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Diesel-Driven Emergency Generation Units For Saudi village in Rafah City-Gaza Strip

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إقـــــرار

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Diesel-Driven Emergency Generation Units For Saudi village in Rafah City-Gaza Strip

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The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ بلال دياب مصطفى ضميده لنيل درجة الماجستير في كلية *الهندسة* قسم الهندسة الكهربائية – أنظمة التحكم وموضوعها:

تشغيل مولدات الديزل في حالة الطوارئ للحي السعودي في رفح – قطاع غزة

Diesel-Engine-Driven Emergency Generation Units For Saudi Village in Rafah city- Gaza Strip

وبعد المناقشة العلنية التي تمت اليوم الاثنين 20 جماد الأولى 1437هـ، الموافق 2016/02/29م الساعة الحادية عشرة صباحاً بمبنى القدس، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في كلية *الهندسة*/ قسم الهندسة الكهربائية – أنظمة التحكم.

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق،،،

نائب الرئيس لشئون البحث العلمي والدراسات العليا

أ.د. عبدالرؤوف علي المناعمة

صفحة الحكم

DEDICATION

To my parents, my brothers, my sisters, and my wife, who have been a constant source of motivation, inspiration, and support.

ACKNOWLEDGEMENT

I thank Allah, the Lord of the worlds, for His mercy and limitless help and guidance. May peace and blessings be upon Mohammed the last of the messengers.

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There are no words that can describe how grateful I am to my family specially my wife for her support and encouragement through the years. My deepest thanks go to my brothers and my sisters for their patience and understanding during my busy schedule.

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ABSTRACT

Citizens in the Gaza Strip use small power generation units (3-5KVA) through Gaza Strip streets and markets. You can see many of these units are running on the street with much noise and pollution. This problem increases the suffering of the people in Gaza Strip. In addition to that these units consume large amounts of fuel and more cost on consumers, which cause shortage for cars and transportation from gasoline and diesel, also becoming liability on the people and government to provide fuel to run these units.

This thesis proposes a solution to this problem by using a distributed larger generation units so that these units are connected in a power network. The operation and shutdown of these are based on the local demand for electricity.

This scheme is applied to the Saudi village in the Rafah city. The number of required operating units are computed based on the average demand on power. So that these units operate when the power shortage is on the same electrical grid. A control scheme is proposed for these units for setting up a mechanism to provide these units with fuel.

ETAP software is used for implementation of the project, it is providing the value of load flow analysis, also it is used to calculate the voltage drop and branch losses in cables. We can also obtain a detailed report about the electric grid in the Saudi Neighborhood. The international electrotechnical commission (IEC) standard is used as a reference.

Finally, feasibility studies for the various loading conditions are provided. The study has shown that the payback period varies between 4-5 years at a price of NIS 1.5/kWh and about 1 year at a price of NIS 2/kWh.

CHAPTER 1
INTRODUCTION

1.1 Background

The electric power is an essential foundation for social and economic development in any society. It is the main source of the driving forces in industrial, agricultural residential and business facilities in villages and cities. Providing stable and continuous service to wide range in order to use electricity in industry, commerce, agriculture, residents and public utilities. It is essential to ensure that the electricity is provided to these places with high quality at the lowest possible losses in balancing the load throwing three phases.

Gaza Strip is one of highest overpopulated regions in the world; there are 1.8 million people in 360 km^2. In addition, it is considered one of the poorest regions in the world of stable electricity [1]. Power networks in Gaza Strip have complex systems that cannot be efficiently and securely operated without any management of energy system [2]. As a result of several years in Israeli siege of the Palestinian Territories, the Palestinian economy suffers from major distortions and underdevelopment. During the Israeli siege, infrastructures of the Gaza Strip are largely destroyed.

Electricity sector in the Palestinian land shows a high vulnerability to political instability. The influence of the conflict on the electricity sector goes beyond direct destruction [3].

It results in a modification of electricity consumption, a deceleration in the growth rate, and the retardation of a "healthy" recovery. Also, the lack of investment, public expenditure, high prices, and high transmission losses and constituting fundamental problems for the electricity sector. The quality of the electrical services is inadequate and below standard [4].

The electrical network in Gaza is considered as radial [2]. A radial network leaves the station and passes through the network area with no normal connection to any other supply. This is typical of long rural lines with isolated load areas. An interconnecting network is generally found in more urban areas, it will have multiple connections to other points of supply. These points of connection are normally open, but they allow various configurations by the operating utility with closing and opening switches. Operation of these switches may be by remote control from a control center or by a lineman. The benefit of the interconnected model is in the event of a fault or required maintenance as a small area of network which can be isolated and the remainder keep on supply [5].

The main sources of electricity in Gaza are: Gaza Power Station, the Israeli Electricity Company, and the limited power line that comes from Egypt, which feeds the southern part of Gaza Strip [6, 7].

1.2 Problem Statement

The Saudi village suffers from the power crisis just like any other area in the Gaza Strip. The power cut-offs take place in the Saudi village on a daily basis. Sometimes at night and sometimes during the day. This causes a suffering of the residents who reside in the village. For this reason, the people have resorted the use of alternative methods as a solution to this problem, such as using small-sized generators and candles.
A proposed system in how to operate diesel generation units to cover the loads to Saudi village during electricity cut-offs. These units are supposed to be connected to the same electrical grid. Preparing a feasibility study of this project is to be presented.

1.3 Motivation

The work of this thesis is to overcome or mitigate the crisis of power outages. It experiences on a daily basis. It works to reduce air pollution and noise which results from the proliferation of small-sized diesel generators and capacitance scattered in the streets and buildings. This causes a lot of fires in homes, which results injuries and deaths, as this project will provide job opportunities.

This project applies to the Saudi village in Rafah city as a model that can be applied to the rest of the region.

1.4 Methodology

1. Field Visits: Visits include the Power and Natural Resources Authority, the Electricity Distribution Company, and the Gaza power Generation Plant. The purpose of these visits are to collect the necessary data from expert engineers such as the electric power problems, the current methods of connecting and disconnecting power, energy quality that reaches to the consumer, etc.

2. Analyze and classify these problems by putting clear description for the most important ones, who use the collected data.

3. Identify similar systems in other countries; also identify their problems and how they are solved.

4. Choose the best way to an electricity generation network in Saudi village.

5. Develop model simulates with distribution of network to test and evaluate the System.

6. Test the developed model and collect the results and feedbacks.

1.5 Literature Review

chirl Park, (1999), proposed models of small turbine generators (i.e. a combustion turbine, a diesel engine, etc), that were used for dynamic distributed generation. Also, he proposed the detailed synchronous machine and the excitation system model were obtained for the standard simulation. The simulation was performed with an infinite bus system model. The synchronous machine was connected with a local load in order to develop the terminal voltage and avoiding the differentiation.

Hermann, (2006), proposed designing a micro-hydro powered battery charging system for rural village electrification. The other investigated and explored the possibilities of battery charging by using small hydropower resources in rural areas with respect to its economical and technical feasibility.

Nayar, Tang and Suponthana (2008), proposed an innovative wind/PV/diesel hybrid system implemented in three remote islands in the Republic of Maldives. The newly developed and installed system can provide very good opportunities to showcase high penetration of renewable energies, also using state of the art wind turbines, photovoltaic modules, advanced power electronics, control technology and the future possibilities of distributed generation in remote locations.

Bustami, (2008), proposed an optimum design and performance analysis of a proposed Palestinian electrical network, where he outlined an integrated electrical network with standard voltages, low power losses, high quality electrical energy, high reliability, source diversity, good voltage level, and low transmission cost. Its integrated model allowed for future connection to the seven Arab country grids, and eventually supplied end users with low cost electrical energy, however, his proposal did not present any approach to monitoring or controlling the network.

Abu Meteir, (2012), proposed designing a Supervisory Control and Data Acquisition (SCADA System) for the management of the electricity network in the Gaza Strip. He expected from this system work to transfer all the data necessary for the system operator, and provide specialists with the necessary information about the network and transformer substations in the sub-regions such as voltage, current and productive capacity in order to reduce losses on the network to help develop plans to manage power distribution in a fair.

1.6 Thesis Structure

The thesis is organized into 6 chapters. Firstly, **chapter 1** begins with an introduction describing the topic to readers. **Chapter 2** covers the Electricity network in the Gaza Strip and the electricity crisis which are found in the Strip. **Chapter 3** covers the electric grid in the Saudi village. **Chapter 4 Presents** proposal for resolving the crisis in Saudi village using diesel generators and the costs of these solutions. **Chapter 5** proposes a feasibility study of the proposed solutions. Finally, **Chapter 6** concludes this study and proposes future work and recommendations.

Chapter 2
ELECTRIC ENERGY IN GAZA STRIP

2.1 Background

The Gaza strip is located at the south-west area of Palestine as shown in Fig. (2.1). It expands along the Mediterranean Sea with 40 km long and between 6 and 12 km wide. The total area of the Gaza strip is estimated at 360 km^2. Its height above sea level reach 50 m in some locations. It is located on Longitude 34^o 26' east and Latitude 31^o 10' north [8, 9].

Gaza Strip has come to be known as the fast growing area of the Middle East in terms of population in recent years. It began with a manageable population of 1.2 million in 2002, which reached 1.7 million in 2012. Gaza Strip’s population is expected to grow at a rate of 4.2% annually and will reach a total of 2.13 million in 2020 [10].

Energy is vital for all living-beings on earth. Modern life-style has further increases its importance, since a faster life means faster transportation, faster communication and faster manufacturing processes. All these lead to an increase in energy demand that is required for all those modern systems [9].

The Gaza strip population of 1.7 million Palestinians residents must cope with scheduled electricity cuts 8 hours on daily basis due to the increment in annual demand growth Statistic for energy consumption revealed that the electrical energy consumption per person is the lowest indicator in the region and is estimated at 583kWh as the electrical consumption rose by 28% in Gaza Strip and West bank during the period 2003-2009 [11, 12, 13].

The Palestinian electricity sector suffers from many electrical problems such as high electrical deficit rate, transmission losses, and absent energy management strategies. Energy efficiency improvement is an important way to reduce electrical deficit with various opportunities available in a cost-effective manner [14].

Other problems in the Gaza Strip electric power sector include high system losses, delays in completion of new plants, low plant efficiencies, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance [15].

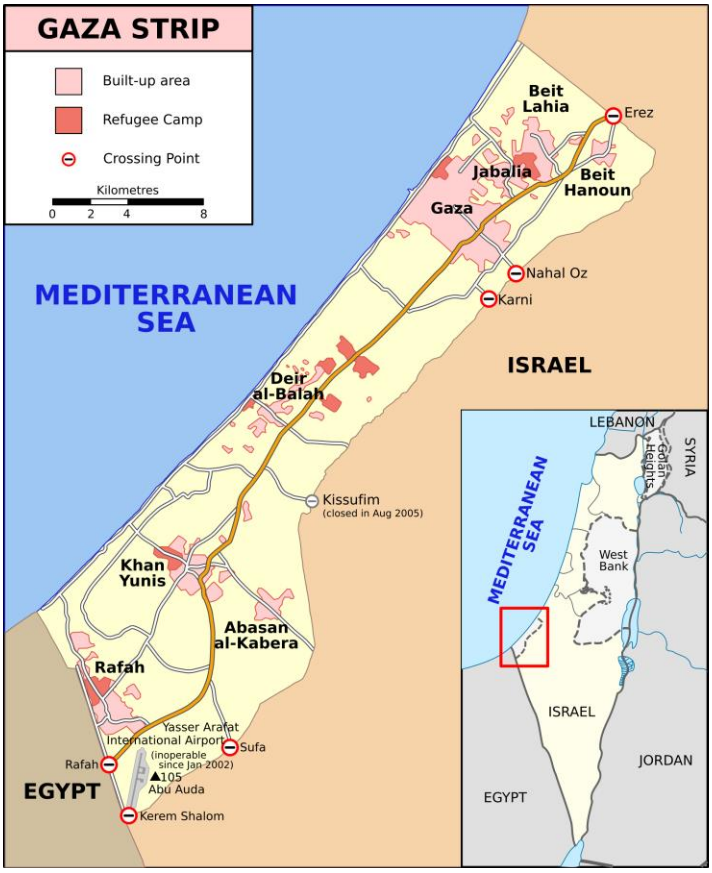

Figure 2.1: The Gaza Strip map [16]

2.2 Electricity in Gaza strip

There are multiple sources of electric energy that provide Gaza with electricity. The need of the Gaza Strip's electricity is currently between 350 and 450 MW which is expected to raise up to 600 MW in case of lifting the Israeli siege.
There are three primary sources as shown in Fig. (2.2):

1- The Israeli electricity company, which supplies 120 MW via ten electric lines [17]. Divided as follows:

- Gaza City: Dome line, Baghdad line, Sha'af line, and the sea line (Shared between Gaza City and the north area).
- North area: Jabalya line and Beit Lahiya line.
- Central area: Line K7 and line 11 (shared between the Central area and Khan Younis).
- Khan Younis: Line 8.
- Rafah: Line 9 (joint between Khan Younis and Rafah) [18, 21].

2- The power station in Gaza and its theoretical capacity is to produce 140 MW though its actual average of production is only 80 MW due to the generators transformers have been destroyed in 2006 as a result of the Zionist shelling, also its dependency on the amount of fuel is available for the production of electricity.

3- The Egyptian electricity grid that supplies Gaza with around 27 MW through two main electric lines.

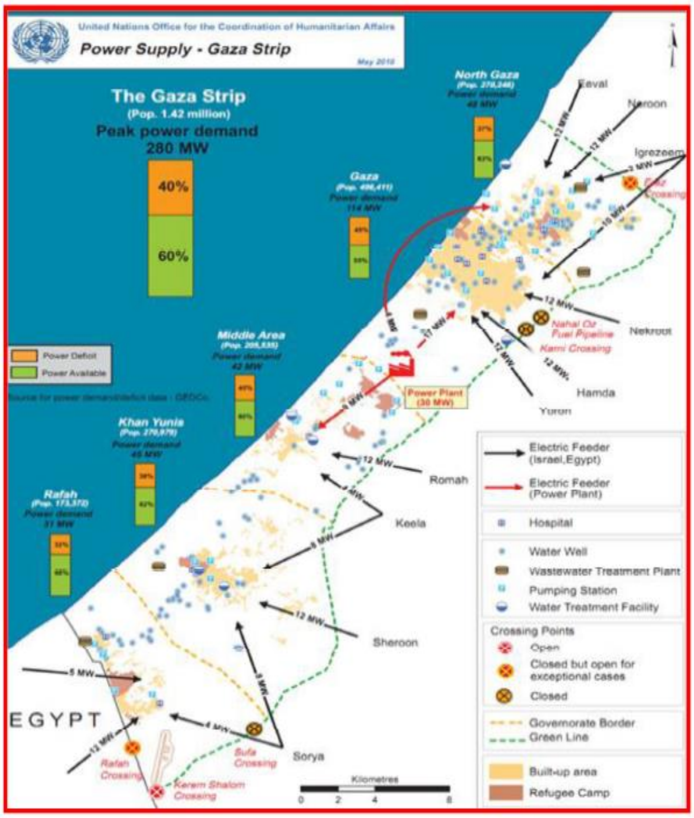

Figure 2.2: Electrical power supply for Gaza Strip in 2010[9]

This means that the total electricity quantity available from the three sources is about 227 MW with a seasonal variation of the electricity needs of Gaza that reach its peak to 440 MW in summer and winter. Accordingly, this shows large deficit up to more than 150 MW, representing 35 % to 40% of the total needs of electricity, which is largely influenced by the change in the supply and demand causing a power failure. [17].

The demand for electricity is growing at a rate of 7% per year without any well designed plan to meet the demand. The main problem of energy in the Gaza Strip is that it has almost no conventional energy sources. This problem becomes worse by the high density pollution of the Gaza strip and the difficult political status which are caused by (Israel) occupation [9].

2.3 Generation Plant in Gaza Strip

In 2003, with generation plant with a nominal power of 120 MW and a capacity that can reach 140 MW, Gaza Strip was set for the next five years. The Western power substation was destroyed by Israel on 28/6/2006 which led to the destruction of transformers up number 4 with voltage rate 220 / 11KV and transformers down with voltage rate 220 / 22KV number 2 where the power plant completely stopped working and the Gaza Strip suffers from a large deficit in the electric power. The value of the damage caused totaled about $ 6 million. The power station needs to the amount of 650 thousand liters of industrial diesel daily to operate at full capacity (120 MW).

It was planned that the station was expand at several stages to reach production capacity of 570 megawatts, but the Israeli aggression and the siege has prevented the implementation of this expansion so far.[18]
Due to the siege on Gaza Strip imposed by Israel, Gaza Power Generation Company is unable to expand its facilities and generate more power. Reducing losses on the transmission and distribution networks requires major investments, while efficiency and management programs requires much less investment with individual paybacks [14].

2.4 Electrical energy price in Gaza Strip

Electrical prices typically are very high compared to international prices; this is considered one of the main problems for the Palestinian energy sector. Currently, a new electricity tariff structure was approved and implemented in Aug 2011 by GEDCO (Gaza Energy Distribution Company) and became with average rate 0.5 NIS for household prices and 0.592 NIS for other sectors [19]. The fact that electricity production is monopolized by the IEC with the power to impose high prices. The price of energy differs between regions due to the full control of Israeli Authority on energy sources for the Palestinian Territory [20]. Most utilities offer industrial customers a lower price per kWh as consumption increases but in Gaza, a higher price per kWh as consumption. This situation is abnormal and differs from international regulations. This is in particular to encourage less consumption during the peak period of the power system.

2.5 The power crisis in the Gaza Strip

For many years to now, Gaza Strip has been suffering from a chronic crisis in the electricity sector. This crisis is connected with a variety of crises which its intensity varies according to the changing circumstances and contexts that affect them. The continuation of the electricity crisis has actual impacted on large sectors of the Gaza Strip. About 75% of the total available electricity is used for domestic purposes, while the remaining percentage is for the rest of the activities, including industrial productivity and other economic aspects. Most factories and industrial companies have stopped working either completely or partially due to the continued power outages. In addition, the services in the field of health and education sectors have been badly affected through the negative impact on the work of the equipment and facilities that operate on electricity and the inability of students which pursue their studies, don't forget to mention risks arising from the use of alternative means such as candles, which have caused many disasters, fires and injuries [17].

Due to the electricity crisis and insufficient electricity to the needs of Gaza Strip is the sense of "electricity shortfall" terrible. This deficit, which is exacerbated and growing every year with the increasing of natural annual loads and the stability of the sources unchanged. But the decline in the truth now is less than the past. Whereas the needs of the sector in 2005 do not exceed 214 MW.
While the combined sources of electricity in the Gaza Strip (from Egypt and the occupation and the station) isn't more than 227 MW the best conditions. This means that we are suffering from a constant deficit of electricity up to 45% even with the station work at full capacity [18].

As for other details of the crisis of non-payment of bills or lack of fuel for the power station or the imposition of tax. etc., all of them sub-details increase the severity of the crisis and are not the crisis itself, and any procedures or administrative improvements or financial in the file management or provide fuel or bring grants to operate the plant For it only move us in the area of reducing the deficit even no more than 45% (which is part expressed as "variable deficit" in the illustration and value of 22% is the ratio of the station) work.. This preface is necessary and important to understand this complex file and interlaced, and lest fancy one that the solution to the electricity crisis is generating its own station, or in paying bills alone, or in free fuel saving alone, but it must be with all of that to provide additional electricity sources, such as any country in the world to keep up with increasing terrible consumption year after year, strategy which is not based on this rule (additional sources of electricity) is throwing dust in the eyes and isn't put the wheel on the road as a radical solution to the crisis is compounded each year and does not end.[18]

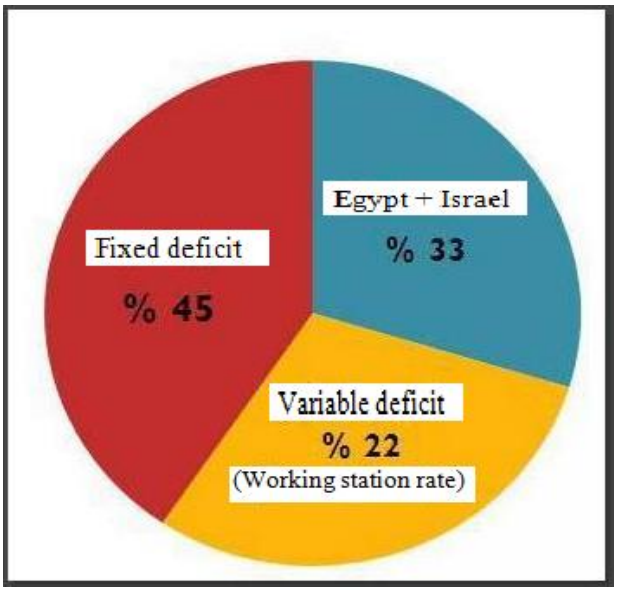

Figure 2.3: Electrical deficit for Gaza Strip [18]

Chapter 3
STUDY MODEL

3.1 Background

Saudi village is located in the Rafah in the Gaza Strip within the land is vacated by the Israeli occupation of the Gaza Strip in 2005[22]. This project aimed to provide homes for the families which the Israeli occupation destroyed their homes in Rafah in 2003 and 2004 to alleviate the suffering of the Palestinian refugees. This project was established in accordance with the latest international schemes were set up roads and streets on modern style. The project provided facilities, educational institutions, market and Yards green [23].

Saudi Village consists of 8 electrical transformers that convert the voltage of 22 KV to 0.4 KV. The capacity of these electrical transformers is either 1250 KVA or 1600 KVA. Each transform connects to a set of the Sub Distribution Board (S.D.B) via underground cable 3×240 mm^2 + 1×120 mm^2 Aluminum. Each underground cable is connected to a set of L.V Metering Panel (M.P) via underground cable 4×150 mm^2 Aluminum, the houses subscription from electricity network from L.V Metering Panel (M.P) via L.V. Cable 2×10 mm^2 Cupper.
The village contains 1790 housing units. Each unit consumes about 7 A (1.2 KWh) per hour. The Saudi village contains about 6 schools, the consumption rate for each school (7.04 KWh) per hour, a Masjid contains the water well with consumption rate of electricity (21.12 KWh) per hour, a cultural center and kindergarten with consumption rate of electricity is (21.12 KWh) per hour, a health center with consumption rate of electricity is (111.2 KWh) per hour, and commercial center with consumption rate of electricity is (31.68 KWh), as shown in Table (3.1).
Next to each electrical transformer the Board controls the street lighting, used two types of electrical cables in street lighting, underground 5×16 mm^2 and underground 3×35 mm^2 +16 mm^2 and different capacity lamp, which lights between 250 W and 400 W and it is installed on the lighting poles in length vary from 4 m, 8m, 10m and 12 m depending on the nature Location, the consumption rate of electricity is (60 KWh) per hour as shown in Fig. (3.1).

Table 3.1: Consumption in Saudi Village in Hour

Sector	Units	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
		A	KVA		
housing unit	1790	7	1.5	1.2	2148
School	6	40	8.8	7.04	42.24
Masjid	1	120	26.4	21.12	21.12
cultural center and kindergarten	1	120	26.4	21.12	21.12
health center	1	630	139	111.2	111.2
commercial center	1	180	39.6	31.68	31.68
Street Lighting	-	341	75	60	60
Total	1800	1438	316.7	253.36	2435.36

3.2 ETAP Software

ETAP is software designed to help electrical engineers in the processes of designing, simulating, operating and optimizing power systems. The software allows you to perform load flow analysis, short-circuit analysis, motor acceleration analysis, harmonic analysis and transient stability analysis. The software is made up of several modules that users can choose from at purchase.

ETAP offers a large array of tools for power system design. The designed project can be studied by performing load flow analysis, short-circuit analysis, motor acceleration analysis, harmonic analysis, transient stability analysis and others. Control system diagrams can be created. Cable pulling force can be predicted and graphical underground raceway systems are provided, among others. Users can create and edit one-line diagrams, 3D cable systems, plots, 3D ground grid systems and the list can go on. The program is meant to combine electrical, mechanical, logical and physical attributes that describe system elements. Mastering the utility does not require special computer skills.

ETAP is a complex utility that can support engineers in monitoring power, managing energy, optimizing a system or automating certain processes [24]. This software is utilized for simulation in this thesis.

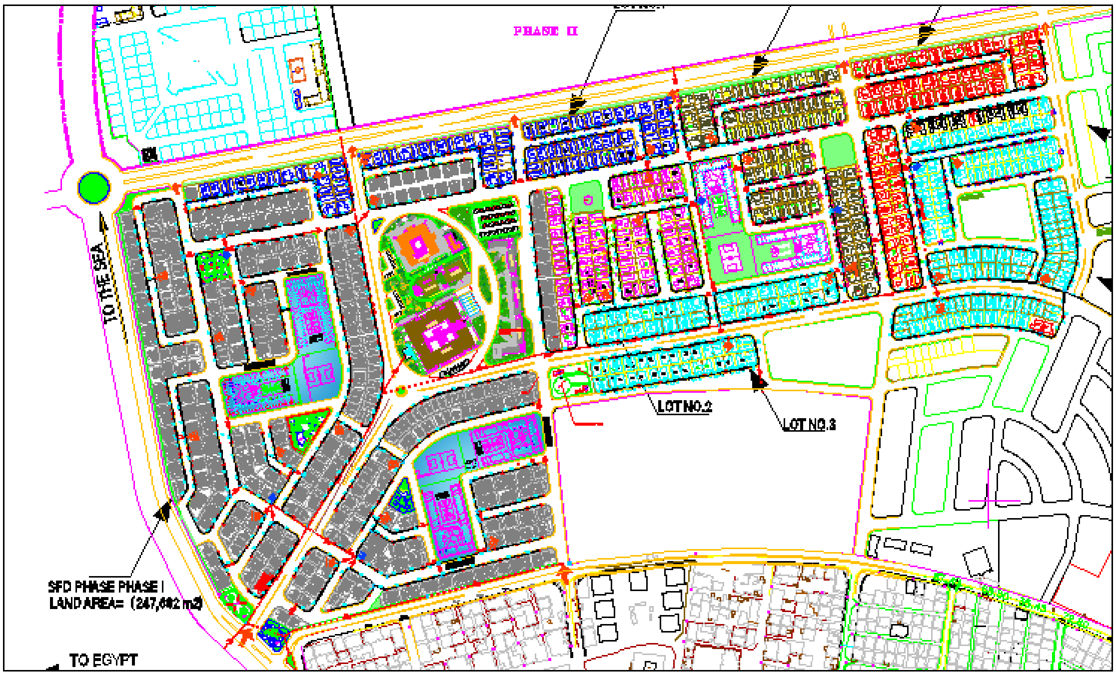

Figure 3.1: The Saudi village in Auto CAD program

3.3 Simulation in ETAP

In this section, we used ETAP software to simulate the electric grid in Saudi village. We have data entry as eight electrical transformers, electrical cables, buildings and other facilities, such as Continuous Maximum Rating (C.M.R), Cooling method (ONAN), Normal Voltage Between Phases (22/.4 KVA), Connection and Vector Group (delta to star), Cross Section for cables, Material, Insulation to cables, Maximum DC Resistance of Conductor, average electric demand to load in Ampere units, power factors 0.8 PF, frequency 50 HZ, voltage 220 V and other data.
We obtained these values from the catalogs which are taken from the electricity company in Gaza Strip.

The ETAP software provides the value of load flow analysis such as KW, Kvar, KVA, Amp and %PF of sources, loads , each Sub distribution board S.D.B. and each metering panel M.P. Also it calculates the voltage drop and branch losses in cables. We can also obtain a detailed report about the electric grid in the Saudi Neighborhood. The international electrotechnical commission (IEC) standard is used as the reference.
The capacity of the electrical transformers used are either 1250 KVA or 1600 KVA, where each transform is connected to a set of Sub Distribution Board (S.D.B), The S.D.B is connected to a set of L.V Metering Panel (M.P).

3.3.1 First Transform (T1)

The first transform (T1) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T1 includes 4 Sub Distribution Board (S.D.B) named (T1A, T1B, T1C, T1D) and two lighting cables as shown in Fig. (3.2).

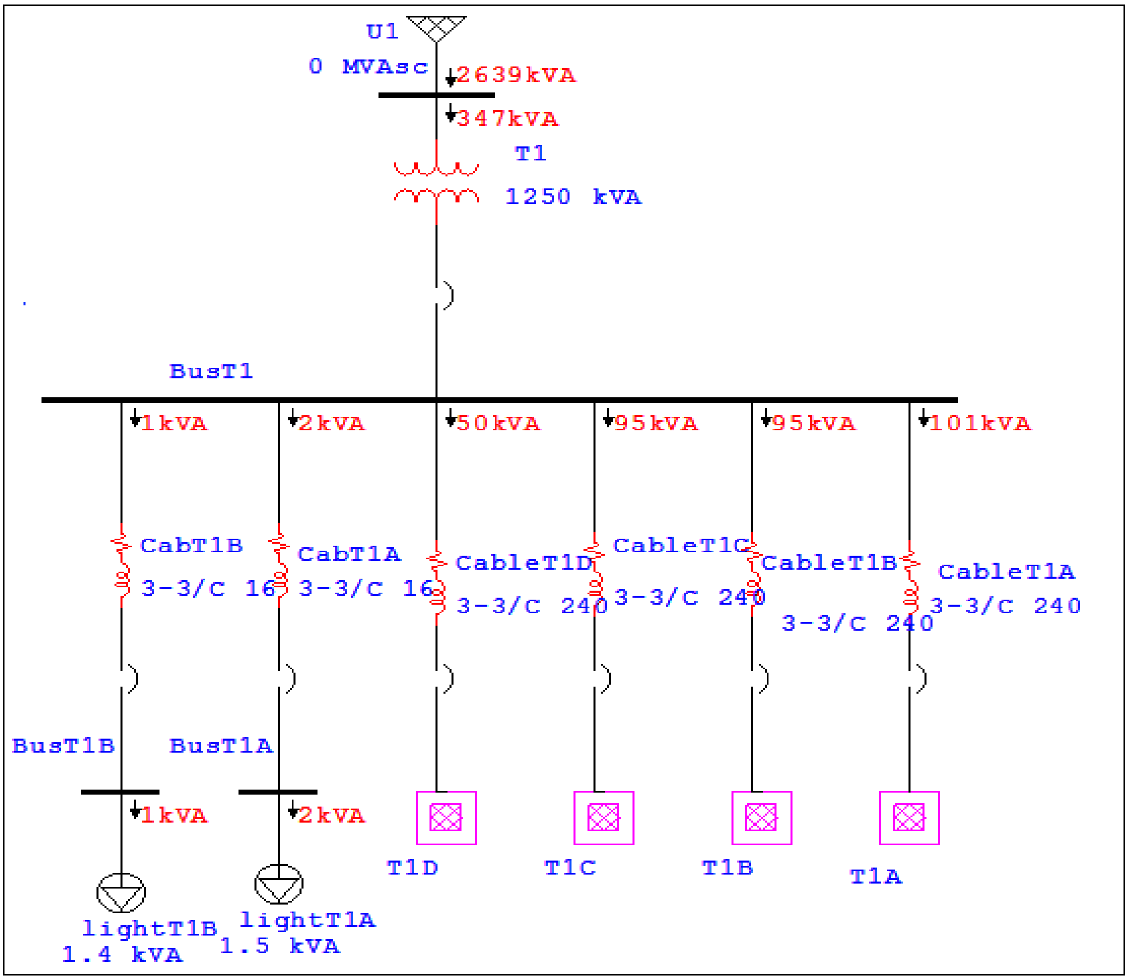

Figure 3.2: Branches of Transform T1

Table 3.2: Load on Transform T1

Sub Distribution Board (S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			A	KVA		
T1A	5B	14	32.2	22	17.6	81.84
	6B	14	33.2	23	18.8	
	7B	15	34.5	24	19.2	
	8B	15	34.5	24	19.2	
	School1	1	40	8.8	7.04	
T1B	1A	26	36.8	25	20	75.2
	2A	20	46	31	24.8	
	3B	14	32.2	22	17.6	
	4A	10	23	16	12.8	
T1C	13A	18	41.4	28	22.4	76.3
	14B	14	32.2	22	17.6	
	12C	10	23	16	12.8	
	15C	8	18.4	13	10.4	
	11C	10	23	16	12.8	
T1D	9B	12	27.6	19	15.2	39.84
	10B	14	32.2	22	17.6	
	School2	1	40	8.8	7.04	
lightT1A			6.7	1.5	1.2	1.2
lightT1B			6.1	1.4	1.12	1.12
Total		216	563	343.5	275.5	275.5

T1A branches into 4 L.V Metering Panel (M.P) (5B, 6B, 7B, 8B) which feed the housing units and school. The average energy consumption per hour of all loads are as follows: School consumes an average of 7.04 KWh, 5B consumes an average of 17.6 KWh, 6B consumes an average of 18.8 KWh, 7B consumes an average 19.2 KWh, and 8B consumes an average 19.2 KWh. While 5B, 6B, 7B, 8B feed housing units only with an average energy consumption of 1.2 KWh per unit as shown in Fig. (3.3).

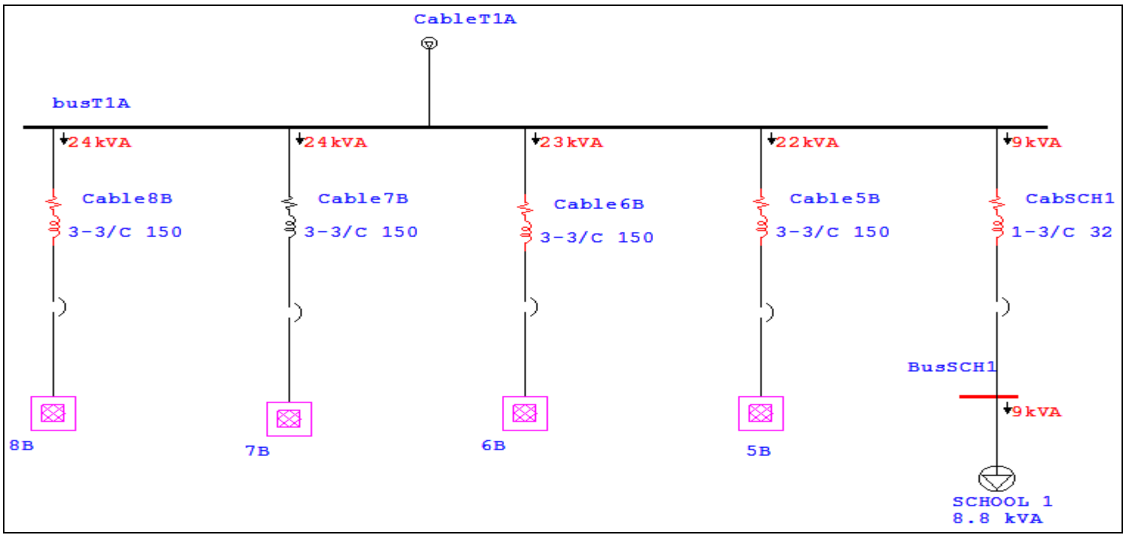

Figure 3.3: Branches T1A in Transform T1

For more details about 5B, 6B, 7B, and 8B, please refer to Appendix A.1.

T1B branches into 4 L.V Metering Panel (M.P) named (1A, 2A, 3B, 4A) which feed the housing units. The average energy consumption per hour of all loads are as follows: 1A consumes an average 20 KWh, 2A consumes an average 24.8 KWh, 3B consumes an average 17.6 KWh, and 4A consumes an average 12.8 KWh. While 1A, 2A, 3B, 4A feed housing units only as shown in Fig. (3.4).

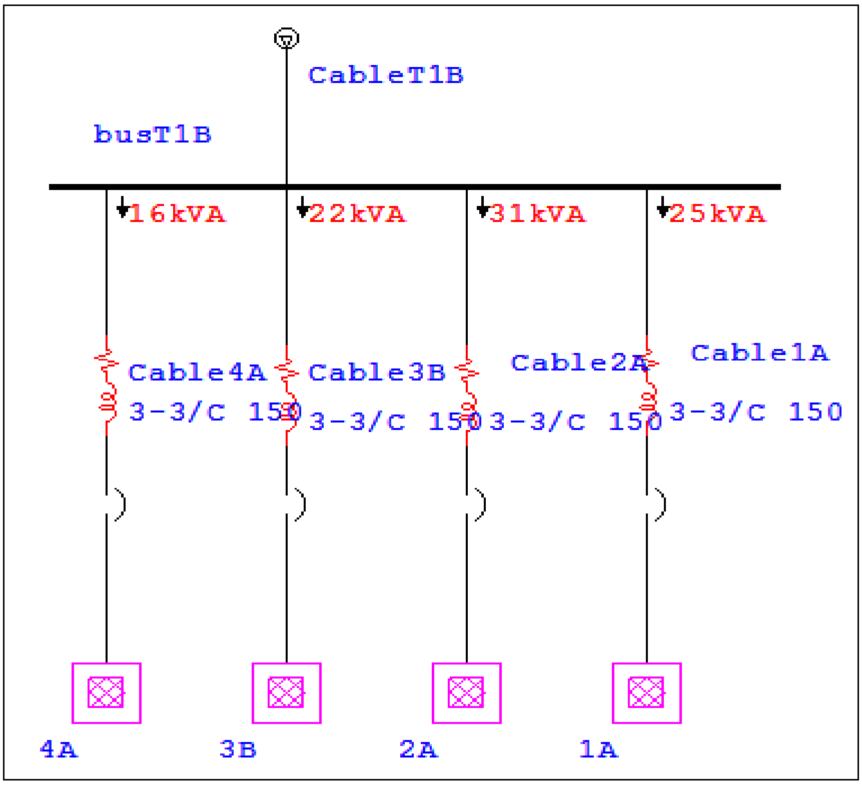

Figure 3.4: Branches T1B in Transform T1

For more details about 1A, 2A, 3B, and 4A, please refer to Appendix A.2.

T1C branches into 5 L.V Metering Panel (M.P) named (11C, 15C, 12C, 14B, 13A) which feed the housing units. The average energy consumption per hour of all loads are as follows: 11C consumes an average of 12.8 KWh, 15C consumes an average of 10.4 KWh, 12C consumes an average of 12.8 KWh, 14B consumes an average of 17.6 KWh, and 13A consumes an average of 22.4 KWh, While 11C, 15C, 12C, 14B, 13A feed housing units only as shown in Fig. (3.5).

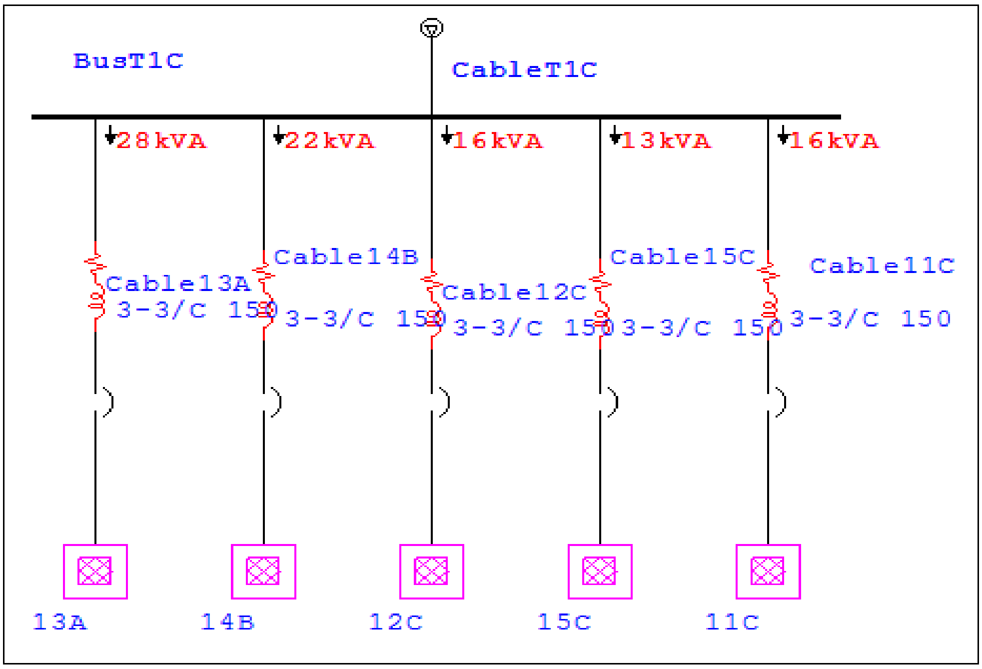

Figure 3.5: Branches T1C in Transform T1

For more details about 11C, 15C, 12C, 14B, and 13A, please refer to Appendix A.3.

T1D branches into 2 L.V Metering Panel (M.P) named (9B, 10B) which feed the Housing units and school. The average energy consumption per hour of all loads is as follows: School consumes an average of 7.04 KWh, 9B consumes an average of 15.2 KWh, and 10B consumes an average of 17.6 KWh as shown in Fig. (3.6).

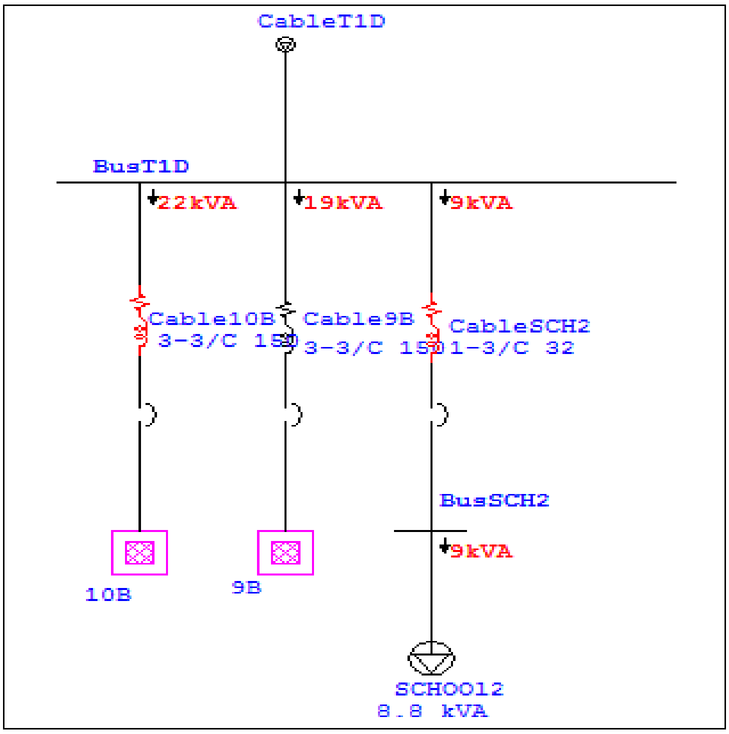

Figure 3.6: Branches T1D in Transform T1

For more details about 9B, and 10B, please refer to Appendix A.4.

3.3.2 Second Transform (T2)

The Second transform (T2) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T2 includes 5 Sub Distribution Board (S.D.B) named (T2A, T2B, T2C, T2D, T2E) and lighting cable as shown in Fig. (3.7).

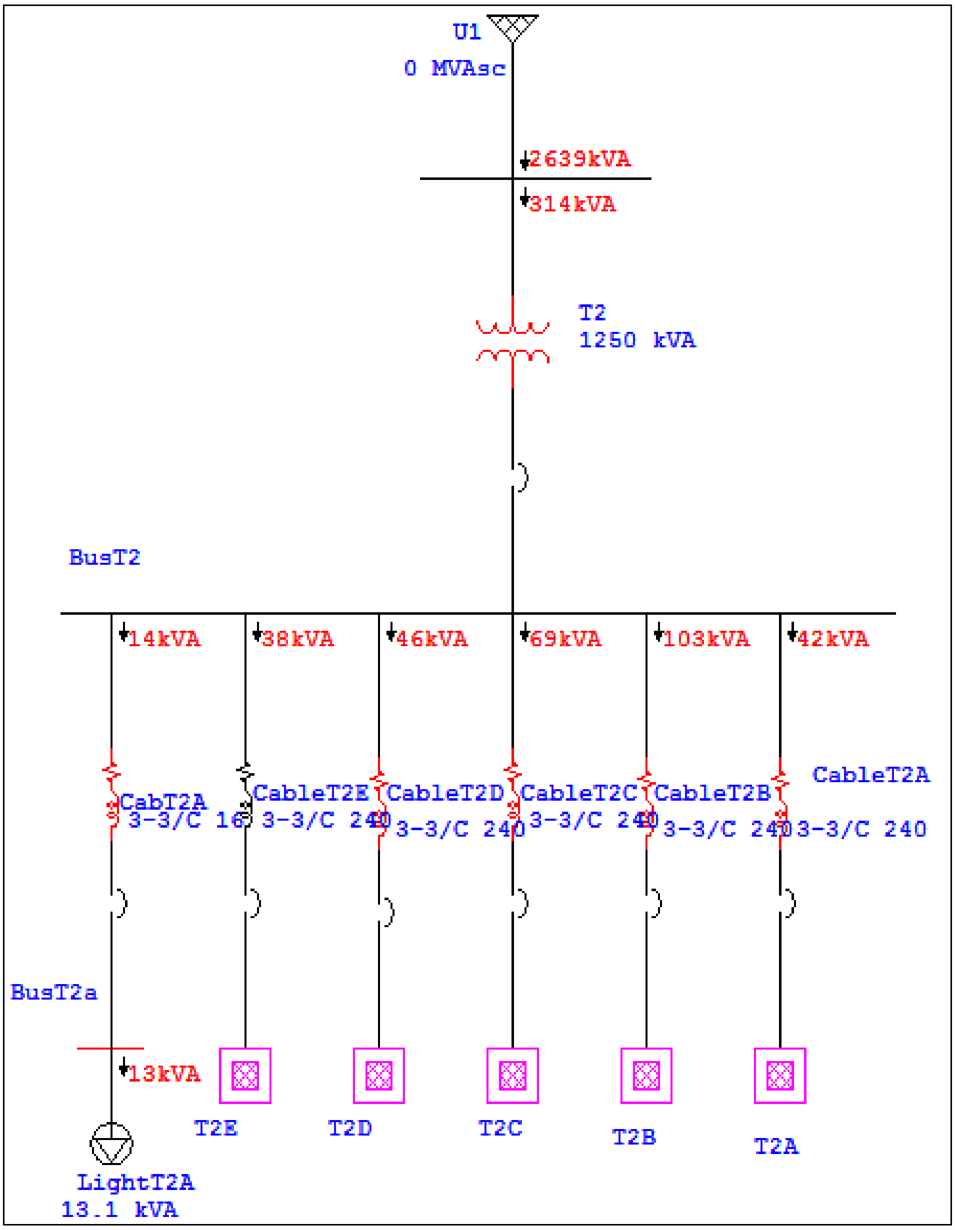

Figure 3.7: Branches in Transform T2

Table 3.3: Load on Transform T2

Sub Distribution Board(S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
T2A	32C	7	11	16.1	8.8	33.44
	33B	14	22	32.2	17.6	
	School3	1	8.8	40	7.04	
T2B	18C	9	14	20.7	11.2	81.6
	23B	14	22	32.2	17.6	
	17C	11	17	25.3	13.6	
	22C	11	17	25.3	13.6	
	16C	10	16	23	12.8	
	21C	10	16	23	12.8	
T2C	30C	12	19	27.6	15.2	55.04
	31C	10	16	23	12.8	
	29C	9	14	20.7	11.2	
	28C	7	11	16.1	8.8	
	School4	1	8.8	40	7.04	
T2D	26C	8	13	18.4	10.4	36.8
	27C	7	11	16.1	8.8	
	25C	6	9	13.8	7.2	
	24C	8	13	18.4	10.4	
T2E	19B	12	19	27.5	15.2	30.4
	20B	12	19	27.5	15.2	
lightT2A			13.1	59.67	10.48	10.48
Total		179	309.7	546.57	247.76	247.76

T2A Branches into 2 L.V Metering Panel (M.P) named (32C, 33B) which feed the Housing units and school. The average energy consumption per hour of all loads is as follows: School consumes an average of 7.04 KWh, 32C consumes an average of 8.8 KWh, and 33B consumes an average of 17.6 KWh, While 32C, 33B feed housing units only with an average energy consumption of 1.2 KWh per unit as shown in Fig. (3.8).

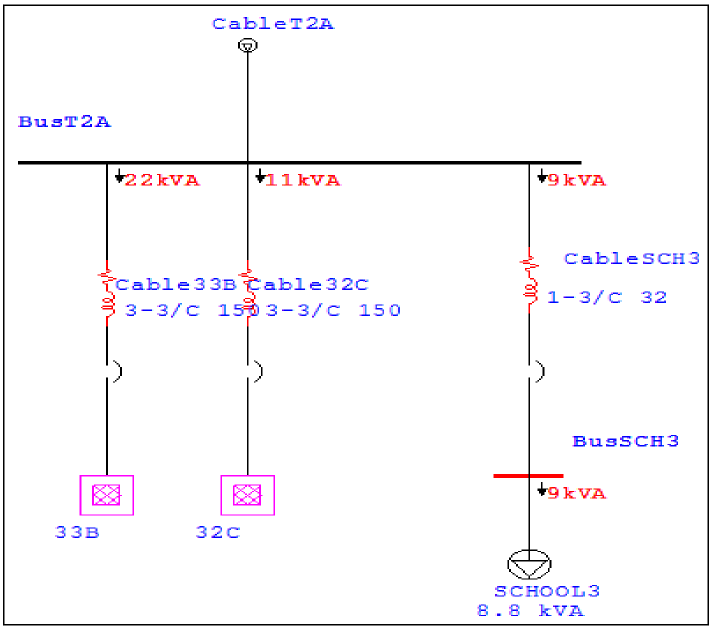

Figure 3.8: Branch T2A in Transform T2

For more details about 32C, and 33B, please refer to Appendix B.1.

T2B branches into 6 L.V Metering Panel (M.P) named (18C, 23B, 17C, 22C, 16C, 21C) which feed the housing units. The average energy consumption per hour of all loads are as follows: 18C consumes an average of 1.2 KWh, 23B consumes an average of 17.6 KWh, 17C consumes an average of 13.6KWh, 22C consumes an average of 13.6 KWh, 16C consumes an average of 12.8 KWh, and 21C consumes an average of 12.8 KWh. While 18C, 23B, 17C, 22C, 16C, 21C feed housing units only as shown in Fig. (3.9).

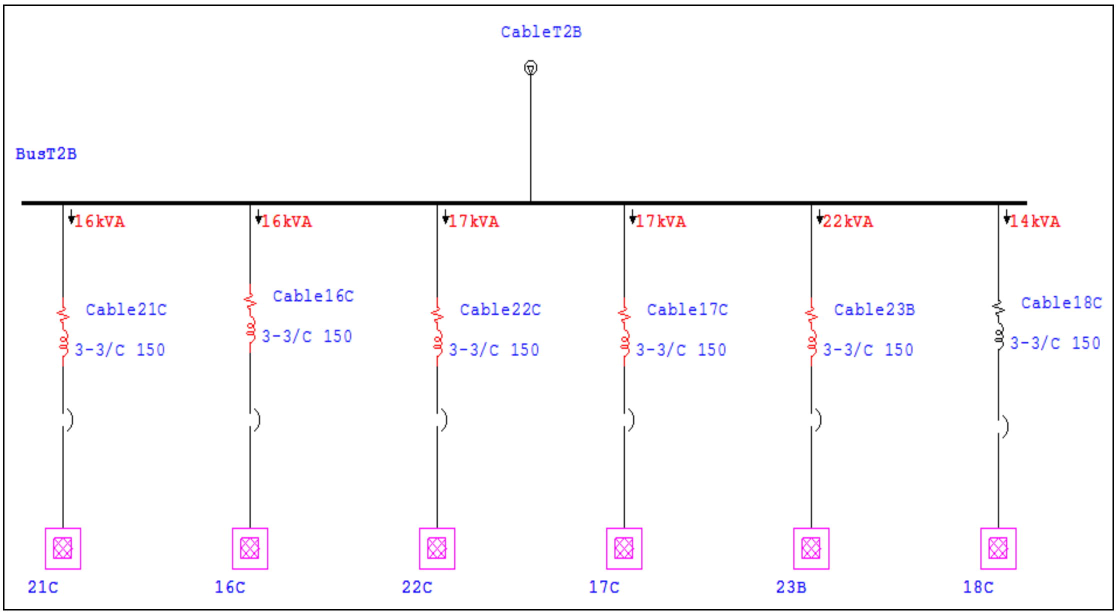

Figure 3.9: Branch T2B in Transform T2

For more details about 18C, 23B, 17C, 22C, 16C, and 21C, please refer to Appendix B.2.

T2C branches into 4 L.V Metering Panel (M.P) named (28C, 29C, 31C, 30C) which feed the housing units and school. The average energy consumption per hour of all loads are as follows: School consumes an average of 7.04 KWh, 28C consumes an average of 8.8 KWh, 29C consumes an average of 11.2 KWh, 31C consumes an average of 12.8 KWh, and 30C consumes an average of 15.2 KWh, while 28C, 29C, 31C, 30C feed housing units only with an average energy consumption of 1.2 KWh per unit as shown in Fig. (3.10).

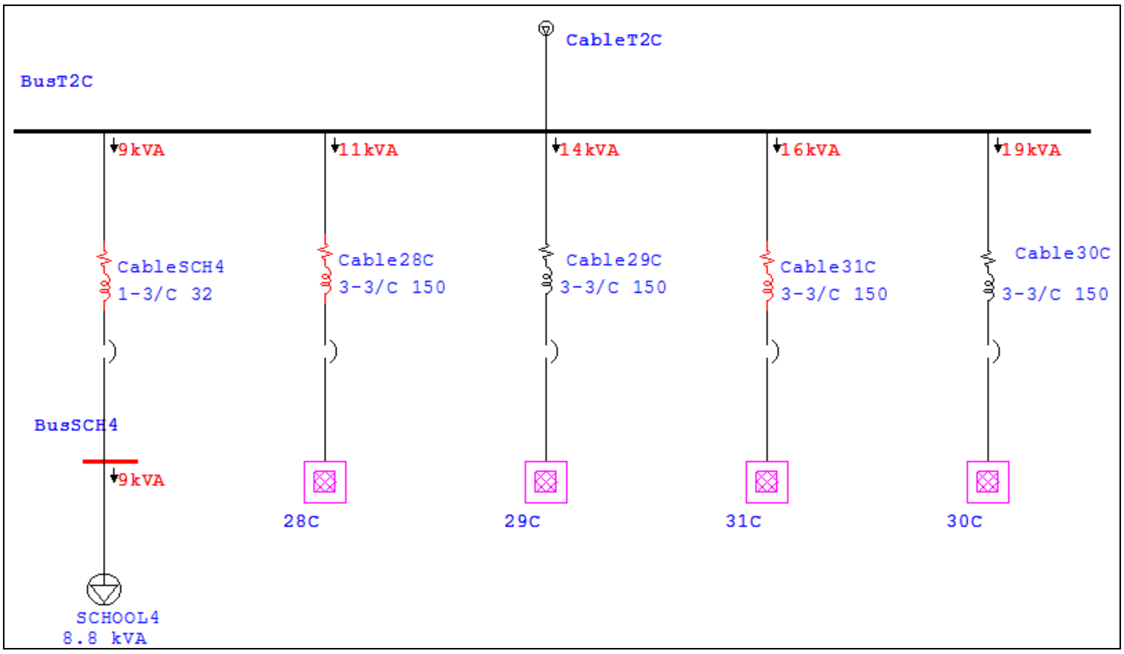

Figure 3.10: Branch T2C in Transform T2

For more details about 28C, 29C, 31C, and 30C, please refer to Appendix B.3.

T2D branches into 4 L.V Metering Panel (M.P) named (24C, 25C, 27C, 26C) which feed the housing units. The average energy consumption per hour of all loads is as follows: 24C consumes an average of 10.4 KWh, 25C consumes an average of 7.2 KWh, 27C consumes an average of 8.8 KWh, and 26C consumes an average of 10.4 KWh, while 24C, 25C, 27C, 26C feed housing units only as shown in Fig. (3.11).

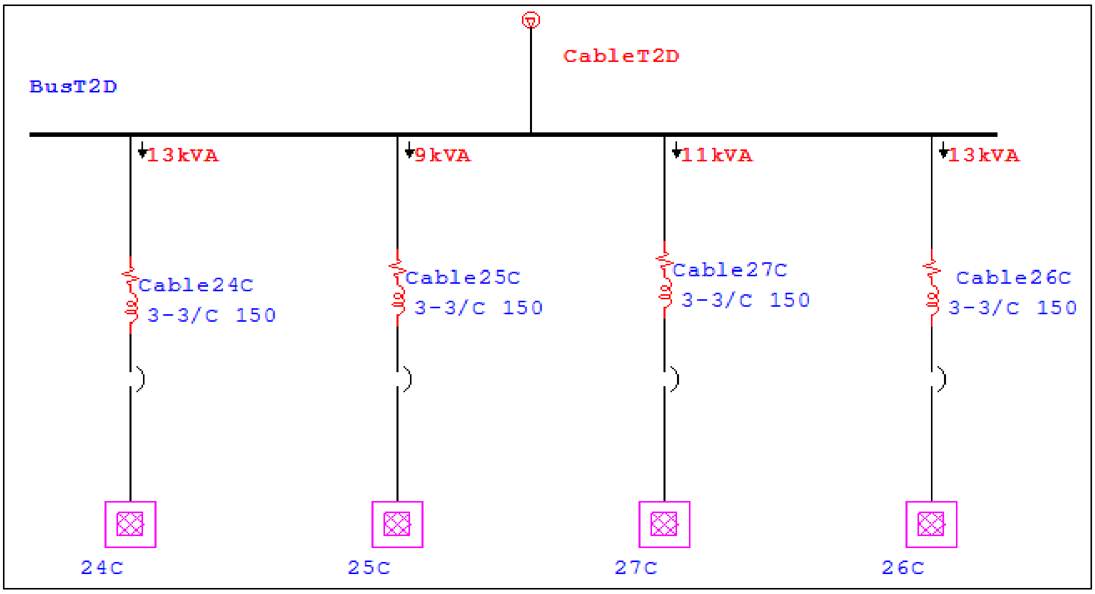

Figure 3.11: Branch T2D in Transform T2

For more details about 24C, 25C, 27C, and 26C, please refer to Appendix B.4.

T2E branches into 2 L.V Metering Panel (M.P) named (20B, 19B) which feed the housing units. The average energy consumption per hour of all loads is as follows: 20B consumes an average of 15.2 KWh, and 19B consumes an average of 15.2 KWh, while 20B, 19Bfeed housing units only as shown in Fig. (3.12).

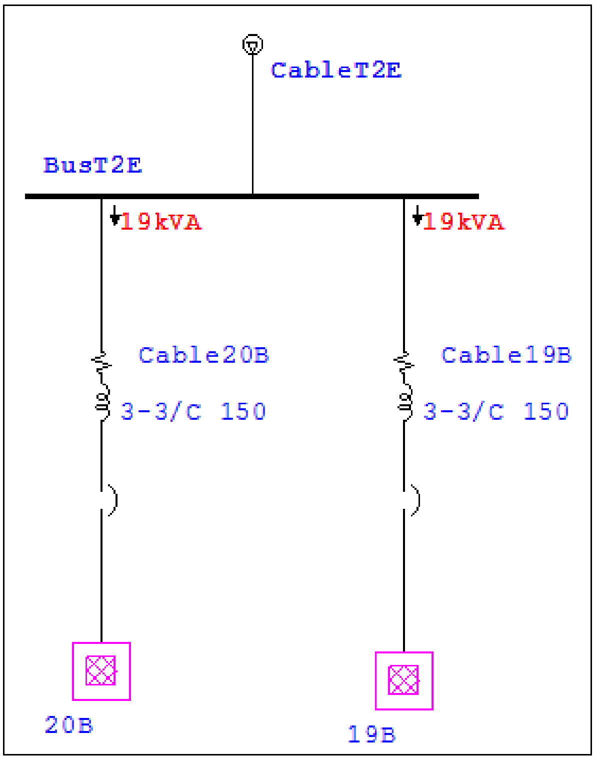

Figure 3.12: Branch T2E in Transform T2

For more details about 20B, and 19B, please refer to Appendix B.5.

3.3.3 Third Transform (T3)

The third transform (T3) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T3 includes 3 Sub Distribution Board (S.D.B) named (T3A, T3B, T3C) and two lighting cables as shown in Fig. (3.13).

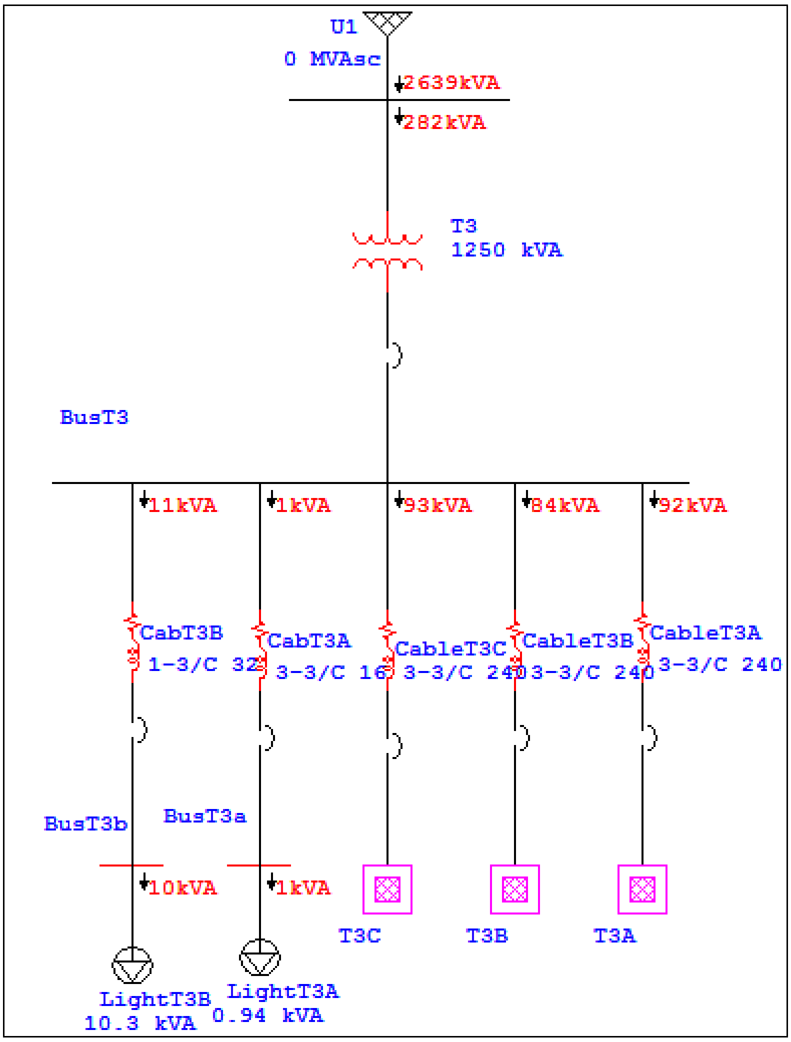

Figure 3.13: Branches in Transform T3

Table 3.4: Load on Transform T3

Sub Distribution Board (S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
T3A	44B	14	22	32.2	17.6	72
	46C	9	14	20.7	11.2	
	48C	11	17	25.3	13.6	
	47C	11	17	25.3	13.6	
	45B	13	20	29.9	16	
T3B	40C	7	11	16.1	8.8	66.4
	81C	6	9	13.8	7.2	
	41A	18	28	41.3	22.4	
	43C	10	16	23	12.8	
	42B	12	19	27.6	15.2	
T3C	34C	6	9	13.8	7.2	74.4
	39C	10	16	23	12.8	
	35B	12	19	27.6	15.2	
	37C	10	16	23	12.8	
	38C	11	17	25.3	13.6	
	36C	10	16	23	12.8	
lightT3A			0.94	4.26	0.752	0.752
lightT3B			10.3	46.59	8.24	8.24
Total		170	277.24	441.55	221.792	221.792

T3A branches into 5 L.V Metering Panel (M.P) named (44B, 46C, 48C, 47C, 45B) which feed the Housing units. The average energy consumption per hour of all loads are as follows: 44B consumes an average of 17.6 KWh, 46C consumes an average of 11.2 KWh, 48C consumes an average of 13.6 KWh, 47C consumes an average of 13.6 KWh, and 45B consumes an average of 16 KWh, while 44B, 46C, 48C, 47C, 45B feed housing units only as shown in Fig. (3.14).

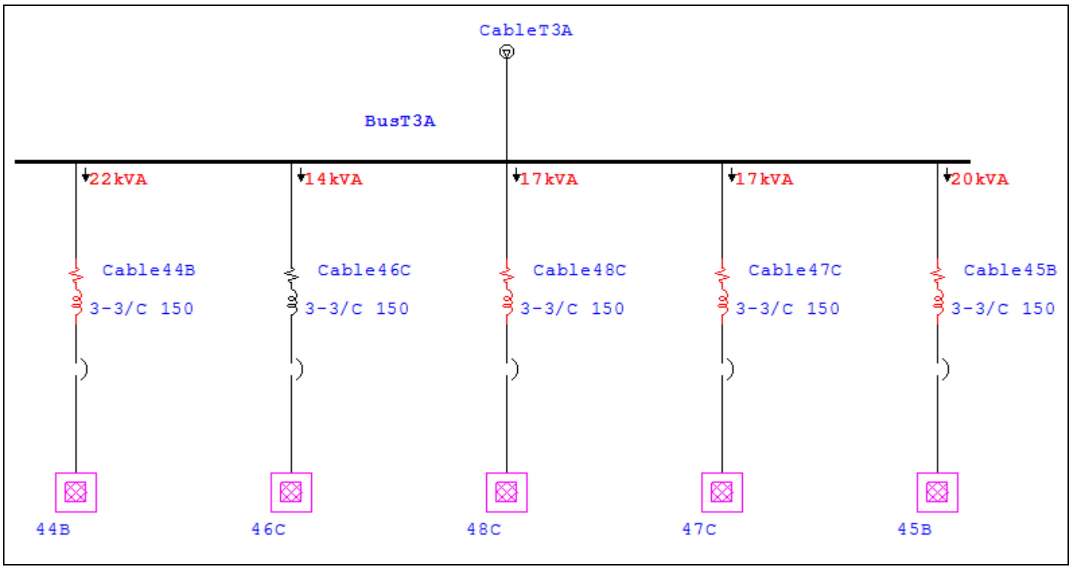

Figure 3.14: Branch T3A in Transform T3

For more details about 44B, 46C, 48C, 47C, and 45B, please refer to Appendix C.1.

T3B branches into 5 L.V Metering Panel (M.P) named (40C, 81C, 41A, 43C, 42B) which feed the housing units. The average energy consumption per hour of all loads are as follows: 40C consumes an average of 8.8 KWh, 81C consumes an average of 7.2 KWh, 41A consumes an average of 22.4 KWh, 43C consumes an average of 12.8 KWh, and 42B consumes an average of 15.2 KWh as shown in Fig. (3.15).

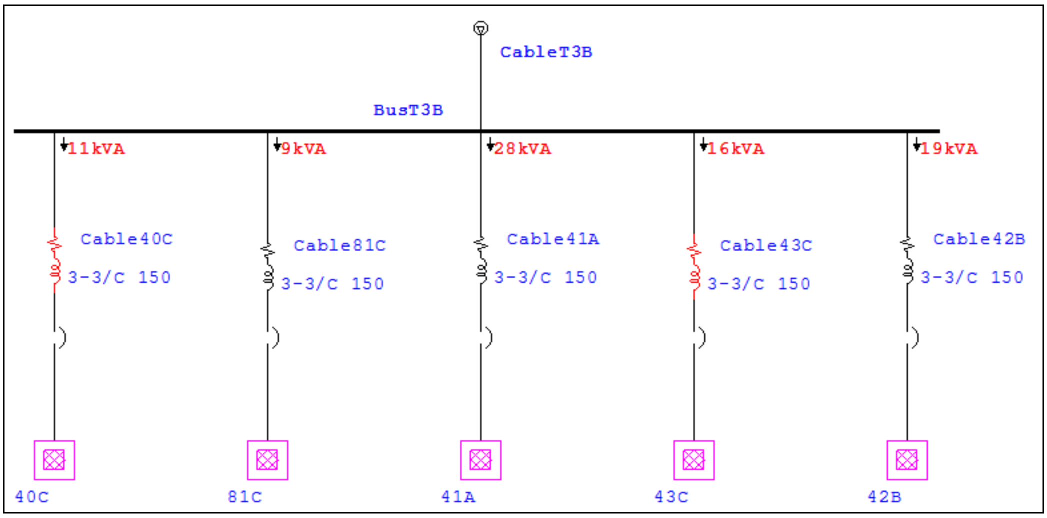

Figure 3.15: Branch T3B in Transform T3

For more details about 40C, 81C, 41A, 43C, and 42B, please refer to Appendix C.2.

T3C branches into 6 L.V Metering Panel (M.P) named (34C, 39C, 35B, 37C, 38C, 36C) which feed the housing units. The average energy consumption per hour of all loads are as follows: 34C consumes an average of 7.2 KWh, 39C consumes an average of 12.8 KWh, 35B consumes an average of 15.2 KWh, 37C consumes an average of 12.8 KWh, 38C consumes an average of 13.6 KWh, and 36C consumes an average of 12.8 KWh, while 34C, 39C, 35B, 37C, 38C, 36C feed housing units only as shown in Fig. (3.16).

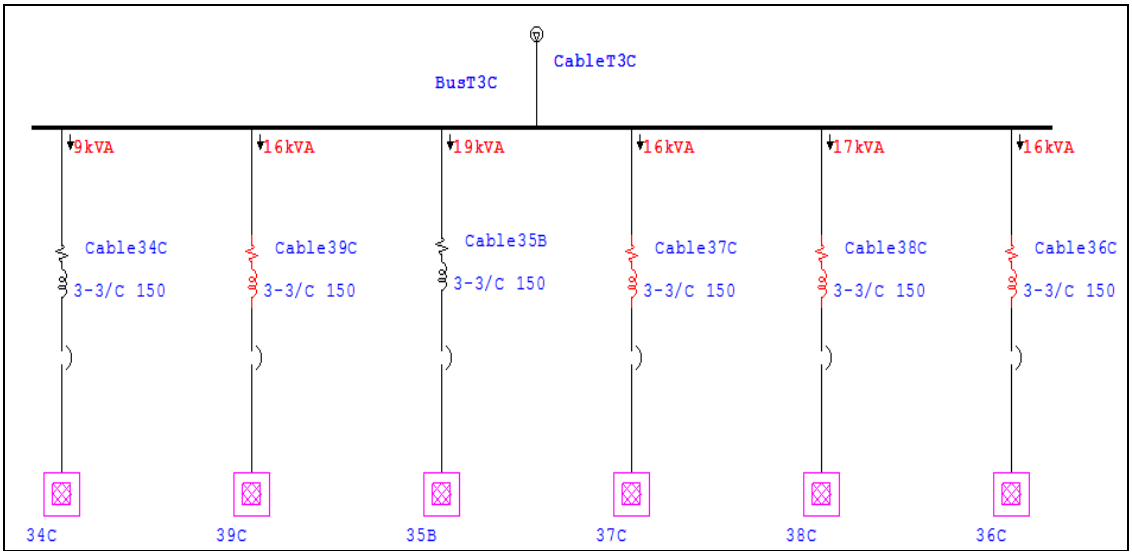

Figure 3.16: Branch T3C in Transform T3

For more details about 34C, 39C, 35B, 37C, 38C and 36C please refer to Appendix C.3.

3.3.4 Fourth Transform (T4)

The fourth transform (T4) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T4 includes 5 Sub Distribution Board (S.D.B) named (T4A, T4B, T4C, T4D,T4E) and lighting cables as shown in Fig. (3.17).

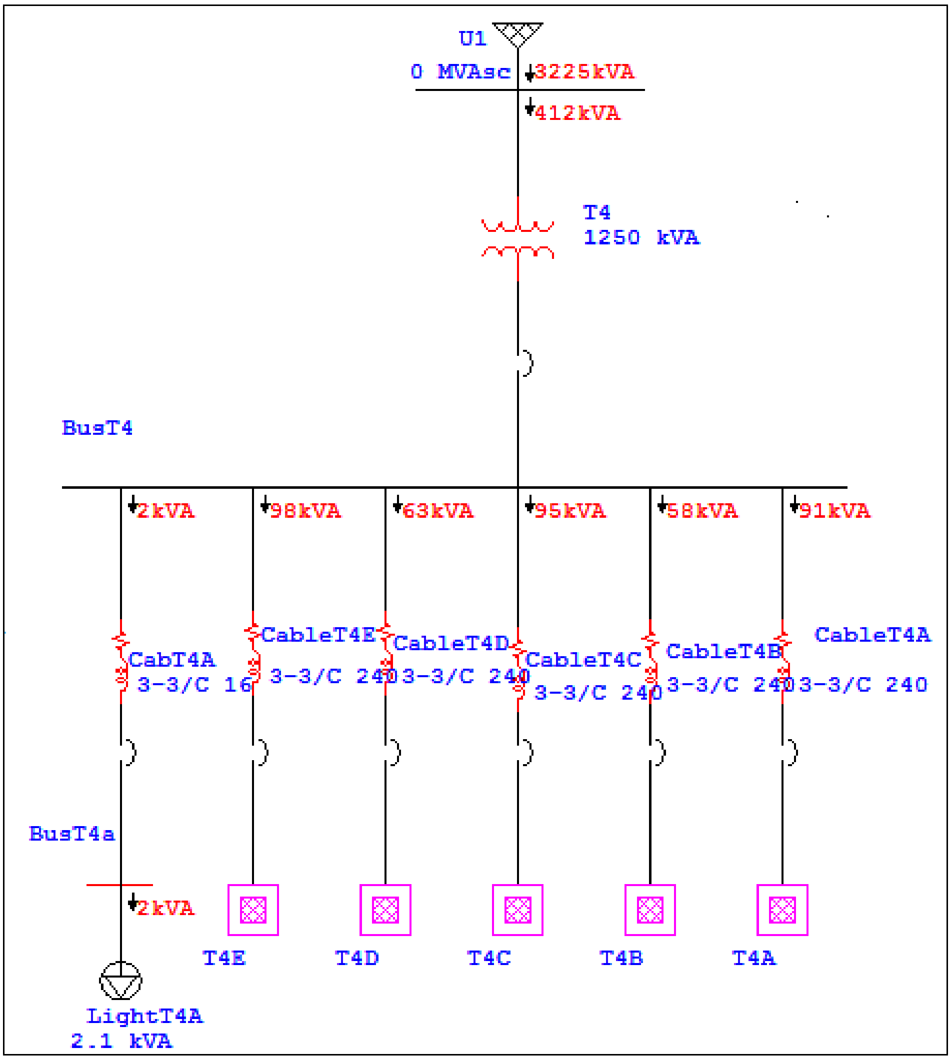

Figure 3.17: Branches in Transform T4

Table 3.5: Load on Transform T4

Sub Distribution Board(S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
T4A	50C	7	11	16.1	8.8	72.8
	49C	9	14	20.7	11.2	
	51B	14	22	32.2	17.6	
	52B	13	20	29.9	16	
	53B	15	24	34.5	19.2	
T4B	54B	15	24	34.5	19.2	47.2
	55C	10	16	23	12.8	
	56B	12	19	27.6	15.2	
T4C	58B	12	19	27.6	15.2	76
	59C	10	16	23	12.8	
	68B	16	25	36.8	20	
	60B	12	19	27.6	15.2	
	57C	10	16	23	12.8	
T4D	62B	13	20	29.9	16	50.4
	82C	8	13	18.4	10.4	
	83C	8	13	18.4	10.4	
	61C	11	17	25.3	13.6	
T4E	63B	14	22	32.2	17.6	77.6
	65B	13	20	29.9	16	
	66B	14	22	32.2	17.6	
	64C	10	16	23	12.8	
	67C	11	17	25.3	13.6	
lightT4A			2.1	9.66	1.68	1.68
Total		257	407.1	600.76	325.68	325.68

T4A branches into 5 L.V Metering Panel (M.P) named (50C, 49C, 51B, 52B, 53B) which feed the housing units. The average energy consumption per hour of all loads are as follows: 50C consumes an average of 8.8 KWh, 49C consumes an average of 11.2 KWh, 51B consumes an average of 17.6 KWh, 52B consumes an average of 16 KWh, and 53B consumes an average of 19.2 KWh, while 50C, 49C, 51B, 52B, 53B feed housing units only with an average energy consumption of 1.2 KWh per unit as shown in Fig. (3.18).

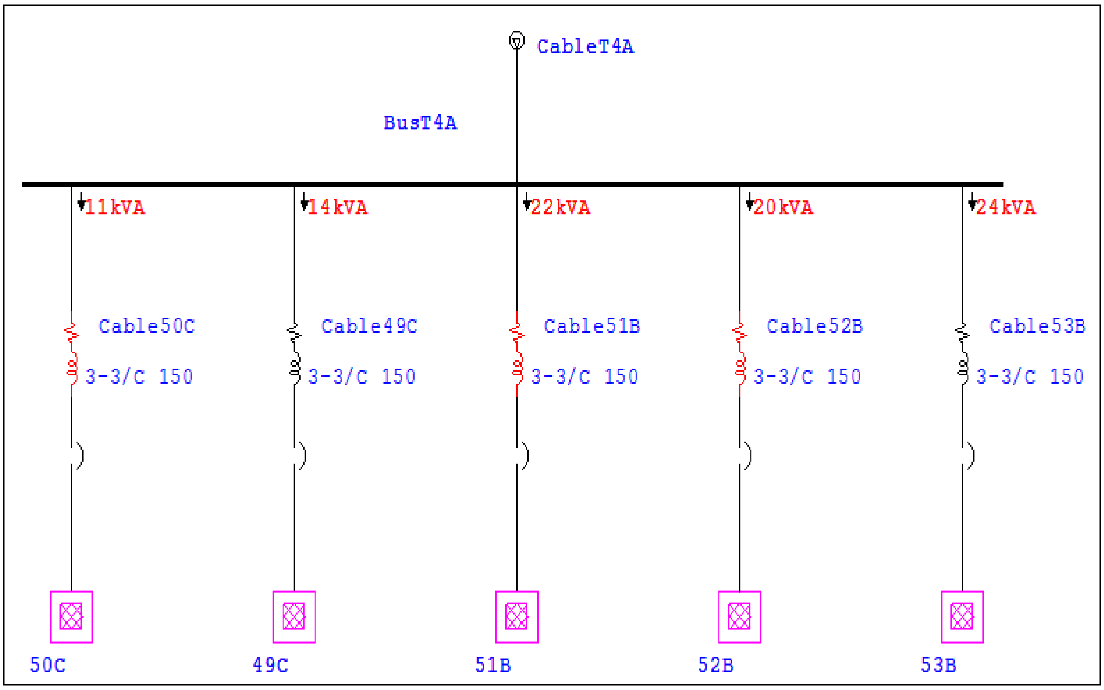

Figure 3.18: Branch T4A in Transform T4

For more details about 50C, 49C, 51B, 52B, and 53B, please refer to Appendix D.1.

T4B branches into 3 L.V Metering Panel (M.P) named (54B, 55C, 56B) which feed the housing units. The average energy consumption per hour of all loads is as follows: 54B consumes an average of 19.2 KWh, 55C consumes an average of 12.8 KWh, and 56B consumes an average of 15.2 KWh, while 54B, 55C, 56B feed housing units only as shown in Fig. (3.19).

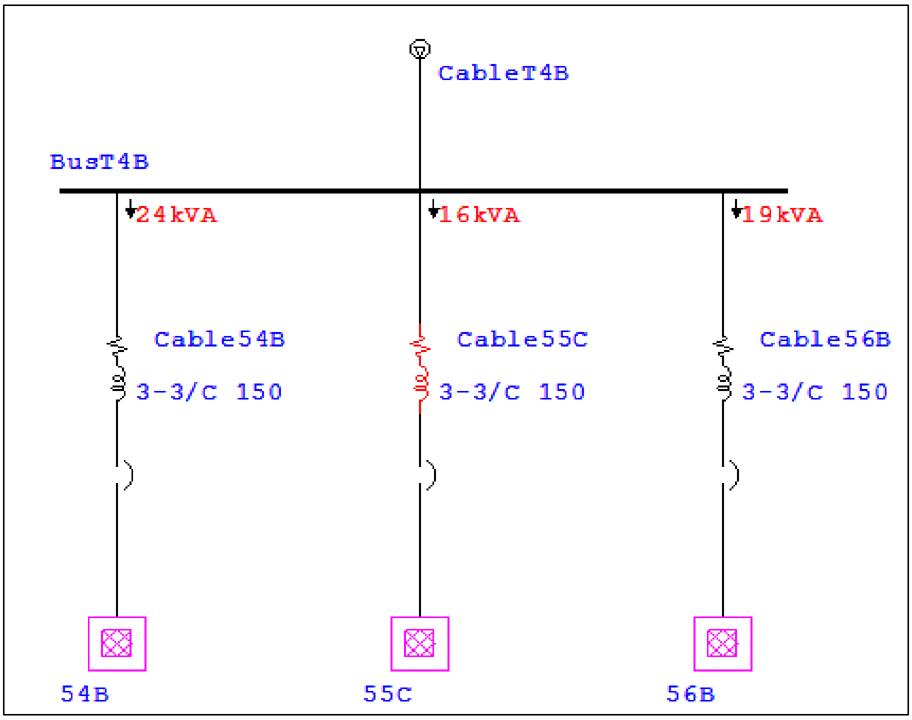

Figure 3.19: Branch T4B in Transform T4

For more details about 54B, 55C, and 56B, please refer to Appendix D.2.

T4C branches into 5 L.V Metering Panel (M.P) named (57C, 60B, 68B, 59C, 58B) which feed the housing units. The average energy consumption per hour of all loads are as follows: 57C consumes an average of 12.8 KWh, 60B consumes an average of 15.2 KWh, 68B consumes an average of 20 KWh, 59C consumes an average of 12.8 KWh, and 58B consumes an average of 15.2 KWh, while 57C, 60B, 68B, 59C, 58B feed housing units only as shown in Fig. (3.20).

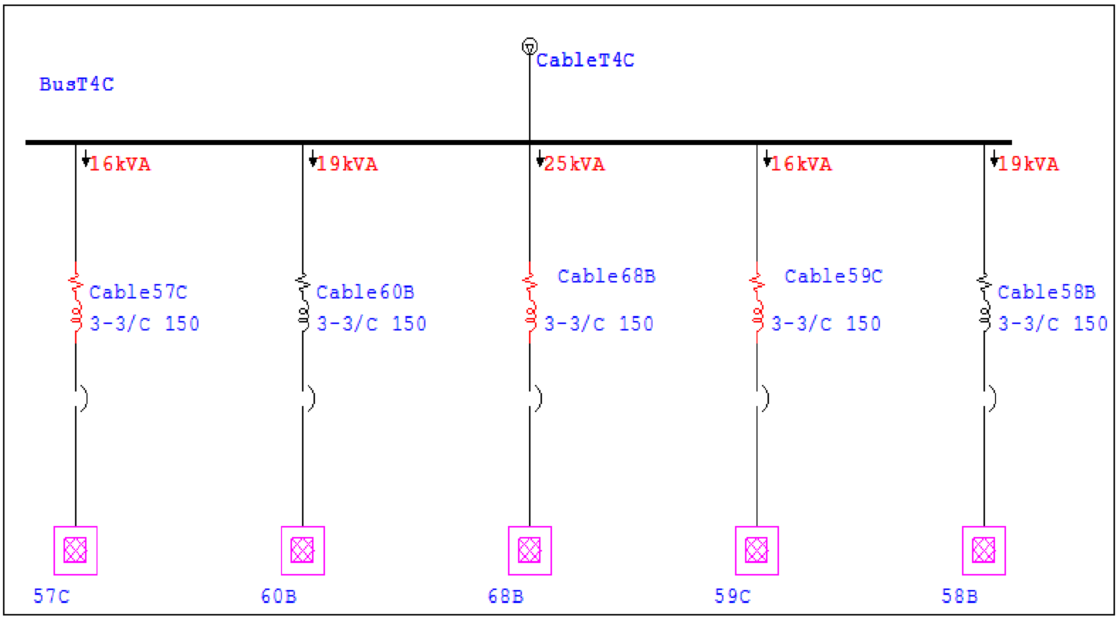

Figure 3.20: Branch T4C in Transform T4

For more details about 57C, 60B, 68B, 59C, and 58B, please refer to Appendix D.3.

T4D branches into 4 L.V Metering Panel (M.P) (61C, 83C, 82C, 62B) which feed the housing units. The average energy consumption per hour of all loads is as follows: 61C consumes an average of 13.6 KWh, 83C consumes an average of 10.4 KWh, 82C consumes an average of 10.4 KWh, and 62B consumes an average of 16 KWh, while 61C, 83C, 82C, 62B feed housing units only as shown in Fig. (3.21).

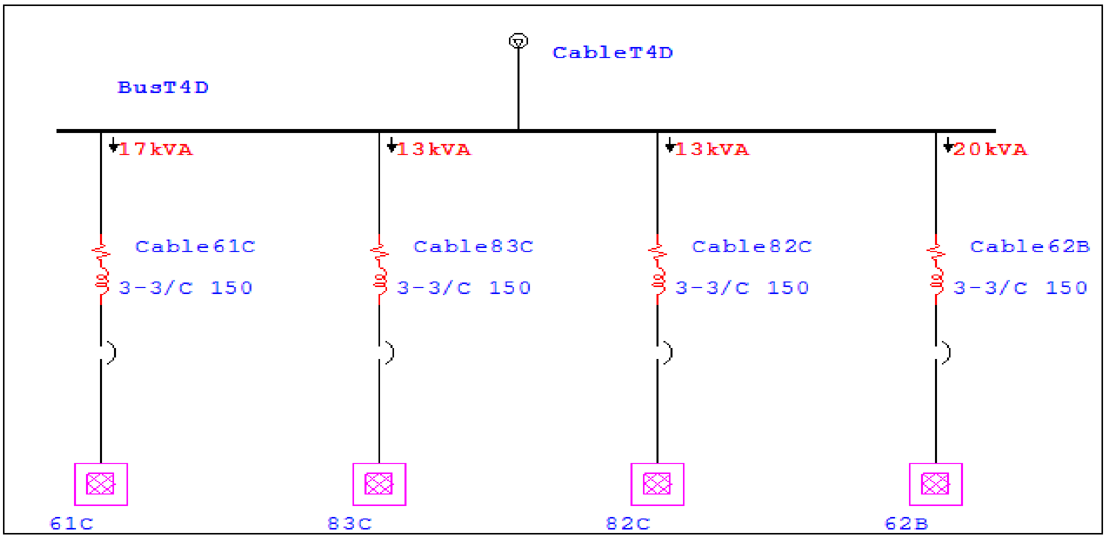

Figure 3.21: Branch T4D in Transform T4

For more details about 61C, 83C, 82C, and 62B, please refer to Appendix D.4.

T4E branches into 5 L.V Metering Panel (M.P) named (67C, 64C, 66B, 65B, 63B) which feed the housing units. The average energy consumption per hour of all loads are as follows: 67C consumes an average of 13.6 KWh, 64C consumes an average of 12.8 KWh, 66B consumes an average of 17.6 KWh, 65B consumes an average of 16 KWh, and 63B consumes an average of 17.6 KWh, while 67C, 64C, 66B, 65B, 63B feed housing units only as shown in Fig. (3.22).

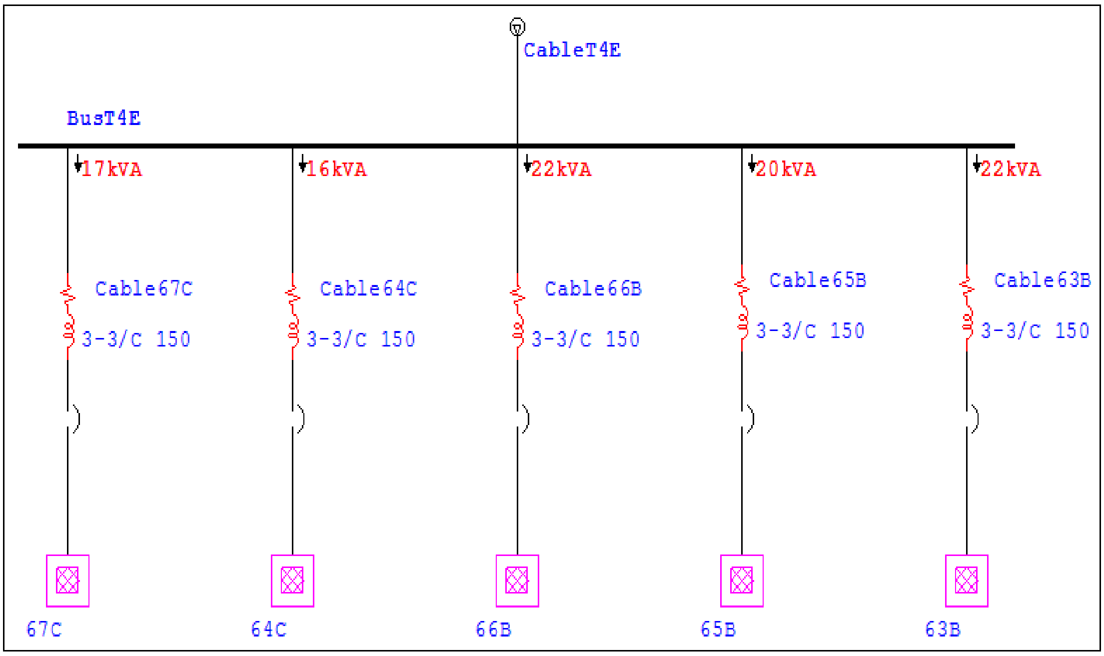

Figure 3.22: Branch T4E in Transform T4

For more details about 67C, 64C, 66B, 65B, and 63B, please refer to Appendix D.5.

3.3.5 Fifth Transform (T5)

The fifth transform (T5) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T5 includes 4 Sub Distribution Board (S.D.B) named (T5A, T5B, T5C, T5D, T5E) and sixth lighting cables as shown in Fig. (3.23).

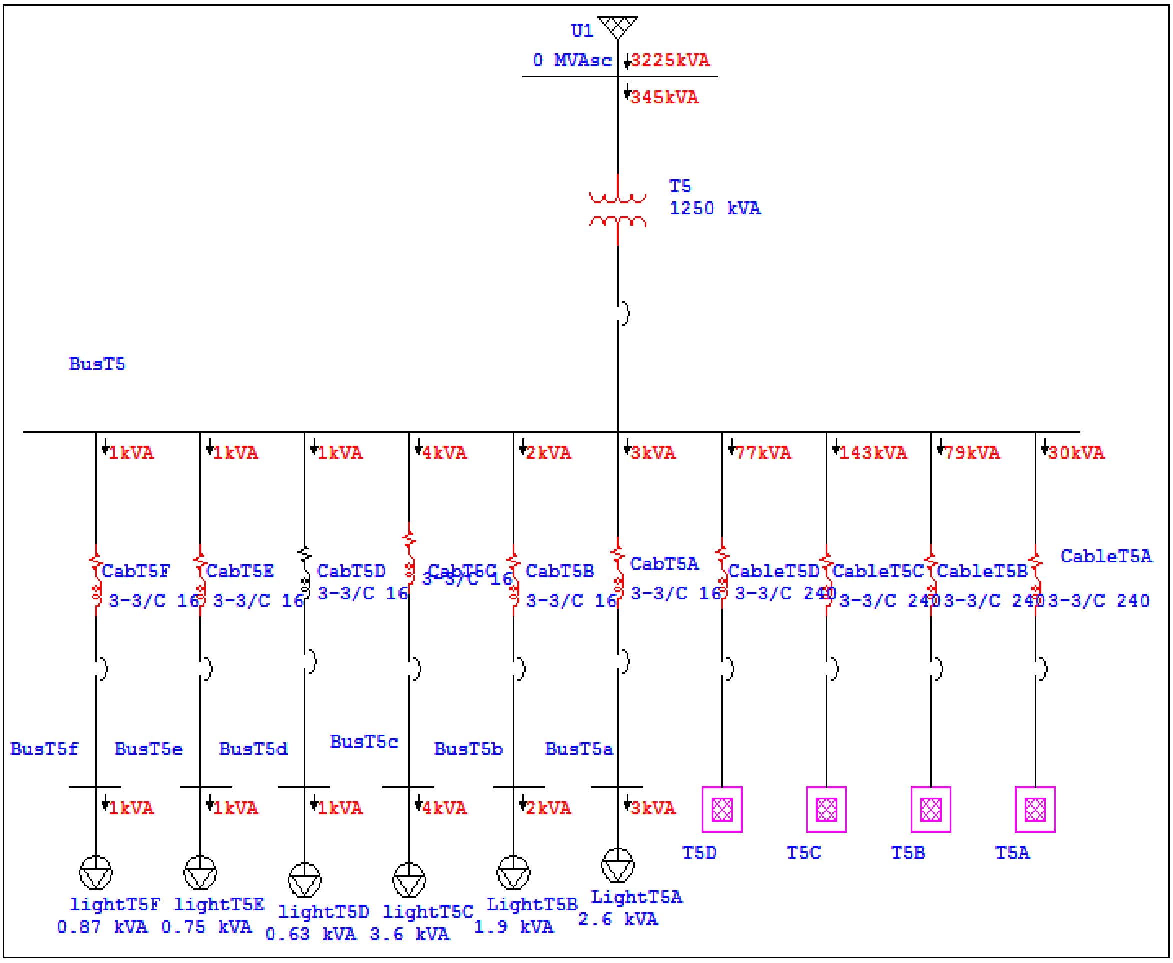

Figure 3.23: Branches in Transform T5

Table 3.6: Load on Transform T5

Sub Distribution Board(S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
T5A	71C	9	14	20.7	11.2	24
	72C	10	16	23	12.8	
T5B	69C	8	13	18.4	10.4	63.04
	70C	8	13	18.4	10.4	
	Masjid	1	26.4	120	21.12	
	Cultural center	1	26.4	120	21.12	
T5C	Health center	1	139	630	111.2	111.2
T5D	76C	8	13	18.4	10.4	61.28
	77C	7	11	16.1	8.8	
	78C	8	13	18.4	10.4	
	Commercial center	1	39.6	180	31.68	
lightT5A			2.6	11.93	2.08	2.08
lightT5B			1.9	8.52	1.52	1.52
lightT5C			3.6	16.46	2.88	2.88
lightT5D			0.63	2.84	0.504	0.504
lightT5E			0.75	3.41	0.6	0.6
lightT5F			0.87	3.96	0.696	0.696
Total		62	334.75	1230.52	267.8	267.8

T5A branches into 2 L.V Metering Panel (M.P) named (71C, 72C) which feed the housing units. The average energy consumption per hour of all loads is as follows: 71C consumes an average of 11.2 KWh, and 72C consumes an average of 12.8 KWh, while 71C, 72C feed housing units only as shown in Fig. (3.24).

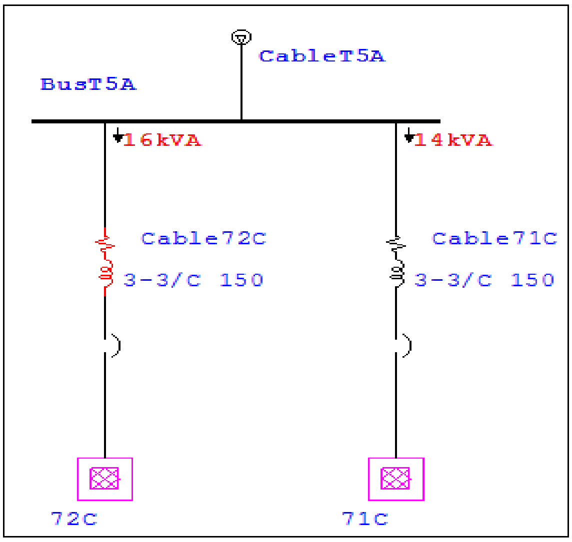

Figure 3.24: Branch T5A in Transform T5

For more details about 71C, and 72C, please refer to Appendix E.1.

T5B branches into 2 L.V Metering Panel (M.P) named (69C, 70C) which feed the housing units, masjid and cultural center. The average energy consumption per hour of all loads is as follows: The cultural center consumes an average of 21.12 KWh, the masjid consumes an average of 21.12 KWh, 69C consumes an average of 10.4 KWh, and 70C consumes an average of 10.4 KWh, while 69C, 70C feed housing units only as shown in Fig. (3.25).

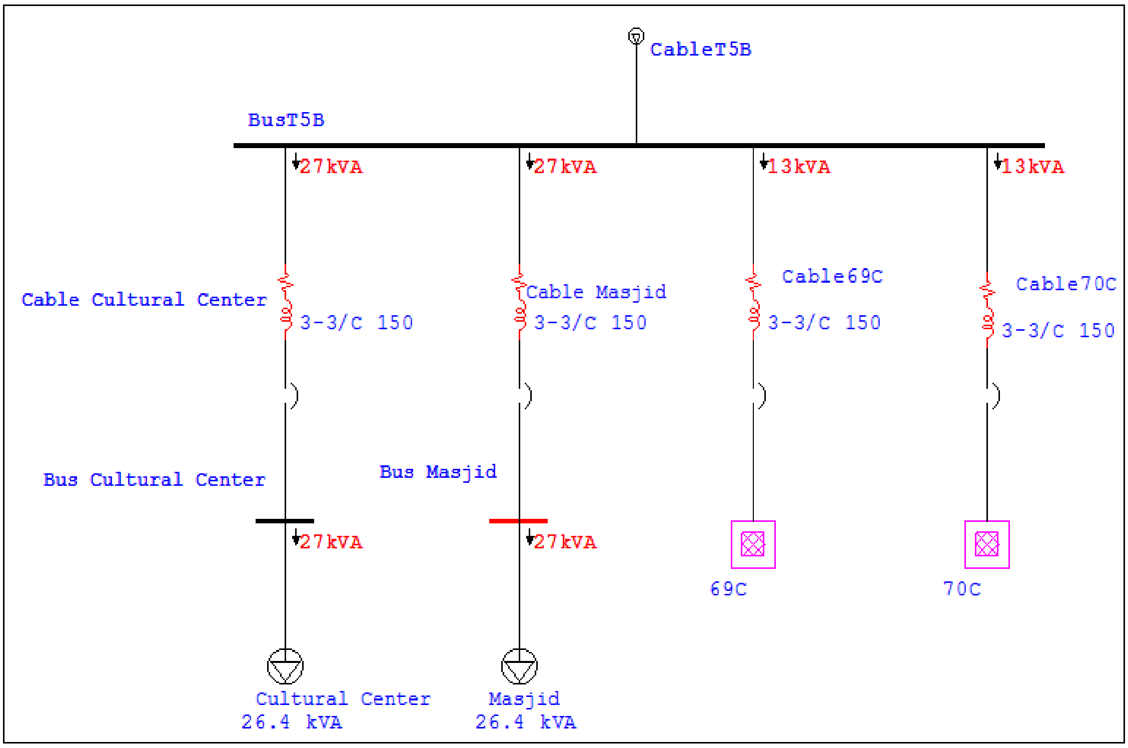

Figure 3.25: Branch T5B in Transform T5

For more details about 69C, and 70C, please refer to Appendix E.2.

The T5C feeding the health center, consumes an average of 111.2 KWh as shown in Fig. (3.26).

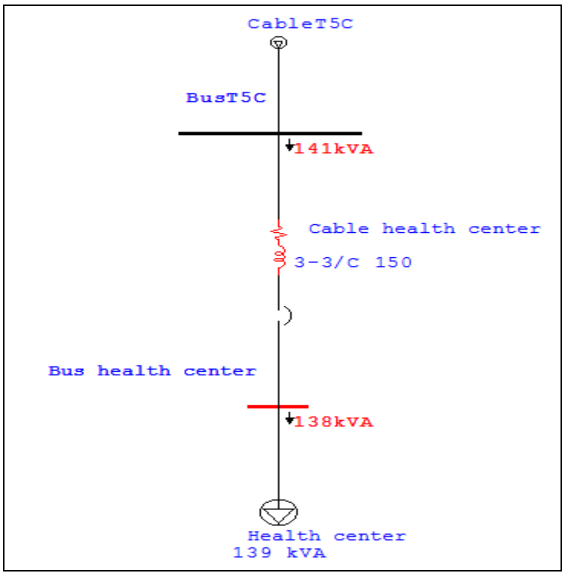

Figure 3.26: Branch T5C in Transform T5

T5D branches into 3 L.V Metering Panel (M.P) named (78C, 77C, 76C,) and commercial center, The average energy consumption per hour of all loads are as follows: the commercial center consumes an average of 31.68 KWh, 78C consumes an average of 10.4 KWh, 77C consumes an average of 8.8 KWh, and 76C consumes an average of 10.4 KWh, while 78C, 77C, 76C feed housing units only as shown in Fig. (3.27).

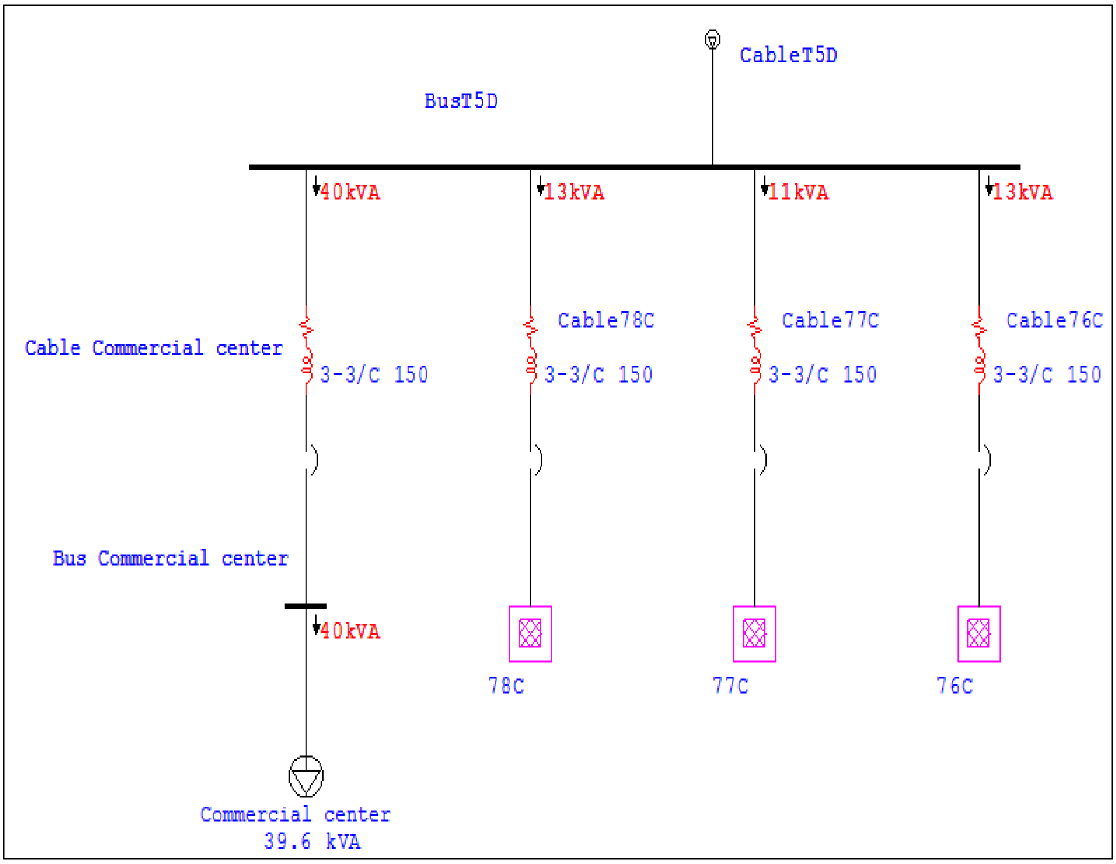

Figure 3.27: Branch T5D in Transform T5

For more details about 78C, 77C, and 76C, please refer to Appendix E.3.

3.3.6 Sixth Transform (T6)

The sixth transform (T6) has a capacity of 1600 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T6 includes 5 Sub Distribution Board (S.D.B) named (S.D.B1, S.D.B2, S.D.B3, S.D.B4, S.D.B5) and lighting cable as shown in Fig. (3.28).

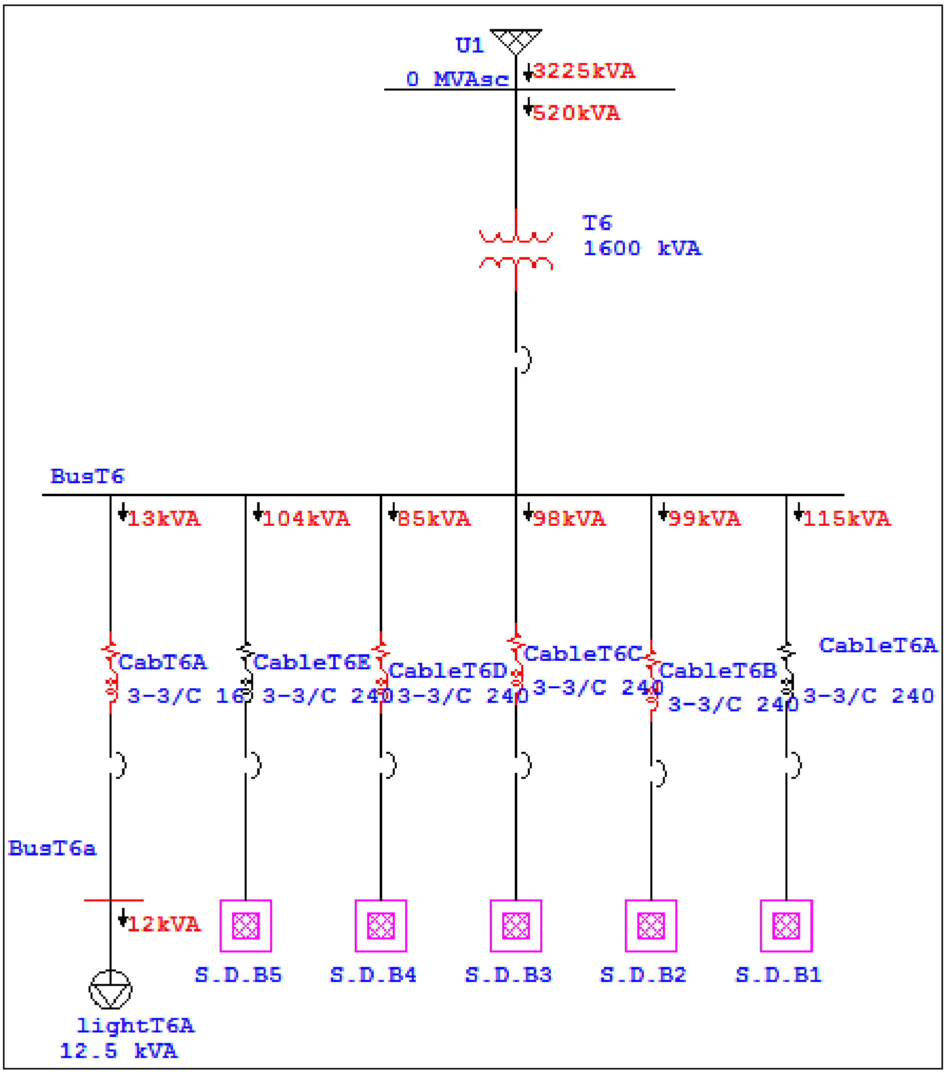

Figure 3.28: Branches in Transform T6

Table 3.7: Load on Transform T6

Sub Distribution Board(S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
S.D.B1	M.P1/1	20	31	46.1	24.8	91.2
	M.P1/2	19	30	43.8	24	
	M.P1/3	20	31	46.1	24.8	
	M.P1/4	14	22	32.2	17.6	
S.D.B2	M.P2/1	19	30	43.7	24	80
	M.P2/2	14	22	32.2	17.6	
	M.P2/3	15	24	34.5	19.2	
	M.P2/4	15	24	34.5	19.2	
S.D.B3	M.P3/1	15	24	34.5	19.2	79.2
	M.P3/2	14	22	32.2	19.2	
	M.P3/3	20	31	46.1	24.8	
	M.P3/4	13	20	29.9	16	
S.D.B4	M.P4/1	10	16	23	12.8	68.5
	M.P4/2	12	19	27.6	15.2	
	M.P4/3	10	16	23	12.8	
	M.P4/4	12	19	27.6	15.2	
	M.P4/5	10	16	23	12.8	
S.D.B5	M.P5/1	11	17	25.3	13.6	82.4
	M.P5/2	9	14	20.7	11.2	
	M.P5/3	16	25	36.8	20	
	M.P5/4	19	30	43.8	24	
	M.P5/5	11	17	25.3	13.6	
lightT6A			12.5	56.82	10	10
Total		318	512.5	788.72	411.3	411.3

S.D.B1 branches into 4 L.V Metering Panel (M.P) named (M.P1/1, M.P1/2, M.P1/3, and M.P1/4). The average energy consumption per hour of all loads is as follows: M.P1/1 consumes an average of 24.8 KWh, M.P1/2 consumes an average of 24 KWh, M.P1/3 consumes an average of 24.8 KWh, and M.P1/4 consumes an average of 17.6 KWh. While M.P1/1, M.P1/2, M.P1/3, and M.P1/4 feed housing units only as shown in Fig. (3.29).

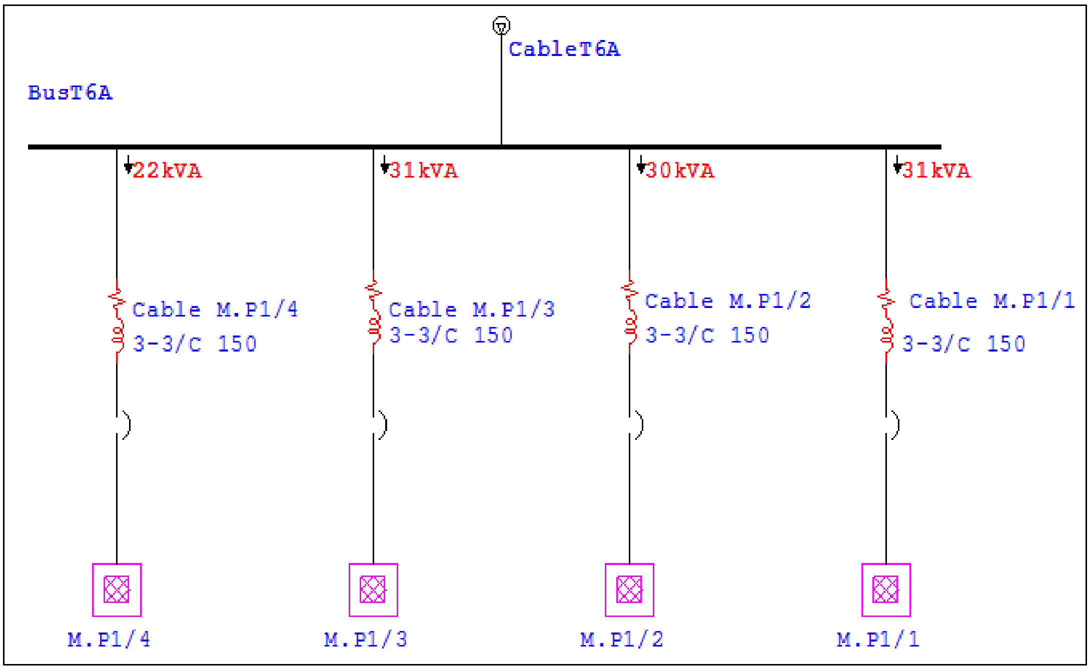

Figure 3.29: Branch S.D.B1 in Transform T6

For more details about M.P1/1, M.P1/2, M.P1/3, and M.P1/4, please refer to Appendix F.1.

S.D.B2 branches into 4 L.V Metering Panel (M.P) named (M.P2/1, M.P2/2, M.P2/3, and M.P2/4). The average energy consumption per hour of all loads is as follows: M.P2/1 consumes an average of 24 KWh, M.P2/2 consumes an average of 17.6 KWh, M.P2/3 consumes an average of 19.2 KWh, and M.P2/4 consumes an average of 19.2 KWh. While M.P2/1, M.P2/2, M.P2/3, and M.P2/4 feed housing units only as shown in Fig. (3.30).

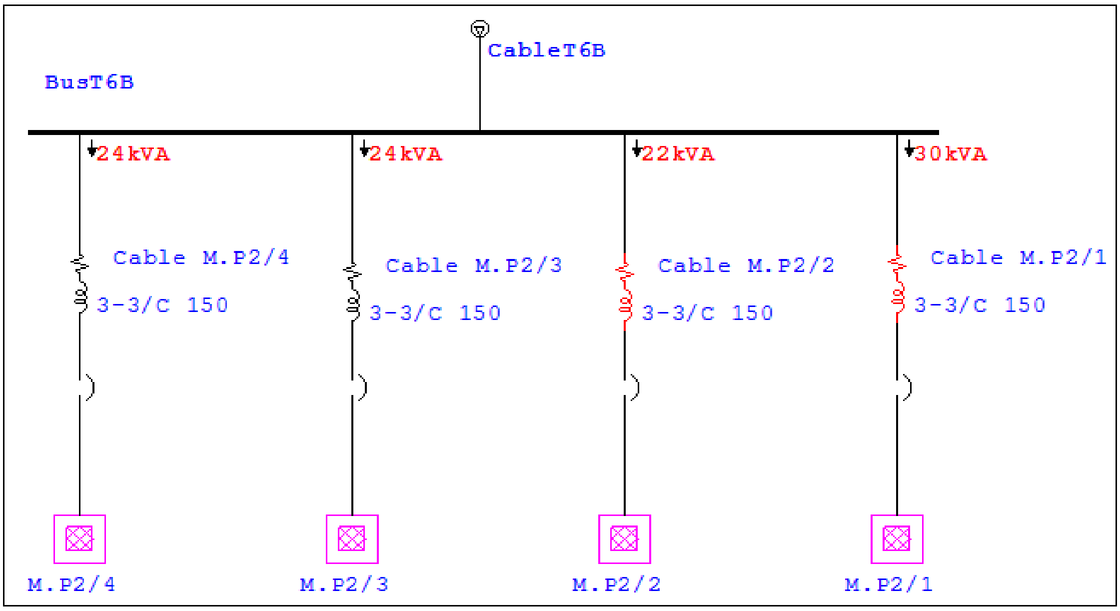

Figure 3.30: Branch S.D.B2 Transform T6

For more details about M.P2/1, M.P2/2, M.P2/3, and M.P2/4, please refer to Appendix F.2.

S.D.B3 branches into 4 L.V Metering Panel (M.P) named (M.P3/1, M.P3/2, M.P3/3, and M.P3/4). The average energy consumption per hour of all loads is as follows: M.P3/1 consumes an average of 19.2 KWh, M.P3/2 consumes an average of 17.6 KWh, M.P3/3 consumes an average of 24.8 KWh, and M.P3/4 consumes an average of 16 KWh. While M.P3/1, M.P3/2, M.P3/3, and M.P3/4 feed housing units only as shown in Fig. (3.31).

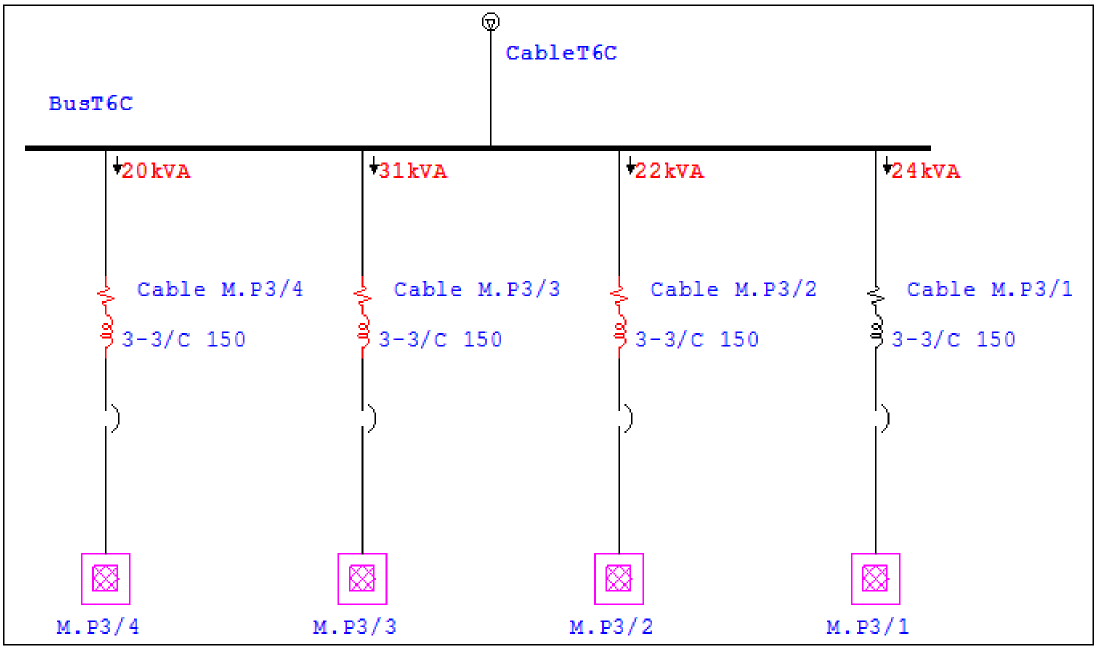

Figure 3.31: Branch S.D.B3 Transform T6

For more details about M.P3/1, M.P3/2, M.P3/3, and M.P3/4, please refer to Appendix F.3.

S.D.B4 branches into 5 L.V Metering Panel (M.P) named (M.P4/1, M.P4/2, M.P4/3, and M.P4/4, M.P4/5) to feed the housing units. The average energy consumption per hour of all loads is as follows: M.P4/1 consumes an average of 12.8 KWh, M.P4/2 consumes an average of 15.2 KWh, M.P4/3 consumes an average of 12.8 KWh, M.P4/4 consumes an average of 15.2 KWh, and M.P4/5 consumes an average of 12.8 KWh. While M.P4/1, M.P4/2, M.P4/3, M.P4/4, and M.P4/5 feed housing units only as shown in Fig. (3.32).

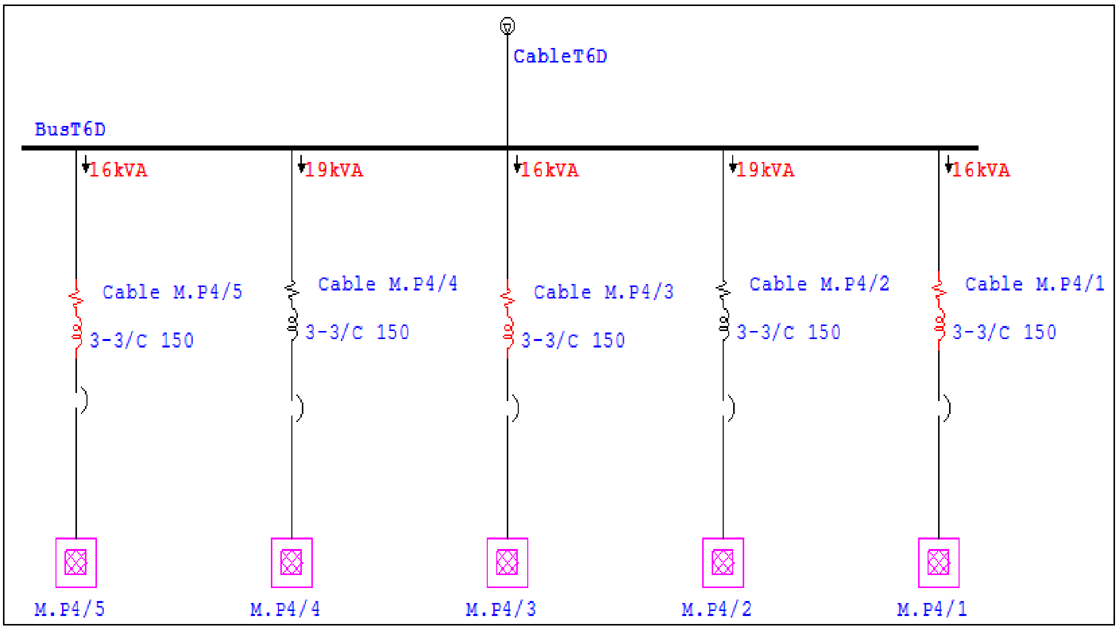

Figure 3.32: Branch S.D.B4 Transform T6

For more details about M.P4/1, M.P4/2, M.P4/3, M.P4/4, and M.P4/5, please refer to Appendix F.4.

S.D.B5 branches into 5 L.V Metering Panel (M.P) named (M.P5/1, M.P5/2, M.P5/3, and M.P5/4, M.P5/5) to feed the housing units. The average energy consumption per hour of all loads is as follows: M.P5/1 consumes an average of 13.6 KWh, M.P5/2 consumes an average of 11.2 KWh, M.P5/3 consumes an average of 20 KWh, M.P5/4 consumes an average of 24 KWh, and M.P5/5 consumes an average of 13.6 KWh. While M.P5/1, M.P5/2, M.P5/3, M.P5/4, and M.P5/5 feed housing units only as shown in Fig. (3.33).

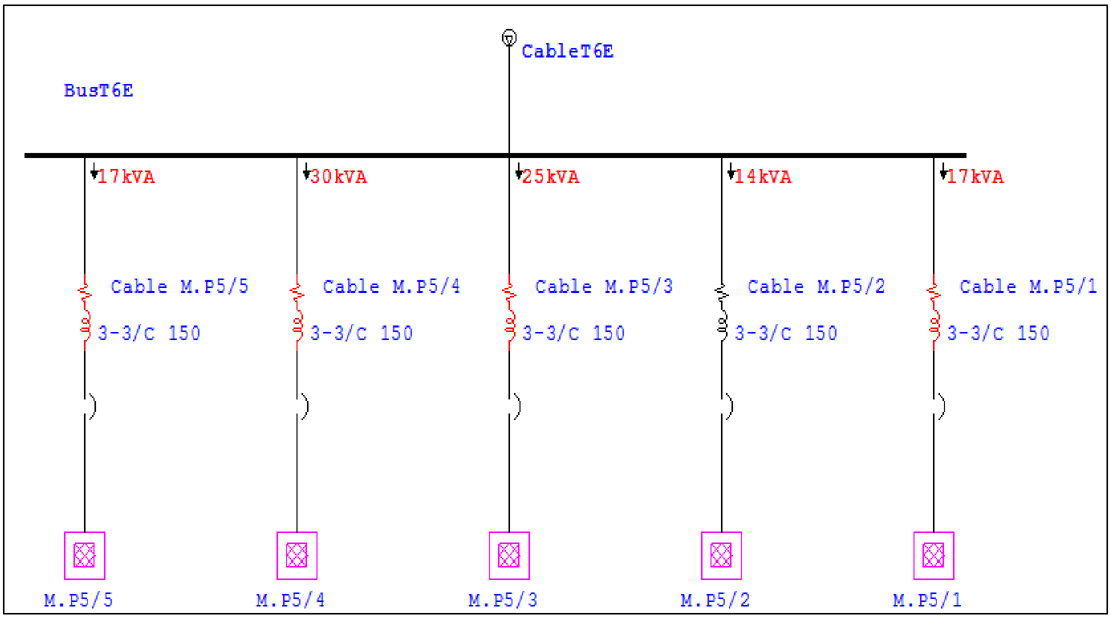

Figure 3.33: Branch S.D.B5 Transform T6

For more details about M.P5/1, M.P5/2, M.P5/3, M.P5/4, and M.P5/5, please refer to Appendix F.5.

3.3.7 Seventh Transform (T7)

The seventh transform (T7) has a capacity of 1250 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T7 includes 4 Sub Distribution Board (S.D.B) named (S.D.B6, S.D.B7, S.D.B8, S.D.B9) and lighting cable as shown in Fig. (3.34).

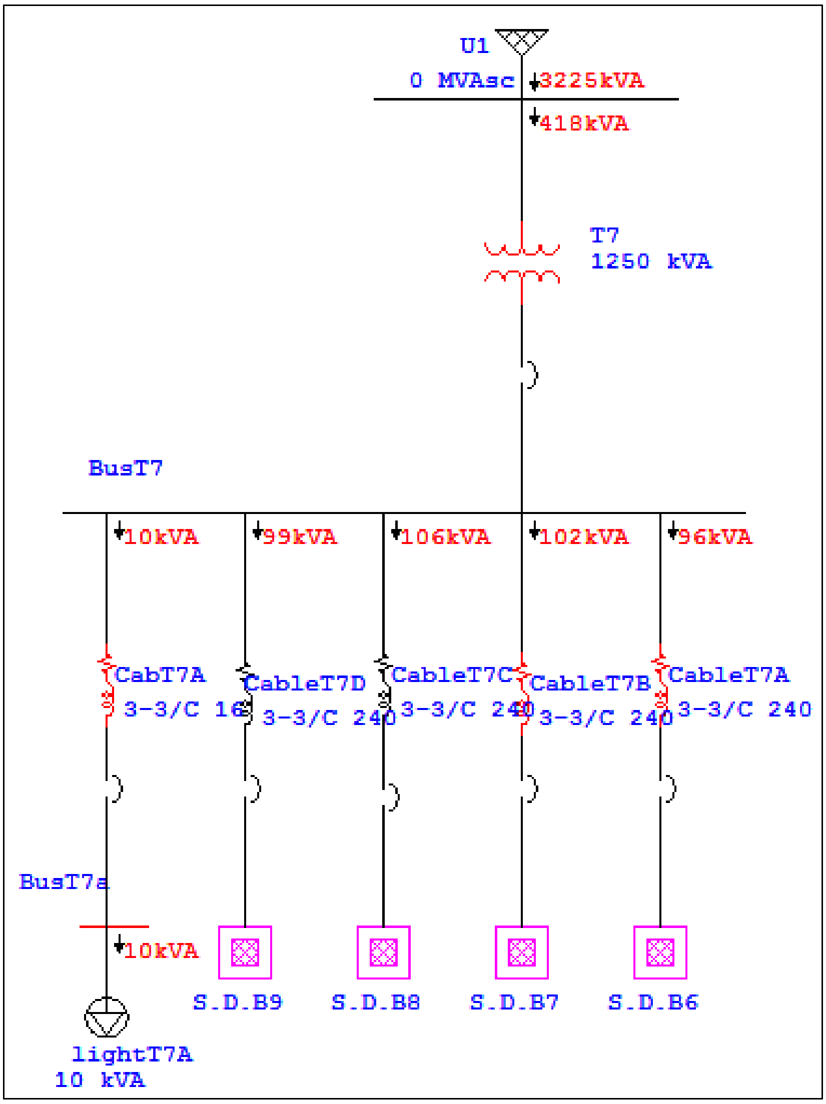

Figure 3.34: Branches in Transform T7

Table 3.8: Load on Transform T7

Sub Distribution Board(S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
S.D.B6	M.P6/1	16	25	36.8	20	75.84
	M.P6/2	18	28	41.4	22.4	
	M.P6/3	11	17	25.3	13.6	
	M.P6/4	10	16	23	12.8	
	School 5	1	8.8	40	7.04	
S.D.B7	M.P7/1	18	28	41.5	22.4	81.6
	M.P7/2	12	19	27.6	15.2	
	M.P7/3	12	19	27.6	15.2	
	M.P7/4	11	17	25.3	13.6	
	M.P7/5	12	19	27.6	15.2	
S.D.B8	M.P8/1	14	22	32.2	17.6	84.8
	M.P8/2	15	24	34.5	19.2	
	M.P8/3	15	24	34.5	19.2	
	M.P8/4	13	20	29.9	16	
	M.P8/5	10	16	23	12.8	
S.D.B9	M.P9/1	13	20	29.9	16	78.4
	M.P9/2	10	16	23	12.8	
	M.P9/3	11	17	25.3	13.6	
	M.P9/4	11	17	25.3	13.6	
	M.P9/5	18	28	41.5	22.4	
lightT7A			10	45.45	8	8
Total		251	410.8	660.65	328.64	328.64

S.D.B 6 branches into 4 L.V Metering Panel (M.P) named (M.P6/1, M.P6/2, M.P6/3, M.P6/4) which feed the housing units and school. The average energy consumption per hour of all loads are as follows: school consumes an average of 7.04 KWh, M.P6/1 consumes an average of 20 KWh, M.P6/2 consumes an average of 22.4 KWh, M.P6/3 consumes an average of 13.6 KWh, and M.P6/4 consumes an average of 12.8 KWh, while M.P6/1, M.P6/2, M.P6/3, M.P6/4 feed housing units only as shown in Fig. (3.35).

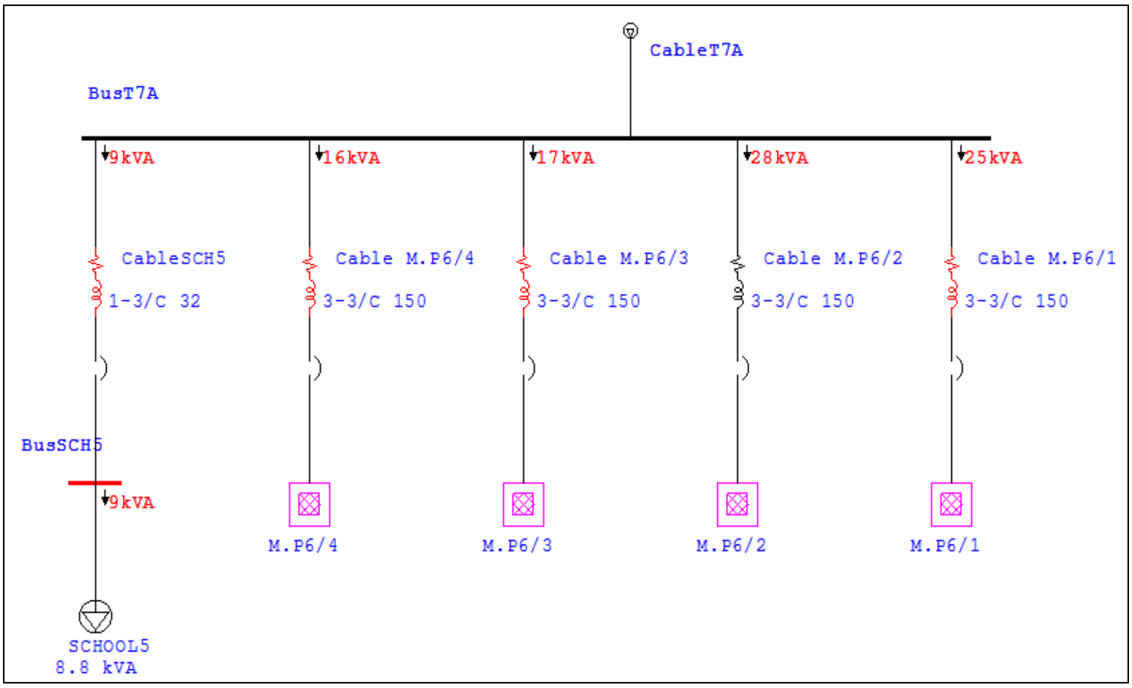

Figure 3.35: Branch S.D.B6 Transform T7

For more details about M.P6/1, M.P6/2, M.P6/3, and M.P6/4, please refer to Appendix G.1.

S.D.B7 branches into 5 L.V Metering Panel (M.P) named (M.P7/1, M.P7/2, M.P7/3, and M.P7/4, M.P7/5) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P7/1 consumes an average of 22.4 KWh, M.P7/2 consumes an average of 15.2 KWh, M.P7/3 consumes an average of 15.2 KWh, M.P7/4 consumes an average of 13.6 KWh, and M.P7/5 consumes an average of 15.2 KWh. While M.P7/1, M.P7/2, M.P7/3, M.P7/4, and M.P7/5 feed housing units only as shown in Fig. (3.36).

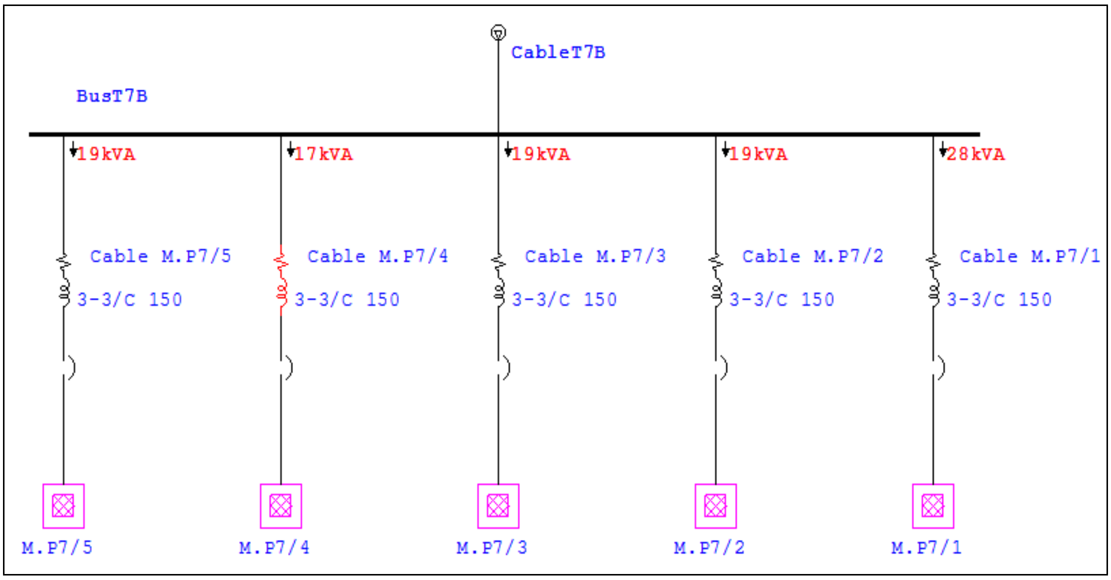

Figure 3.36: Branch S.D.B7 Transform T7

For more details about M.P7/1, M.P7/2, M.P7/3, M.P7/4, and M.P7/5, please refer to Appendix G.2.

S.D.B8 branches into 5 L.V Metering Panel (M.P) named (M.P8/1, M.P8/2, M.P8/3, and M.P8/4, M.P8/5) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P8/1 consumes an average of 17.6 KWh, M.P8/2 consumes an average of 19.2 KWh, M.P8/3 consumes an average of 19.2 KWh, M.P8/4 consumes an average of 16 KWh, and M.P8/5 consumes an average of 12.8 KWh. While M.P8/1, M.P8/2, M.P8/3, M.P8/4, and M.P8/5 feed housing units only as shown in Fig. (3.37).

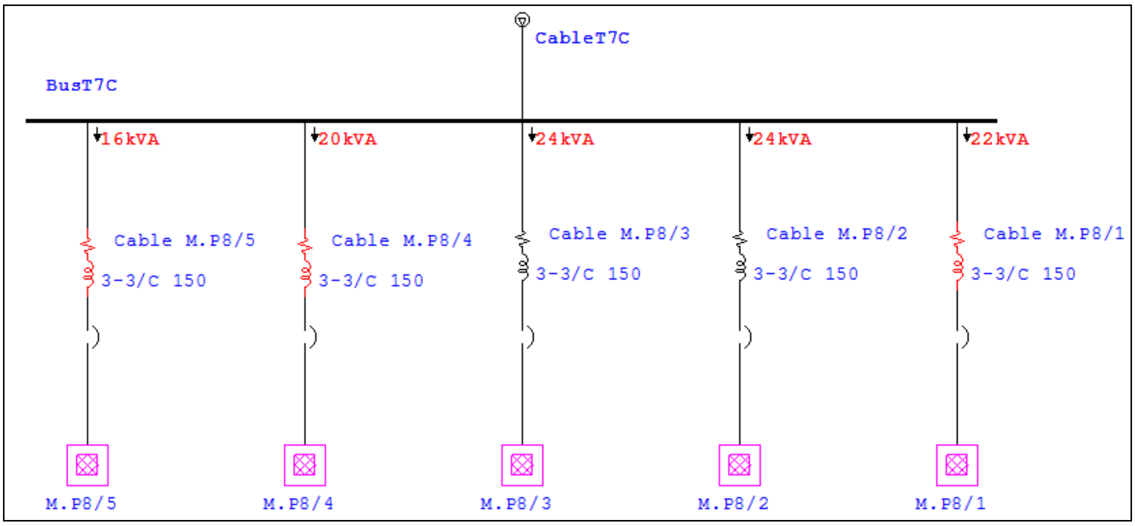

Figure 3.37: Branch S.D.B8 Transform T7

For more details about M.P8/1, M.P8/2, M.P8/3, M.P8/4, and M.P8/5, please refer to Appendix G.3.

S.D.B 9 branches into 5 L.V Metering Panel (M.P) named (M.P9/1, M.P9/2, M.P9/3, M.P9/4, M.P9/5) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P9/1 consumes an average of 16 KWh, M.P9/2 consumes an average of 12.8 KWh, M.P9/3 consumes an average of 13.6 KWh, M.P9/4 consumes an average of 13.6 KWh, and M.P9/5 consumes an average of 22.4 KWh as shown in Fig. (3.38).

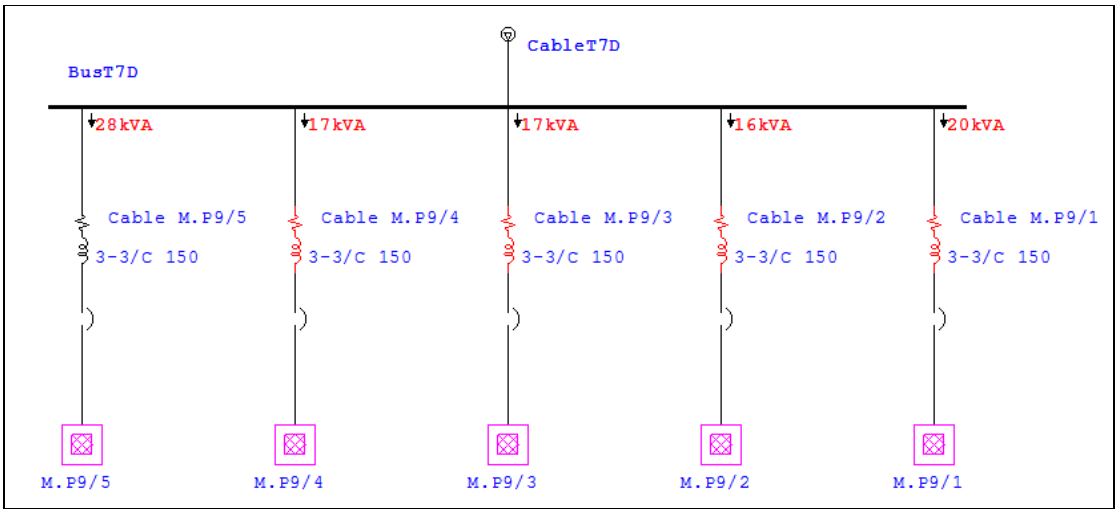

Figure 3.38: Branch S.D.B9 Transform T7

For more details about M.P9/1, M.P9/2, M.P9/3, M.P9/4, and M.P9/5, please refer to Appendix G.4.

3.3.8 Eighth Transform (T8)

The eighth transform (T8) has a capacity of 1600 KVA and power factor 0.8, which converts the next voltage of the electric grid (22 KV) to low voltage network (0.4KV) which feeds the Saudi Village, T8 includes 6 Sub Distribution Board (S.D.B) named (S.D.B10, S.D.B11, S.D.B12, S.D.B13, S.D.B14, S.D.B15) and lighting cable as shown in Fig. (3.39) as shown in Fig. (3.39).

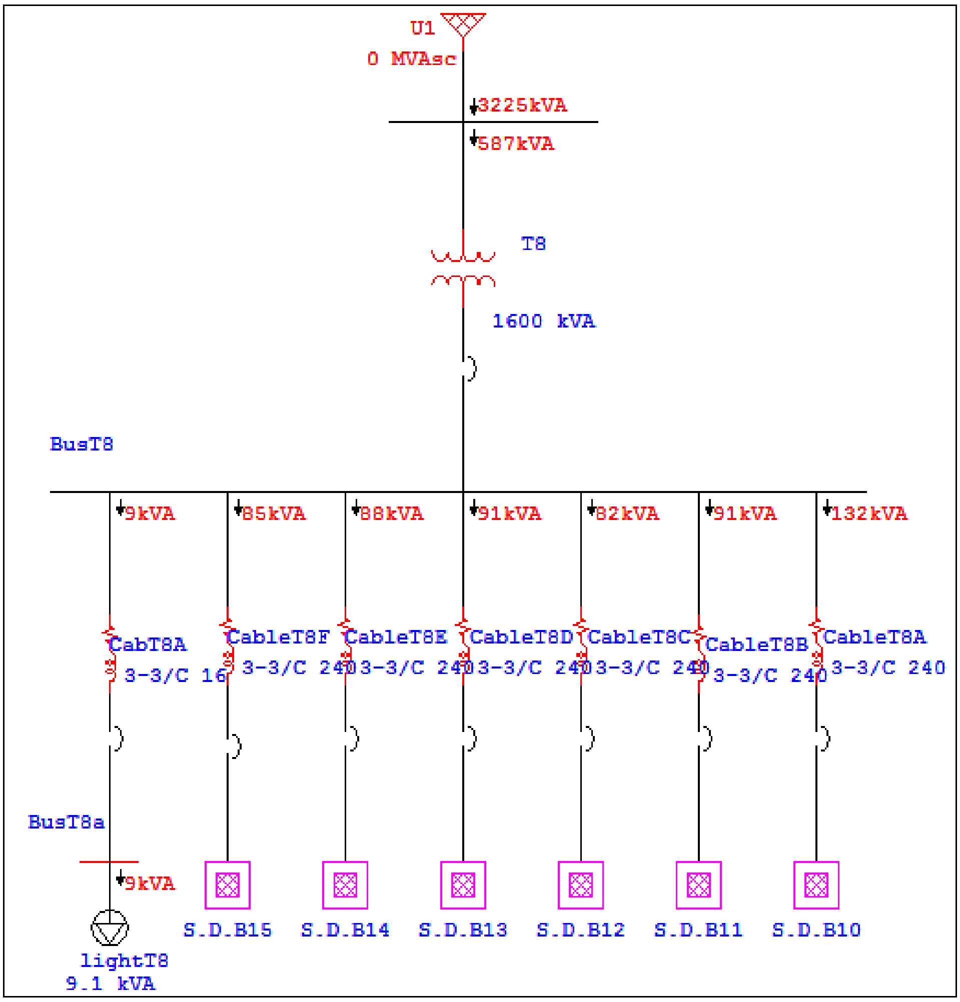

Figure 3.39: Branches in Transform T8

Table 3.9: Load on Transform T8

Sub Distribution Board (S.D.B)	Metering Panel (M.P)	Number of unit	Average Electricity Demand		Average Consumption (KWh)	Total Consumption (KWh)
			KVA	A		
S.D.B10	M.P10/1	16	25	36.9	20	105.44
	M.P10/2	11	17	25.4	13.6	
	M.P10/3	10	16	23.1	12.8	
	M.P10/4	19	30	43.8	24	
	M.P10/5	22	35	50.8	28	
	School 6	1	8.8	40	7.04	
S.D.B11	M.P11/1	19	30	43.8	24	72.8
	M.P11/2	12	19	27.6	15.2	
	M.P11/3	18	28	41.5	22.4	
	M.P11/4	9	14	20.7	11.2	
S.D.B12	M.P12/1	14	22	32.2	17.6	65.6
	M.P12/2	18	28	41.5	22.4	
	M.P12/3	12	19	27.6	15.2	
	M.P12/4	8	13	18.4	10.4	
S.D.B13	M.P13/1	13	20	29.9	16	73.6
	M.P13/2	15	24	34.6	19.2	
	M.P13/3	15	24	34.6	19.2	
	M.P13/4	15	24	34.6	19.2	
S.D.B14	M.P14/1	22	35	50.1	28	71.2
	M.P14/2	15	24	34.6	19.2	
	M.P14/3	19	30	43.8	24	
S.D.B15	M.P15/1	14	22	32.2	17.6	68
	M.P15/2	10	16	23	12.8	
	M.P15/3	13	20	29.9	16	
	M.P15/4	17	27	39.2	21.6	
lightT8A			9.1	41.2	7.28	7.28
Total		357	579.92	901	463.92	463.92

S.D.B10 branches into 5 L.V Metering Panel (M.P) named (M.P10/1, M.P10/2, M.P10/3, and M.P10/4, M.P10/5) which feed the housing units and school. The average energy consumption per hour of all loads are as follows: School consumes an average of 7.04 KWh, M.P10/1 consumes an average of 20 KWh, M.P10/2 consumes an average of 13.6 KWh, M.P10/3 consumes an average of 12.8 KWh, M.P10/4 consumes an average of 24 KWh, and M.P10/5 consumes an average of 28 KWh. While M.P10/1, M.P10/2, M.P10/3, M.P10/4, and M.P10/5 feed housing units only as shown in Fig. (3.40).

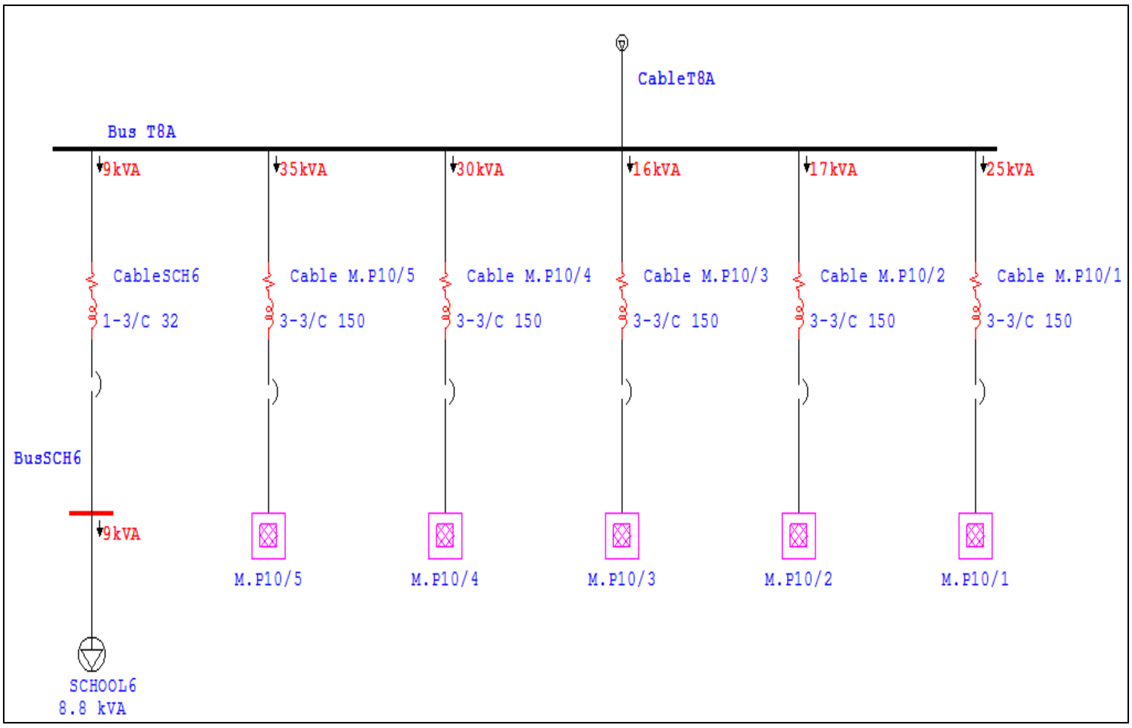

Figure 3.40: Branch S.D.B10 Transform T8

For more details about M.P10/1, M.P10/2, M.P10/3, M.P10/4, and M.P10/5, please refer to Appendix H.1.

S.D.B11 branches into 4 L.V Metering Panel (M.P) named (M.P11/1, M.P11/2, and M.P11/3, M.P11/4) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P11/1 consumes an average of 24 KWh, M.P11/2 consumes an average of 15.2 KWh, M.P11/3 consumes an average of 22.4 KWh, and M.P11/4 consumes an average of 11.2 KWh as shown in Fig. (3.41).

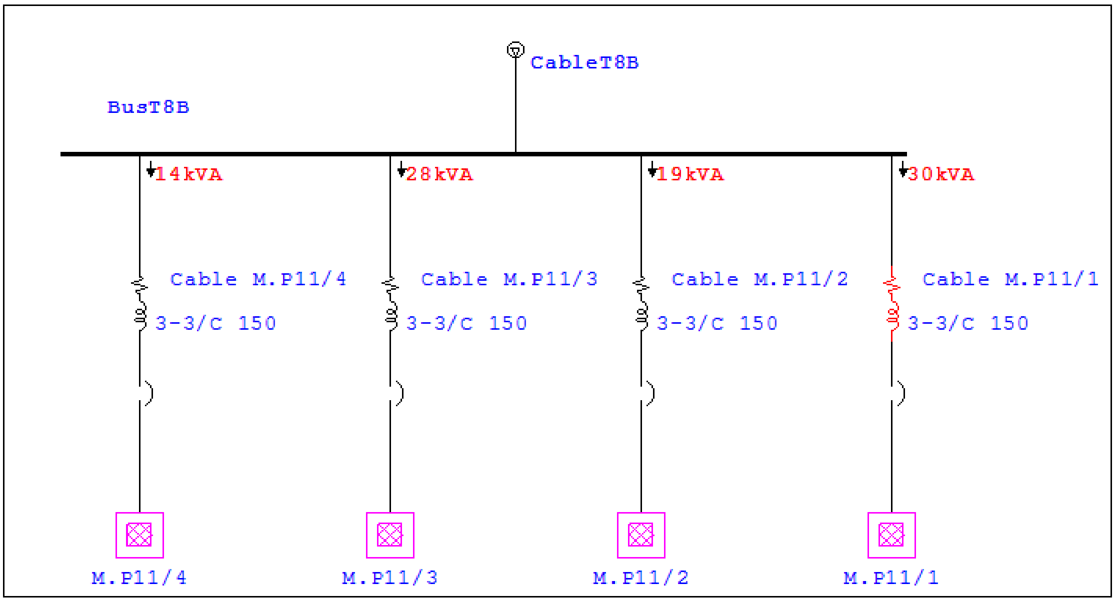

Figure 3.41: Branch S.D.B11 Transform T8

For more details about M.P11/1, M.P11/2, M.P11/3, and M.P11/4, please refer to Appendix H.2.

S.D.B12 branches into 4 L.V Metering Panel (M.P) named (M.P12/1, M.P12/2, and M.P12/3, M.P12/4) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P12/1 consumes an average of 17.6 KWh, M.P12/2 consumes an average of 22.4 KWh, M.P12/3 consumes an average of 15.2 KWh, and M.P12/4 consumes an average of 10.4 KWh as shown in Fig. (3.42).

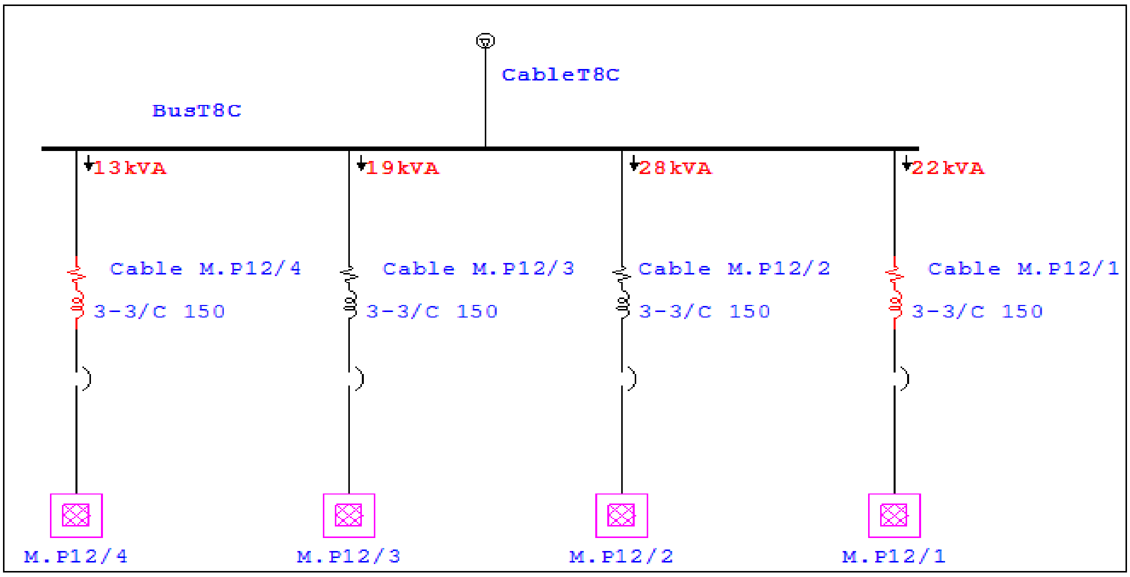

Figure 3.42: Branch S.D.B12 Transform T8

For more details about M.P12/1, M.P12/2, M.P12/3, and M.P12/4, please refer to Appendix H.3.

S.D.B13 branches into 4 L.V Metering Panel (M.P) named (M.P13/1, M.P13/2, and M.P13/3, M.P13/4) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P13/1 consumes an average of 16 KWh, M.P13/2 consumes an average of 19.2 KWh, M.P13/3 consumes an average of 19.2 KWh, and M.P13/4 consumes an average of 20 KWh as shown in Fig. (3.43).

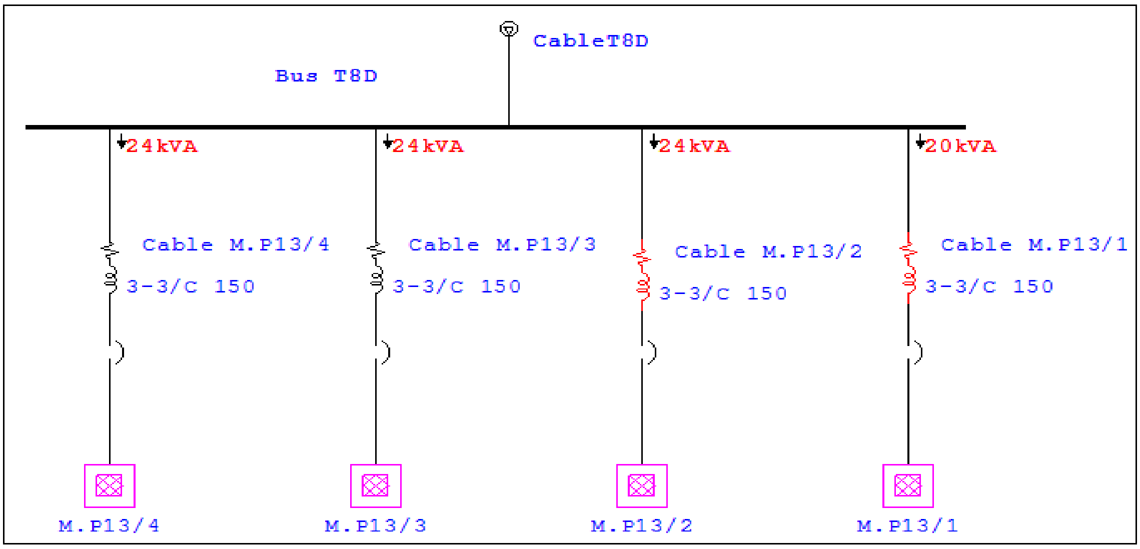

Figure 3.43: Branch S.D.B13 Transform T8

For more details about M.P13/1, M.P13/2, M.P13/3, and M.P13/4, please refer to Appendix H.4.

S.D.B14 branches into 3 L.V Metering Panel (M.P) named (M.P14/1, M.P14/2, and M.P14/3) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P14/1 consumes an average of 28 KWh, M.P14/2 consumes an average of 19.2 KWh, and M.P14/3 consumes an average of 24 KWh as shown in Fig. (3.44).

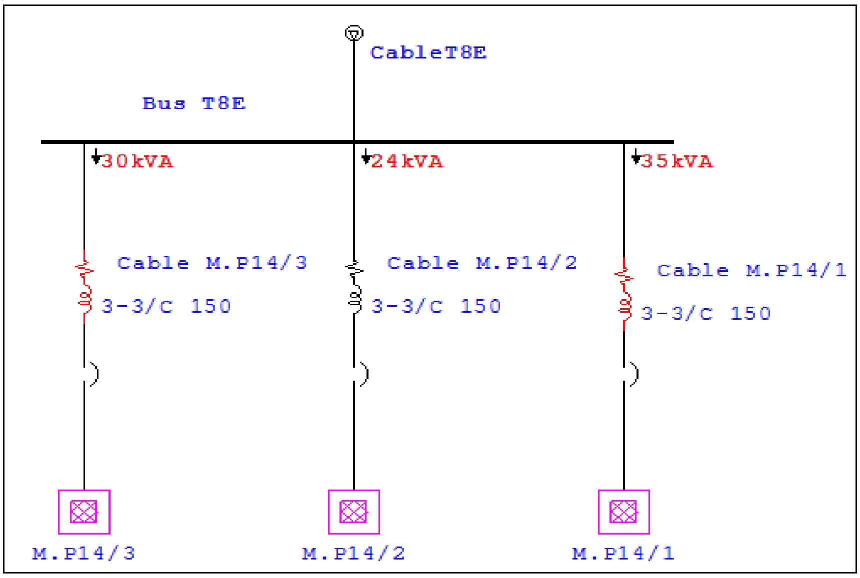

Figure 3.44: Branch S.D.B14 Transform T8

For more details about M.P14/1, M.P14/2, and M.P14/3, please refers to Appendix H.5.

S.D.B15 branches into 4 L.V Metering Panel (M.P) named (M.P15/1, M.P15/2, M.P15/3, M.P15/4) which feed the housing units. The average energy consumption per hour of all loads is as follows: M.P15/1 consumes an average of 17.6 KWh, M.P15/2 consumes an average of 12.8 KWh, M.P15/3 consumes an average of 16 KWh, and M.P15/4 consumes an average of 21.6 KWh as shown in Fig. (3.45).

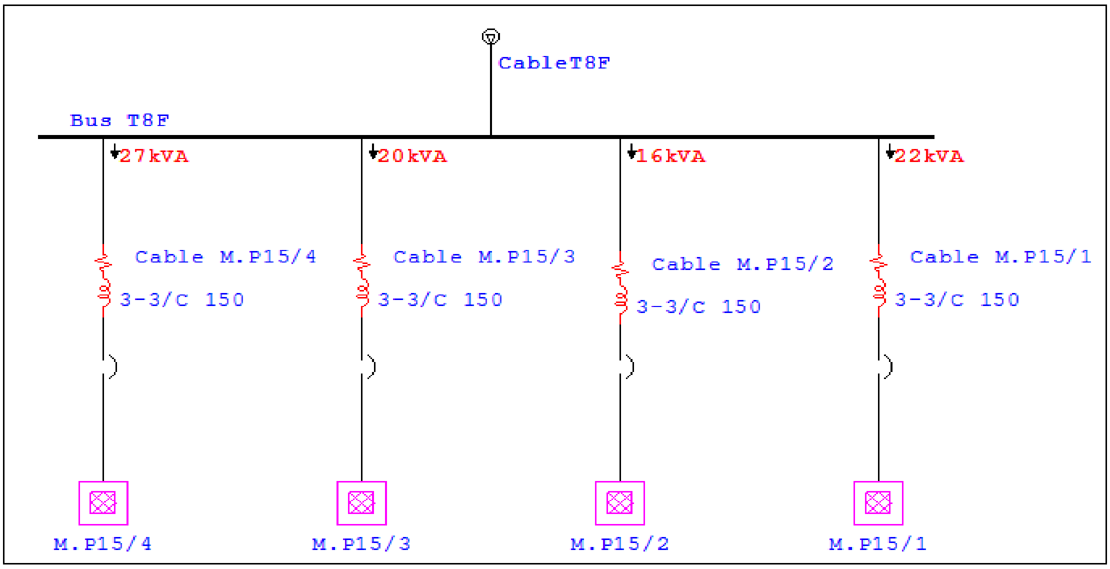

Figure 3.45: Branch S.D.B15 Transform T8

For more details about M.P15/1, M.P15/2, M.P15/3, and M.P15/4, please refer to Appendix H.6.

Chapter 4
Suggested Scheme

4.1 Background

To overcome the problem of power outages in the Saudi village, we use eight diesel generators, where each generator is placed beside each electric transformer from the eight electrical transformers and covers the load on that transformer, and is manufactured by FG Wilson Company. The capacity of these generators is the average consumption rate load of the electrical transformers. Use the generators in two cases.
First case used in prime rate and second case used in standby rate Table (4.1) and the comparison is made between the two cases.

Table 4.1: Generator Capacity at Prime and standby rates (KVA)

generator	Prime Rate	Standby Rate
1	400	400
2	350	330
3	300	300
4	455	450
5	400	400
6	550	550
7	455	450
8	600	605
Total	3510	3485

Prime Rating, These ratings are applicable for supplying continuous electrical power (At variable load) in lieu of commercially purchased power. There is not limitation to the annual hours of operation and same model can be supply 10% overload power for 1 hour in 12 hours [25].
Standby Rating, These ratings are applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. Overload isn't permitted on these ratings [25].
Power Cut off duration is usually eight hours per day; these hours are sometimes in the day and sometimes at night as what set on a schedule regularly by the Electricity Distribution Company in Gaza Strip. In the case of power cuts at night. The electrical loads for schools neglected, and when the power cut on day, the electrical loads for street lighting neglected, and in public holidays the street lighting and loads schools are neglected during the day.
In this chapter , we working study to provide electricity on Saudi village using these generators on the same electrical grid, and we account the financial cost, consumption of fuel for these generators, And we take the account of the annual maintenance , the price of generators , the proportion of risk , the cost of using the electricity network in the case of the implementation of this project from outside the electricity distribution company (Wheeling cost) and the cost of installing automatic

transfer switch (ATS) system operation on/off generators automatically in the following cases.

1. Generators operating at full capacity.
2. Generators operating at full load.
3. Generators operating at full load without street lighting.
4. Generators operating at full load without schools.
5. Generators operating at full load without the streets Lighting and schools.
6. Generators operating when the loads distributor on 366 day as figure (4.1).

The 366 day divides into two sections. The First Section, where generators operating with schools and the number of his days 240 days divide into two parts, the first part, the generator operates at night, so the electricity load schools are neglected and the number of his days 120 days, the second part, which calculates the electrical load of the schools.

The second section, where generators operating without schools and the number of days 90 days (summer vacation) is added to Fridays in the remaining nine months and is divided into two parts, the first part without lighting and schools and a number of days is 63, and the second part without schools and the number of days is 63.

The days of year in the sixth case as follows.

Without school 120+63 = 183 day

Without light 120=120 day

Without light & school =63 day

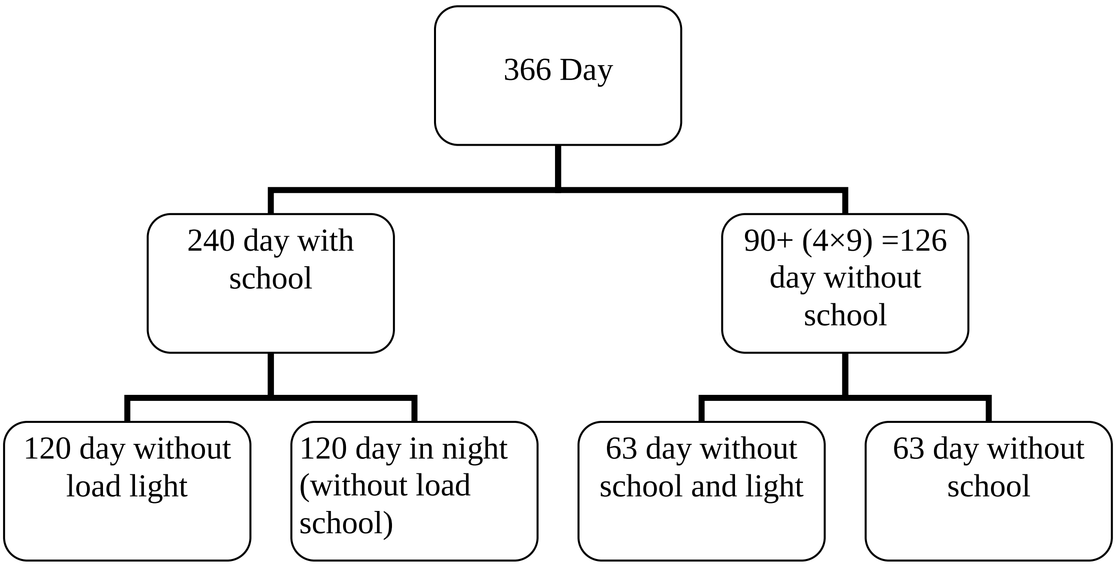

Figure 4.1: Generators Operation during 366 days

in the case 2,3,4,5 are calculated the fuel consumption base on of the electrical load on the generator as the 1 KVA consumes about 0.2 liters of diesel on average, as inferred from catalogs used generators, while in Case 1 is calculated fuel consumption of direct catalog, and in the case 6 days year will be divided by the previous cases.

4.2 Generators Specifications

In this study, we choose generators FG Wilson Company are obtained on the prices of these generators and necessary ATS system from Murtaja Company, which imports and sells these generators in the Gaza Strip as in Table 4.2.

Table 4.2: Generator Cost at Prime and Standby Rate

Generator	Standby $	ATS Standby NIS	Prime $	ATS Prime NIS
1	62000	8500	65000	9000
2	52000	7500	62000	8500
3	50000	7000	52000	7500
4	65000	9000	67000	9500
5	62000	8500	65000	9000
6	70000	10000	72000	10500
7	65000	9000	67000	9500
8	72000	10500	75000	11000
Total	498000	70000 $18372.7	525000	74500 $19553.8

The generator operates at frequency 50 HZ and 1500 rpm [25, 26]

4.3 Simulation in ETAP

In this section we use power factor 0.8 PF and the number house equal 1790 unit approximately , that require an average of 1.5 KVA (1.2 KW) per unit, and six schools that require an average of 8.8 KVA (7.04 KW) per school, unique Masjid contain the water well requires an average about 26.4 KVA (21.12 KW), a cultural center and kindergarten requires an average about 26.4 KVA (21.12 KW), a health center requires an average of about 139 KVA (111.2 KW), commercial center requires an average about 39.6 KVA (31.68 KW), and light street requires an average 75 KVA (60 KW) , and we use cost Liter Diesel equal NIS5.2=$1.36, and $1 equal 3.81NIS , the load capacity as shown in Table 4.3.

We used ETAP software to simulate the same electric grid in Saudi village. We have data entry of eight electrical generators, electrical cables connected to generators, buildings and other facilities. We obtained these values from the catalogs which have taken from Murtaja Company in Gaza Strip. The ETAP software provides the value of load flow analysis of sources, loads, each Sub distribution board S.D.B. and each metering panel M.P. The international electro technical commission (IEC) standard is used as a reference.

Table 4.3: Various Loading Conditions (KVA)

Generator	Full Load	Full Load without Light &school	Full Load without school	Full Load without Light
1	346	325	328	343
2	313	281	295	299
3	282	270	282	270
4	411	409	411	409
5	344	334	344	334
6	520	507	520	507
7	418	398	409	407
8	587	568	578	577
Total	3221	3092	3167	3146

4.4 Case One: Generators Full Capacity Operation

From the catalogue generator the fuel consumption and its cost when the liter diesel equal 5.2 NIS as shown in table 4.4:

Table 4.4: Generator Fuel Consumption and Cost at Full Capacity Operation

Generator	Fuel consumption at 1500 rpm L/hr	Cost fuel in hour $
1	79	107.44
2	64.8	88.128
3	60.1	81.73
4	89.2	121.31
5	79	107.44
6	108.6	147.69
7	89.2	121.31
8	119.3	162.24
Total	689.2	937.28

4.4.1 Energy Consumption

Housing Units: 1.5×0.8 =1.2KW.
1.2KW × 1 h×1790 unit = 2148 KWh.
Schools: 8.8×0.8=7.04 KW.
7.04 KW ×1 h× 6 unit = 42.24 KWh.
Masjid: 26.4×0.8= 21.12 KW.
21.12 KW ×1 h ×1unit=21.12 KWh.
Cultural Center: 26.4×0.8= 21.12 KW.
21.12 KW ×1 h ×1unit = 21.12 KWh.
Health center: 139×0.8= 111.2 KW.
111.2 KW ×1h×1unit= 111.2 KWh.
Commercial center: 39.6×0.8= 31.68 KW
31.68 KW ×1h ×1unit= 31.68 KWh.
Street Lighting: 75×0.8= 60 KW.
60 KW ×1h ×1unit=60 KWh.

Consumption load per hour = 2148 + 42.24+21.12 + 21.12 + 111.2 + 31.68 + 60
= 2435.36 KWh.
Consumption load in day = 2435.36 × 8 = 19482.88 KWh.
Consumption load in year = 19482.88 × 366 = 7130734.08 KWh.
The wheeling cost equals NIS 0.05 per 1 KWh.
The wheeling cost = 7130734.08 ×0.05 = NIS 356536.704 = $93579.187.
Cost fuel at Full capacity Operation = 689.2 L/hr = 937.3 $/hr.
In day 8 hour at Full capacity Operation.
$937.3 × 8 = $7498.4 in Day.
$7498.4 × 15 = $112476 in 15 Day.
798.4 $ × 30 =$224952 in 30 day.

4.4.2 Generator at Standby Rate

The initial cost from this project equals to adding generator cost and ATS cost as shown in Table 4.2.
Initial cost: ATS cost + Generator cost = $18372.7 +$ 498000 = $516372.7.
The risk cost and inflation rate equals 2% from the initial cost = $10327.45.
The maintenance cost equals 5% from initial cost =$ 25818.6.

Annual cost.

In first year.

Total cost=initial cost + fuel cost in year + wheeling cost = 516372.7+ (7498.4×366) + 93579.187 = 516372.7+2744414.4 + 93579.187 = $3354366.287

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6+ 10327.45 + 2744414.4 + 93579.187 =$2874139.637.
In third year equals second year.

4.4.3 Generator at Prime Rate

The initial cost from this project equals summation generator cost and ATS cost as shown in Table 4.2.
Initial cost: ATS cost + Generator cost = $19553.8 + $525000 = $544553
The risk cost and inflation rate equals 2% from the initial cost = $10891.06
The maintenance cost equals 5% from initial cost = $27227.65
From the catalogue generator the fuel consumption and its cost when the liter diesel equals NIS 5.2 as shown in table 4.5:

Table 4.5: Fuel Consumption and Cost from Generator in Prime Rate per Hour

Generator	Fuel consumption at 1500 rpm L/hr	fuel Cost $
1	79.9	108.66
2	69.6	94.65
3	59.5	80.92
4	94	127.84
5	79.9	108.66
6	108	146.88
7	94	127.84
8	120.3	163.6
Total	705.2	959.05

Cost fuel at Full capacity Operation = 705.2 L/hr = 959.05 $/hr.
In day 8 hour Full capacity Operation.
$959.05 × 8 = $7672.4 in Day.
$7672.4 × 15 = $115086 in 15 Day.
$7672.4×30=$230172 in 30 day.

Annual cost.

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (7672.4 ×366) + 93579.187 = 544553 +2808098.4 + 93579.187 = $3446230.587.

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2808098.4 + 93579.187 =$2939796.297.
In third year equal second year.

4.5 Case Two: Generators Operation at Full Load

From the catalogue generator the fuel consumption and its cost when the liter diesel equals NIS 5.2 as shown in Table 4.6:
1KVA consumes 0.2 liter from diesel.

Table 4.6: Generator Fuel Consumption and Cost at Full Load Operation

Generator	Load capacity KVA	Fuel consumption at 1500 rpm L/hr	Cost fuel per hour $
1	346	69.2	94.112
2	313	62.6	85.136
3	282	56.4	76.704
4	411	82.2	111.792
5	344	68.8	93.568
6	520	104	141.44
7	418	83.6	113.696
8	587	117.4	159.664
Total	3221	644.2	876.11

The wheeling cost = 7130734.08 ×0.05 = NIS 356536.704 = $93579.187.
Cost fuel at full load = 644.2 L/hr = 876.11 $/hr.
In day 8 hour at full load
$876.11×8= $7008.88 in day.
$7008.88 ×15 = $105133.2 in 15 day.
$7008.88×30 = $210266.4 in 30 day.

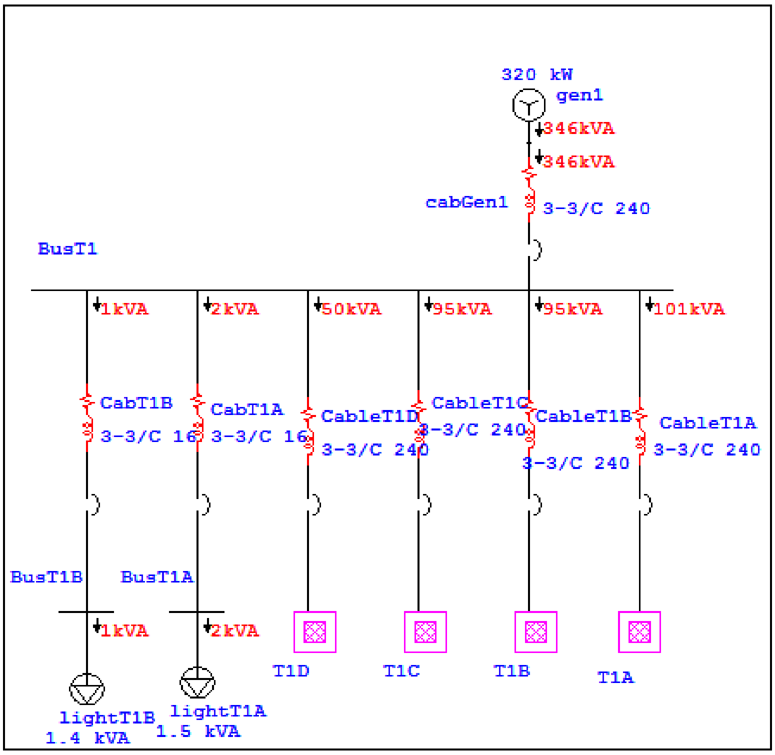

Figure 4.2: Generator 1 When Operation at Full Load

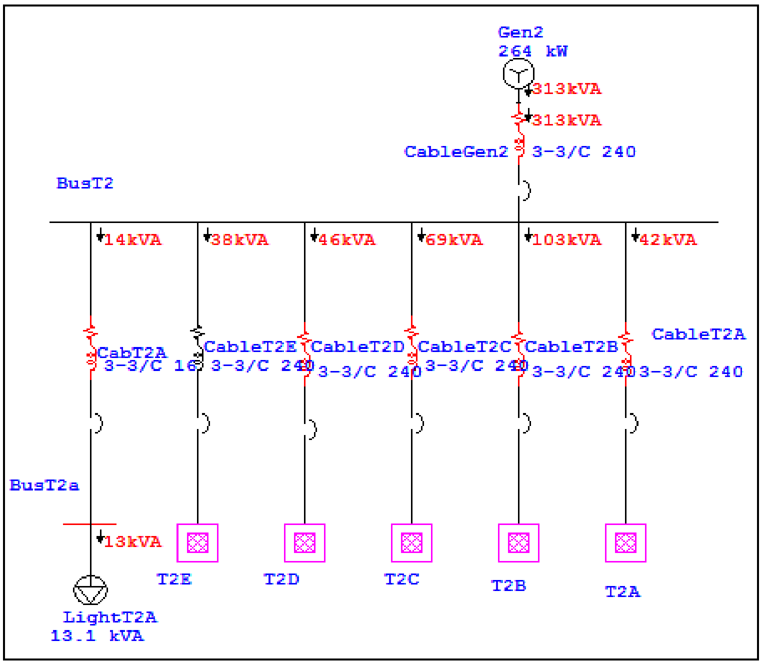

Figure 4.3: Generator 2 When Operation at Full Load

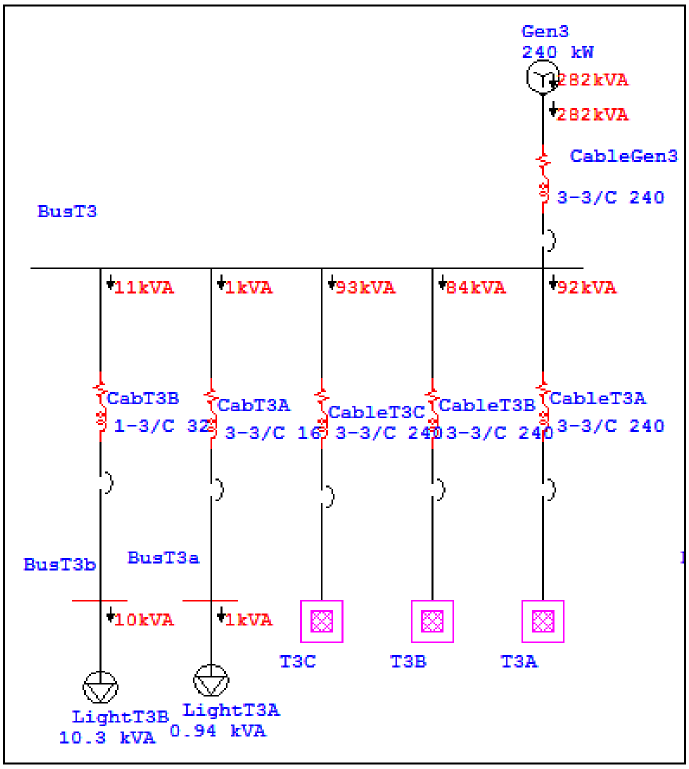

Figure 4.4: Generator 3 When Operation at Full Load

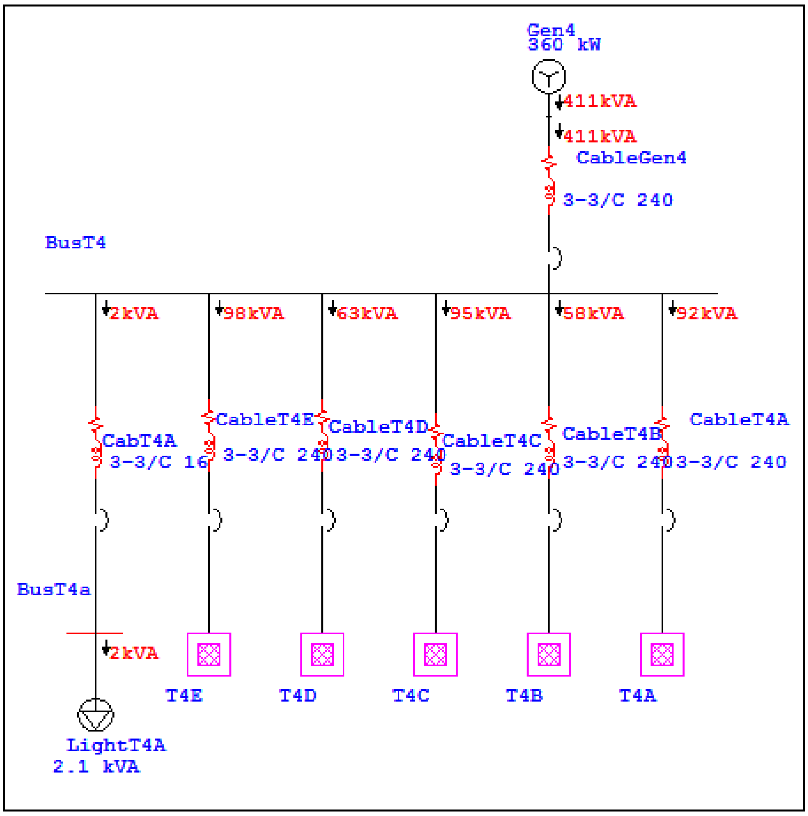

Figure 4.5: Generator 4 When Operation at Full Load

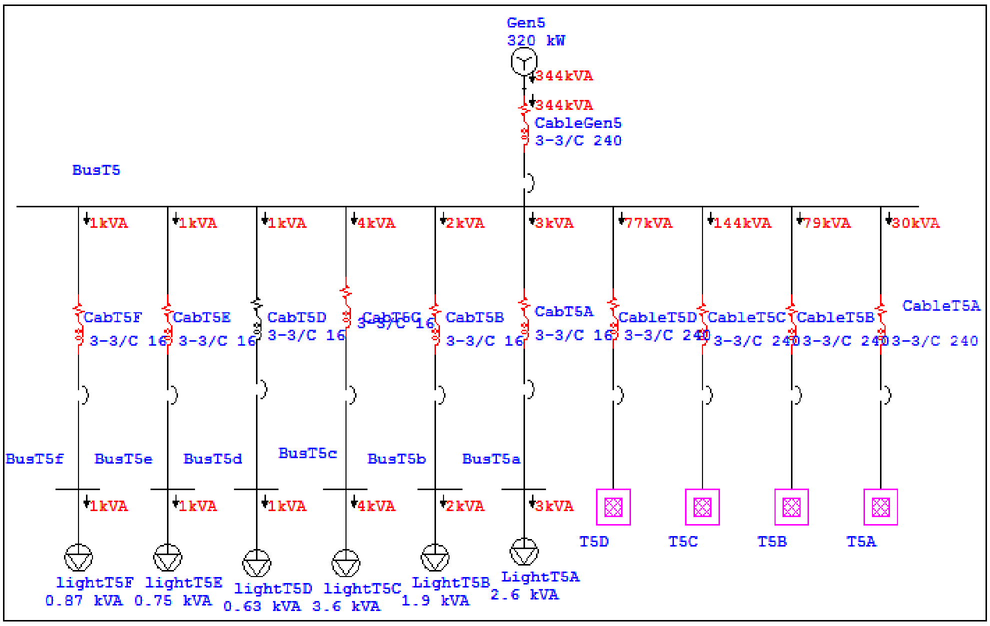

Figure 4.6: Generator 5 When Operation at Full Load

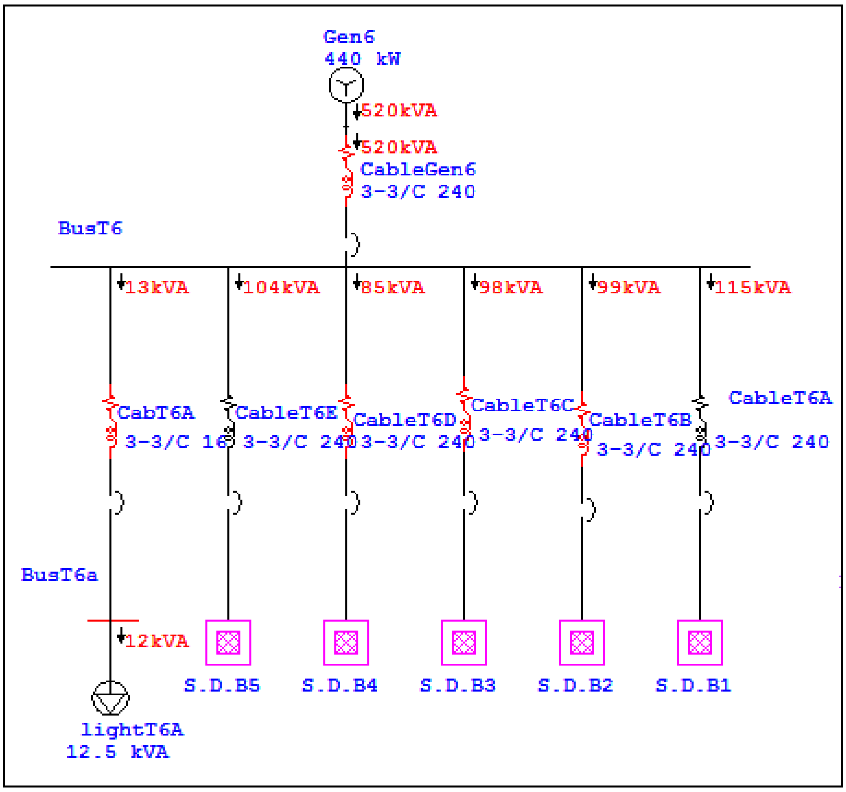

Figure 4.7: Generator 6 When Operation at Full Load

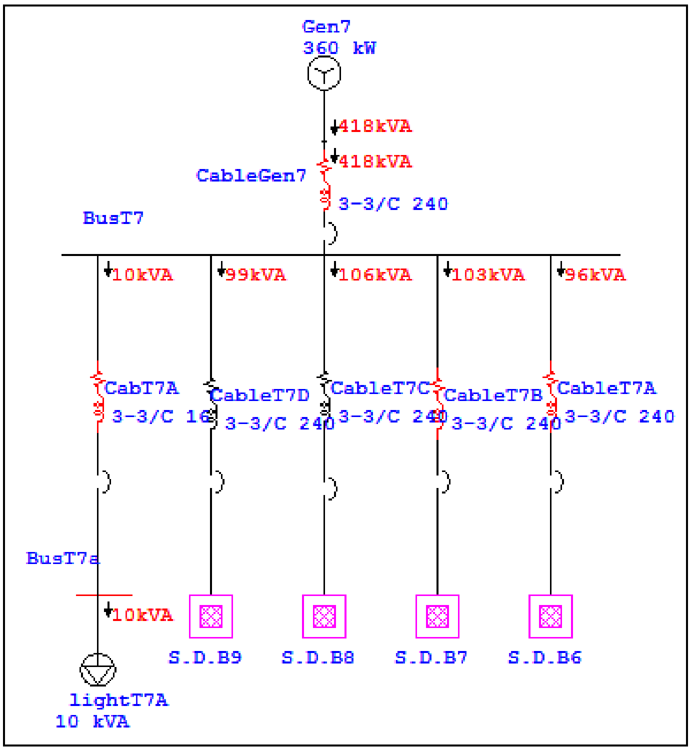

Figure 4.8: Generator 7 When Operation at Full Load

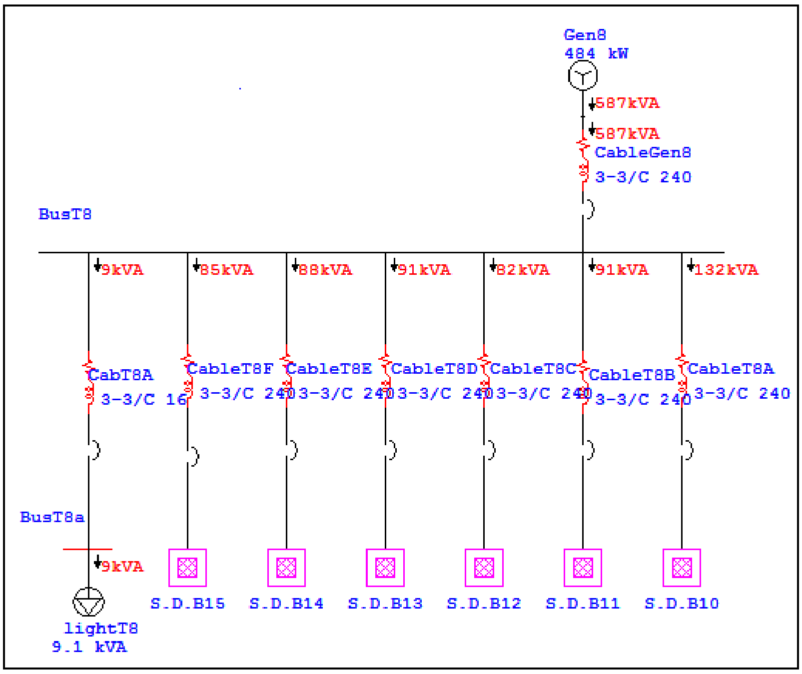

Figure 4.9: Generator 8 During Operation at Full Load

4.5.1 Generator at Standby Rate

Initial cost: ATS cost + Generator cost = $18372.7 + $498000 = $516372.7.
The risk cost and inflation rate equals 2% from the initial cost = $10327.45.
The maintenance cost equals 5% from initial cost = $25818.6.

Annual cost.

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 516372.7+ (7008.88×366) + 93579.187 = 516372.7+ 2565250.05+ 93579.187 = $3175201.967.

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6+ 10327.45 + 2565250.05+ 93579.187 =$2694975.317.
In third year equals second year.

4.5.2 Generator at Prime Rate

Initial cost: ATS cost + Generator cost = $19553.8 + $525000 =$ 544553.
The risk cost and inflation rate equals 2% from the initial cost = $10891.06.
The maintenance cost equals 5% from initial cost = $27227.65.

Annual cost.

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (7008.88×366) + 93579.187 = 544553 + 2565250.05+ 93579.187 = $3203382.237.

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2565250.05 + 93579.187 =$2696947.947.
In third year equals second year.

4.6 Case Three: Generators Operating at Full Load without Street Lighting

From the catalogue generator the fuel consumption and its cost when the liter diesel equals 5.2 NIS as shown in Table 4.7:
1KVA consumes 0.2 liter from diesel.

Table 4.7: Generator Fuel Consumption and Cost at Full Load Operation without Street Lighting per Hour

Generator	Load capacity KVA	Fuel consumption at 1500 rpm L/hr	Cost Fuel $
1	343	68.6	93.29
2	299	59.8	81.32
3	270	54	73.44
4	409	81.8	111.28
5	334	66.8	90.848
6	507	101.4	137.9
7	407	81.4	110.7
8	577	115.4	156.94
Total	3146	629.2	855.71

4.6.1 Energy Consumption

Housing Units: 1.5×0.8 =1.2KW.
1.2KW × 1 h×1790 unit = 2148 KWh.
Schools: 8.8×0.8=7.04 KW.
7.04KW ×1 h× 6 unit = 42.24 KWh.
Masjid: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit=21.12 KWh.
Cultural Center: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit = 21.12 KWh.
Health center: 139×0.8= 111.2 KW.
111.2KW ×1h×1unit= 111.2 KWh.
Commercial center: 39.6×0.8= 31.68 KW.
31.68KW ×1h ×1unit= 31.68 KWh.
Consumption load per hour = 2148 + 42.24+21.12 + 21.12 + 111.2 + 31.68 = 2375.36 KWh.
Consumption load in day = 2375.36 × 8 = 19002.88 KWh.
Consumption load in year = 19482.88 × 366 = 6955054.08 KWh.
The wheeling cost equals NIS 0.05 per 1 KWh.
The wheeling cost = 7130734.08 ×0.05 = NIS 347752.704 = $91273.67.
Cost fuel at full load without street lighting = 629.2 L/hr = 855.71 $/hr.
In day 8 hour at full load without street lighting.
$855.71 ×8 = $6845.68 in day.
$6845.68 ×15 = $102685.2 in 15 day.
$6845.68×30 = $205370.4 in 30 day.

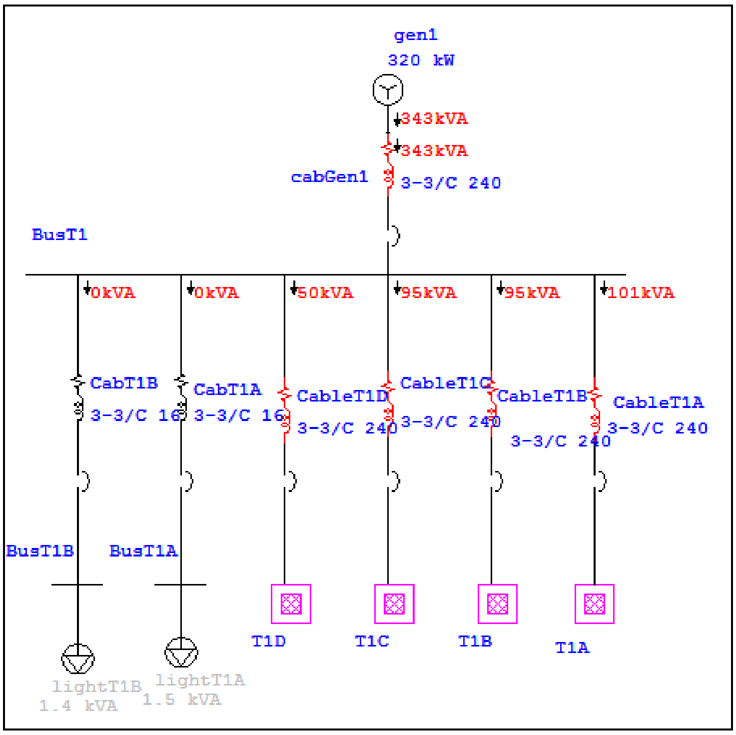

Figure 4.10: Generator 1 When Operation at Full Load without Street Lighting

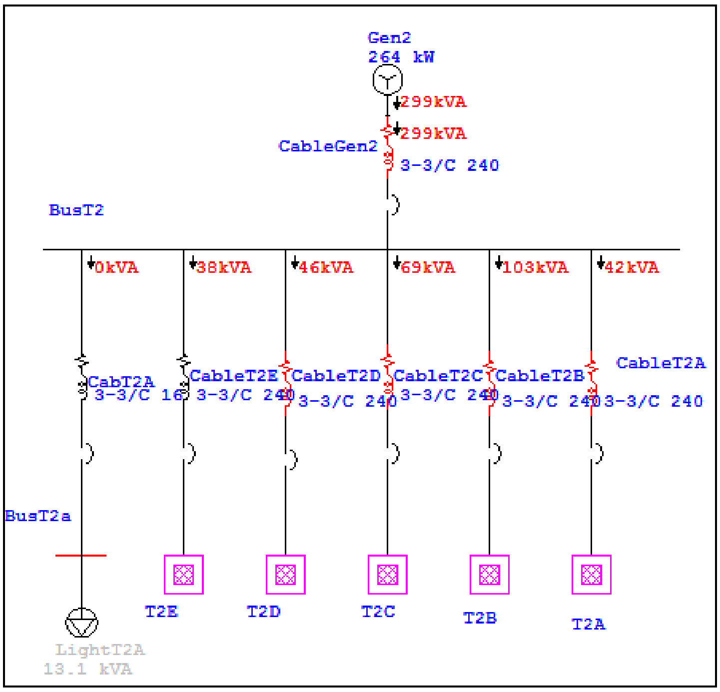

Figure 4.11: Generator 2 When Operation at Full Load without Street Lighting

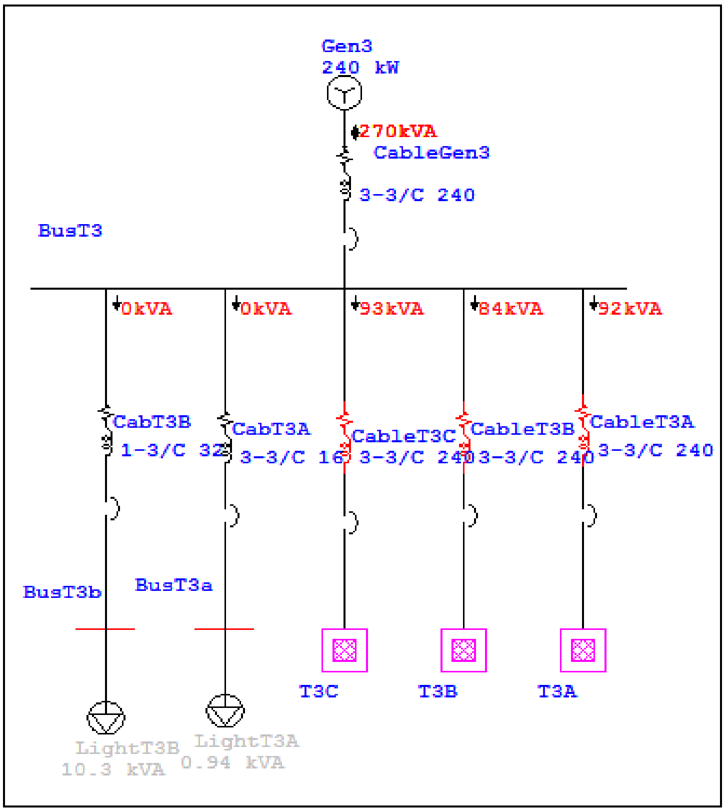

Figure 4.12: Generator 3 When Operation at Full Load without Street Lighting

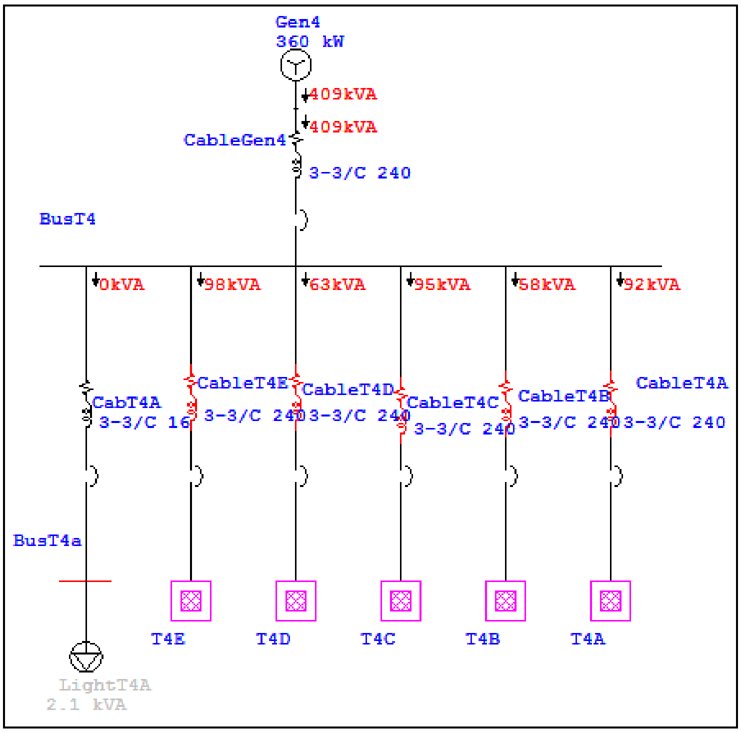

Figure 4.13: Generator 4 When Operation at Full Load without Street Lighting

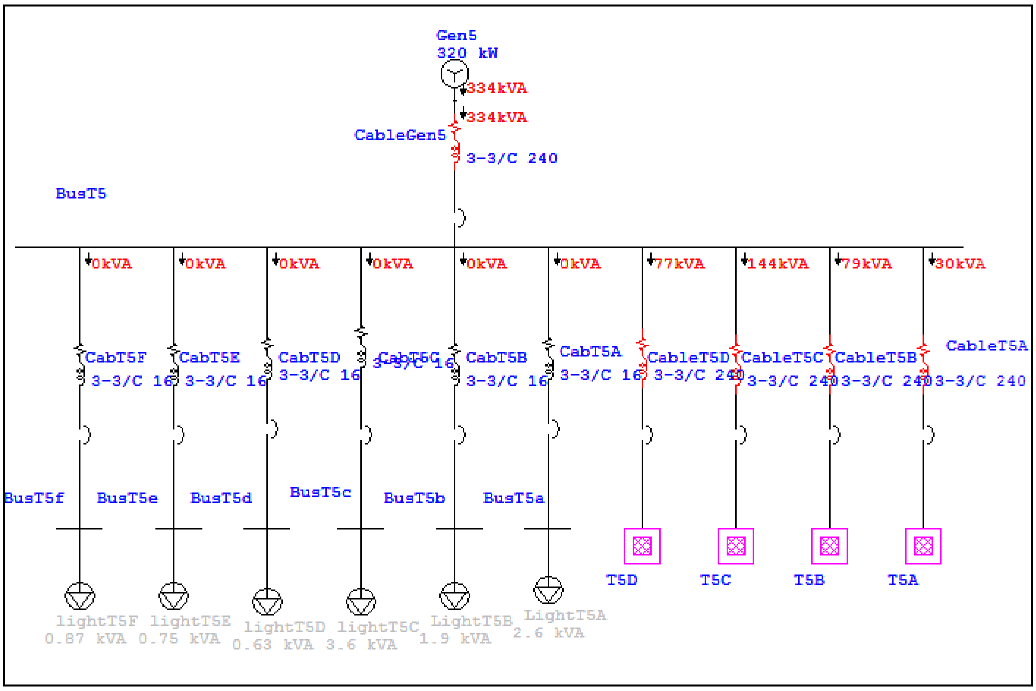

Figure 4.14: Generator 5 When Operation at Full Load without Street Lighting

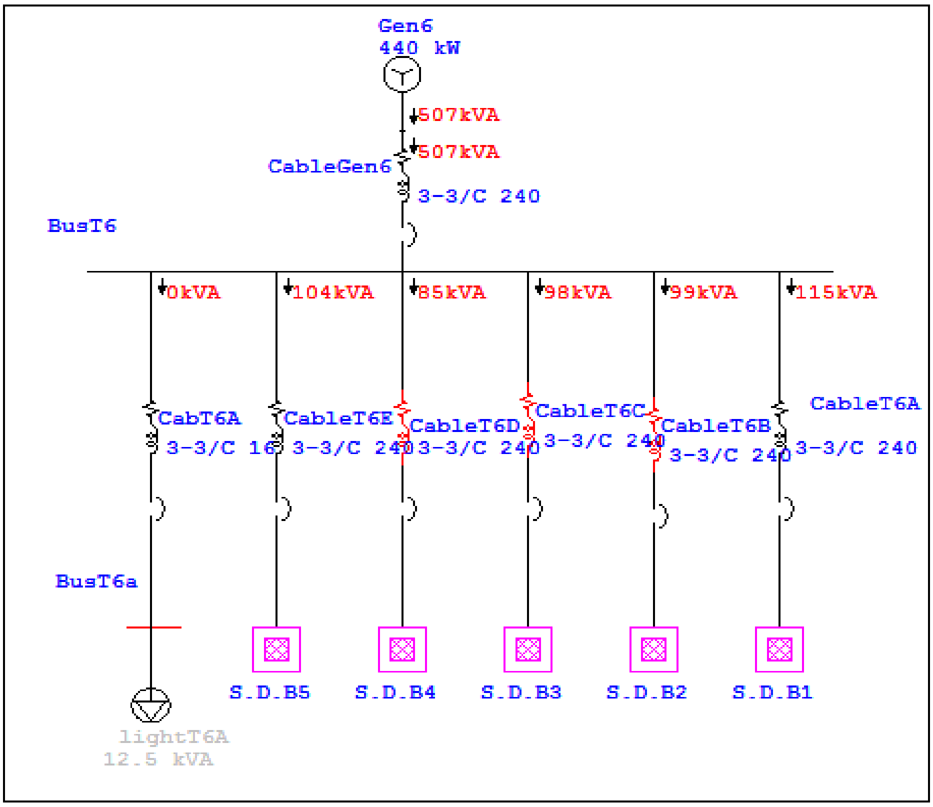

Figure 4.15: Generator 6 When Operation at Full Load without Street Lighting

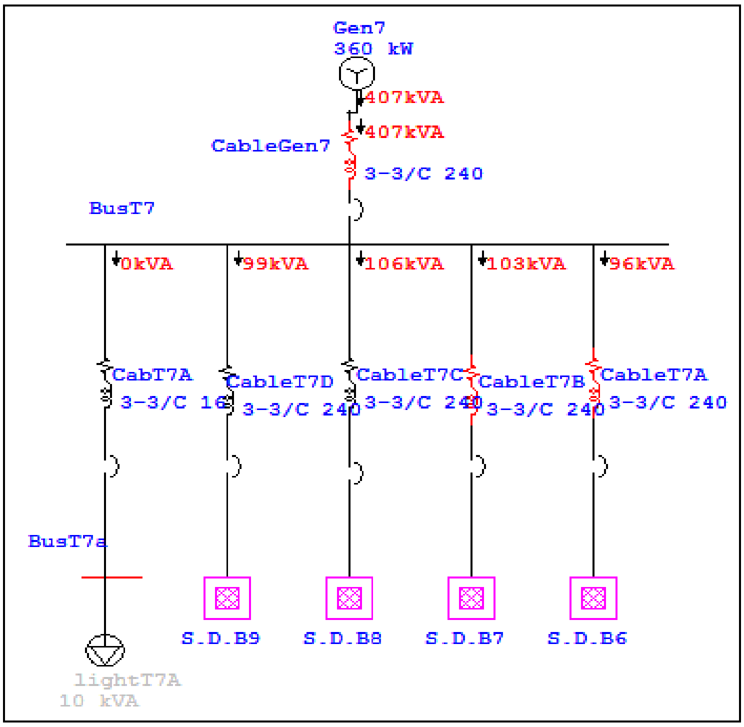

Figure 4.16: Generator 7 When Operation at Full Load without Street Lighting

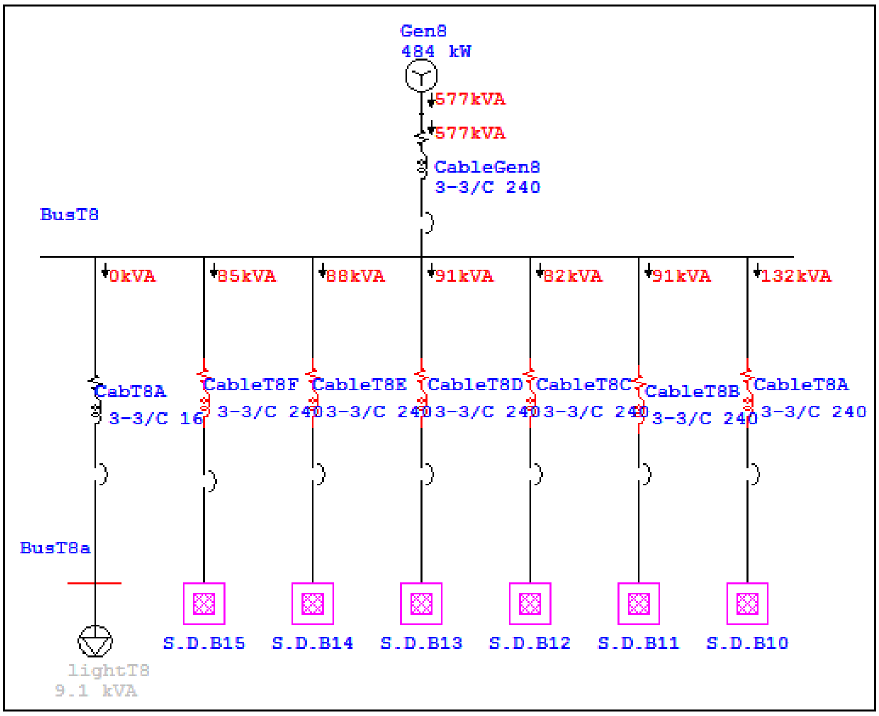

Figure 4.17: Generator 8 When Operation at Full Load without Street Lighting

4.6.2 Generator at Standby Rate

Initial cost: ATS cost + Generator cost = $18372.7 + $498000 = $516372.7.
The risk cost and inflation rate equals 2% from the initial cost = $10327.45.
The maintenance cost equals 5% from initial cost = $25818.6.

Annual cost

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 516372.7+ (6845.68 ×366) + 91273.67 = 516372.7+ 2505518.88 + 91273.67 = $3113165.25.

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6 + 10327.45 + 2505518.88 + 91273.67 =$2632938.6.
In third year equals second year.

4.6.3 Generator at Prime Rate

Initial cost: ATS cost + Generator cost = $19553.8 + $525000 = $544553.
The risk cost and inflation rate equals 2% from the initial cost = $10891.06.
The maintenance cost equals 5% from initial cost = $27227.65.

Annual cost

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (6845.68 ×366) + 91273.67 = 544553 + 2505518.88 + 91273.67 = $3141345.55.

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2505518.88 + 91273.67 =$2634911.26.
In third year equals second year.

4.7 Case Four: Generators Operating at Full Load without Schools

From the catalogue generator the fuel consumption and its cost when the liter diesel equals 5.2 NIS as shown in Table 4.8:
1KVA consumes 0.2 liter from diesel.

Table 4.8: Generator Fuel Consumption and Cost is Full Load Operation without Schools per Hour

Generator	Load capacity KVA	Fuel consumption at 1500 rpm L/hr	Cost fuel $
1	328	65.6	89.21
2	295	59	80.24
3	282	56.4	76.7
4	411	82.2	111.79
5	344	68.8	93.568
6	520	104	141.44
7	409	81.8	111.248
8	578	115.6	157.21
Total	3167	633.4	861.42

4.7.1 Energy Consumption

Housing Units: 1.5×0.8 =1.2KW.
1.2KW × 1 h×1790 unit = 2148 KWh.
Masjids: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit=21.12 KWh.
Cultural Center: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit = 21.12 KWh.
Health center: 139×0.8= 111.2 KW.
111.2KW ×1h×1unit= 111.2 KWh.
Commercial center: 39.6×0.8= 31.68 KW.
31.68KW ×1h ×1unit= 31.68 KWh.
Light: 75×0.8= 60 KW.
60KW ×1h ×1unit=60 KWh.
Consumption load per hour = 214+21.12+21.12 +111.2+31.68+60= 2393.12 KWh.
Consumption load in day = 2393.12 × 8 = 19144.96 KWh.
Consumption load in year = 19144.96 × 366 = 7007055.36 KWh.
The wheeling cost equals NIS 0.05 per 1 KWh.
The wheeling cost = 7007055.36 ×0.05 = NIS 350352.768 = $91956.1.
Cost fuel at full load without schools = 633.4 L/hr = 861.42 $/hr.
In day 8 hour full load without schools.
$861.42 ×8 = $6891.36 in day.
$6891.36 ×15 = $103370.4 in 15 day.
$6891.36×30 = $206740.8 in 30 day.

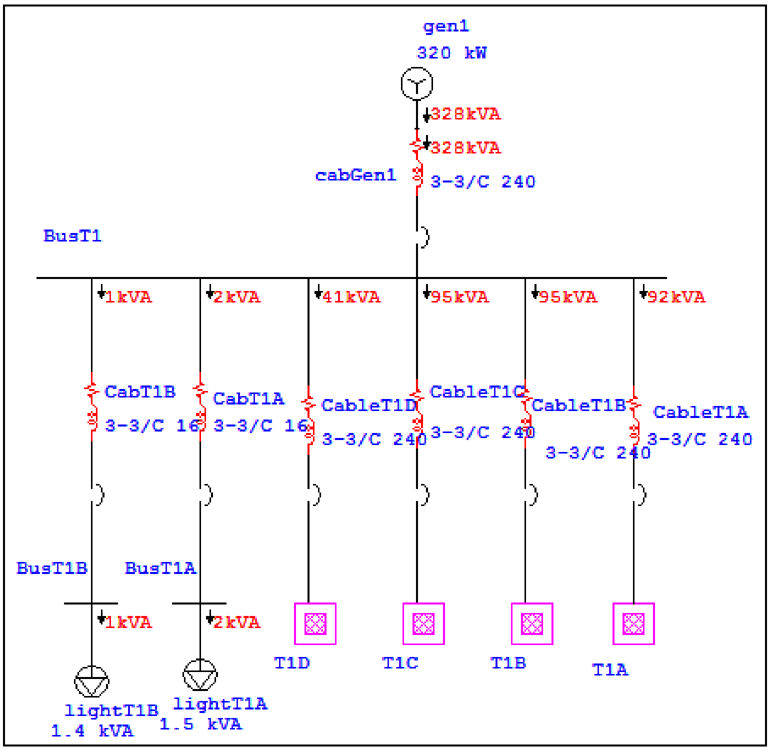

Figure 4.18: Generator 1 When Operating at Full Load without Street Schools

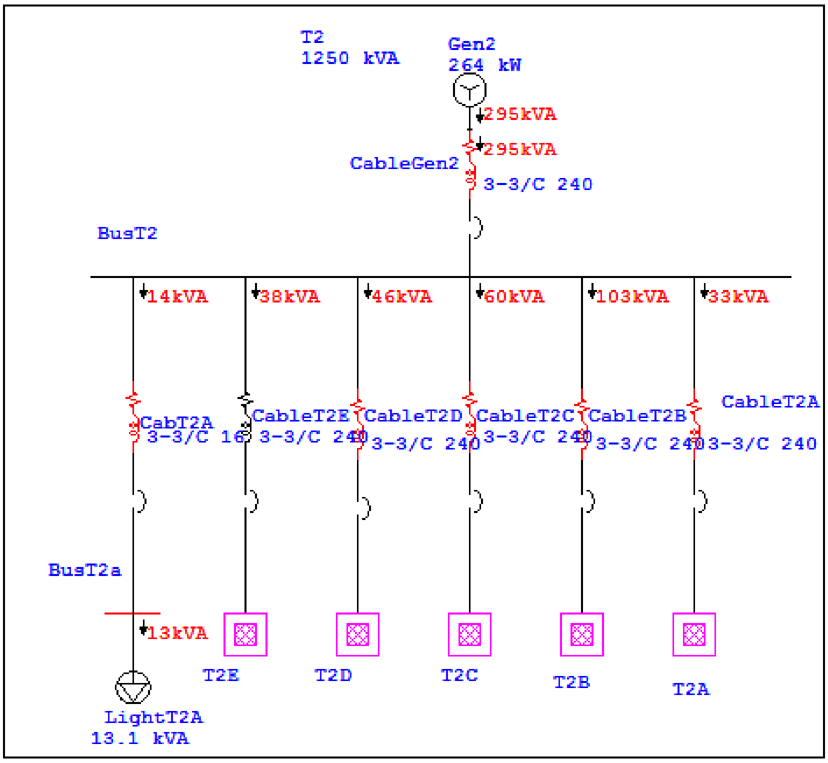

Figure 4.19: Generator 2 When Operating at Full Load without Street Schools

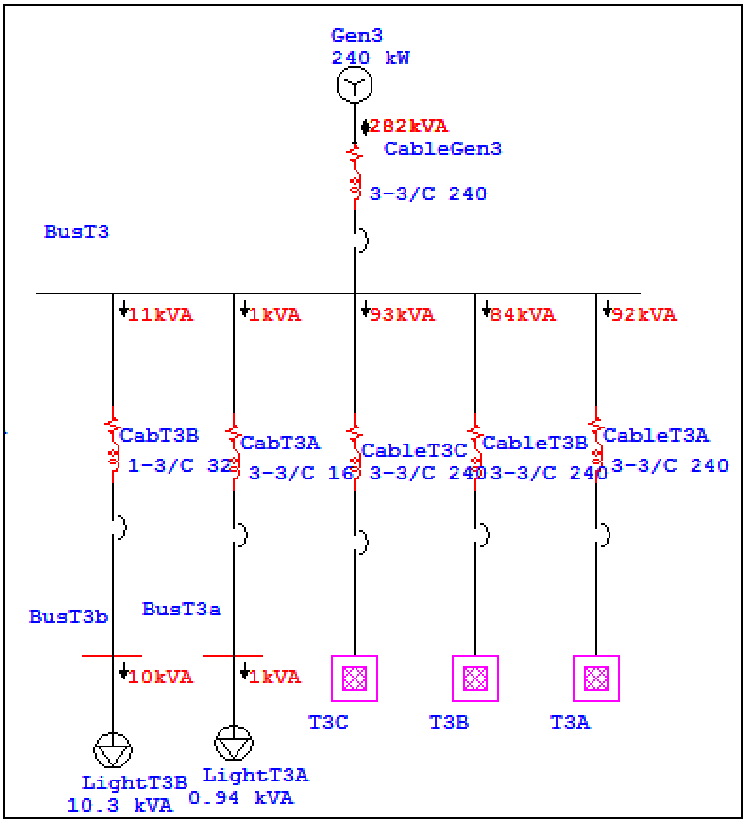

Figure 4.20: Generator 3 When Operating at Full Load without Street Schools

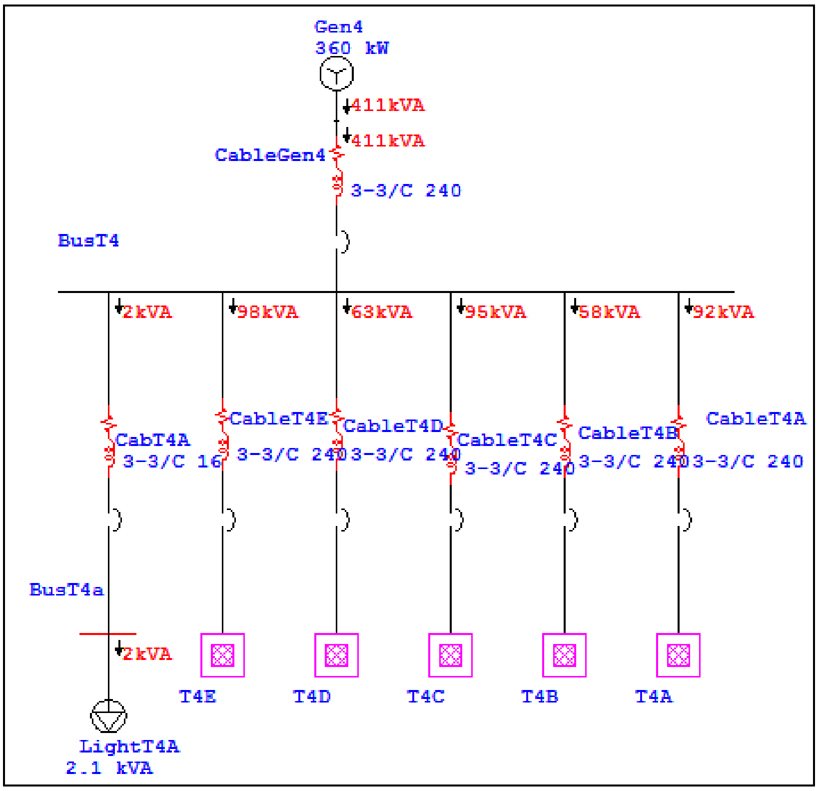

Figure 4.21: Generator 4 When Operating at Full Load without Street Schools

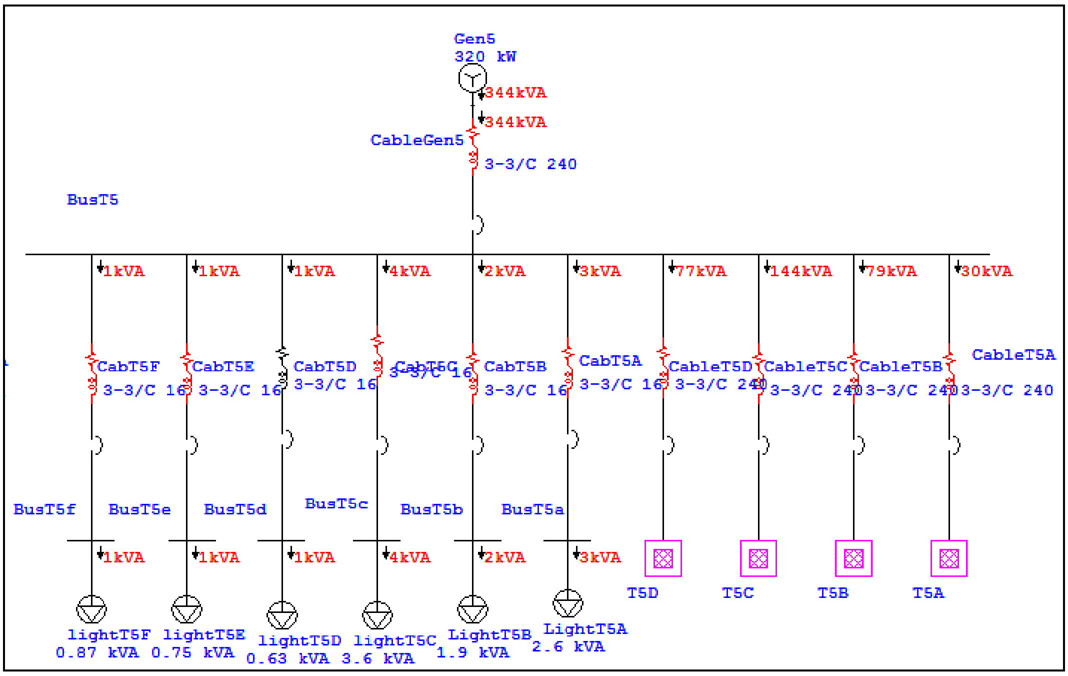

Figure 4.22: Generator 5 When Operating at Full Load without Street Schools

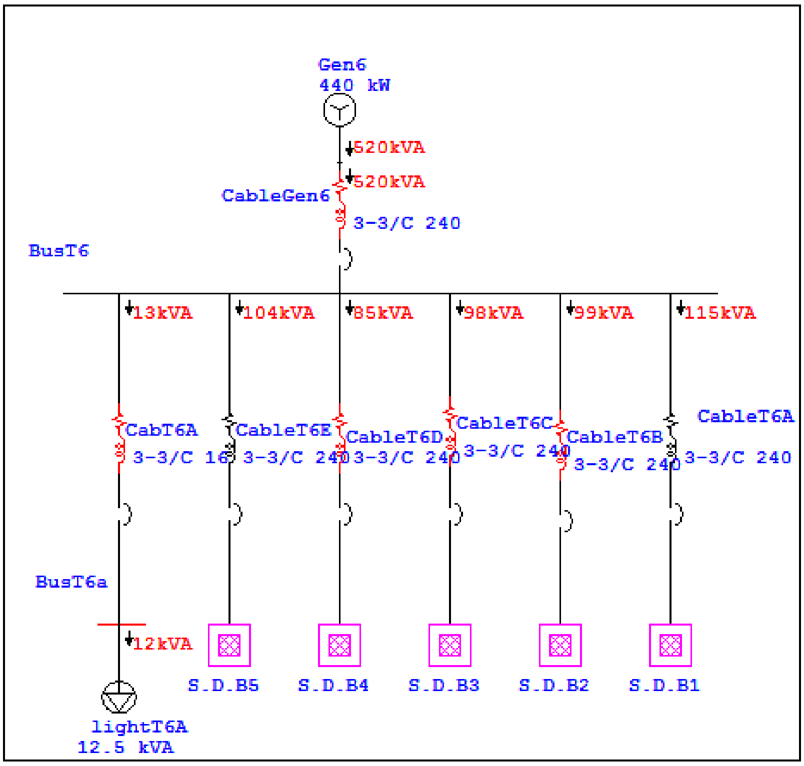

Figure 4.23: Generator 6 When Operating at Full Load without Street Schools

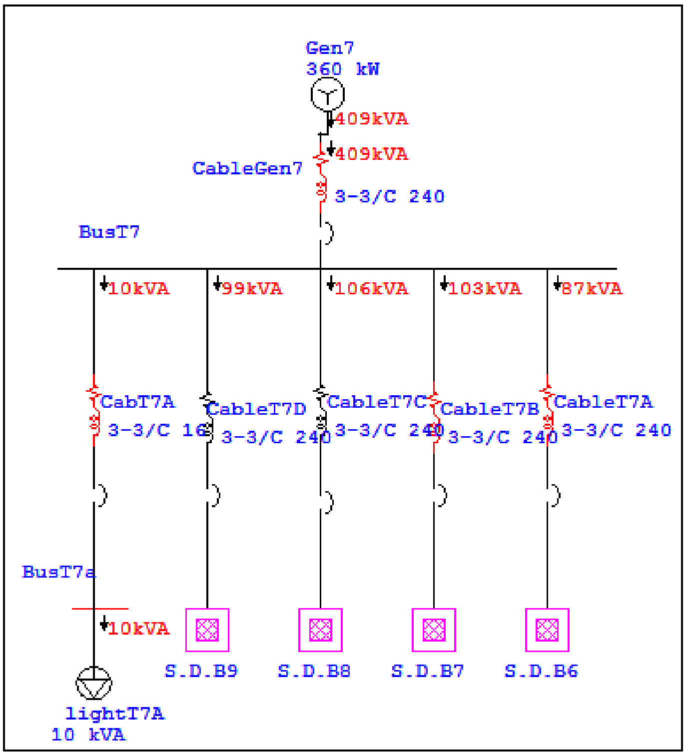

Figure 4.24: Generator 7 When Operating at Full Load without Street Schools

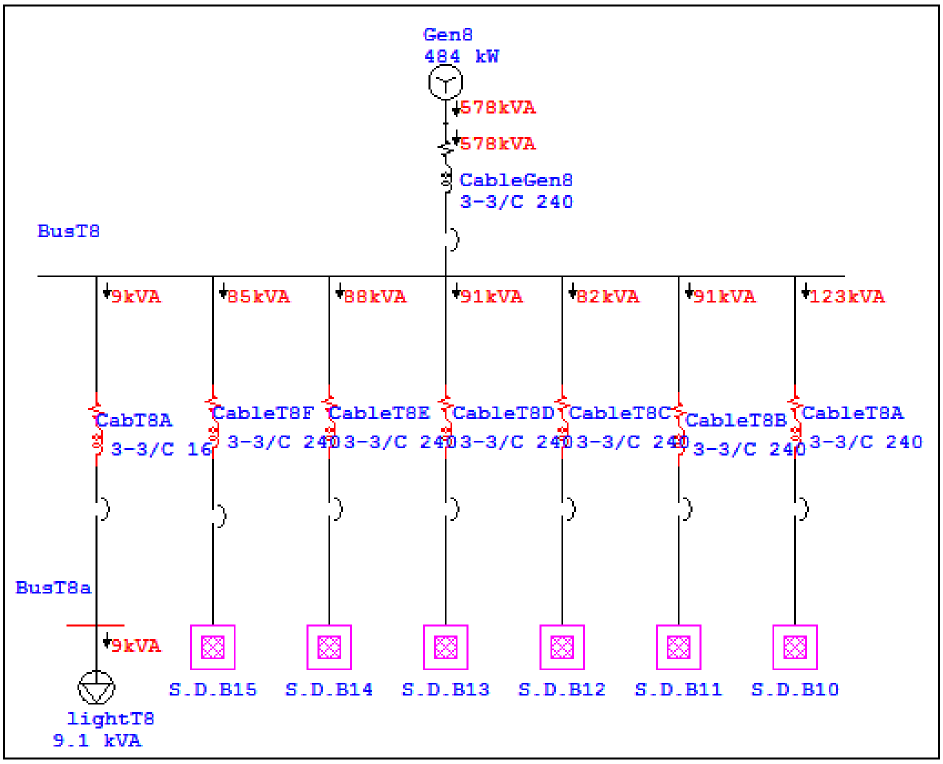

Figure 4.25: Generator 8 When Operating at Full Load without Street Schools

4.7.2 Generator at Standby Rate

Initial cost: ATS cost + Generator cost = \$18372.7 + \$498000 = \$516372.7
The risk cost and inflation rate equals 2% from the initial cost = \$10327.45
The maintenance cost equals 5% from initial cost = \$25818.6

Annual cost

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 516372.7+ (6891.36 ×366) + 91956.1 = 516372.7+ 2522237.76 + 91956.1= \$3130566.56

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6+ 10327.45 + 2522237.76 + 91956.1 = \$2650339.91
In third year equals second year.

4.7.3 Generator at Prime Rate

Initial cost: ATS cost + Generator cost = \$19553.8 + \$525000 = \$544553
the risk cost and inflation rate equals 2% from the initial cost = \$10891.06
The maintenance cost equals 5% from initial cost = \$27227.65

Annual cost

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (6891.36 ×366) + 91956.1 = 544553 + 2522237.76 + 91956.1= \$3158746.86

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2522237.76 + 91956.1 = \$2652311.98
In third year equals second year

4.8 Case Five: Generators Operating at Full Load without Streets Lighting and Schools

From the catalogue generator the fuel consumption and its cost when the liter diesel equal 5.2 NIS as shown in Table 4.9:
1KVA consumes 0.2 liter from diesel.

Table 4.9: Generators Fuel Consumption and Cost at Full Load Operation without Streets Lighting and Schools per Hour

Generator	Load capacity KVA	Fuel consumption at 1500 rpm L/hr	Cost fuel $
1	325	65	88.4
2	281	56.2	76.43
3	270	54	73.44
4	409	81.8	111.248
5	334	66.8	90.848
6	507	101.4	137.9
7	398	79.6	108.25
8	568	113.6	154.49
Total	3092	618.4	841.02

4.8.1 Energy Consumption

Housing Units: 1.5×0.8 =1.2KW.
1.2KW × 1 h×1790 unit = 2148 KWh.
Masjid: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit=21.12 KWh.
Cultural Center: 26.4×0.8= 21.12 KW.
21.12KW ×1 h ×1unit = 21.12 KWh.
Health center: 139×0.8= 111.2 KW.
111.2KW ×1h×1unit= 111.2 KWh.
Commercial center: 39.6×0.8= 31.68 KW.
31.68KW ×1h ×1unit= 31.68 KWh.
Consumption load per hour = 2148 +21.12 + 21.12 + 111.2 + 31.68 = 2333.12 KWh.
Consumption load in day = 2333.12 × 8 = 18664.96 KWh.
Consumption load in year = 18664.96 × 366 = 6831375.36 KWh.
The wheeling cost equals NIS 0.05 per 1 KWh.
The wheeling cost = 6831375.36 ×0.05 = NIS 341568.768 = $89650.59.
Cost fuel at full load less the streets Lighting and schools = 618.4 L/hr = 841.02 $/hr.
In day 8 hour full load less the streets lighting and schools.
$841.02 ×8 = $6728.16 in day.
$6891.36 ×15 = $100922.4 in 15 day.
$6891.36×30 = $201844.8 in 30 day.

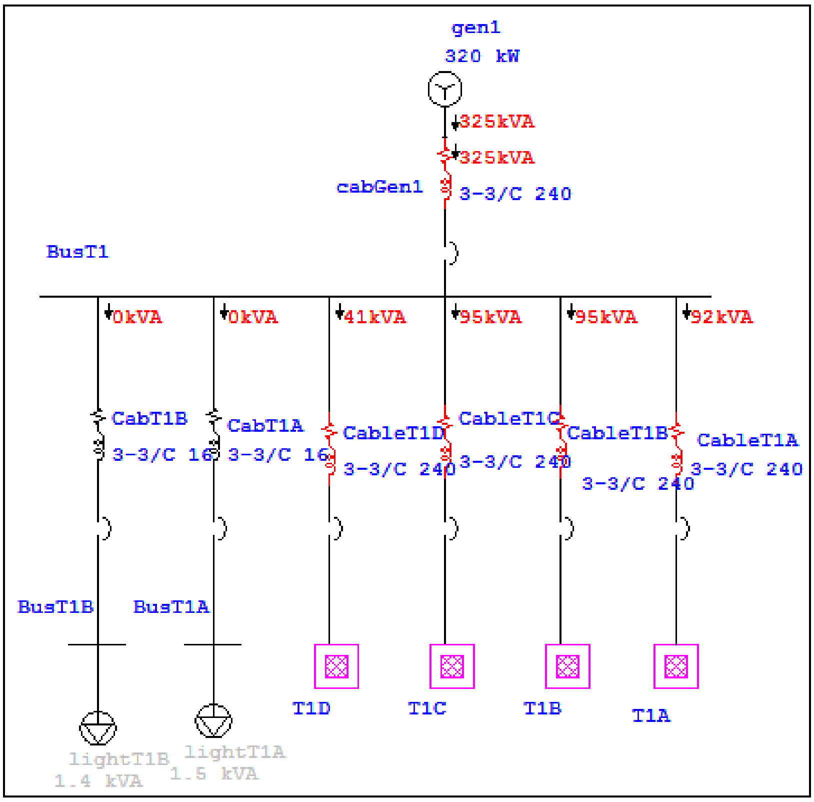

Figure 4.26: Generator 1 When Operating at Full Load without Streets Lighting and Schools

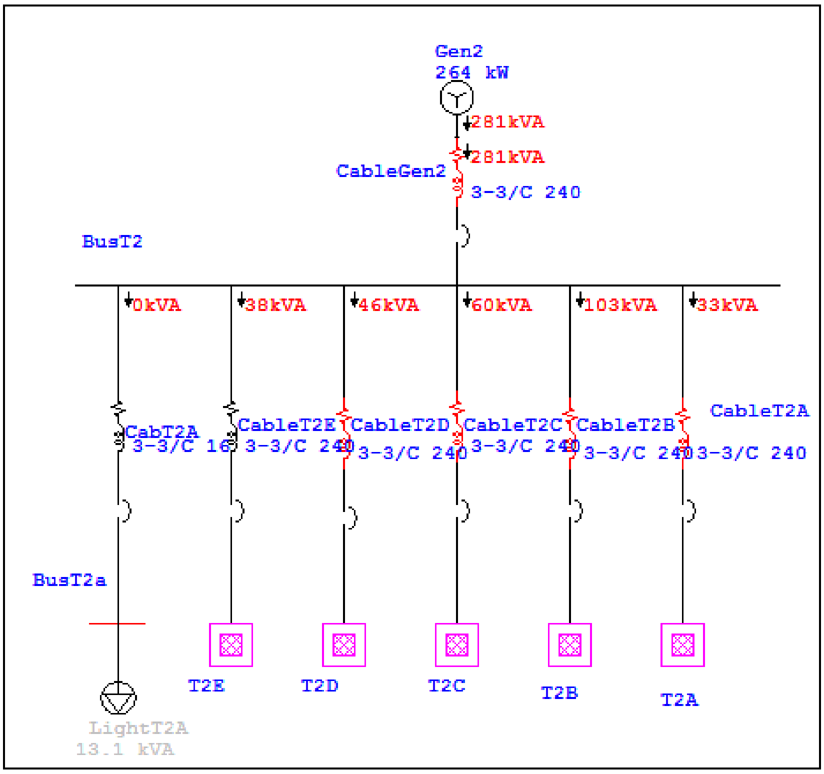

Figure 4.27: Generator 2 When Operating at Full Load without Streets Lighting and Schools

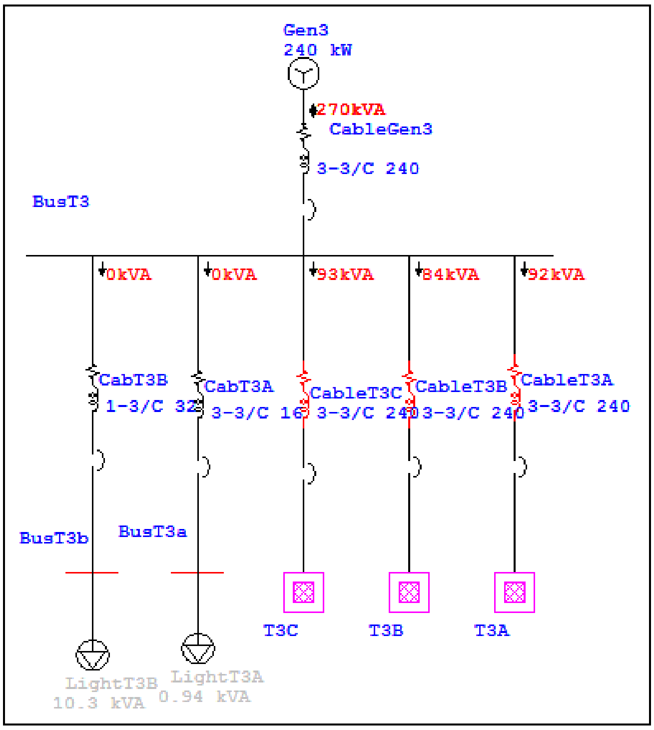

Figure 4.28: Generator 3 When Operating at Full Load without Streets Lighting and Schools

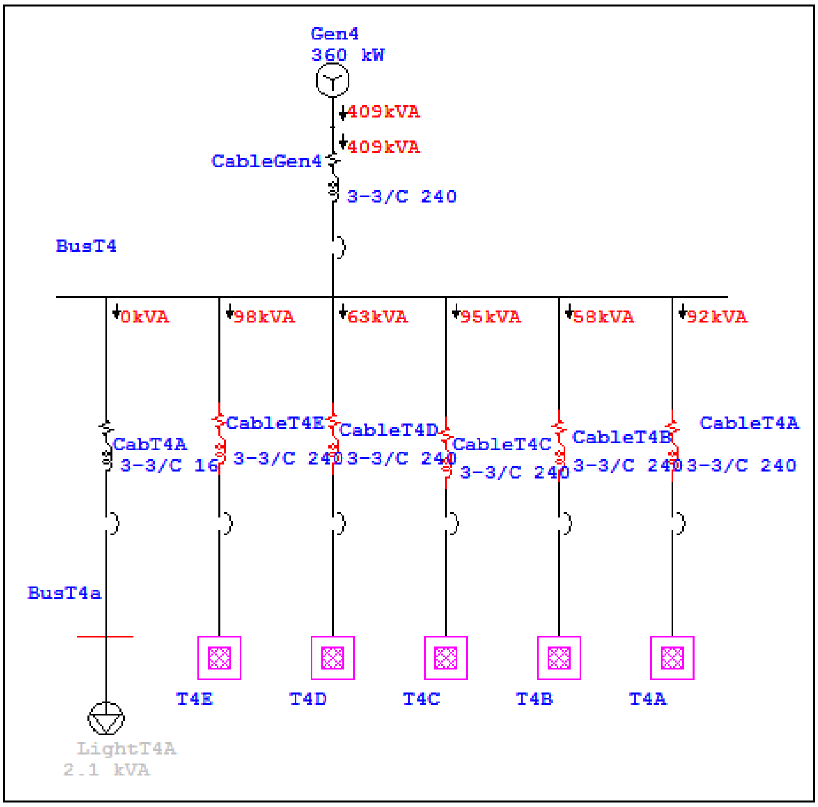

Figure 4.29: Generator 4 When Operating at Full Load without Streets Lighting and Schools

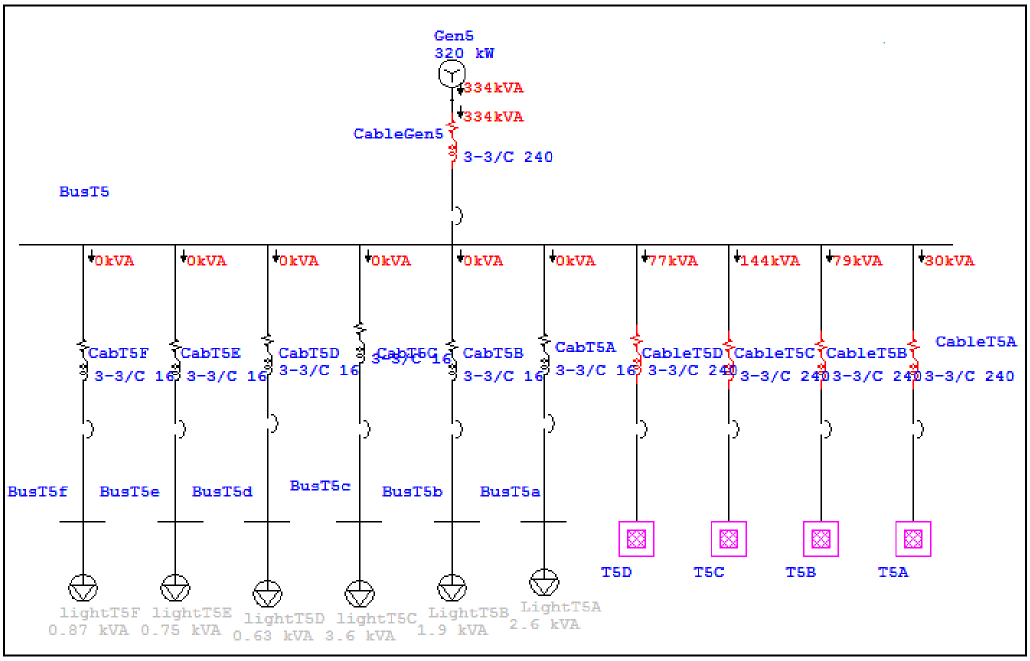

Figure 4.30: Generator 5 When Operating at Full Load without Streets Lighting and Schools

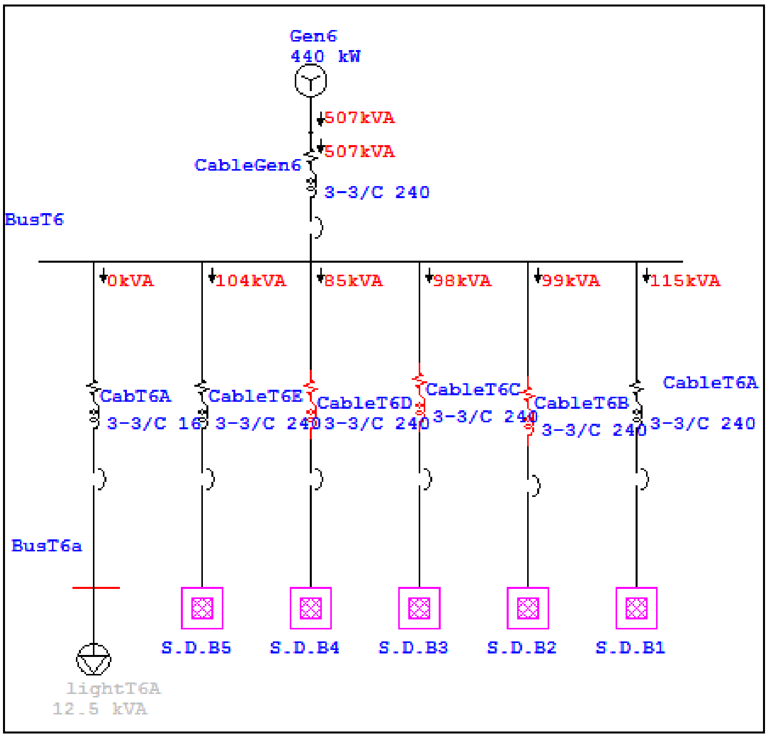

Figure 4.31: Generator 6 When Operating at Full Load without Streets Lighting and Schools

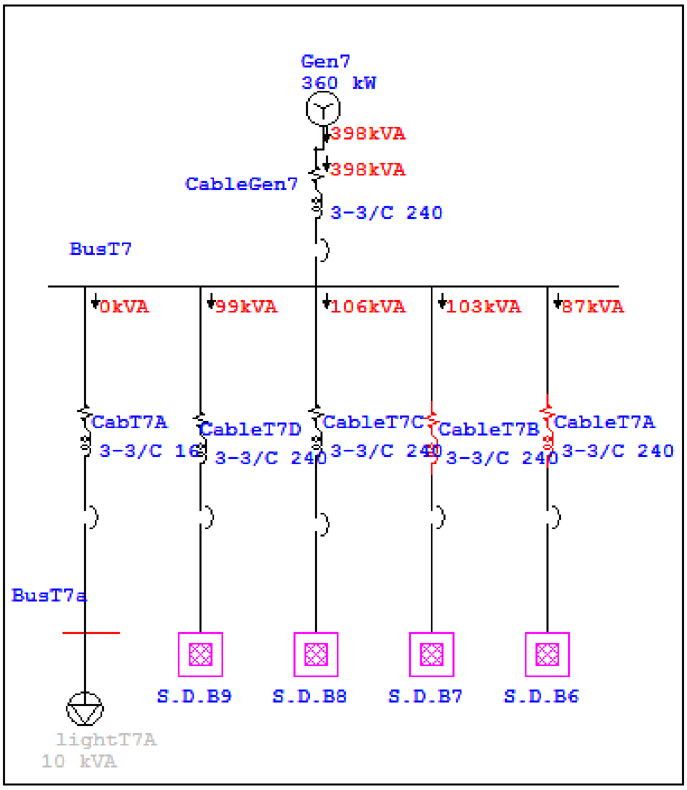

Figure 4.32: Generator 7 When Operating at Full Load without Streets Lighting and Schools

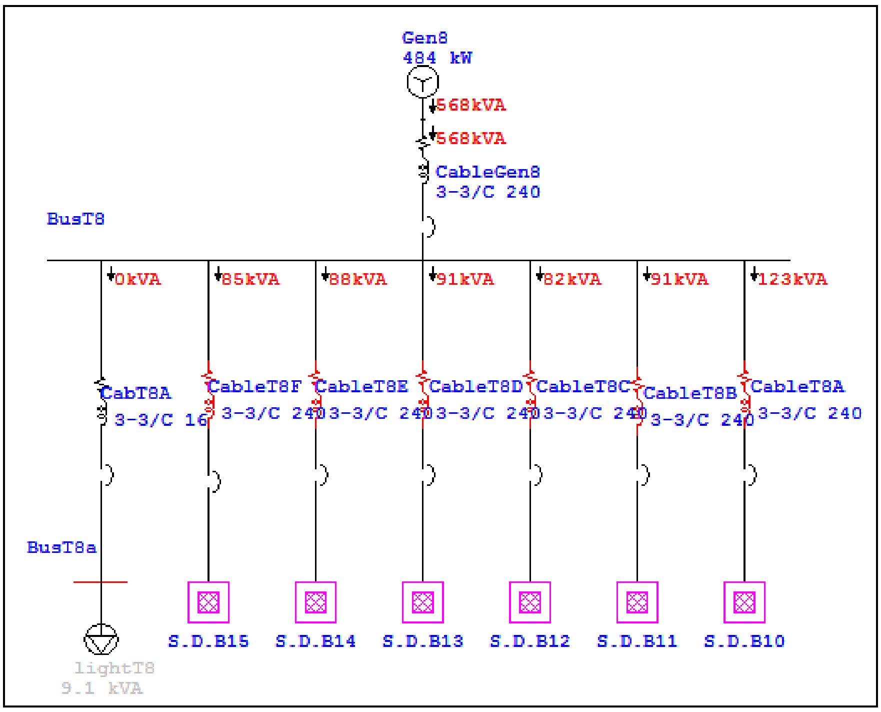

Figure 4.33: Generator 8 When Operating at Full Load without Streets Lighting and Schools

4.8.2 Generator at Standby Rate

Initial cost: ATS cost + Generator cost = $18372.7 + $498000 = $516372.7
The risk cost and inflation rate equals 2% from the initial cost = $10327.45
The maintenance cost equals 5% from initial cost = $25818.6

Annual cost

In first year.
Total cost = initial cost + fuel cost in year + wheeling cost = 516372.7+ (6728.16 ×366) + 89650.59 = 516372.7+ 2462506.56 + 89650.59= $3068529.85

In second year.
Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6+ 10327.45 + 2462506.56 + 89650.59 = $2588303.2
In third year equals second year.

4.8.3 Generator at Prime Rate

Initial cost: ATS cost + Generator cost = $19553.8 + $525000 = $544553
The risk cost and inflation rate equals 2% from the initial cost = $10891.06
The maintenance cost equals 5% from initial cost = $27227.65

Annual cost.

In first year.
Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (6728.16 ×366) + 89650.59 = 544553 + 2462506.56 + 89650.59= $3096710.15

In second year.
Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2462506.56 + 89650.59 = $2590275.86
In third year equals second year.

4.9 Case Six: Generators Operating at Loads Distributor on 366 Day

The loads distributor 183day without school, 120 day are without light and 63 day without light and school.
The average wheeling cost = (93579.187 + 91273.67 + 91956.1 + 89650.59)/4= $91614.88

4.9.1 Generator at Standby Rate

Initial cost: ATS cost + Generator cost = $18372.7 + $498000 = $516372.7
The risk cost and inflation rate equals 2% from the initial cost = $10327.45
The maintenance cost equals 5% from initial cost = $25818.6

Annual cost

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 516372.7+ (6845.68 × 120) + (6891.36 × 183) + (6728.16 × 63) + 91614.88 = 516372.7+ (821481.6 + 1261118.88 + 423874.08) + 91614.88 = 516372.7+ 2506474.56 + 91614.88 = $3114462.14

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 25818.6+ 10327.45 + 2506474.56 + 91614.88 = $2634235.49

In third year equals second year.

4.9.2 Generator at Prime Rate

Initial cost: ATS cost + Generator cost = $19553.8 + $525000 = $544553

The risk cost and inflation rate equals 2% from the initial cost = $10891.06

The maintenance cost equals 5% from initial cost = $27227.65

Annual cost.

In first year.

Total cost = initial cost + fuel cost in year + wheeling cost = 544553 + (6845.68 × 120) + (6891.36 × 183) + (6728.16 × 63) + 91614.88 = 544553 + (821481.6 + 1261118.88 + 423874.08) + 91614.88 = 544553 + 2506474.56 + 91614.88 = $3142642.44

In second year.

Total cost = maintenance + risk cost + fuel cost in year + wheeling cost = 27227.65 + 10891.06 + 2506474.56 + 91614.88 = $2636208.15

In third year equal second year.

4.10 Comparison between Prime and Standby Rates

Table 4.10: Comparison Between Prime and Standby Rates $

Annual cost		Standby Rate	Prime Rate
Initial cost		516372.7	544553
Risk cost		10327.45	10891.06
Maintenance cost		25818.6	27227.65
Wheeling cost		Equal for Standby / Prime Rates	
The case one cost	First year	3354366.287	3446230.587
	Second year	2874139.637	2939796.297
The case two cost	First year	3175201.967	3203382.237
	Second year	2694975.317	2696947.947
The case three cost	First year	3113165.25	3141345.55
	Second year	2632938.6	2634911.26
The case four cost	First year	3130566.56	3158746.86
	Second year	2650339.91	2652311.98
The case five cost	First year	3068529.85	3096710.15
	Second year	2588303.2	2590275.86
The case six cost	First year	3114462.14	3142642.44
	Second year	2634235.49	2636208.15

Chapter 5
Feasibility Study

5.1 Background

In this chapter we will study the different scenarios for the implementation of this project to get the best quality at the lowest cost. We will study the price of 1KWh equals 1.5 NIS and 2 NIS, The application of this study is to all previous cases in chapter 4 and comparing to them, which will apply on the project? Is the electricity distribution company, government or contractors and businessmen? Is the project funded by the third party or not? What and How this fund? when this project will achieve its goals and reap profits? when will the owner of project recover the Equity capital? All of these questions will take in this chapter with more details.

5.2 Annual Income of The Project

1. at NIS 1.5 per KWH

House 1.5×0.8 =1.2KW.

1.2KW ×8 h=9.6 KWh.

9.6 KWh ×1.5NIS ×1790 unit = NIS 25776 = $6765.35 in day.

School 8.8×0.8=7.04 KW.

7.04 KW ×8 h=56.32 KWh.

56.32 KWh ×1.5 NIS×6 unit = NIS 506.88 = $133.03 in day.

Masjid 26.4×0.8= 21.12 KW.

21.12 KW ×8 h =168.96kwh.

168.96kwh ×1.5NIS ×1unit= NIS 253.44 = $66.51 in day.

Cultural Center 26.4×0.8= 21.12 KW.

21.12 KW ×8 h =168.96 KWh.

168.96 KWh ×1.5NIS ×1unit= NIS 253.44= $66.51 in day.

Health center 139×0.8= 111.2 KW.

111.2 KW ×8h =889.6KWh.

889.6KWh ×1.5 NIS×1unit= NIS 1334.4 = $350.23 in day.

Commercial center 39.6×0.8= 31.68 KW.

31.68 KW ×8h =253.44 KWh.

253.44 KWh ×1.5×1unit= NIS 380.16 = $99.77 in day.

Light 75×0.8= 60 KW.

60 KW ×8h =480 KWh.

480 KWh ×1.5×1unit= NIS 720 = $188.97 in day.

Consumption in Day

6765.35+133.03+66.51+66.51+350.23+99.77+188.97=$7670.37

In 15 day 7670.37×15=$115055.55

In 30 day 7670.37×30=$230111.1

Year 7670.37×366= $2807355.42

Annual income = 7670.37×366= $2807355.42

2. When 1 KWh = 2 NIS.

House 1.5×0.8 =1.2KW.

1.2KW ×8h =9.6 KWh.

9.6 KWh ×2×1790 unit = NIS 34368 = $9020.47 in day.

School 8.8×0.8=7.04 KW.

7.04 KW ×8h=56.32 KWh.

56.32 KWh ×2 × 6 unit = NIS 675.84 = $177.38 in day.

Masjid 26.4×0.8= 21.12 KW.

21.12 KW ×8h =168.96 KWh.

168.96 KWh ×2 ×1unit= NIS 337.92 = $88.69 in day.

Cultural Center 26.4×0.8= 21.12 KW.

21.12 KW ×8h =168.96 KWh.

168.96 KWh ×2 ×1unit= NIS 337.92 = $88.69 in day.

Health center 139×0.8= 111.2 KW.

111.2 KW ×8h =889.6 KWh.

889.6 KWh ×2×1unit=1779.2NIS =$466.98 in day.

Commercial center 39.6×0.8= 31.68 KW.

31.68 KW ×8h =253.44 KWh.

253.44 KWh ×2 ×1unit= NIS 506.88 = $133.03 in day.

Light 75×0.8= 60 KW.

60 KW ×8h =480 KWh.

480 KWh ×2×1unit= NIS 960 = $251.96 in day.

Consumption in Day

9020.47+177.38 +88.69 + 88.69+ 466.98 + 133.03+ 251.96 =$10227.2

In 15 day 10227.2 ×15=$153408

In 30 day 10227.2 ×30=$306816

In year 10227.2 ×366= $3743155.2

Income cost in year 10227.2 ×366= $3743155.2

5.3 Payback Period

5.3.1 Case 1 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3354366.287. This means that there is deficit of $547010.867. In the second year, the expenses equal $2874139.637 with the fixing income remains; This means that there is a deficit of $66784.217, and every year this deficit increases by $66784.217.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42; while the capital and the running cost equal $3446230.587 This means that there is deficit of $638875.167. In the second year, the expenses equal $2939796.297 with the fixing income remains; This means that there is deficit of $132440.877, and every year this deficit increases by $132440.877.

5.3.2 Case 1 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3354366.287. This means that there is profit of $388788.917, and recovers the owner of this Equity capital project in about 327 day ($3743155.2/366=10227.2 income cost in day. In 327 recovers the Equity capital and other day is a profit). In the second year, the expenses equal $2874139.637 with the fixing income remains; This means that there is profit of $869015.563, and every year the profit increases by $869015.563.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3446230.587. This means that there is profit of $296924.613, and recovers the owner of this Equity capital project in about 337 day. In the second year, the expenses equal $2939796 With the fixing income remains; This means that there is profit of $803358.903, and every year the profit increases by $803358.903.

Table 5.1: Profit in Case one

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-547010.867	-66784.217	-638875.167	-132440.877
at NIS 2 Per KWH	388788.917	869015.563	296924.613	803358.903

5.3.3 Case 2 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42; while the capital and the running cost equal $3175201.967. This means that there is deficit of $367846.547. In the second year, the expenses equal $2694975.317, with the fixing income remains, This means that there is profit of $112380.103, and every year the profit increases by $112380.103 and recovers the owner of this Equity capital project in about 4 year and 3 month.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3203382.237; this means that there is deficit of $396026.817. In the second year, the expenses equal $2696947.947, with the fixing income remains, This means that there is profit of $110407.473, and every year the profit increases by $110407.473, and recovers the owner of this Equity capital project in about 4 year and 5 month.

5.3.4 Case 2 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3175201.967 this means that there is profit of $567953.233, and recovers the owner of this Equity capital project in about 310 day. In the second year, the expenses equal $2694975.317 with the fixing income remains; This means that there is profit of $1048179.883, and every year the profit increases by $1048179.883.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3203382.237, This means that there is profit of $539772.963, and recovers the owner of this Equity capital project in about 313 day. In the second year, the expenses equal $2696947.947, with the fixing income remains; This means that there is profit of $1046207.253, and every year the profit increases by $1046207.253.

Table 5.2: Profit in Case 2

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-367846.547	112380.103	-396026.817	110407.473
at NIS 2 Per KWH	567953.233	1048179.883	539772.963	1046207.253

5.3.5 Case 3 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3113165.25; this means that there is deficit of $305809.83. In the second year, the expenses equal $2632938.6, with the fixing income remains. This means that there is profit of $174416.82, and every year the profit increases by $174416.82, and recovers the owner of this Equity capital project in about 3 year and 3 month.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3141345.55; this means that there is deficit of $333990.13. In the second year, the expenses equal $2634911.26, with the fixing income remains. This means that there is profit of $172444.16, and every year the profit increases by $172444.16, and recovers the owner of this Equity capital project in about 3 year and 1 month.

5.3.6 Case 3 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3113165.25, this means that there is profit of $629989.95, and recovers the owner of this Equity capital project in about 304 day. In the second year, the expenses equal $2632938.6 with the fixing income remains. This means that there is profit of $1110216.6, and every year the profit increases by $1110216.6.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3141345.55, this means that there is profit of $601809.65, and recovers the owner of this Equity capital project in about 307 day. In the second year, the expenses equal $2634911.26 with the fixing income remains. This means that there is profit of $1108243.94, and every year the profit increases by $1108243.94.

Table 5.3: Profit in Case 3

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-305809.83	174416.82	-333990.13	172444.16
at NIS 2 Per KWH	629989.95	1110216.6	601809.65	1108243.94

5.3.7 Case 4 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3130566.56; this means that there is deficit of $323211.14. In the second year, the expenses equal $2650339.91 with the fixing income remains, This means that there is profit of $157015.51, and every year the profit increases by $157015.51, and recovers the owner of this Equity capital project in about 3 year.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3158746.86; this means that there is deficit of $351391.44. In the second year, the expenses equal $2652311.98 with the fixing income remains, This means that there is profit of $155043.44, and every year the profit increases by $155043.44, and recovers the owner of this Equity capital project in about 3 year and 2 month.

5.3.8 Case 4 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $ 3130566.56; this means that there is profit of $612588.64, and recovers the owner of this Equity capital project in about 306 day. In the second year, the expenses equal $2650339.91, with the fixing income remains; This means that there is profit of $1092815.29, and every year the profit increases by $1092815.29.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3158746.86, this means that there is profit of $584408.34, and recovers the owner of this Equity capital project in about 308 day, In the second year, the expenses equal $2652311.98, with the fixing income remains, This means that there is profit of $1090843.22, and every year the profit increases by $1090843.22,

Table 5.4: Profit in Case 4

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-323211.14	157015.51	-351391.44	155043.44
at NIS 2 Per KWH	612588.64	1092815.29	584408.34	1090843.22

5.3.9 Case 5 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3068529.85; this means that there is deficit of $261174.43. In the second year, the expenses equal $2588303.2, with the fixing income remains, This means that there is profit of $219052.22, and every year the profit increases by $219052.22, and recovers the owner of this Equity capital project in about 2 year and 3 month.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3096710.15; this means that there is deficit of $289354.73. In the second year, the expenses equal $2590275.86, with the fixing income remains, This means that there is profit of $217079.56, and every year the profit increases by $217079.56, and recovers the owner of this Equity capital project in about 2 year and 3 month.

5.3.10 Case 5 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3068529.85, this means that there is profit of $674625.35, and recovers the owner of this Equity capital project in about 300 day In the second year, the expenses equal $2588303.2, with the fixing income remains, This means that there is profit of $1154852, and every year the profit increases by $1154852.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $3096710.15, this means that there is profit of $646445.05, and recovers the owner of this Equity capital project in about 302 day In the second year, the expenses equal $2590275.86, with the fixing income remains, This means that there is profit of $1152879.34, and every year the profit increases by $1152879.34.

Table 5.5: Profit in Case 5

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-261174.43	219052.22	-289354.73	217079.56
at NIS 2 Per KWH	674625.35	1154852	646445.05	1152879.34

5.3.11 Case 6 at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3114462.14; this means that there is deficit of $307106.72. In the second year, the expenses equal $2634235.49, with the fixing income remains. This means that there is profit of $173119.93, and every year the profit increases by $173119.93, and recovers the owner of this Equity capital project in about 2 year and 9 month.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3142642.44; this means that there is deficit of $335287.02. In the second year, the expenses equal $2636208.15, with the fixing income remains. This means that there is profit of $171147.27, and every year the profit increases by $171147.27, and recovers the owner of this Equity capital project in about 2 year and 11 month.

5.3.12 Case 6 at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, whiles the capital and the running cost equal $3114462.14; this means that there is profit of $628693.06, and recovers the owner of this Equity capital project in about 304 day. In the second year, the expenses equal $2634235.49, with the fixing income remains. This means that there is profit of $1108919.71, and every year the profit increases by $1108919.71.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, whiles the capital and the running cost equal $3142642.44; this means that there is profit of $600512.76, and recovers the owner of this Equity capital project in about 307 day. In the second year, the expenses equal $2636208.15, with the fixing income remains. This means that there is profit of $1106947.05, and every year the profit increases by $1106947.05.

Table 5.6: Profit in Case 6

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-307106.72	173119.93	-335287.02	171147.27
at NIS 2 Per KWH	628693.06	1108919.71	600512.76	1106947.05

5.3.13 The average cases

1. at NIS 1.5 per KWH

- **Standby Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3159382.009; this means that there is deficit of $352026.589. In the second year, the expenses equal $2679155.359, with the fixing income remains. This means that there is profit of $128200.061, and every year the profit increases by $128200.061, and recovers the owner of this Equity capital project in about 4 year and 10 month.

- **Prime Rate**

For the first year, the income in this case equals $2807355.42, while the capital and the running cost equal $3198176.304; this means that there is deficit of $390820.884. In the second year, the expenses equal $2691741.916, with the fixing income remains. This means that there is profit of $115613.504, and every year the profit increases by $115613.504, and recovers the owner of this Equity capital project in about 5 year and 5 month.

2. at NIS 2 per KWH

- **Standby Rate**

For the first year, the income in this case equals $3743155.2, whiles the capital and the running cost equal $3159382.009; this means that there is profit of $583773.191, and recovers the owner of this Equity capital project in about 308 day. In the second year, the expenses equal $2679155.359, with the fixing income remains. This means that there is profit of $1063999.841, and every year the profit increases by $1063999.841.

- **Prime Rate**

For the first year, the income in this case equals $3743155.2, while the capital and the running cost equal $ 3198176.304; this means that there is profit of $544978.896, and recovers the owner of this Equity capital project in about 312 day. In the second year, the expenses equal $2691741.916, with the fixing income remains. This means that there is profit of $1051413.284, and very year the profit increases by $1051413.284.

Table 5.7: Profit in Average Cases

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
at NIS 1.5 Per KWH	-352026.589	128200.061	-390820.884	115613.504
at NIS 2 Per KWH	583773.191	1063999.841	544978.896	1051413.284

Table 5.1: Comparison between Profit in Prime and Standby Rates at 1KWh equal 1.5 NIS

Annual cost	profit in Standby Rate $		profit in Prime Rate $	
	First year	Second year	First year	Second year
The first case cost	-547010.867	-66784.217	-638875.167	-132440.877
The second case cost	-367846.547	112380.103	-396026.817	110407.473
The third case cost	-305809.83	174416.82	-333990.13	172444.16
The fourth case cost	-323211.14	157015.51	-351391.44	155043.44
The fifth case cost	-261174.43	219052.22	-289354.73	217079.56
The sixth case cost	-307106.72	173119.93	-335287.02	171147.27
The average cases cost	-352026.589	128200.061	-390820.884	115613.504

Table5.2: Comparison between Profit in Prime and Standby Rates at 1KWh equal 2 NIS

Annual cost	profit in Standby Rate $		profit in Prime Rate$	
	First year	Second year	First year	Second year
The first case cost	388788.917	869015.563	296924.613	803358.903
The second case cost	567953.233	1048179.883	539772.963	1046207.253
The third case cost	629989.95	1110216.6	601809.65	1108243.94
The fourth case cost	612588.64	1092815.29	584408.34	1090843.22
The fifth case cost	674625.35	1154852	646445.05	1152879.34
The sixth case cost	628693.06	1108919.71	600512.76	1106947.05
The average cases cost	583773.191	1063999.841	544978.896	1051413.284

5.4 Implementation of The Project

In the case the local authority or private investors want to apply this project. The equity capital used in this project will be recovered in maximum duration a five years at the worst case. When the price of the 1 KWh equals NIS 1.5. But when the price of l KWh equal NIS 2, we will recover the equity capital in first year only. In the case, the electrical distribution company that apply this project, the equity capital will recover faster than the previous case because the wheeling cost will be deducted from the cost of this project in each year as shown Table 5.3.

Table5.3: The Wheeling Cost to All Cases in Prime and Standby Rates

Annual cost	Wheeling cost $
The first case cost	93579.187
The second case cost	93579.187
The third case cost	91273.67
The fourth case cost	91956.1
The fifth case cost	89650.59
The sixth case cost	91614.88
The average cases cost	91942.269

This project can be successful and can achieve its objectives and application without external financier from the third party, for example at a price of 1.5 NIS by 1 KWh, but having a financier may lead to lower the price of 1KWh and works to speed up the implementation of this project which depends on the nature of this funding.

Chapter 6
CONCLUSIONS AND FUTURE WORK

6.1 Conclusions

The need to improve the electricity sector has become more significant in the Gaza Strip. This can be done in several ways including creating a new technique to solve shortage in electricity and improving the quality of the energy and voltage stability.

The study presents a design of an emergency system that works during power cut-offs to provide electricity to customers in the Saudi village. Eight diesel generation units are required with capacity varying between 330-605 KVA. The electricity grid is used where no extra wiring is required for various operating conditions and a feasibility study is also provided for each condition.

ETAP software is used to simulate all cases by using the same electric grid in Saudi village. The parameters are entered to ETAP software to provide the value of load flow analysis.

For a price of NIS 1.5 per 1 KWh, the payback period is about five years, and for a price of NIS 2 per 1 KWh, the payback period is about one year.

It is recommended to start the project with a price of NIS 2 per 1 KWh in the first year, and then reduce the price to NIS 1.5 per 1 KWh.

We do hope that local authorities will benefits from this study in other places to lessen the suffering of the residents of the Gaza Strip.

6.2 Future Work

- Study the use of wind and solar energy as an alternative to generators
- The use of energy-saving measures

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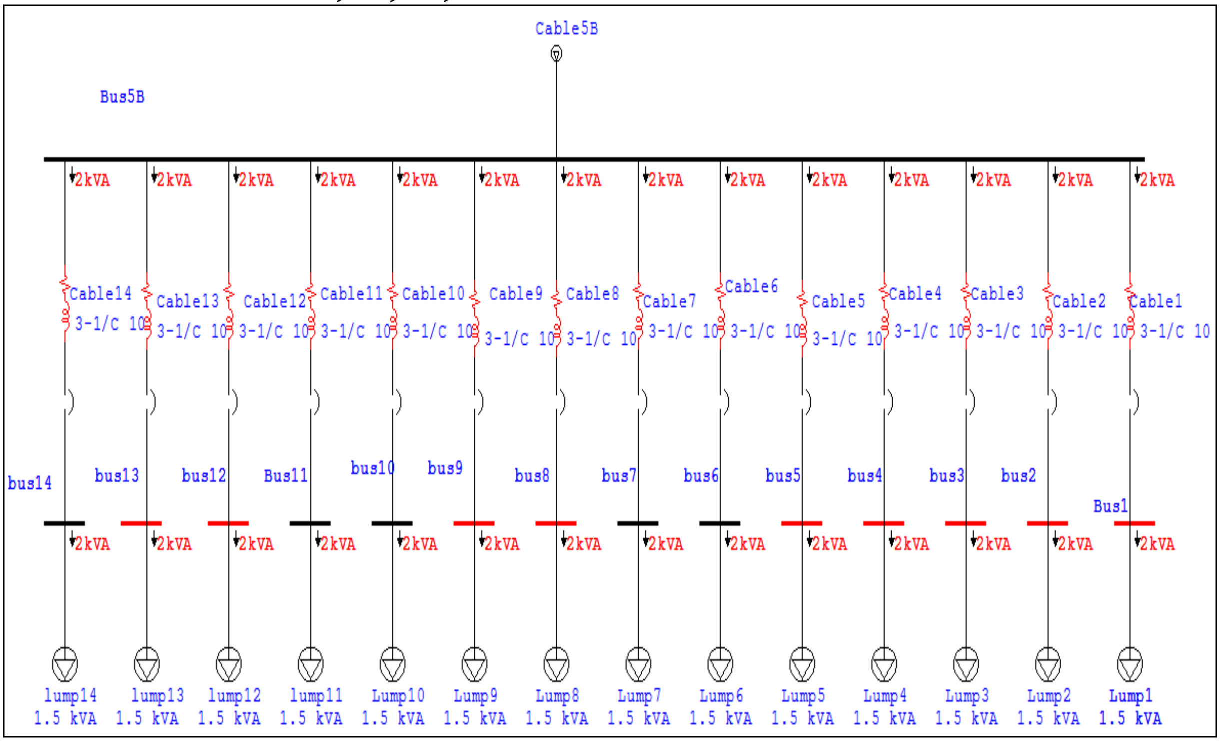
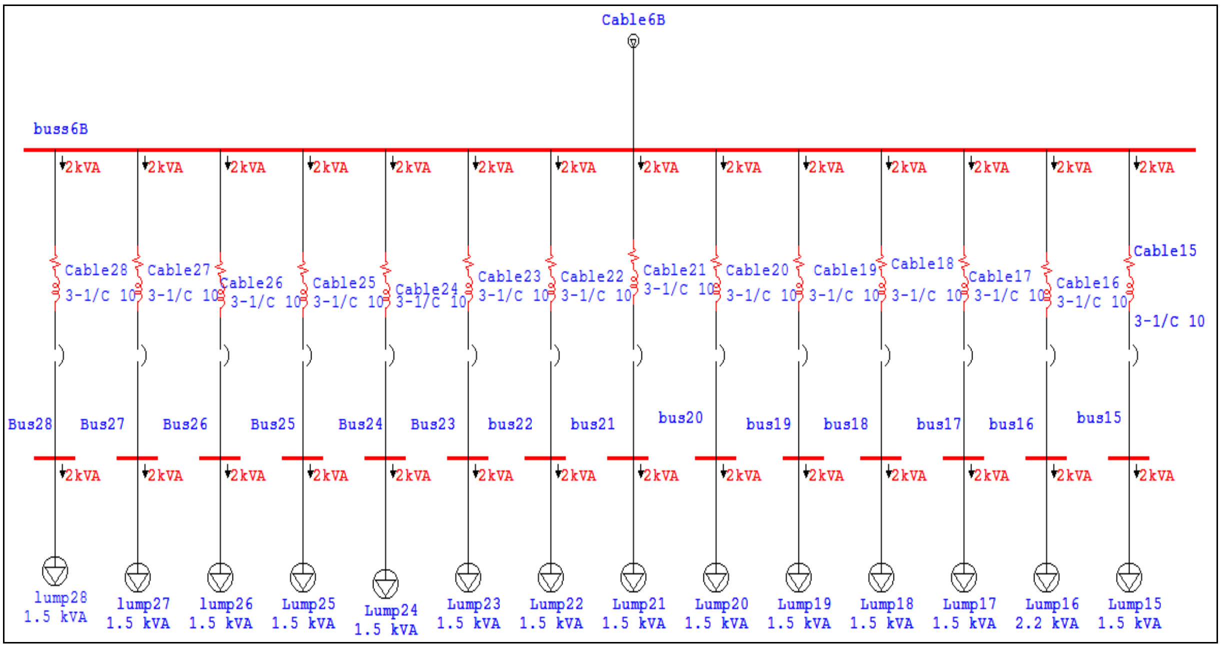
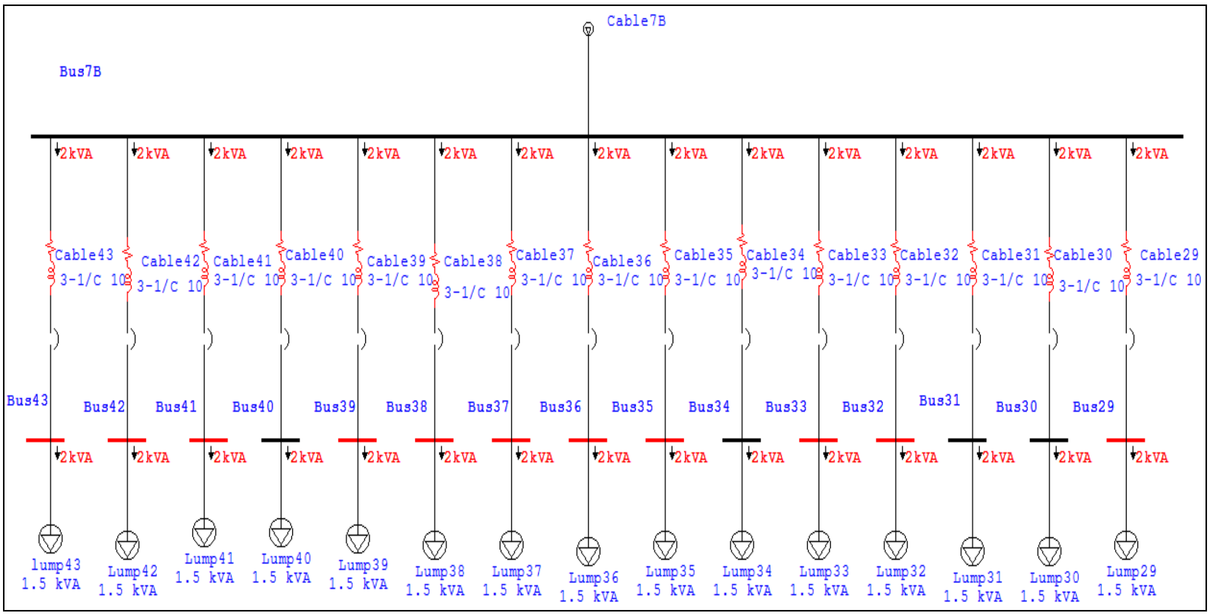
APPENDIX A

A.1 Branches 5B, 6B, 7B, and 8B from Branch T1A in Transform T1



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Bus7B
2kVA
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Cable42
Cable41
Cable40
Cable39
Cable38
Cable37
Cable36
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Cable33
Cable32
Cable31
Cable30
Cable29
3-1/C 10
Bus43
Bus42
Bus41
Bus40
Bus39
Bus38
Bus37
Bus36
Bus35
Bus34
Bus33
Bus32
Bus31
Bus30
Bus29
Lump43
Lump42
Lump41
Lump40
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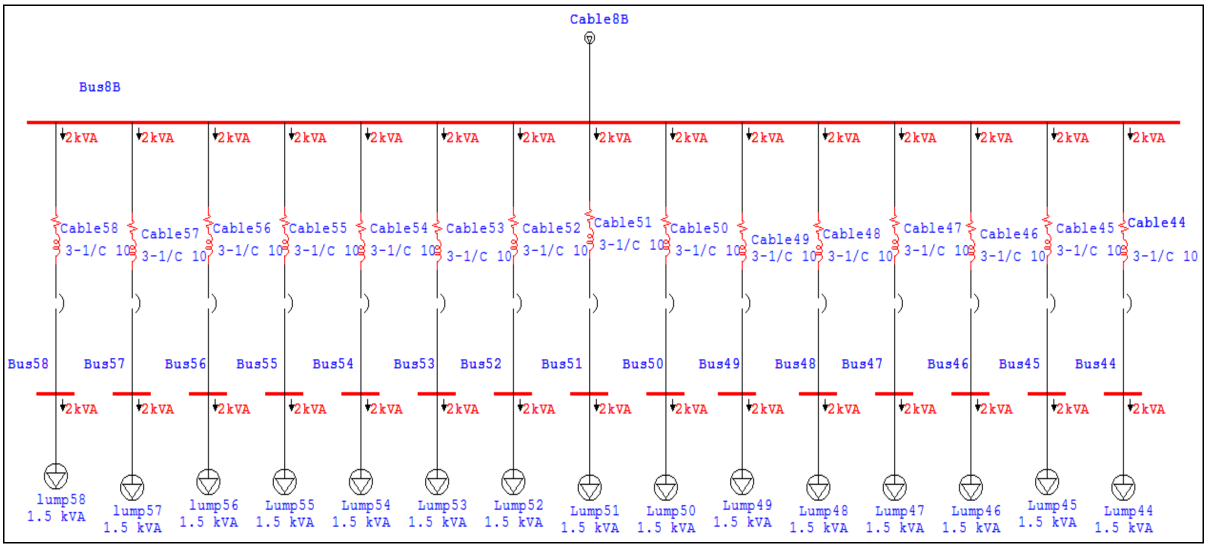
Lump30
Lump29
1.5 kVA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Bus8B
2kVA
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Cable57
Cable56
Cable55
Cable54
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Cable52
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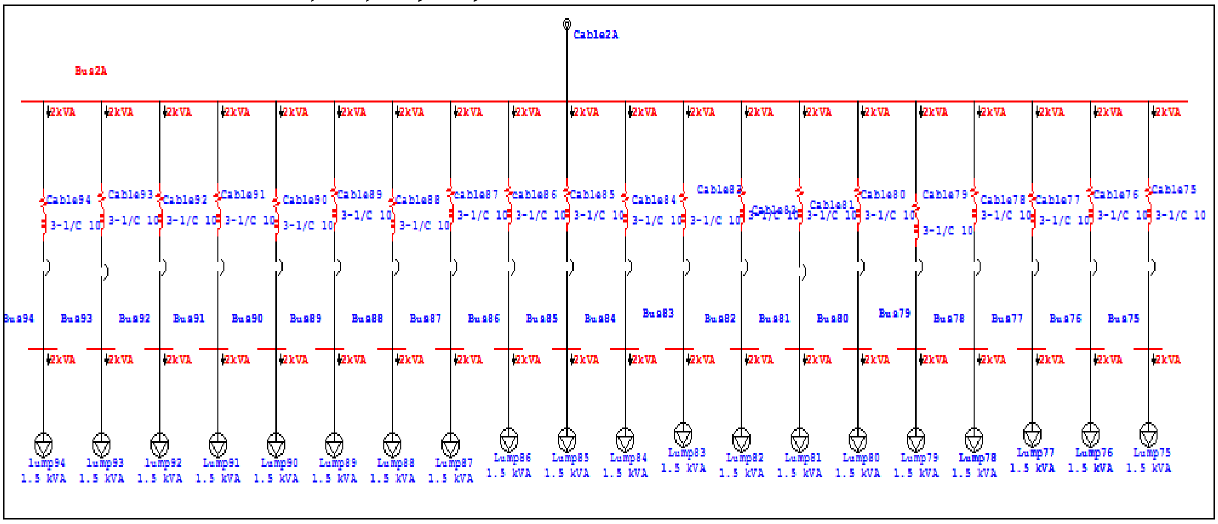
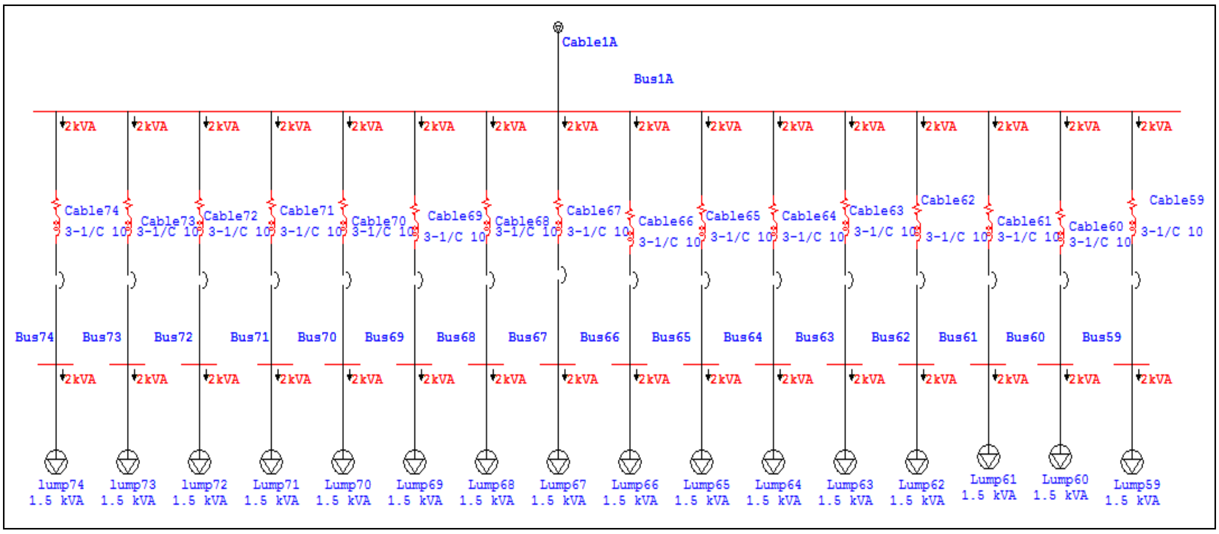
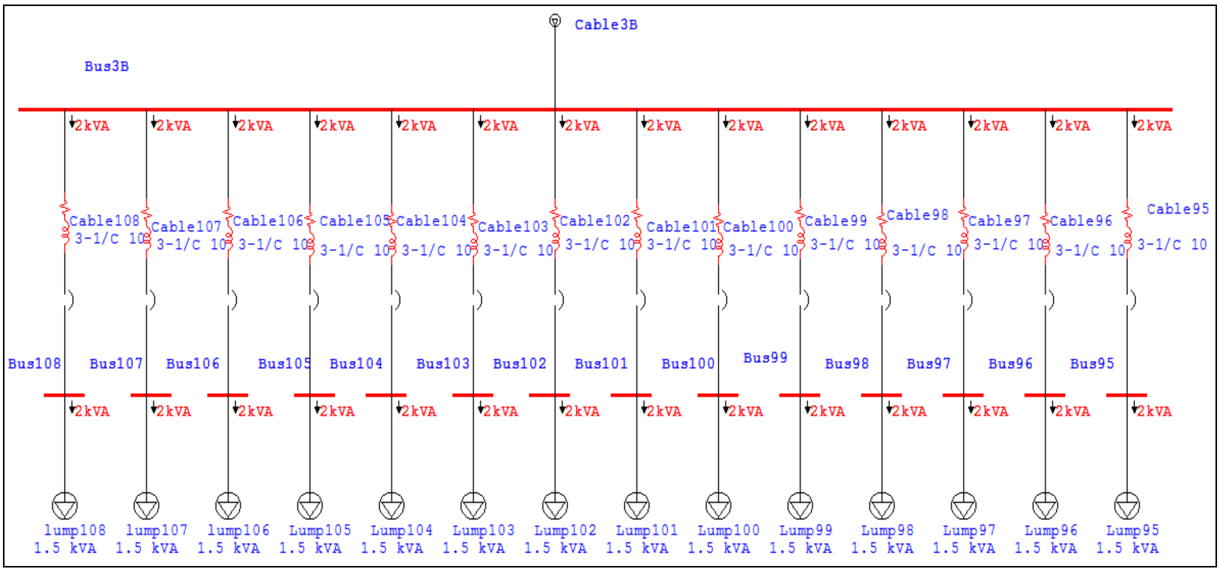
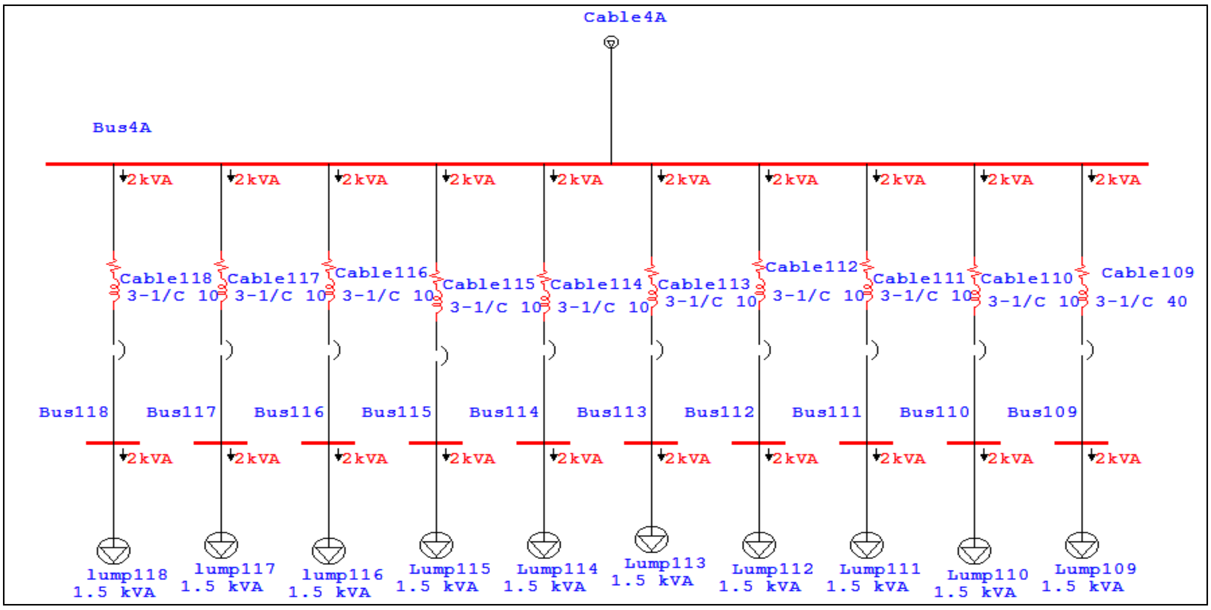
Cable48
Cable47
Cable46
Cable45
Cable44
3-1/C 10
Bus58
Bus57
Bus56
Bus55
Bus54
Bus53
Bus52
Bus51
Bus50
Bus49
Bus48
Bus47
Bus46
Bus45
Bus44
lump58
lump57
lump56
Lump55
Lump54
Lump53
Lump52
Lump51
Lump50
Lump49
Lump48
Lump47
Lump46
Lump45
Lump44
1.5 kVA

A.2 Branches 1A, 2A, 3B, 4A, and 8B from Branch T1B in Transform T1

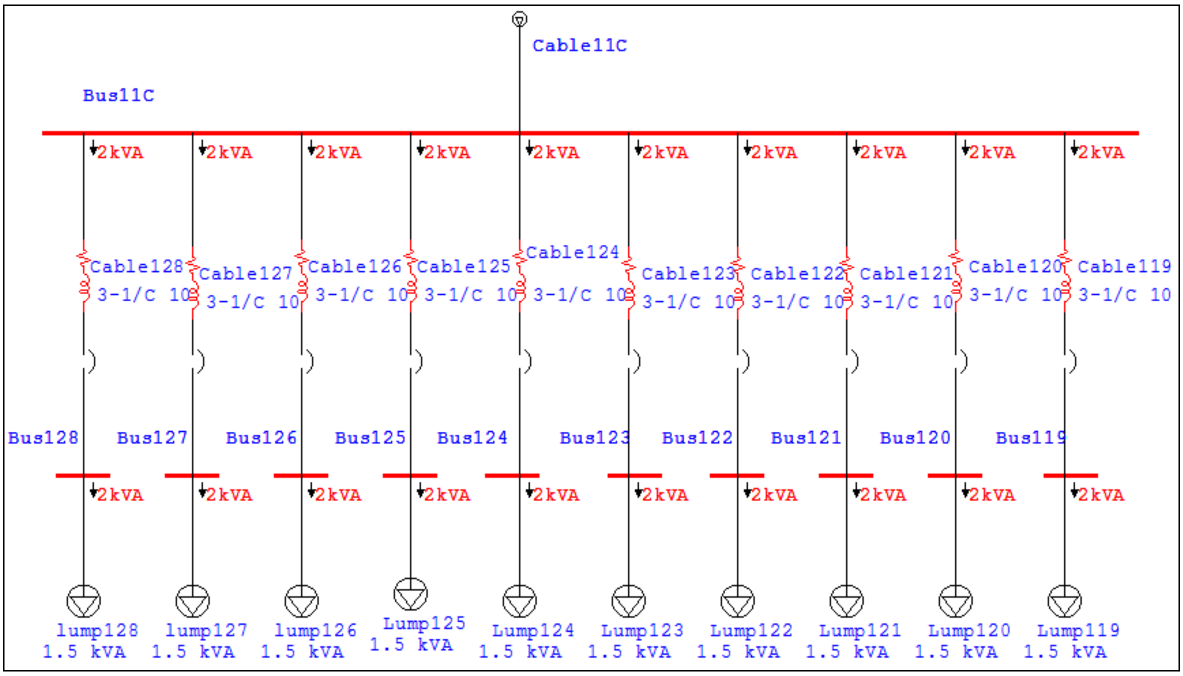


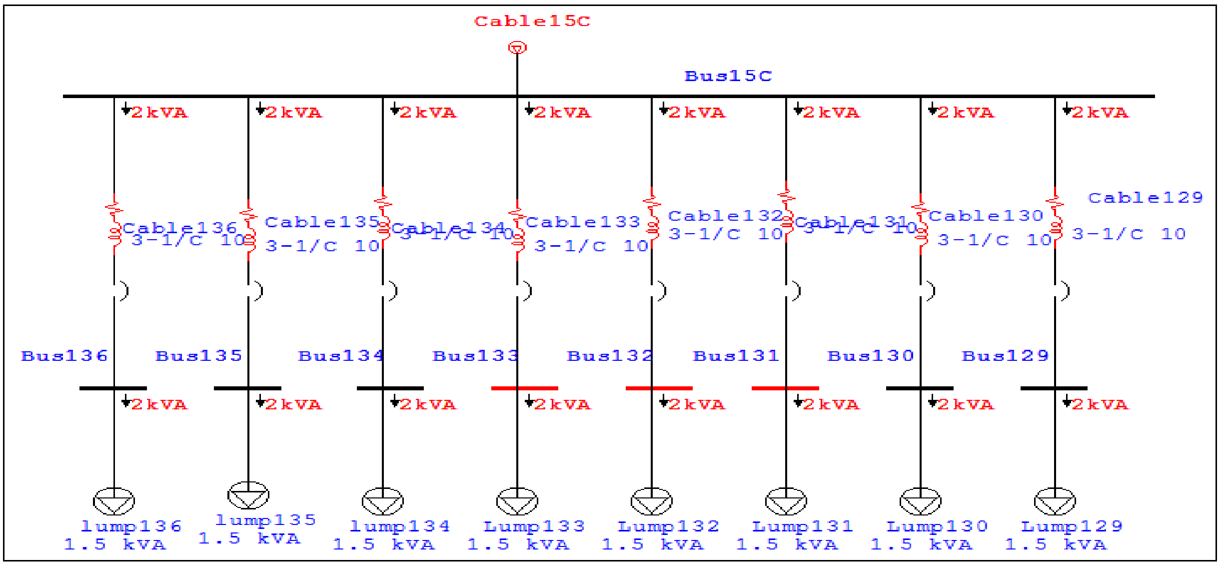






A.3 Branches 11C, 15C, 12C, 14B, and 13A from Branch T1C in Transform T1

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Bus15C
2kVA
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Cable135 3-1/C 10
Cable134 3-1/C 10
Cable133 3-1/C 10
Cable132 3-1/C 10
Cable131 3-1/C 10
Cable130 3-1/C 10
Cable129 3-1/C 10
Bus136
Bus135
Bus134
Bus133
Bus132
Bus131
Bus130
Bus129
lump136 1.5 kVA
lump135 1.5 kVA
lump134 1.5 kVA
Lump133 1.5 kVA
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Lump131 1.5 kVA
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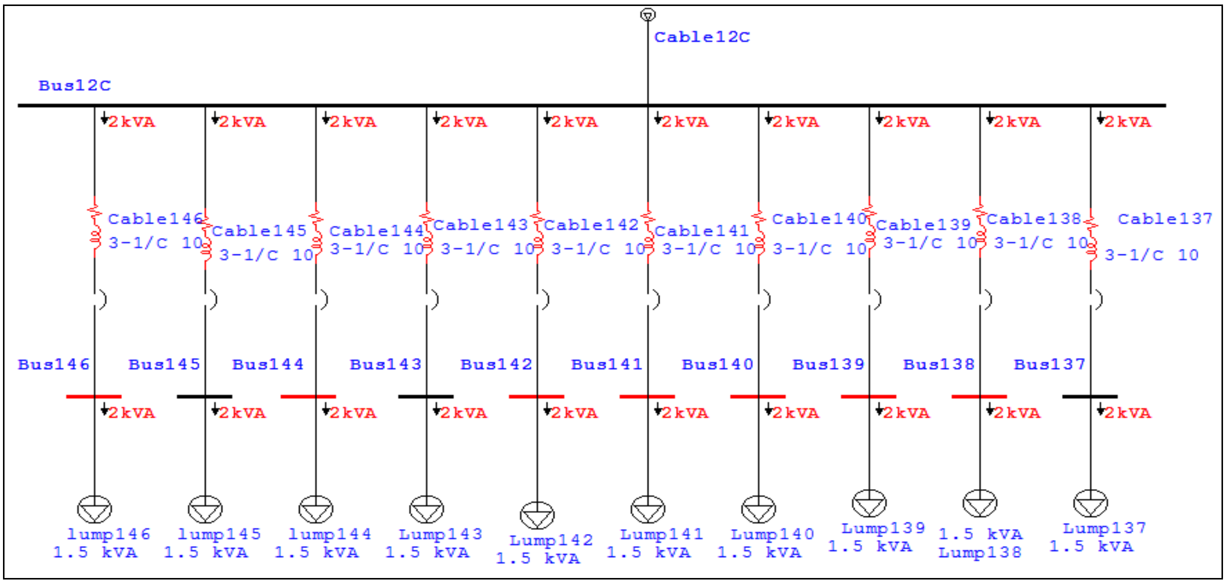
Lump129 1.5 kVA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Cable145 3-1/C 10
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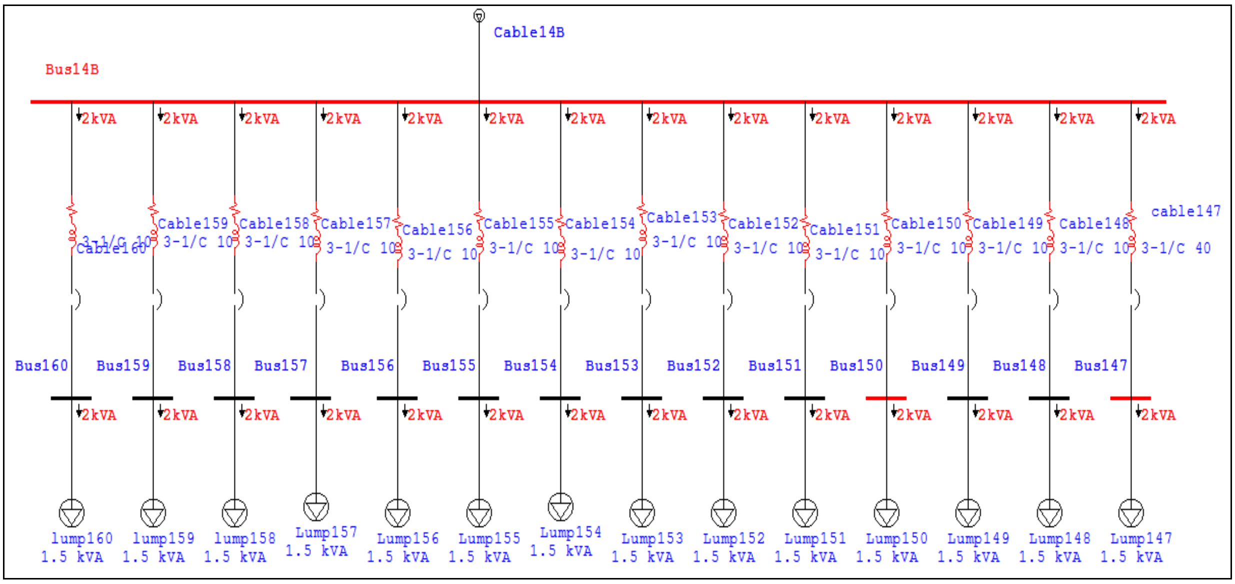
Cable141 3-1/C 10
Cable140 3-1/C 10
Cable139 3-1/C 10
Cable138 3-1/C 10
Cable137 3-1/C 10
Bus146
Bus145
Bus144
Bus143
Bus142
Bus141
Bus140
Bus139
Bus138
Bus137
lump146 1.5 kVA
lump145 1.5 kVA
lump144 1.5 kVA
Lump143 1.5 kVA
Lump142 1.5 kVA
Lump141 1.5 kVA
Lump140 1.5 kVA
Lump139 1.5 kVA
1.5 kVA Lump138
Lump137 1.5 kVA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Bus14B
2kVA
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Cable159 3-1/C 10
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Cable157 3-1/C 10
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Cable155 3-1/C 10
Cable154 3-1/C 10
Cable153 3-1/C 10
Cable152 3-1/C 10
Cable151 3-1/C 10
Cable150 3-1/C 10
Cable149 3-1/C 10
Cable148 3-1/C 10
cable147 3-1/C 40
Bus160
Bus159
Bus158
Bus157
Bus156
Bus155
Bus154
Bus153
Bus152
Bus151
Bus150
Bus149
Bus148
Bus147
lump160 1.5 kVA
lump159 1.5 kVA
lump158 1.5 kVA
Lump157 1.5 kVA
Lump156 1.5 kVA
Lump155 1.5 kVA
Lump154 1.5 kVA
Lump153 1.5 kVA
Lump152 1.5 kVA
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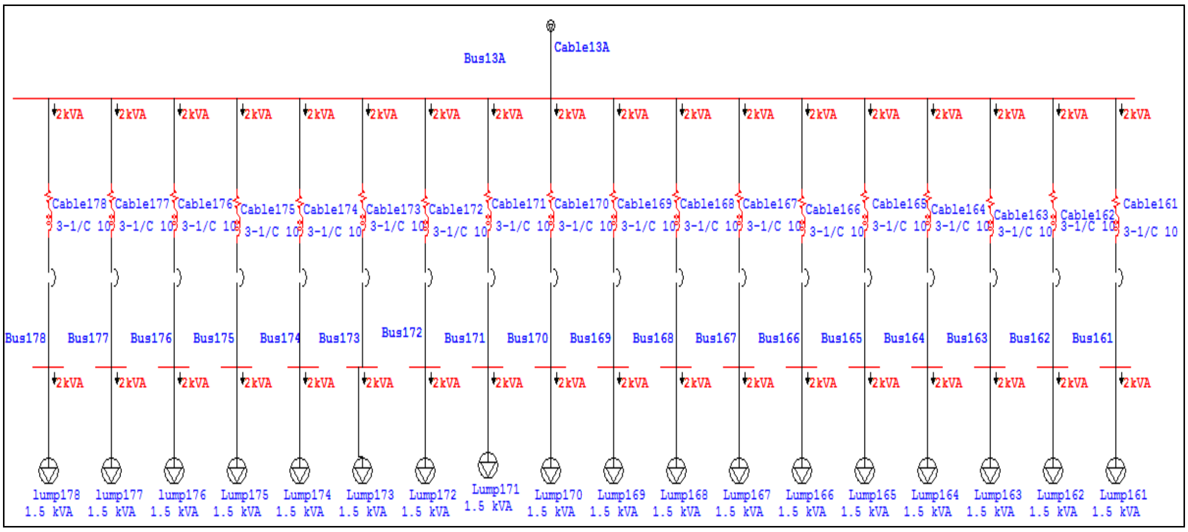
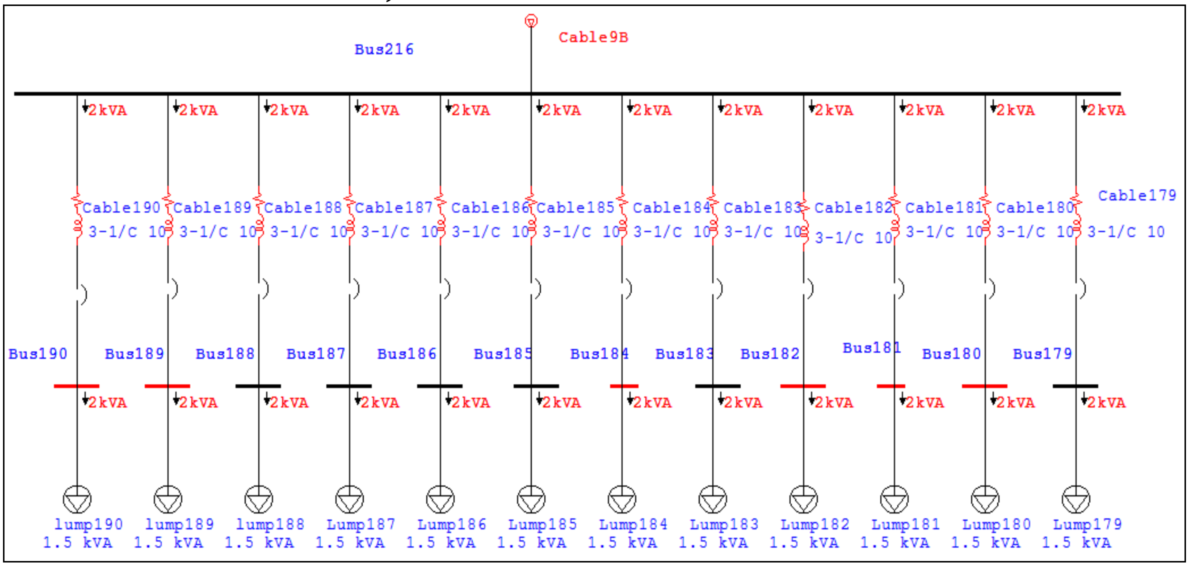
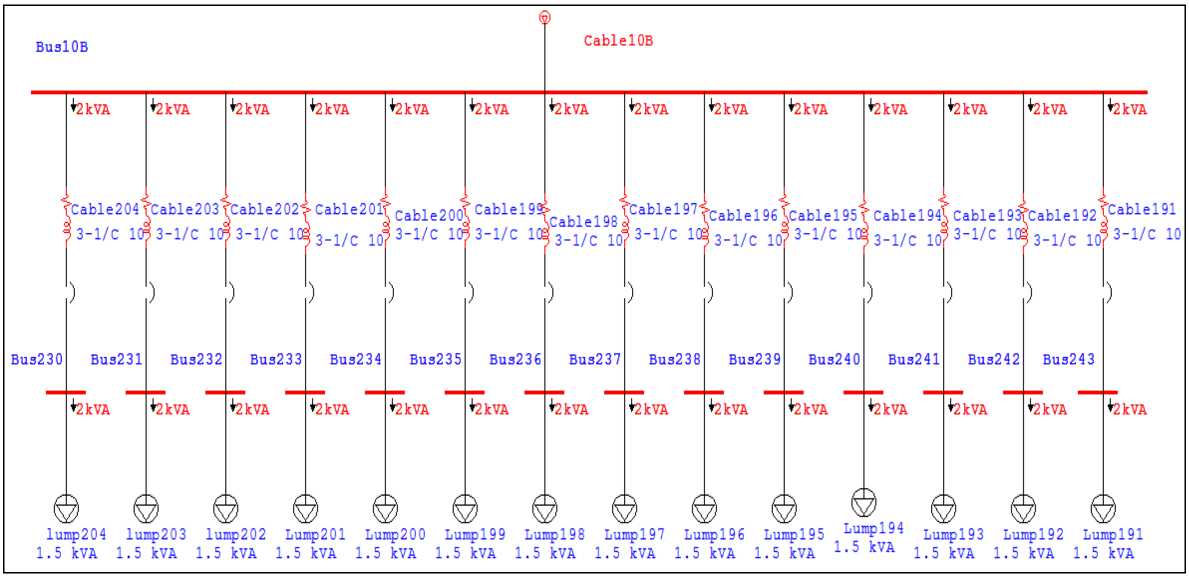
Lump147 1.5 kVA



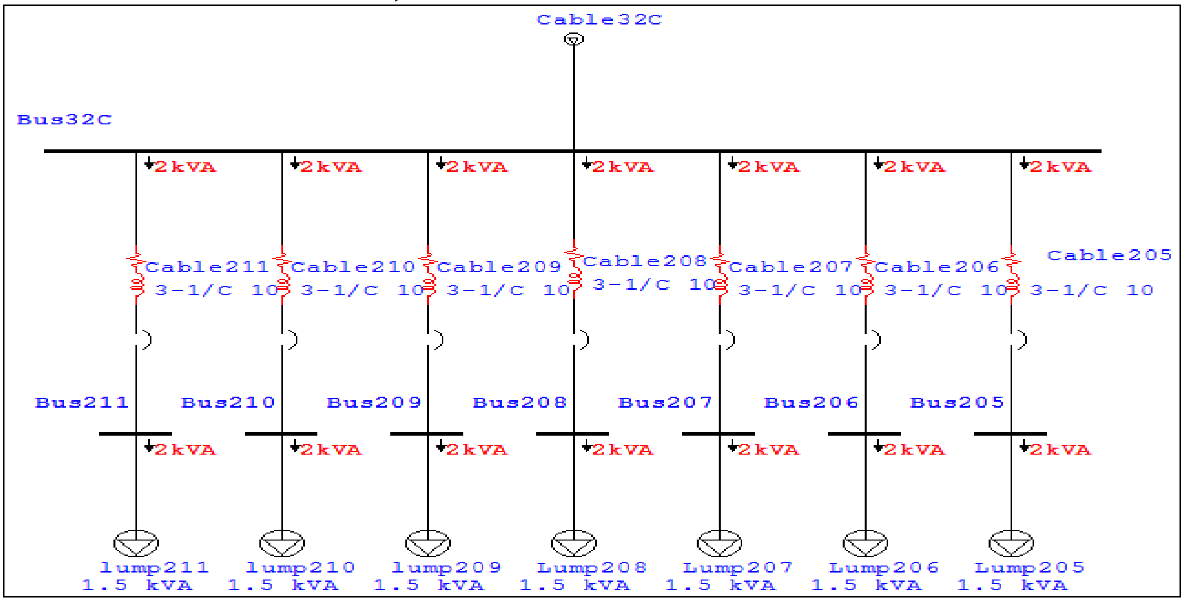
A.4 Branches 9B, and10B from Branch T1D in Transform T1

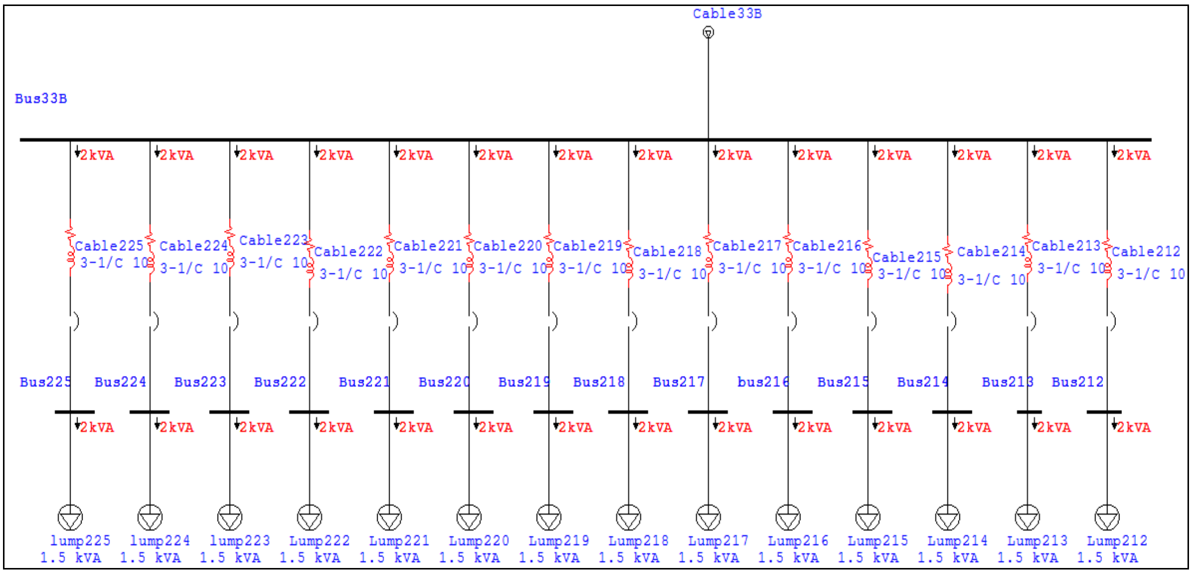




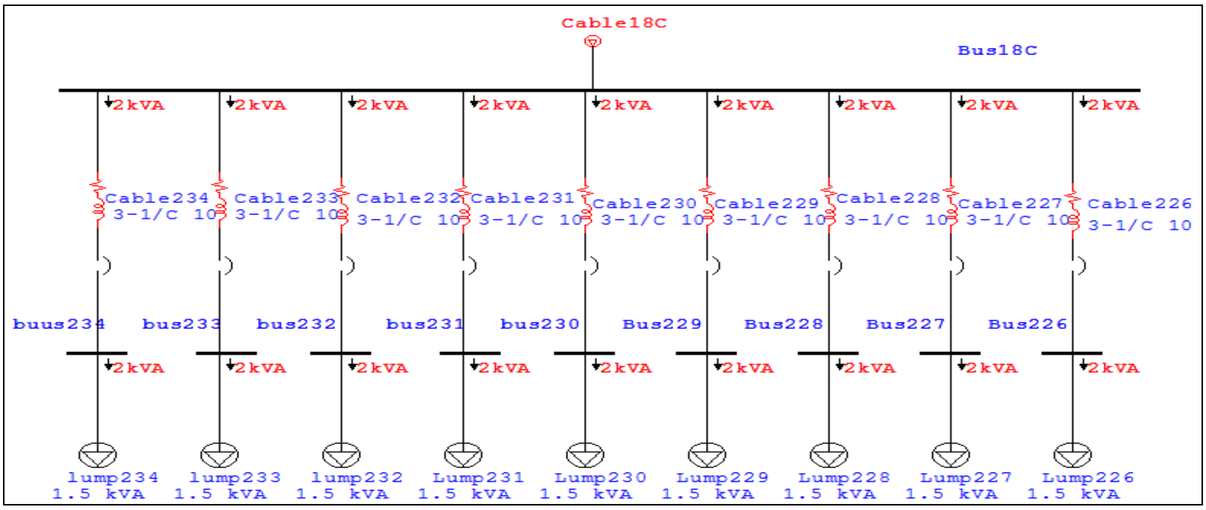
APPENDIX B

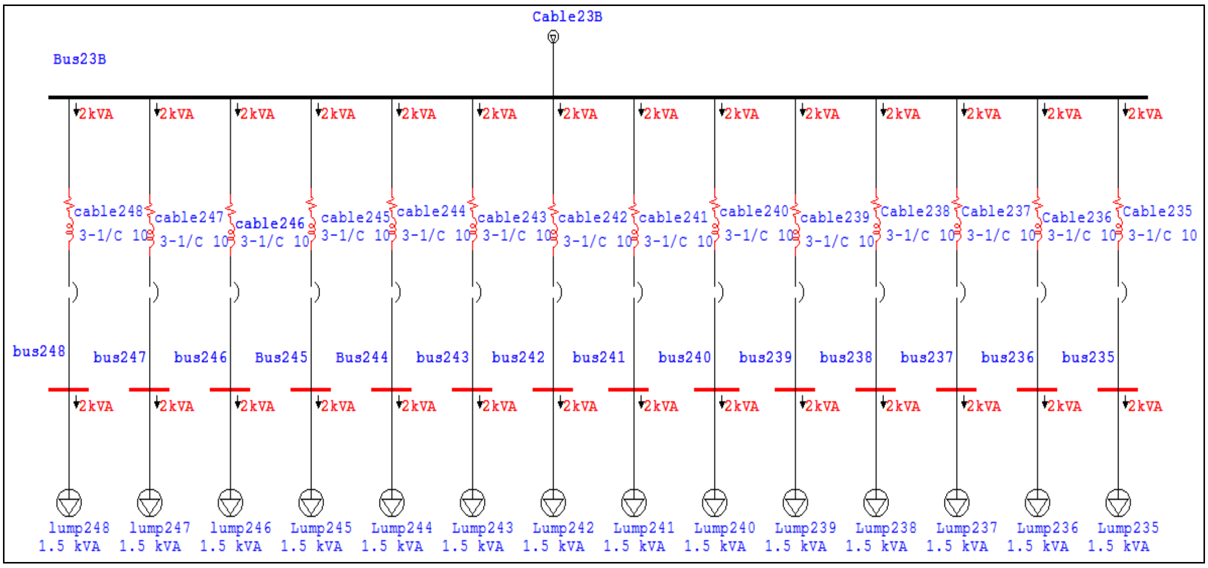
B.1 Branches 32C, and33B from Branch T2A in Transform T2

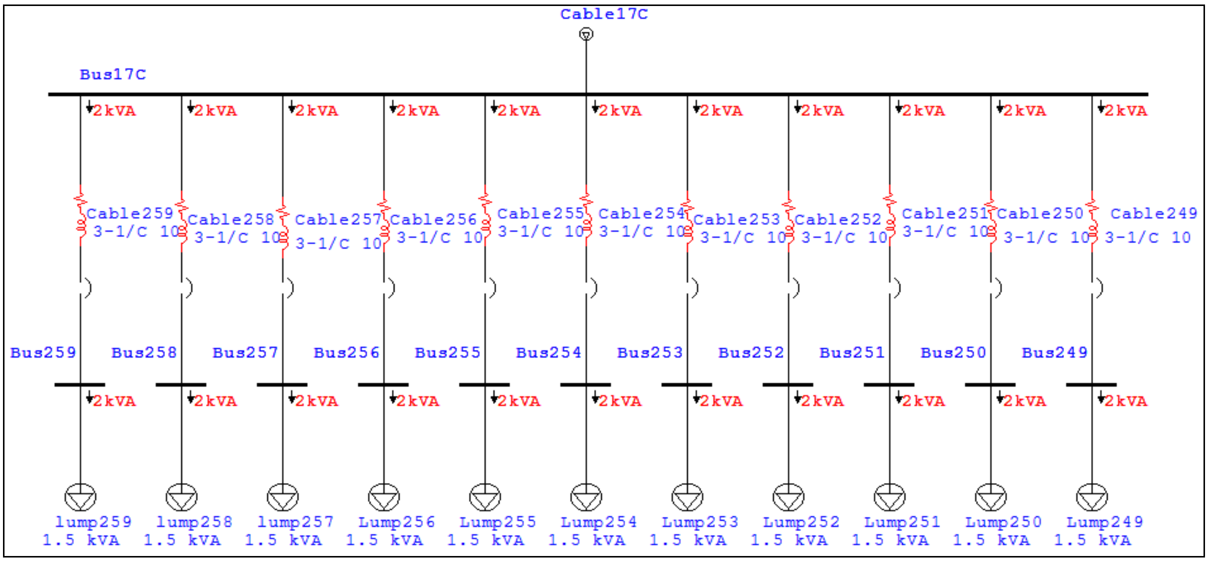


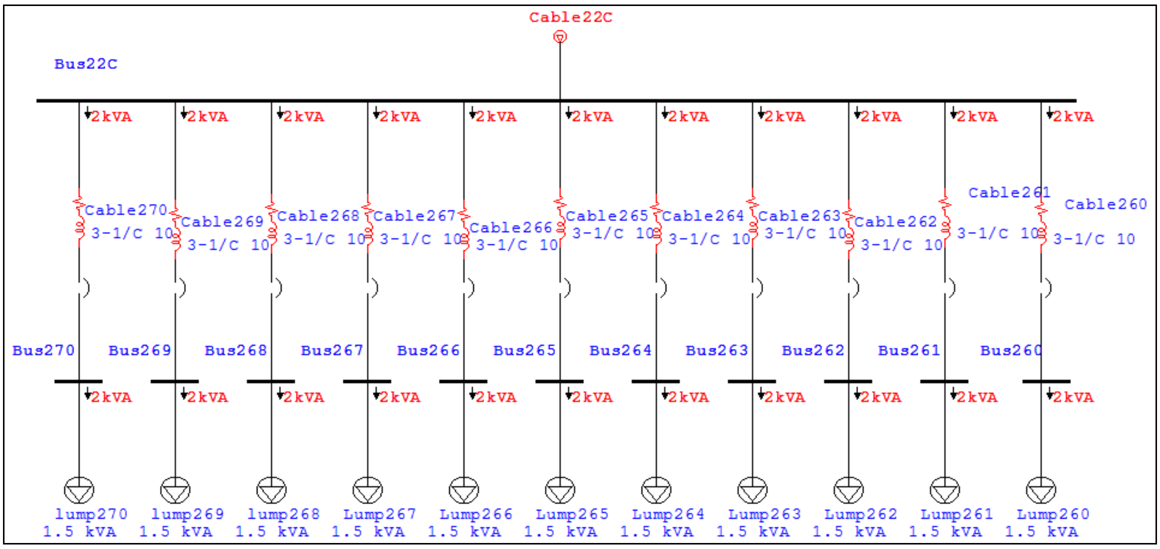


B.2 Branches 18C, 23B, 17C, 22C, 16C, and21C from Branch T2B in Transform T2





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Cable265 3-1/C 10
Cable264 3-1/C 10
Cable263 3-1/C 10
Cable262 3-1/C 10
Cable261 3-1/C 10
Cable260 3-1/C 10
Bus270 Bus269 Bus268 Bus267 Bus266 Bus265 Bus264 Bus263 Bus262 Bus261 Bus260
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lump269 1.5 kVA
lump268 1.5 kVA
Lump267 1.5 kVA
Lump266 1.5 kVA
Lump265 1.5 kVA
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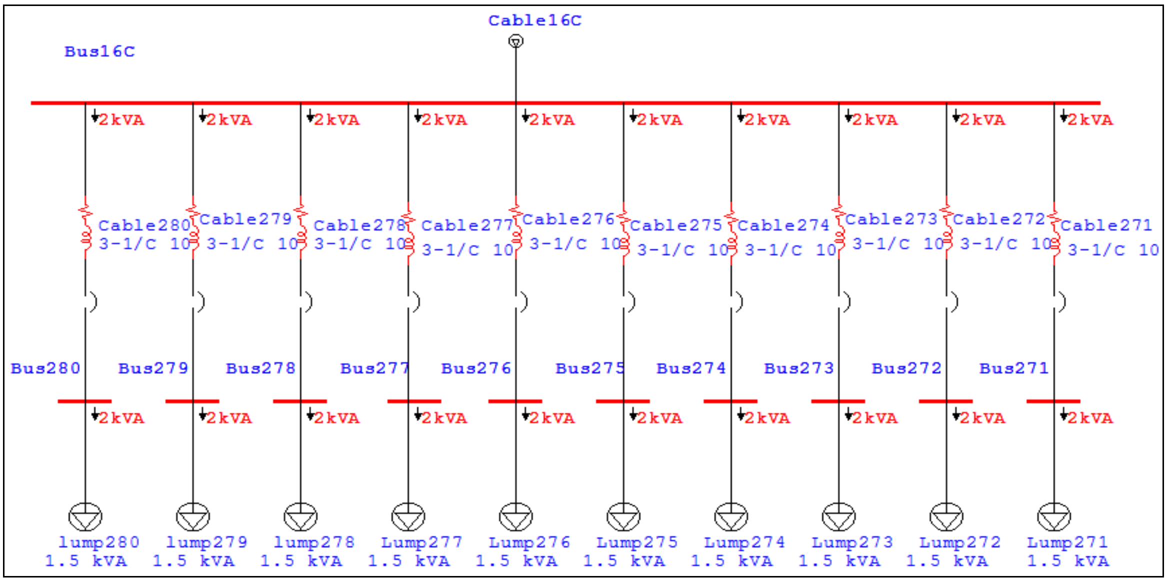
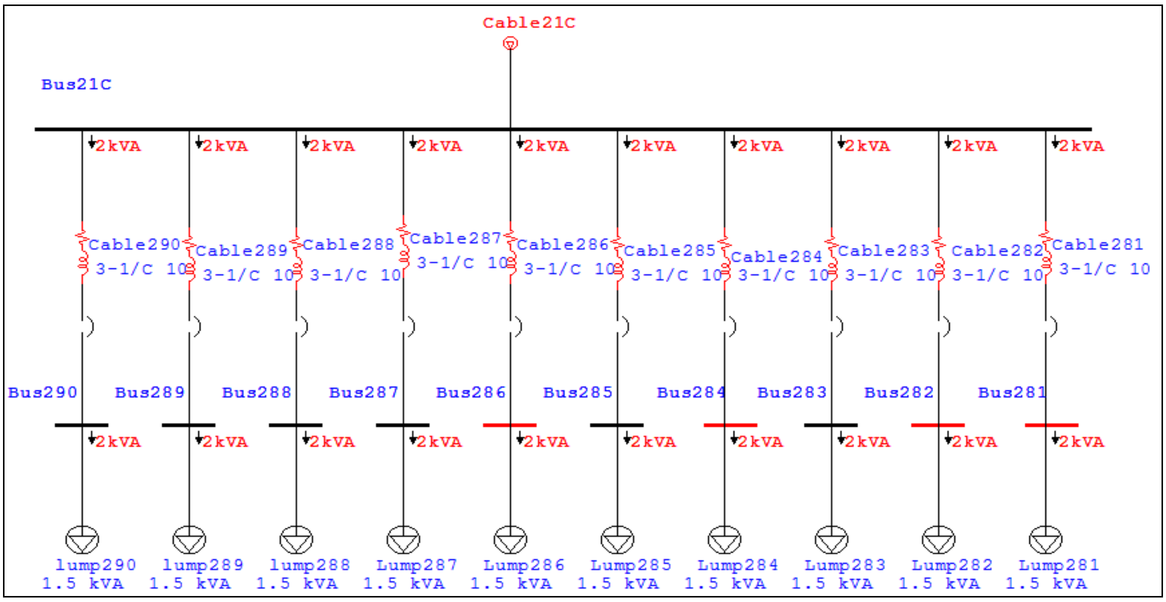
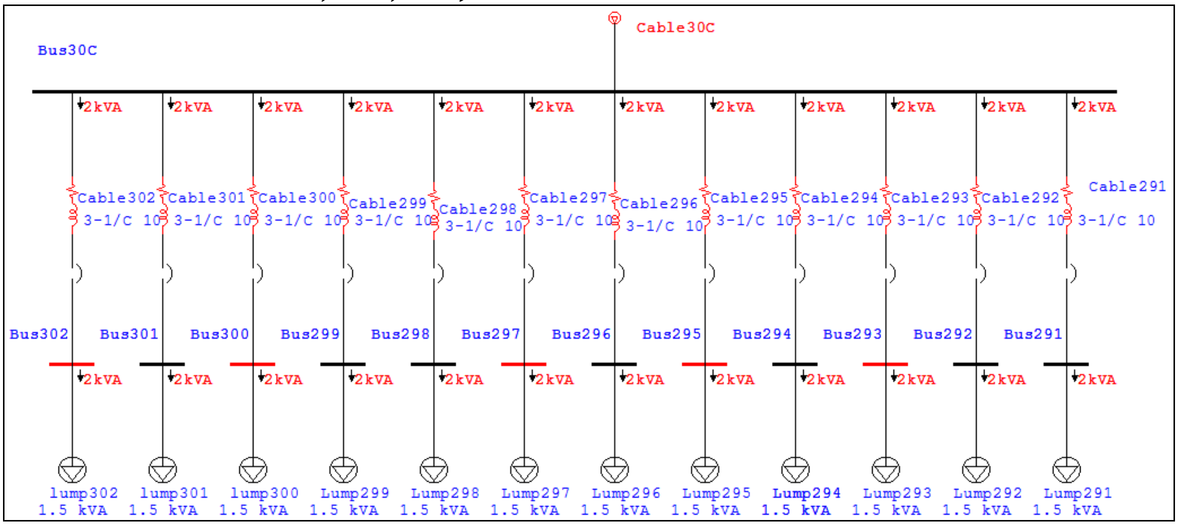
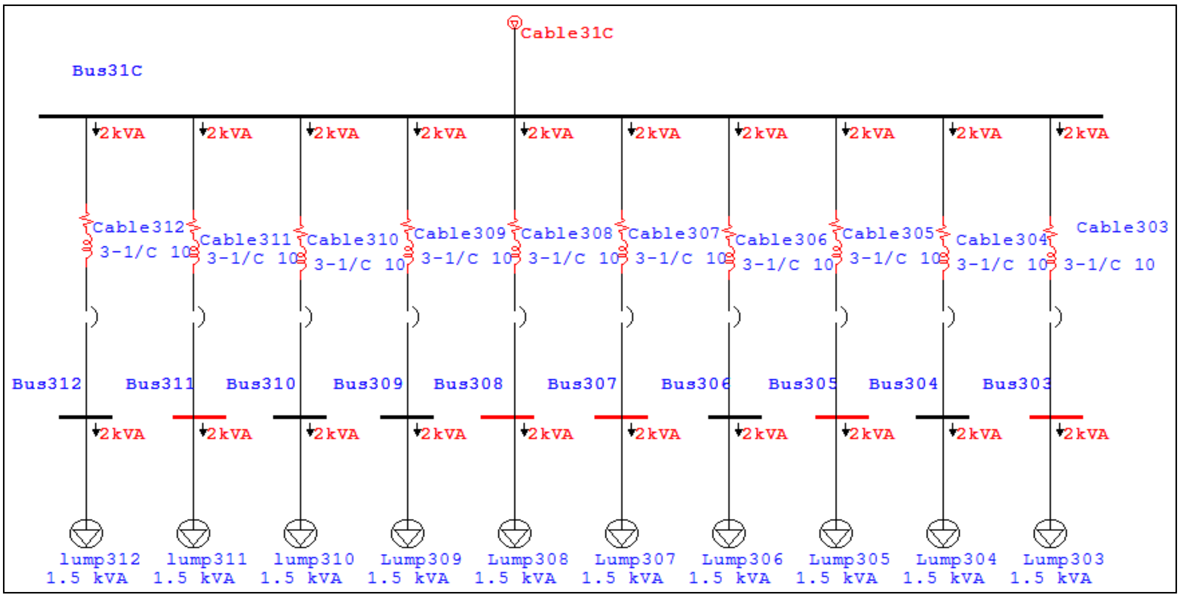
Lump260 1.5 kVA

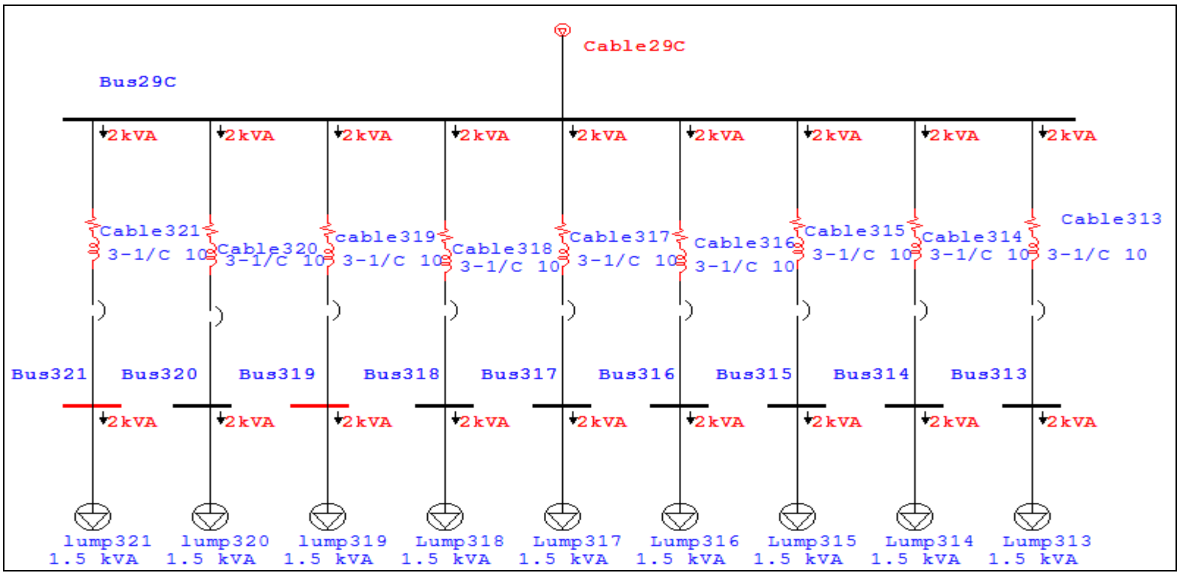

Cable16C
Bus16C
2kVA
Cable280 3-1/C 10
Cable279 3-1/C 10
Cable278 3-1/C 10
Cable277 3-1/C 10
Cable276 3-1/C 10
Cable275 3-1/C 10
Cable274 3-1/C 10
Cable273 3-1/C 10
Cable272 3-1/C 10
Cable271 3-1/C 10
Bus280 Bus279 Bus278 Bus277 Bus276 Bus275 Bus274 Bus273 Bus272 Bus271
lump280 1.5 kVA
lump279 1.5 kVA
lump278 1.5 kVA
Lump277 1.5 kVA
Lump276 1.5 kVA
Lump275 1.5 kVA
Lump274 1.5 kVA
Lump273 1.5 kVA
Lump272 1.5 kVA
Lump271 1.5 kVA

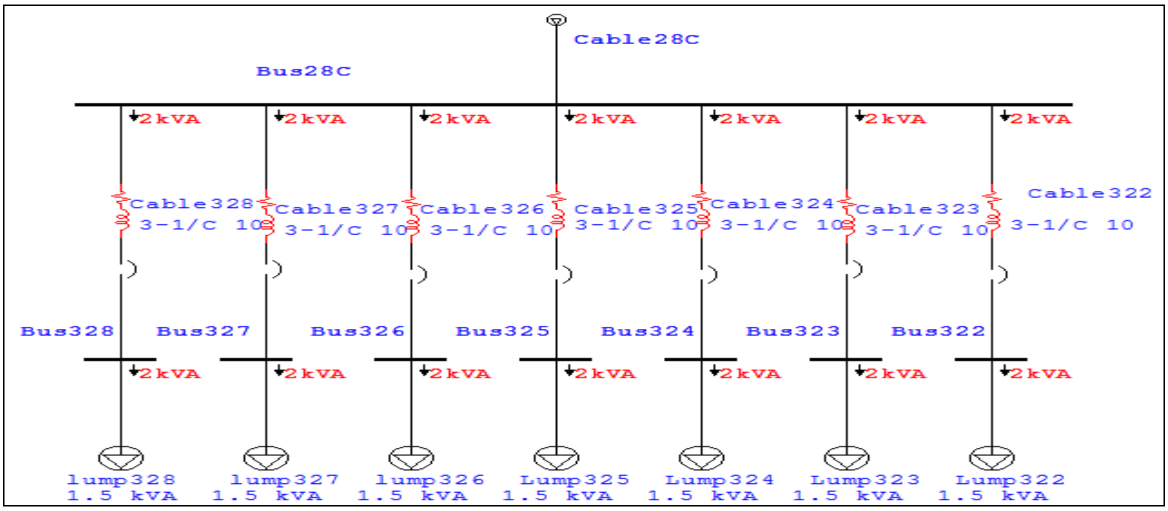

Cable21C
Bus21C
2kVA
Cable290 3-1/C 10
Cable289 3-1/C 10
Cable288 3-1/C 10
Cable287 3-1/C 10
Cable286 3-1/C 10
Cable285 3-1/C 10
Cable284 3-1/C 10
Cable283 3-1/C 10
Cable282 3-1/C 10
Cable281 3-1/C 10
Bus290 Bus289 Bus288 Bus287 Bus286 Bus285 Bus284 Bus283 Bus282 Bus281
lump290 1.5 kVA
lump289 1.5 kVA
lump288 1.5 kVA
Lump287 1.5 kVA
Lump286 1.5 kVA
Lump285 1.5 kVA
Lump284 1.5 kVA
Lump283 1.5 kVA
Lump282 1.5 kVA
Lump281 1.5 kVA

B.3 Branches 28C, 29C, 31C**, and** 30C **from Branch T2C in Transform T2**

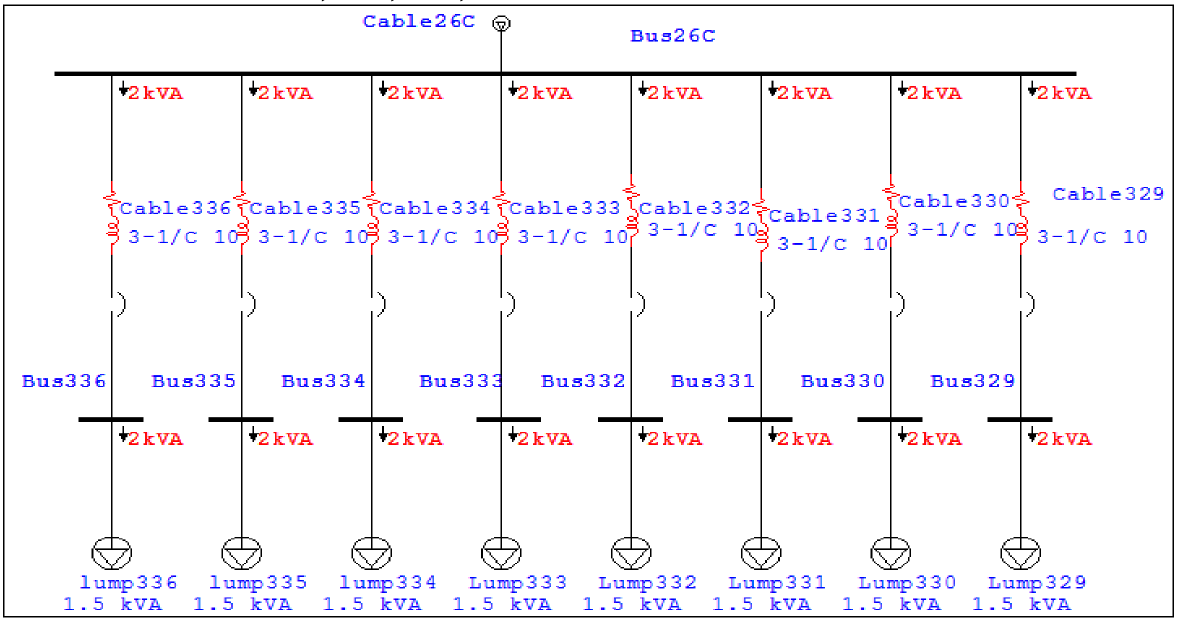


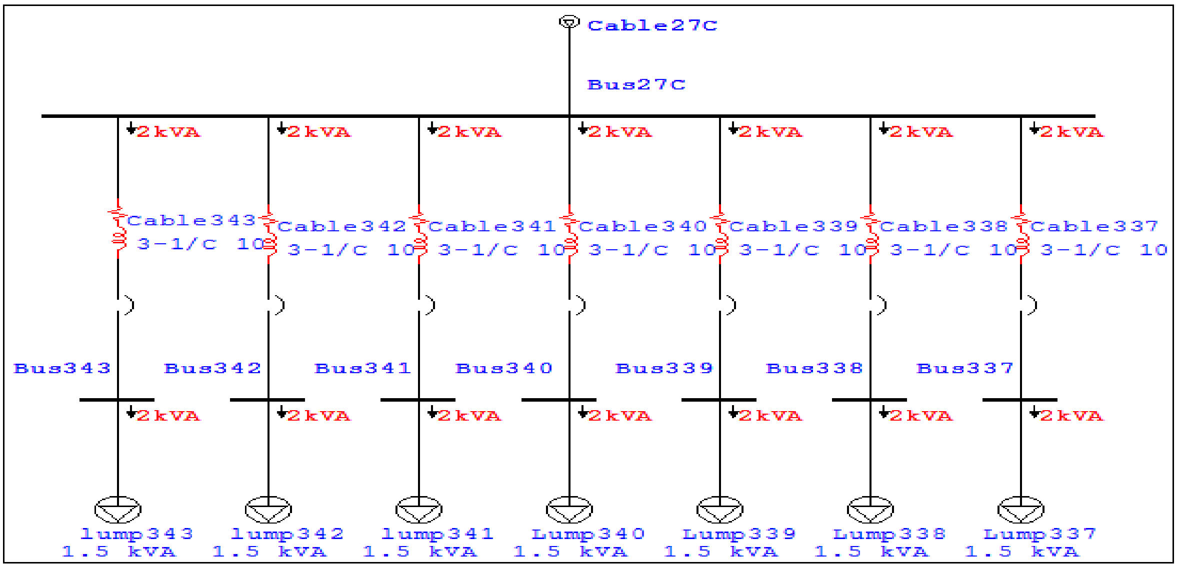


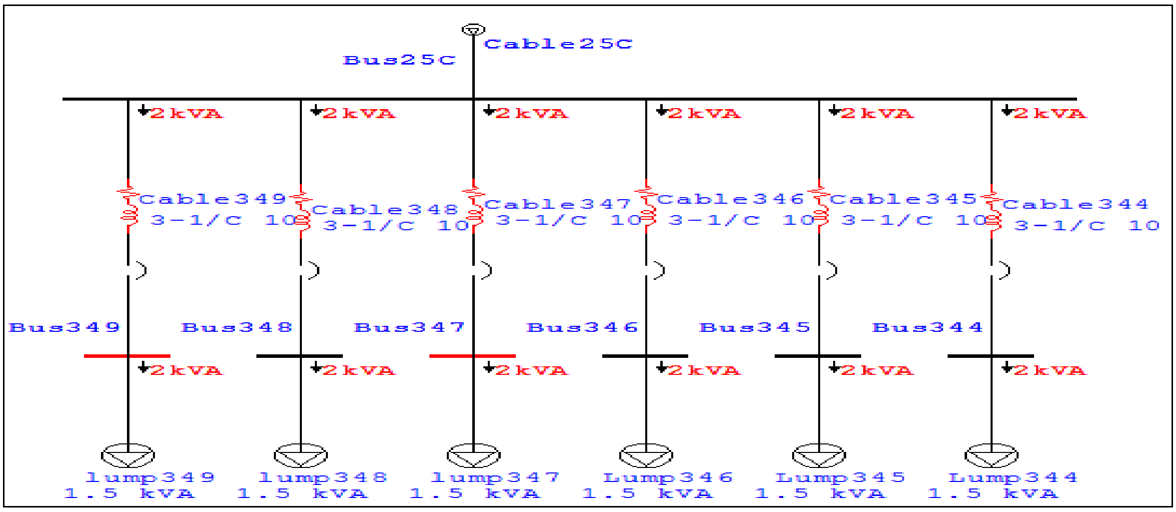


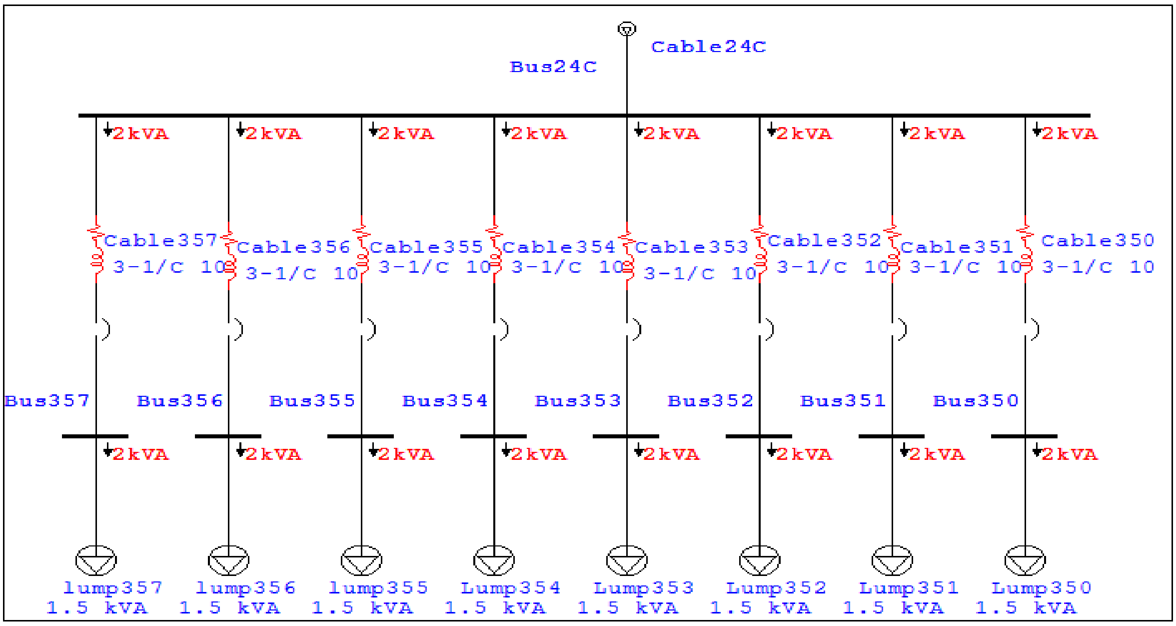


B.4 Branches 24C, 25C, 27C, **and** 26C **from Branch T2D in Transform T2**

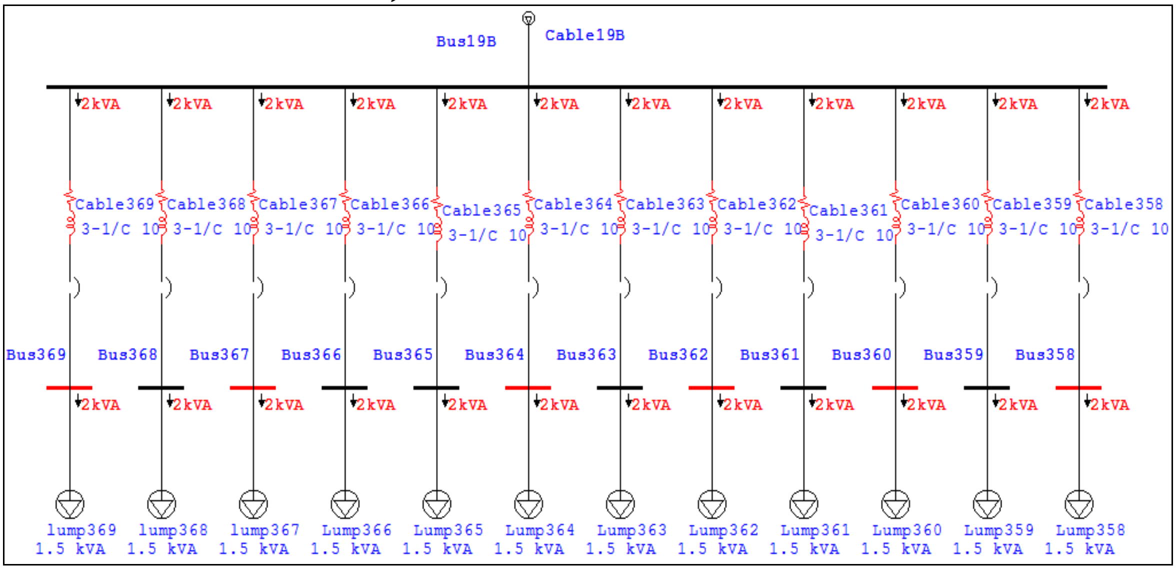


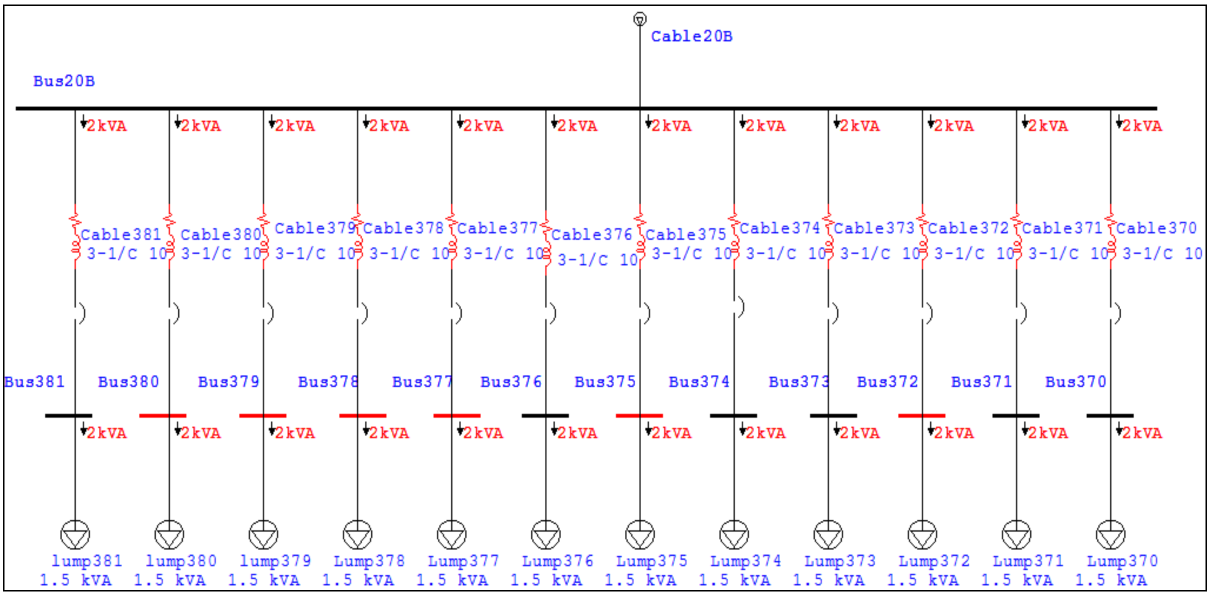






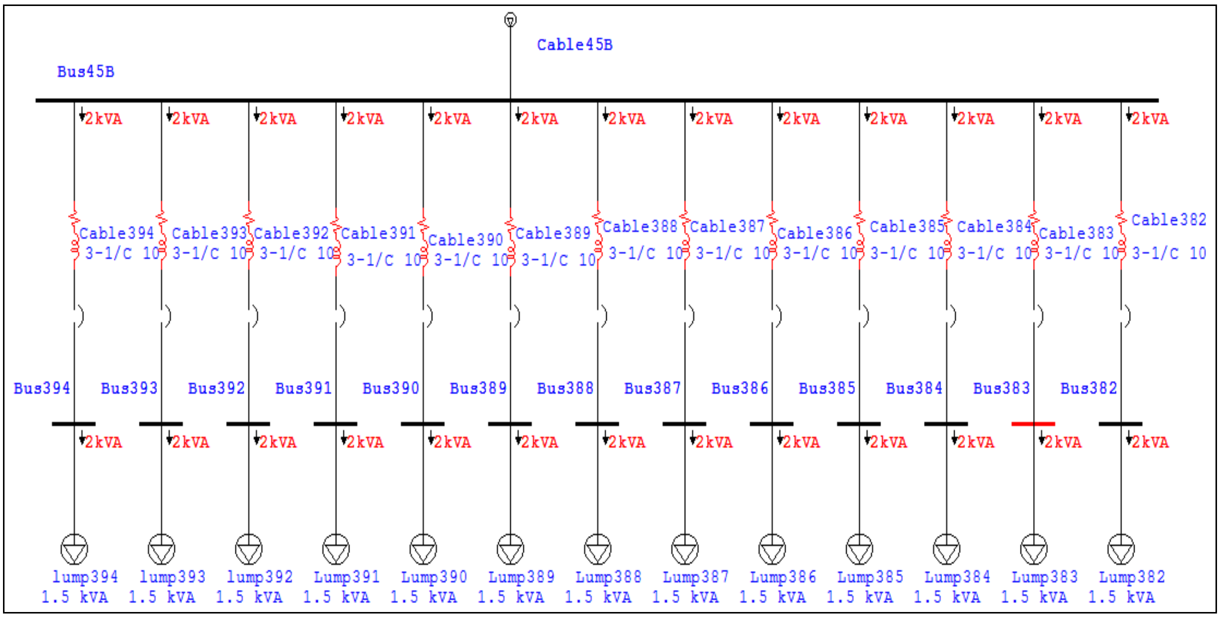
B.5 Branches 20B, and 19B from Branch T2E in Transform T2

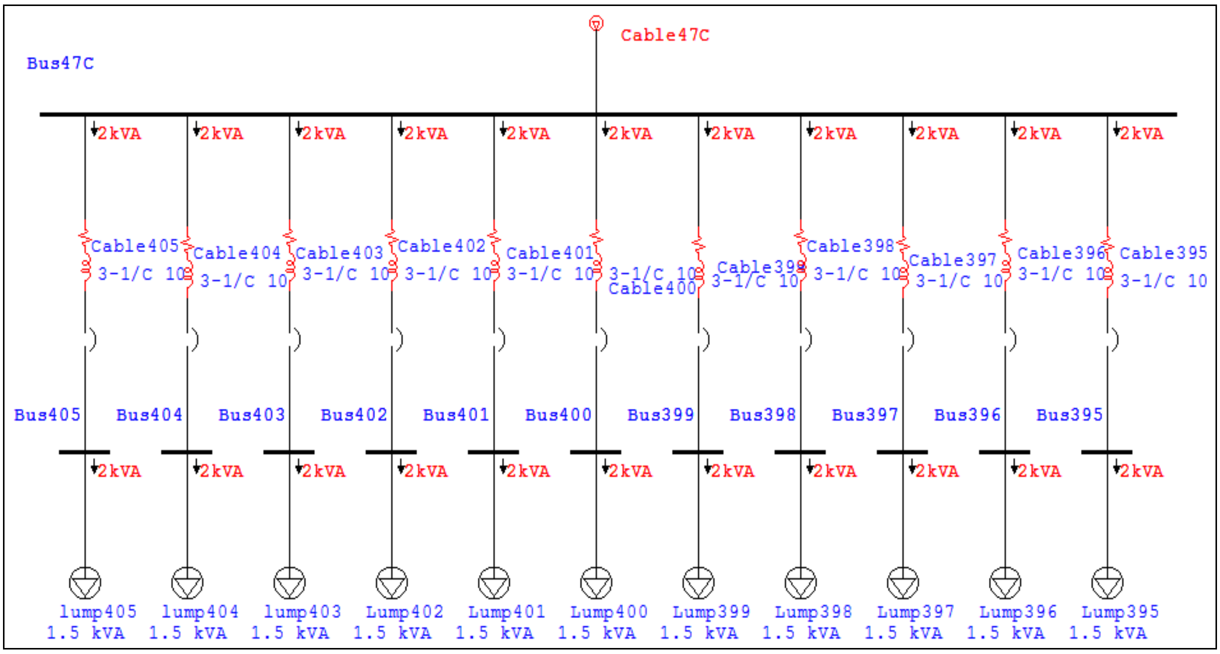


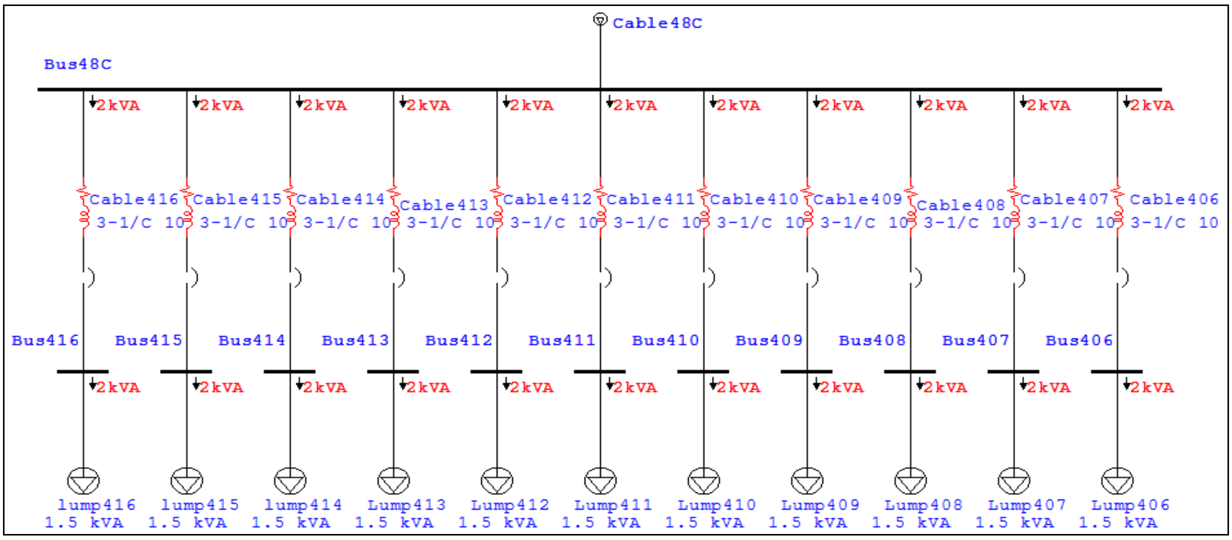


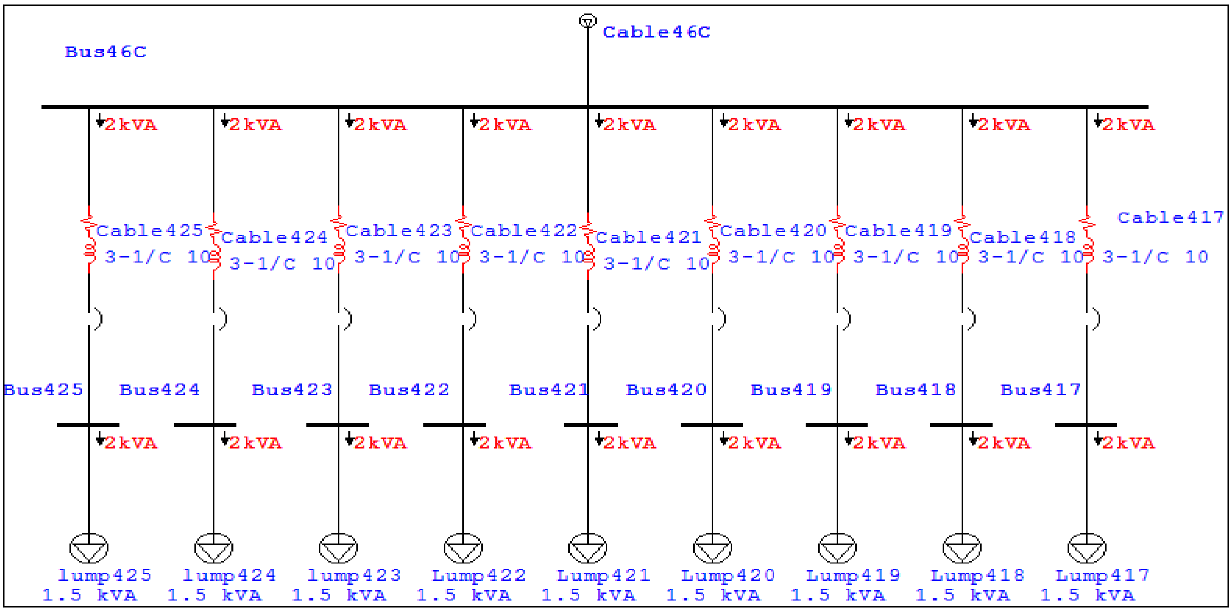
APPENDIX C

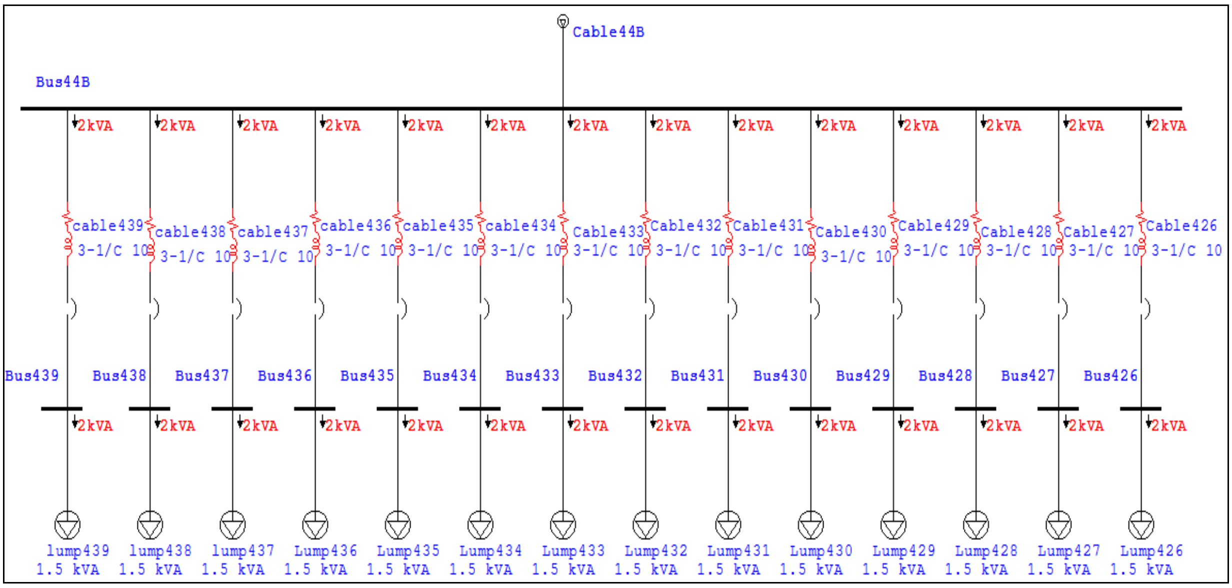
C.1 Branches 44B, 46C, 48C, 47C, and 45B from Branch T3A in Transform T3



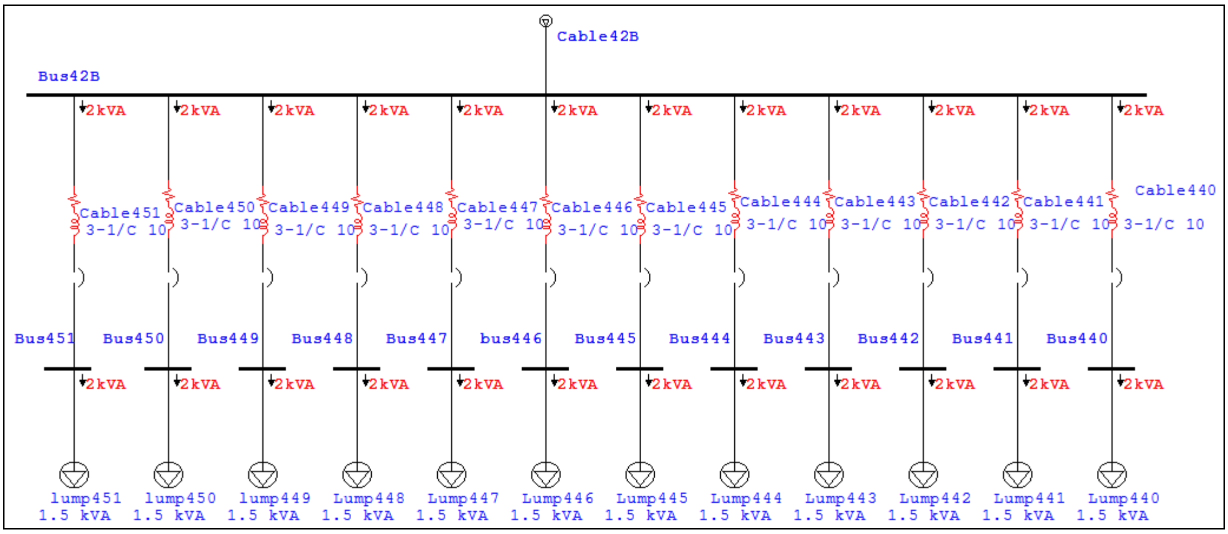

Cable47C
Bus47C
2kVA
Cable405 3-1/C 10
Cable404 3-1/C 10
Cable403 3-1/C 10
Cable402 3-1/C 10
Cable401 3-1/C 10
Cable400 3-1/C 10
Cable399 3-1/C 10
Cable398 3-1/C 10
Cable397 3-1/C 10
Cable396 3-1/C 10
Cable395 3-1/C 10
Bus405
Bus404
Bus403
Bus402
Bus401
Bus400
Bus399
Bus398
Bus397
Bus396
Bus395
lump405 1.5 kVA
lump404 1.5 kVA
lump403 1.5 kVA
Lump402 1.5 kVA
Lump401 1.5 kVA
Lump400 1.5 kVA
Lump399 1.5 kVA
Lump398 1.5 kVA
Lump397 1.5 kVA
Lump396 1.5 kVA
Lump395 1.5 kVA

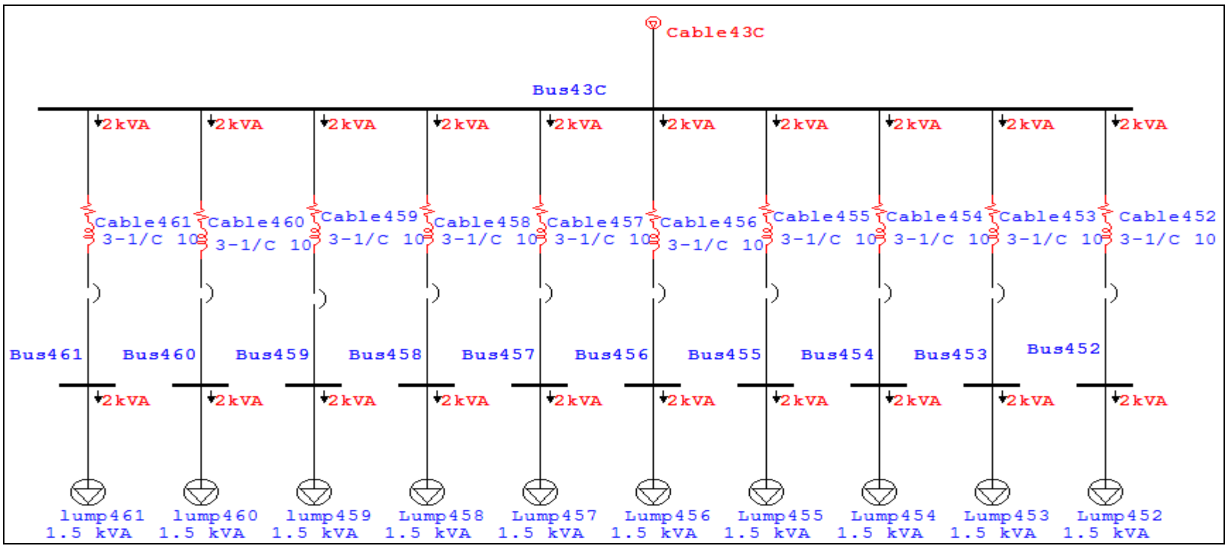

Cable48C
Bus48C
2kVA
Cable416 3-1/C 10
Cable415 3-1/C 10
Cable414 3-1/C 10
Cable413 3-1/C 10
Cable412 3-1/C 10
Cable411 3-1/C 10
Cable410 3-1/C 10
Cable409 3-1/C 10
Cable408 3-1/C 10
Cable407 3-1/C 10
Cable406 3-1/C 10
Bus416
Bus415
Bus414
Bus413
Bus412
Bus411
Bus410
Bus409
Bus408
Bus407
Bus406
lump416 1.5 kVA
lump415 1.5 kVA
lump414 1.5 kVA
Lump413 1.5 kVA
Lump412 1.5 kVA
Lump411 1.5 kVA
Lump410 1.5 kVA
Lump409 1.5 kVA
Lump408 1.5 kVA
Lump407 1.5 kVA
Lump406 1.5 kVA

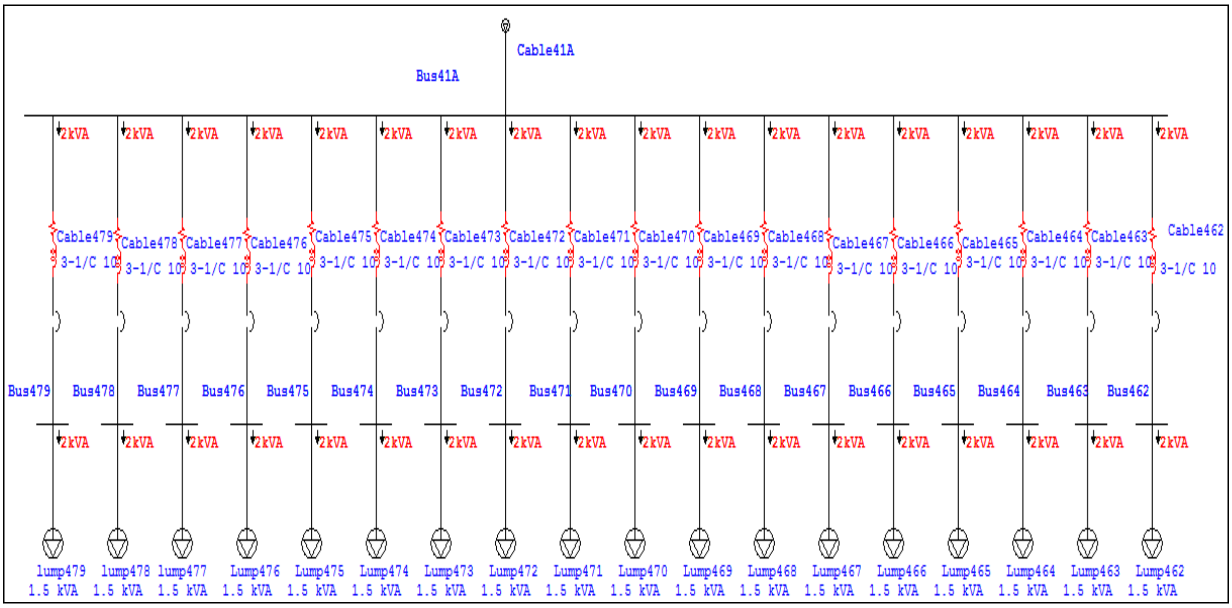


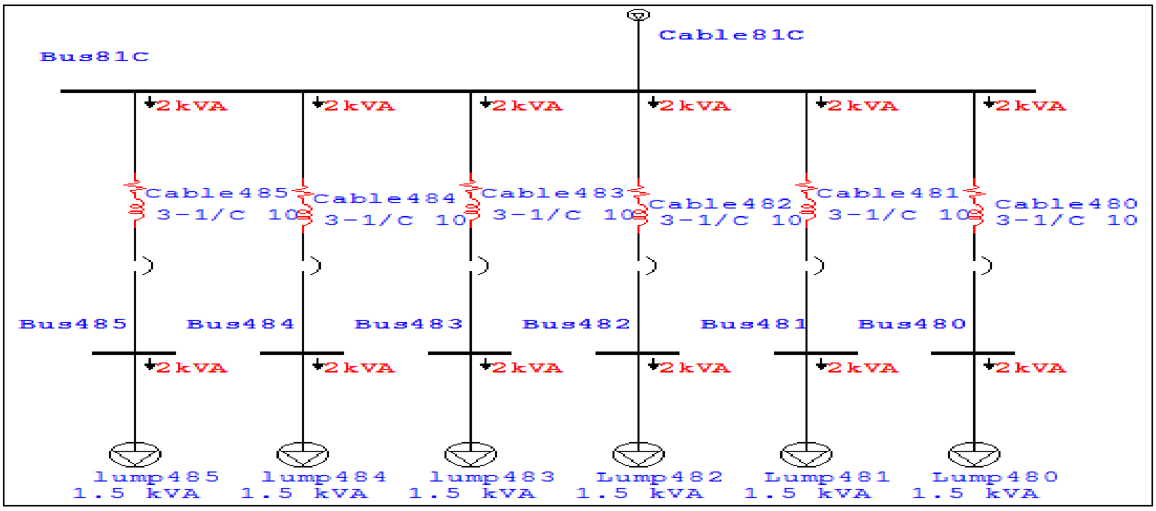


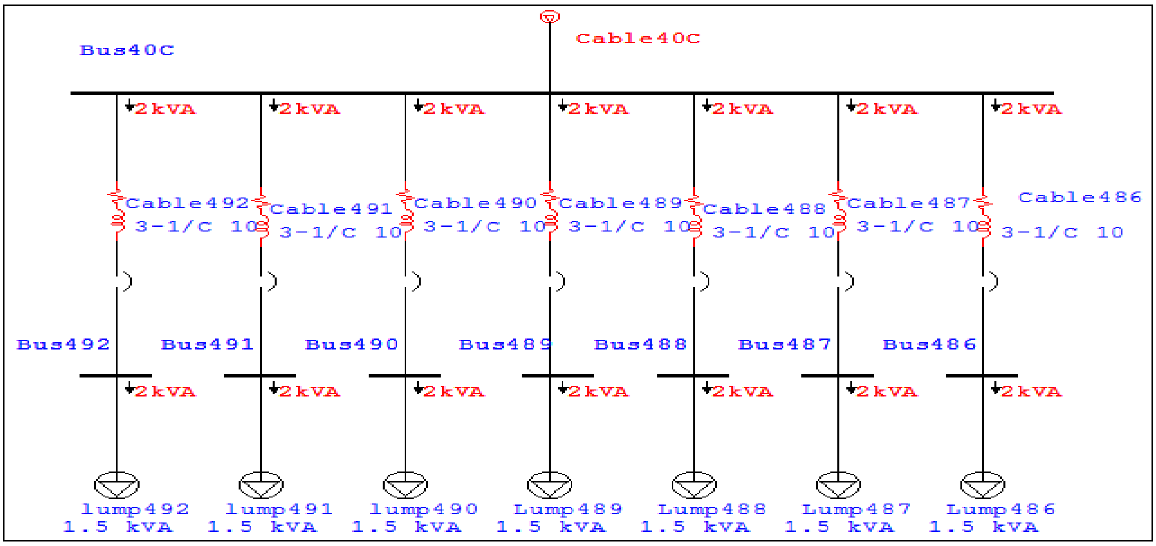
C.2 Branches 40C, 81C, 41A, 43C, and 42B from Branch T3B in Transform T3


Cable42B
Bus42B
2kVA
Cable451 3-1/C 10
Cable450 3-1/C 10
Cable449 3-1/C 10
Cable448 3-1/C 10
Cable447 3-1/C 10
Cable446 3-1/C 10
Cable445 3-1/C 10
Cable444 3-1/C 10
Cable443 3-1/C 10
Cable442 3-1/C 10
Cable441 3-1/C 10
Cable440 3-1/C 10
Bus451 Bus450 Bus449 Bus448 Bus447 bus446 Bus445 Bus444 Bus443 Bus442 Bus441 Bus440
lump451 1.5 kVA
lump450 1.5 kVA
lump449 1.5 kVA
Lump448 1.5 kVA
Lump447 1.5 kVA
Lump446 1.5 kVA
Lump445 1.5 kVA
Lump444 1.5 kVA
Lump443 1.5 kVA
Lump442 1.5 kVA
Lump441 1.5 kVA
Lump440 1.5 kVA

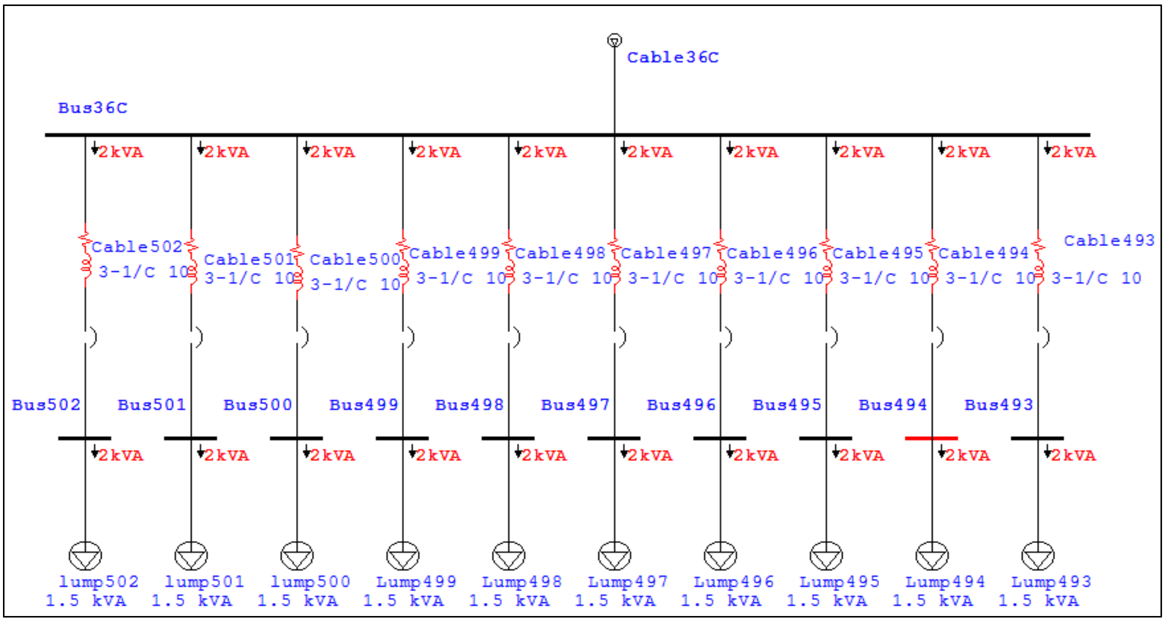

Cable43C
Bus43C
2kVA
Cable461 3-1/C 10
Cable460 3-1/C 10
Cable459 3-1/C 10
Cable458 3-1/C 10
Cable457 3-1/C 10
Cable456 3-1/C 10
Cable455 3-1/C 10
Cable454 3-1/C 10
Cable453 3-1/C 10
Cable452 3-1/C 10
Bus461 Bus460 Bus459 Bus458 Bus457 Bus456 Bus455 Bus454 Bus453 Bus452
lump461 1.5 kVA
lump460 1.5 kVA
lump459 1.5 kVA
Lump458 1.5 kVA
Lump457 1.5 kVA
Lump456 1.5 kVA
Lump455 1.5 kVA
Lump454 1.5 kVA
Lump453 1.5 kVA
Lump452 1.5 kVA

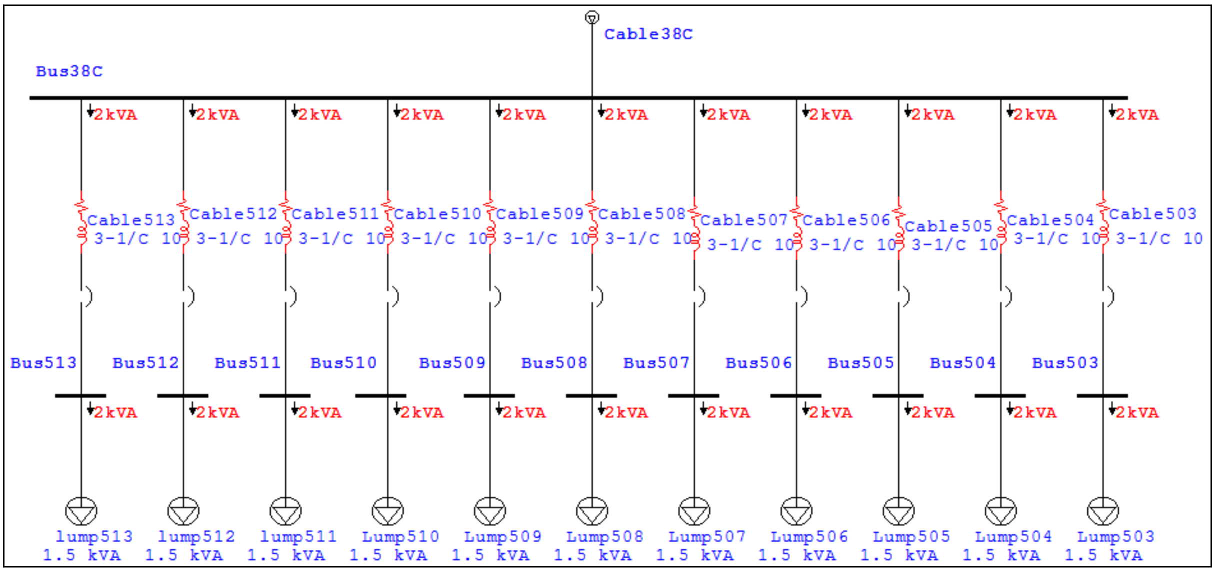

Cable41A
Bus41A
2kVA
Cable479 3-1/C 10
Cable478 3-1/C 10
Cable477 3-1/C 10
Cable476 3-1/C 10
Cable475 3-1/C 10
Cable474 3-1/C 10
Cable473 3-1/C 10
Cable472 3-1/C 10
Cable471 3-1/C 10
Cable470 3-1/C 10
Cable469 3-1/C 10
Cable468 3-1/C 10
Cable467 3-1/C 10
Cable466 3-1/C 10
Cable465 3-1/C 10
Cable464 3-1/C 10
Cable463 3-1/C 10
Cable462 3-1/C 10
Bus479 Bus478 Bus477 Bus476 Bus475 Bus474 Bus473 Bus472 Bus471 Bus470 Bus469 Bus468 Bus467 Bus466 Bus465 Bus464 Bus463 Bus462
lump479 1.5 kVA
lump478 1.5 kVA
lump477 1.5 kVA
Lump476 1.5 kVA
Lump475 1.5 kVA
Lump474 1.5 kVA
Lump473 1.5 kVA
Lump472 1.5 kVA
Lump471 1.5 kVA
Lump470 1.5 kVA
Lump469 1.5 kVA
Lump468 1.5 kVA
Lump467 1.5 kVA
Lump466 1.5 kVA
Lump465 1.5 kVA
Lump464 1.5 kVA
Lump463 1.5 kVA
Lump462 1.5 kVA

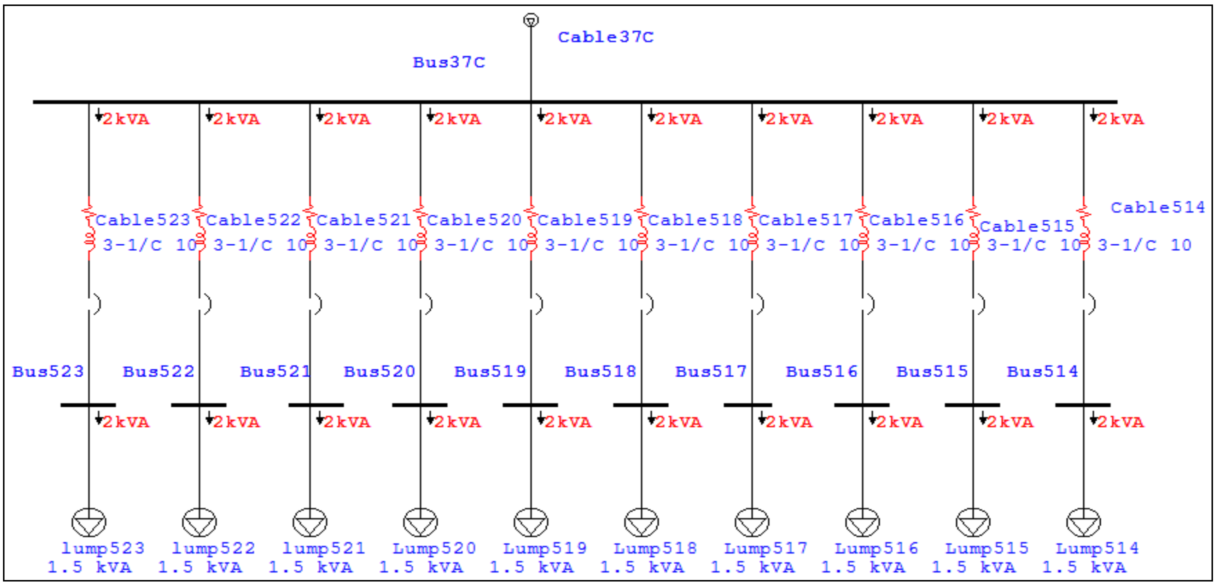


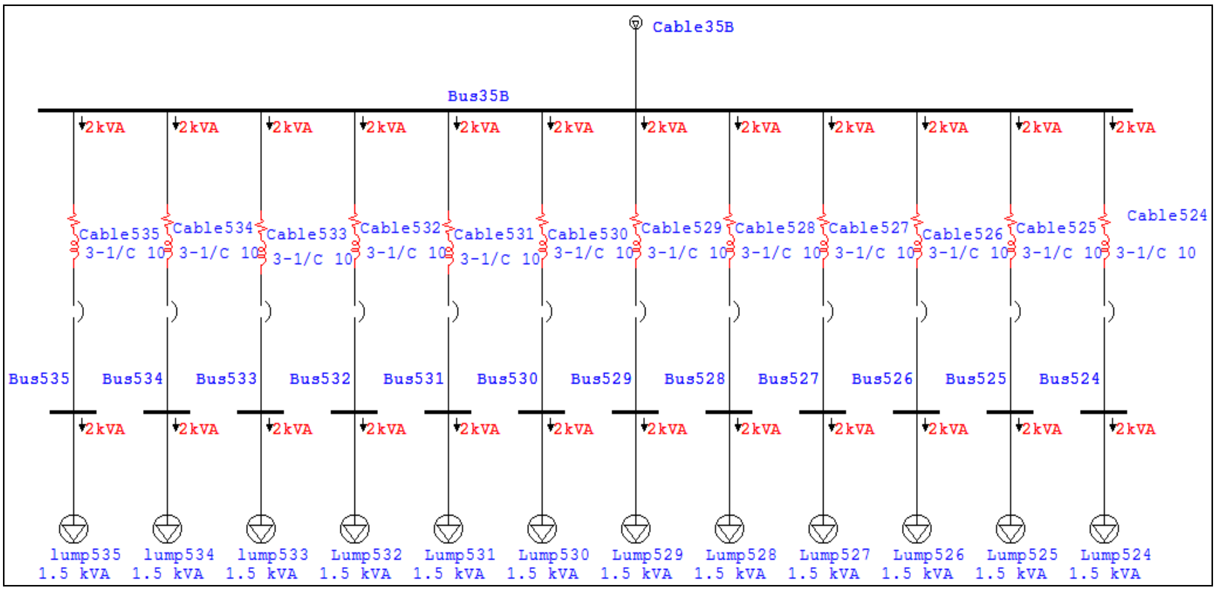


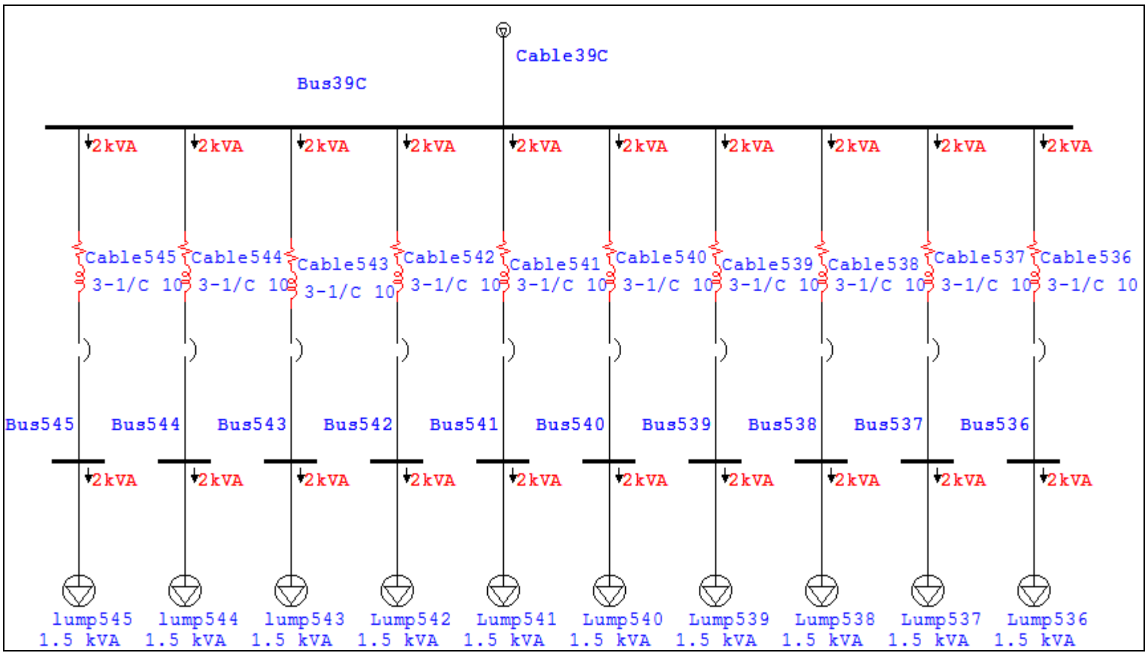
C.3 Branches 34C, 39C, 35B, 37C, 38C, and 36C from Branch T3C in Transform T3

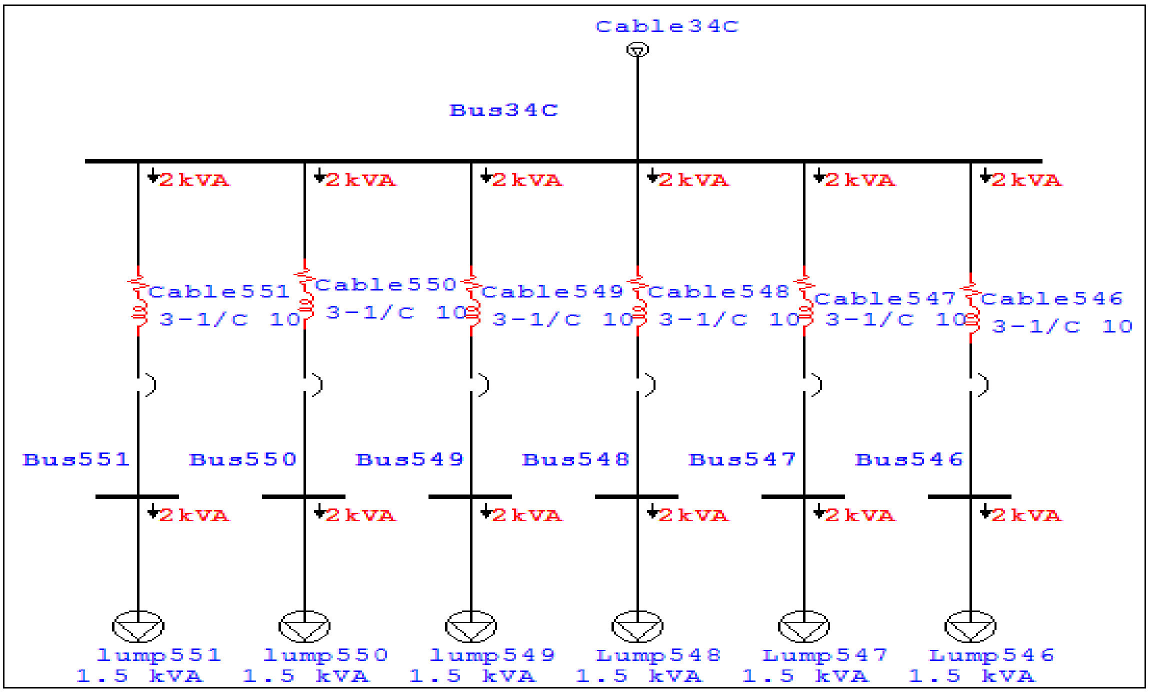



Cable38C
Bus38C
2kVA
Cable513 3-1/C 10
Cable512 3-1/C 10
Cable511 3-1/C 10
Cable510 3-1/C 10
Cable509 3-1/C 10
Cable508 3-1/C 10
Cable507 3-1/C 10
Cable506 3-1/C 10
Cable505 3-1/C 10
Cable504 3-1/C 10
Cable503 3-1/C 10
Bus513
Bus512
Bus511
Bus510
Bus509
Bus508
Bus507
Bus506
Bus505
Bus504
Bus503
lump513 1.5 kVA
lump512 1.5 kVA
lump511 1.5 kVA
Lump510 1.5 kVA
Lump509 1.5 kVA
Lump508 1.5 kVA
Lump507 1.5 kVA
Lump506 1.5 kVA
Lump505 1.5 kVA
Lump504 1.5 kVA
Lump503 1.5 kVA


Cable37C
Bus37C
2kVA
Cable523 3-1/C 10
Cable522 3-1/C 10
Cable521 3-1/C 10
Cable520 3-1/C 10
Cable519 3-1/C 10
Cable518 3-1/C 10
Cable517 3-1/C 10
Cable516 3-1/C 10
Cable515 3-1/C 10
Cable514 3-1/C 10
Bus523
Bus522
Bus521
Bus520
Bus519
Bus518
Bus517
Bus516
Bus515
Bus514
lump523 1.5 kVA
lump522 1.5 kVA
lump521 1.5 kVA
Lump520 1.5 kVA
Lump519 1.5 kVA
Lump518 1.5 kVA
Lump517 1.5 kVA
Lump516 1.5 kVA
Lump515 1.5 kVA
Lump514 1.5 kVA

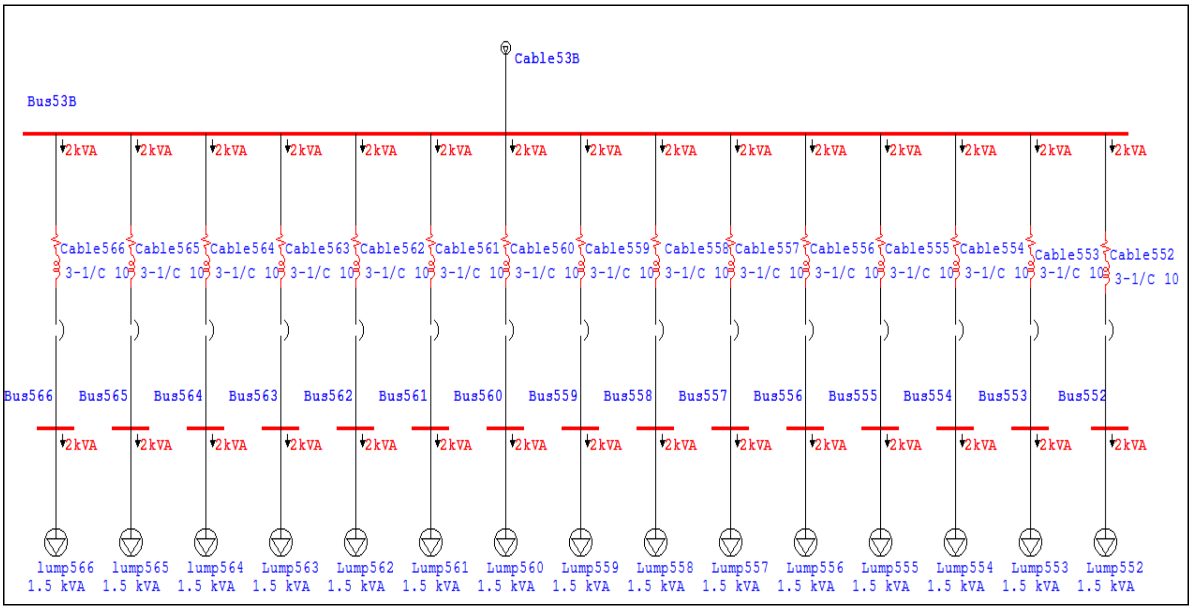

Cable35B
Bus35B
2kVA
Cable535 3-1/C 10
Cable534 3-1/C 10
Cable533 3-1/C 10
Cable532 3-1/C 10
Cable531 3-1/C 10
Cable530 3-1/C 10
Cable529 3-1/C 10
Cable528 3-1/C 10
Cable527 3-1/C 10
Cable526 3-1/C 10
Cable525 3-1/C 10
Cable524 3-1/C 10
Bus535
Bus534
Bus533
Bus532
Bus531
Bus530
Bus529
Bus528
Bus527
Bus526
Bus525
Bus524
lump535 1.5 kVA
lump534 1.5 kVA
lump533 1.5 kVA
Lump532 1.5 kVA
Lump531 1.5 kVA
Lump530 1.5 kVA
Lump529 1.5 kVA
Lump528 1.5 kVA
Lump527 1.5 kVA
Lump526 1.5 kVA
Lump525 1.5 kVA
Lump524 1.5 kVA

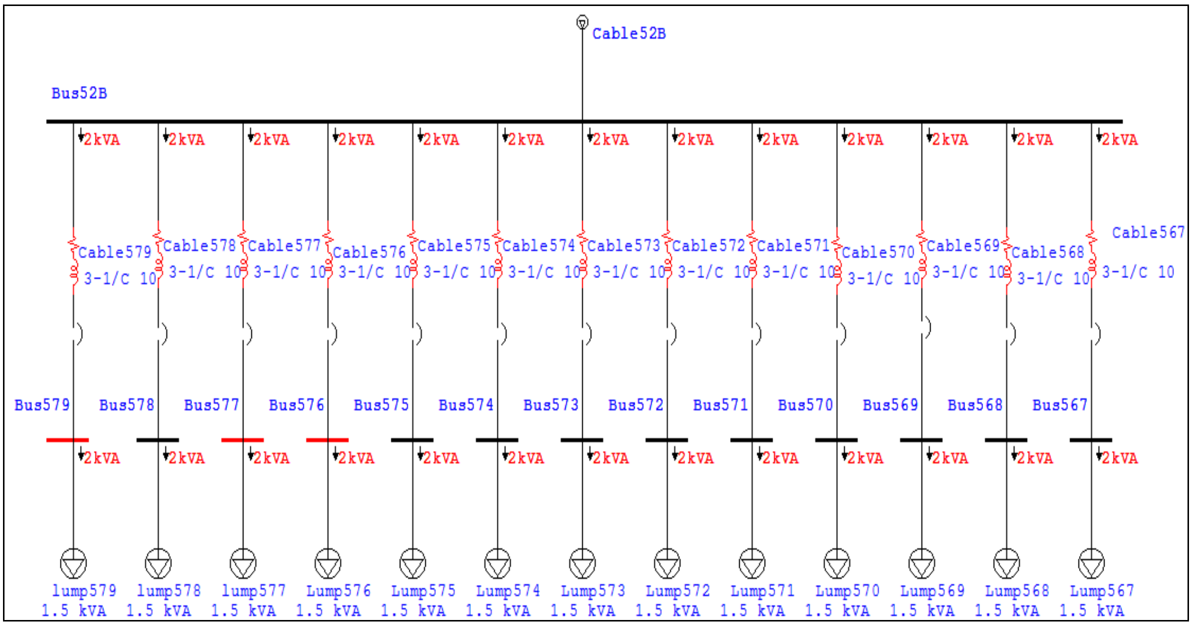

Cable39C
Bus39C
2kVA
Cable545 3-1/C 10
Cable544 3-1/C 10
Cable543 3-1/C 10
Cable542 3-1/C 10
Cable541 3-1/C 10
Cable540 3-1/C 10
Cable539 3-1/C 10
Cable538 3-1/C 10
Cable537 3-1/C 10
Cable536 3-1/C 10
Bus545
Bus544
Bus543
Bus542
Bus541
Bus540
Bus539
Bus538
Bus537
Bus536
lump545 1.5 kVA
lump544 1.5 kVA
lump543 1.5 kVA
Lump542 1.5 kVA
Lump541 1.5 kVA
Lump540 1.5 kVA
Lump539 1.5 kVA
Lump538 1.5 kVA
Lump537 1.5 kVA
Lump536 1.5 kVA

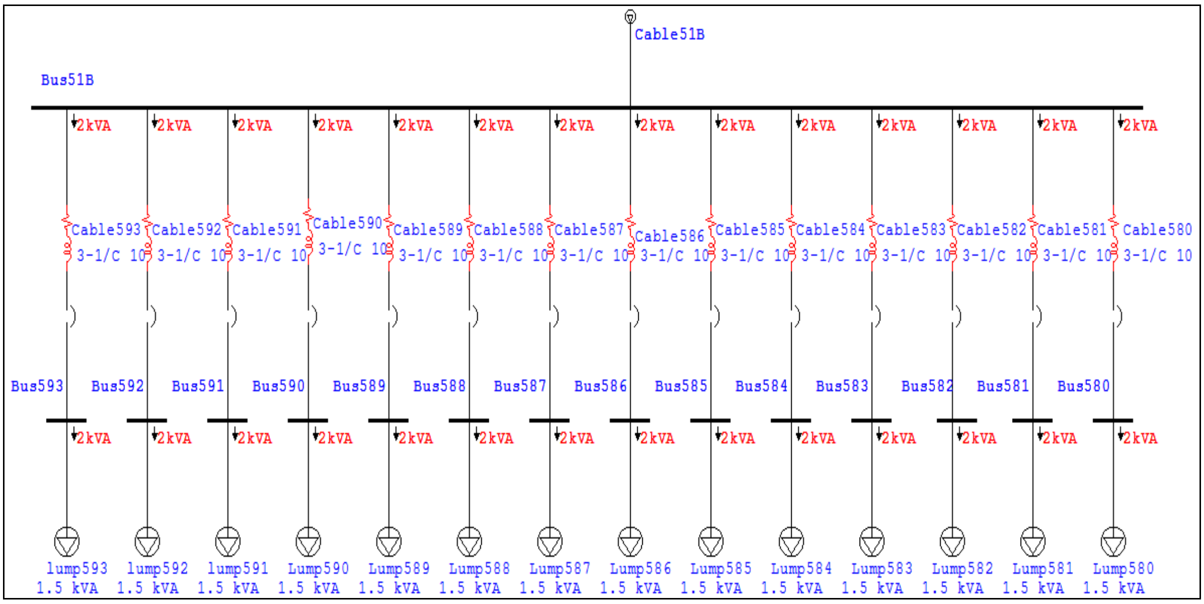

Cable34C
Bus34C
2kVA
Cable551 3-1/C 10
Cable550 3-1/C 10
Cable549 3-1/C 10
Cable548 3-1/C 10
Cable547 3-1/C 10
Cable546 3-1/C 10
Bus551
Bus550
Bus549
Bus548
Bus547
Bus546
lump551 1.5 kVA
lump550 1.5 kVA
lump549 1.5 kVA
Lump548 1.5 kVA
Lump547 1.5 kVA
Lump546 1.5 kVA

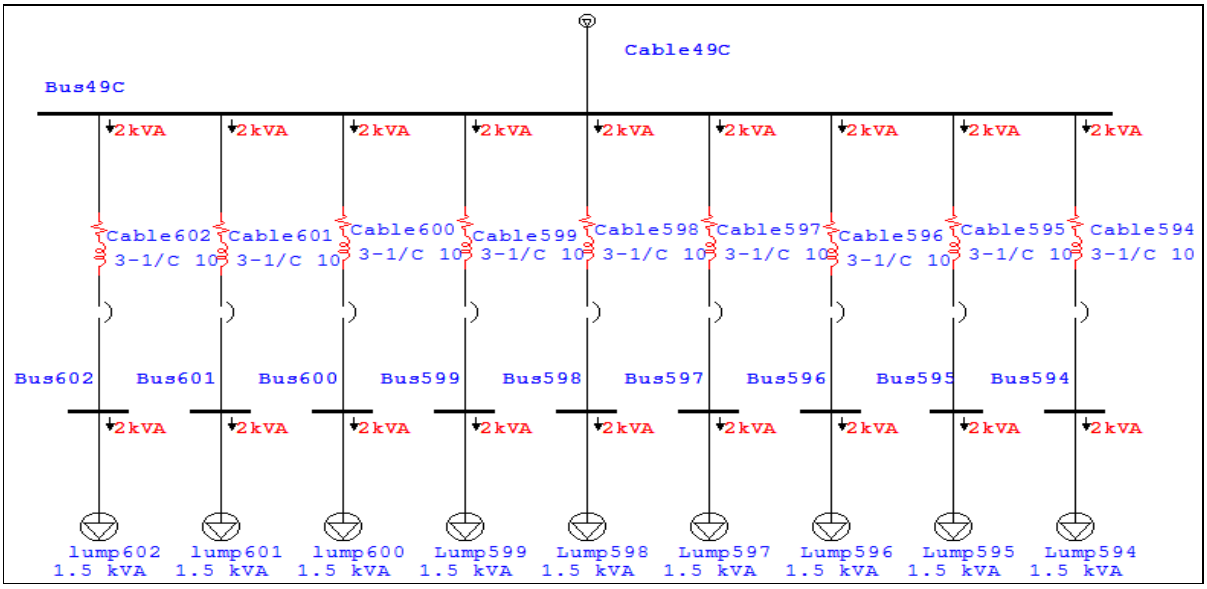
APPENDIX D

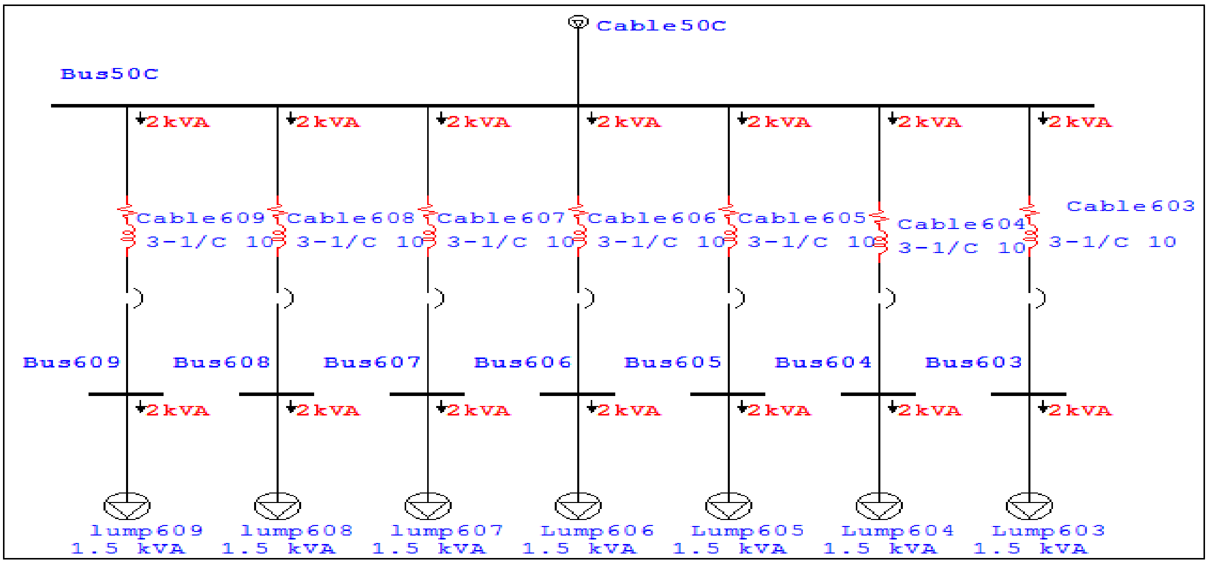
D.1 Branches 50C, 49C, 51B, 52B, and 53B from Branch T4A in Transform T4



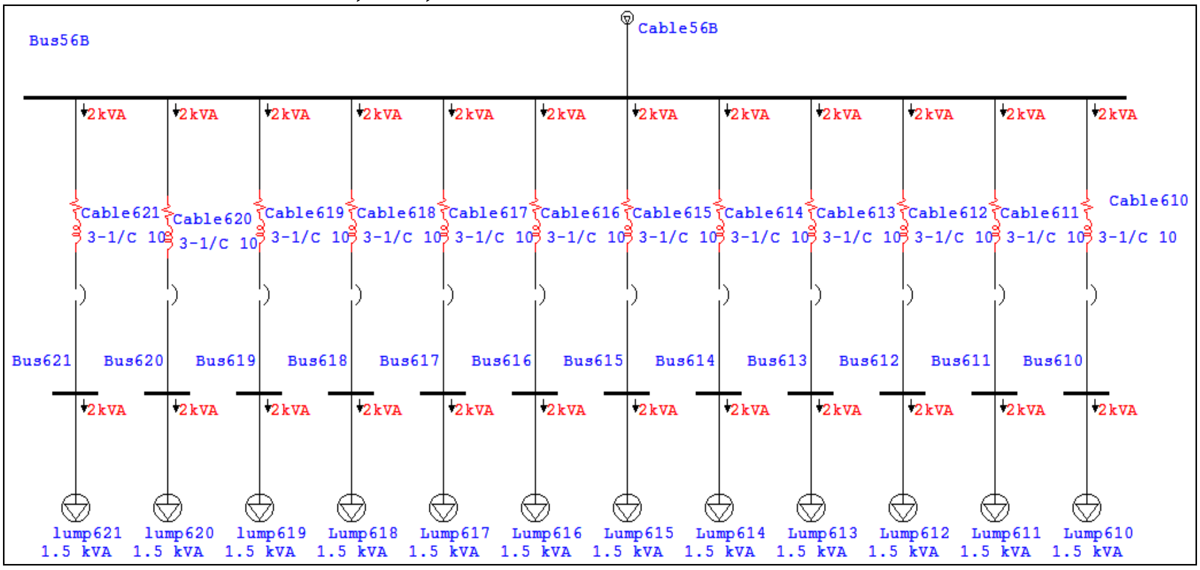


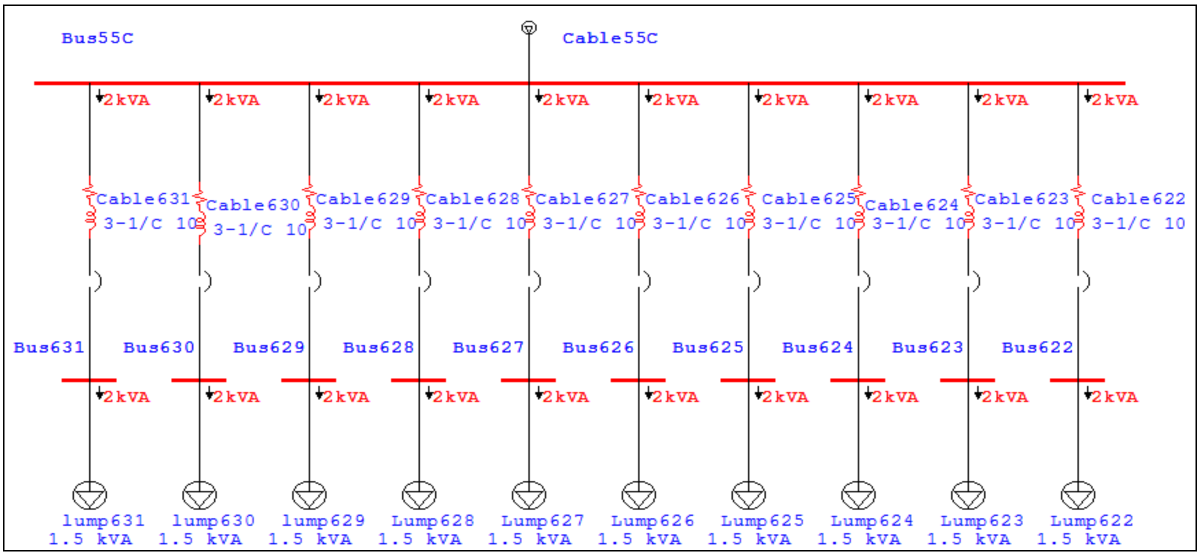

Cable51B
Bus51B
2kVA
Cable593 3-1/C 10
Cable592 3-1/C 10
Cable591 3-1/C 10
Cable590 3-1/C 10
Cable589 3-1/C 10
Cable588 3-1/C 10
Cable587 3-1/C 10
Cable586 3-1/C 10
Cable585 3-1/C 10
Cable584 3-1/C 10
Cable583 3-1/C 10
Cable582 3-1/C 10
Cable581 3-1/C 10
Cable580 3-1/C 10
Bus593
Bus592
Bus591
Bus590
Bus589
Bus588
Bus587
Bus586
Bus585
Bus584
Bus583
Bus582
Bus581
Bus580
lump593 1.5 kVA
lump592 1.5 kVA
lump591 1.5 kVA
Lump590 1.5 kVA
Lump589 1.5 kVA
Lump588 1.5 kVA
Lump587 1.5 kVA
Lump586 1.5 kVA
Lump585 1.5 kVA
Lump584 1.5 kVA
Lump583 1.5 kVA
Lump582 1.5 kVA
Lump581 1.5 kVA
Lump580 1.5 kVA

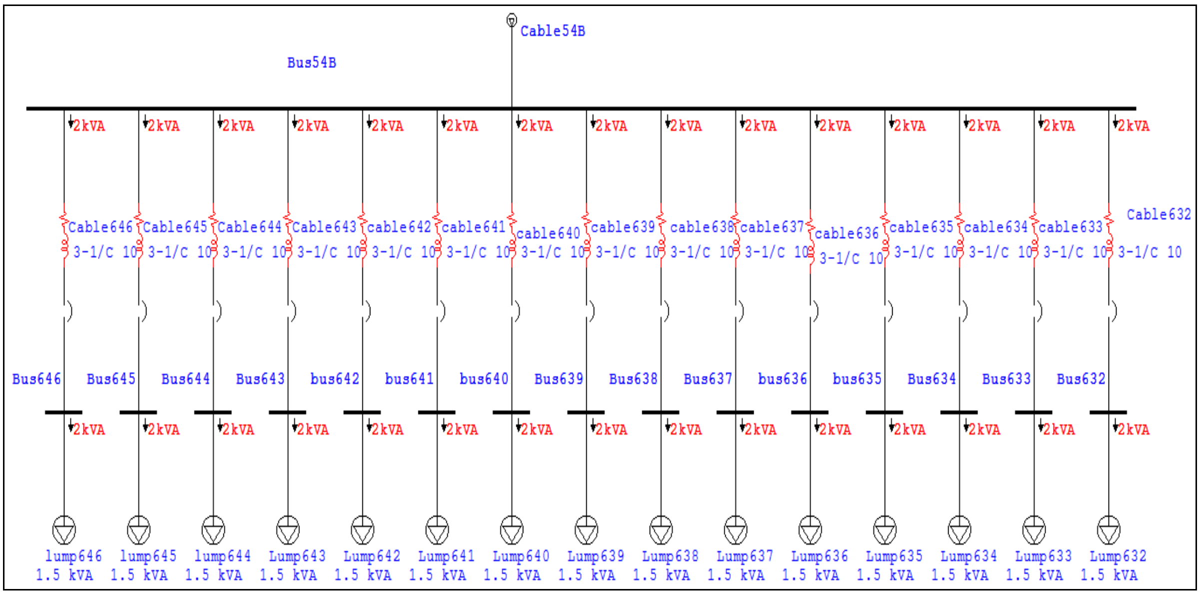

Cable49C
Bus49C
2kVA
Cable602 3-1/C 10
Cable601 3-1/C 10
Cable600 3-1/C 10
Cable599 3-1/C 10
Cable598 3-1/C 10
Cable597 3-1/C 10
Cable596 3-1/C 10
Cable595 3-1/C 10
Cable594 3-1/C 10
Bus602
Bus601
Bus600
Bus599
Bus598
Bus597
Bus596
Bus595
Bus594
lump602 1.5 kVA
lump601 1.5 kVA
lump600 1.5 kVA
Lump599 1.5 kVA
Lump598 1.5 kVA
Lump597 1.5 kVA
Lump596 1.5 kVA
Lump595 1.5 kVA
Lump594 1.5 kVA


Cable50C
Bus50C
2kVA
Cable609 3-1/C 10
Cable608 3-1/C 10
Cable607 3-1/C 10
Cable606 3-1/C 10
Cable605 3-1/C 10
Cable604 3-1/C 10
Cable603 3-1/C 10
Bus609
Bus608
Bus607
Bus606
Bus605
Bus604
Bus603
lump609 1.5 kVA
lump608 1.5 kVA
lump607 1.5 kVA
Lump606 1.5 kVA
Lump605 1.5 kVA
Lump604 1.5 kVA
Lump603 1.5 kVA

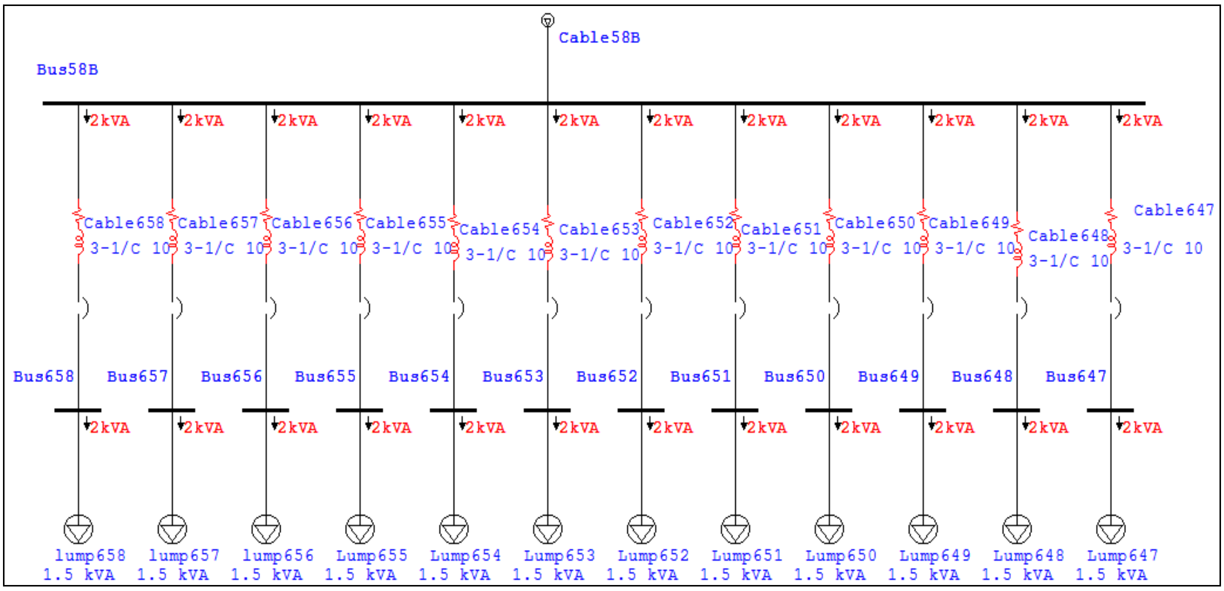
D.2 Branches 54B, 55C, and 56B from Branch T4B in Transform T4

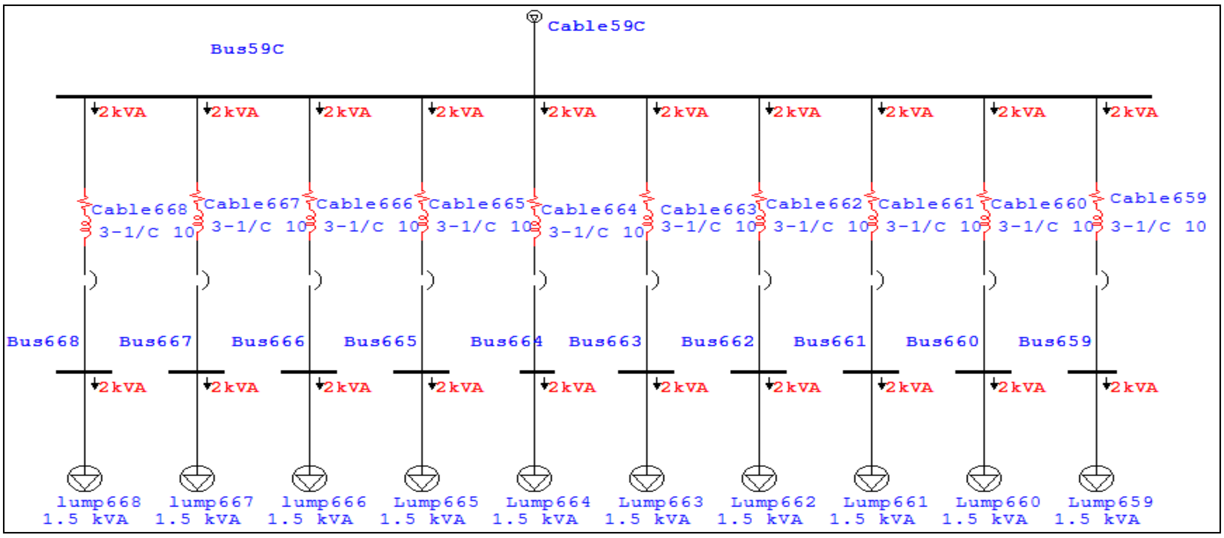


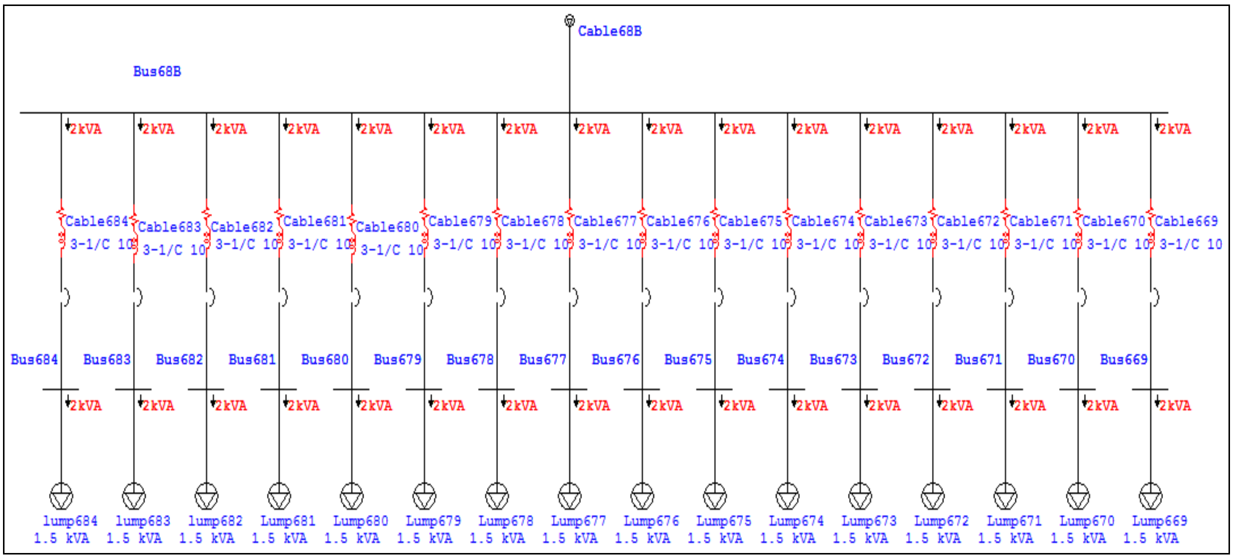


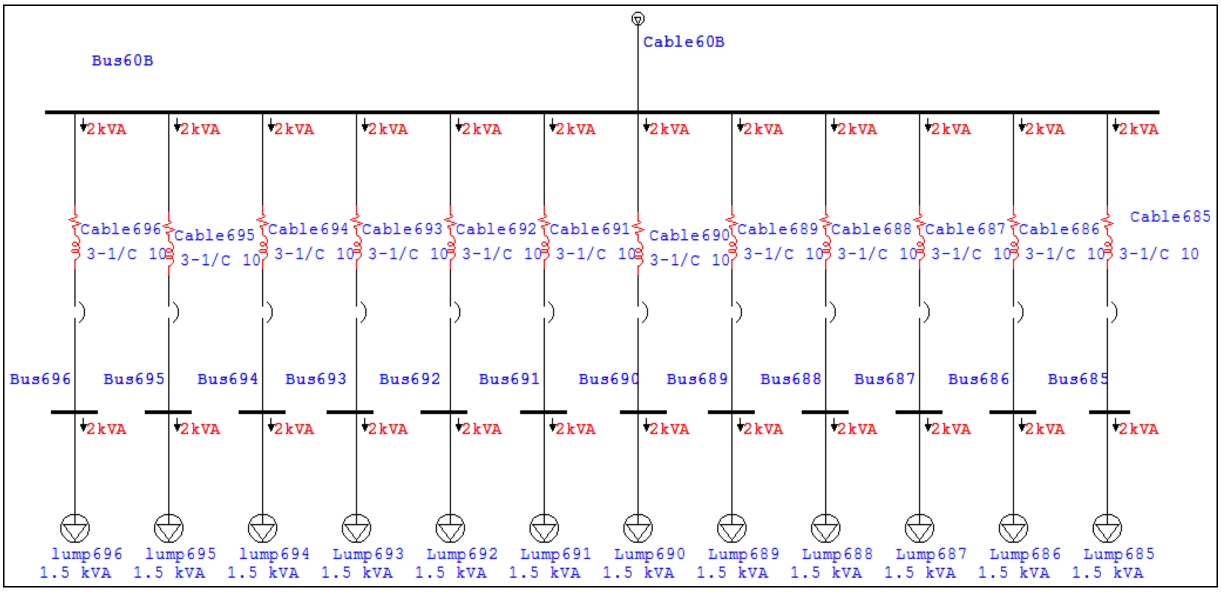


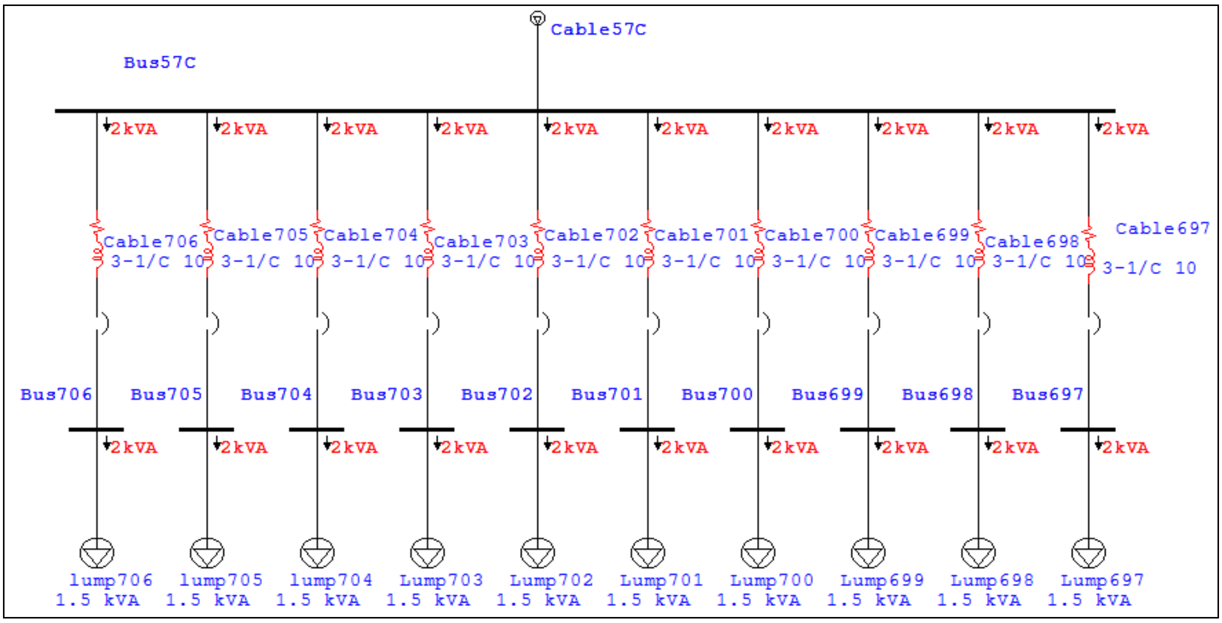
D.3 Branches 57C, 60B, 68B, 59C, and 58B from Branch T4C in Transform T4



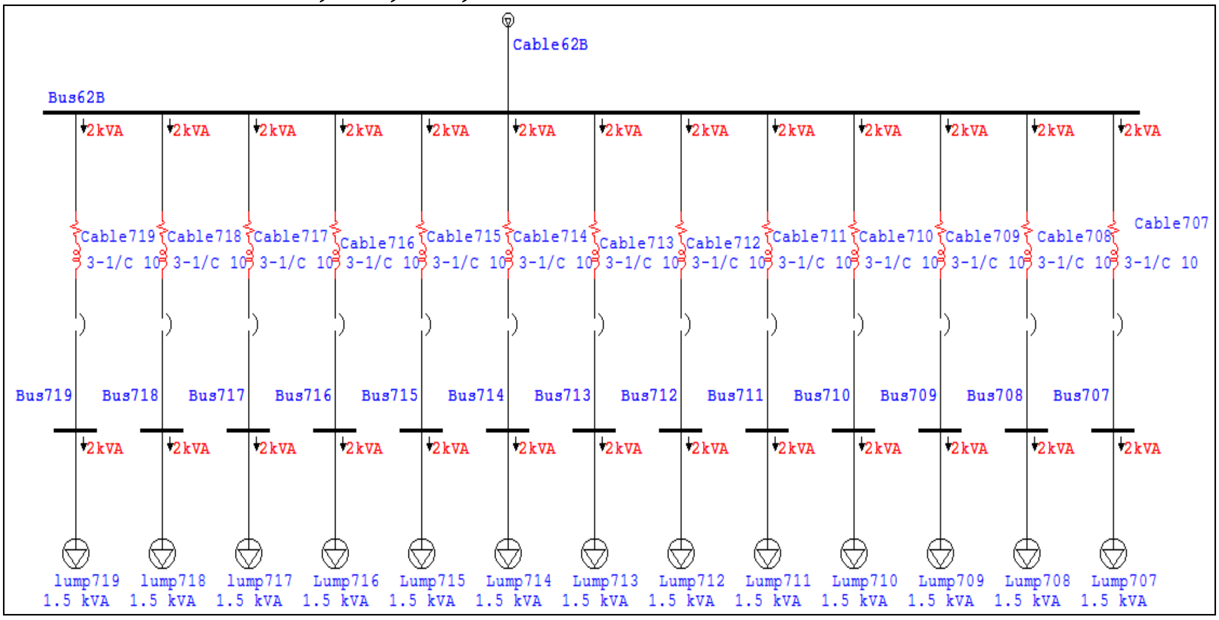


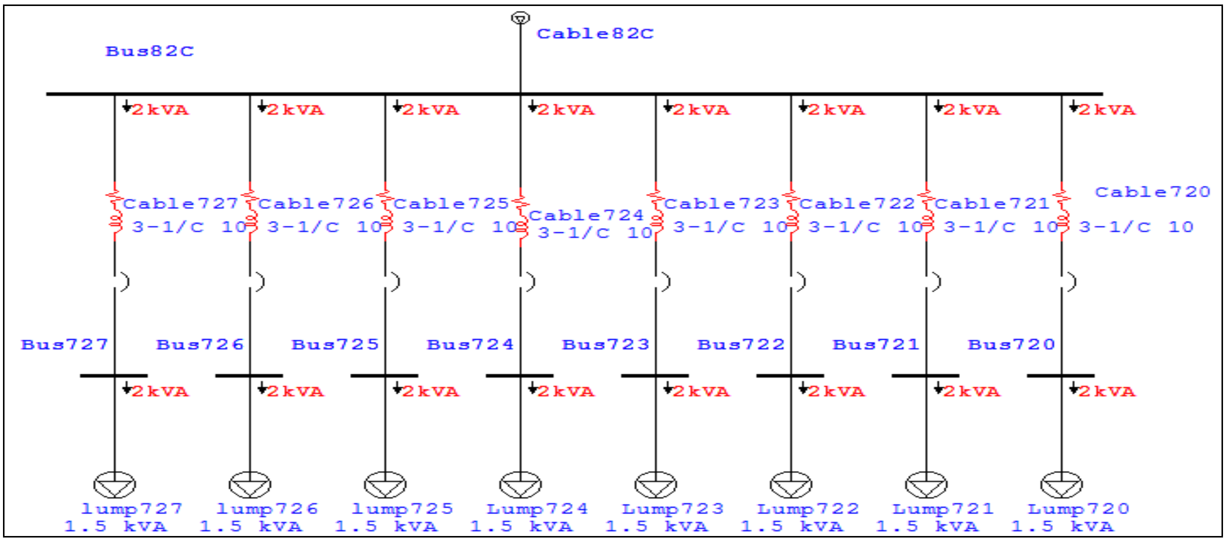


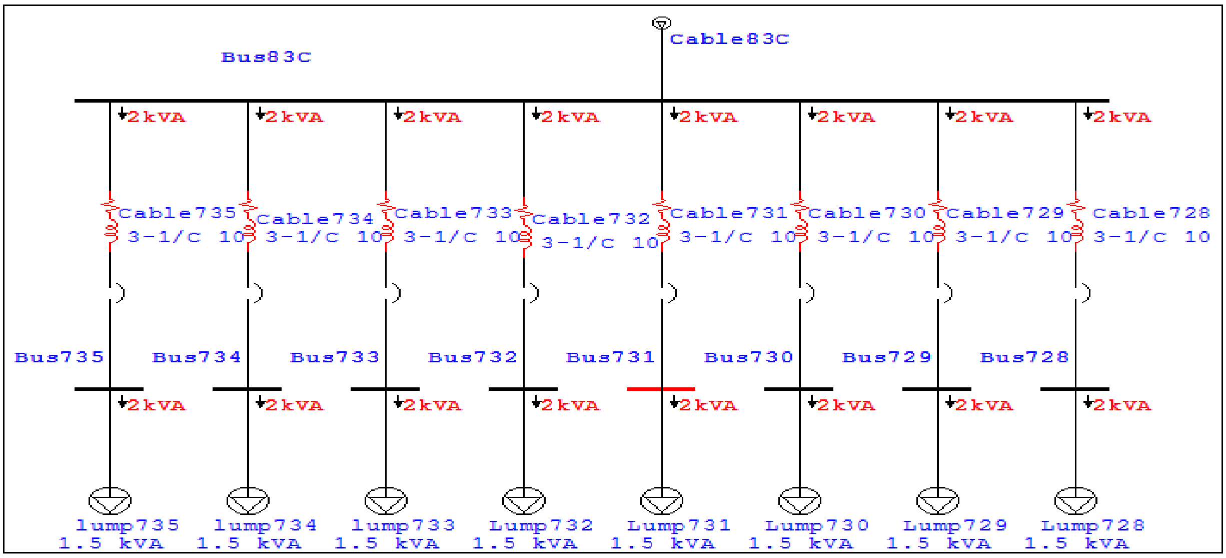

Cable60B
Bus60B
2kVA
Cable696 3-1/C 10
Cable695 3-1/C 10
Cable694 3-1/C 10
Cable693 3-1/C 10
Cable692 3-1/C 10
Cable691 3-1/C 10
Cable690 3-1/C 10
Cable689 3-1/C 10
Cable688 3-1/C 10
Cable687 3-1/C 10
Cable686 3-1/C 10
Cable685 3-1/C 10
Bus696
Bus695
Bus694
Bus693
Bus692
Bus691
Bus690
Bus689
Bus688
Bus687
Bus686
Bus685
lump696 1.5 kVA
lump695 1.5 kVA
lump694 1.5 kVA
Lump693 1.5 kVA
Lump692 1.5 kVA
Lump691 1.5 kVA
Lump690 1.5 kVA
Lump689 1.5 kVA
Lump688 1.5 kVA
Lump687 1.5 kVA
Lump686 1.5 kVA
Lump685 1.5 kVA

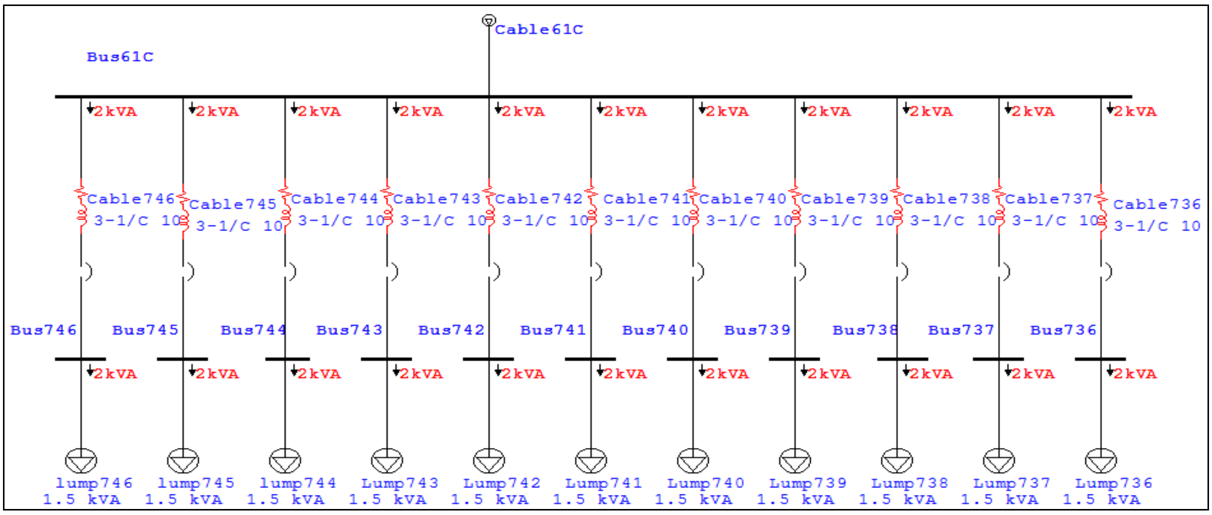

Cable57C
Bus57C
2kVA
Cable706 3-1/C 10
Cable705 3-1/C 10
Cable704 3-1/C 10
Cable703 3-1/C 10
Cable702 3-1/C 10
Cable701 3-1/C 10
Cable700 3-1/C 10
Cable699 3-1/C 10
Cable698 3-1/C 10
Cable697 3-1/C 10
Bus706
Bus705
Bus704
Bus703
Bus702
Bus701
Bus700
Bus699
Bus698
Bus697
lump706 1.5 kVA
lump705 1.5 kVA
lump704 1.5 kVA
Lump703 1.5 kVA
Lump702 1.5 kVA
Lump701 1.5 kVA
Lump700 1.5 kVA
Lump699 1.5 kVA
Lump698 1.5 kVA
Lump697 1.5 kVA

D.4 Branches 61C, 83C, 82C, and 62B from Branch T4D in Transform T4

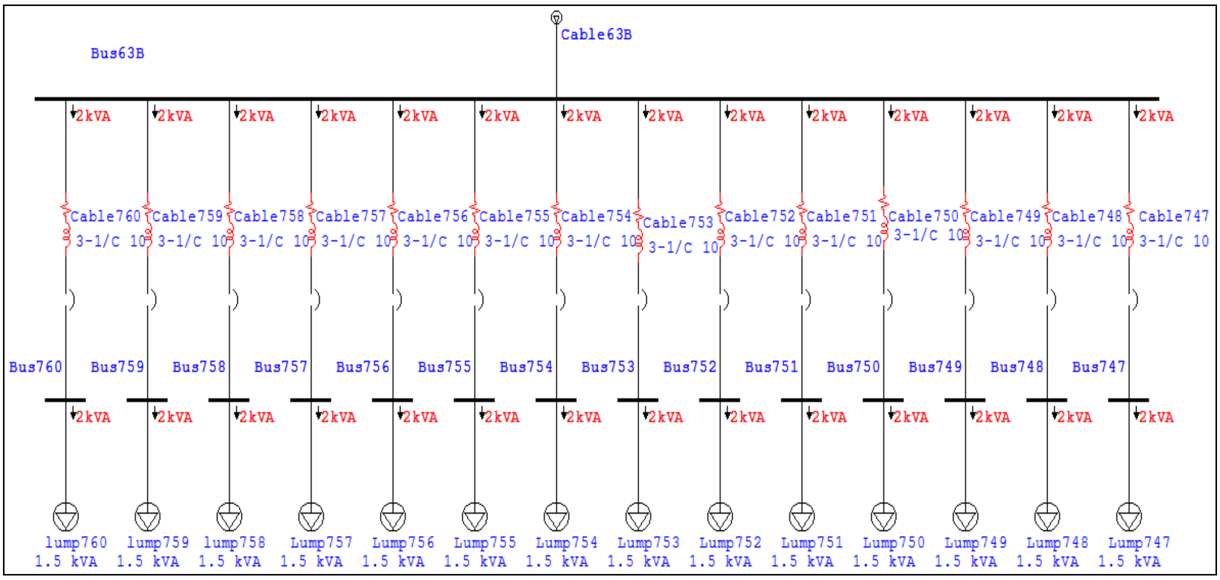


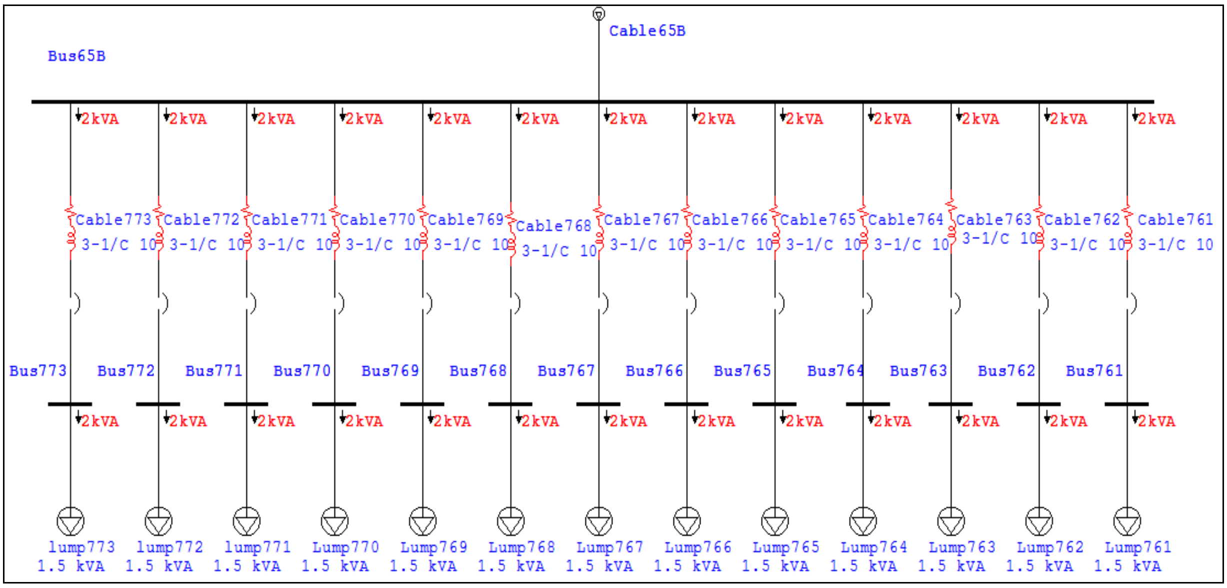


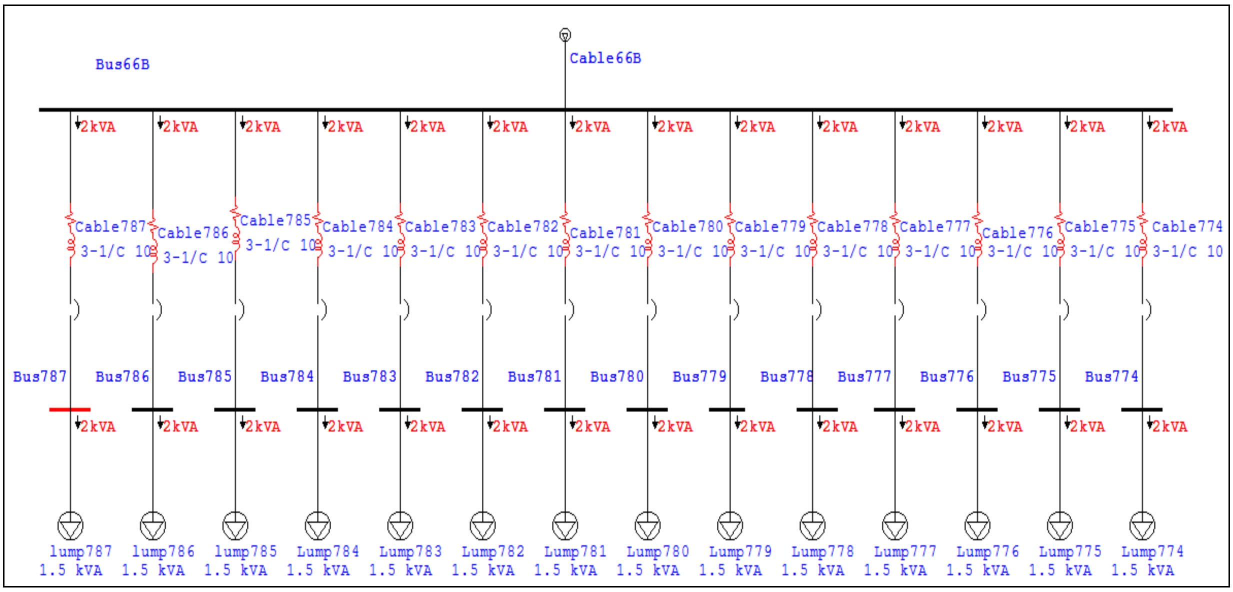


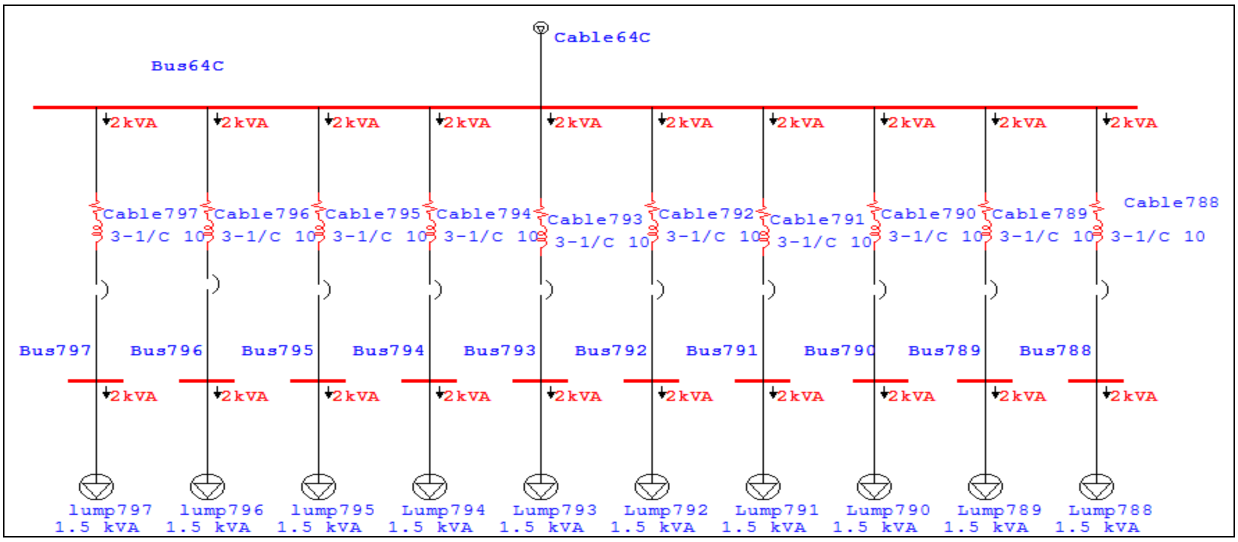


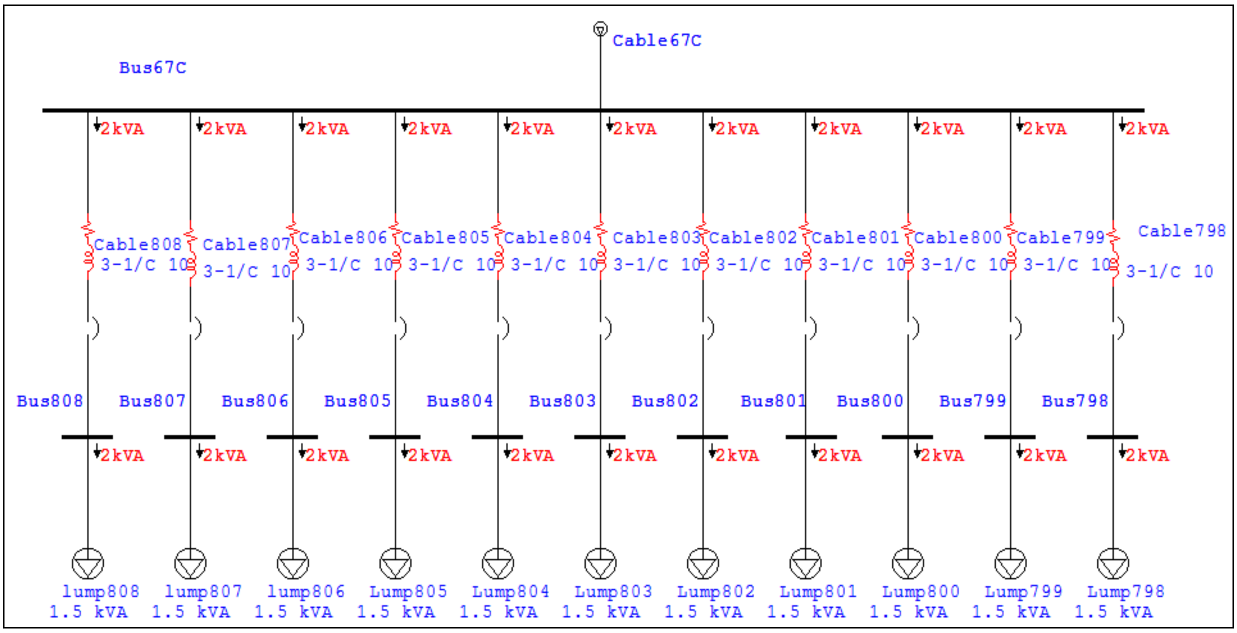
D.5 Branches 67C, 64C, 66B, 65B, and 63B from Branch T4E in Transform T4





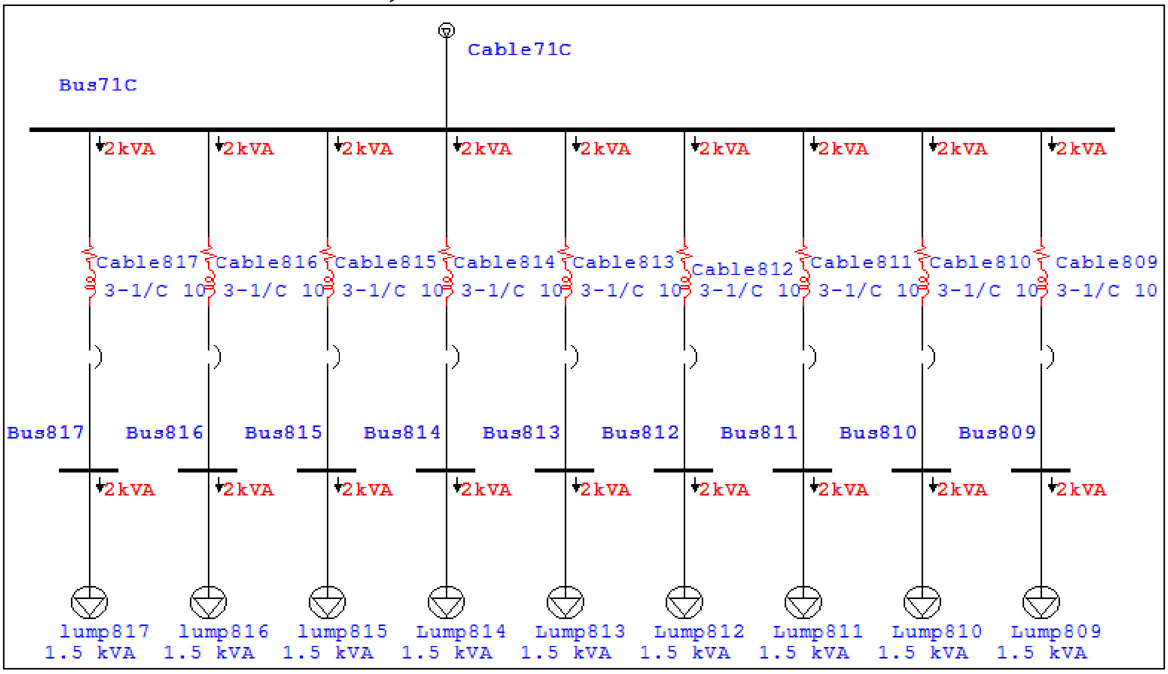

Cable66B
Bus66B
2kVA
Cable787 3-1/C 10
Cable786 3-1/C 10
Cable785 3-1/C 10
Cable784 3-1/C 10
Cable783 3-1/C 10
Cable782 3-1/C 10
Cable781 3-1/C 10
Cable780 3-1/C 10
Cable779 3-1/C 10
Cable778 3-1/C 10
Cable777 3-1/C 10
Cable776 3-1/C 10
Cable775 3-1/C 10
Cable774 3-1/C 10
Bus787 Bus786 Bus785 Bus784 Bus783 Bus782 Bus781 Bus780 Bus779 Bus778 Bus777 Bus776 Bus775 Bus774
lump787 1.5 kVA
lump786 1.5 kVA
lump785 1.5 kVA
Lump784 1.5 kVA
Lump783 1.5 kVA
Lump782 1.5 kVA
Lump781 1.5 kVA
Lump780 1.5 kVA
Lump779 1.5 kVA
Lump778 1.5 kVA
Lump777 1.5 kVA
Lump776 1.5 kVA
Lump775 1.5 kVA
Lump774 1.5 kVA

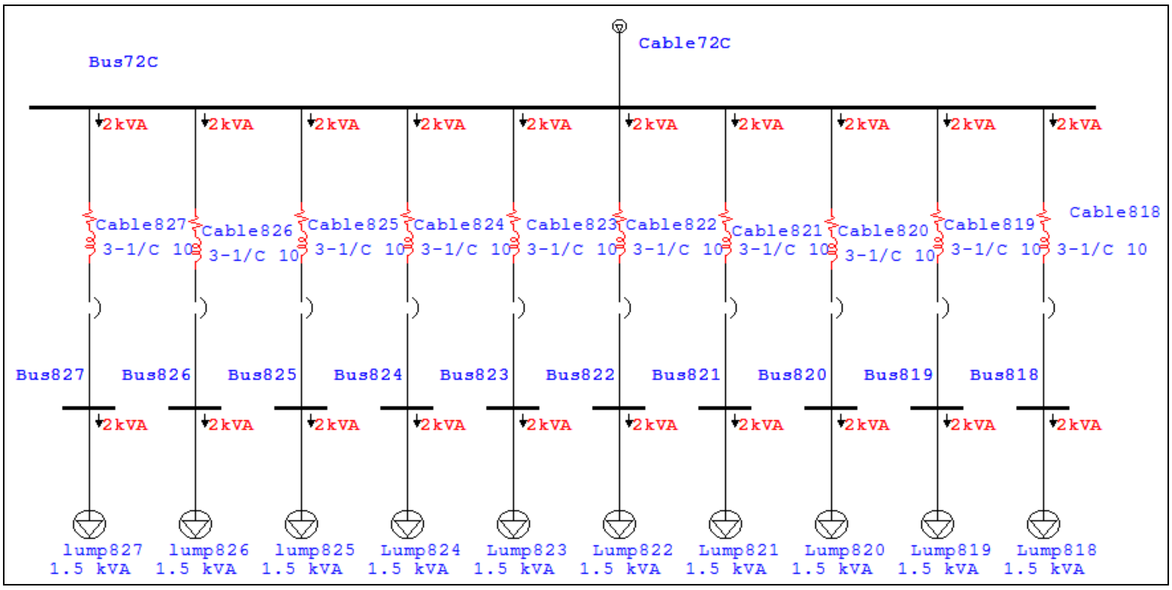

Cable64C
Bus64C
2kVA
Cable797 3-1/C 10
Cable796 3-1/C 10
Cable795 3-1/C 10
Cable794 3-1/C 10
Cable793 3-1/C 10
Cable792 3-1/C 10
Cable791 3-1/C 10
Cable790 3-1/C 10
Cable789 3-1/C 10
Cable788 3-1/C 10
Bus797 Bus796 Bus795 Bus794 Bus793 Bus792 Bus791 Bus790 Bus789 Bus788
lump797 1.5 kVA
lump796 1.5 kVA
lump795 1.5 kVA
Lump794 1.5 kVA
Lump793 1.5 kVA
Lump792 1.5 kVA
Lump791 1.5 kVA
Lump790 1.5 kVA
Lump789 1.5 kVA
Lump788 1.5 kVA


Cable67C
Bus67C
2kVA
Cable808 3-1/C 10
Cable807 3-1/C 10
Cable806 3-1/C 10
Cable805 3-1/C 10
Cable804 3-1/C 10
Cable803 3-1/C 10
Cable802 3-1/C 10
Cable801 3-1/C 10
Cable800 3-1/C 10
Cable799 3-1/C 10
Cable798 3-1/C 10
Bus808 Bus807 Bus806 Bus805 Bus804 Bus803 Bus802 Bus801 Bus800 Bus799 Bus798
lump808 1.5 kVA
lump807 1.5 kVA
lump806 1.5 kVA
Lump805 1.5 kVA
Lump804 1.5 kVA
Lump803 1.5 kVA
Lump802 1.5 kVA
Lump801 1.5 kVA
Lump800 1.5 kVA
Lump799 1.5 kVA
Lump798 1.5 kVA

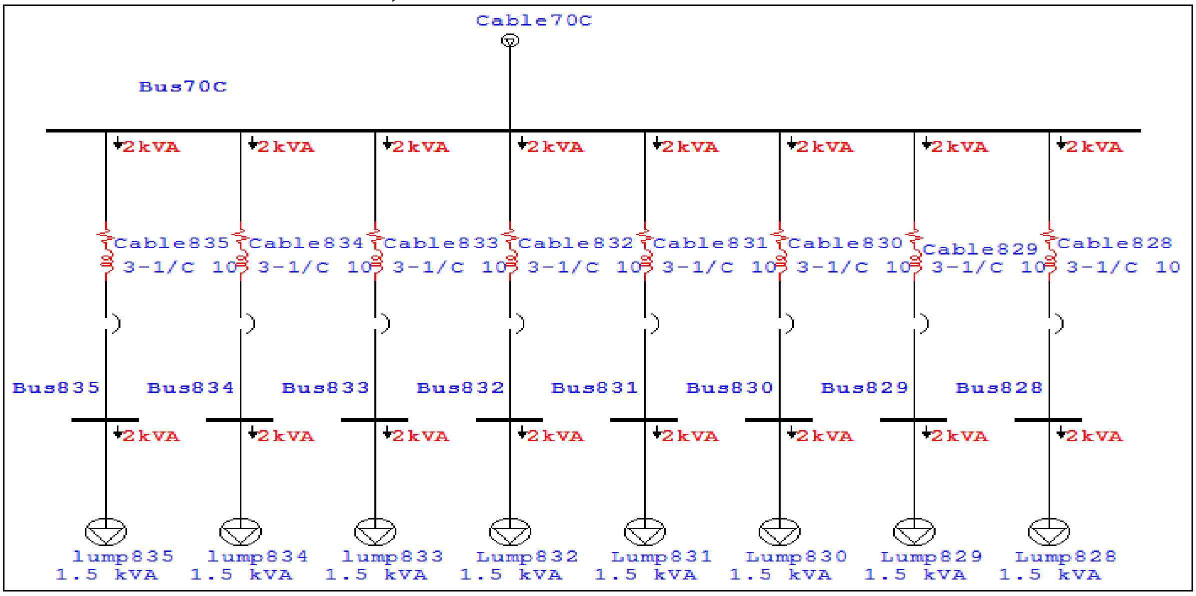
APPENDIX E

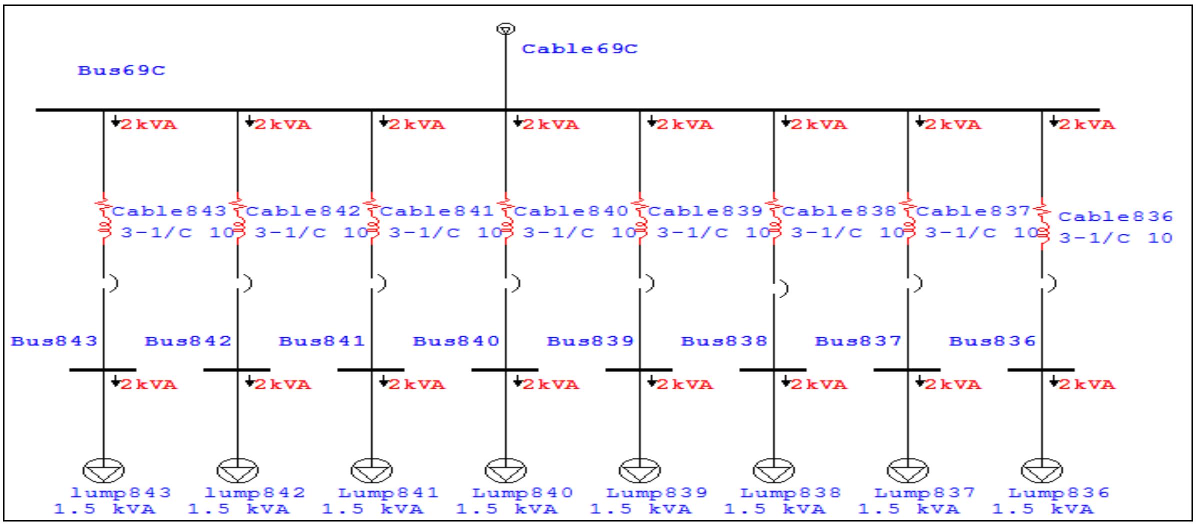
E.1 Branches 71C, and 72C from Branch T5A in Transform T5



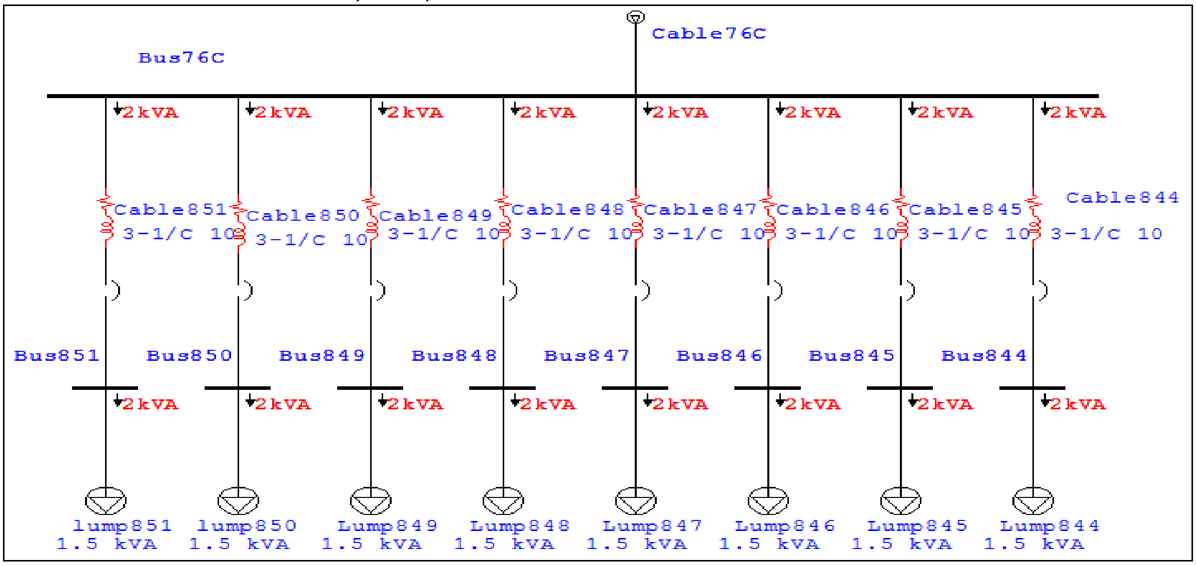


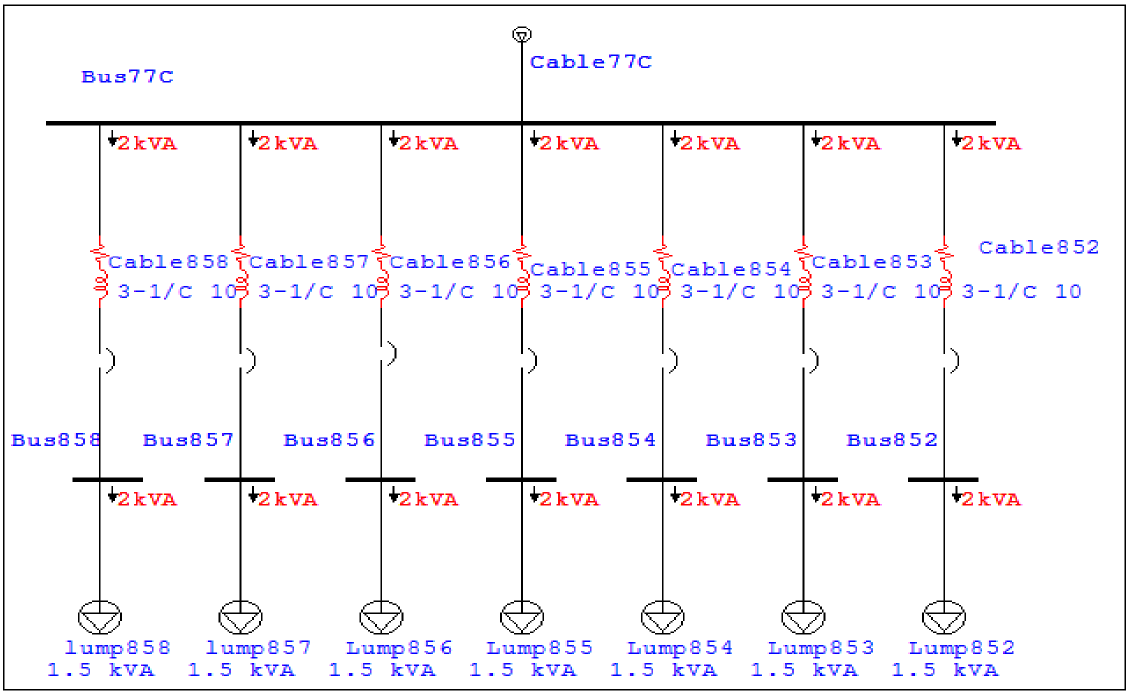
E.2 Branches 69C, and 70C from Branch T5B in Transform T5

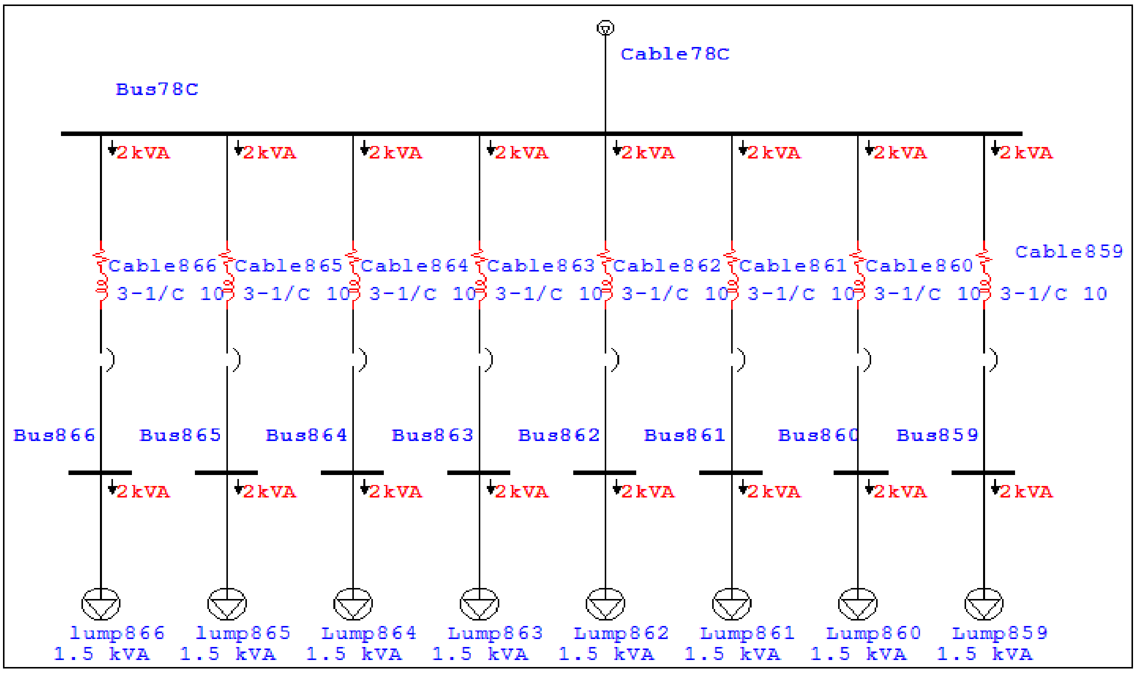




E.3 Branches 78C, 77C, and 76C from Branch T5D in Transform T5

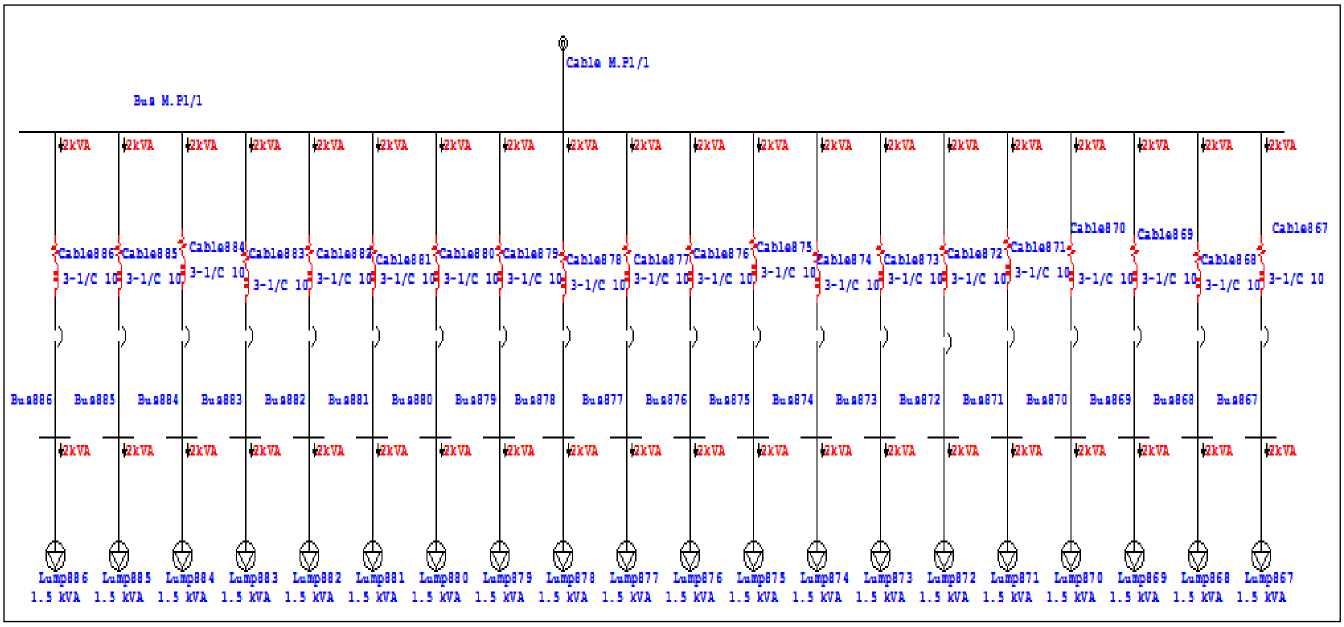


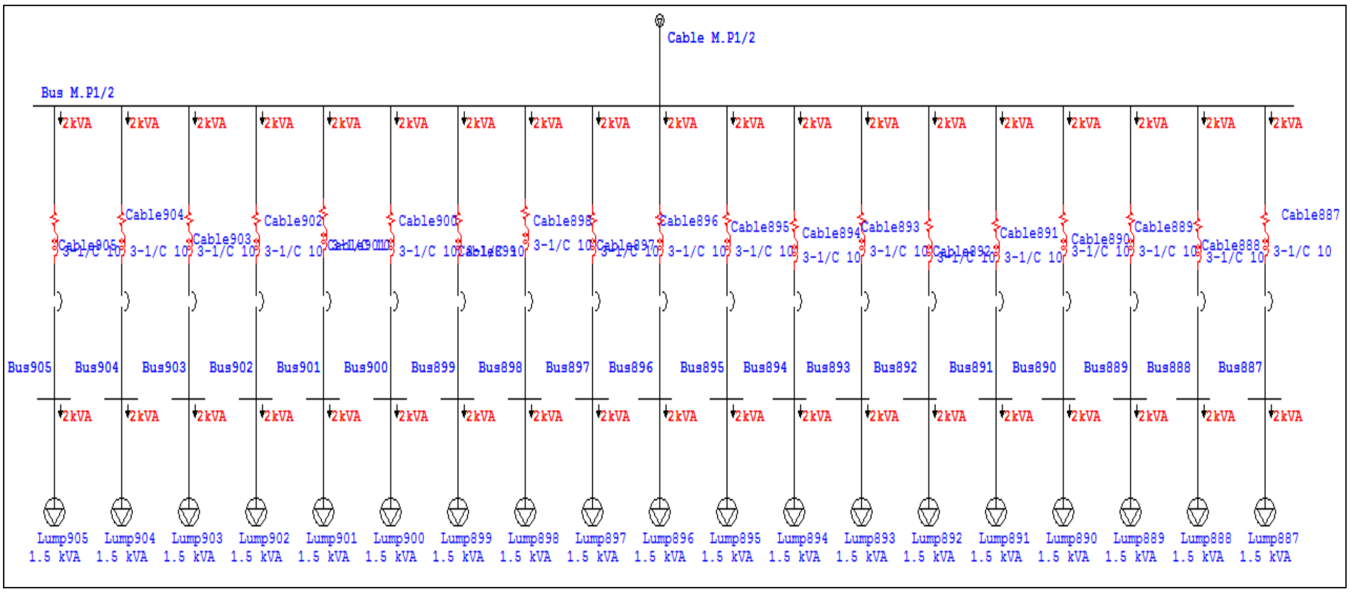

Bus77C
Cable77C
2kVA
Cable858 3-1/C 10
Cable857 3-1/C 10
Cable856 3-1/C 10
Cable855 3-1/C 10
Cable854 3-1/C 10
Cable853 3-1/C 10
Cable852 3-1/C 10
Bus858
Bus857
Bus856
Bus855
Bus854
Bus853
Bus852
lump858 1.5 kVA
lump857 1.5 kVA
Lump856 1.5 kVA
Lump855 1.5 kVA
Lump854 1.5 kVA
Lump853 1.5 kVA
Lump852 1.5 kVA

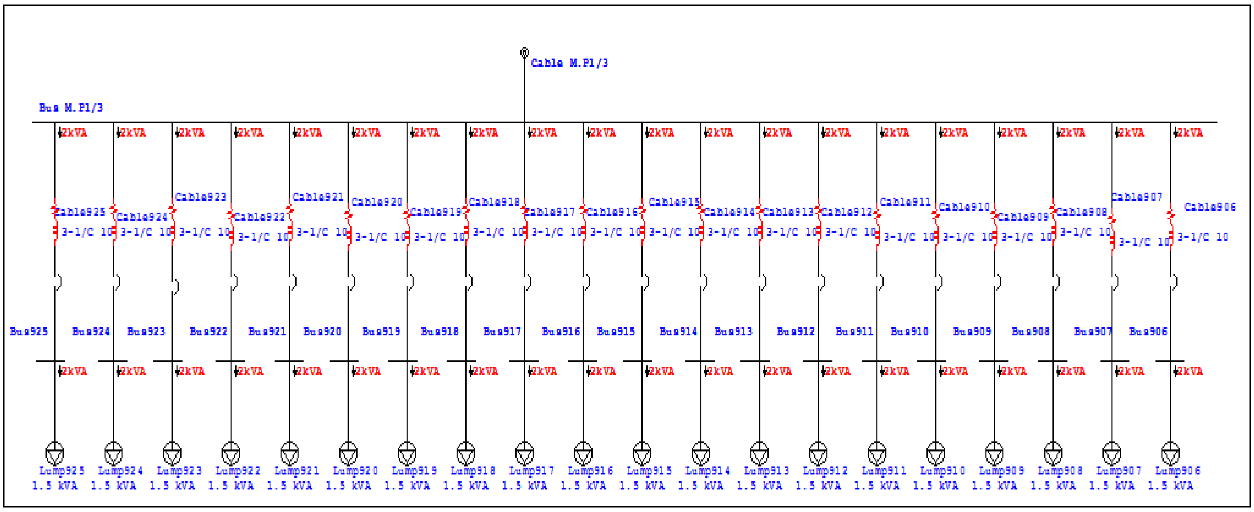

Bus78C
Cable78C
2kVA
Cable866 3-1/C 10
Cable865 3-1/C 10
Cable864 3-1/C 10
Cable863 3-1/C 10
Cable862 3-1/C 10
Cable861 3-1/C 10
Cable860 3-1/C 10
Cable859 3-1/C 10
Bus866
Bus865
Bus864
Bus863
Bus862
Bus861
Bus860
Bus859
lump866 1.5 kVA
lump865 1.5 kVA
Lump864 1.5 kVA
Lump863 1.5 kVA
Lump862 1.5 kVA
Lump861 1.5 kVA
Lump860 1.5 kVA
Lump859 1.5 kVA

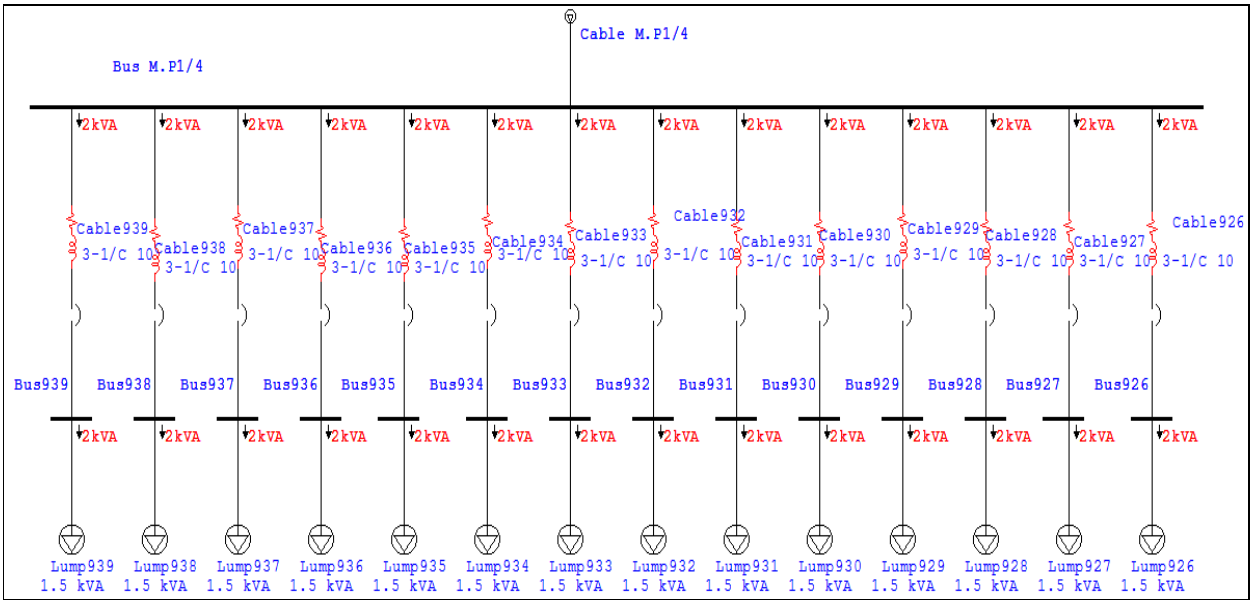
APPENDIX F

F.1 Branches M.P1/1, M.P1/2, M.P1/3, and M.P1/4 from Branch S.D.B1 in Transform T6

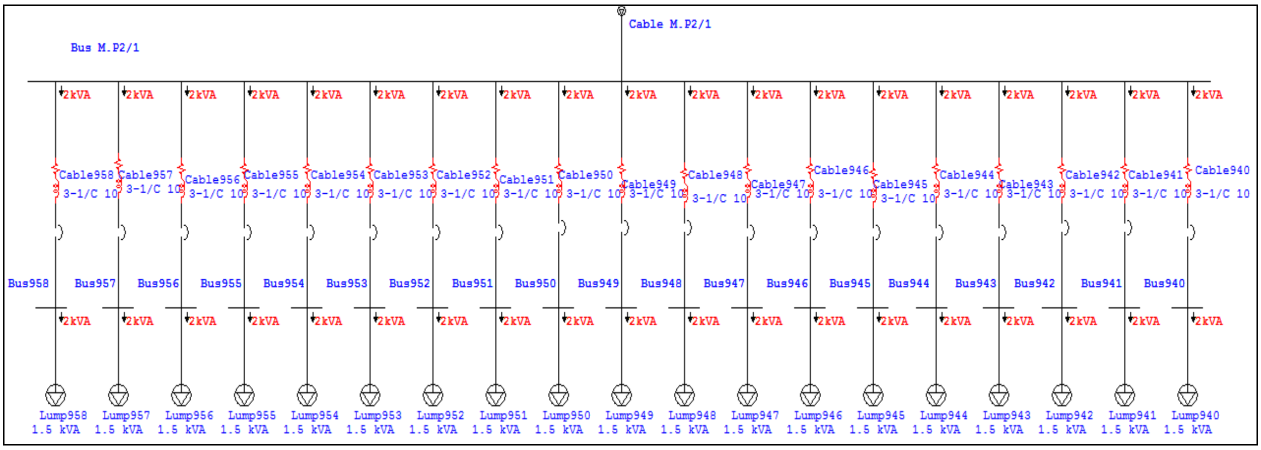


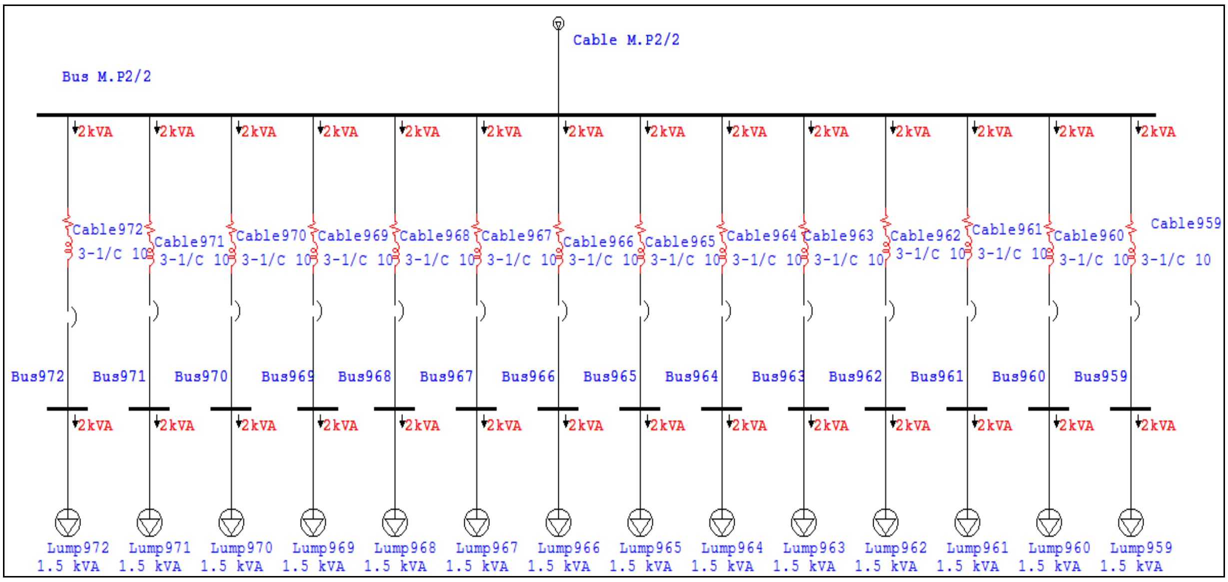


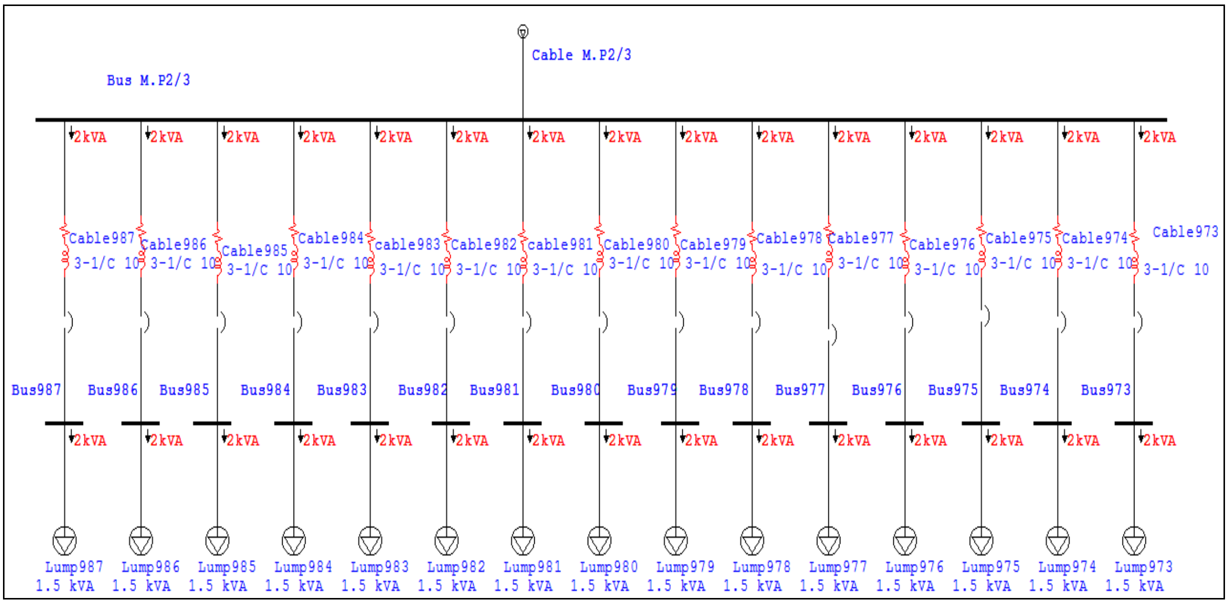


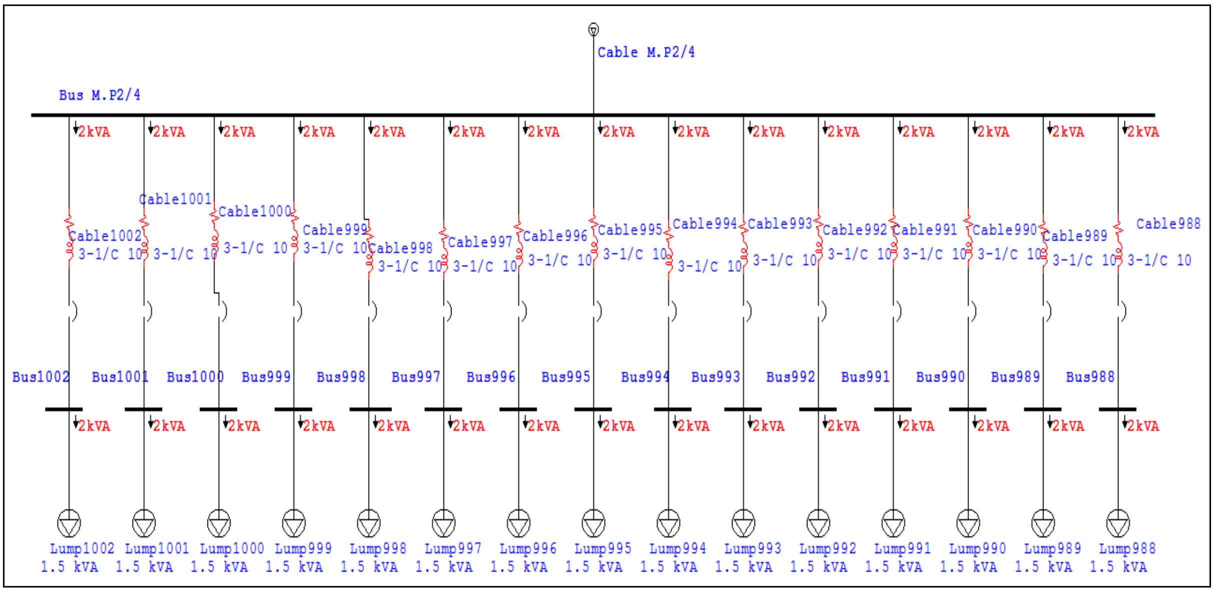


F.2 Branches M.P2/1, M.P2/2, M.P2/3, and M.P2/4 from Branch S.D.B2 in Transform T6

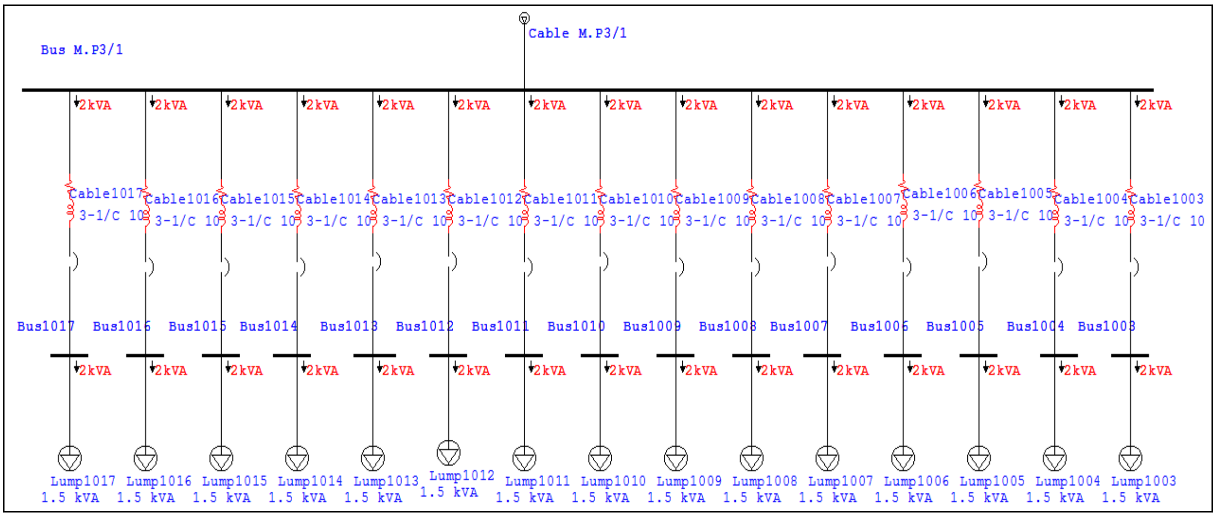


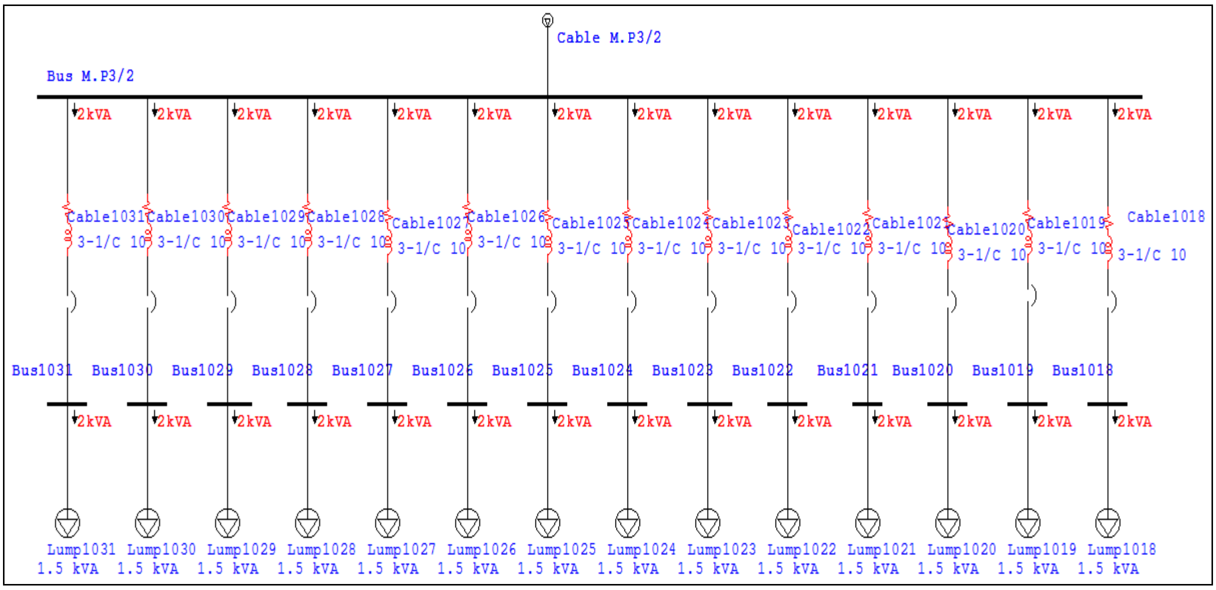

Cable M.P2/2
Bus M.P2/2
2kVA
Cable972 3-1/C 10
Cable971 3-1/C 10
Cable970 3-1/C 10
Cable969 3-1/C 10
Cable968 3-1/C 10
Cable967 3-1/C 10
Cable966 3-1/C 10
Cable965 3-1/C 10
Cable964 3-1/C 10
Cable963 3-1/C 10
Cable962 3-1/C 10
Cable961 3-1/C 10
Cable960 3-1/C 10
Cable959 3-1/C 10
Bus972
Bus971
Bus970
Bus969
Bus968
Bus967
Bus966
Bus965
Bus964
Bus963
Bus962
Bus961
Bus960
Bus959
Lump972 1.5 kVA
Lump971 1.5 kVA
Lump970 1.5 kVA
Lump969 1.5 kVA
Lump968 1.5 kVA
Lump967 1.5 kVA
Lump966 1.5 kVA
Lump965 1.5 kVA
Lump964 1.5 kVA
Lump963 1.5 kVA
Lump962 1.5 kVA
Lump961 1.5 kVA
Lump960 1.5 kVA
Lump959 1.5 kVA

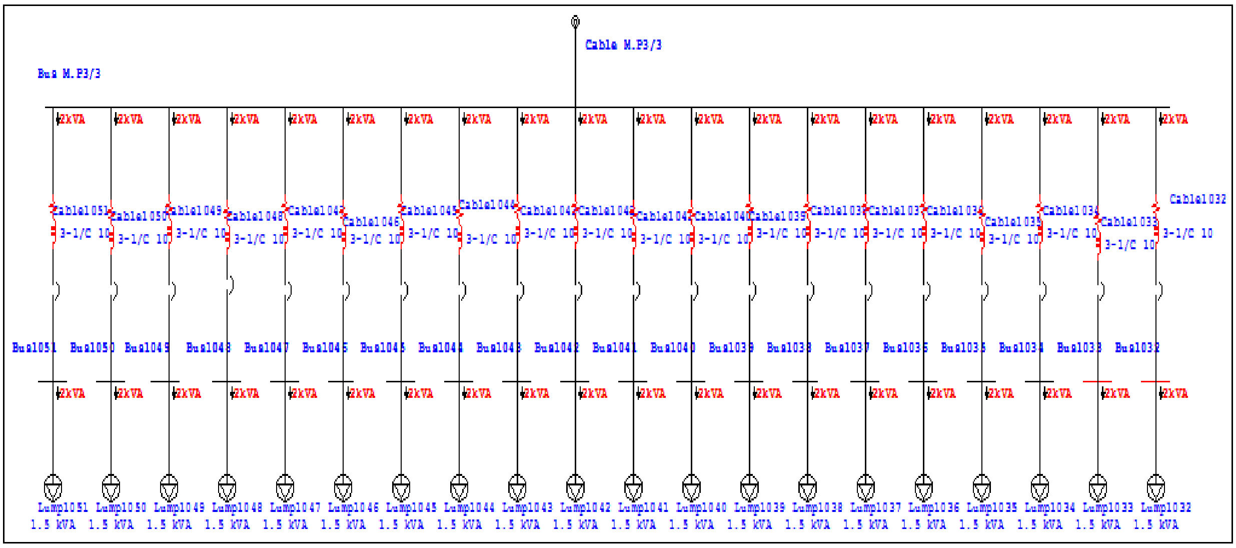

Cable M.P2/3
Bus M.P2/3
2kVA
Cable987 3-1/C 10
Cable986 3-1/C 10
Cable985 3-1/C 10
Cable984 3-1/C 10
cable983 3-1/C 10
Cable982 3-1/C 10
cable981 3-1/C 10
Cable980 3-1/C 10
Cable979 3-1/C 10
Cable978 3-1/C 10
Cable977 3-1/C 10
Cable976 3-1/C 10
Cable975 3-1/C 10
Cable974 3-1/C 10
Cable973 3-1/C 10
Bus987
Bus986
Bus985
Bus984
Bus983
Bus982
Bus981
Bus980
Bus979
Bus978
Bus977
Bus976
Bus975
Bus974
Bus973
Lump987 1.5 kVA
Lump986 1.5 kVA
Lump985 1.5 kVA
Lump984 1.5 kVA
Lump983 1.5 kVA
Lump982 1.5 kVA
Lump981 1.5 kVA
Lump980 1.5 kVA
Lump979 1.5 kVA
Lump978 1.5 kVA
Lump977 1.5 kVA
Lump976 1.5 kVA
Lump975 1.5 kVA
Lump974 1.5 kVA
Lump973 1.5 kVA

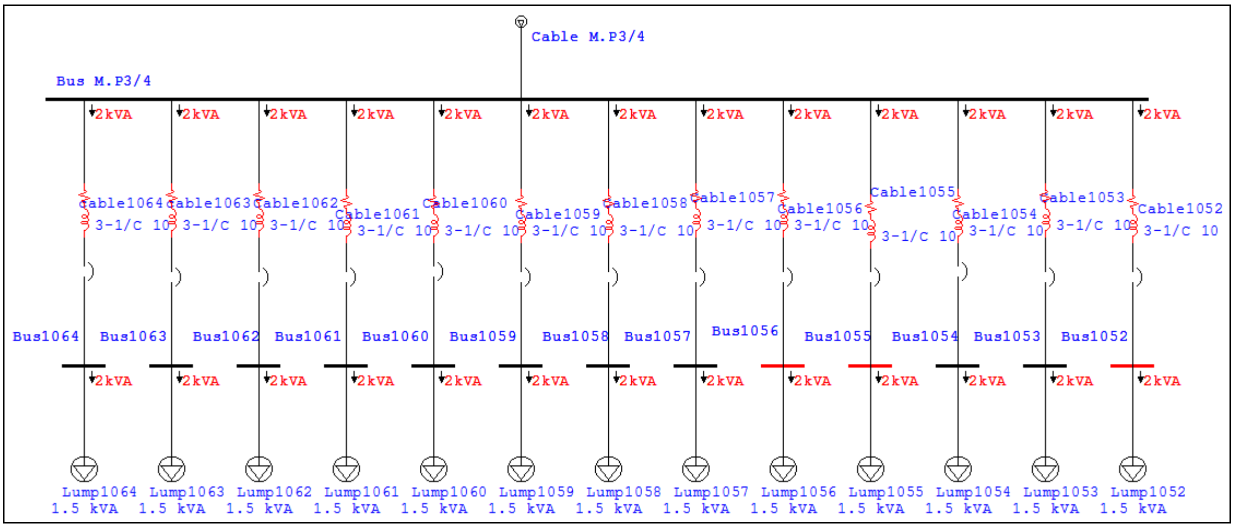


F.3 Branches M.P3/1, M.P3/2, M.P3/3, and M.P3/4 from Branch S.D.B3 in Transform T6

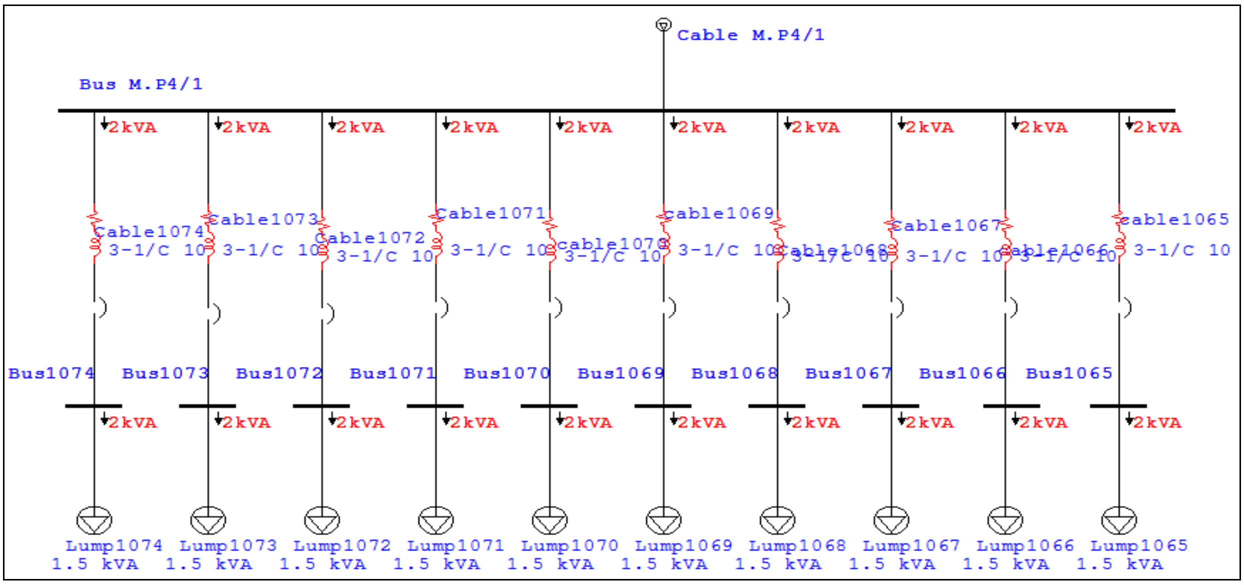


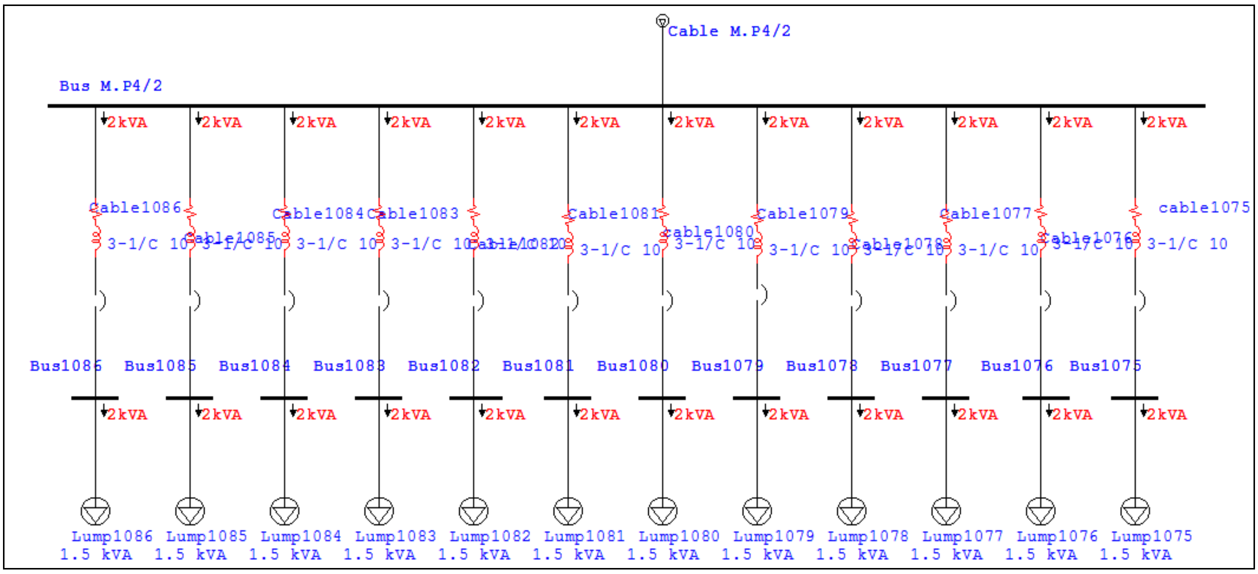


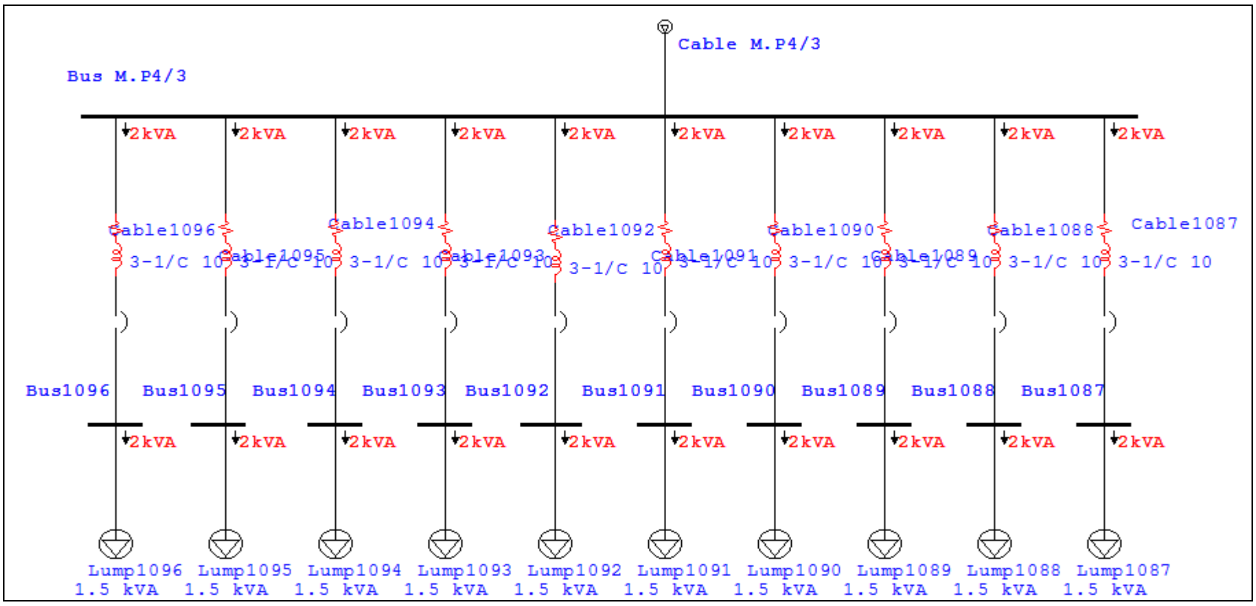


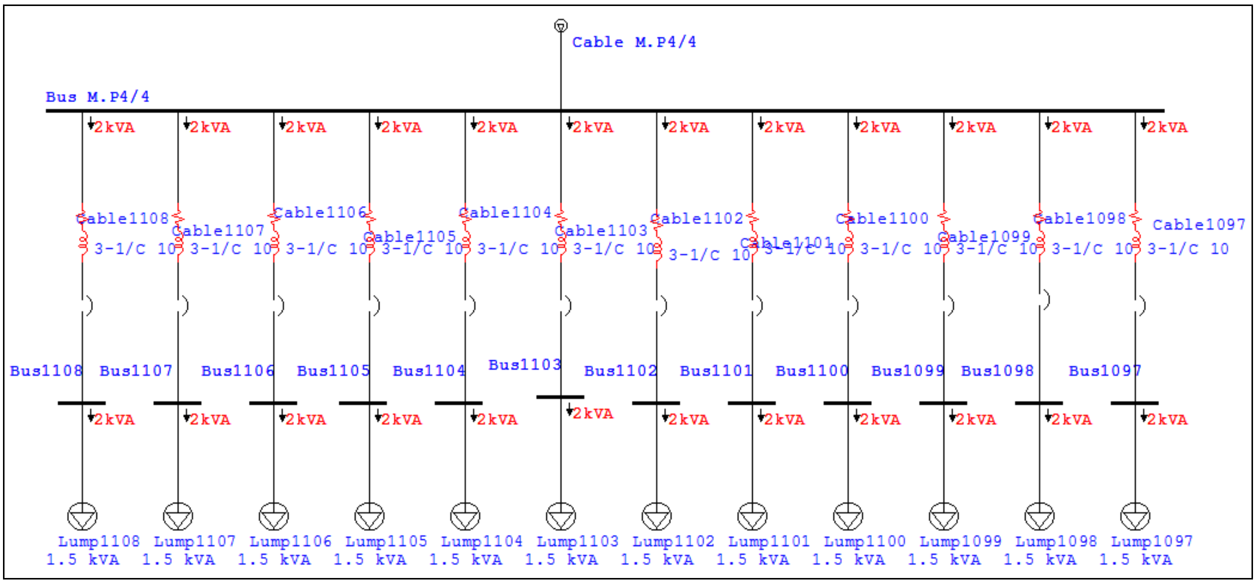


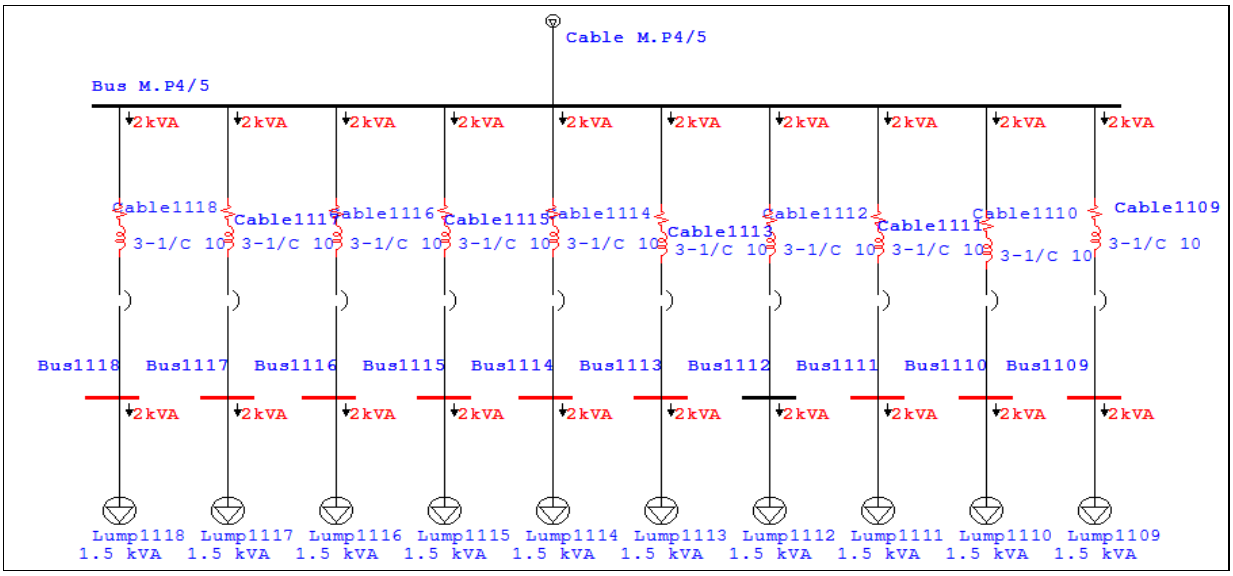
F.4 Branches M.P4/1, M.P4/2, M.P4/3, M.P4/4, and M.P4/5 from Branch S.D.B4 in Transform T6



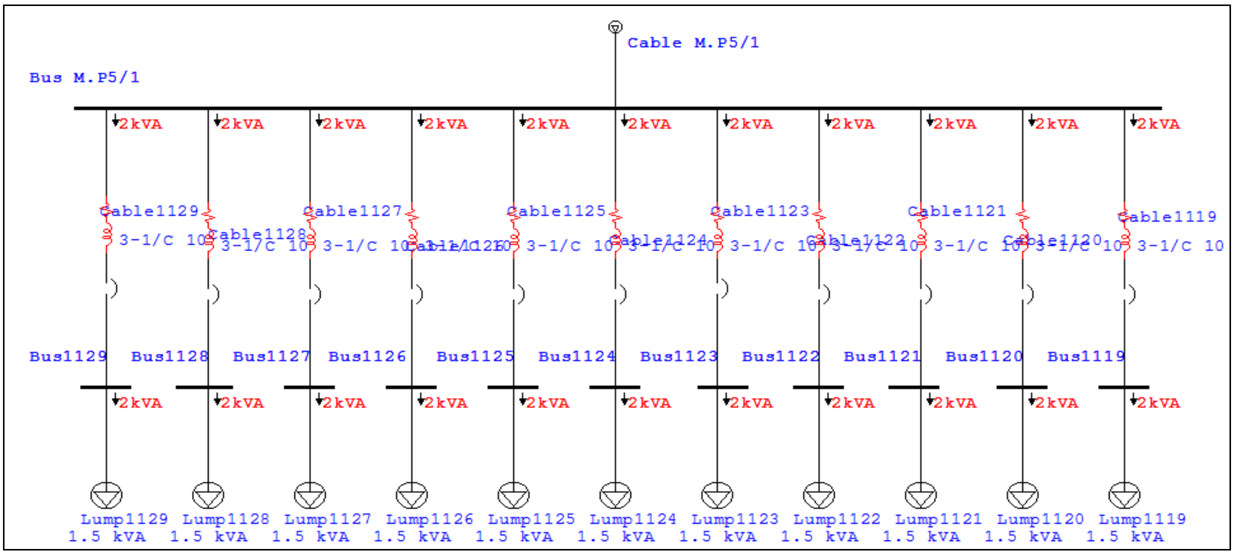

Cable M.P4/2
Bus M.P4/2
2kVA
Cable1086
Cable1085
Cable1084
Cable1083
Cable1082
Cable1081
Cable1080
Cable1079
Cable1078
Cable1077
Cable1076
cable1075
3-1/C 10
Bus1086 Bus1085 Bus1084 Bus1083 Bus1082 Bus1081 Bus1080 Bus1079 Bus1078 Bus1077 Bus1076 Bus1075
Lump1086 Lump1085 Lump1084 Lump1083 Lump1082 Lump1081 Lump1080 Lump1079 Lump1078 Lump1077 Lump1076 Lump1075
1.5 kVA

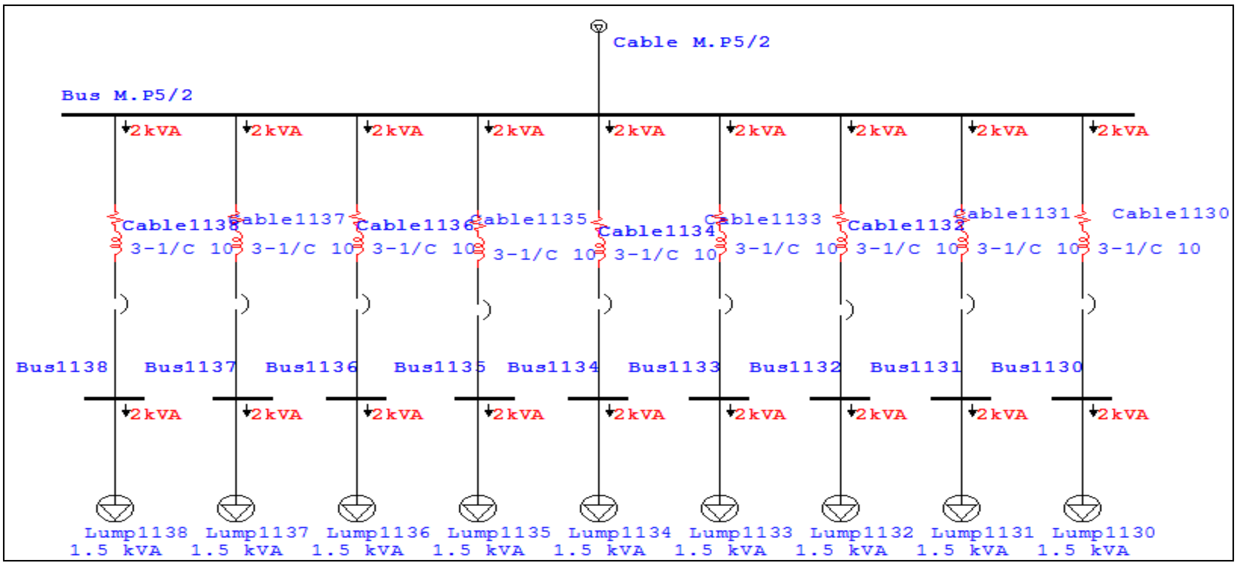

Cable M.P4/3
Bus M.P4/3
2kVA
Cable1096
Cable1095
Cable1094
Cable1093
Cable1092
Cable1091
Cable1090
Cable1089
Cable1088
Cable1087
3-1/C 10
Bus1096 Bus1095 Bus1094 Bus1093 Bus1092 Bus1091 Bus1090 Bus1089 Bus1088 Bus1087
Lump1096 Lump1095 Lump1094 Lump1093 Lump1092 Lump1091 Lump1090 Lump1089 Lump1088 Lump1087
1.5 kVA

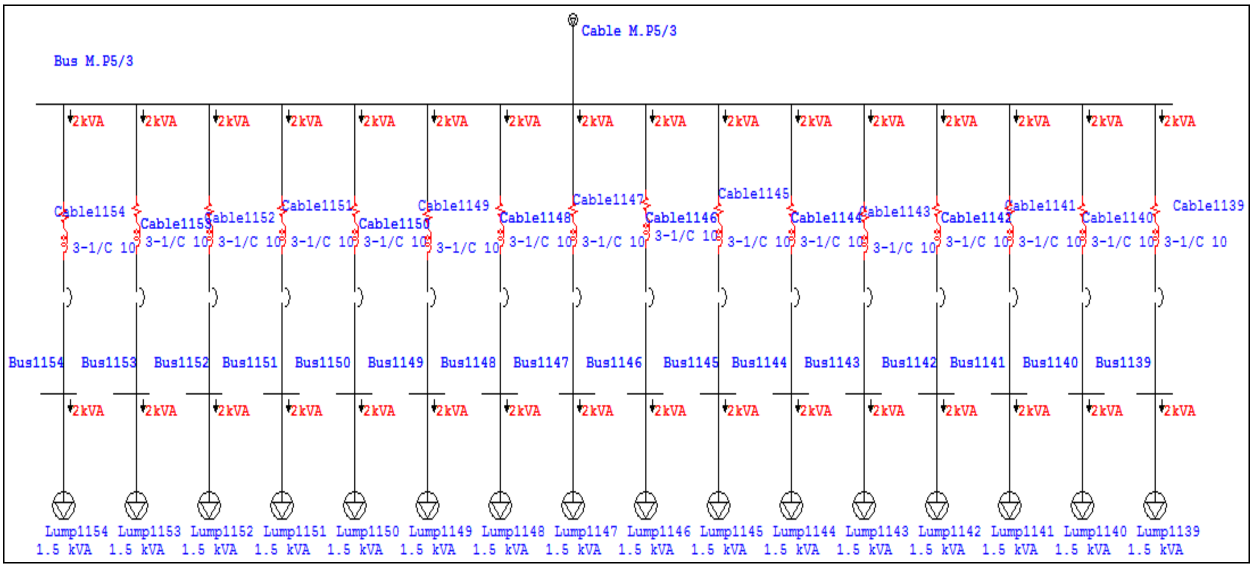

Cable M.P4/4
Bus M.P4/4
2kVA
Cable1108
Cable1107
Cable1106
Cable1105
Cable1104
Cable1103
Cable1102
Cable1101
Cable1100
Cable1099
Cable1098
Cable1097
3-1/C 10
Bus1108 Bus1107 Bus1106 Bus1105 Bus1104 Bus1103 Bus1102 Bus1101 Bus1100 Bus1099 Bus1098 Bus1097
Lump1108 Lump1107 Lump1106 Lump1105 Lump1104 Lump1103 Lump1102 Lump1101 Lump1100 Lump1099 Lump1098 Lump1097
1.5 kVA

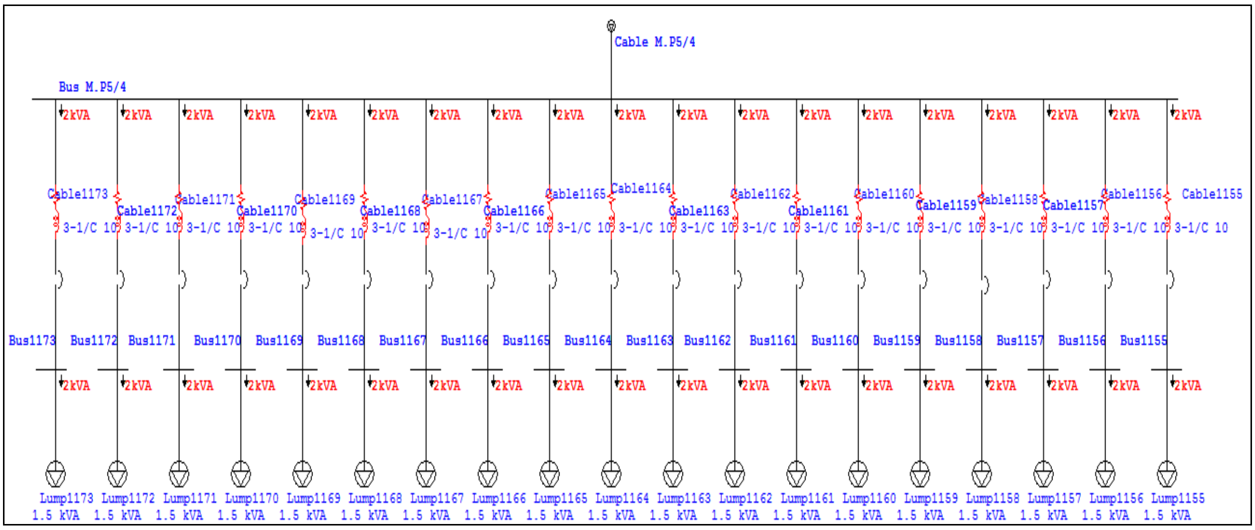


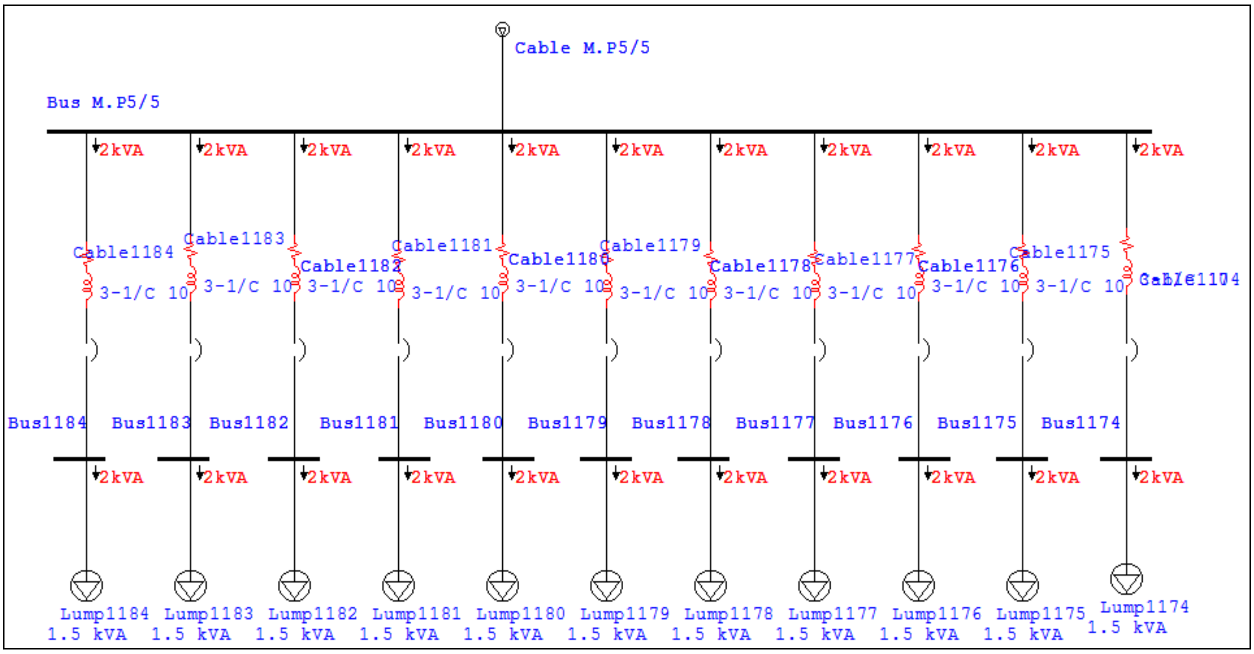
F.5 Branches M.P5/1, M.P5/2, M.P5/3, M.P5/4, and M.P5/5from Branch S.D.B5 in Transform T6





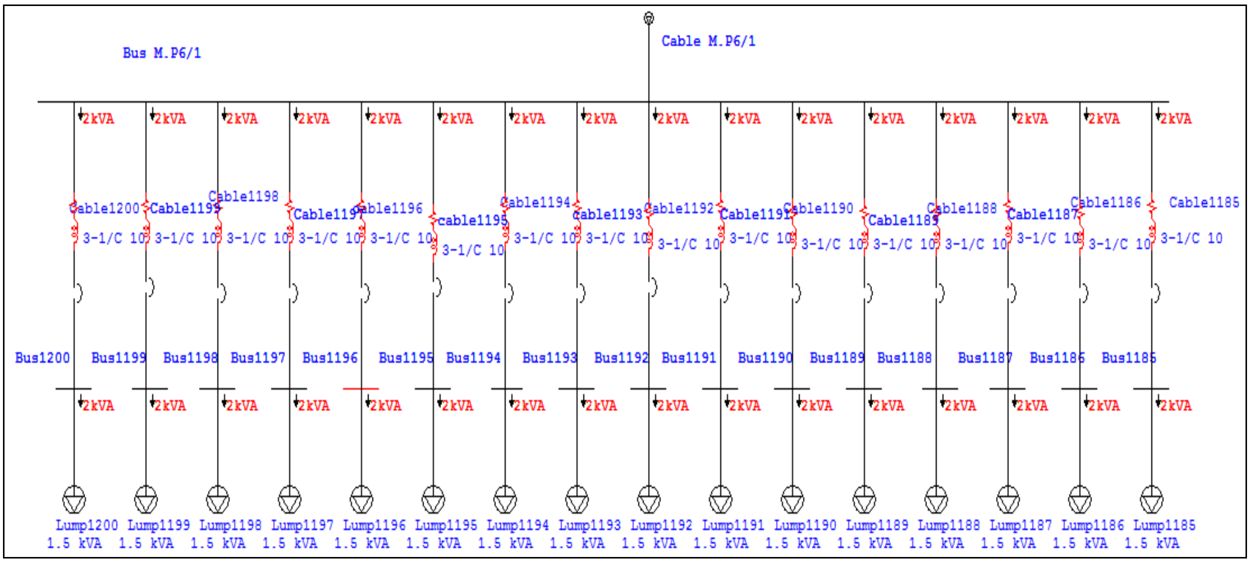

Cable M.P5/3
Bus M.P5/3
2kVA
Cable1154 Cable1153 Cable1152 Cable1151 Cable1150 Cable1149 Cable1148 Cable1147 Cable1146 Cable1145 Cable1144 Cable1143 Cable1142 Cable1141 Cable1140 Cable1139
3-1/C 10
Bus1154 Bus1153 Bus1152 Bus1151 Bus1150 Bus1149 Bus1148 Bus1147 Bus1146 Bus1145 Bus1144 Bus1143 Bus1142 Bus1141 Bus1140 Bus1139
Lump1154 Lump1153 Lump1152 Lump1151 Lump1150 Lump1149 Lump1148 Lump1147 Lump1146 Lump1145 Lump1144 Lump1143 Lump1142 Lump1141 Lump1140 Lump1139
1.5 kVA

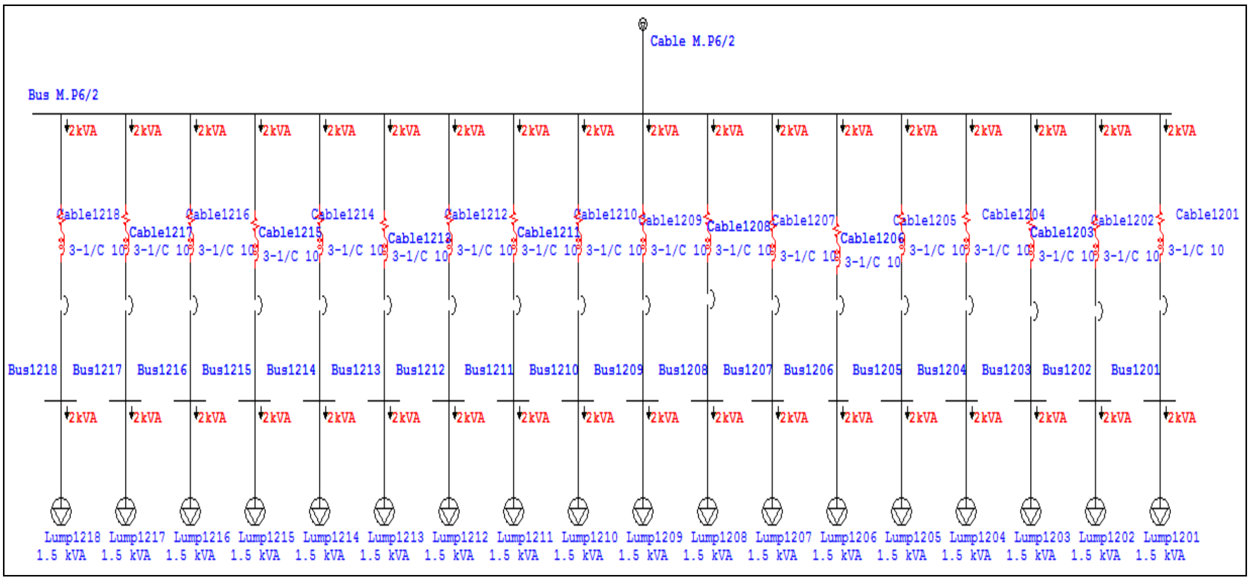

Cable M.P5/4
Bus M.P5/4
2kVA
Cable1173 Cable1172 Cable1171 Cable1170 Cable1169 Cable1168 Cable1167 Cable1166 Cable1165 Cable1164 Cable1163 Cable1162 Cable1161 Cable1160 Cable1159 Cable1158 Cable1157 Cable1156 Cable1155
3-1/C 10
Bus1173 Bus1172 Bus1171 Bus1170 Bus1169 Bus1168 Bus1167 Bus1166 Bus1165 Bus1164 Bus1163 Bus1162 Bus1161 Bus1160 Bus1159 Bus1158 Bus1157 Bus1156 Bus1155
Lump1173 Lump1172 Lump1171 Lump1170 Lump1169 Lump1168 Lump1167 Lump1166 Lump1165 Lump1164 Lump1163 Lump1162 Lump1161 Lump1160 Lump1159 Lump1158 Lump1157 Lump1156 Lump1155
1.5 kVA

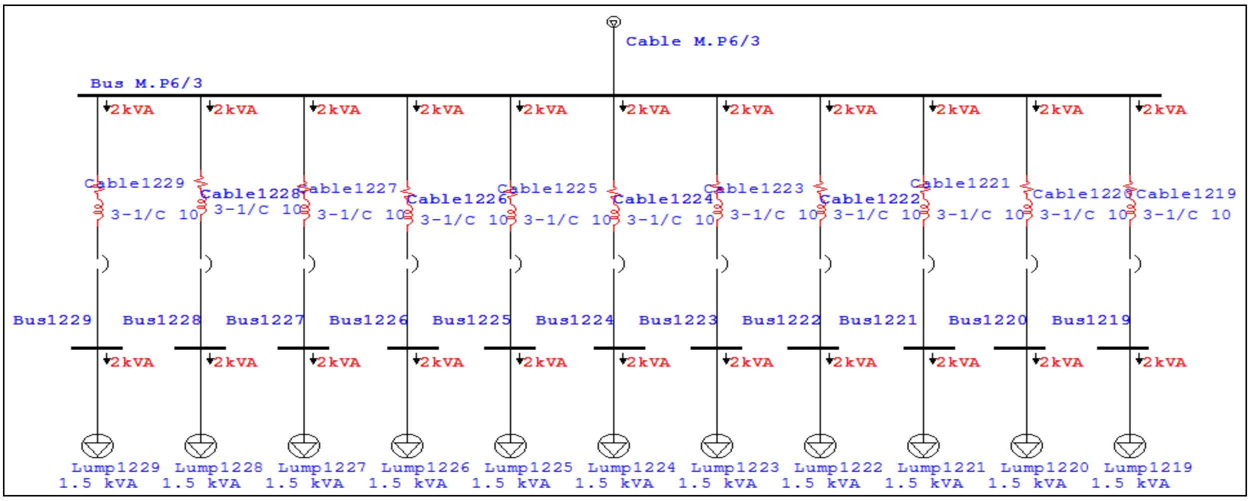

Cable M.P5/5
Bus M.P5/5
2kVA
Cable1184 Cable1183 Cable1182 Cable1181 Cable1180 Cable1179 Cable1178 Cable1177 Cable1176 Cable1175 Cable1174
3-1/C 10
Bus1184 Bus1183 Bus1182 Bus1181 Bus1180 Bus1179 Bus1178 Bus1177 Bus1176 Bus1175 Bus1174
Lump1184 Lump1183 Lump1182 Lump1181 Lump1180 Lump1179 Lump1178 Lump1177 Lump1176 Lump1175 Lump1174
1.5 kVA

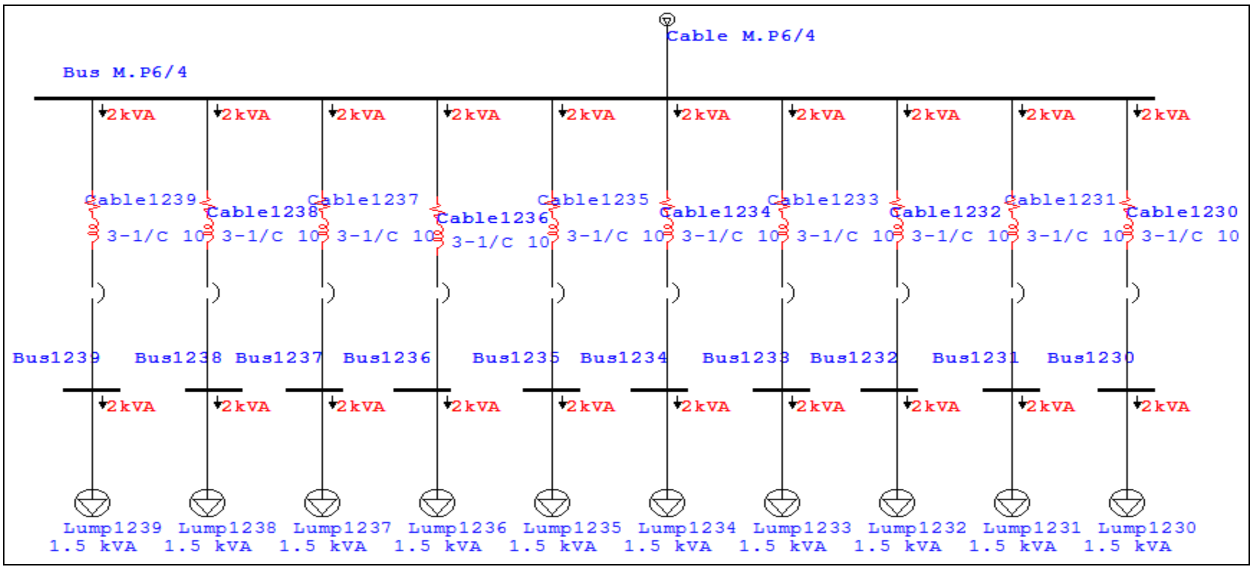
APPENDIX G

G.1 Branches M.P6/1, M.P6/2, M.P6/3, and M.P6/4 from Branch S.D.B6 in Transform T7

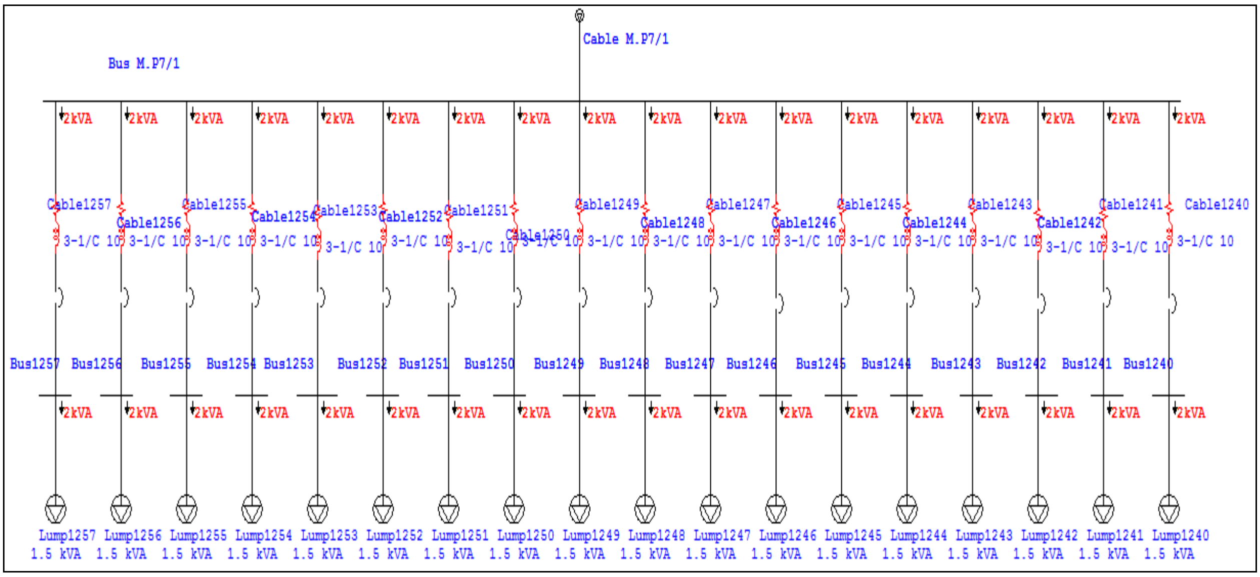


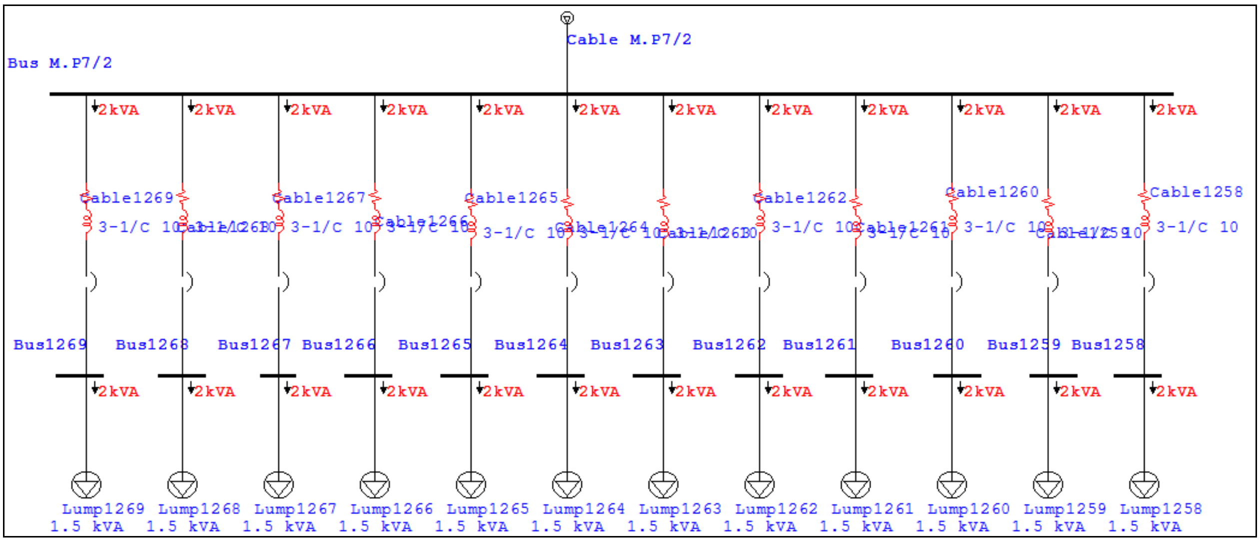


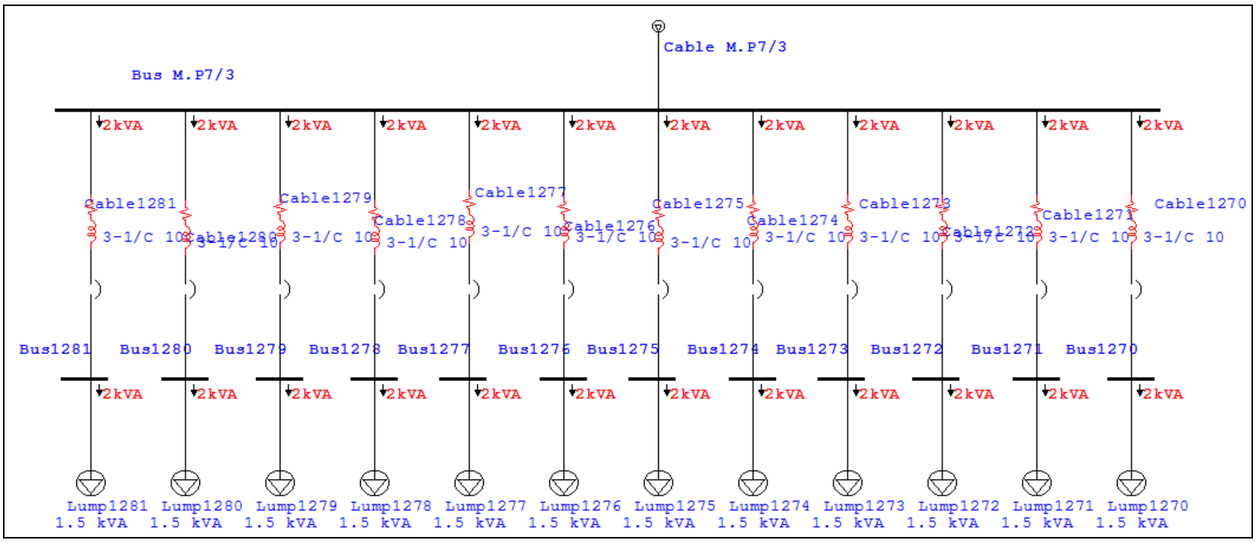


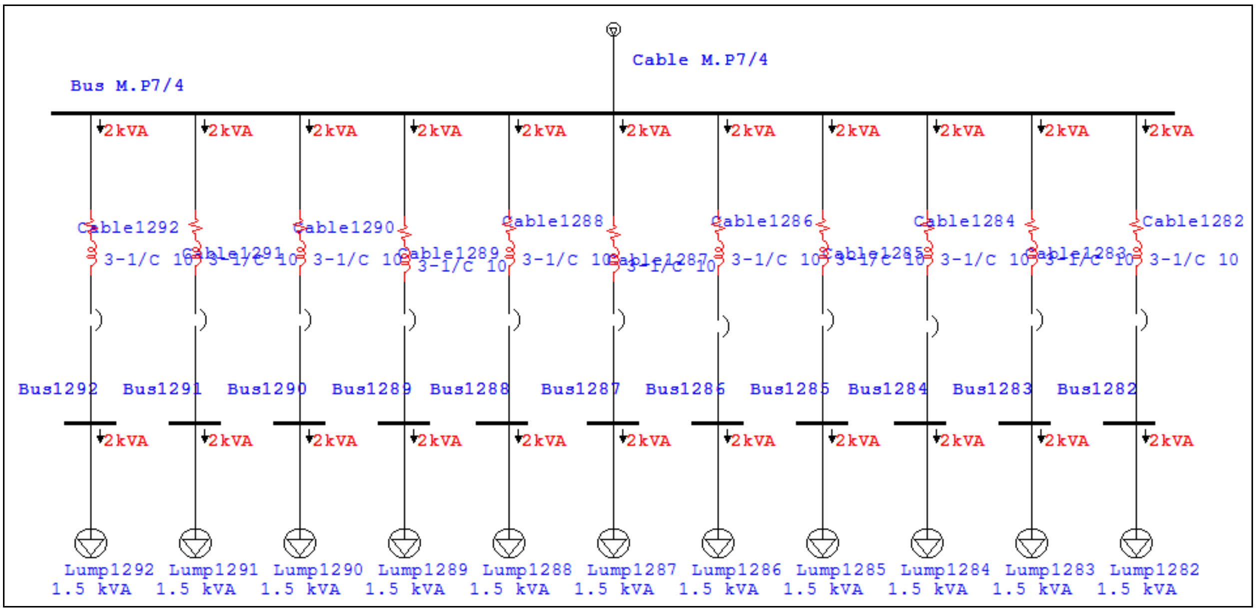


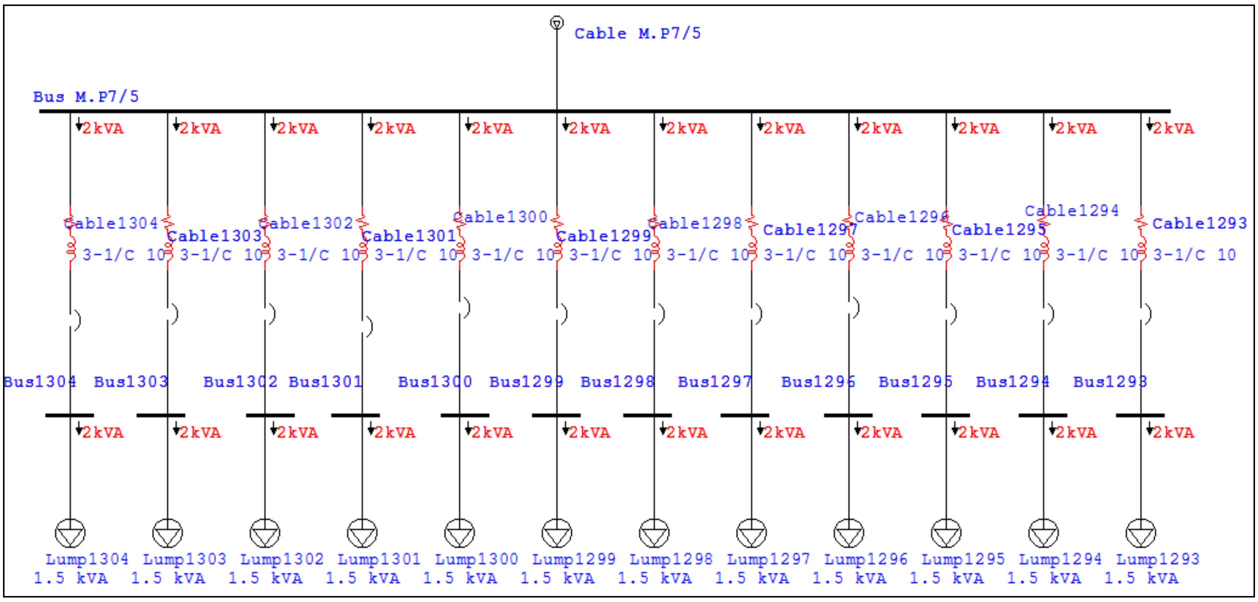
G.2 Branches M.P7/1, M.P7/2, M.P7/3, M.P7/4, and M.P7/5 from Branch S.D.B7 in Transform T7



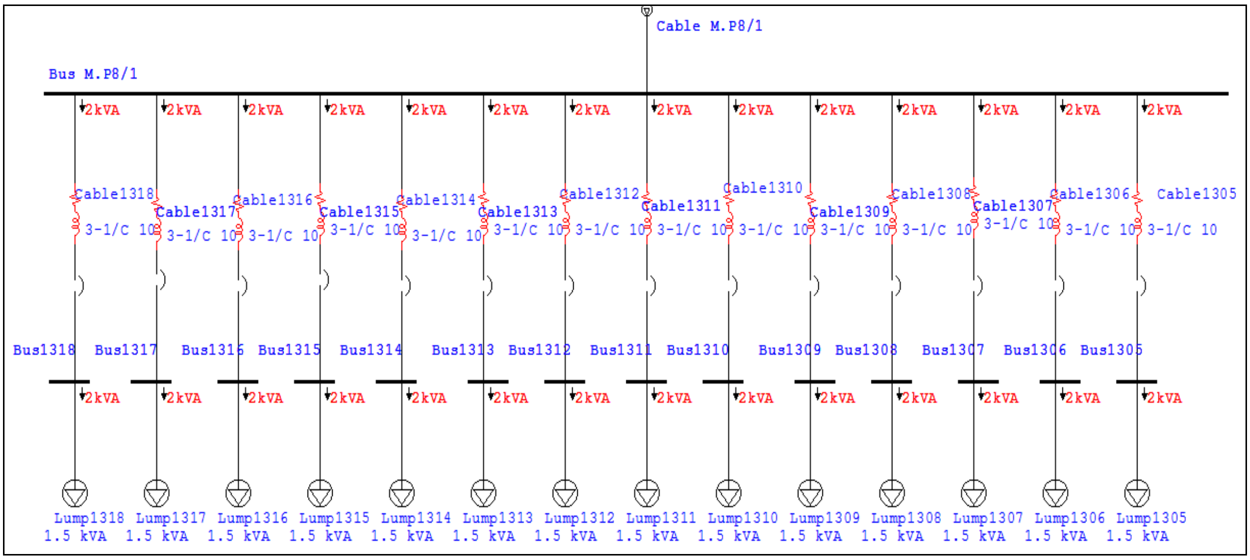


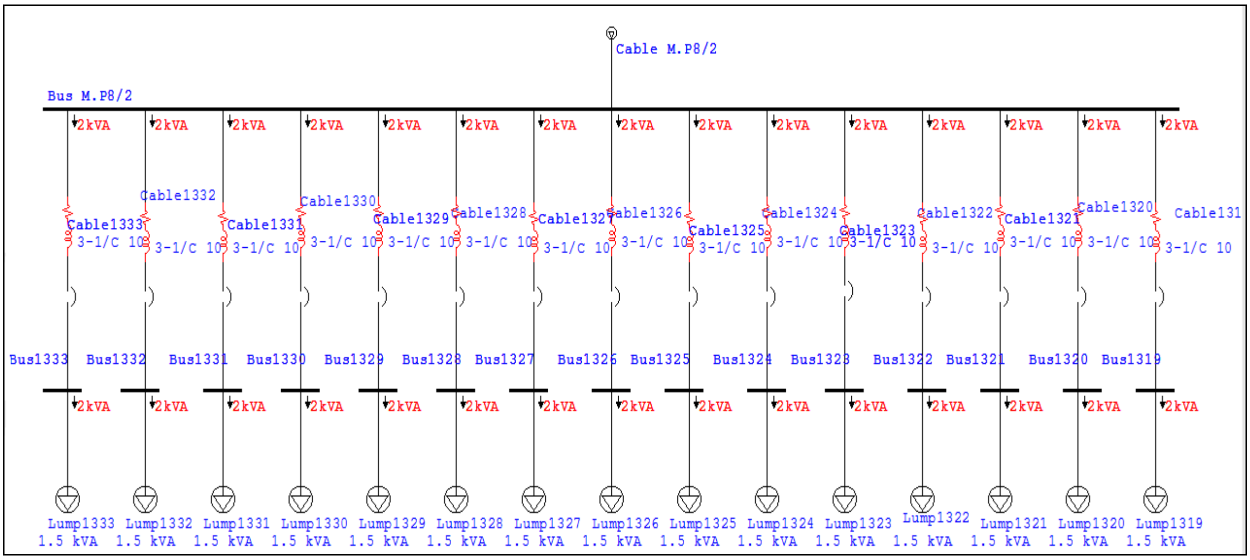

Cable M.P7/3
Bus M.P7/3
2kVA
Cable1281 Cable1280 Cable1279 Cable1278 Cable1277 Cable1276 Cable1275 Cable1274 Cable1273 Cable1272 Cable1271 Cable1270
3-1/C 10
Bus1281 Bus1280 Bus1279 Bus1278 Bus1277 Bus1276 Bus1275 Bus1274 Bus1273 Bus1272 Bus1271 Bus1270
Lump1281 Lump1280 Lump1279 Lump1278 Lump1277 Lump1276 Lump1275 Lump1274 Lump1273 Lump1272 Lump1271 Lump1270
1.5 kVA

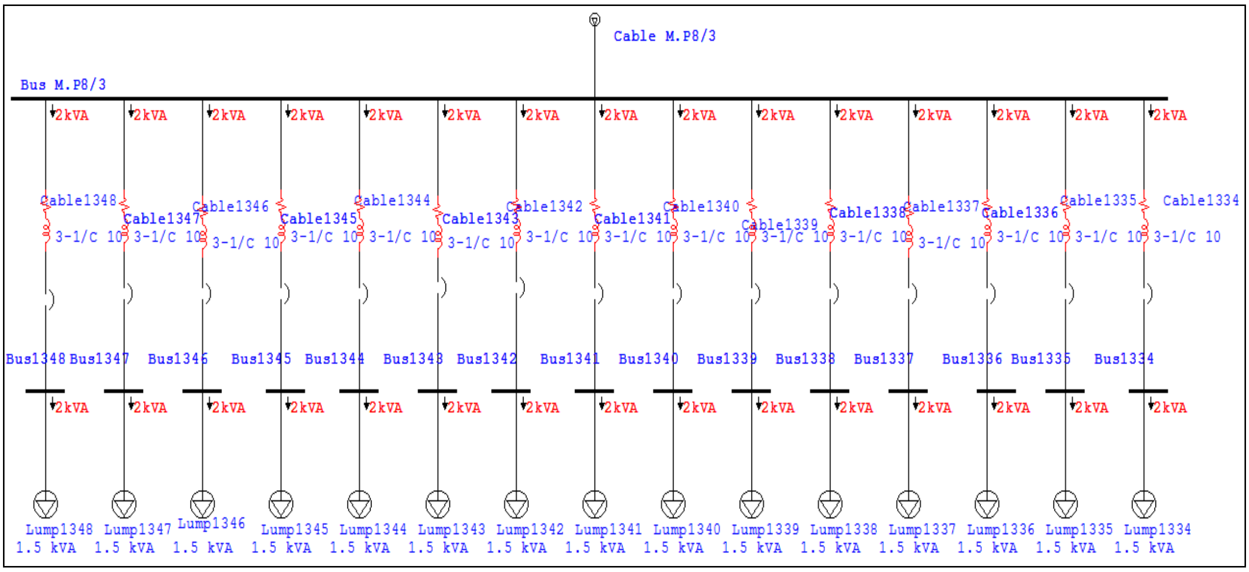

Cable M.P7/4
Bus M.P7/4
2kVA
Cable1292 Cable1291 Cable1290 Cable1289 Cable1288 Cable1287 Cable1286 Cable1285 Cable1284 Cable1283 Cable1282
3-1/C 10
Bus1292 Bus1291 Bus1290 Bus1289 Bus1288 Bus1287 Bus1286 Bus1285 Bus1284 Bus1283 Bus1282
Lump1292 Lump1291 Lump1290 Lump1289 Lump1288 Lump1287 Lump1286 Lump1285 Lump1284 Lump1283 Lump1282
1.5 kVA

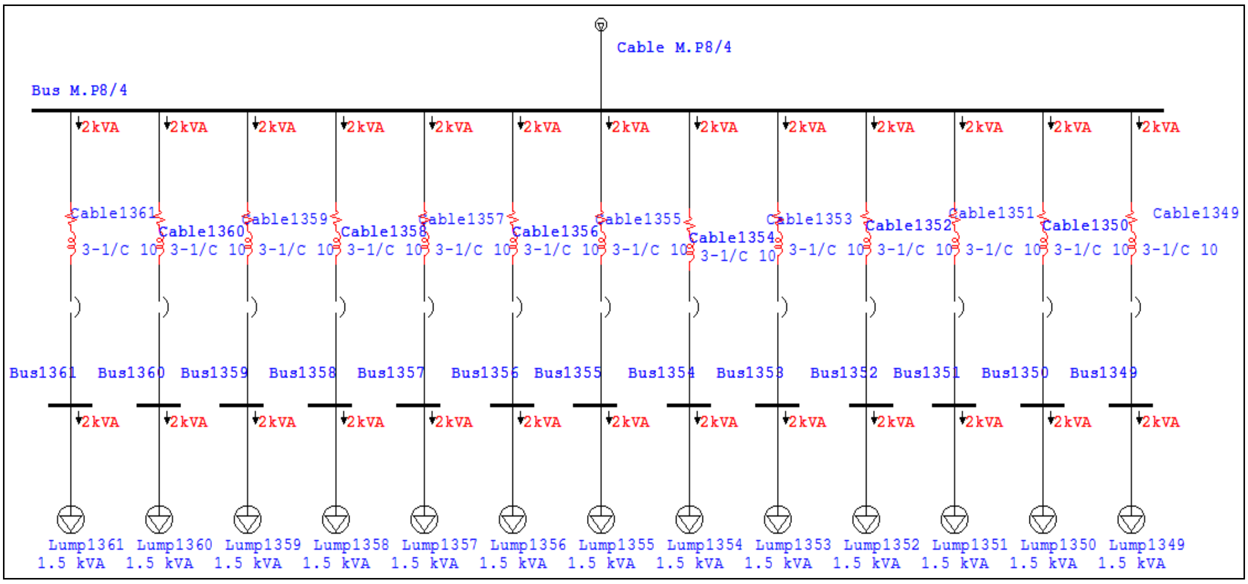

Cable M.P7/5
Bus M.P7/5
2kVA
Cable1304 Cable1303 Cable1302 Cable1301 Cable1300 Cable1299 Cable1298 Cable1297 Cable1296 Cable1295 Cable1294 Cable1293
3-1/C 10
Bus1304 Bus1303 Bus1302 Bus1301 Bus1300 Bus1299 Bus1298 Bus1297 Bus1296 Bus1295 Bus1294 Bus1293
Lump1304 Lump1303 Lump1302 Lump1301 Lump1300 Lump1299 Lump1298 Lump1297 Lump1296 Lump1295 Lump1294 Lump1293
1.5 kVA

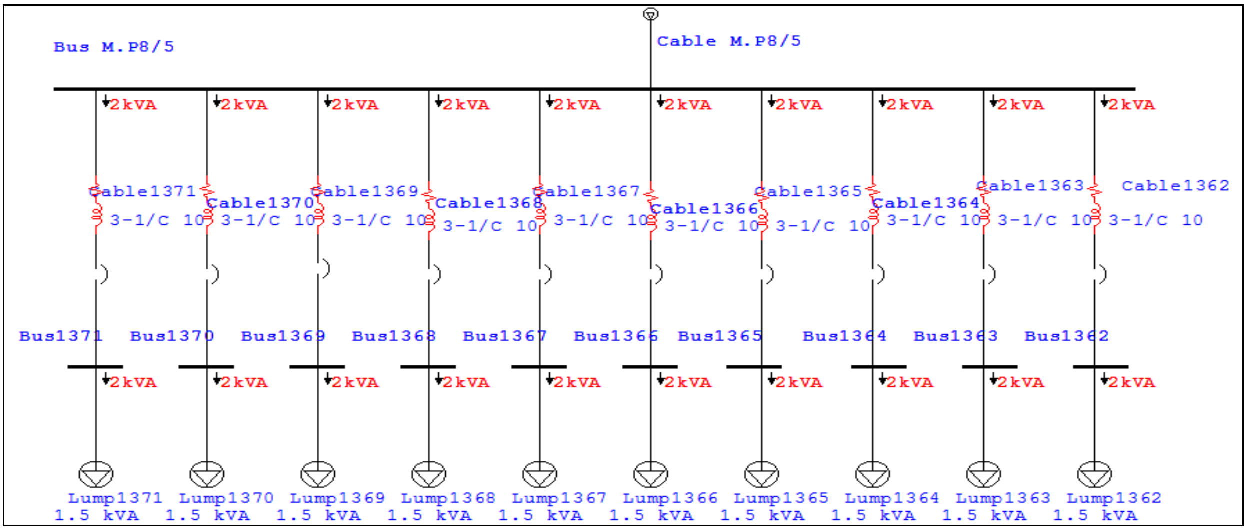
G.3 Branches M.P8/1, M.P8/2, M.P8/3, M.P8/4, and M.P8/5 from Branch S.D.B8 in Transform T7



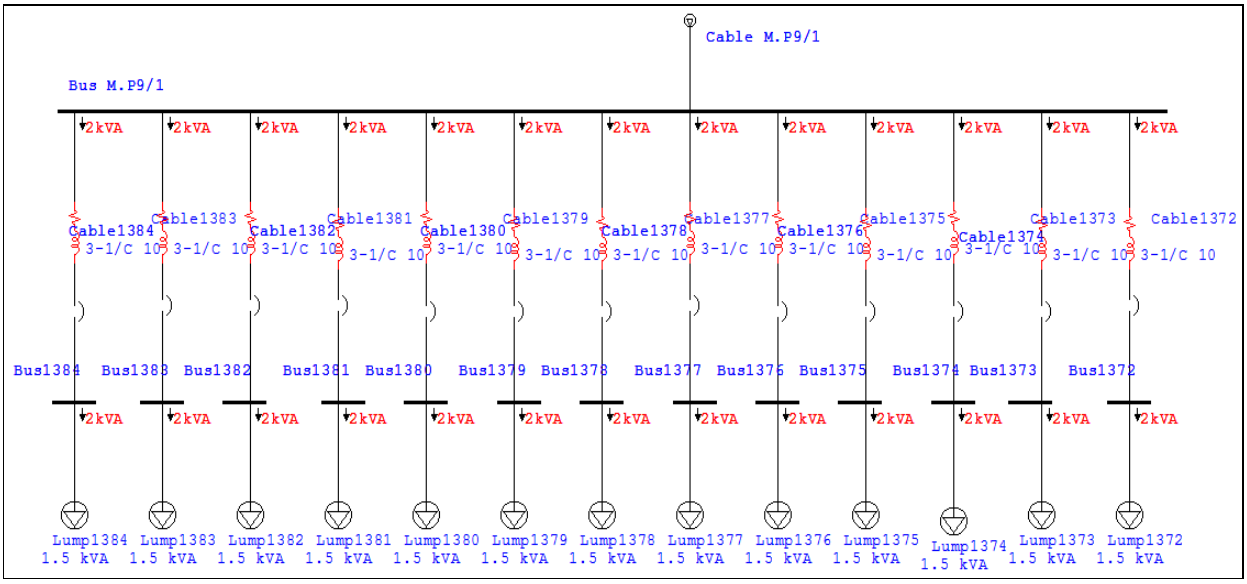


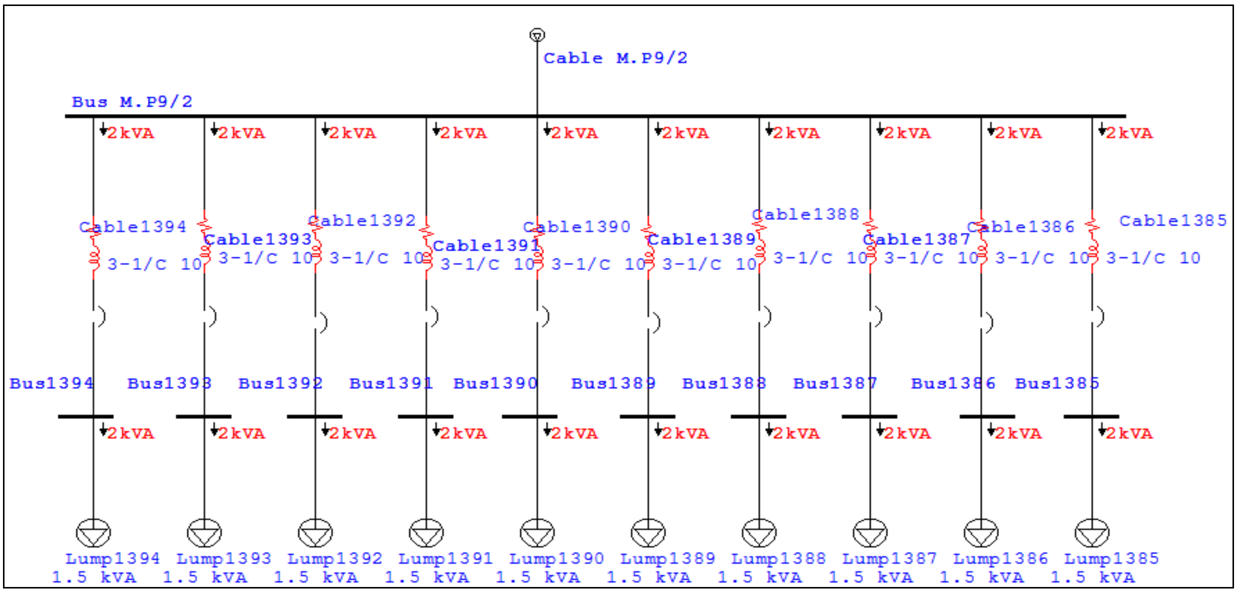


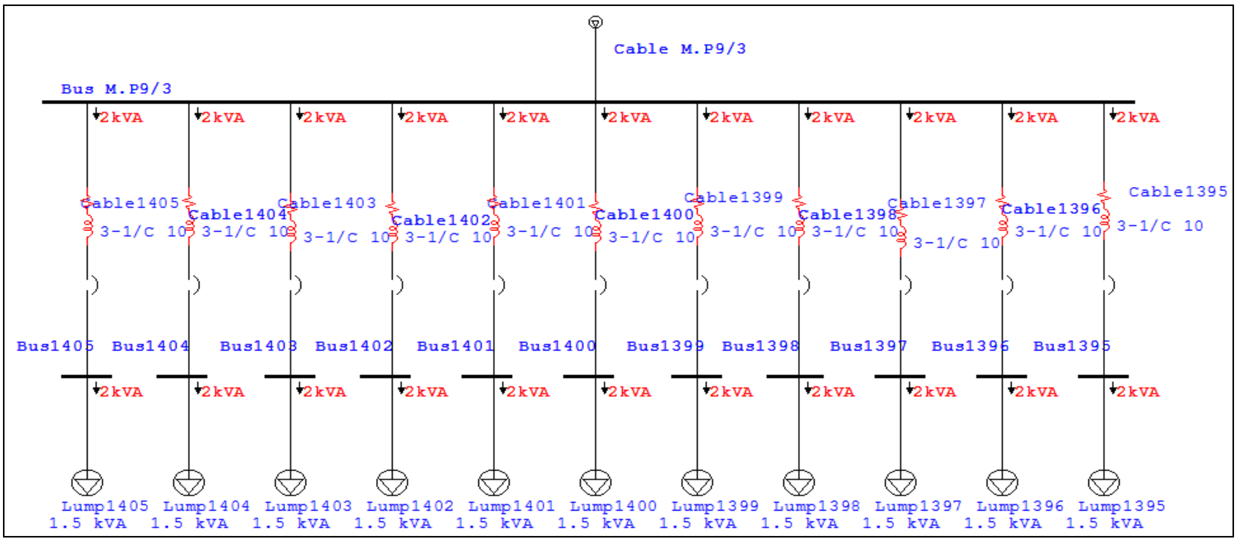


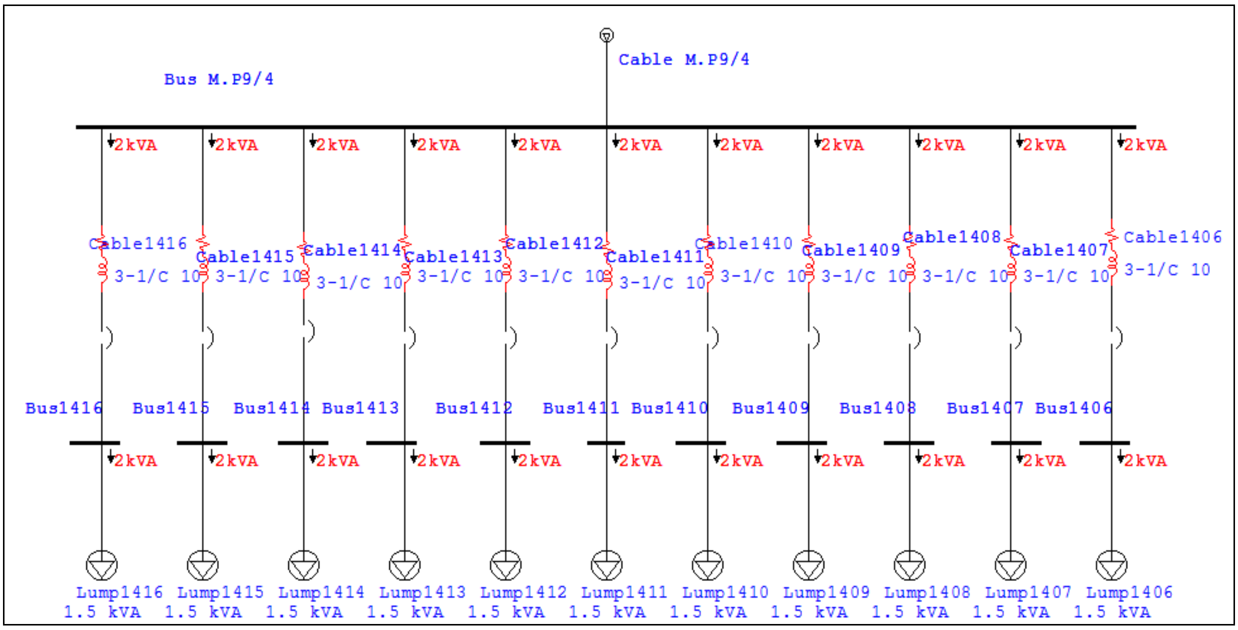


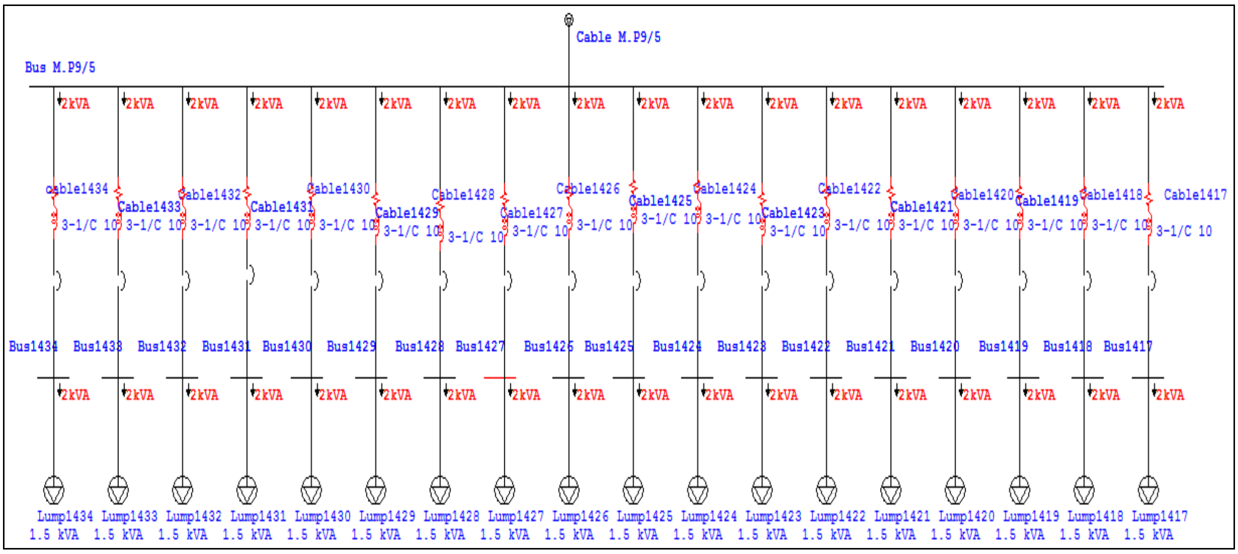
G.4 Branches M.P9/1, M.P9/2, M.P9/3, M.P9/4, and M.P9/5 from Branch S.D.B9 in Transform T7




Cable M.P9/2
Bus M.P9/2
2kVA
Cable1394 Cable1393 Cable1392 Cable1391 Cable1390 Cable1389 Cable1388 Cable1387 Cable1386 Cable1385
3-1/C 10
Bus1394 Bus1393 Bus1392 Bus1391 Bus1390 Bus1389 Bus1388 Bus1387 Bus1386 Bus1385
Lump1394 Lump1393 Lump1392 Lump1391 Lump1390 Lump1389 Lump1388 Lump1387 Lump1386 Lump1385
1.5 kVA

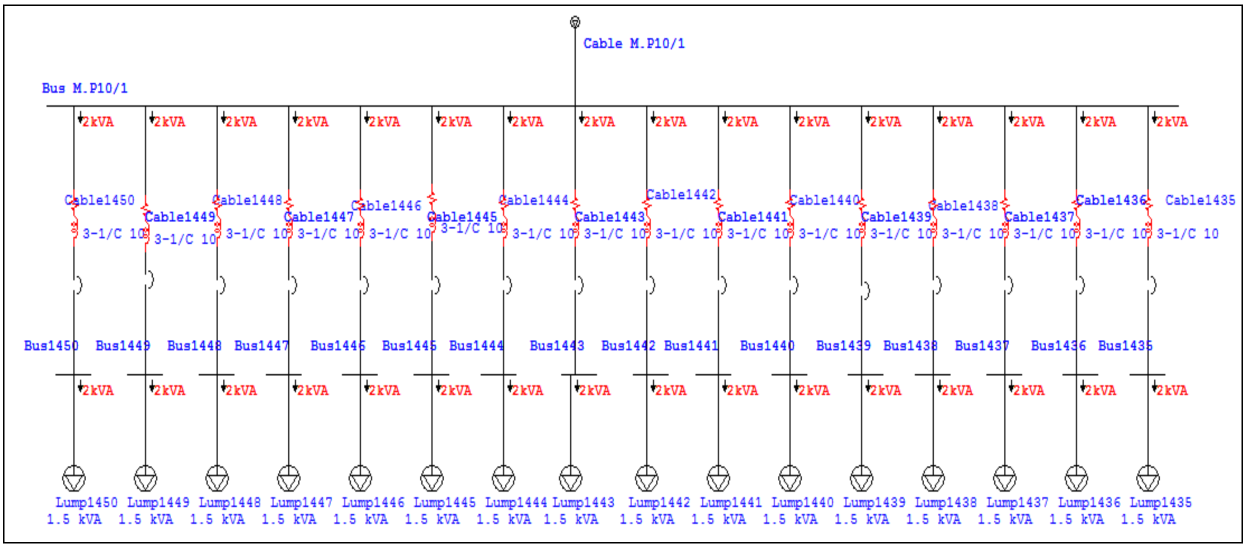

Cable M.P9/3
Bus M.P9/3
2kVA
Cable1405 Cable1404 Cable1403 Cable1402 Cable1401 Cable1400 Cable1399 Cable1398 Cable1397 Cable1396 Cable1395
3-1/C 10
Bus1405 Bus1404 Bus1403 Bus1402 Bus1401 Bus1400 Bus1399 Bus1398 Bus1397 Bus1396 Bus1395
Lump1405 Lump1404 Lump1403 Lump1402 Lump1401 Lump1400 Lump1399 Lump1398 Lump1397 Lump1396 Lump1395
1.5 kVA

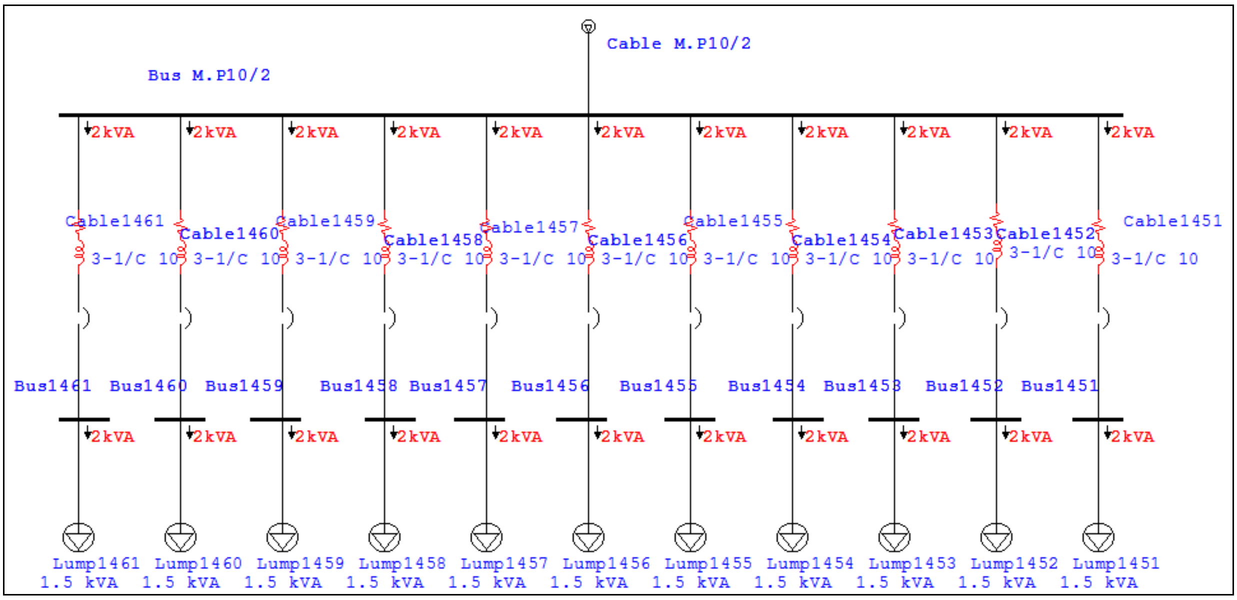

Cable M.P9/4
Bus M.P9/4
2kVA
Cable1416 Cable1415 Cable1414 Cable1413 Cable1412 Cable1411 Cable1410 Cable1409 Cable1408 Cable1407 Cable1406
3-1/C 10
Bus1416 Bus1415 Bus1414 Bus1413 Bus1412 Bus1411 Bus1410 Bus1409 Bus1408 Bus1407 Bus1406
Lump1416 Lump1415 Lump1414 Lump1413 Lump1412 Lump1411 Lump1410 Lump1409 Lump1408 Lump1407 Lump1406
1.5 kVA

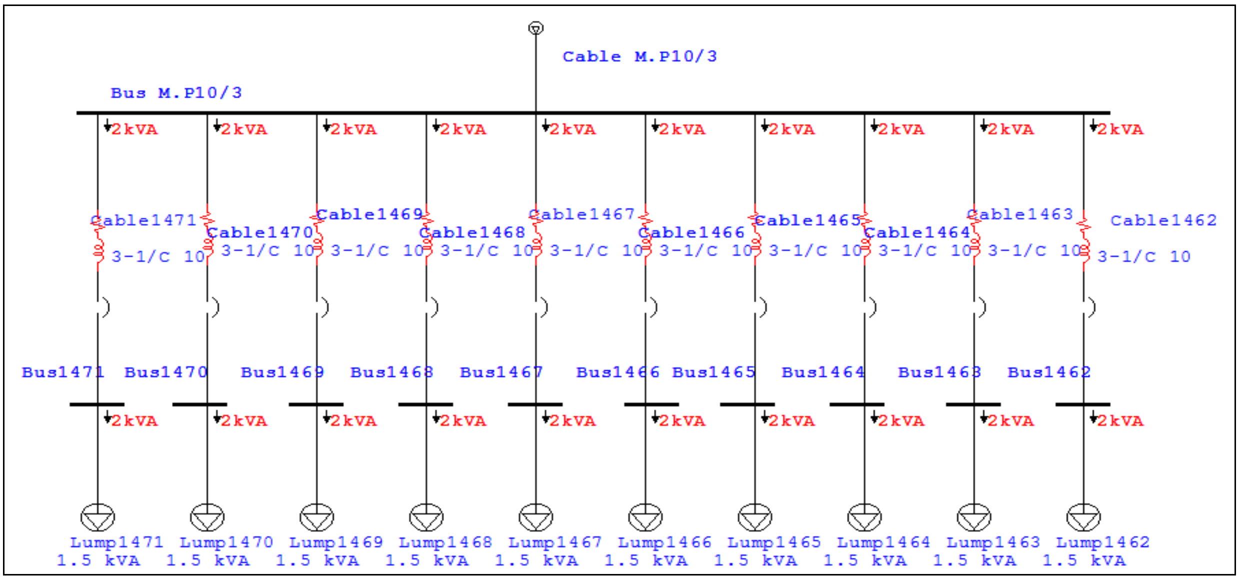


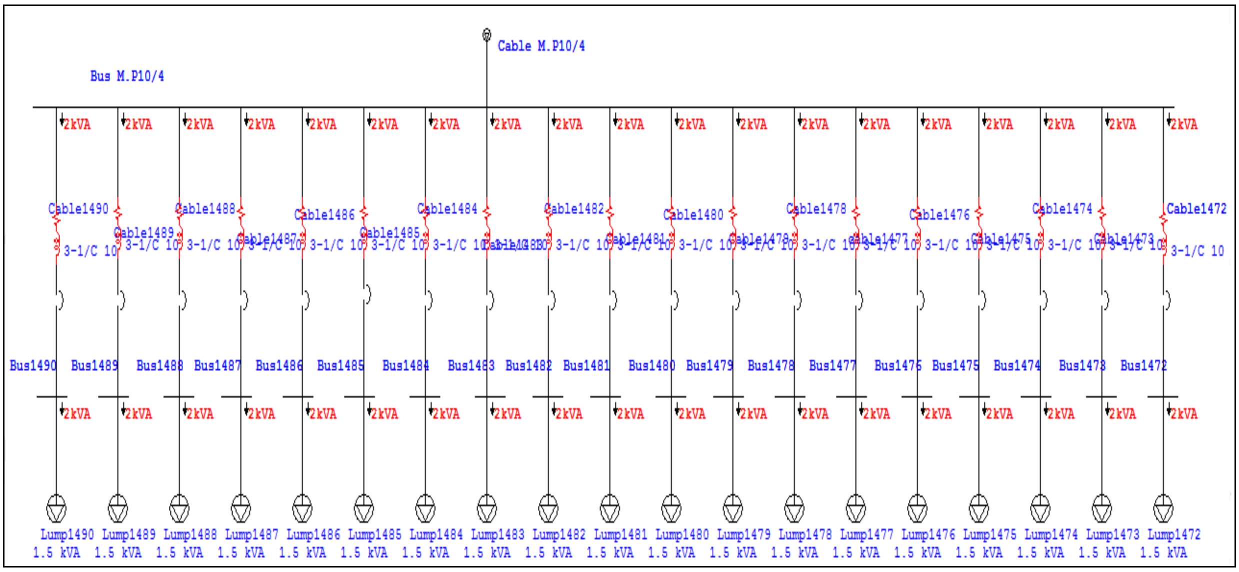
APPENDIX H

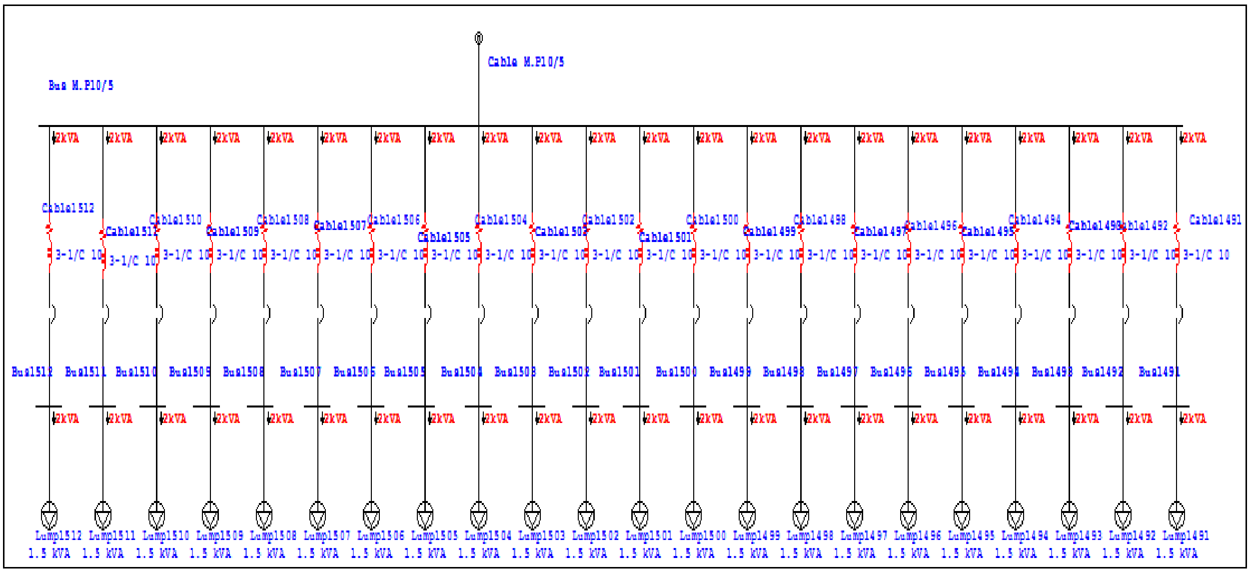
H.1 Branches M.P10/1, M.P10/2, M.P10/3, M.P10/4, and M.P10/5 from Branch S.D.B10 in Transform T8



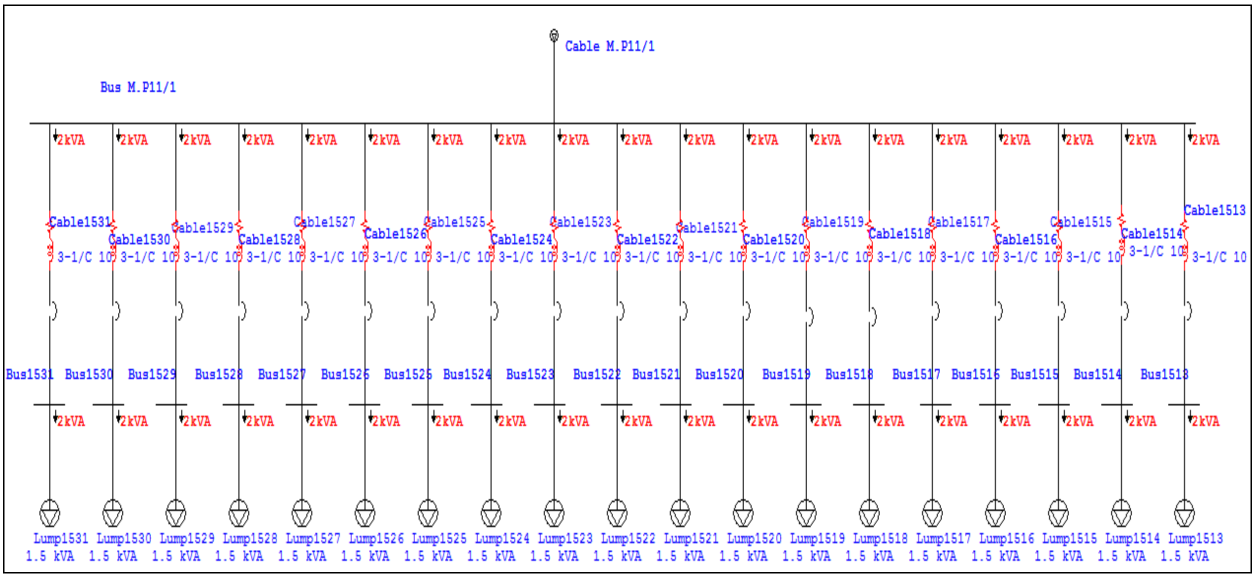

Cable M.P10/2
Bus M.P10/2
2kVA
Cable1461 Cable1460 Cable1459 Cable1458 Cable1457 Cable1456 Cable1455 Cable1454 Cable1453 Cable1452 Cable1451
3-1/C 10
Bus1461 Bus1460 Bus1459 Bus1458 Bus1457 Bus1456 Bus1455 Bus1454 Bus1453 Bus1452 Bus1451
Lump1461 Lump1460 Lump1459 Lump1458 Lump1457 Lump1456 Lump1455 Lump1454 Lump1453 Lump1452 Lump1451
1.5 kVA

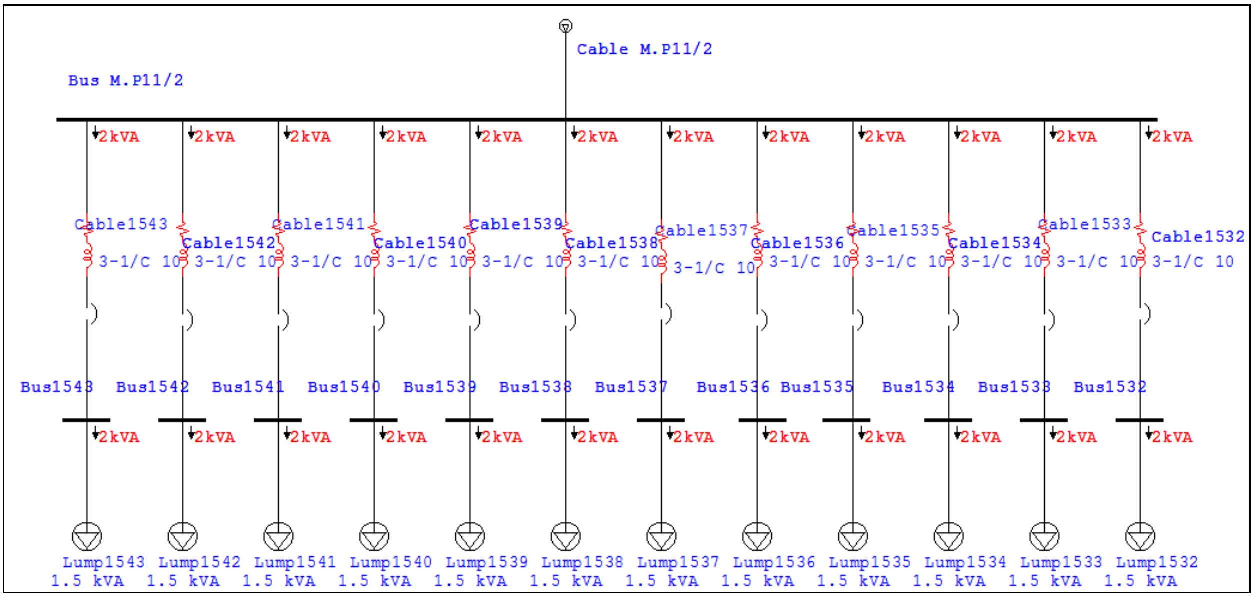

Cable M.P10/3
Bus M.P10/3
2kVA
Cable1471 Cable1470 Cable1469 Cable1468 Cable1467 Cable1466 Cable1465 Cable1464 Cable1463 Cable1462
3-1/C 10
Bus1471 Bus1470 Bus1469 Bus1468 Bus1467 Bus1466 Bus1465 Bus1464 Bus1463 Bus1462
Lump1471 Lump1470 Lump1469 Lump1468 Lump1467 Lump1466 Lump1465 Lump1464 Lump1463 Lump1462
1.5 kVA

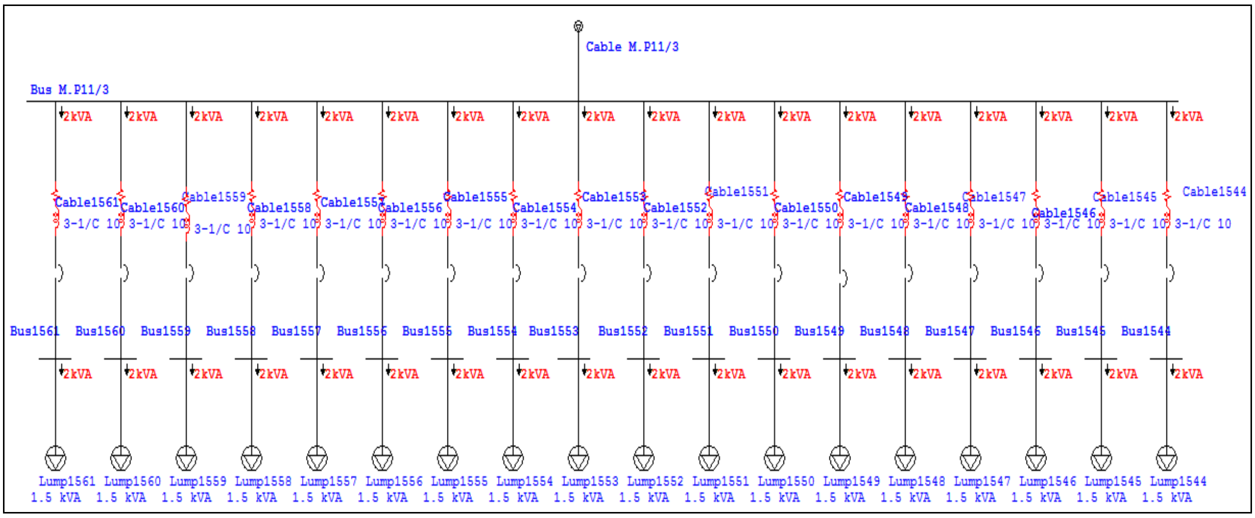

Cable M.P10/4
Bus M.P10/4
2kVA
Cable1490 Cable1488 Cable1486 Cable1484 Cable1482 Cable1480 Cable1478 Cable1476 Cable1474 Cable1472
3-1/C 10
Bus1490 Bus1489 Bus1488 Bus1487 Bus1486 Bus1485 Bus1484 Bus1483 Bus1482 Bus1481 Bus1480 Bus1479 Bus1478 Bus1477 Bus1476 Bus1475 Bus1474 Bus1473 Bus1472
Lump1490 Lump1489 Lump1488 Lump1487 Lump1486 Lump1485 Lump1484 Lump1483 Lump1482 Lump1481 Lump1480 Lump1479 Lump1478 Lump1477 Lump1476 Lump1475 Lump1474 Lump1473 Lump1472
1.5 kVA

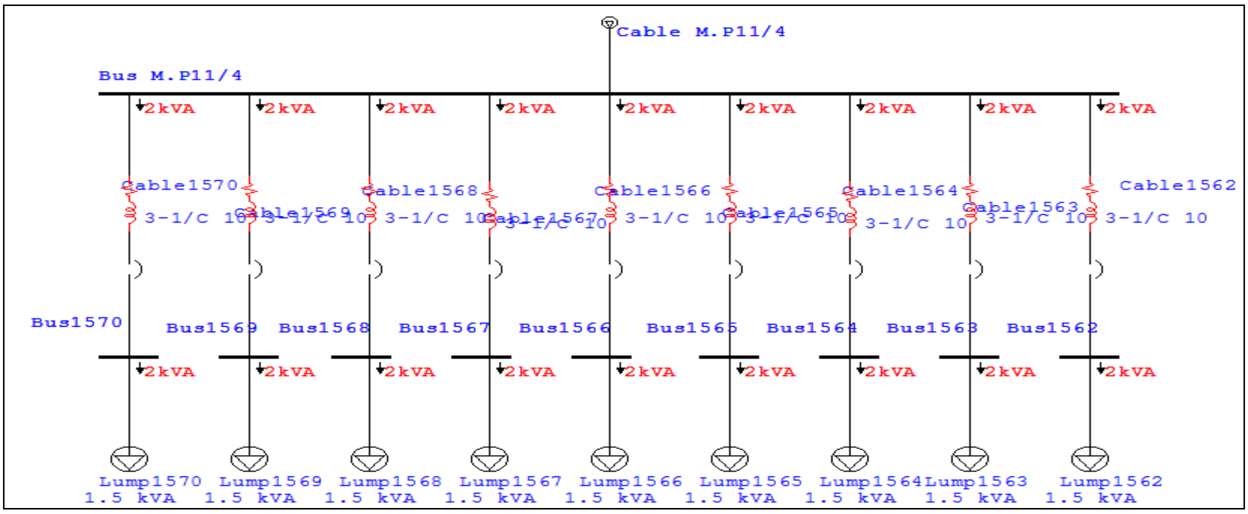


H.2 Branches M.P11/1, M.P11/2, M.P11/3, and M.P11/4 from Branch S.D.B11 in Transform T8

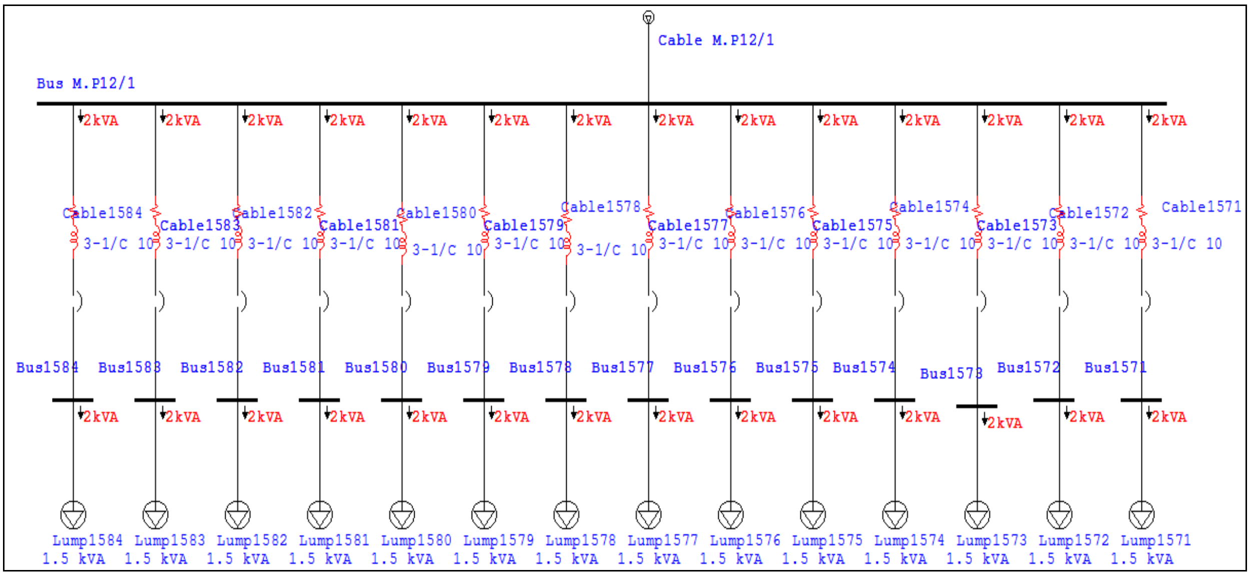


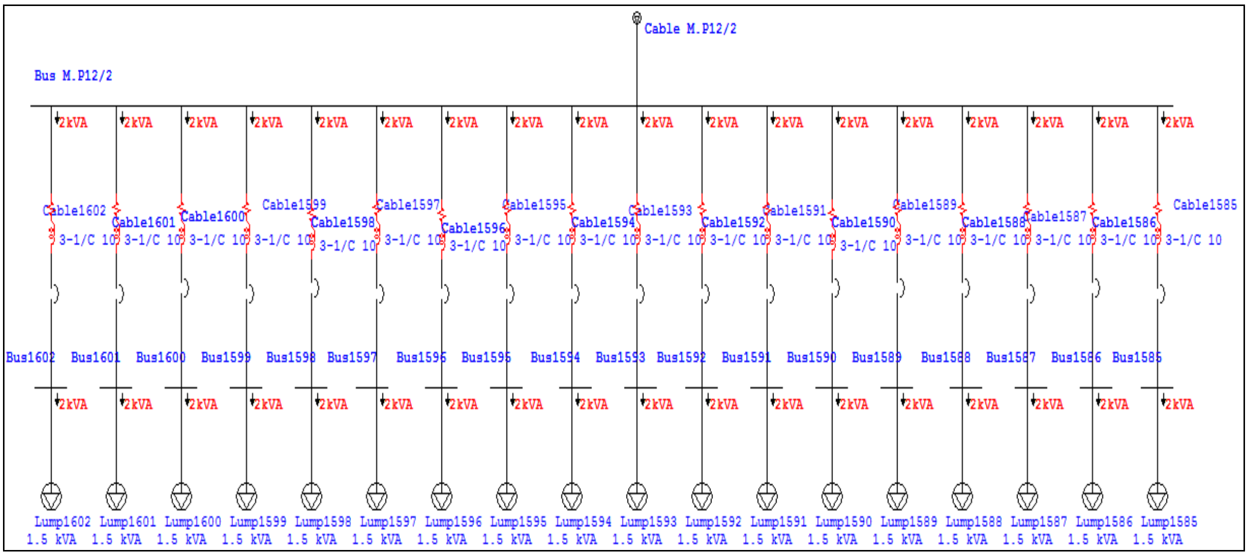


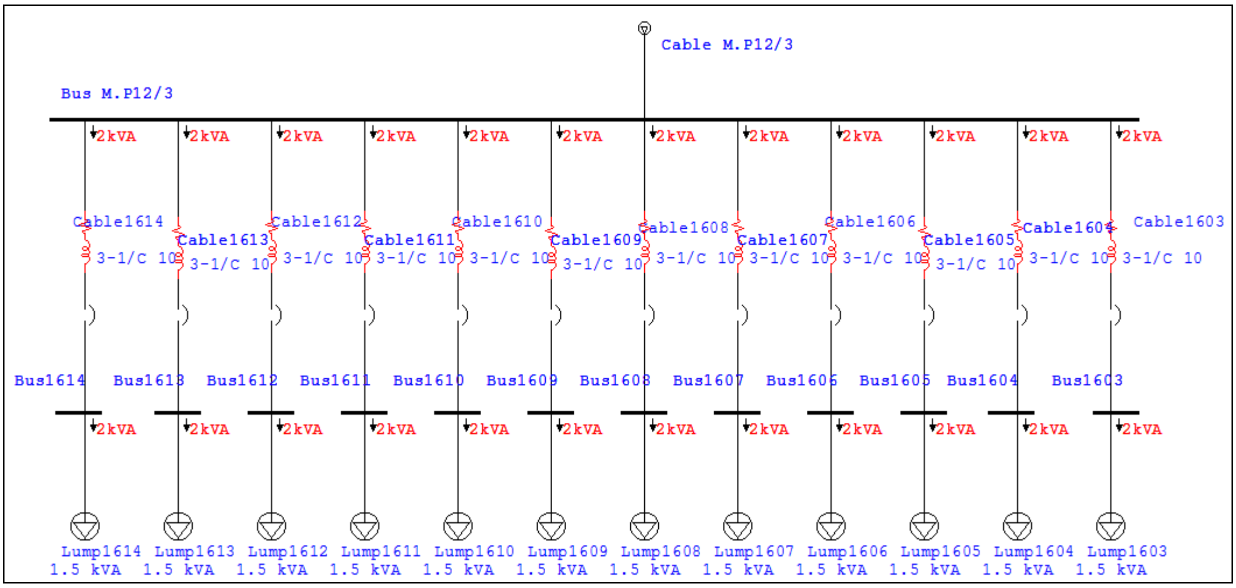


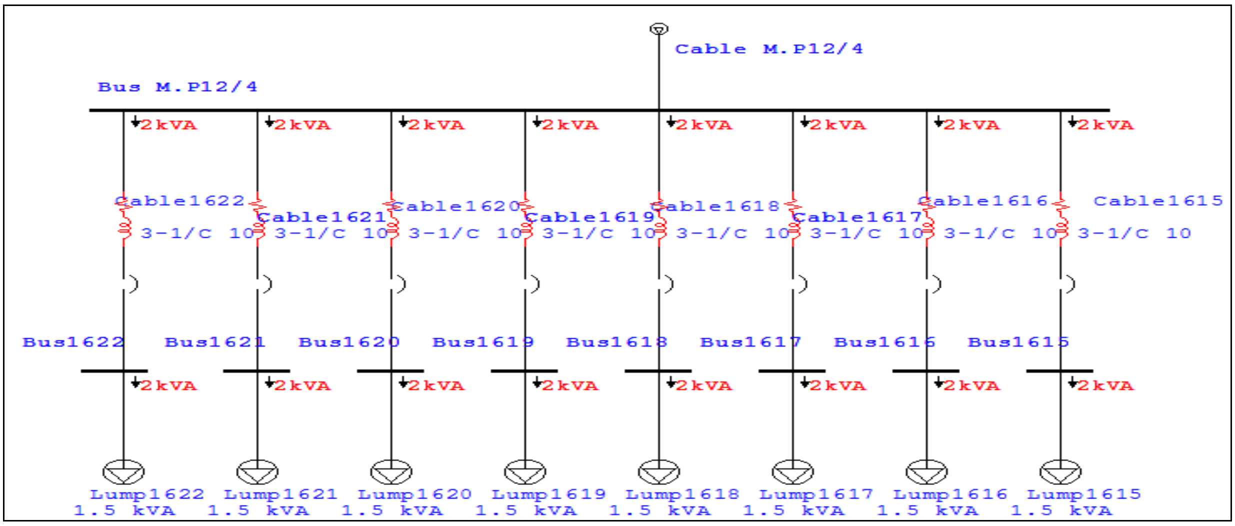


H.3 Branches M.P12/1, M.P12/2, M.P12/3, and M.P12/4 from Branch S.D.B12 in Transform T8

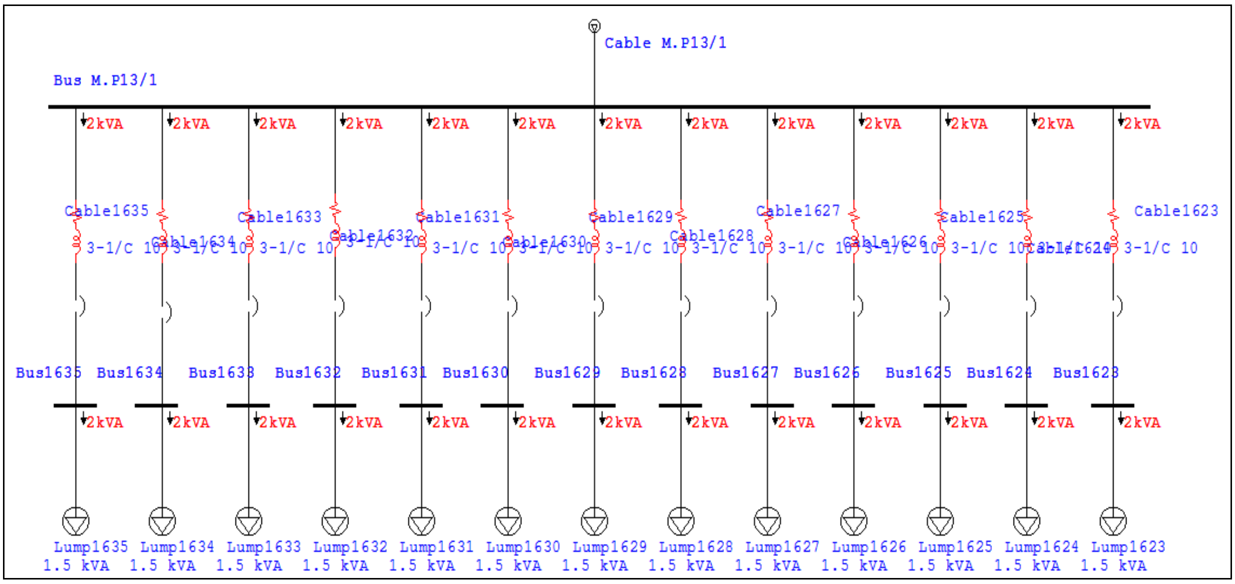

Cable M.P12/1
Bus M.P12/1
2kVA
Cable1584 Cable1583 Cable1582 Cable1581 Cable1580 Cable1579 Cable1578 Cable1577 Cable1576 Cable1575 Cable1574 Cable1573 Cable1572 Cable1571
3-1/C 10
Bus1584 Bus1583 Bus1582 Bus1581 Bus1580 Bus1579 Bus1578 Bus1577 Bus1576 Bus1575 Bus1574 Bus1573 Bus1572 Bus1571
Lump1584 Lump1583 Lump1582 Lump1581 Lump1580 Lump1579 Lump1578 Lump1577 Lump1576 Lump1575 Lump1574 Lump1573 Lump1572 Lump1571
1.5 kVA

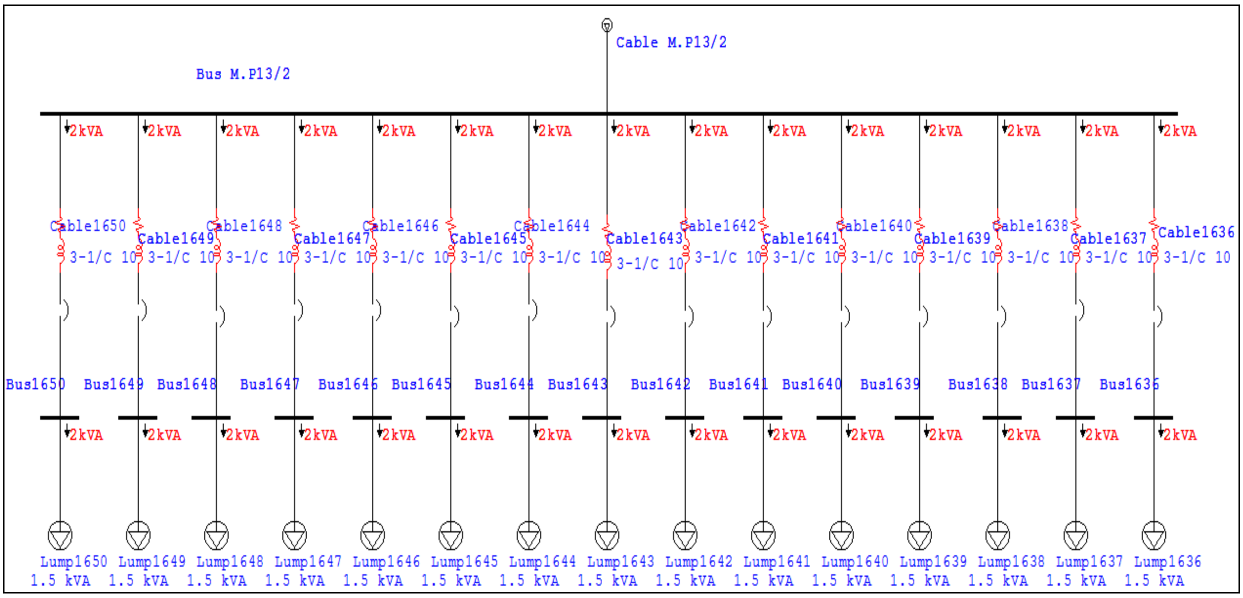

Cable M.P12/2
Bus M.P12/2
2kVA
Cable1602 Cable1601 Cable1600 Cable1599 Cable1598 Cable1597 Cable1596 Cable1595 Cable1594 Cable1593 Cable1592 Cable1591 Cable1590 Cable1589 Cable1588 Cable1587 Cable1586 Cable1585
3-1/C 10
Bus1602 Bus1601 Bus1600 Bus1599 Bus1598 Bus1597 Bus1596 Bus1595 Bus1594 Bus1593 Bus1592 Bus1591 Bus1590 Bus1589 Bus1588 Bus1587 Bus1586 Bus1585
Lump1602 Lump1601 Lump1600 Lump1599 Lump1598 Lump1597 Lump1596 Lump1595 Lump1594 Lump1593 Lump1592 Lump1591 Lump1590 Lump1589 Lump1588 Lump1587 Lump1586 Lump1585
1.5 kVA

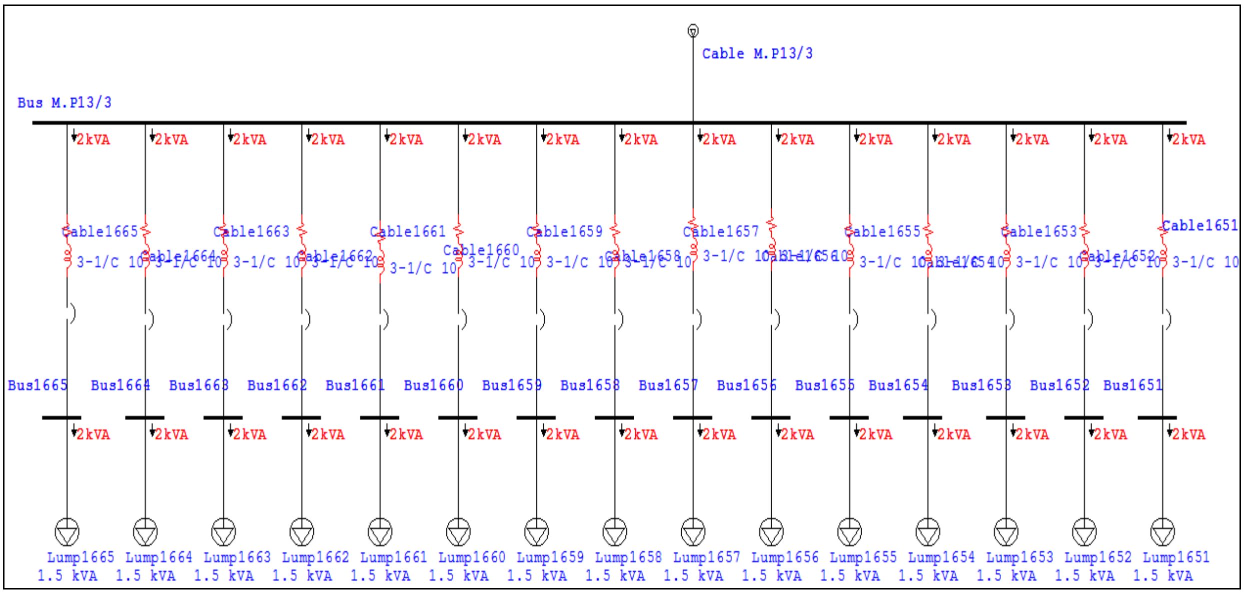

Cable M.P12/3
Bus M.P12/3
2kVA
Cable1614 Cable1613 Cable1612 Cable1611 Cable1610 Cable1609 Cable1608 Cable1607 Cable1606 Cable1605 Cable1604 Cable1603
3-1/C 10
Bus1614 Bus1613 Bus1612 Bus1611 Bus1610 Bus1609 Bus1608 Bus1607 Bus1606 Bus1605 Bus1604 Bus1603
Lump1614 Lump1613 Lump1612 Lump1611 Lump1610 Lump1609 Lump1608 Lump1607 Lump1606 Lump1605 Lump1604 Lump1603
1.5 kVA

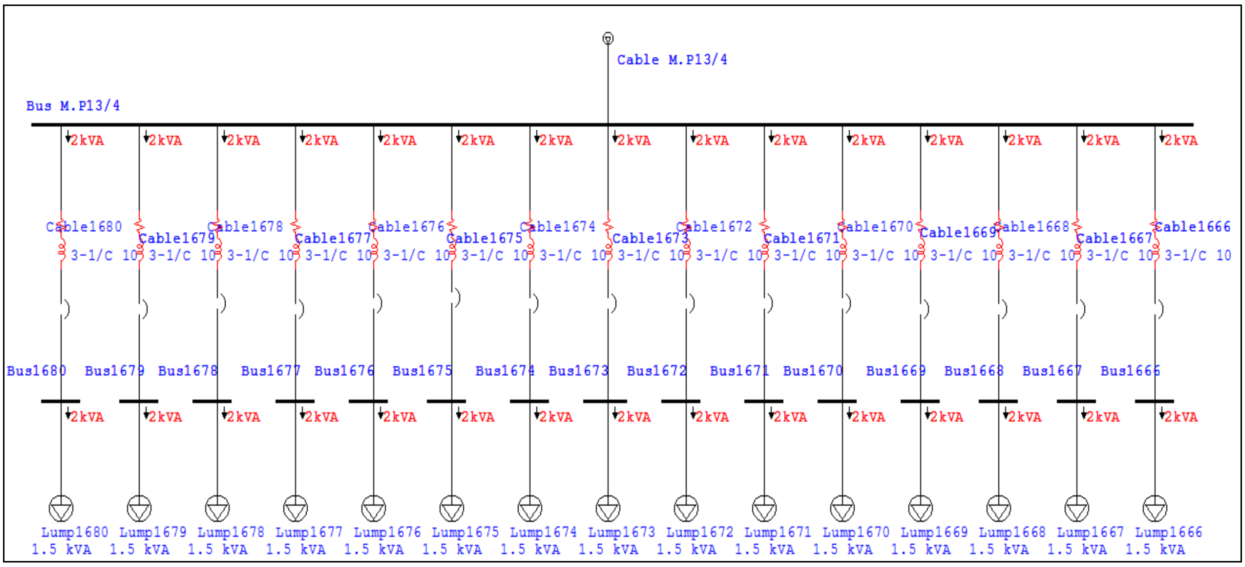


H.4 Branches M.P13/1, M.P13/2, M.P13/3, and M.P13/4 from Branch S.D.B13 in Transform T8

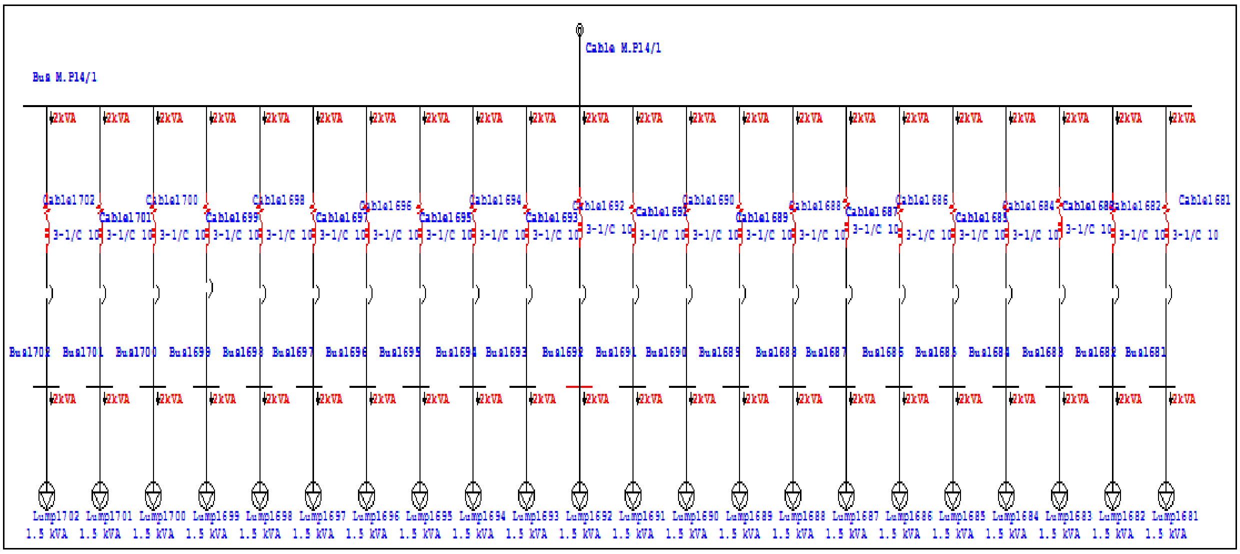


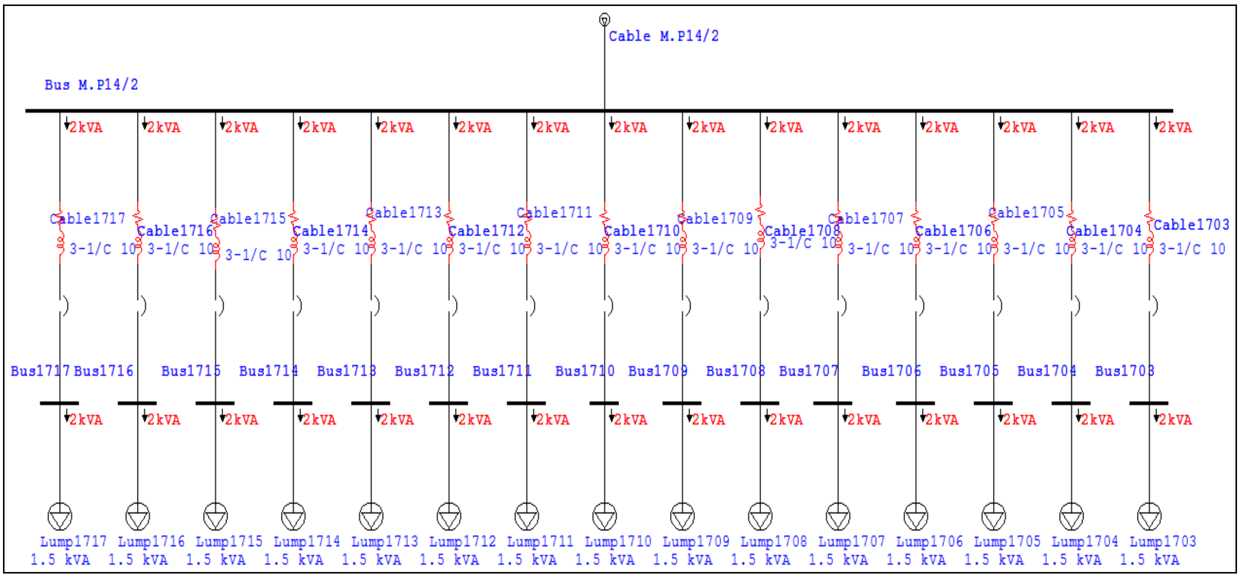

Cable M.P13/2
Bus M.P13/2
2kVA
Cable1650 Cable1649 Cable1648 Cable1647 Cable1646 Cable1645 Cable1644 Cable1643 Cable1642 Cable1641 Cable1640 Cable1639 Cable1638 Cable1637 Cable1636
3-1/C 10
Bus1650 Bus1649 Bus1648 Bus1647 Bus1646 Bus1645 Bus1644 Bus1643 Bus1642 Bus1641 Bus1640 Bus1639 Bus1638 Bus1637 Bus1636
Lump1650 Lump1649 Lump1648 Lump1647 Lump1646 Lump1645 Lump1644 Lump1643 Lump1642 Lump1641 Lump1640 Lump1639 Lump1638 Lump1637 Lump1636
1.5 kVA

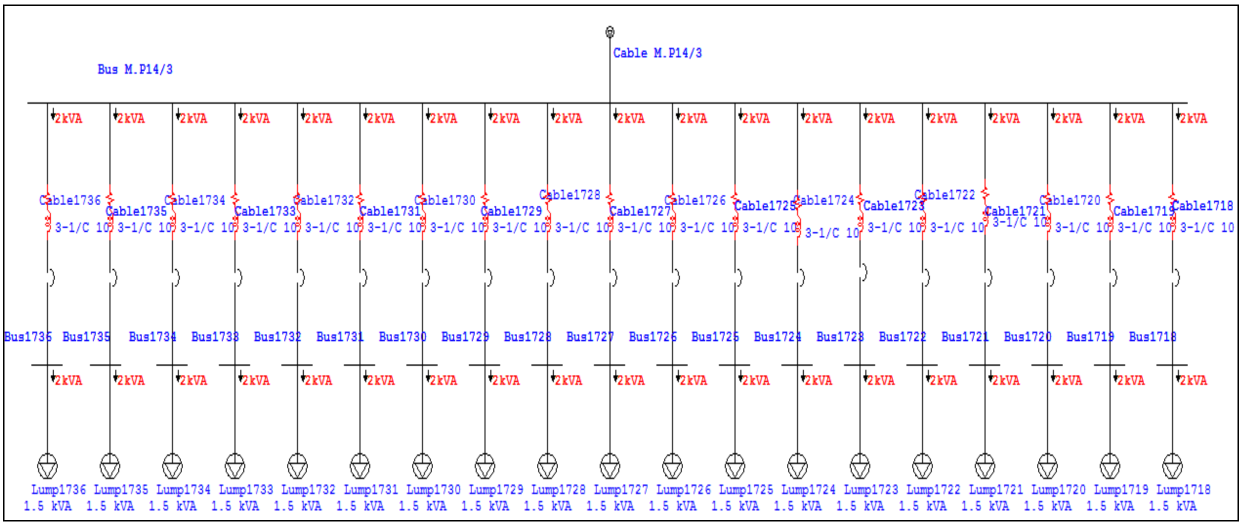

Cable M.P13/3
Bus M.P13/3
2kVA
Cable1665 Cable1664 Cable1663 Cable1662 Cable1661 Cable1660 Cable1659 Cable1658 Cable1657 Cable1656 Cable1655 Cable1654 Cable1653 Cable1652 Cable1651
3-1/C 10
Bus1665 Bus1664 Bus1663 Bus1662 Bus1661 Bus1660 Bus1659 Bus1658 Bus1657 Bus1656 Bus1655 Bus1654 Bus1653 Bus1652 Bus1651
Lump1665 Lump1664 Lump1663 Lump1662 Lump1661 Lump1660 Lump1659 Lump1658 Lump1657 Lump1656 Lump1655 Lump1654 Lump1653 Lump1652 Lump1651
1.5 kVA


Cable M.P13/4
Bus M.P13/4
2kVA
Cable1680 Cable1679 Cable1678 Cable1677 Cable1676 Cable1675 Cable1674 Cable1673 Cable1672 Cable1671 Cable1670 Cable1669 Cable1668 Cable1667 Cable1666
3-1/C 10
Bus1680 Bus1679 Bus1678 Bus1677 Bus1676 Bus1675 Bus1674 Bus1673 Bus1672 Bus1671 Bus1670 Bus1669 Bus1668 Bus1667 Bus1666
Lump1680 Lump1679 Lump1678 Lump1677 Lump1676 Lump1675 Lump1674 Lump1673 Lump1672 Lump1671 Lump1670 Lump1669 Lump1668 Lump1667 Lump1666
1.5 kVA

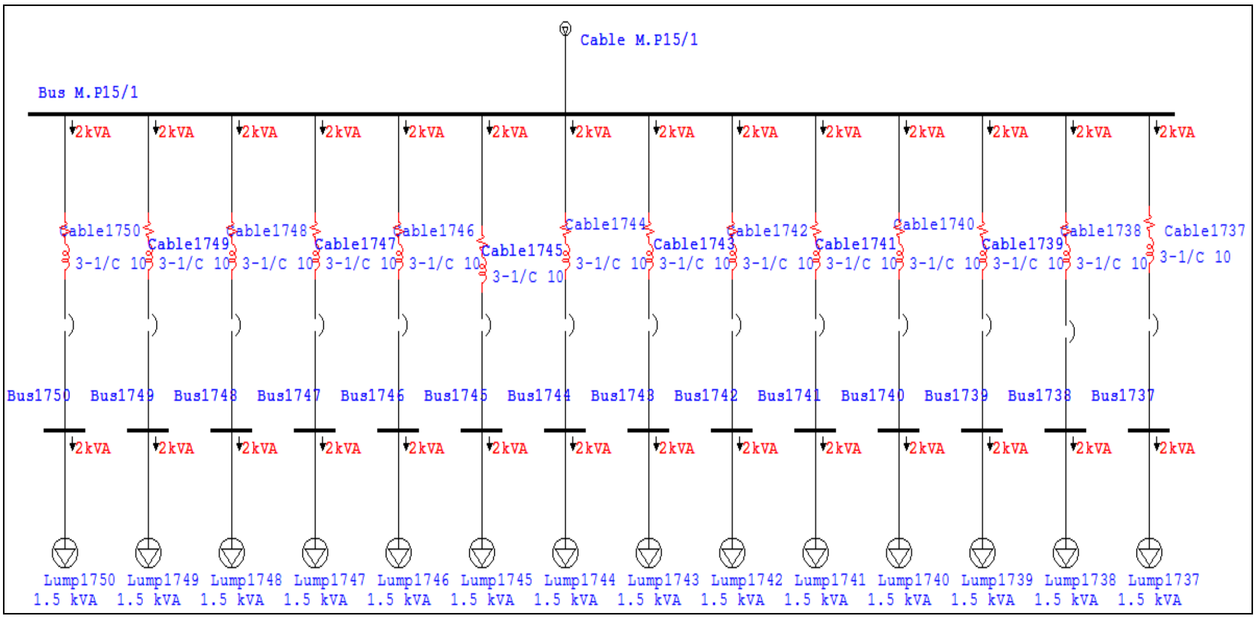
H.5 Branches M.P14/1, M.P14/2, and M.P14/3 from Branch S.D.B14 in Transform T8

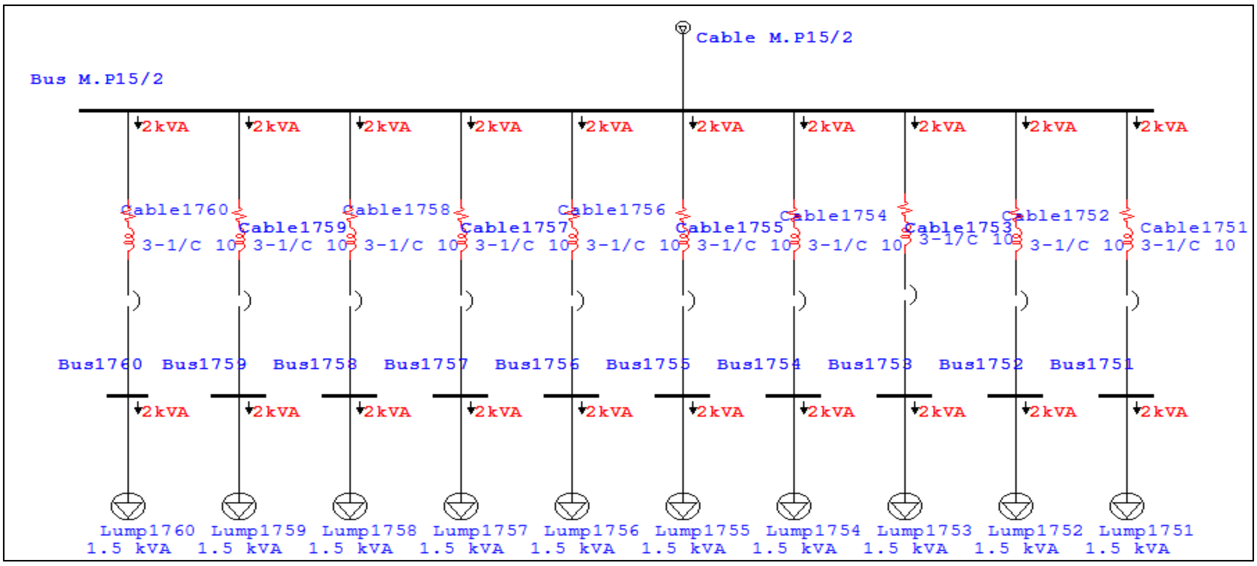


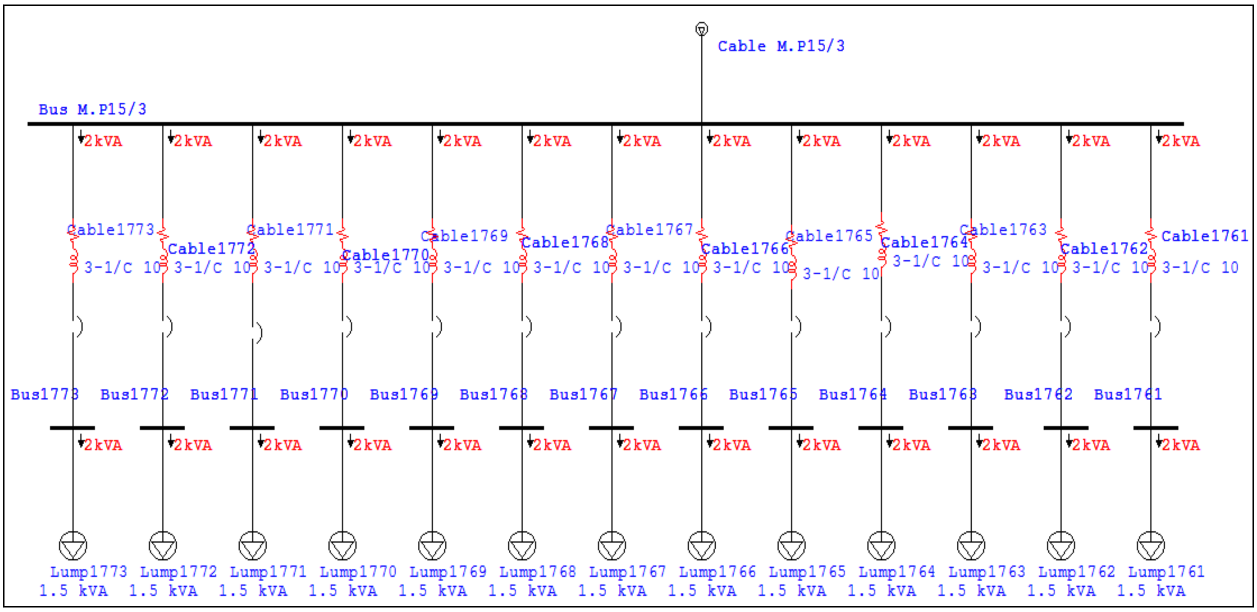


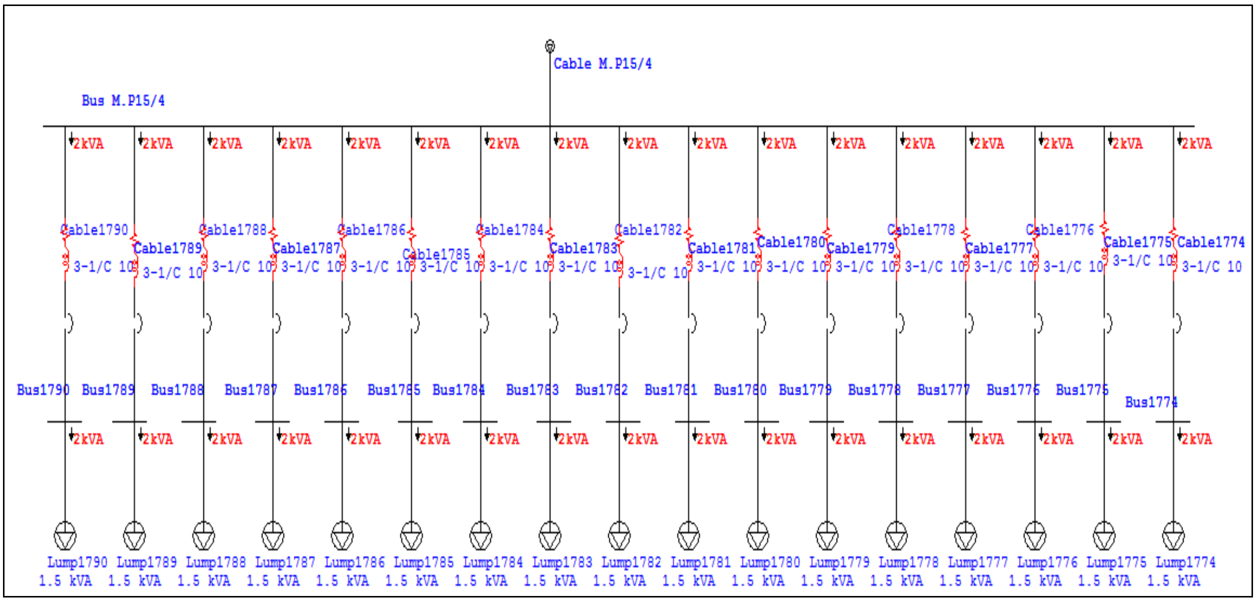


H.6 Branches M.P15/1, M.P15/2, M.P15/3, and M.P15/4 from Branch S.D.B15 in Transform T8






Cable M.P15/3
Bus M.P15/3
2kVA
Cable1773 Cable1772 Cable1771 Cable1770 Cable1769 Cable1768 Cable1767 Cable1766 Cable1765 Cable1764 Cable1763 Cable1762 Cable1761
3-1/C 10
Bus1773 Bus1772 Bus1771 Bus1770 Bus1769 Bus1768 Bus1767 Bus1766 Bus1765 Bus1764 Bus1763 Bus1762 Bus1761
Lump1773 Lump1772 Lump1771 Lump1770 Lump1769 Lump1768 Lump1767 Lump1766 Lump1765 Lump1764 Lump1763 Lump1762 Lump1761
1.5 kVA


Cable M.P15/4
Bus M.P15/4
2kVA
Cable1790 Cable1789 Cable1788 Cable1787 Cable1786 Cable1785 Cable1784 Cable1783 Cable1782 Cable1781 Cable1780 Cable1779 Cable1778 Cable1777 Cable1776 Cable1775 Cable1774
3-1/C 10
Bus1790 Bus1789 Bus1788 Bus1787 Bus1786 Bus1785 Bus1784 Bus1783 Bus1782 Bus1781 Bus1780 Bus1779 Bus1778 Bus1777 Bus1776 Bus1775 Bus1774
Lump1790 Lump1789 Lump1788 Lump1787 Lump1786 Lump1785 Lump1784 Lump1783 Lump1782 Lump1781 Lump1780 Lump1779 Lump1778 Lump1777 Lump1776 Lump1775 Lump1774
1.5 kVA