minutes.
- **Plt** = Long-term flicker severity is calculated as from a sequence of 12 Pst values over an interval of 2 hours



Vrms and Power

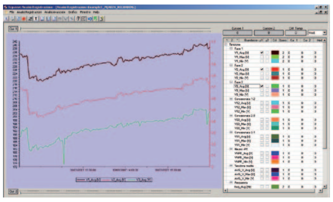
Graphs show TRMS values of quantities and powers displaying MAX, MIN and AVERAGE values during the whole recording.



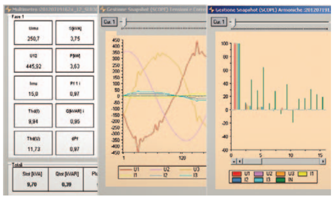


TopView software

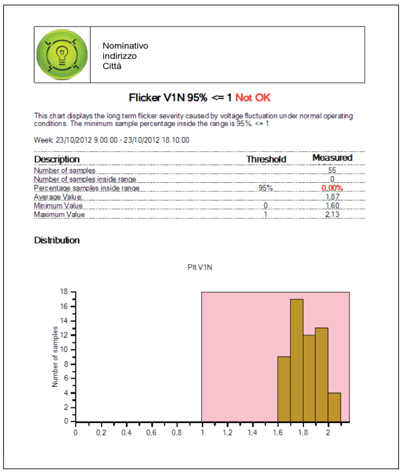
TopView software is a multifunctional application program capable of managing results measured by safety testers, power quality analyzers and combined instruments.
As for power quality analyzers (PQA82x / VEGA78) software permits the following operations:
- Instrument setting (system type, recording parameters, etc.)
- On line display of quantities measured by the instrument (numerical values, waveforms, histograms, saving of instantaneous samplings)
- Start/Stop of a recording
- Data transfer from instrument to PC through USB and accurate data analysis with graphs and tables
- Creation of professional reports on power quality according to EN50160
- Differential analysis of energy consumption per time
- Creation of custom printing reports which can be exported as XLS and PDF format



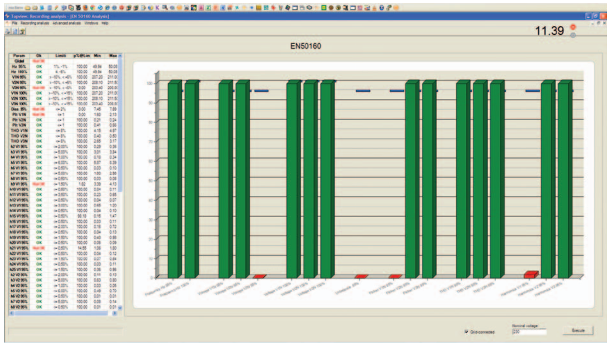
Selection and analysis of recording data



On line display of measured quantities

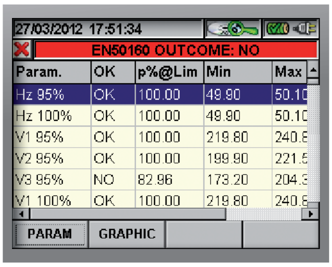


Detailed display of report EN50160

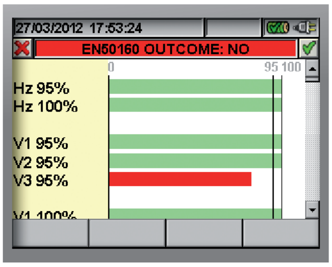


Overall display of report EN50160

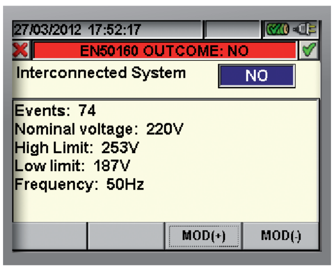
Report EN50160



Numerical display of analysis data according to EN50160



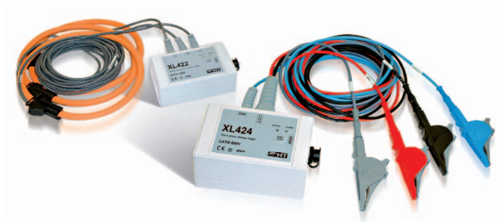
Graphical histogram display of analysis data according to EN50160



Summary display of analysis data according to EN50160

Data loggers for single-phase and three-phase TRMS current and voltage

XL421, XL422, XL423, XL424 are innovative portable Data Loggers, capable of measuring AC current and voltage in real efficient (TRMS) value up to 2500A and 600V respectively, in single-phase or three-phase electric systems. These instruments are very useful especially in the industrial sector (evaluations of electric load consumption, verification of nominal power of transformers, measurement of mains voltage, unbalanced loads, etc.) and are extremely versatile due to their small size, thanks to which they are easily installed also as panel units. These models are enclosed in a practical and safe plastic case, with a high mechanical protection index IP65 (protected both against dust and water sprays); they are, therefore, suitable for use in common industrial environments. These models are provided with appropriate in-built flexible clamps or cables with alligator clips respectively, which allow safely carrying out current and voltage measurements (also on cables and/or big bars). Thanks to a sophisticated internal memory algorithm, continuous recordings are possible also for prolonged time intervals and, therefore, it is possible to accurately monitor electric mains.



FUNCTIONS	XL421	XL422	XL423	XL424
TRMS current measurement	Single phase	Three phase	Single phase	Three phase
Measurement range	1 ÷ 2500A AC		0 ÷ 600V AC	
Accuracy	±(1.0%rdg+1dgt)		±(1.0%rdg+1dgt)	
Resolution	1A		1A	
Frequency range	50±6Hz, 60±6Hz		50±6Hz, 60±6Hz	
Bandwidth	3200Hz		3200Hz	
Sample rate	64 points in 20ms		64 points in 20ms	
Integration period	1s, 6s, 30s, 60s, 5min		1s, 6s, 30s, 60s, 5min	
Memory size	1Mbyte		1Mbyte	
PC serial interface	RS-232		RS-232	
Integration period	Recording duration (days)		Recording duration (days)	
1s	5	1,5	5	1,5
6s	34	8	34	8
30s	170	42	170	42
60s	364(*)	91	364(*)	91
5min	1820(*)	455(*)	1820(*)	455(*)

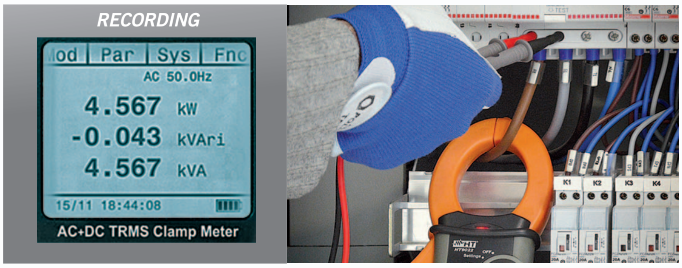
(*) Depending on battery life

Clamp-on power quality analyzer with Bluetooth connection

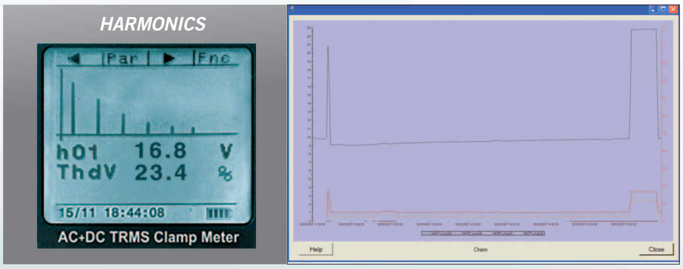
HT9022

HT9022 is a combination of a power quality analyzer, a phase sequence/conformity detector, a clamp meter and a voltage detector in one single handy device. The advanced design of HT9022 ensures reliable and accurate measurements under a wide range of operating conditions. HT9022 is the ideal instrument for troubleshooting power quality problems, calculating power factor correctors, recording energy consumption, recording DC power, etc. Unlike the data loggers that take snapshots of the electrical parameters in regular intervals, losing what happens between an interval and the next, HT9022 continuously records all electrical parameters as a true power quality analyzer. The internal memory enables long-term recording for further download to (and analysis on) a PC, a PDA or a smartphone. HT9022 is flexible and portable to grant the user the most reliable measurements with an easy-to-use interface.

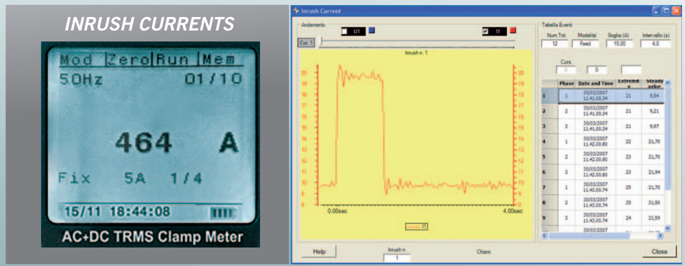
FUNCTIONS
Measuring/recording of DC and AC+DC TRMS voltage
Measuring/recording of DC and AC+DC TRMS current
Phase sequence and conformity
Measuring/recording of active, reactive and apparent power, power factor in single-phase and balanced three-phase systems
Measuring/recording of active, reactive and apparent energy in single-phase and balanced three-phase systems
Measuring/recording V / I harmonics up to the 25th order and THD%
Measuring/recording of DC power
Measuring/recording of current and voltage frequency
Resistance measurement and continuity test with buzzer
Inrush current
Non-contact AC voltage detection with built-in sensor
MAX/MIN/CREST
Bluetooth connection
Backlight
Auto Power OFF
Data HOLD
MAX/MIN/CREST
PC connection with Bluetooth



DIsplay and recording power



Display harmonics and analysis software



Inrush currents and analysis software

POWER QUALITY ANALYZERS and DATA LOGGERS	POWER QUALITY ANALYZERS				DATA LOGGERS			
Model	**PQA824**	**PQA823**	**VEGA78**	**HT9022**	**XL423**	**XL424**	**XL421**	**XL422**
AC TRMS voltage in single phase plants	•	•	•	•	•	•		
AC TRMS voltage in three phase plants	•	•	•			•		
AC TRMS current in single phase plants	•	•	•	•			•	•
AC TRMS current in three phase plants	•	•	•					•
AC TRMS voltage, current, power, energy, PF in single phase plants	•	•	•	•				
AC TRMS voltage, current, power, energy, PF in three phase plants	•	•	•					
Neutral to ground voltage	•	•	•	•				
DC voltage, current, power	•	•	•	•				
Neutral current	•	•	•	•				
Phase sequence indication	•	•	•	•				
Voltage unbalance (NEG%, ZERO%)	•	•	•					
Voltage Flicker (Pst, Plt)	•	•						
Measurements by external CTs and VTs	•	•	•					
Voltage/current waveforms with selectable pages	•	•	•					
Voltage/current harmonic histograms and THD% calculation	•	•	•	•				
Voltage/current vectorial diagram	•	•	•					
Recording analysis with selectable integration period IP	•(1s-60m)	•(1s-60m)	•(1s-60m)	•(1s-15m)	•(1s-60m)	•(1s-60m)	•(1s-60m)	•(1s-60m)
Simultaneous recording of any available parameter	•	•	•	•				
Max number of selectable parameters for simultaneous recording	251	251	251	60 (fixed)	1	3	1	3
Voltage/current harmonic analysis up to 49th order	•	•	•	•(25th)				
Complete EN50160 analysis	•	•						
Voltage anomalies (sags, swells) from 10ms @50Hz with selectable thresholds	•	•	•					
Inrush currents of electric motors	•	•		•				
Voltage fast transients (spikes) (5μs resolution, 200kHz sampling rate)	•							
Recording duration indication	•	•	•	•				
Predefined and customized recording settings	•	•	•					
"Touch screen" LCD display	•	•	•					
Display resolution (pxl)	320x240	320x240	320x240	128x128				
Colour display	•	•	•					
Battery	Li-Ion	Li-Ion	Li-Ion	Alkaline	Alkaline	Alkaline	Alkaline	Alkaline
Power supply by rechargeable battery	•	•	•					
Power supply by external AC/DC adapter	•	•	•					
Auto Power OFF	•	•	•	•				
Internal memory size	15Mb	15Mb	15Mb	2Mb	1Mb	1Mb	1Mb	1Mb
External Compact Flash memory	•	•	•					
USB port for external memory stick	•	•	•					
Approx. memory duration (in days @ IP=15min @ max parameters)	110	110	110	2.1	365(60s)	365(60s)	365(60s)	365(60s)
PC interface	USB	USB	USB	Bluetooth	RS232	RS232	RS232	RS232
Contextual help at display on each screen	•	•	•					
Saving of recordings and snapshots	•	•	•	•				
Protection password on recordings	•	•	•					
Dimensions (LxWxH) (mm)	235x165x75	235x165x75	235x165x75	252x88x44	120x80x43	120x80x43	120x80x43	120x80x43
Weight (batteries included)	1 Kg	1 Kg	1 Kg	0,42 Kg	0,5 Kg	0,5 Kg	0,5 Kg	0,5 Kg
Safety in compliance with IEC/EN61010-1	•	•	•	•	•	•	•	•
Power quality analysis reference	EN50160	EN50160						

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CONCEPT "CAMPOVISIVO" FAENZA ITALY 05-2013

Part 3

load data from VEGA 78 of all Domestic Transformers

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
1	Name: طلعة عمرو Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	141.8	134.71	44.277	0.95
		MAX	322.5	309.6	90.3	0.96
		AVG	216.372	207.71	60.58	0.96

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
2	Name: سنوت Rating-KVA: 400 Type Loads: Domestic Size of Loads: Medium	MIN	123.72	108.87	58.76	0.88
		MAX	228.88	189.97	161.12	0.83
		AVG	205.37	180.72	97.54	0.88

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
4	Name: خلة الوردة Rating-KVA: 400 Type Loads: Domestic Size of Loads: Medium	MIN	131.3	112.61	69.17	0.85
		MAX	242.91	206.47	127.96	0.85
		AVG	217.96	185.26	114.82	0.85

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
6	Name: خلة الشعرة Rating-KVA: 400 Type Loads: Domestic Size of Loads: Light	MIN	43.49	41.75	12.177	0.96
		MAX	110.48	103.85	37.69	0.94
		AVG	65.38	62.76	18.3	0.96

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
7	Name: مثلث أبو الهايل Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	208.84	198.4	65.21	0.95
		MAX	386.35	359.3	142	0.93
		AVG	346.67	325.85	118.28	0.94

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
8	Name: مسجد النبي لوط Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	90.16	86.56	25.24	0.96
		MAX	166.8	146.78	79.23	0.88
		AVG	149.7	134.73	65.25	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
10	Name: خلة أبو بيضة Rating-KVA: 400 Type Loads: Domestic Size of Loads: Medium	MIN	123.72	108.87	38.67	0.88
		MAX	228.88	189.97	161.12	0.83
		AVG	205.37	180.72	97.54	0.88

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
11	Name: الكوربة Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	215.53	198.28	84.47	0.92
		MAX	377.73	339.95	164.6	0.9
		AVG	303.55	273.19	132.31	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
12	Name: البريد Rating-KVA: 630 Type Loads: Domestic Size of Loads: Heavy	MIN	186.13	135.88	127.21	0.73
		MAX	344.34	299.58	169.78	0.87
		AVG	308.98	256.45	172.34	0.83

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
13	Name: مثلث عربية Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	140.53	130.34	52.53	0.93
		MAX	260	231.4	118.55	0.89
		AVG	233.28	223.95	65.32	0.96

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
14	Name: واد المغير Rating-KVA: 250 Type Loads: Domestic Size of Loads: Heavy	MIN	120.71	110.1	49.5	0.91
		MAX	223.31	198.76	101.82	0.89
		AVG	200.38	170.33	105.56	0.85

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
16	Name: حي وجا Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	141.8	134.71	44.27	0.95
		MAX	322.5	309.6	90.3	0.96
		AVG	216.37	207.71	60.56	0.96

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
27	Name: حي عربية التحتا Rating-KVA: 400 Type Loads: Domestic Size of Loads: Heavy	MIN	208.84	198.4	65.21	0.95
		MAX	386.35	359.3	142	0.93
		AVG	346.67	325.85	118.28	0.94

Part 4

load data from VEGA 78 of all Industrial Transformers

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
3	Name: مصنع المقالع Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	32.58	27.7	17.16	0.85
		MAX	130.31	105.56	76.43	0.81

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
5	Name: مصنع خليل خليل Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	18.88	17.74	6.44	0.94
		MAX	326.2	293.58	142.19	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
9	Name: صورمعين Rating-KVA: 400 Type Loads: Industrial Size of Loads: >3 Consumer	MIN	34.11	31.72	12.53	0.93
		MAX	83.38	77.55	30.65	0.93

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
15	Name: الكسارة Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	290.88	247.24	153.23	0.85
		MAX	383.78	326.21	202.16	0.85

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
17	Name: حي الزيدات Rating-KVA: 250 Type Loads: Industrial Size of Loads: One Consumer	MIN	38.7	35.6	15.3	0.92
		MAX	214.04	194.78	88.74	0.91

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
18	Name: محاجر الزيدات Rating-KVA: 400 Type Loads: Industrial Size of Loads: >3 Consumer	MIN	18.88	17.74	6.44	0.94
		MAX	326.2	293.58	142.19	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
19	Name: خلة اللوزة Rating-KVA: 250 Type Loads: Industrial Size of Loads: One Consumer	MIN	11.97	9.93	6.67	0.83
		MAX	190.7	148.74	119.33	0.78

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
20	Name: مصنع خلة اللوزة Rating-KVA: 400 Type Loads: Industrial Size of Loads: 2-3 Consumer	MIN	28.1	23.88	14.81	0.85
		MAX	205.45	170.33	114.88	0.83

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
21	Name: مصنع الرافدين Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	66.14	57.54	32.64	0.87
		MAX	388.9	346.1	177.32	0.89

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
22	Name: منشار زكريا Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	38.42	30.75	23.1	0.8
		MAX	240.46	204.39	126.67	0.85

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
23	Name: مصنع البلاستيك Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	56.42	48.52	28.79	0.86
		MAX	376.14	338.53	163.96	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
24	Name: منشار أبو زايد Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	47.19	45.3	16.1	0.94
		MAX	218.6	192.36	103.8	0.88

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
25	Name: منشار الوسام Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	165.77	149.19	72.25	0.9
		MAX	171	159.03	62.85	0.93

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
26	Name: مصنع التحرير Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	290.88	247.24	153.23	0.85
		MAX	383.78	326.21	202.16	0.85

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
28	Name: مصنع المناوس Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	44.52	41.86	15.19	0.94
		MAX	494.62	464.94	168.75	0.94

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
29	**Name:** منشار النبعة **Rating-KVA:** 630 **Type Loads:** Industrial **Size of Loads:** One Consumer	MIN	33.12	29.79	14.43	0.9
		MAX	450.22	396.19	213.84	0.88

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
30	**Name:** مصنع رضوان **Rating-KVA:** 630 **Type Loads:** Industrial **Size of Loads:** One Consumer	MIN	20.7	18.63	9.02	0.9
		MAX	138.035	126.99	54.09	0.92

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
31	**Name:** محاجر **Rating-KVA:** 400 **Type Loads:** Industrial **Size of Loads:** One Consumer	MIN	32.58	27.7	17.16	0.81
		MAX	130.31	105.56	76.43	0.81

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
32	**Name:** منشار فؤاد **Rating-KVA:** 250 **Type Loads:** Industrial **Size of Loads:** One Consumer	MIN	21.6	19.87	8.47	0.92
		MAX	183.2	152.1	102.18	0.83

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
33	**Name:** 1-مصنع العويوي **Rating-KVA:** 630 **Type Loads:** Industrial **Size of Loads:** One Consumer	MIN	289.97	234.87	170.04	0.81
		MAX	317.48	244.45	202.56	0.77

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
34	Name: مصنع العويوي-2 Rating-KVA: 250 Type Loads: Industrial Size of Loads: One Consumer	MIN	11.97	9.93	6.67	0.83
		MAX	190.7	148.73	119.33	0.78

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
35	Name: مصنع عودة Rating-KVA: 400 Type Loads: Industrial Size of Loads: One Consumer	MIN	18.88	17.74	6.44	0.94
		MAX	362.2	325.98	157.87	0.9

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
36	Name: مصنع شحدة Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	289.97	234.87	170.04	0.81
		MAX	317.98	244.45	202.56	0.77

No.	Tr.Information	Value	S (kva)	P(kw)	Q(kvar)	Pf
37	Name: منشار ياسين Rating-KVA: 630 Type Loads: Industrial Size of Loads: One Consumer	MIN	20.7	18.63	9.02	0.9
		MAX	138.03	126.99	54.09	0.92

Part 5

E-TAP Program

E-TAP Program

1- Introduction:

ETAP Power Station is a fully graphical electrical transient analyzer program that can run under the Microsoft Windows 98. NT. 4.0. 2000. Me. and XP environments. The Windows NT, 4.0 and 2000 platforms provide the highest performance level for demanding applications, such as large network analysis requiring intensive computation and online monitoring and control applications.

Windows NT. 4.0. And 2000 also provide the highest levels of reliability, protection. And security of critical applications. Large PowerStation projects (approximately 500 buses and larger) should be built and maintained via Windows NT. 4.0. Or 2000. The Windows 98 and me platforms provide excellent performance for analysis of small and medium size systems (a few hundred buses) and support a variety of other popular applications show figure 1.

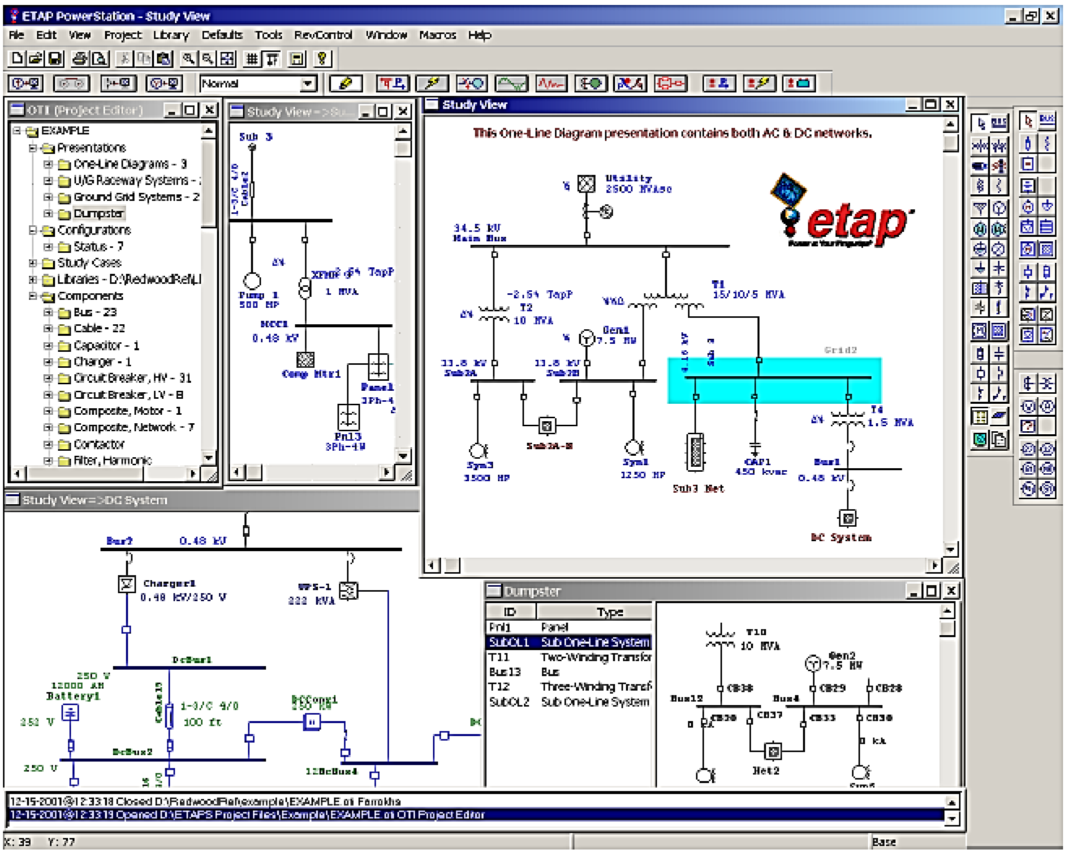

Figure-1 E-TAP configuration.

2- E-TAP Description

Modeling:

1- Virtual reality operation.

2- Total integration of data (electrical, logical, mechanical, and physical attributes).

3- Ring and radial systems.

4- Unlimited isolated subsystems.

5- No system connection limitations.

6- Multiple loading conditions.

7- User access control and data validation.

8- Asynchronous calculations, allow multiple modules to calculate simultaneously.

3-phase and single-phase modeling including panels and subpanels

3- Enter data

must enter the needing data in special fields for each of the, feeder, transmission line, cable, transformer, and load.

4- Feeder

1-Choose 3 phase connection feeders from info Icon.

2 - Choose "in" service feeder from info Icon.

3- Choose swing mode feeder from info Icon.

4- Choose 3 MVA delta connection feeder from short circuit icon.

This step is clear in figure 2.

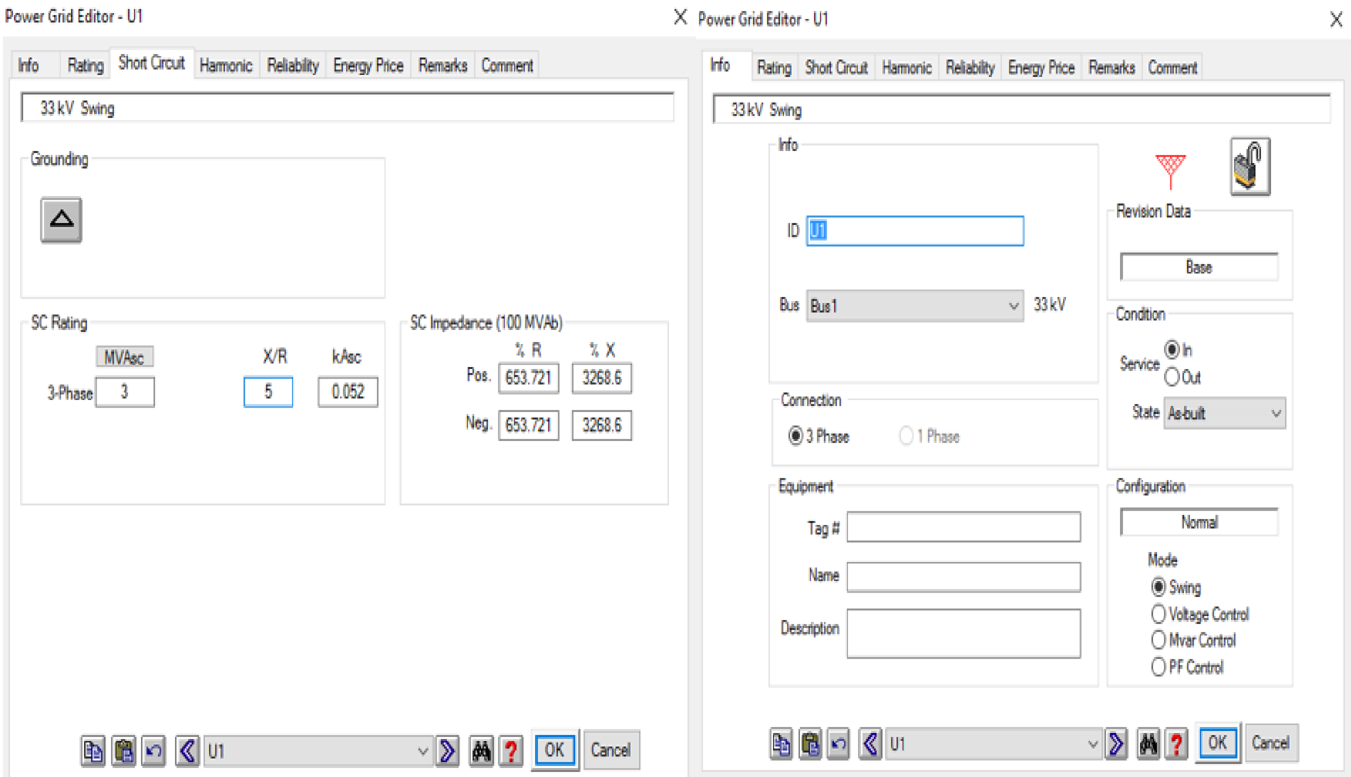

Figure- 2 feeder data in E-TAP.

4.1.3.2 Cable

Bani Na’im network using 95mm underground cable in industrial region that implemented by the following parameter

**Impedance per conductor

After filing the needed data from data sheet in to the library of the program, the program chooses atypical value for impedance per conductor per length unit.

**Reliability parameter

Shows the reliability of the cable per year per length unit.

** Power parameter

Gives the rated current and voltage for the cable show figure 3.

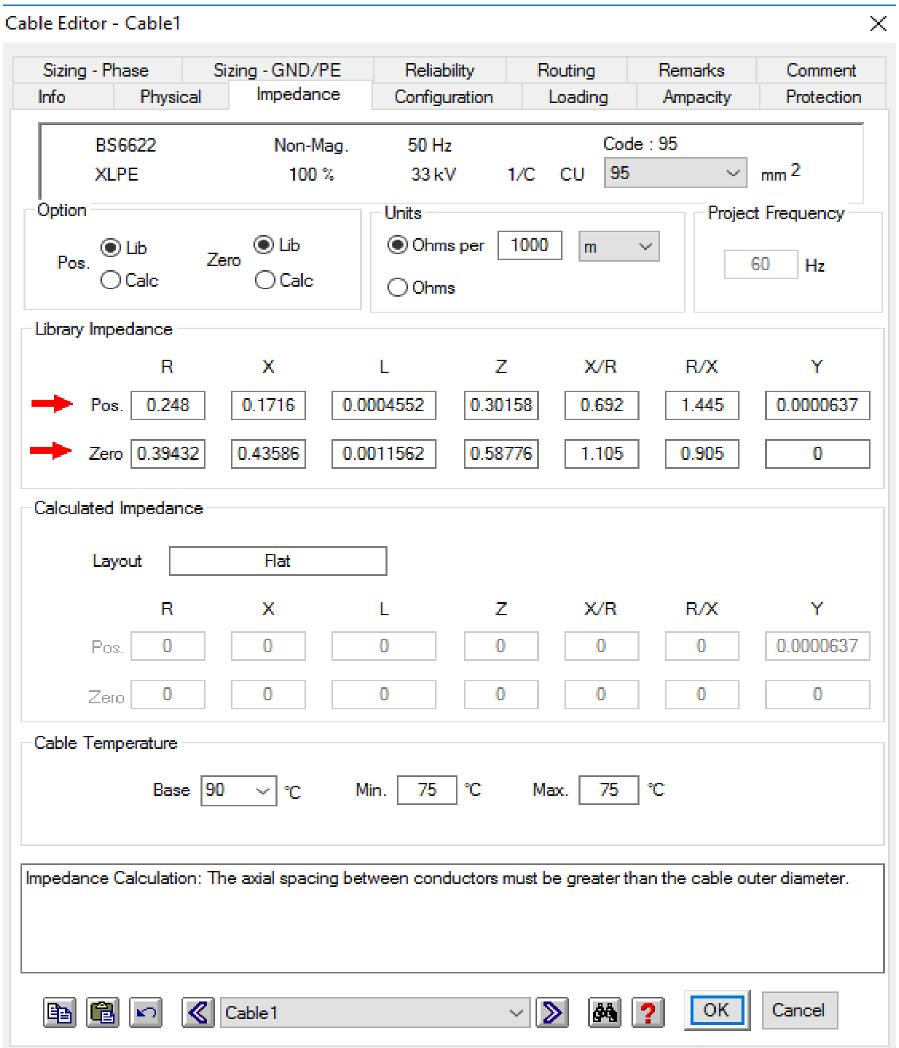

Figure- 3 Cable data in E-TAP.

4.1.3.3 Transformers

From the data in chapter two for transformer Specifications and data in chapter three for transformer loading we can fill this parameter

** rating

In the E-TAP window below shows voltage rating and power rating that needed for power flow calculation and short circuit analysis show figure 4.

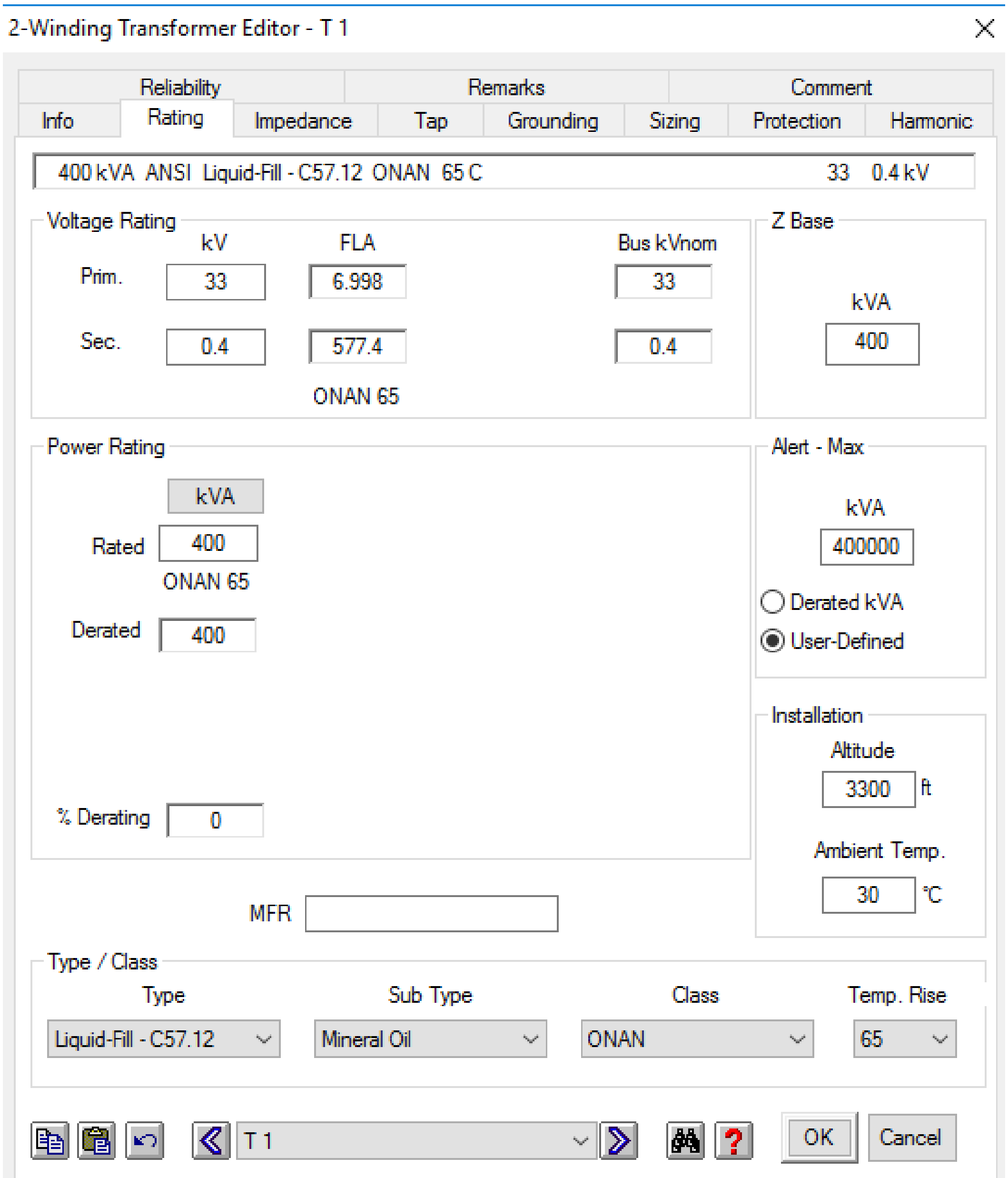

Figure- 4 Transformers data in E-TAP.

** Impedance

The program selects the zero and positive impedance parameter for X, R, Z.

**Reliability parameter

Shows the reliability of the cable as failure and repair per year.

4.1.3.4 Transmission line

In this part, we can put transmission line parameters and how-to put the information of impedance and how to fill the parameter to calculate the sizing of correct conductor and we see Conductor resistance vs. temperature and Physical parameter show figure 5.

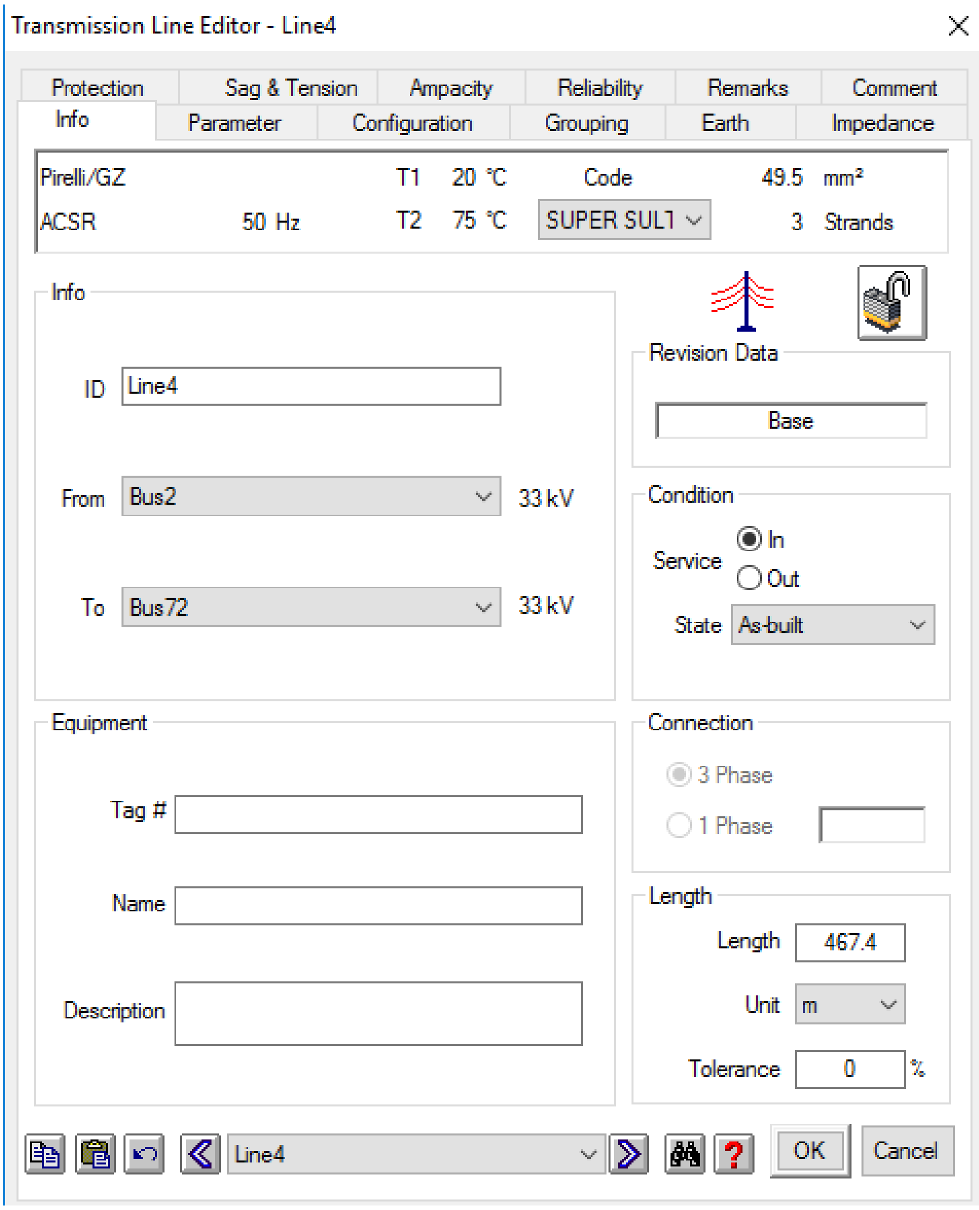

Figure- 5 Transmission line data in E-TAP.

4.1.3.5 Load

In the following parameter that concerning load we put the power in MVA for lumped load rating and choose a value of resistive load between 15% and 20% in demos tic transformer and smaller or larger value of " R " percentage in the industrial region because of induction and synchronous motors, the E-TAP window show the parameter that filled for a Sponge factory show in figure 6.

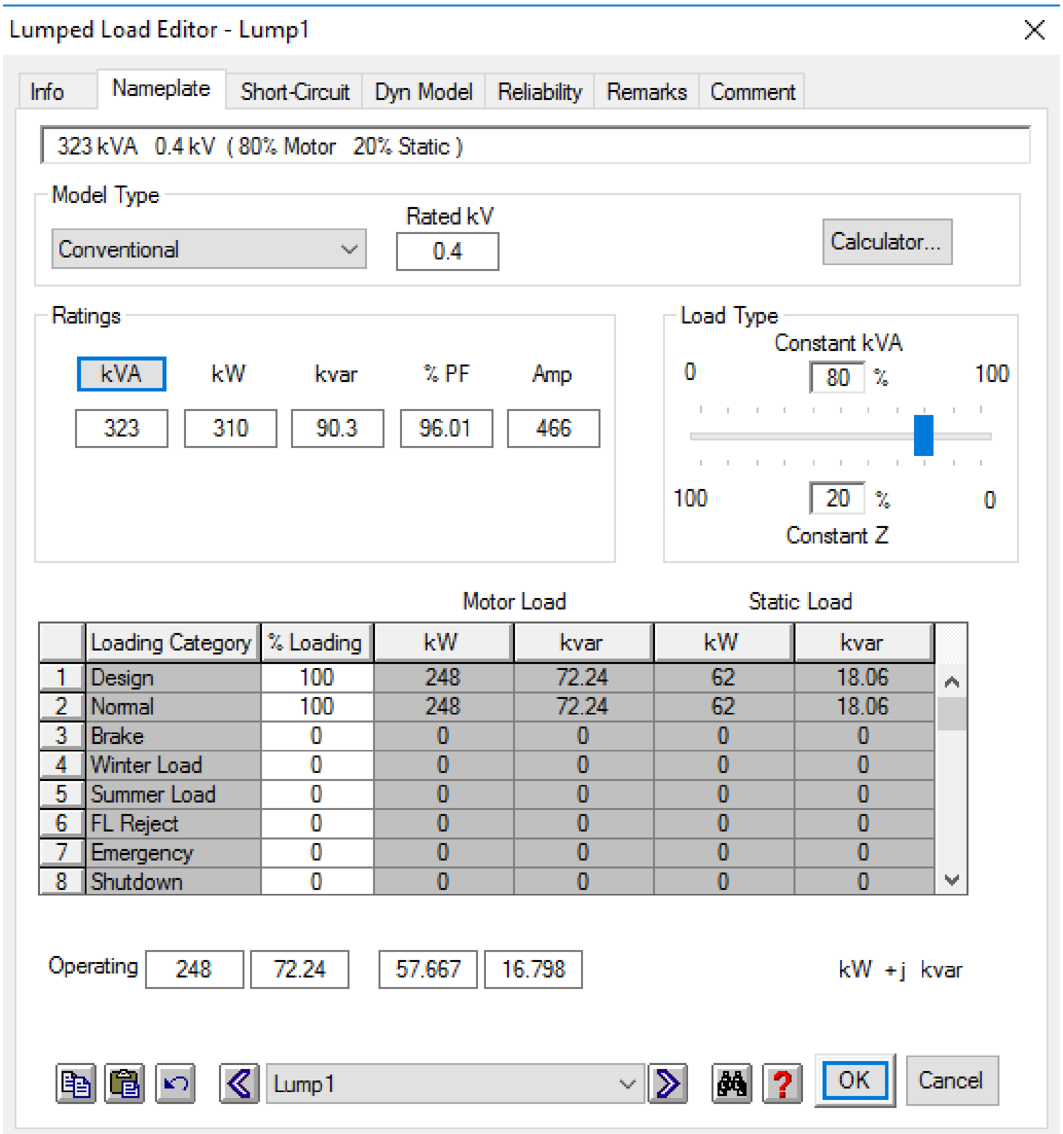

Figure - 6 Load data in E-TAP

Part 7

Complete report of Load Flow Analysis

before solve problems

Electrical Transient Analyzer Program

Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

	Swing	V-Control	Load	Total
Number of Buses:	1	0	69	70

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	37	0	0	32	0	0	69

Method of Solution:	Adaptive Newton-Raphson Method
Maximum No. of Iteration:	99
Precision of Solution:	0.0001000
System Frequency:	50.00 Hz
Unit System:	Metric
Project Filename:	Project1
Output Filename:	C:\Users\HP\Desktop\Project1\Load Flow Analysis-1.lfr

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus1	33.000	1	100.0	0.0								
Bus2	33.000	1	100.0	0.0								
Bus3	0.400	1	100.0	0.0	0.166	0.048	0.041	0.012				
Bus5	33.000	1	100.0	0.0								
Bus6	0.400	1	100.0	0.0	0.144	0.078	0.036	0.019				
Bus7	33.000	1	100.0	0.0								
Bus8	0.400	1	100.0	0.0	0.084	0.061	0.021	0.015				
Bus9	0.400	1	100.0	0.0	0.148	0.092	0.037	0.023				
Bus14	33.000	1	100.0	0.0								
Bus17	0.400	1	100.0	0.0	0.261	0.095	0.065	0.024				
Bus18	33.000	1	100.0	0.0								
Bus19	33.000	1	100.0	0.0								
Bus20	0.400	1	100.0	0.0	0.108	0.052	0.027	0.013				
Bus21	0.400	1	100.0	0.0	0.062	0.025	0.016	0.006				
Bus22	33.000	1	100.0	0.0								
Bus23	33.000	1	100.0	0.0								
Bus24	0.400	1	100.0	0.0	0.219	0.106	0.055	0.027				
Bus25	0.400	1	100.0	0.0	0.144	0.078	0.036	0.019				
Bus26	33.000	1	100.0	0.0								
Bus27	0.400	1	100.0	0.0	0.205	0.138	0.051	0.034				
Bus28	33.000	1	100.0	0.0								
Bus29	0.400	1	100.0	0.0	0.179	0.052	0.045	0.013				
Bus30	33.000	1	100.0	0.0								
Bus31	0.400	1	100.0	0.0	0.167	0.049	0.042	0.012				
Bus32	33.000	1	100.0	0.0								
Bus33	0.400	1	100.0	0.0	0.156	0.071	0.039	0.018				
Bus34	0.400	1	100.0	0.0	0.235	0.114	0.059	0.029				
Bus35	33.000	1	100.0	0.0								
Bus36	0.400	1	100.0	0.0	0.119	0.096	0.030	0.024				
Bus37	0.400	1	100.0	0.0	0.136	0.092	0.034	0.023				
Bus38	33.000	1	100.0	0.0								
Bus39	0.400	1	100.0	0.0	0.261	0.162	0.065	0.040				
Bus40	0.400	1	100.0	0.0	0.137	0.085	0.034	0.021				

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus41	33.000	1	100.0	0.0								
Bus42	0.400	1	100.0	0.0	0.277	0.142	0.069	0.035				
Bus43	33.000	1	100.0	0.0								
Bus44	0.400	1	100.0	0.0	0.164	0.102	0.041	0.025				
Bus45	0.400	1	100.0	0.0	0.271	0.131	0.068	0.033				
Bus46	33.000	1	100.0	0.0								
Bus47	0.400	1	100.0	0.0	0.127	0.050	0.032	0.013				
Bus48	0.400	1	100.0	0.0	0.154	0.083	0.039	0.021				
Bus49	33.000	1	100.0	0.0								
Bus50	0.400	1	100.0	0.0	0.261	0.162	0.065	0.040				
Bus51	33.000	1	100.0	0.0								
Bus52	0.400	1	100.0	0.0	0.317	0.171	0.079	0.043				
Bus53	0.400	1	100.0	0.0	0.372	0.135	0.093	0.034				
Bus54	0.400	1	100.0	0.0	0.261	0.095	0.065	0.024				
Bus55	33.000	1	100.0	0.0								
Bus56	0.400	1	100.0	0.0	0.102	0.043	0.025	0.011				
Bus57	33.000	1	100.0	0.0								
Bus58	0.400	1	100.0	0.0	0.084	0.061	0.021	0.015				
Bus59	0.400	1	100.0	0.0	0.122	0.082	0.030	0.020				
Bus60	33.000	1	100.0	0.0								
Bus61	0.400	1	100.0	0.0	0.196	0.162	0.049	0.041				
Bus62	0.400	1	100.0	0.0	0.102	0.043	0.025	0.011				
Bus63	33.000	1	100.0	0.0								
Bus64	0.400	1	100.0	0.0	0.261	0.126	0.065	0.032				
Bus65	0.400	1	100.0	0.0	0.119	0.096	0.030	0.024				
Bus66	0.400	1	100.0	0.0	0.196	0.162	0.049	0.041				
Bus68	33.000	1	100.0	0.0								
Bus70	0.400	1	100.0	0.0	0.235	0.114	0.059	0.028				
Bus71	33.000	1	100.0	0.0								
Bus72	33.000	1	100.0	0.0								
Bus73	33.000	1	100.0	0.0								
Bus75	0.400	1	100.0	0.0	0.050	0.015	0.013	0.004				
Bus76	33.000	1	100.0	0.0								
Bus77	33.000	1	100.0	0.0								
Bus78	33.000	1	100.0	0.0								

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus79	33.000	1	100.0	0.0								
Bus80	33.000	1	100.0	0.0								
Total Number of Buses: 70					6.601	3.467	1.650	0.867	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus1	33.000	Swing	1	100.0	0.0					
						0.000	0.000			

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
Cable1	33NCUS1	95	2624.7	0.0	1	75	0.072096	0.052304	0.0000194
Line1		49.5	1968.5	0.0	1	75	0.435771	0.116631	0.0000017
Line2		49.5	1916.4	0.0	1	75	0.435771	0.116631	0.0000017
Line3		49.5	1900.6	0.0	1	75	0.435771	0.116631	0.0000017
Line4		49.5	1533.5	0.0	1	75	0.435771	0.116631	0.0000017
Line6		49.5	1108.3	0.0	1	75	0.435771	0.116631	0.0000017
Line8		49.5	2331.7	0.0	1	75	0.435771	0.116631	0.0000017
Line9		49.5	705.1	0.0	1	75	0.435771	0.116631	0.0000017
Line10		49.5	298.9	0.0	1	75	0.435771	0.116631	0.0000017
Line11		49.5	3068.2	0.0	1	75	0.435771	0.116631	0.0000017
Line12		49.5	196.9	0.0	1	75	0.435771	0.116631	0.0000017
Line13		49.5	2911.4	0.0	1	75	0.435771	0.116631	0.0000017
Line14		49.5	2332.0	0.0	1	75	0.435771	0.116631	0.0000017
Line15		49.5	3280.8	0.0	1	75	0.435771	0.116631	0.0000017
Line16		49.5	2231.0	0.0	1	75	0.435771	0.116631	0.0000017
Line17		49.5	2296.6	0.0	1	75	0.435771	0.116631	0.0000017
Line18		49.5	1752.0	0.0	1	75	0.435771	0.116631	0.0000017
Line19		49.5	393.7	0.0	1	75	0.435771	0.116631	0.0000017
Line20		49.5	393.7	0.0	1	75	0.435771	0.116631	0.0000017
Line21		49.5	387.1	0.0	1	75	0.435771	0.116631	0.0000017
Line22		49.5	764.4	0.0	1	75	0.435771	0.116631	0.0000017
Line23		49.5	328.1	0.0	1	75	0.435771	0.116631	0.0000017
Line24		49.5	675.9	0.0	1	75	0.435771	0.116631	0.0000017
Line25		49.5	506.2	0.0	1	75	0.435771	0.116631	0.0000017
Line26		49.5	388.1	0.0	1	75	0.435771	0.116631	0.0000017
Line27		49.5	1148.3	0.0	1	75	0.435771	0.116631	0.0000017
Line28		49.5	3221.5	0.0	1	75	0.435771	0.116631	0.0000017
Line29		49.5	4327.4	0.0	1	75	0.435771	0.116628	0.0000017
Line30		49.5	3487.5	0.0	1	75	0.435771	0.116631	0.0000017
Line31		49.5	3280.8	0.0	1	75	0.435771	0.116631	0.0000017
Line32		49.5	656.2	0.0	1	75	0.435771	0.116631	0.0000017
Line33		49.5	328.1	0.0	1	75	0.435771	0.116631	0.0000017

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T 1	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 2	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 3	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 4	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 5	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 6.	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 7	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 8	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 9	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 10	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 11	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 12	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 13	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 14	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 15	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T16	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 17	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 18	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 19	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 20	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 21	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 22	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 23	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 24	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 25	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 26	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 27	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 28	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T29	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 30	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 31	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 32	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 33	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 34	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T 35	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 36	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000
T 37	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	0	7.2500	Dyn	0.000

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bus	To Bus	R	X	Z	Y
T 1	2W XFMR	Bus2	Bus3	558.07	1724.45	1812.50	
T 2	2W XFMR	Bus5	Bus6	558.07	1724.45	1812.50	
T 3	2W XFMR	Bus68	Bus8	558.07	1724.45	1812.50	
T 4	2W XFMR	Bus71	Bus9	558.07	1724.45	1812.50	
T 5	2W XFMR	Bus68	Bus70	558.07	1724.45	1812.50	
T 6.	2W XFMR	Bus73	Bus75	558.07	1724.45	1812.50	
T 7	2W XFMR	Bus14	Bus17	558.07	1724.45	1812.50	
T 8	2W XFMR	Bus19	Bus20	558.07	1724.45	1812.50	
T 9	2W XFMR	Bus76	Bus21	558.07	1724.45	1812.50	
T 10	2W XFMR	Bus23	Bus25	558.07	1724.45	1812.50	
T 11	2W XFMR	Bus77	Bus24	558.07	1724.45	1812.50	
T 12	2W XFMR	Bus26	Bus27	281.76	1115.77	1150.79	
T 13	2W XFMR	Bus28	Bus29	558.07	1724.45	1812.50	
T 14	2W XFMR	Bus38	Bus40	892.92	2759.11	2900.00	
T 15	2W XFMR	Bus78	Bus39	558.07	1724.45	1812.50	
T16	2W XFMR	Bus30	Bus31	558.07	1724.45	1812.50	
T 17	2W XFMR	Bus32	Bus33	892.92	2759.11	2900.00	
T 18	2W XFMR	Bus32	Bus34	558.07	1724.45	1812.50	
T 19	2W XFMR	Bus35	Bus36	892.92	2759.11	2900.00	
T 20	2W XFMR	Bus35	Bus37	558.07	1724.45	1812.50	
T 21	2W XFMR	Bus41	Bus42	281.76	1115.77	1150.79	
T 22	2W XFMR	Bus43	Bus44	558.07	1724.45	1812.50	
T 23	2W XFMR	Bus43	Bus45	558.07	1724.45	1812.50	
T 24	2W XFMR	Bus46	Bus48	558.07	1724.45	1812.50	
T 25	2W XFMR	Bus46	Bus47	281.76	1115.77	1150.79	
T 26	2W XFMR	Bus49	Bus50	558.07	1724.45	1812.50	
T 27	2W XFMR	Bus51	Bus54	558.07	1724.45	1812.50	
T 28	2W XFMR	Bus51	Bus53	281.76	1115.77	1150.79	
T29	2W XFMR	Bus51	Bus52	281.76	1115.77	1150.79	
T 30	2W XFMR	Bus55	Bus56	281.76	1115.77	1150.79	
T 31	2W XFMR	Bus57	Bus58	558.07	1724.45	1812.50	
T 32	2W XFMR	Bus57	Bus59	892.92	2759.11	2900.00	
T 33	2W XFMR	Bus63	Bus66	281.76	1115.77	1150.79	
T 34	2W XFMR	Bus63	Bus65	892.92	2759.11	2900.00	
T 35	2W XFMR	Bus80	Bus64	558.07	1724.45	1812.50	
T 36	2W XFMR	Bus60	Bus61	281.76	1115.77	1150.79	
T 37	2W XFMR	Bus79	Bus62	281.76	1115.77	1150.79	

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bus	To Bus	R	X	Z	Y
Cable1	Cable	Bus19	Bus76	1.74	1.26	2.15	0.0555129
Line1	Line	Bus1	Bus2	7.88	2.11	8.15	0.0037084
Line2	Line	Bus2	Bus5	7.67	2.05	7.94	0.0036103
Line3	Line	Bus5	Bus7	7.61	2.04	7.87	0.0035805
Line4	Line	Bus2	Bus72	6.14	1.64	6.35	0.0028889
Line6	Line	Bus72	Bus14	4.43	1.19	4.59	0.0020878
Line8	Line	Bus14	Bus18	9.33	2.50	9.66	0.0043926
Line9	Line	Bus18	Bus19	2.82	0.76	2.92	0.0013282
Line10	Line	Bus18	Bus22	1.20	0.32	1.24	0.0005631
Line11	Line	Bus22	Bus23	12.28	3.29	12.71	0.0057802
Line12	Line	Bus22	Bus26	0.79	0.21	0.82	0.0003708
Line13	Line	Bus26	Bus28	11.65	3.12	12.06	0.0054847
Line14	Line	Bus28	Bus30	9.33	2.50	9.66	0.0043932
Line15	Line	Bus30	Bus32	13.13	3.51	13.59	0.0061807
Line16	Line	Bus32	Bus35	8.93	2.39	9.24	0.0042029
Line17	Line	Bus28	Bus38	9.19	2.46	9.51	0.0043265
Line18	Line	Bus28	Bus41	7.01	1.88	7.26	0.0033005
Line19	Line	Bus41	Bus43	1.58	0.42	1.63	0.0007417
Line20	Line	Bus41	Bus46	1.58	0.42	1.63	0.0007417
Line21	Line	Bus46	Bus49	1.55	0.41	1.60	0.0007293
Line22	Line	Bus49	Bus51	3.06	0.82	3.17	0.0014401
Line23	Line	Bus51	Bus55	1.31	0.35	1.36	0.0006181
Line24	Line	Bus55	Bus57	2.70	0.72	2.80	0.0012732
Line25	Line	Bus55	Bus60	2.03	0.54	2.10	0.0009537
Line26	Line	Bus55	Bus63	1.55	0.42	1.61	0.0007312
Line27	Line	Bus7	Bus68	4.59	1.23	4.76	0.0021632
Line28	Line	Bus7	Bus71	12.89	3.45	13.34	0.0060688
Line29	Line	Bus72	Bus73	17.32	4.63	17.93	0.0081547
Line30	Line	Bus23	Bus77	13.96	3.74	14.45	0.0065701
Line31	Line	Bus38	Bus78	13.13	3.51	13.59	0.0061807
Line32	Line	Bus60	Bus79	2.63	0.70	2.72	0.0012361
Line33	Line	Bus63	Bus80	1.31	0.35	1.36	0.0006181

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
* Bus1	33.000	100.000	0.0	8.496	4.640	0	0	Bus2	8.496	4.640	169.4	87.8	
Bus2	33.000	99.233	0.1	0	0	0	0	Bus1	-8.422	-4.624	169.4	87.7	
								Bus5	0.765	0.448	15.6	86.3	
								Bus72	7.449	4.109	150.0	87.6	
								Bus3	0.208	0.068	3.9	95.0	
Bus3	0.400	96.936	-1.8	0	0	0.205	0.060	Bus2	-0.205	-0.060	317.7	96.0	
Bus5	33.000	99.165	0.1	0	0	0	0	Bus2	-0.765	-0.451	15.7	86.1	
								Bus7	0.585	0.347	12.0	86.0	
								Bus6	0.180	0.104	3.7	86.7	
Bus6	0.400	96.383	-1.4	0	0	0.178	0.096	Bus5	-0.178	-0.096	302.6	88.0	
Bus7	33.000	99.113	0.1	0	0	0	0	Bus5	-0.584	-0.351	12.0	85.7	
								Bus68	0.399	0.235	8.2	86.2	
								Bus71	0.185	0.116	3.9	84.8	
Bus8	0.400	97.145	-0.7	0	0	0.104	0.075	Bus68	-0.104	-0.075	191.0	81.0	
Bus9	0.400	95.958	-1.4	0	0	0.182	0.113	Bus71	-0.182	-0.113	322.7	85.0	
Bus14	33.000	98.326	0.2	0	0	0	0	Bus72	-7.309	-4.082	149.0	87.3	
								Bus18	6.983	3.944	142.7	87.1	
								Bus17	0.326	0.138	6.3	92.1	
Bus17	0.400	94.183	-2.8	0	0	0.319	0.116	Bus14	-0.319	-0.116	519.8	94.0	
Bus18	33.000	97.563	0.4	0	0	0	0	Bus14	-6.921	-3.931	142.7	87.0	
								Bus19	0.211	0.046	3.9	97.7	
								Bus22	6.710	3.886	139.0	86.5	
Bus19	33.000	97.556	0.4	0	0	0	0	Bus76	0.077	-0.021	1.4	-96.4	
								Bus18	-0.211	-0.047	3.9	97.6	
								Bus20	0.134	0.068	2.7	89.1	
Bus20	0.400	95.602	-0.8	0	0	0.133	0.064	Bus19	-0.133	-0.064	222.6	90.0	
Bus21	0.400	96.566	-0.3	0	0	0.077	0.030	Bus76	-0.077	-0.030	123.0	93.0	
Bus22	33.000	97.468	0.4	0	0	0	0	Bus18	-6.703	-3.884	139.1	86.5	
								Bus23	0.452	0.238	9.2	88.5	
								Bus26	6.251	3.646	129.9	86.4	
Bus23	33.000	97.403	0.4	0	0	0	0	Bus22	-0.451	-0.243	9.2	88.0	
								Bus77	0.272	0.140	5.5	88.9	
								Bus25	0.179	0.103	3.7	86.7	
Bus24	0.400	93.290	-2.1	0	0	0.267	0.129	Bus77	-0.267	-0.129	458.1	90.0	
Bus25	0.400	94.587	-1.2	0	0	0.177	0.095	Bus23	-0.177	-0.095	306.2	88.0	
Bus26	33.000	97.409	0.4	0	0	0	0	Bus22	-6.247	-3.645	129.9	86.4	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
								Bus28	5.993	3.465	124.3	86.6	
								Bus27	0.254	0.180	5.6	81.6	
Bus27	0.400	94.641	-1.1	0	0	0.251	0.169	Bus26	-0.251	-0.169	461.4	83.0	
Bus28	33.000	96.582	0.5	0	0	0	0	Bus26	-5.934	-3.455	124.4	86.4	
								Bus30	1.010	0.560	20.9	87.4	
								Bus38	0.494	0.329	10.8	83.2	
								Bus41	4.208	2.491	88.6	86.0	
								Bus29	0.222	0.074	4.2	94.9	
Bus29	0.400	94.050	-1.6	0	0	0.219	0.064	Bus28	-0.219	-0.064	349.3	96.0	
Bus30	33.000	96.470	0.5	0	0	0	0	Bus28	-1.008	-0.564	21.0	87.3	
								Bus32	0.802	0.496	17.1	85.1	
								Bus31	0.206	0.068	3.9	95.0	
Bus31	0.400	94.117	-1.5	0	0	0.204	0.059	Bus30	-0.204	-0.059	325.2	96.0	
Bus32	33.000	96.343	0.6	0	0	0	0	Bus30	-0.801	-0.501	17.2	84.8	
								Bus35	0.316	0.243	7.2	79.3	
								Bus33	0.193	0.100	4.0	88.8	
								Bus34	0.292	0.159	6.0	87.9	
Bus33	0.400	91.804	-2.3	0	0	0.189	0.086	Bus32	-0.189	-0.086	325.9	91.0	
Bus34	0.400	91.914	-2.1	0	0	0.285	0.138	Bus32	-0.285	-0.138	497.6	90.0	
Bus35	33.000	96.307	0.6	0	0	0	0	Bus32	-0.316	-0.247	7.3	78.8	
								Bus36	0.148	0.127	3.5	75.9	
								Bus37	0.168	0.120	3.7	81.4	
Bus36	0.400	91.355	-1.4	0	0	0.144	0.116	Bus35	-0.144	-0.116	291.8	78.0	
Bus37	0.400	93.219	-0.9	0	0	0.165	0.112	Bus35	-0.165	-0.112	309.1	82.8	
Bus38	33.000	96.527	0.5	0	0	0	0	Bus28	-0.494	-0.333	10.8	82.9	
								Bus78	0.324	0.218	7.1	83.0	
								Bus40	0.169	0.115	3.7	82.8	
Bus39	0.400	90.709	-2.3	0	0	0.315	0.195	Bus78	-0.315	-0.195	589.4	85.0	
Bus40	0.400	91.751	-1.8	0	0	0.165	0.103	Bus38	-0.165	-0.103	306.2	85.0	
Bus41	33.000	96.228	0.6	0	0	0	0	Bus28	-4.190	-2.490	88.6	86.0	
								Bus43	0.538	0.319	11.4	86.0	
								Bus46	3.310	1.979	70.1	85.8	
								Bus42	0.342	0.191	7.1	87.3	
Bus42	0.400	93.074	-1.5	0	0	0.337	0.173	Bus41	-0.337	-0.173	587.1	89.0	
Bus43	33.000	96.218	0.6	0	0	0	0	Bus41	-0.538	-0.320	11.4	86.0	
								Bus44	0.203	0.134	4.4	83.3	
								Bus45	0.336	0.186	7.0	87.5	
Bus44	0.400	92.678	-1.2	0	0	0.199	0.123	Bus43	-0.199	-0.123	364.7	85.0	
Bus45	0.400	91.076	-2.5	0	0	0.327	0.158	Bus43	-0.327	-0.158	575.6	90.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
Bus46	33.000	96.165	0.6	0	0	0	0	Bus41	-3.307	-1.979	70.1	85.8	
								Bus49	2.960	1.804	63.1	85.4	
								Bus48	0.191	0.110	4.0	86.5	
								Bus47	0.157	0.065	3.1	92.4	
Bus47	0.400	94.965	-0.4	0	0	0.156	0.062	Bus46	-0.156	-0.062	254.8	93.0	
Bus48	0.400	93.123	-1.1	0	0	0.188	0.101	Bus46	-0.188	-0.101	330.4	88.0	
Bus49	33.000	96.110	0.6	0	0	0	0	Bus46	-2.958	-1.804	63.1	85.4	
								Bus51	2.634	1.580	55.9	85.8	
								Bus50	0.324	0.224	7.2	82.3	
Bus50	0.400	90.328	-2.3	0	0	0.314	0.195	Bus49	-0.314	-0.195	591.0	85.0	
Bus51	33.000	96.013	0.6	0	0	0	0	Bus49	-2.631	-1.581	55.9	85.7	
								Bus55	1.458	1.016	32.4	82.0	
								Bus54	0.323	0.138	6.4	92.0	
								Bus53	0.460	0.194	9.1	92.1	
								Bus52	0.391	0.232	8.3	85.9	
Bus52	0.400	92.247	-1.8	0	0	0.384	0.207	Bus51	-0.384	-0.207	683.1	88.0	
Bus53	0.400	92.531	-2.3	0	0	0.452	0.164	Bus51	-0.452	-0.164	749.9	94.0	
Bus54	0.400	91.795	-2.5	0	0	0.316	0.115	Bus51	-0.316	-0.115	528.4	94.0	
Bus55	33.000	95.989	0.6	0	0	0	0	Bus51	-1.457	-1.017	32.4	82.0	
								Bus57	0.254	0.186	5.7	80.8	
								Bus60	0.366	0.263	8.2	81.2	
								Bus63	0.712	0.513	16.0	81.1	
								Bus56	0.125	0.055	2.5	91.5	
Bus56	0.400	94.988	-0.2	0	0	0.124	0.053	Bus55	-0.124	-0.053	205.6	92.0	
Bus57	33.000	95.980	0.6	0	0	0	0	Bus55	-0.254	-0.187	5.7	80.6	
								Bus58	0.104	0.078	2.4	80.1	
								Bus59	0.150	0.109	3.4	80.9	
Bus58	0.400	93.993	-0.2	0	0	0.103	0.074	Bus57	-0.103	-0.074	195.0	81.0	
Bus59	0.400	91.506	-1.5	0	0	0.147	0.099	Bus57	-0.147	-0.099	279.3	83.0	
Bus60	33.000	95.980	0.6	0	0	0	0	Bus55	-0.366	-0.264	8.2	81.1	
								Bus79	0.125	0.054	2.5	91.8	
								Bus61	0.241	0.210	5.8	75.5	
Bus61	0.400	92.860	-0.7	0	0	0.238	0.197	Bus60	-0.238	-0.197	480.7	77.0	
Bus62	0.400	94.975	-0.2	0	0	0.124	0.053	Bus79	-0.124	-0.053	205.6	92.0	
Bus63	33.000	95.975	0.6	0	0	0	0	Bus55	-0.712	-0.514	16.0	81.1	
								Bus80	0.323	0.177	6.7	87.7	
								Bus66	0.241	0.210	5.8	75.5	
								Bus65	0.148	0.127	3.5	75.9	
Bus64	0.400	91.022	-2.4	0	0	0.315	0.152	Bus80	-0.315	-0.152	554.3	90.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
Bus65	0.400	91.010	-1.3	0	0	0.144	0.115	Bus63	-0.144	-0.115	292.5	78.0	
Bus66	0.400	92.855	-0.7	0	0	0.238	0.197	Bus63	-0.238	-0.197	480.7	77.0	
Bus68	33.000	99.091	0.1	0	0	0	0	Bus7	-0.399	-0.237	8.2	86.0	
								Bus8	0.105	0.078	2.3	80.2	
								Bus70	0.294	0.159	5.9	88.0	
Bus70	0.400	94.767	-2.4	0	0	0.287	0.139	Bus68	-0.287	-0.139	486.4	90.0	
Bus71	33.000	99.084	0.1	0	0	0	0	Bus7	-0.185	-0.122	3.9	83.6	
								Bus9	0.185	0.122	3.9	83.6	
Bus72	33.000	98.705	0.2	0	0	0	0	Bus2	-7.404	-4.099	150.0	87.5	
								Bus14	7.341	4.088	148.9	87.4	
								Bus73	0.063	0.011	1.1	98.5	
Bus73	33.000	98.693	0.2	0	0	0	0	Bus72	-0.063	-0.019	1.2	95.7	
								Bus75	0.063	0.019	1.2	95.7	
Bus75	0.400	98.014	-0.4	0	0	0.062	0.018	Bus73	-0.062	-0.018	95.6	96.0	
Bus76	33.000	97.555	0.4	0	0	0	0	Bus19	-0.077	-0.031	1.5	92.5	
								Bus21	0.077	0.031	1.5	92.5	
Bus77	33.000	97.358	0.4	0	0	0	0	Bus23	-0.272	-0.146	5.6	88.1	
								Bus24	0.272	0.146	5.6	88.1	
Bus78	33.000	96.474	0.5	0	0	0	0	Bus38	-0.324	-0.224	7.1	82.3	
								Bus39	0.324	0.224	7.1	82.3	
Bus79	33.000	95.976	0.6	0	0	0	0	Bus60	-0.125	-0.055	2.5	91.5	
								Bus62	0.125	0.055	2.5	91.5	
Bus80	33.000	95.970	0.6	0	0	0	0	Bus63	-0.323	-0.178	6.7	87.6	
								Bus64	0.323	0.178	6.7	87.6	

* 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

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus1	33.000		0	0	0	0	0	0	0	0	9.681	87.8	169.4	
Bus2	33.000		0	0	0	0	0	0	0	0	9.608	87.7	169.4	
Bus3	0.400		0.166	0.048	0.039	0.011	0	0	0	0	0.213	96.0	317.7	
Bus5	33.000		0	0	0	0	0	0	0	0	0.888	86.1	15.7	
Bus6	0.400		0.144	0.078	0.034	0.018	0	0	0	0	0.202	88.0	302.6	
Bus7	33.000		0	0	0	0	0	0	0	0	0.681	85.7	12.0	
Bus8	0.400		0.084	0.061	0.020	0.014	0	0	0	0	0.129	81.0	191.0	
Bus9	0.400		0.148	0.092	0.034	0.021	0	0	0	0	0.215	85.0	322.7	
Bus14	33.000		0	0	0	0	0	0	0	0	8.372	87.3	149.0	
Bus17	0.400		0.261	0.095	0.058	0.021	0	0	0	0	0.339	94.0	519.8	
Bus18	33.000		0	0	0	0	0	0	0	0	7.960	87.0	142.7	
Bus19	33.000		0	0	0	0	0	0	0	0	0.222	95.1	4.0	
Bus20	0.400		0.108	0.052	0.025	0.012	0	0	0	0	0.147	90.0	222.6	
Bus21	0.400		0.062	0.025	0.014	0.006	0	0	0	0	0.082	93.0	123.0	
Bus22	33.000		0	0	0	0	0	0	0	0	7.747	86.5	139.1	
Bus23	33.000		0	0	0	0	0	0	0	0	0.513	88.0	9.2	
Bus24	0.400		0.219	0.106	0.048	0.023	0	0	0	0	0.296	90.0	458.1	
Bus25	0.400		0.144	0.078	0.032	0.017	0	0	0	0	0.201	88.0	306.2	
Bus26	33.000		0	0	0	0	0	0	0	0	7.232	86.4	129.9	
Bus27	0.400		0.205	0.138	0.046	0.031	0	0	0	0	0.303	83.0	461.4	
Bus28	33.000		0	0	0	0	0	0	0	0	6.866	86.4	124.4	
Bus29	0.400		0.179	0.052	0.040	0.012	0	0	0	0	0.228	96.0	349.3	
Bus30	33.000		0	0	0	0	0	0	0	0	1.155	87.3	21.0	
Bus31	0.400		0.167	0.049	0.037	0.011	0	0	0	0	0.212	96.0	325.2	
Bus32	33.000		0	0	0	0	0	0	0	0	0.945	84.8	17.2	
Bus33	0.400		0.156	0.071	0.033	0.015	0	0	0	0	0.207	91.0	325.9	
Bus34	0.400		0.235	0.114	0.050	0.024	0	0	0	0	0.317	90.0	497.6	
Bus35	33.000		0	0	0	0	0	0	0	0	0.401	78.8	7.3	
Bus36	0.400		0.119	0.096	0.025	0.020	0	0	0	0	0.185	78.0	291.8	
Bus37	0.400		0.136	0.092	0.030	0.020	0	0	0	0	0.200	82.8	309.1	
Bus38	33.000		0	0	0	0	0	0	0	0	0.596	82.9	10.8	
Bus39	0.400		0.261	0.162	0.054	0.033	0	0	0	0	0.370	85.0	589.4	
Bus40	0.400		0.137	0.085	0.029	0.018	0	0	0	0	0.195	85.0	306.2	
Bus41	33.000		0	0	0	0	0	0	0	0	4.874	86.0	88.6	
Bus42	0.400		0.277	0.142	0.060	0.031	0	0	0	0	0.379	89.0	587.1	
Bus43	33.000		0	0	0	0	0	0	0	0	0.626	86.0	11.4	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus44	0.400		0.164	0.102	0.035	0.022	0	0	0	0	0.234	85.0	364.7	
Bus45	0.400		0.271	0.131	0.056	0.027	0	0	0	0	0.363	90.0	575.6	
Bus46	33.000		0	0	0	0	0	0	0	0	3.854	85.8	70.1	
Bus47	0.400		0.127	0.050	0.029	0.011	0	0	0	0	0.168	93.0	254.8	
Bus48	0.400		0.154	0.083	0.033	0.018	0	0	0	0	0.213	88.0	330.4	
Bus49	33.000		0	0	0	0	0	0	0	0	3.465	85.4	63.1	
Bus50	0.400		0.261	0.162	0.053	0.033	0	0	0	0	0.370	85.0	591.0	
Bus51	33.000		0	0	0	0	0	0	0	0	3.069	85.7	55.9	
Bus52	0.400		0.317	0.171	0.067	0.036	0	0	0	0	0.437	88.0	683.1	
Bus53	0.400		0.372	0.135	0.080	0.029	0	0	0	0	0.481	94.0	749.9	
Bus54	0.400		0.261	0.095	0.055	0.020	0	0	0	0	0.336	94.0	528.4	
Bus55	33.000		0	0	0	0	0	0	0	0	1.777	82.0	32.4	
Bus56	0.400		0.102	0.043	0.023	0.010	0	0	0	0	0.135	92.0	205.6	
Bus57	33.000		0	0	0	0	0	0	0	0	0.315	80.6	5.7	
Bus58	0.400		0.084	0.061	0.019	0.013	0	0	0	0	0.127	81.0	195.0	
Bus59	0.400		0.122	0.082	0.025	0.017	0	0	0	0	0.177	83.0	279.3	
Bus60	33.000		0	0	0	0	0	0	0	0	0.451	81.1	8.2	
Bus61	0.400		0.196	0.162	0.042	0.035	0	0	0	0	0.309	77.0	480.7	
Bus62	0.400		0.102	0.043	0.023	0.010	0	0	0	0	0.135	92.0	205.6	
Bus63	33.000		0	0	0	0	0	0	0	0	0.878	81.1	16.0	
Bus64	0.400		0.261	0.126	0.054	0.026	0	0	0	0	0.350	90.0	554.3	
Bus65	0.400		0.119	0.096	0.025	0.020	0	0	0	0	0.184	78.0	292.5	
Bus66	0.400		0.196	0.162	0.042	0.035	0	0	0	0	0.309	77.0	480.7	
Bus68	33.000		0	0	0	0	0	0	0	0	0.464	86.0	8.2	
Bus70	0.400		0.235	0.114	0.053	0.026	0	0	0	0	0.319	90.0	486.4	
Bus71	33.000		0	0	0	0	0	0	0	0	0.222	83.6	3.9	
Bus72	33.000		0	0	0	0	0	0	0	0	8.463	87.5	150.0	
Bus73	33.000		0	0	0	0	0	0	0	0	0.065	95.7	1.2	
Bus75	0.400		0.050	0.015	0.012	0.004	0	0	0	0	0.065	96.0	95.6	
Bus76	33.000		0	0	0	0	0	0	0	0	0.083	92.5	1.5	
Bus77	33.000		0	0	0	0	0	0	0	0	0.309	88.1	5.6	
Bus78	33.000		0	0	0	0	0	0	0	0	0.394	82.3	7.1	
Bus79	33.000		0	0	0	0	0	0	0	0	0.137	91.5	2.5	
Bus80	33.000		0	0	0	0	0	0	0	0	0.369	87.6	6.7	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
Cable1	Cable	344.84	1.49	0.43					
T 1	Transformer				400.000	0.218	0.1	0.213	0.1
T 2	Transformer				0.400	0.208	52.0	0.202	50.5
T 3	Transformer				0.400	0.131	32.8	0.129	32.1
T 4	Transformer				0.400	0.222	55.4	0.215	53.6
T 5	Transformer				0.400	0.334	83.5	0.319	79.8
T 6.	Transformer				0.400	0.065	16.3	0.065	16.2
T 7	Transformer				0.400	0.354	88.5	0.339	84.8
T 8	Transformer				0.400	0.150	37.6	0.147	36.9
T 9	Transformer				0.400	0.083	20.8	0.082	20.6
T 10	Transformer				0.400	0.207	51.7	0.201	50.2
T 11	Transformer				0.400	0.309	77.3	0.296	74.0
T 12	Transformer				0.630	0.311	49.4	0.303	48.0
T 13	Transformer				0.400	0.234	58.4	0.228	56.9
T 14	Transformer				0.250	0.205	81.9	0.195	77.9
T 15	Transformer				0.400	0.394	98.5	0.370	92.6
T16	Transformer				0.400	0.217	54.3	0.212	53.0
T 17	Transformer				0.250	0.218	87.0	0.207	82.9
T 18	Transformer				0.400	0.332	83.0	0.317	79.2
T 19	Transformer				0.250	0.195	77.9	0.185	73.9
T 20	Transformer				0.400	0.206	51.6	0.200	49.9
T 21	Transformer				0.630	0.391	62.1	0.379	60.1
T 22	Transformer				0.400	0.243	60.8	0.234	58.6
T 23	Transformer				0.400	0.384	95.9	0.363	90.8
T 24	Transformer				0.400	0.220	55.0	0.213	53.3
T 25	Transformer				0.630	0.170	26.9	0.168	26.6
T 26	Transformer				0.400	0.394	98.4	0.370	92.5
T 27	Transformer				0.400	0.352	87.9	0.336	84.0
T 28	Transformer				0.630	0.499	79.2	0.481	76.3
T29	Transformer				0.630	0.454	72.1	0.437	69.3
T 30	Transformer				0.630	0.137	21.7	0.135	21.5
T 31	Transformer				0.400	0.130	32.4	0.127	31.7
T 32	Transformer				0.250	0.186	74.3	0.177	70.8

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
T 33	Transformer				0.630	0.320	50.7	0.309	49.1
T 34	Transformer				0.250	0.195	77.8	0.184	73.8
T 35	Transformer				0.400	0.369	92.1	0.350	87.4
T 36	Transformer				630.000	0.320	0.1	0.309	0.0
T 37	Transformer				0.630	0.137	21.7	0.135	21.5

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line1	8.496	4.640	-8.422	-4.624	73.8	16.1	100.0	99.2	0.77
Line2	0.765	0.448	-0.765	-0.451	0.6	-3.4	99.2	99.2	0.07
Line4	7.449	4.109	-7.404	-4.099	45.1	9.2	99.2	98.7	0.53
T 1	0.208	0.068	-0.205	-0.060	2.7	8.4	99.2	96.9	2.30
Line3	0.585	0.347	-0.584	-0.351	0.4	-3.4	99.2	99.1	0.05
T 2	0.180	0.104	-0.178	-0.096	2.5	7.6	99.2	96.4	2.78
Line27	0.399	0.235	-0.399	-0.237	0.1	-2.1	99.1	99.1	0.02
Line28	0.185	0.116	-0.185	-0.122	0.1	-5.9	99.1	99.1	0.03
T 3	-0.104	-0.075	0.105	0.078	1.0	3.0	97.1	99.1	1.95
T 4	-0.182	-0.113	0.185	0.122	2.8	8.6	96.0	99.1	3.13
Line6	-7.309	-4.082	7.341	4.088	32.1	6.6	98.3	98.7	0.38
Line8	6.983	3.944	-6.921	-3.931	62.1	12.4	98.3	97.6	0.76
T 7	0.326	0.138	-0.319	-0.116	7.2	22.4	98.3	94.2	4.14
Line9	0.211	0.046	-0.211	-0.047	0.0	-1.3	97.6	97.6	0.01
Line10	6.710	3.886	-6.703	-3.884	7.6	1.5	97.6	97.5	0.10
Cable1	0.077	-0.021	-0.077	-0.031	0.0	-52.8	97.6	97.6	0.00
T 8	0.134	0.068	-0.133	-0.064	1.3	4.1	97.6	95.6	1.95
T 9	-0.077	-0.030	0.077	0.031	0.4	1.3	96.6	97.6	0.99
Line11	0.452	0.238	-0.451	-0.243	0.3	-5.4	97.5	97.4	0.07
Line12	6.251	3.646	-6.247	-3.645	4.3	0.8	97.5	97.4	0.06
Line30	0.272	0.140	-0.272	-0.146	0.1	-6.2	97.4	97.4	0.04
T 10	0.179	0.103	-0.177	-0.095	2.5	7.8	97.4	94.6	2.82
T 11	-0.267	-0.129	0.272	0.146	5.6	17.4	93.3	97.4	4.07
Line13	5.993	3.465	-5.934	-3.455	58.9	10.6	97.4	96.6	0.83
T 12	0.254	0.180	-0.251	-0.169	2.9	11.4	97.4	94.6	2.77
Line14	1.010	0.560	-1.008	-0.564	1.3	-3.7	96.6	96.5	0.11
Line17	0.494	0.329	-0.494	-0.333	0.3	-3.9	96.6	96.5	0.06
Line18	4.208	2.491	-4.190	-2.490	18.0	1.7	96.6	96.2	0.35
T 13	0.222	0.074	-0.219	-0.064	3.3	10.1	96.6	94.0	2.53
Line15	0.802	0.496	-0.801	-0.501	1.3	-5.4	96.5	96.3	0.13
T16	0.206	0.068	-0.204	-0.059	2.8	8.8	96.5	94.1	2.35
Line16	0.316	0.243	-0.316	-0.247	0.2	-3.9	96.3	96.3	0.04
T 17	0.193	0.100	-0.189	-0.086	4.6	14.1	96.3	91.8	4.54
T 18	0.292	0.159	-0.285	-0.138	6.6	20.5	96.3	91.9	4.43
T 19	0.148	0.127	-0.144	-0.116	3.6	11.3	96.3	91.4	4.95

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	% Drop in Vmag
T 20	0.168	0.120	-0.165	-0.112	2.6	7.9	96.3	93.2	3.09
Line31	0.324	0.218	-0.324	-0.224	0.2	-5.7	96.5	96.5	0.05
T 14	0.169	0.115	-0.165	-0.103	4.0	12.4	96.5	91.8	4.78
T 15	-0.315	-0.195	0.324	0.224	9.3	28.8	90.7	96.5	5.76
Line19	0.538	0.319	-0.538	-0.320	0.1	-0.7	96.2	96.2	0.01
Line20	3.310	1.979	-3.307	-1.979	2.5	0.0	96.2	96.2	0.06
T 21	0.342	0.191	-0.337	-0.173	4.7	18.5	96.2	93.1	3.15
T 22	0.203	0.134	-0.199	-0.123	3.6	11.0	96.2	92.7	3.54
T 23	0.336	0.186	-0.327	-0.158	8.9	27.4	96.2	91.1	5.14
Line21	2.960	1.804	-2.958	-1.804	2.0	-0.1	96.2	96.1	0.06
T 24	0.191	0.110	-0.188	-0.101	2.9	9.0	96.2	93.1	3.04
T 25	0.157	0.065	-0.156	-0.062	0.9	3.5	96.2	95.0	1.20
Line22	2.634	1.580	-2.631	-1.581	3.1	-0.5	96.1	96.0	0.10
T 26	0.324	0.224	-0.314	-0.195	9.4	28.9	96.1	90.3	5.78
Line23	1.458	1.016	-1.457	-1.017	0.4	-0.4	96.0	96.0	0.02
T 27	0.323	0.138	-0.316	-0.115	7.5	23.1	96.0	91.8	4.22
T 28	0.460	0.194	-0.452	-0.164	7.6	30.1	96.0	92.5	3.48
T29	0.391	0.232	-0.384	-0.207	6.3	25.0	96.0	92.2	3.77
Line24	0.254	0.186	-0.254	-0.187	0.0	-1.2	96.0	96.0	0.01
Line25	0.366	0.263	-0.366	-0.264	0.0	-0.9	96.0	96.0	0.01
Line26	0.712	0.513	-0.712	-0.514	0.1	-0.6	96.0	96.0	0.01
T 30	0.125	0.055	-0.124	-0.053	0.6	2.3	96.0	95.0	1.00
T 31	0.104	0.078	-0.103	-0.074	1.0	3.1	96.0	94.0	1.99
T 32	0.150	0.109	-0.147	-0.099	3.3	10.3	96.0	91.5	4.47
Line32	0.125	0.054	-0.125	-0.055	0.0	-1.1	96.0	96.0	0.00
T 36	0.241	0.210	-0.238	-0.197	3.1	12.4	96.0	92.9	3.12
T 37	-0.124	-0.053	0.125	0.055	0.6	2.3	95.0	96.0	1.00
Line33	0.323	0.177	-0.323	-0.178	0.0	-0.6	96.0	96.0	0.01
T 33	0.241	0.210	-0.238	-0.197	3.1	12.4	96.0	92.9	3.12
T 34	0.148	0.127	-0.144	-0.115	3.7	11.3	96.0	91.0	4.96
T 35	-0.315	-0.152	0.323	0.178	8.2	25.4	91.0	96.0	4.95
T 5	0.294	0.159	-0.287	-0.139	6.3	19.6	99.1	94.8	4.32
Line29	0.063	0.011	-0.063	-0.019	0.0	-7.9	98.7	98.7	0.01
T 6.	0.063	0.019	-0.062	-0.018	0.2	0.8	98.7	98.0	0.68
					462.9	423.7			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus17	Bus	Under Voltage	0.40	kV	0.38	94.2	3-Phase
Bus24	Bus	Under Voltage	0.40	kV	0.37	93.3	3-Phase
Bus25	Bus	Under Voltage	0.40	kV	0.38	94.6	3-Phase
Bus27	Bus	Under Voltage	0.40	kV	0.38	94.6	3-Phase
Bus29	Bus	Under Voltage	0.40	kV	0.38	94.0	3-Phase
Bus31	Bus	Under Voltage	0.40	kV	0.38	94.1	3-Phase
Bus33	Bus	Under Voltage	0.40	kV	0.37	91.8	3-Phase
Bus34	Bus	Under Voltage	0.40	kV	0.37	91.9	3-Phase
Bus36	Bus	Under Voltage	0.40	kV	0.37	91.4	3-Phase
Bus37	Bus	Under Voltage	0.40	kV	0.37	93.2	3-Phase
Bus39	Bus	Under Voltage	0.40	kV	0.36	90.7	3-Phase
Bus40	Bus	Under Voltage	0.40	kV	0.37	91.8	3-Phase
Bus42	Bus	Under Voltage	0.40	kV	0.37	93.1	3-Phase
Bus44	Bus	Under Voltage	0.40	kV	0.37	92.7	3-Phase
Bus45	Bus	Under Voltage	0.40	kV	0.36	91.1	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus47	Bus	Under Voltage	0.40	kV	0.38	95.0	3-Phase
Bus48	Bus	Under Voltage	0.40	kV	0.37	93.1	3-Phase
Bus50	Bus	Under Voltage	0.40	kV	0.36	90.3	3-Phase
Bus52	Bus	Under Voltage	0.40	kV	0.37	92.2	3-Phase
Bus53	Bus	Under Voltage	0.40	kV	0.37	92.5	3-Phase
Bus54	Bus	Under Voltage	0.40	kV	0.37	91.8	3-Phase
Bus56	Bus	Under Voltage	0.40	kV	0.38	95.0	3-Phase
Bus58	Bus	Under Voltage	0.40	kV	0.38	94.0	3-Phase
Bus59	Bus	Under Voltage	0.40	kV	0.37	91.5	3-Phase
Bus61	Bus	Under Voltage	0.40	kV	0.37	92.9	3-Phase
Bus62	Bus	Under Voltage	0.40	kV	0.38	95.0	3-Phase
Bus64	Bus	Under Voltage	0.40	kV	0.36	91.0	3-Phase
Bus65	Bus	Under Voltage	0.40	kV	0.36	91.0	3-Phase
Bus66	Bus	Under Voltage	0.40	kV	0.37	92.9	3-Phase
Bus70	Bus	Under Voltage	0.40	kV	0.38	94.8	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus18	Bus	Under Voltage	33.00	kV	32.20	97.6	3-Phase
Bus19	Bus	Under Voltage	33.00	kV	32.19	97.6	3-Phase
Bus20	Bus	Under Voltage	0.40	kV	0.38	95.6	3-Phase
Bus21	Bus	Under Voltage	0.40	kV	0.39	96.6	3-Phase
Bus22	Bus	Under Voltage	33.00	kV	32.16	97.5	3-Phase
Bus23	Bus	Under Voltage	33.00	kV	32.14	97.4	3-Phase
Bus26	Bus	Under Voltage	33.00	kV	32.15	97.4	3-Phase
Bus28	Bus	Under Voltage	33.00	kV	31.87	96.6	3-Phase
Bus3	Bus	Under Voltage	0.40	kV	0.39	96.9	3-Phase
Bus30	Bus	Under Voltage	33.00	kV	31.84	96.5	3-Phase
Bus32	Bus	Under Voltage	33.00	kV	31.79	96.3	3-Phase
Bus35	Bus	Under Voltage	33.00	kV	31.78	96.3	3-Phase
Bus38	Bus	Under Voltage	33.00	kV	31.85	96.5	3-Phase
Bus41	Bus	Under Voltage	33.00	kV	31.76	96.2	3-Phase
Bus43	Bus	Under Voltage	33.00	kV	31.75	96.2	3-Phase
Bus46	Bus	Under Voltage	33.00	kV	31.73	96.2	3-Phase
Bus49	Bus	Under Voltage	33.00	kV	31.72	96.1	3-Phase
Bus51	Bus	Under Voltage	33.00	kV	31.68	96.0	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus55	Bus	Under Voltage	33.00	kV	31.68	96.0	3-Phase
Bus57	Bus	Under Voltage	33.00	kV	31.67	96.0	3-Phase
Bus6	Bus	Under Voltage	0.40	kV	0.39	96.4	3-Phase
Bus60	Bus	Under Voltage	33.00	kV	31.67	96.0	3-Phase
Bus63	Bus	Under Voltage	33.00	kV	31.67	96.0	3-Phase
Bus76	Bus	Under Voltage	33.00	kV	32.19	97.6	3-Phase
Bus77	Bus	Under Voltage	33.00	kV	32.13	97.4	3-Phase
Bus78	Bus	Under Voltage	33.00	kV	31.84	96.5	3-Phase
Bus79	Bus	Under Voltage	33.00	kV	31.67	96.0	3-Phase
Bus8	Bus	Under Voltage	0.40	kV	0.39	97.1	3-Phase
Bus80	Bus	Under Voltage	33.00	kV	31.67	96.0	3-Phase
Bus9	Bus	Under Voltage	0.40	kV	0.38	96.0	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	8.496	4.640	9.681	87.76 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	8.496	4.640	9.681	87.76 Lagging
Total Motor Load:	6.601	3.467	7.456	88.53 Lagging
Total Static Load:	1.432	0.750	1.616	88.59 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.463	0.424		
System Mismatch:	0.000	0.000		

Number of Iterations: 3

Part 9

Complete report of Load Flow Analysis

after solve problems

Electrical Transient Analyzer Program

Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

	Swing	V-Control	Load	Total
Number of Buses:	1	0	94	95

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	37	0	0	32	0	25	94

Method of Solution:	Adaptive Newton-Raphson Method
Maximum No. of Iteration:	99
Precision of Solution:	0.0001000
System Frequency:	50.00 Hz
Unit System:	Metric
Project Filename:	Project2
Output Filename:	C:\Users\HP\Desktop\Project2\Load Flow Analysis-2.lfr

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus1	33.000	1	100.0	0.0								
Bus2	33.000	1	100.0	0.0								
Bus3	0.400	1	100.0	0.0	0.166	0.048	0.041	0.012				
Bus4	0.400	1	100.0	0.0	0.084	0.061	0.021	-0.025				
Bus5	33.000	1	100.0	0.0								
Bus6	0.400	1	100.0	0.0								
Bus7	33.000	1	100.0	0.0								
Bus8	0.400	1	100.0	0.0								
Bus9	0.400	1	100.0	0.0								
Bus10	0.400	1	100.0	0.0	0.148	0.092	0.037	-0.017				
Bus11	0.400	1	100.0	0.0	0.205	0.138	0.051	-0.026				
Bus12	0.400	1	100.0	0.0	0.137	0.085	0.034	-0.019				
Bus13	0.400	1	100.0	0.0	0.119	0.096	0.030	-0.076				
Bus14	33.000	1	100.0	0.0								
Bus15	0.400	1	100.0	0.0	0.136	0.092	0.034	-0.017				
Bus16	0.400	1	100.0	0.0	0.164	0.102	0.041	-0.015				
Bus17	0.400	1	100.0	0.0	0.261	0.095	0.065	0.024				
Bus18	33.000	1	100.0	0.0								
Bus19	33.000	1	100.0	0.0								
Bus20	0.400	1	100.0	0.0								
Bus21	0.400	1	100.0	0.0	0.062	0.025	0.016	0.006				
Bus22	33.000	1	100.0	0.0								
Bus23	33.000	1	100.0	0.0								
Bus24	0.400	1	100.0	0.0								
Bus25	0.400	1	100.0	0.0								
Bus26	33.000	1	100.0	0.0								
Bus27	0.400	1	100.0	0.0								
Bus28	33.000	1	100.0	0.0								
Bus29	0.400	1	100.0	0.0	0.179	0.052	0.045	0.013				
Bus30	33.000	1	100.0	0.0								
Bus31	0.400	1	100.0	0.0	0.167	0.049	0.042	0.012				
Bus32	33.000	1	100.0	0.0								
Bus33	0.400	1	100.0	0.0	0.156	0.071	0.039	0.018				

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus34	0.400	1	100.0	0.0								
Bus35	33.000	1	100.0	0.0								
Bus36	0.400	1	100.0	0.0								
Bus37	0.400	1	100.0	0.0								
Bus38	33.000	1	100.0	0.0								
Bus39	0.400	1	100.0	0.0								
Bus40	0.400	1	100.0	0.0								
Bus41	33.000	1	100.0	0.0								
Bus42	0.400	1	100.0	0.0								
Bus43	33.000	1	100.0	0.0								
Bus44	0.400	1	100.0	0.0								
Bus45	0.400	1	100.0	0.0								
Bus46	33.000	1	100.0	0.0								
Bus47	0.400	1	100.0	0.0	0.127	0.050	0.032	0.013				
Bus48	0.400	1	100.0	0.0								
Bus49	33.000	1	100.0	0.0								
Bus50	0.400	1	100.0	0.0								
Bus51	33.000	1	100.0	0.0								
Bus52	0.400	1	100.0	0.0								
Bus53	0.400	1	100.0	0.0	0.372	0.135	0.093	0.034				
Bus54	0.400	1	100.0	0.0	0.261	0.095	0.065	0.024				
Bus55	33.000	1	100.0	0.0								
Bus56	0.400	1	100.0	0.0	0.102	0.043	0.025	0.011				
Bus57	33.000	1	100.0	0.0								
Bus58	0.400	1	100.0	0.0								
Bus59	0.400	1	100.0	0.0								
Bus60	33.000	1	100.0	0.0								
Bus61	0.400	1	100.0	0.0								
Bus62	0.400	1	100.0	0.0	0.102	0.043	0.025	0.011				
Bus63	33.000	1	100.0	0.0								
Bus64	0.400	1	100.0	0.0								
Bus65	0.400	1	100.0	0.0								
Bus66	0.400	1	100.0	0.0								
Bus67	0.400	1	100.0	0.0	0.261	0.162	0.065	-0.060				
Bus68	33.000	1	100.0	0.0								

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus69	0.400	1	100.0	0.0	0.084	0.061	0.021	-0.025				
Bus70	0.400	1	100.0	0.0								
Bus71	33.000	1	100.0	0.0								
Bus72	33.000	1	100.0	0.0								
Bus73	33.000	1	100.0	0.0								
Bus74	0.400	1	100.0	0.0	0.122	0.082	0.030	-0.060				
Bus75	0.400	1	100.0	0.0	0.050	0.015	0.013	0.004				
Bus76	33.000	1	100.0	0.0								
Bus77	33.000	1	100.0	0.0								
Bus78	33.000	1	100.0	0.0								
Bus79	33.000	1	100.0	0.0								
Bus80	33.000	1	100.0	0.0								
Bus81	0.400	1	100.0	0.0	0.119	0.096	0.030	-0.076				
Bus82	0.400	1	100.0	0.0	0.196	0.162	0.049	-0.059				
Bus83	0.400	1	100.0	0.0	0.196	0.162	0.049	-0.159				
Bus84	0.400	1	100.0	0.0	0.144	0.078	0.036	-0.021				
Bus85	0.400	1	100.0	0.0	0.235	0.114	0.059	-0.012				
Bus86	0.400	1	100.0	0.0	0.108	0.052	0.027	-0.027				
Bus87	0.400	1	100.0	0.0	0.144	0.078	0.036	-0.021				
Bus88	0.400	1	100.0	0.0	0.219	0.106	0.055	-0.013				
Bus89	0.400	1	100.0	0.0	0.204	0.126	0.051	-0.068				
Bus90	0.400	1	100.0	0.0	0.235	0.114	0.059	-0.011				
Bus91	0.400	1	100.0	0.0	0.277	0.142	0.069	-0.005				
Bus92	0.400	1	100.0	0.0	0.154	0.083	0.039	-0.019				
Bus93	0.400	1	100.0	0.0	0.317	0.171	0.079	-0.057				
Bus94	0.400	1	100.0	0.0	0.261	0.126	0.065	-0.008				
Bus95	0.400	1	100.0	0.0	0.271	0.131	0.068	-0.007				
Total Number of Buses: 95					6.544	3.431	1.636	-0.722	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus1	33.000	Swing	1	100.0	0.0					
						0.000	0.000			

Line/Cable Input Data

Line/Cable			Length				Ohms or Siemens/1000 ft per Conductor (Cable) or per Phase (Line)		
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R	X	Y
Cable1	33NCUS1	95	2624.7	0.0	1	75	0.072096	0.052304	0.0000194
Line1		120	1968.5	0.0	1	75	0.122808	0.085700	0.0000020
Line2		49.5	1916.4	0.0	1	75	0.435771	0.116631	0.0000017
Line3		49.5	1900.6	0.0	1	75	0.435771	0.116631	0.0000017
Line4		120	1533.5	0.0	1	75	0.122808	0.085700	0.0000020
Line6		120	1108.3	0.0	1	75	0.122808	0.085700	0.0000020
Line8		120	2331.7	0.0	1	75	0.122808	0.085700	0.0000020
Line9		49.5	705.1	0.0	1	75	0.435771	0.116631	0.0000017
Line10		120	298.9	0.0	1	75	0.122808	0.085700	0.0000020
Line11		77.3	3068.2	0.0	1	75	0.235560	0.106436	0.0000018
Line12		120	196.9	0.0	1	75	0.122808	0.085700	0.0000020
Line13		120	2911.4	0.0	1	75	0.122808	0.085700	0.0000020
Line14		77.3	2332.0	0.0	1	75	0.235560	0.106436	0.0000018
Line15		77.3	3280.8	0.0	1	75	0.235560	0.106436	0.0000018
Line16		49.5	2231.0	0.0	1	75	0.435771	0.116631	0.0000017
Line17		49.5	2296.6	0.0	1	75	0.435771	0.116631	0.0000017
Line18		77.3	1752.0	0.0	1	75	0.235560	0.106436	0.0000018
Line19		49.5	393.7	0.0	1	75	0.435771	0.116631	0.0000017
Line20		120	393.7	0.0	1	75	0.122808	0.085700	0.0000020
Line21		49.5	387.1	0.0	1	75	0.435771	0.116631	0.0000017
Line22		49.5	764.4	0.0	1	75	0.435771	0.116631	0.0000017
Line23		77.3	328.1	0.0	1	75	0.235560	0.106436	0.0000018
Line24		49.5	675.9	0.0	1	75	0.435771	0.116631	0.0000017
Line25		49.5	506.2	0.0	1	75	0.435771	0.116631	0.0000017
Line26		49.5	388.1	0.0	1	75	0.435771	0.116631	0.0000017
Line27		49.5	1148.3	0.0	1	75	0.435771	0.116631	0.0000017
Line28		49.5	3221.5	0.0	1	75	0.435771	0.116631	0.0000017
Line29		49.5	4327.4	0.0	1	75	0.435771	0.116628	0.0000017
Line30		77.3	3487.5	0.0	1	75	0.235560	0.106436	0.0000018
Line31		77.3	3280.8	0.0	1	75	0.235560	0.106436	0.0000018
Line32		49.5	656.2	0.0	1	75	0.435771	0.116631	0.0000017
Line33		49.5	328.1	0.0	1	75	0.435771	0.116631	0.0000017

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T 1	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 2	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 3	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 4	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 5	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 6.	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	0	7.2500	Dyn	0.000
T 7	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 8	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	2.500	5.000	7.2500	Dyn	0.000
T 9	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 10	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 11	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 12	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	2.500	7.2500	Dyn	0.000
T 13	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T 14	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 15	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T16	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T 17	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	-2.500	5.000	7.2500	Dyn	0.000
T 18	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 19	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 20	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 21	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	-5.000	0	7.2500	Dyn	0.000
T 22	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 23	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	5.000	7.2500	Dyn	0.000
T 24	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T 25	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	-2.500	0	7.2500	Dyn	0.000
T 26	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T 27	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	5.000	7.2500	Dyn	0.000
T 28	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T29	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	-2.500	2.500	7.2500	Dyn	0.000
T 30	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	2.500	5.000	7.2500	Dyn	0.000
T 31	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	0	2.500	7.2500	Dyn	0.000
T 32	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000
T 33	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	0	5.000	7.2500	Dyn	0.000
T 34	3-Phase	0.250	33.000	0.400	7.25	3.09	0	0	0	0	5.000	7.2500	Dyn	0.000

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T 35	3-Phase	0.400	33.000	0.400	7.25	3.09	0	0	0	-2.500	5.000	7.2500	Dyn	0.000
T 36	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	2.500	5.000	7.2500	Dyn	0.000
T 37	3-Phase	0.630	33.000	0.400	7.25	3.96	0	0	0	2.500	5.000	7.2500	Dyn	0.000

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bus	To Bus	R	X	Z	Y
T 1	2W XFMR	Bus2	Bus3	572.02	1767.56	1857.81	
T 2	2W XFMR	Bus5	Bus6	572.02	1767.56	1857.81	
T 3	2W XFMR	Bus68	Bus8	572.02	1767.56	1857.81	
T 4	2W XFMR	Bus71	Bus9	572.02	1767.56	1857.81	
T 5	2W XFMR	Bus68	Bus70	585.98	1810.67	1903.13	
T 6.	2W XFMR	Bus73	Bus75	558.07	1724.45	1812.50	
T 7	2W XFMR	Bus14	Bus17	585.98	1810.67	1903.13	
T 8	2W XFMR	Bus19	Bus20	600.63	1855.93	1950.70	
T 9	2W XFMR	Bus76	Bus21	572.02	1767.56	1857.81	
T 10	2W XFMR	Bus23	Bus25	585.98	1810.67	1903.13	
T 11	2W XFMR	Bus77	Bus24	585.98	1810.67	1903.13	
T 12	2W XFMR	Bus26	Bus27	288.80	1143.66	1179.56	
T 13	2W XFMR	Bus28	Bus29	557.72	1723.37	1811.37	
T 14	2W XFMR	Bus38	Bus40	937.56	2897.07	3045.00	
T 15	2W XFMR	Bus78	Bus39	585.98	1810.67	1903.13	
T16	2W XFMR	Bus30	Bus31	557.72	1723.37	1811.37	
T 17	2W XFMR	Bus32	Bus33	914.12	2824.64	2968.88	
T 18	2W XFMR	Bus32	Bus34	585.98	1810.67	1903.13	
T 19	2W XFMR	Bus35	Bus36	937.56	2897.07	3045.00	
T 20	2W XFMR	Bus35	Bus37	585.98	1810.67	1903.13	
T 21	2W XFMR	Bus41	Bus42	267.67	1059.98	1093.25	
T 22	2W XFMR	Bus43	Bus44	585.98	1810.67	1903.13	
T 23	2W XFMR	Bus43	Bus45	571.33	1765.40	1855.55	
T 24	2W XFMR	Bus46	Bus48	557.72	1723.37	1811.37	
T 25	2W XFMR	Bus46	Bus47	274.72	1087.87	1122.02	
T 26	2W XFMR	Bus49	Bus50	557.72	1723.37	1811.37	
T 27	2W XFMR	Bus51	Bus54	571.33	1765.40	1855.55	
T 28	2W XFMR	Bus51	Bus53	281.58	1115.07	1150.07	
T29	2W XFMR	Bus51	Bus52	281.58	1115.07	1150.07	
T 30	2W XFMR	Bus55	Bus56	303.24	1200.85	1238.54	
T 31	2W XFMR	Bus57	Bus58	572.02	1767.56	1857.81	
T 32	2W XFMR	Bus57	Bus59	937.56	2897.07	3045.00	
T 33	2W XFMR	Bus63	Bus66	295.85	1171.56	1208.33	
T 34	2W XFMR	Bus63	Bus65	937.56	2897.07	3045.00	
T 35	2W XFMR	Bus80	Bus64	571.33	1765.40	1855.55	
T 36	2W XFMR	Bus60	Bus61	303.24	1200.85	1238.54	
T 37	2W XFMR	Bus79	Bus62	303.24	1200.85	1238.54	

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bus	To Bus	R	X	Z	Y
Cable1	Cable	Bus19	Bus76	1.74	1.26	2.15	0.0555129
Line1	Line	Bus1	Bus2	2.22	1.55	2.71	0.0042509
Line2	Line	Bus2	Bus5	7.67	2.05	7.94	0.0036103
Line3	Line	Bus5	Bus7	7.61	2.04	7.87	0.0035805
Line4	Line	Bus2	Bus72	1.73	1.21	2.11	0.0033114
Line6	Line	Bus72	Bus14	1.25	0.87	1.52	0.0023932
Line8	Line	Bus14	Bus18	2.63	1.83	3.21	0.0050352
Line9	Line	Bus18	Bus19	2.82	0.76	2.92	0.0013282
Line10	Line	Bus18	Bus22	0.34	0.24	0.41	0.0006454
Line11	Line	Bus22	Bus23	6.64	3.00	7.28	0.0061665
Line12	Line	Bus22	Bus26	0.22	0.15	0.27	0.0004251
Line13	Line	Bus26	Bus28	3.28	2.29	4.00	0.0062871
Line14	Line	Bus28	Bus30	5.04	2.28	5.54	0.0046869
Line15	Line	Bus30	Bus32	7.10	3.21	7.79	0.0065938
Line16	Line	Bus32	Bus35	8.93	2.39	9.24	0.0042029
Line17	Line	Bus28	Bus38	9.19	2.46	9.51	0.0043265
Line18	Line	Bus28	Bus41	3.79	1.71	4.16	0.0035211
Line19	Line	Bus41	Bus43	1.58	0.42	1.63	0.0007417
Line20	Line	Bus41	Bus46	0.44	0.31	0.54	0.0008502
Line21	Line	Bus46	Bus49	1.55	0.41	1.60	0.0007293
Line22	Line	Bus49	Bus51	3.06	0.82	3.17	0.0014401
Line23	Line	Bus51	Bus55	0.71	0.32	0.78	0.0006594
Line24	Line	Bus55	Bus57	2.70	0.72	2.80	0.0012732
Line25	Line	Bus55	Bus60	2.03	0.54	2.10	0.0009537
Line26	Line	Bus55	Bus63	1.55	0.42	1.61	0.0007312
Line27	Line	Bus7	Bus68	4.59	1.23	4.76	0.0021632
Line28	Line	Bus7	Bus71	12.89	3.45	13.34	0.0060688
Line29	Line	Bus72	Bus73	17.32	4.63	17.93	0.0081547
Line30	Line	Bus23	Bus77	7.54	3.41	8.28	0.0070092
Line31	Line	Bus38	Bus78	7.10	3.21	7.79	0.0065938
Line32	Line	Bus60	Bus79	2.63	0.70	2.72	0.0012361
Line33	Line	Bus63	Bus80	1.31	0.35	1.36	0.0006181
CB5	Tie Breakr	Bus6	Bus84				
CB7	Tie Breakr	Bus8	Bus4				
CB8	Tie Breakr	Bus9	Bus10				
CB17	Tie Breakr	Bus20	Bus86				
CB21	Tie Breakr	Bus24	Bus88				
CB22	Tie Breakr	Bus25	Bus87				
CB24	Tie Breakr	Bus27	Bus11				

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bus	To Bus	R	X	Z	Y
CB31	Tie Breakr	Bus34	Bus90				
CB33	Tie Breakr	Bus36	Bus13				
CB34	Tie Breakr	Bus37	Bus15				
CB36	Tie Breakr	Bus39	Bus89				
CB37	Tie Breakr	Bus40	Bus12				
CB39	Tie Breakr	Bus42	Bus91				
CB41	Tie Breakr	Bus44	Bus16				
CB42	Tie Breakr	Bus45	Bus95				
CB45	Tie Breakr	Bus48	Bus92				
CB47	Tie Breakr	Bus50	Bus67				
CB49	Tie Breakr	Bus52	Bus93				
CB55	Tie Breakr	Bus58	Bus69				
CB56	Tie Breakr	Bus59	Bus74				
CB58	Tie Breakr	Bus61	Bus83				
CB61	Tie Breakr	Bus64	Bus94				
CB62	Tie Breakr	Bus65	Bus81				
CB63	Tie Breakr	Bus66	Bus82				
CB66	Tie Breakr	Bus70	Bus85				

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
* Bus1	33.000	100.000	0.0	8.412	2.997	0	0	Bus2	8.412	2.997	156.2	94.2	
Bus2	33.000	99.767	0.0	0	0	0	0	Bus1	-8.394	-2.988	156.3	94.2	
								Bus5	0.777	0.289	14.5	93.7	
								Bus72	7.407	2.630	137.8	94.2	
								Bus3	0.210	0.069	3.9	95.0	
Bus3	0.400	99.891	-1.9	0	0	0.207	0.060	Bus2	-0.207	-0.060	312.0	96.0	2.500
Bus4	0.400	100.849	-1.0	0	0	0.106	0.036	Bus8	-0.106	-0.036	159.7	94.7	
Bus5	33.000	99.701	0.0	0	0	0	0	Bus2	-0.777	-0.293	14.6	93.6	
								Bus7	0.594	0.229	11.2	93.3	
								Bus6	0.183	0.064	3.4	94.4	
Bus6	0.400	100.056	-1.7	0	0	0	0	Bus5	-0.180	-0.057	273.1	95.3	2.500
								Bus84	0.180	0.057	273.1	95.3	
Bus7	33.000	99.651	0.0	0	0	0	0	Bus5	-0.594	-0.232	11.2	93.1	
								Bus68	0.407	0.156	7.6	93.4	
								Bus71	0.187	0.076	3.6	92.6	
Bus8	0.400	100.849	-1.0	0	0	0	0	Bus68	-0.106	-0.036	159.7	94.7	2.500
								Bus4	0.106	0.036	159.7	94.7	
Bus9	0.400	99.620	-1.7	0	0	0	0	Bus71	-0.185	-0.075	289.2	92.7	2.500
								Bus10	0.185	0.075	289.2	92.7	
Bus10	0.400	99.620	-1.7	0	0	0.185	0.075	Bus9	-0.185	-0.075	289.2	92.7	
Bus11	0.400	99.574	-1.6	0	0	0.256	0.113	Bus27	-0.256	-0.113	405.4	91.5	
Bus12	0.400	100.085	-2.7	0	0	0.171	0.066	Bus40	-0.171	-0.066	264.1	93.3	
Bus13	0.400	101.693	-2.6	0	0	0.150	0.017	Bus36	-0.150	-0.017	214.2	99.4	
Bus14	33.000	99.492	-0.1	0	0	0	0	Bus72	-7.326	-2.612	136.8	94.2	
								Bus18	6.992	2.471	130.4	94.3	
								Bus17	0.334	0.141	6.4	92.1	
Bus15	0.400	101.271	-1.7	0	0	0.171	0.074	Bus37	-0.171	-0.074	265.4	91.7	
Bus16	0.400	100.754	-2.0	0	0	0.205	0.087	Bus44	-0.205	-0.087	319.5	92.1	
Bus17	0.400	100.067	-3.1	0	0	0.326	0.118	Bus14	-0.326	-0.118	500.7	94.0	5.000
Bus18	33.000	99.261	-0.1	0	0	0	0	Bus14	-6.977	-2.466	130.4	94.3	
								Bus19	0.215	0.005	3.8	100.0	
								Bus22	6.763	2.461	126.8	94.0	
Bus19	33.000	99.255	-0.1	0	0	0	0	Bus76	0.078	-0.023	1.4	-96.0	
								Bus18	-0.215	-0.006	3.8	100.0	
								Bus20	0.136	0.029	2.5	97.8	2.500
Bus20	0.400	100.341	-1.5	0	0	0	0	Bus19	-0.135	-0.025	197.8	98.3	5.000

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
								Bus86	0.135	0.025	197.8	98.3	
Bus21	0.400	100.722	-0.8	0	0	0.078	0.031	Bus76	-0.078	-0.031	119.8	93.0	2.500
Bus22	33.000	99.233	-0.1	0	0	0	0	Bus18	-6.761	-2.460	126.9	94.0	
								Bus23	0.464	0.158	8.6	94.6	
								Bus26	6.298	2.302	118.2	93.9	
Bus23	33.000	99.197	-0.1	0	0	0	0	Bus22	-0.463	-0.164	8.7	94.2	
								Bus77	0.279	0.101	5.2	94.0	
								Bus25	0.184	0.063	3.4	94.6	
Bus24	0.400	100.605	-2.7	0	0	0	0	Bus77	-0.274	-0.092	415.2	94.8	5.000
								Bus88	0.274	0.092	415.2	94.8	
Bus25	0.400	101.960	-1.8	0	0	0	0	Bus23	-0.182	-0.057	269.6	95.5	5.000
								Bus87	0.182	0.057	269.6	95.5	
Bus26	33.000	99.215	-0.1	0	0	0	0	Bus22	-6.297	-2.302	118.2	93.9	
								Bus28	6.038	2.180	113.2	94.1	
								Bus27	0.258	0.122	5.0	90.5	
Bus27	0.400	99.574	-1.6	0	0	0	0	Bus26	-0.256	-0.113	405.4	91.5	2.500
								Bus11	0.256	0.113	405.4	91.5	
Bus28	33.000	98.965	-0.2	0	0	0	0	Bus26	-6.024	-2.177	113.2	94.1	
								Bus30	1.039	0.383	19.6	93.8	
								Bus38	0.435	0.135	8.0	95.5	
								Bus41	4.322	1.583	81.4	93.9	
								Bus29	0.228	0.075	4.2	95.0	-2.500
Bus29	0.400	101.506	-2.2	0	0	0.225	0.066	Bus28	-0.225	-0.066	333.3	96.0	2.500
Bus30	33.000	98.903	-0.2	0	0	0	0	Bus28	-1.039	-0.388	19.6	93.7	
								Bus32	0.826	0.318	15.7	93.3	
								Bus31	0.212	0.069	4.0	95.0	-2.500
Bus31	0.400	101.621	-2.0	0	0	0.210	0.061	Bus30	-0.210	-0.061	310.2	96.0	2.500
Bus32	33.000	98.833	-0.2	0	0	0	0	Bus30	-0.826	-0.324	15.7	93.1	
								Bus35	0.325	0.100	6.0	95.5	
								Bus33	0.201	0.103	4.0	89.0	-2.500
								Bus34	0.300	0.121	5.7	92.7	
Bus33	0.400	101.749	-2.9	0	0	0.196	0.089	Bus32	-0.196	-0.089	305.7	91.0	5.000
Bus34	0.400	99.892	-2.9	0	0	0	0	Bus32	-0.294	-0.103	450.2	94.4	5.000
								Bus90	0.294	0.103	450.2	94.4	
Bus35	33.000	98.801	-0.2	0	0	0	0	Bus32	-0.325	-0.104	6.0	95.2	
								Bus36	0.152	0.024	2.7	98.8	
								Bus37	0.173	0.081	3.4	90.6	
Bus36	0.400	101.693	-2.6	0	0	0	0	Bus35	-0.150	-0.017	214.2	99.4	5.000
								Bus13	0.150	0.017	214.2	99.4	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
Bus37	0.400	101.271	-1.7	0	0	0	0	Bus35	-0.171	-0.074	265.4	91.7	5.000
								Bus15	0.171	0.074	265.4	91.7	
Bus38	33.000	98.921	-0.2	0	0	0	0	Bus28	-0.435	-0.139	8.1	95.3	
								Bus78	0.260	0.063	4.7	97.2	
								Bus40	0.174	0.076	3.4	91.6	
Bus39	0.400	101.128	-2.6	0	0	0	0	Bus78	-0.256	-0.056	374.4	97.7	5.000
								Bus89	0.256	0.056	374.4	97.7	
Bus40	0.400	100.085	-2.7	0	0	0	0	Bus38	-0.171	-0.066	264.1	93.3	5.000
								Bus12	0.171	0.066	264.1	93.3	
Bus41	33.000	98.772	-0.2	0	0	0	0	Bus28	-4.314	-1.583	81.4	93.9	
								Bus43	0.557	0.243	10.8	91.7	
								Bus46	3.405	1.187	63.9	94.4	
								Bus42	0.352	0.152	6.8	91.8	-5.000
Bus42	0.400	101.436	-2.1	0	0	0	0	Bus41	-0.348	-0.137	532.6	93.0	
								Bus91	0.348	0.137	532.6	93.0	
Bus43	33.000	98.762	-0.2	0	0	0	0	Bus41	-0.557	-0.244	10.8	91.6	
								Bus44	0.208	0.096	4.1	90.8	
								Bus45	0.349	0.148	6.7	92.1	-2.500
Bus44	0.400	100.754	-2.0	0	0	0	0	Bus43	-0.205	-0.087	319.5	92.1	5.000
								Bus16	0.205	0.087	319.5	92.1	
Bus45	0.400	101.843	-3.2	0	0	0	0	Bus43	-0.341	-0.124	514.0	94.0	5.000
								Bus95	0.341	0.124	514.0	94.0	
Bus46	33.000	98.753	-0.2	0	0	0	0	Bus41	-3.404	-1.188	63.9	94.4	
								Bus49	3.048	1.051	57.1	94.5	
								Bus48	0.196	0.071	3.7	94.1	-2.500
								Bus47	0.160	0.066	3.1	92.4	-2.500
Bus47	0.400	100.124	-1.1	0	0	0.159	0.063	Bus46	-0.159	-0.063	246.6	93.0	
Bus48	0.400	101.519	-1.9	0	0	0	0	Bus46	-0.194	-0.063	290.1	95.0	2.500
								Bus92	0.194	0.063	290.1	95.0	
Bus49	33.000	98.700	-0.2	0	0	0	0	Bus46	-3.046	-1.051	57.1	94.5	
								Bus51	2.713	0.928	50.8	94.6	
								Bus50	0.333	0.124	6.3	93.7	-2.500
Bus50	0.400	99.851	-3.1	0	0	0	0	Bus49	-0.326	-0.102	494.3	95.4	2.500
								Bus67	0.326	0.102	494.3	95.4	
Bus51	33.000	98.609	-0.2	0	0	0	0	Bus49	-2.711	-0.928	50.8	94.6	
								Bus55	1.499	0.457	27.8	95.7	
								Bus54	0.336	0.142	6.5	92.1	-2.500
								Bus53	0.473	0.198	9.1	92.3	-2.500
								Bus52	0.403	0.132	7.5	95.0	-2.500

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
Bus52	0.400	101.109	-2.5	0	0	0	0	Bus51	-0.398	-0.112	590.1	96.2	2.500
								Bus93	0.398	0.112	590.1	96.2	
Bus53	0.400	100.194	-2.9	0	0	0.466	0.169	Bus51	-0.466	-0.169	713.6	94.0	2.500
Bus54	0.400	101.844	-3.1	0	0	0.329	0.119	Bus51	-0.329	-0.119	495.4	94.0	5.000
Bus55	33.000	98.596	-0.2	0	0	0	0	Bus51	-1.499	-0.457	27.8	95.6	
								Bus57	0.261	0.065	4.8	97.0	
								Bus60	0.374	0.064	6.7	98.6	
								Bus63	0.736	0.272	13.9	93.8	
								Bus56	0.128	0.056	2.5	91.5	2.500
Bus56	0.400	99.931	-1.0	0	0	0.127	0.054	Bus55	-0.127	-0.054	199.3	92.0	5.000
Bus57	33.000	98.589	-0.2	0	0	0	0	Bus55	-0.261	-0.066	4.8	96.9	
								Bus58	0.106	0.039	2.0	94.0	
								Bus59	0.155	0.028	2.8	98.5	
Bus58	0.400	99.761	-1.1	0	0	0	0	Bus57	-0.105	-0.036	161.0	94.5	2.500
								Bus69	0.105	0.036	161.0	94.5	
Bus59	0.400	101.327	-2.6	0	0	0	0	Bus57	-0.153	-0.020	219.5	99.1	5.000
								Bus74	0.153	0.020	219.5	99.1	
Bus60	33.000	98.588	-0.2	0	0	0	0	Bus55	-0.374	-0.065	6.7	98.5	
								Bus79	0.128	0.055	2.5	91.8	
								Bus61	0.247	0.010	4.4	99.9	2.500
Bus61	0.400	100.159	-1.9	0	0	0	0	Bus60	-0.245	-0.002	353.1	100.0	5.000
								Bus83	0.245	0.002	353.1	100.0	
Bus62	0.400	99.919	-1.0	0	0	0.127	0.054	Bus79	-0.127	-0.054	199.3	92.0	5.000
Bus63	33.000	98.584	-0.2	0	0	0	0	Bus55	-0.736	-0.273	13.9	93.8	
								Bus80	0.335	0.139	6.4	92.4	
								Bus66	0.248	0.110	4.8	91.5	
								Bus65	0.152	0.024	2.7	98.8	
Bus64	0.400	101.848	-3.1	0	0	0	0	Bus80	-0.328	-0.117	494.1	94.2	5.000
								Bus94	0.328	0.117	494.1	94.2	
Bus65	0.400	101.450	-2.6	0	0	0	0	Bus63	-0.150	-0.017	214.6	99.3	5.000
								Bus81	0.150	0.017	214.6	99.3	
Bus66	0.400	101.499	-1.6	0	0	0	0	Bus63	-0.246	-0.101	378.7	92.5	5.000
								Bus82	0.246	0.101	378.7	92.5	
Bus67	0.400	99.851	-3.1	0	0	0.326	0.102	Bus50	-0.326	-0.102	494.3	95.4	
Bus68	33.000	99.630	0.0	0	0	0	0	Bus7	-0.407	-0.158	7.7	93.2	
								Bus8	0.106	0.038	2.0	94.2	
								Bus70	0.300	0.120	5.7	92.8	
Bus69	0.400	99.761	-1.1	0	0	0.105	0.036	Bus58	-0.105	-0.036	161.0	94.5	
Bus70	0.400	100.776	-2.7	0	0	0	0	Bus68	-0.294	-0.102	446.1	94.5	5.000

Bus		**Voltage**		**Generation**		**Load**		**Load Flow**					**XFMR**
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
								Bus85	0.294	0.102	446.1	94.5	
Bus71	33.000	99.624	0.0	0	0	0	0	Bus7	-0.187	-0.082	3.6	91.6	
								Bus9	0.187	0.082	3.6	91.6	
Bus72	33.000	99.607	-0.1	0	0	0	0	Bus2	-7.396	-2.626	137.9	94.2	
								Bus14	7.333	2.615	136.8	94.2	
								Bus73	0.063	0.011	1.1	98.5	
Bus73	33.000	99.595	-0.1	0	0	0	0	Bus72	-0.063	-0.019	1.2	95.7	
								Bus75	0.063	0.019	1.2	95.7	
Bus74	0.400	101.327	-2.6	0	0	0.153	0.020	Bus59	-0.153	-0.020	219.5	99.1	
Bus75	0.400	98.920	-0.6	0	0	0.063	0.018	Bus73	-0.063	-0.018	95.0	96.0	
Bus76	33.000	99.254	-0.1	0	0	0	0	Bus19	-0.078	-0.032	1.5	92.6	
								Bus21	0.078	0.032	1.5	92.6	
Bus77	33.000	99.172	-0.1	0	0	0	0	Bus23	-0.279	-0.108	5.3	93.3	
								Bus24	0.279	0.108	5.3	93.3	
Bus78	33.000	98.900	-0.2	0	0	0	0	Bus38	-0.260	-0.069	4.8	96.6	
								Bus39	0.260	0.069	4.8	96.6	
Bus79	33.000	98.585	-0.2	0	0	0	0	Bus60	-0.128	-0.056	2.5	91.5	
								Bus62	0.128	0.056	2.5	91.5	2.500
Bus80	33.000	98.579	-0.2	0	0	0	0	Bus63	-0.335	-0.140	6.4	92.3	
								Bus64	0.335	0.140	6.4	92.3	-2.500
Bus81	0.400	101.450	-2.6	0	0	0.150	0.017	Bus65	-0.150	-0.017	214.6	99.3	
Bus82	0.400	101.499	-1.6	0	0	0.246	0.101	Bus66	-0.246	-0.101	378.7	92.5	
Bus83	0.400	100.159	-1.9	0	0	0.245	0.002	Bus61	-0.245	-0.002	353.1	100.0	
Bus84	0.400	100.056	-1.7	0	0	0.180	0.057	Bus6	-0.180	-0.057	273.1	95.3	
Bus85	0.400	100.776	-2.7	0	0	0.294	0.102	Bus70	-0.294	-0.102	446.1	94.5	
Bus86	0.400	100.341	-1.5	0	0	0.135	0.025	Bus20	-0.135	-0.025	197.8	98.3	
Bus87	0.400	101.960	-1.8	0	0	0.182	0.057	Bus25	-0.182	-0.057	269.6	95.5	
Bus88	0.400	100.605	-2.7	0	0	0.274	0.092	Bus24	-0.274	-0.092	415.2	94.8	
Bus89	0.400	101.128	-2.6	0	0	0.256	0.056	Bus39	-0.256	-0.056	374.4	97.7	
Bus90	0.400	99.892	-2.9	0	0	0.294	0.103	Bus34	-0.294	-0.103	450.2	94.4	
Bus91	0.400	101.436	-2.1	0	0	0.348	0.137	Bus42	-0.348	-0.137	532.6	93.0	
Bus92	0.400	101.519	-1.9	0	0	0.194	0.063	Bus48	-0.194	-0.063	290.1	95.0	
Bus93	0.400	101.109	-2.5	0	0	0.398	0.112	Bus52	-0.398	-0.112	590.1	96.2	
Bus94	0.400	101.848	-3.1	0	0	0.328	0.117	Bus64	-0.328	-0.117	494.1	94.2	
Bus95	0.400	101.843	-3.2	0	0	0.341	0.124	Bus45	-0.341	-0.124	514.0	94.0	

* 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

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus1	33.000		0	0	0	0	0	0	0	0	8.930	94.2	156.2	
Bus2	33.000		0	0	0	0	0	0	0	0	8.910	94.2	156.3	
Bus3	0.400		0.166	0.048	0.041	0.012	0	0	0	0	0.216	96.0	312.0	
Bus4	0.400		0.084	0.061	0.021	-0.025	0	0	0	0	0.130	81.0	186.7	
Bus5	33.000		0	0	0	0	0	0	0	0	0.830	93.6	14.6	
Bus6	0.400		0	0	0	0	0	0	0	0	0.189	95.3	273.1	
Bus7	33.000		0	0	0	0	0	0	0	0	0.638	93.1	11.2	
Bus8	0.400		0	0	0	0	0	0	0	0	0.112	94.7	159.7	
Bus9	0.400		0	0	0	0	0	0	0	0	0.200	92.7	289.2	
Bus10	0.400		0.148	0.092	0.037	-0.017	0	0	0	0	0.218	85.0	315.4	
Bus11	0.400		0.205	0.138	0.051	-0.025	0	0	0	0	0.308	83.0	447.2	
Bus12	0.400		0.137	0.085	0.034	-0.019	0	0	0	0	0.201	85.0	290.0	
Bus13	0.400		0.119	0.096	0.031	-0.079	0	0	0	0	0.192	78.0	272.9	
Bus14	33.000		0	0	0	0	0	0	0	0	7.778	94.2	136.8	
Bus15	0.400		0.136	0.092	0.035	-0.017	0	0	0	0	0.206	82.8	293.7	
Bus16	0.400		0.164	0.102	0.042	-0.015	0	0	0	0	0.242	85.0	346.3	
Bus17	0.400		0.261	0.095	0.065	0.024	0	0	0	0	0.347	94.0	500.7	
Bus18	33.000		0	0	0	0	0	0	0	0	7.400	94.3	130.4	
Bus19	33.000		0	0	0	0	0	0	0	0	0.216	99.1	3.8	
Bus20	0.400		0	0	0	0	0	0	0	0	0.138	98.3	197.8	
Bus21	0.400		0.062	0.025	0.016	0.006	0	0	0	0	0.084	93.0	119.8	
Bus22	33.000		0	0	0	0	0	0	0	0	7.195	94.0	126.9	
Bus23	33.000		0	0	0	0	0	0	0	0	0.492	94.2	8.7	
Bus24	0.400		0	0	0	0	0	0	0	0	0.289	94.8	415.2	
Bus25	0.400		0	0	0	0	0	0	0	0	0.190	95.5	269.6	
Bus26	33.000		0	0	0	0	0	0	0	0	6.704	93.9	118.2	
Bus27	0.400		0	0	0	0	0	0	0	0	0.280	91.5	405.4	
Bus28	33.000		0	0	0	0	0	0	0	0	6.406	94.1	113.2	
Bus29	0.400		0.179	0.052	0.046	0.013	0	0	0	0	0.234	96.0	333.3	
Bus30	33.000		0	0	0	0	0	0	0	0	1.109	93.7	19.6	
Bus31	0.400		0.167	0.049	0.043	0.013	0	0	0	0	0.218	96.0	310.2	
Bus32	33.000		0	0	0	0	0	0	0	0	0.887	93.1	15.7	
Bus33	0.400		0.156	0.071	0.040	0.018	0	0	0	0	0.216	91.0	305.7	
Bus34	0.400		0	0	0	0	0	0	0	0	0.312	94.4	450.2	
Bus35	33.000		0	0	0	0	0	0	0	0	0.341	95.2	6.0	
Bus36	0.400		0	0	0	0	0	0	0	0	0.151	99.4	214.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus37	0.400		0	0	0	0	0	0	0	0	0.186	91.7	265.4	
Bus38	33.000		0	0	0	0	0	0	0	0	0.456	95.3	8.1	
Bus39	0.400		0	0	0	0	0	0	0	0	0.262	97.7	374.4	
Bus40	0.400		0	0	0	0	0	0	0	0	0.183	93.3	264.1	
Bus41	33.000		0	0	0	0	0	0	0	0	4.595	93.9	81.4	
Bus42	0.400		0	0	0	0	0	0	0	0	0.374	93.0	532.6	
Bus43	33.000		0	0	0	0	0	0	0	0	0.608	91.6	10.8	
Bus44	0.400		0	0	0	0	0	0	0	0	0.223	92.1	319.5	
Bus45	0.400		0	0	0	0	0	0	0	0	0.363	94.0	514.0	
Bus46	33.000		0	0	0	0	0	0	0	0	3.605	94.4	63.9	
Bus47	0.400		0.127	0.050	0.032	0.013	0	0	0	0	0.171	93.0	246.6	
Bus48	0.400		0	0	0	0	0	0	0	0	0.204	95.0	290.1	
Bus49	33.000		0	0	0	0	0	0	0	0	3.223	94.5	57.1	
Bus50	0.400		0	0	0	0	0	0	0	0	0.342	95.4	494.3	
Bus51	33.000		0	0	0	0	0	0	0	0	2.865	94.6	50.8	
Bus52	0.400		0	0	0	0	0	0	0	0	0.413	96.2	590.1	
Bus53	0.400		0.372	0.135	0.093	0.034	0	0	0	0	0.495	94.0	713.6	
Bus54	0.400		0.261	0.095	0.068	0.025	0	0	0	0	0.350	94.0	495.4	
Bus55	33.000		0	0	0	0	0	0	0	0	1.567	95.6	27.8	
Bus56	0.400		0.102	0.043	0.025	0.011	0	0	0	0	0.138	92.0	199.3	
Bus57	33.000		0	0	0	0	0	0	0	0	0.269	96.9	4.8	
Bus58	0.400		0	0	0	0	0	0	0	0	0.111	94.5	161.0	
Bus59	0.400		0	0	0	0	0	0	0	0	0.154	99.1	219.5	
Bus60	33.000		0	0	0	0	0	0	0	0	0.380	98.5	6.7	
Bus61	0.400		0	0	0	0	0	0	0	0	0.245	100.0	353.1	
Bus62	0.400		0.102	0.043	0.025	0.011	0	0	0	0	0.138	92.0	199.3	
Bus63	33.000		0	0	0	0	0	0	0	0	0.785	93.8	13.9	
Bus64	0.400		0	0	0	0	0	0	0	0	0.349	94.2	494.1	
Bus65	0.400		0	0	0	0	0	0	0	0	0.151	99.3	214.6	
Bus66	0.400		0	0	0	0	0	0	0	0	0.266	92.5	378.7	
Bus67	0.400		0.261	0.162	0.065	-0.059	0	0	0	0	0.384	85.0	554.8	
Bus68	33.000		0	0	0	0	0	0	0	0	0.436	93.2	7.7	
Bus69	0.400		0.084	0.061	0.021	-0.025	0	0	0	0	0.130	81.0	187.9	
Bus70	0.400		0	0	0	0	0	0	0	0	0.311	94.5	446.1	
Bus71	33.000		0	0	0	0	0	0	0	0	0.205	91.6	3.6	
Bus72	33.000		0	0	0	0	0	0	0	0	7.849	94.2	137.9	
Bus73	33.000		0	0	0	0	0	0	0	0	0.066	95.7	1.2	
Bus74	0.400		0.122	0.082	0.031	-0.061	0	0	0	0	0.184	83.0	262.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus75	0.400		0.050	0.015	0.012	0.004	0	0	0	0	0.065	96.0	95.0	
Bus76	33.000		0	0	0	0	0	0	0	0	0.084	92.6	1.5	
Bus77	33.000		0	0	0	0	0	0	0	0	0.300	93.3	5.3	
Bus78	33.000		0	0	0	0	0	0	0	0	0.269	96.6	4.8	
Bus79	33.000		0	0	0	0	0	0	0	0	0.139	91.5	2.5	
Bus80	33.000		0	0	0	0	0	0	0	0	0.363	92.3	6.4	
Bus81	0.400		0.119	0.096	0.031	-0.078	0	0	0	0	0.192	78.0	273.3	
Bus82	0.400		0.196	0.162	0.050	-0.061	0	0	0	0	0.320	77.0	454.9	
Bus83	0.400		0.196	0.162	0.049	-0.160	0	0	0	0	0.318	77.0	458.6	
Bus84	0.400		0.144	0.078	0.036	-0.021	0	0	0	0	0.205	88.0	295.8	
Bus85	0.400		0.235	0.114	0.060	-0.012	0	0	0	0	0.327	90.0	468.4	
Bus86	0.400		0.108	0.052	0.027	-0.027	0	0	0	0	0.150	90.0	216.1	
Bus87	0.400		0.144	0.078	0.038	-0.021	0	0	0	0	0.207	88.0	292.5	
Bus88	0.400		0.219	0.106	0.055	-0.014	0	0	0	0	0.305	90.0	437.2	
Bus89	0.400		0.204	0.126	0.052	-0.070	0	0	0	0	0.301	85.0	430.1	
Bus90	0.400		0.235	0.114	0.059	-0.011	0	0	0	0	0.327	90.0	472.3	
Bus91	0.400		0.277	0.142	0.071	-0.005	0	0	0	0	0.391	89.0	556.7	
Bus92	0.400		0.154	0.083	0.040	-0.020	0	0	0	0	0.220	88.0	313.3	
Bus93	0.400		0.317	0.171	0.081	-0.059	0	0	0	0	0.452	88.0	645.3	
Bus94	0.400		0.261	0.126	0.068	-0.009	0	0	0	0	0.365	90.0	516.9	
Bus95	0.400		0.271	0.131	0.070	-0.007	0	0	0	0	0.379	90.0	536.9	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
Cable1	Cable	344.84	1.49	0.43					
T 1	Transformer				400.000	0.221	0.1	0.216	0.1
T 2	Transformer				0.400	0.193	48.3	0.189	47.3
T 3	Transformer				0.400	0.113	28.2	0.112	27.9
T 4	Transformer				0.400	0.205	51.2	0.200	49.9
T 5	Transformer				0.400	0.323	80.8	0.311	77.9
T 6.	Transformer				0.400	0.066	16.4	0.065	16.3
T 7	Transformer				0.400	0.362	90.6	0.347	86.8
T 8	Transformer				0.400	0.139	34.8	0.138	34.4
T 9	Transformer				0.400	0.084	21.1	0.084	20.9
T 10	Transformer				0.400	0.195	48.6	0.190	47.6
T 11	Transformer				0.400	0.300	74.9	0.289	72.3
T 12	Transformer				0.630	0.286	45.3	0.280	44.4
T 13	Transformer				0.400	0.240	60.1	0.234	58.6
T 14	Transformer				0.250	0.190	76.0	0.183	73.3
T 15	Transformer				0.400	0.269	67.3	0.262	65.6
T16	Transformer				0.400	0.223	55.9	0.218	54.6
T 17	Transformer				0.250	0.225	90.2	0.216	86.2
T 18	Transformer				0.400	0.324	80.9	0.312	77.9
T 19	Transformer				0.250	0.154	61.6	0.151	60.4
T 20	Transformer				0.400	0.191	47.7	0.186	46.5
T 21	Transformer				0.630	0.384	60.9	0.374	59.4
T 22	Transformer				0.400	0.230	57.4	0.223	55.8
T 23	Transformer				0.400	0.379	94.7	0.363	90.7
T 24	Transformer				0.400	0.209	52.2	0.204	51.0
T 25	Transformer				0.630	0.173	27.5	0.171	27.2
T 26	Transformer				0.400	0.355	88.8	0.342	85.5
T 27	Transformer				0.400	0.365	91.1	0.350	87.4
T 28	Transformer				0.630	0.513	81.4	0.495	78.6
T29	Transformer				0.630	0.424	67.3	0.413	65.6
T 30	Transformer				0.630	0.139	22.1	0.138	21.9
T 31	Transformer				0.400	0.113	28.2	0.111	27.8
T 32	Transformer				0.250	0.157	63.0	0.154	61.6

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
T 33	Transformer				0.630	0.272	43.1	0.266	42.3
T 34	Transformer				0.250	0.154	61.6	0.151	60.3
T 35	Transformer				0.400	0.363	90.8	0.349	87.2
T 36	Transformer				630.000	0.247	0.0	0.245	0.0
T 37	Transformer				0.630	0.139	22.1	0.138	21.9

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line1	8.412	2.997	-8.394	-2.988	17.7	8.1	100.0	99.8	0.23
Line2	0.777	0.289	-0.777	-0.293	0.5	-3.4	99.8	99.7	0.07
Line4	7.407	2.630	-7.396	-2.626	10.7	4.2	99.8	99.6	0.16
T 1	0.210	0.069	-0.207	-0.060	2.7	8.5	99.8	99.9	0.12
Line3	0.594	0.229	-0.594	-0.232	0.3	-3.5	99.7	99.7	0.05
T 2	0.183	0.064	-0.180	-0.057	2.1	6.5	99.7	100.1	0.35
Line27	0.407	0.156	-0.407	-0.158	0.1	-2.1	99.7	99.6	0.02
Line28	0.187	0.076	-0.187	-0.082	0.1	-6.0	99.7	99.6	0.03
T 3	-0.106	-0.036	0.106	0.038	0.7	2.2	100.8	99.6	1.22
T 4	-0.185	-0.075	0.187	0.082	2.4	7.3	99.6	99.6	0.00
Line6	-7.326	-2.612	7.333	2.615	7.6	3.0	99.5	99.6	0.11
Line8	6.992	2.471	-6.977	-2.466	14.6	5.2	99.5	99.3	0.23
T 7	0.334	0.141	-0.326	-0.118	7.4	22.9	99.5	100.1	0.58
Line9	0.215	0.005	-0.215	-0.006	0.0	-1.3	99.3	99.3	0.01
Line10	6.763	2.461	-6.761	-2.460	1.8	0.6	99.3	99.2	0.03
Cable1	0.078	-0.023	-0.078	-0.032	0.0	-54.7	99.3	99.3	0.00
T 8	0.136	0.029	-0.135	-0.025	1.2	3.6	99.3	100.3	1.09
T 9	-0.078	-0.031	0.078	0.032	0.4	1.2	100.7	99.3	1.47
Line11	0.464	0.158	-0.463	-0.164	0.2	-6.0	99.2	99.2	0.04
Line12	6.298	2.302	-6.297	-2.302	1.0	0.3	99.2	99.2	0.02
Line30	0.279	0.101	-0.279	-0.108	0.1	-6.9	99.2	99.2	0.02
T 10	0.184	0.063	-0.182	-0.057	2.1	6.6	99.2	102.0	2.76
T 11	-0.274	-0.092	0.279	0.108	5.1	15.7	100.6	99.2	1.43
Line13	6.038	2.180	-6.024	-2.177	13.8	3.4	99.2	99.0	0.25
T 12	0.258	0.122	-0.256	-0.113	2.3	9.2	99.2	99.6	0.36
Line14	1.039	0.383	-1.039	-0.388	0.6	-4.3	99.0	98.9	0.06
Line17	0.435	0.135	-0.435	-0.139	0.2	-4.2	99.0	98.9	0.04
Line18	4.322	1.583	-4.314	-1.583	8.2	0.3	99.0	98.8	0.19
T 13	0.228	0.075	-0.225	-0.066	3.1	9.7	99.0	101.5	2.54
Line15	0.826	0.318	-0.826	-0.324	0.6	-6.2	98.9	98.8	0.07
T16	0.212	0.069	-0.210	-0.061	2.7	8.4	98.9	101.6	2.72
Line16	0.325	0.100	-0.325	-0.104	0.1	-4.1	98.8	98.8	0.03
T 17	0.201	0.103	-0.196	-0.089	4.4	13.6	98.8	101.7	2.92
T 18	0.300	0.121	-0.294	-0.103	6.0	18.5	98.8	99.9	1.06
T 19	0.152	0.024	-0.150	-0.017	2.2	6.7	98.8	101.7	2.89

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
T 20	0.173	0.081	-0.171	-0.074	2.1	6.4	98.8	101.3	2.47
Line31	0.260	0.063	-0.260	-0.069	0.1	-6.4	98.9	98.9	0.02
T 14	0.174	0.076	-0.171	-0.066	3.3	10.2	98.9	100.1	1.16
T 15	-0.256	-0.056	0.260	0.069	4.1	12.8	101.1	98.9	2.23
Line19	0.557	0.243	-0.557	-0.244	0.1	-0.7	98.8	98.8	0.01
Line20	3.405	1.187	-3.404	-1.188	0.6	-0.4	98.8	98.8	0.02
T 21	0.352	0.152	-0.348	-0.137	3.8	15.2	98.8	101.4	2.66
T 22	0.208	0.096	-0.205	-0.087	3.0	9.3	98.8	100.8	1.99
T 23	0.349	0.148	-0.341	-0.124	7.8	24.1	98.8	101.8	3.08
Line21	3.048	1.051	-3.046	-1.051	1.7	-0.3	98.8	98.7	0.05
T 24	0.196	0.071	-0.194	-0.063	2.4	7.3	98.8	101.5	2.77
T 25	0.160	0.066	-0.159	-0.063	0.8	3.3	98.8	100.1	1.37
Line22	2.713	0.928	-2.711	-0.928	2.6	-0.7	98.7	98.6	0.09
T 26	0.333	0.124	-0.326	-0.102	6.9	21.2	98.7	99.9	1.15
Line23	1.499	0.457	-1.499	-0.457	0.2	-0.6	98.6	98.6	0.01
T 27	0.336	0.142	-0.329	-0.119	7.2	22.4	98.6	101.8	3.24
T 28	0.473	0.198	-0.466	-0.169	7.2	28.7	98.6	100.2	1.59
T29	0.403	0.132	-0.398	-0.112	4.9	19.6	98.6	101.1	2.50
Line24	0.261	0.065	-0.261	-0.066	0.0	-1.2	98.6	98.6	0.01
Line25	0.374	0.064	-0.374	-0.065	0.0	-0.9	98.6	98.6	0.01
Line26	0.736	0.272	-0.736	-0.273	0.1	-0.7	98.6	98.6	0.01
T 30	0.128	0.056	-0.127	-0.054	0.6	2.3	98.6	99.9	1.34
T 31	0.106	0.039	-0.105	-0.036	0.7	2.3	98.6	99.8	1.17
T 32	0.155	0.028	-0.153	-0.020	2.3	7.0	98.6	101.3	2.74
Line32	0.128	0.055	-0.128	-0.056	0.0	-1.2	98.6	98.6	0.00
T 36	0.247	0.010	-0.245	-0.002	1.9	7.4	98.6	100.2	1.57
T 37	-0.127	-0.054	0.128	0.056	0.6	2.3	99.9	98.6	1.33
Line33	0.335	0.139	-0.335	-0.140	0.0	-0.6	98.6	98.6	0.00
T 33	0.248	0.110	-0.246	-0.101	2.1	8.5	98.6	101.5	2.92
T 34	0.152	0.024	-0.150	-0.017	2.2	6.7	98.6	101.4	2.87
T 35	-0.328	-0.117	0.335	0.140	7.2	22.3	101.8	98.6	3.27
T 5	0.300	0.120	-0.294	-0.102	5.9	18.2	99.6	100.8	1.15
Line29	0.063	0.011	-0.063	-0.019	0.0	-8.1	99.6	99.6	0.01
T 6.	0.063	0.019	-0.063	-0.018	0.2	0.7	99.6	98.9	0.68
					205.7	299.4			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	8.412	2.997	8.930	94.20 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	8.412	2.997	8.930	94.20 Lagging
Total Motor Load:	6.544	3.431	7.389	88.56 Lagging
Total Static Load:	1.662	-0.734	1.817	91.47 Leading
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.206	0.299		
System Mismatch:	0.000	0.000		

Number of Iterations: 3