PN-ACE-300
100933

DEMAND SIDE MANAGEMENT

PROJECT

FEASIBILITY REPORT ON

UPGRADING OF AGRICULTURAL DISTRIBUTION NETWORK FOR PALRA FEEDER

FOR

HARYANA VIDYUT PRASARAN NIGAM LIMITED

BY

INTERNATIONAL RESOURCE GROUP
&
ENERGY ECONOMY & ENVIRONMENTAL CONSULTANTS

Sponsored by
United States Agency for International Development

October 1998

A

ACKNOWLEDGEMENT

We are profoundly thankful to the Management of Haryana Vidyut Prasaran Nigam (HVPN) for the support given in conducting a Demand Side Management study on the Electrical Distribution Network and the irrigation pump-sets in Haryana

In particular we extend our thanks to Mr Ranjit Issar, Mr P K Vohra, Mr P C Dewan, and Mr S K Ailawadhi

We are also thankful to the World Bank Staff, Mr Djamal Mostefai, Mr S Padmanabhan, Ms Bhavana Bhatia, Mr Mohinder Manrai, Mr Sunil Khosla and others for their valuable suggestions and comments

We like to place on record our thanks to the United States Agency for International Development for sponsoring this project

And in general, we thank all the members in the Headquarters, the Superintendent Engineers, Sub Divisional Officers and Junior Engineers in the respective sub-stations for the timely assistance and valuable information provided for the study

We are sincerely thankful to the field personnel of HVPN and the farmers for their kind co-operation with us during the conduct of this project

EXECUTIVE SUMMARY

Upgrading of Agricultural Distribution Network

INTRODUCTION

This report is a component of the Demand Side Management study taken up by International Resource Group and Energy Economy & Environmental Consultants under the aegis of the United States Agency for International Development (USAID) in Palra Feeder of Haryana Vidyut Prasaran Nigam Limited(HVPN)

BACKGROUND

HVPN supplies approximately ***13,000 million units*** of energy per annum[1] to its consumers in various sectors The agricultural sector consumes 47 % of the total energy supplied The revenue returns from this sector is 17 % of the total revenue obtained by the HVPN The ***subsidized rate*** offered by the HVPN to its agricultural consumers is the reason for the large energy consumption and its disproportionate contribution to revenue returns

THE PROBLEM

Irrigation pump-sets are the major end-users in the agricultural sector These pump-sets operate at an average efficiency of approximately ***29%*** The inefficiency of the pump-sets is a combination of ***irregular maintenance, low voltage supply*** and usage of ***non-standard pumps***

CAUSE IDENTIFICATION

The Low-Tension (LT) distribution constitutes a major portion of energy distribution network in the agricultural sector These LT lines carry large amount of load current and traverse long distances in tree configuration to cover the remotest agricultural areas The ***energy line losses*** occurring in these LT lines contribute towards the ***poor*** quality of the power supplied Therefore, it is imperative that the energy losses be ***minimized*** to increase the input voltage to the irrigation pump-sets

[1] **Data Source** HSEB Annual Accounts for 1995 - 1996

METHODOLOGY

The project has been undertaken for ***Palra Feeder*** located in the ***Sonepat Circle*** of the HVPN distribution network A combination of ***field and analytical studies*** was utilized to arrive at the solution The analysis includes determination of various distribution network losses and the voltage scenario

RECOMMENDED SOLUTION

LT Distribution Network

A solution of using ***LT less distribution system*** has been developed In the proposed distribution network, all the 415V lines are converted to 11 kV and will be extended near to the agricultural pump-sets Pole mounted maintenance free distribution transformers of 11 kV/415 V with a tap changer of 450 V, will be installed near to each energy efficient pump-set

This solution for upgrading the distribution network will improve the distribution voltage level from existing 415 V to 11 kV i e , improvement of approximately 25 times This inturn will reduce the current loading of line by 25 times and line loss (proportional to square of current) by 625 times

HT Distribution Network

In the HT Network, running a new line of 16 2 km starting from the sub-station end and in parallel with the existing line is recommended

ENERGY SAVINGS

As per the recommended **LT less option,** the energy savings to the HVPN will be **885 7 MW hr of per annum**

As per the **HT parallel line** recommendation, the energy savings to the HVPN will be **748 5 MW hr of per annum**

The savings to HVPN is as shown in the table below

System	Line Loss (kW)		Net Annual Energy Savings (MWhr)
	HT	LT	
Existing	785	444 75	Not Applicable
Recommended Solution	410 75	01 9	1634 2

INVESTMENT REQUIRED

The total investment required for **LT less distribution system** will be **Rs 12 83 million**

The total investment required in **HT parallel line** recommendation will be **Rs 2 43 million**

FINANCIAL INDICATORS

A detailed economic feasibility of the proposed system was performed The following table provides the ***financial indicators*** of the proposed system

Indicators	Investment (million rupees)	Savings (million rupees)	Payback Period (years)	NPV (million rupees)	IRR
HT + LT Distribution system	15 26	4 48	3 41	9 55	26 %

CONCLUSION

The proposed modifications to the Palra Feeder are **techno-economically feasible** The energy savings that are realised from this upgradation is **1634 2 MW hr** per annum for an investment of **Rs 15 26 million**

TABLE OF CONTENTS

List of Tables

List of Figures

CHAPTER 1

1. INTRODUCTION

Agriculture is the mainstay of the economy in the state of Haryana This sector not provides employment to the majority of the population, but is also the major revenue earner for the state The sector utilises over 47% of the electrical energy supplied by the Haryana Vidyut Prasaran Nigam Limited (HVPN erstwhile HSEB) However, it contributes approximately 17% of the total revenue generated by HVPN, as the energy is offered at subsidized rates by the utility to this sector

Major portion of the power supplied to the agriculture sector is utilised for the operation of pump-sets The pump-sets are used to irrigate cultivable areas Over 600,000 pump-sets utilising both diesel driven and electrical energy driven motors are located in Haryana The pump-sets operate at a very low efficiency

The possible reasons for the low efficiency of the pump-sets are as follows
- Installation of inefficient pump-sets
- Irregular and Inadequate pump maintenance
- Poor quality of Energy Supply

Demand Side Management (DSM) is one of the methods that can be used to reduce power consumption and improve the quality of power DSM as a concept is being attempted by power utilities of different Indian states such as Haryana, Gujarat, Orissa and Andhra Pradesh, all of which are developing DSM projects[1 2] This method is being considered by the state electricity boards due to reduced capital requirement and low gestation period The DSM solutions have the advantage of decreasing demand, increasing power quality and lowering of tariff In general, the returns in a DSM project are back-end loaded but in cases where the power is subsidized or free (For e g , agricultural pump-sets and line losses) the returns are immediate and attractive The DSM system uses a variety of approaches such as energy conservation, co-generation and energy management techniques for selectively altering the load curve

The current project investigates how to replace the existing inefficient agricultural pump-sets by energy efficient pump-sets In this case, one of the prerequisites is improved line voltage to operate the energy efficient pump-sets Therefore, the project has two components to be effective The first component is to improve the line voltage by reducing voltage drop and consequent line losses Subsequently, energy conservation in the pump-sets can be carried out The distribution modification in this case solves two problems, that of line losses and low voltages, simultaneously

[1] Strategic Approach for DSM in India, RCG/Hagler Baillay Consulting, Inc

[2] Planning for Demand Side Management in the Electricity Sector, Jyoti Parikh et al Tata McGraw-Hill Publishing Company Limited, New Delhi, 1994

Haryana Vidyut Prasaran Nigam Limited (HVPN) is the nodal power utility company in the state of Haryana HVPN is responsible for acceptance and implementation of the various DSM solutions proposed in the project The reform of the HVPN is taking place with the World Bank (WB) funding In principle, HVPN has agreed to fund the implementation of the selected DSM projects jointly with the WB The support for technical assistance for this project comes from the United States Agency for International Development (USAID) USAID has selected International Resource Group (IRG) as the prime consultant for carrying out this project

Energy Economy & Environmental Consultants (3EC) are the Indian counterparts selected and approved by USAID, IRG, WB and HVPN to provide technical services for the project

1 1 SCOPE OF WORK

The DSM Project will be taken up in two phases The first phase will consist of the following three modules

Module 1 Sector-wise Load Analysis
Module 2 Develop Reports for Implementation
Module 3 Training Component

The second phase consisting of two modules is taken up after approval and funding from USAID at a later stage The two modules are

Module 4 Demonstration Projects
Module 5 Monitoring and Evaluation

1 1 1 Sector wise load analysis

A sample load data will be collected to estimate the existing load and a load curve will be developed based on the estimate The data collected include, number of electric equipment in each household during various seasons, the number of hours of usage, pattern of usage etc , in both urban and rural areas in domestic sectors, number of pumps in agriculture sector and the connected load and maximum demand in industrial and commercial sector

1 1 2 Develop Reports for Implementation

The major areas identified for implementation are the following

- Revamping of Agriculture Distribution network
- Pump Replacement Studies
- Co-generation in Sugar or Some Other Industrial Units
- Energy Conservation Projects in Industry
- Energy Conservation Projects in Domestic and Commercial Sectors

1 2 UPGRADING OF AGRICULTURE DISTRIBUTION NETWORK

The disproportionate contribution of the agricultural sector in terms of revenue and energy consumption is largely responsible for the difficulties faced by the Board In view of the magnitude of the problem, the complexity involved and the limited time available, it was decided to concentrate on revamping the agricultural distribution network and come out with a comprehensive solution In view of this, the report actually discusses two issues, voltage improvement along with reduction of line losses and improvement in the efficiency of pump-sets

The scope of work is to prepare a short list of areas for study, out of several areas for detailed study For this, data on current, line diagram, pump details of the existing feeder need to be collected The technical and financial analysis of the field data is performed using appropriate methods Later, implementable options are compared with the existing data to arrive at the techno-economically feasible solution

CHAPTER 2

2. BACKGROUND INFORMATION

Haryana State located in northwestern India is spread over an area of 44,212 square kilometers The state came to existence after the re-organization of the erstwhile Punjab State in 1966 The population of the state is approximately 19 million, with a majority of the population living in rural areas

The farmers of these villages cultivate their lands by growing crops In a normal year, the farmers grow two crops (paddy and wheat) However, some of the farmers grow three crops wherein one is wheat, the second is fodder/vegetable and the third is paddy Paddy is grown in the rainy season in the months of July to October, Wheat is grown in the winter season form November to February and vegetables are grown in any season Irrigation in fields is carried out by farmers by drawing the water through the electrical driven motor pump-sets from the tube wells The power to these pump-sets are supplied by the HVPN through LT distribution lines The LT distribution lines are drawn from the transformers which are connected to the 11kV main and spur HT lines These main and spur lines draw power from the sub-station distribution feeder Paddy growing season is the peak season and the energy consumption is found to reach the peak point during this season

Haryana Vidyut Prasaran Nigam Limited (HVPN) is the nodal power utility company in the state HVPN is responsible for power generation, transmission and distribution and tariff fixing, among others As can be seen in the following graph[3], a gap exists between the average power availability and the maximum power demand The situation has remained unaltered in the last ten years

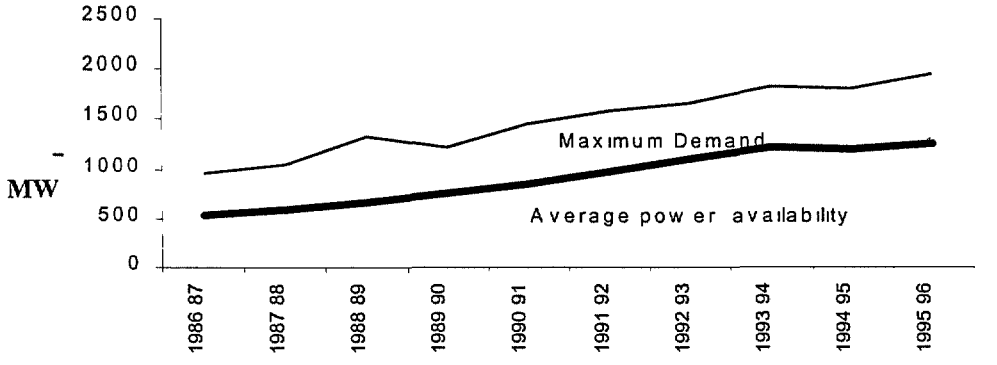


Figure 1 Graph showing average power availability and maximum power demand in Haryana over a ten year period

[3] Haryana Vidyut Prasaran Nigam - Administrative report of 1995 - 96

HVPN supplies the generated power to various sectors, through distribution lines The following pie chart[4] will give the percentage consumption in various sectors of the state economy

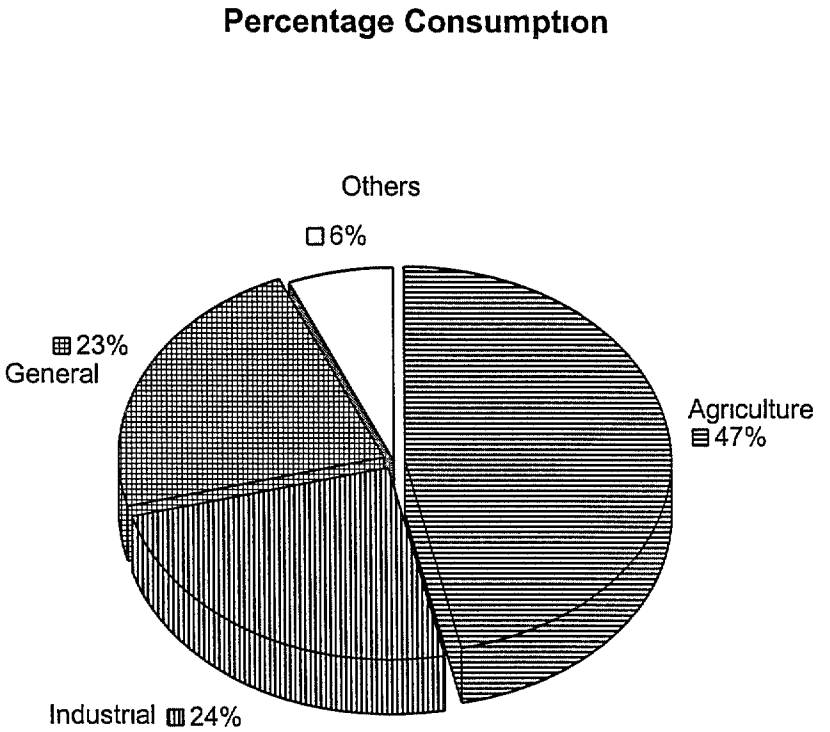


Figure 2 Chart showing sectoral energy consumption in Haryana

As can be seen in the pie chart, agriculture sector is the major energy consumer in the state It consumes upto 47% of the generated energy

2 1 TRANSMISSION AND DISTRIBUTION (T&D) NETWORK

The energy supply to the various sectors is performed using a wide transmission and distribution (T&D) network The T&D network in Haryana consist of 2,200 numbers of 11 kV feeders The power is transmitted through a main High Tension (HT) line with branching Low-Tension (LT) distribution lines It should be noted that the LT distribution lines are drawn over long distances to cover the remote corners of the

[4] Source Haryana Vidyut Prasaran Nigam

electrical distribution network The line, from the transformer point to the first demand point (known as common load carrying segment) carries the total load current of all demand points Therefore, the losses occurring in these LT lines are large Due to these line losses, the voltage drop is high and the quality of power supplied to the end user is affected This has a negative effect on the efficiency of various machines which is dependent on the quality of power supply

2 2 ELECTRICITY USE IN AGRICULTURE SECTOR

Irrigation pump-sets constitute a major portion of electricity use in the agricultural sector In 1995 -1996, there were a total of approximately 600,000 pump-sets in Haryana The reported average rated capacity of the pump-sets is 7 5 HP

2 3 REVENUE RETURNS FOR HVPN

Electricity tariff of HVPN varies as per sector to which the energy is supplied The following table gives the average energy tariff of HVPN

Sl No	Sector	Average Rate in Paise/Unit
1	Domestic	238
2	Industrial	351
3	Agriculture	50
4	Lift Irrigation	181
5	Miscellaneous	320

Table 2 1Average energy tariff of HVPN for various sectors

The revenue returns for the HVPN through energy supply is as shown in the following pie chart

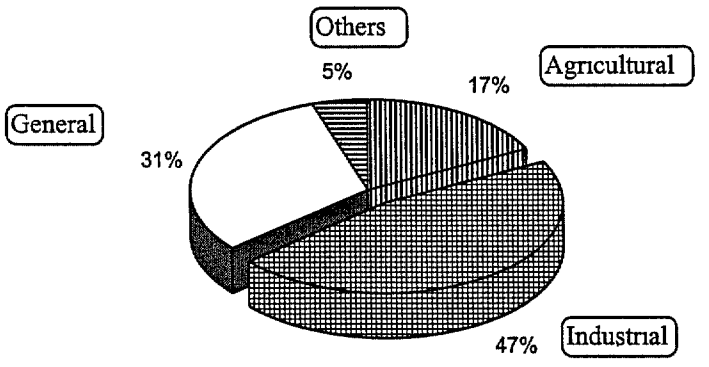


Figure 3 Chart showing revenue returns for HVPN from various sectors

It can be noted that though agricultural sector consumes 47% of the energy supplied, it generates revenue of 17% to the HVPN This is because of the highly subsidized rates provided to the agricultural consumers by the state government

2 4 POWER SUPPLY QUALITY IN THE AGRICULTURE SECTOR

Irrigation pump-sets account for a major portion of consumption of power in the agricultural sector The LT lines traverse long distances in tree-like configuration to reach the pump-sets The losses occurring in these lines are high and in the year 1995 - 1996, it was approximately 32% of the distributed power In addition, the average voltage available at the pump-sets terminal is approximately 70% of the rated voltage, i e , 290 V instead of 415 V Thus, the voltage drop of 30% the rated voltage affects the efficient working of the pump-sets

2 5 CONCEPTS

As noted in the previous sections, revenue earned by HVPN from the agricultural sector is disproportionate to the consumption pattern This revenue loss affects the performance of HVPN, including investments for adding power generation capacities Moreover, the energy losses occurring in the agricultural sector is huge due to the large inefficient network and inefficient pump-sets This energy loss prevents the effective utilization of generated energy in the revenue earning sectors Therefore, HVPN faces a dual problem for supplying energy to the agricultural sector One is of revenue generation and another the extent of energy losses

Increasing the efficiency of the pump-sets reduces the electricity demand in the agricultural sector Therefore, a comprehensive rectification scheme that upgrades the existing pumping system is imperative to have energy efficient pumping system Therefore, it is imperative that the line losses are minimized to ensure better revenues to the HVPN and better power quality to the end user

This report involves a detailed analysis of the Palra feeder and analysis of the pump-sets of the Sonepat circle in the HVPN distribution network This report investigates, interprets, analyses, proposes and recommends the solutions to be implemented The economic feasibility of the various options are also performed

CHAPTER 3

3. METHODOLOGY

The objective of the project is to revamp the agricultural power distribution network and inefficient pump-sets utilised in the agricultural sector The methods that were employed to arrive at a solution are discussed in the following sections

3 1 REPRESENTATIVE FEEDER SELECTION METHODOLOGY

The T&D network in Haryana consists of thirteen circles Four circles were selected for the study The four circles are, Kurukshetra, Jindh, Karnal and Sonepat Representative feeders were selected in these circles for the study

The selection of representative feeder was based on the following six parameters

- Average current demand in the feeder
- HT length
- LT length
- Number of Transformers
- Number of Pump-sets
- Agricultural load

The selection criteria was determined solely on the basis of the average values in the T&D network in the state for each of the parameter considered for selection based on the sample provided by HVPN All the representative feeders satisfied all or most of the parameters, at the time of selection
Table below provides the selection criteria

Sl No	Parameter	Selection Criteria
1	Average Current Demand in the Feeder	200 Amperes
2	HT Length	20 - 30 Kilometers
3	LT Length	40 - 50 Kilometers
4	Number of Transformers	65 - 70
5	Number of Pump-sets	200 - 300
6	Agricultural Load	Minimum 80%

Table 3 1 The parameter and the selection criteria

The representative feeders that were selected for the study are given in table below

Sl No	Circle Name	Sub-Station Name	Feeder Name
1	Kurukshetra	R E C Kurukshetra	Alampur
2	Jindh	Garhi	Rewar
3	Karnal	Gharaunda	Bastara
4	Sonepat	Fazilpur	Palra

Table 3 2 Representative feeders selected for study

3 2 METHODOLOGY FOR HT AND LT LINE LOSS STUDY

The HT line losses study was undertaken by tracing the HT line from the sub-station to the transformers The LT line losses were studied from the transformer tracing the LT line to the pump-sets The required parameters, voltage, current and power factor(selectively) were measured using energy meters Later, the input power taken by the motors was calculated using the following formula

$$P = \sqrt{3}VI \cos \phi$$

Where
P = Power in Watts
V = Voltage in Volts
I = Current in amperes
Cos ϕ = Power factor

In cases where the data was not available power factor is considered as 0 8

3 3 FORMULAE USED FOR CALCULATIONS

The line losses are calculated using,

$$P_L = 3I^2RL$$

where
P_L = Power loss in Watts
I = Current in the conductor in Amps
R = Line conductor resistance in Ohms/Km
L = Length of the conductor in km
3 = Constant for three-phase power

Voltage drop in the line is calculated using,

$$V_D = \sqrt{3}IRL$$

Where
V_D = Voltage drop in the conductors in Volts
I = Current in the conductors in Amps
R = Line conductor resistance in Ohms/Km
L = Length of the conductor in km

A typical model data sheet giving the details of the field data collected is attached as Annexure A

A typical calculation for existing LT network (Transformer # 60) for Palra feeder along with the calculations for proposed options are provided in Annexure C

CHAPTER 4

4. FIELD OBSERVATIONS AND PRACTICAL LIMITATIONS

3EC engineers conducted a field survey during the month of July 1998 A Model data sheet (Refer Anneure A) was designed by us to assist our field engineers in collecting the required information to conduct the above study The Electrical Data collected during the above study is given in Anneure B

Palra feeder is one of the 11kV feeders fed by the Fazilpur sub-station, Sonepat operating circle of HVPN The feeder covers 10 villages Baraulı, Palra, Jagal, Basodı, Makimpur, Deepalpur, Khunera, Khewra, Shamabad, Raipur All the villages are located on the eastern part of the sub-station

The average capacity of the feeder is 4000 kW The 11 kV HT main and spur line length is 70 51 kilometers Total LT line length is 90 kilometers Weasel and Rabbit conductors are used as HT line conductors Squirrel conductors are used as LT conductors The distance covered by each transformer is approximately one kilometer

The feeder contains 92 transformers with ratings of 25, 40, 63 and 100 kVA 471 pump-sets are connected to these transformers Out of these 92 transformers 8 transformers had single pump-set connected to them, 77 transformers had 2-13 pump-sets connected to them, 6 transformers catered load to lighting purpose and one transformer catered to water supply for domestic purpose However, out of these 92 transformers 2 transformers catered to both agricultural and domestic load

The field study shows that the 11 kV Palra feeder capacity is around 360 Amperes The sub-station voltage varies in the range of 9-10 5 kV The average demand is 260 Amperes and is fed for 7 hours Further two phase is provided to the feeder in the night time to cater to domestic demands in the villages

4 1 LINE AND FEEDER OBSERVATIONS

- Voltage available at the pump-sets are normally between 200 - 350 V with lower values for the farthest pump-set on the transformer, located towards the tail end of LT lines
- The lowest and highest values observed are 138 V and 400 V, respectively
- Single Phase supply is converted into 3 phase by connecting the energised phase (having higher voltage) via capacitor to the phase having no power supply, by some farmers, and then the 3 phase tube well pumps are run by these farmers
- There are no panel boards and the wiring is improper and flouting the safety norms of HVPN
- In most places, LT lines were sagging

4 2 PRACTICAL LIMITATIONS AFFECTING THE DATA COLLECTION

- Shortage of power, due to which field works were limited, in some places
- At some places transformer terminals were at very high position
- Weather pattern changes disturbed the study, especially, during rains no agricultural load was supplied in the feeders
- High temperature and humidity affected the Instruments
- Some of the farmers opposed to the checking of their pump-sets
- In some places the farmers had locked the pump-houses This resulted in problems in getting the readings
- In submersible pumps, accurate head measurement was not possible
- Obstructions were placed in the mouth piece in some places, limiting in the measurement of head
- Standard accessories for pump-sets were not used
- Pipe size and pipe materials differed, making friction loss calculations difficult
- In some situations, the farmers operated the pumps temporarily for our reading purpose and later switched off the pumps, therefore variation in the collected data was noticed in accessing the reading of other pumps

CHAPTER 5

5. TECHNICAL ANALYSIS

The technical analysis for the existing distribution network was performed as per the procedure described in the methodology It should be noted that the following assumptions were made for the analysis

1 The load demand is dynamic i e, the loading of pump-sets are changing according to the demand criteria
2 All the pump-sets are in operation
3 The period of energisation of distribution network is taken as 2000 hours per annum

5 1 ANALYSIS OF THE FEEDER

The Palra feeder is one of the 11 kV feeders fed by Fazilpur 132/11 kV sub-station From the field study, it is noted that the average current demand of this feeder is 260 Amperes The average voltage varies in the range of 9 0 - 10 5 kV but at times during the peak demand, the voltage reaches to a lower limit of 8 5 kV The average load demand of Palra feeder recorded is 3 8 MW

The Palra feeder contains ninety two numbers (92) 11kV/415V distribution transformers of different ratings of 25, 40, 63 and 100 kVA The table below gives the details of the transformers

Transformers connected to 2and more pump sets	Transformers connected to one pump-set	Transformers connected to lightning purpose	Transformers connected to water supply	Total number of transformers
77	8	6	1	92

Table 5 1 Detail of transformers connection in Palra feeder

Transformers that are not considered for Study

One transformer # 11, that caters load to domestic water supply and 6 transformers # 13, 44, 59, 68, 74 and 86 cater load to purely domestic purposes These 7 transformers are not considered for study

The 8 transformers that are feeding to single pump-sets were not considered for study as the total loss occurring in these transformer feeders is 1 50 kW This amounts to 0 04% of total power supplied by the sub-station The voltage drop occurring in these feeders is around 10 Volts

The table below gives the number of transformers and the number of pump-sets connected to them

Sl No	No of Pump-sets Connected	No of Transformers Feeding
1	1	8
2	2-5	31
3	6-8	31
4	> 8	15

Table 5 2 The number of Transformers and number of pump-sets connected

The analysis is done for the selected 77 transformer feeders which are feeding to 2 and above pump-sets The analysis consists of determining the voltage profile and line loss in the LT system The electrical data and the required parameters for analysis are taken from the field study (Refer Annexure B) LT network sketches are produced from the field data (Refer Annexure F)

5 2 ANALYSIS OF THE EXISTING SITUATION

The line losses and the voltage drop are occurring both in the LT(415V) and HT (11kV) lines The analysis is performed for both HT and LT distribution line losses and voltage profile considering all pump-sets are in operation

5 2 1 HT distribution network

From the field study, it is observed that the HT line configuration is like a tree structure The main 11 kV HT line is drawn out from the sub-station with a number of branching lines called spur lines(Refer to HT network drawing Annexure F) The distribution transformers of 11 kV/415 V are connected to these main and spur lines From the sub-station to the first load point, the HT line distance is about 1 8 km This line segment carries the total load current of all demand points, supplied by the sub-station and is termed as the common load carrying segment Hence, this segment contributes to the major portion of HT line loss The total loss in the HT line was found to be 785 kW i e , 20 66% of the total power supplied by the sub-station The line loss occurring in the common load carrying segment is 132 41 kW i e , 16 9 % of the total HT loss Some branches of HT network in the common load carrying segment also contribute a significant portion of HT line loss The loss in these common load carrying segment (16 2 kilometers length) is 748 52 kW i e , 95 % of total HT loss

Due to the tree configuration of the HT line, about 2 9 kV voltage drop is found in the line upto the farthest load point It was found that the voltage at the sub-station is in the range of 9 0 - 10 5 kV Therefore, due to HT line drop, available voltage at the farthest load point is 6 1 - 7 6 kV But, in the peak demand condition, the sub-station voltage drops to 8 5 kV, which in return affects the input voltage at the load points

5 2 2 LT Distribution Network

The 11 kV HT main and spur lines contain 11 kV/415 V distribution transformers of 25, 40, 63 and 100 kVA These transformers are feeding to number of pump-sets of 5, 7 5, 10, 12 5 and 15 HP ratings by 415 V LT distribution lines The average LT length from the transformer to the pump-sets is about 1 kilometer The analysis was done for 77 transformer feeders that are feeding to two and above pump-sets The LT line had both tree and radial configuration forms

From the parameters like voltage, current and powerfactor of pump-sets obtained from the field survey, the LT line loss and voltage profile of the existing LT distribution network is calculated (Refer Annexur D, Table 1)

Existing LT line loss and Voltage scenario

The average LT loss occurring in the 77 transformer feeders under study is 444 75 kW This amounts to 11 7 % of total power supplied from the sub-station The distribution transformers also contribute a significant portion of loss, thereby increasing the LT distribution losses The overall LT distribution network loss(including distribution transformer loss) was found to be 532 25 kW ie , 14 % of total power supplied from the sub-station The average voltage drop in LT distribution network is in the range of 50-100V

In cases where the transformer feeders have tree configuration with long line lengths, the line losses are in the range of 25-40% of the power supplied by the distribution transformer These feeders are feeding to five or more pump-sets of 10 HP - 15 HP rating In these cases, maximum line loss as well as voltage drop are occurring in the common load carrying portion of the line

Configuration in the existing LT network

The existing LT network has two configurations The two configurations are

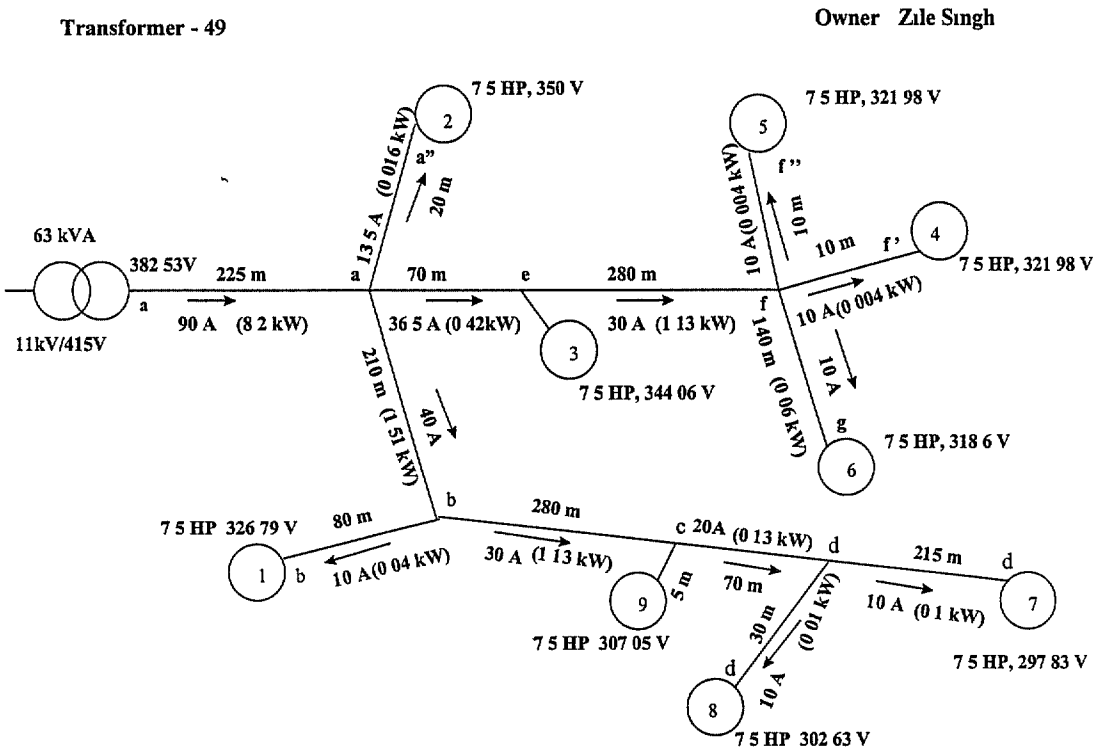
1 **Tree Configuration**
2 **Radial Configuration**

- **Tree Configuration**

One typical sketch for LT network is provided for reference The sketch has been drawn for Transformer # 49 The figure contains distance, current and line loss in each segment This network has a tree like configuration where the common load carrying segment is a'-a The calculated values for current, voltage drop and line loss in this line segment is provided in the following table

Line Segment	Distance in mts	Current in amps	Voltage Drop in Volts	Line Loss in kW
a'-a	225	90	52 6	8 2

Table 5 3 Common load carrying segment details for transformer # 49



Note HP ratings of the pump sets are the ratings as declared by the farmers

Figure 4 Typical sketch of tree configuration

The total loss occurring in the network is 12 76 kW The maximum contribution is coming from this segment Also, the total voltage drop found in the network is 84 7V from the transformer LT side to the farthest load point The major contribution for the voltage drop is from this segment Hence, it can be inferred that in tree configuration, the maximum line loss and voltage drop occurs in the common load carrying segment that carries the maximum load current

- **Radial Configuration**

In radial configuration, the pump-sets are connected from the transformer in radial fashion The common current carrying segment of this type of circuit is less or none It can be inferred that the line loss and voltage drop occurring in the circuit is due to the current of the pump connected to the line segment Hence, in radial configuration line loss and voltage drop are found to be low or average

Findings of the Analysis

The analysis for voltage drop and line loss has been done for the selected 77 transformer feeders Based on the analysis the following categorisation is tabulated

Ratings	No of Transformers	Structural configuration	No of Pumps	Pump sets rating in HP	Line loss	Voltage Drop (Average)	Dist Of pumps (metres)
25 kVA 63 kVA 100 kVA	- 5 9	Tree	6-13	10-15	Very High >21%	Very High >26%	1640 - 2700
25 kVA 63 kVA 100 kVA	1 4 5	Tree	6-13	7 5-15	High 14 -21 %	High 16-26 %	900 -2100
25 kVA 40 kVA 63 KVA 100 kVA	3 1 16 14	Tree and Radial	4-11	5-15	Average 5 - 14 %	Average 9-18 %	800 -1800
25 kVA 40 kVA 63 kVA 100 kVA	13 1 4 1		2-6	5-10	Low < 5%	Low < 9 %	<1000

Table 5 4 Table indicating the categorisation of the 77 transformers under study

Note From the analysis,

- One case was found where, the LT length covered by the distribution transformer feeder is less than 900m and the number of pump-sets connected are 3 Here high loss occurs, due to its tree configuration and long common load carrying segment length (Transformer # 3)

Two exceptional cases were found in average loss category and are

- The LT length covered by the distribution transformer feeder is approximately 385 m and 1270 m and the number of pump-sets connected are 3 and 2 respectively Here, the average loss occurs, due to its tree configuration and long common load carrying segment length (Transformer # 23, 73)

5 3 DISTRIBUTION TRANSFORMER

Existing scenario of the transformers

From the field statistics, it is found that the rate of failure is approximately 38% per year However, the burnt out rate is 58% per year for the cannibalized transformers

Cannibalized transformers are burnt out transformers that are replaced by using old transformers materials

In the existing situation, the transformers are being used for several years From statistics, it is seen that the rate of failure is quite high It means that the existing transformers have been rewound atleast once already Therefore, the loading capacity of the transformers is reduced to a maximum of 64% of its rated capacity and also the transformer loss is high (Refer Annexure D, Table 1)

The following table gives the loading situation in some of the existing transformers

Cases	Transformer Number	Rated kVA Capacity	Loading of Transformer in kVA		Loading of Transformer w r t allowable limit
			Allowable	Existing	
over loaded	38	63	40 3	99 71	247 4%
	51	63	40 3	119 73	297%
	30	63	40 3	70 32	174 5%
under loaded	45	100	64	19 02	29 7%
	31	100	64	13 74	21 47%
	41	63	40 3	12 64	31 4%

Table 5 5 Loading situations in the existing transformers

As can be seen from the table, some of the existing transformers are over loaded Therefore, two equivalent capacity of transformers will be required to meet the load demand In addition, there are some transformers that are underloaded It can be inferred that there is unequal distribution of loading in the network This situation can be rectified by shifting some loads to the underloaded transformers

In the present scenario, the distribution transformers feeding to agricultural pump-sets are over loaded

Reasons for overloading

- Pump-sets draw more power than the ratings
- Length of the distribution lines is large
- Irregular maintenance of transformers
- Loading beyond permissible limits
- Low voltage available at the terminal point

Effects of Overloading

- The transformer core and the windings get heated up to exceed the temperature limits and causes hot spots

- Due to the hot spots, the windings get burnt frequently, reducing the life of the transformer
- HVPN allows the core loss to two to three times of the specified value under normal condition In a rewound transformer, when the overload occurs, core loss increases to exceed the allowable limits
- The copper loss occurring in the transformers is directly proportional to the square of current supplied by the transformer Hence, during overload condition the copper loss increases in terms of square of current, also affecting the cooling system
- Affects the LT side protections

5 3 1 Distribution Transformer Loss

The distribution transformer contributes to a significant portion of loss This loss includes both core and copper loss in the transformer The loss figure is generally in the range of 2-3% of power delivered by the transformer **For analysis purpose, the transformer loss is considered as 2%**

5 4 SUMMARIZATION OF POWER AVAILABILITY AND POWER USAGE IN EXISTING SYSTEM

1	Average current demand	260 Amps
2	Total power available from sub-station	3800 kW
3	Demand of agricultural pump-sets (considering all pumps working) (Refer annexure D, Table -2,3)	2406 kW
4	Total HT distribution line loss	785 kW
5	Total LT distribution line loss	456 25 kW
	a 77 feeders considered for study(≥ 2 pumps)	444 75 kW
	b 8 feeders not considered (1 pump)	1 5 kW
	c Domestic and LD feeders(7feeders)	10 kW
6	Distribution transformer loss	76 kW
7	Total overall distribution loss	532 25 kW
8	Domestic and LD load	76 75 kW

CHAPTER 6

6. PROPOSED OPTIONS

After the completion of the field survey the, options for bridging the gap between demand and availability were arrived for LT distribution network, HT distribution network and Pumping system

6 1 LT DISTRIBUTION NETWORK

Five options were proposed for upgrading the LT distribution network The five proposed options are the following

1 LT less system with single-phase 11 0/0 4 kV pole mounted transformer
2 LT less system with three-phase 11 0/3 3/0 4 kV pole mounted transformer
3 LT less system with three-phase 11 0/0 415 kV, 15/25/40 kVA pole mounted transformer
4 Centralized transformer as at present but with relocation and radial feeders
5 Connecting two or three pumps to a common 11 0/ 0 415 kV, 25 kVA pole mounted transformer

Options 1, 2 and 4 were considered and discussed with the HVPN and dropped But 3, and 5 options were analysed in detail

Each of the proposed options are described in the following sections

6 1 1 LT Less System with Three-Phase 11 0/0 415 kV Pole Mounted Transformer

In this option, 11 kV / 415 V with a tap changer of 450 V, 15/25/40 kVA maintenance free transformers will be installed individually at each motor end points These transformer will be mounted on a pole to supply power to individual pump-sets

6 1 2 Connection of two or three pump-sets to 25 kVA Transformers by Method of Grouping

In this option, 11 kV / 415 V with a tap changer of 450 V, 25kVA maintenance free transformer will be installed to which, two or three pump-sets will be connected This 25 kVA transformer will cater the load to the pump-set

The following table gives the ready merits and limitations of each of the proposed options

Sl No	Criteria	LT less System	Grouping Configuration
1	Description	One transformer catering load to one pump-set	One transformer catering load to many pump-sets
2	Reliability of supply	In case of transformer damages, it affects single user alone	In case of transformer damages, it affects multi-users
3	Attitude of the farmers	Situation of individual responsibility arises	Common property is nobody's property
4	Line loss	Very less (approximately 0 03 % of total power transmitted)	reduced by some extent but not like LT less system (approximately 0 8 % of total power transmitted)
5	Voltage availability	Very good, voltage drop will be less than 0 5 V (approximately 99 9 % of transformer output voltage)	Good, voltage drop will be 1-5 V (approximately 98 % of transformer output voltage)
6	Overloading possibility of transformer	Nil	Currently nil, but will be high in the future and will be resemble the existing system
7	Meeting user requirements	Normal and satisfactory water discharge	Currently satisfactory, but will be fluctuating in the future
8	Future Expansion facilities	Possible, even for single users	Not possible for single users
9	Transformer availability	Few manufacturers supply 15 kVA pole mounted transformers	25 kVA transformers are in the market
10	Maintenance costs	Negligible	Negligible
11	Capital cost	High	High(slightly less than LT less system)
12	Non technical losses	Nil	More
13	Network protection	Good	Not reliable

Table 6 1 Reliability of proposed options based on the criteria

6 1 3 Analysis of Proposed options

6 1 3 1 LT less distribution network

The existing 25/40/63/100 kVA transformers will be replaced The 11 kV line is to be extended near to each pump-set 11 kV/415 V with the tap changer of 450 V, pole mounted maintenance free transformers of 15/25/40 kVA rating is to be installed near to each pump-set

From the field analysis, it is observed that 7 transformers out of 92 are feeding to domestic/industrial purposes The balance 85 transformers feed to 471 pump-sets The 77 feeders which are feeding to 2 and above pump-sets and connected to 463 pumps, are considered under this analysis The 8 pump-sets which are feeding to one pump-set are not considered for study as they are resemble the LT less system

The table below indicates the categorisation of pump-sets(working and not working) for selection of pole mounted transformer for this LT less option, based on the measured HP

Pumps Rating (Actual)	≤ 12 5 HP	> 12 5 HP & ≤ 20 HP
Total Pump-sets in the Palra feeder	462	9
Transformers feeding to one pump-sets	8	0
Pump-sets under study	454	9

Table 6 2 Number of pump-sets in the rating ranges

The rating of the transformer will be selected based on the above HP rating of the pump-sets

Sl No	Pole-Mounted Distribution Transformer		Existing pump-set rating
	Rating	*Nos required*	
1	15 kVA	454	≤ 12 5 HP
2	25 kVA	9	15-20HP

Table 6 3 Number of transformers required depending on the rating of pump-sets

In this proposed option, the existing 415 V LT line is converted to 11 kV HT line For this purpose, the same conductor and poles will be used The investment will be for cross-arms and higher voltage grade insulator As noted in the table above, the new pole mounted transformers are installed as required

Line loss

In existing system, the LT distribution loss of the selected 77 feeders under study is 444 75 kW Upon implementation of this option, the energy loss will bel 9 kW

(0 05 % of total power demand) The distribution transformer is considered to be same as existing system The energy saving on adopting this option is considerable

The energy savings for 77 feeders under study is as given in the table below

System Considered	Line Losses (kW)	Pump-sets Demand (kW)		Net Energy Savings (kW)
		85 Feeders*	77 Feeders*	
Existing system (415 V)	444 75	2406	2359 6	-
Proposed LT less option (11 kV)	1 9	2406	2359 6	442 85

* The demand of pump-sets considering all pump-sets are in operation

Table 6 4 Energy savings for LT less system

Considering that,
The power is fed to distribution lines of 77 feeders for 2000 hrs per annum,
The net savings of energy will be = 442 85 * 2000 kWhr
= 885 7 MW hr/annum

Voltage profile

On implementation of this option, the voltage scenario will be improved to a large extent In existing scenario, the average voltage drop is in the range 50 - 100 V, whereas, upon adopting this option, voltage drop will be less than 0 5 V Here the voltage availability in the motor terminal will be 99 9 % of distribution transformer output voltage
The voltage available at the sub-station is between 9 - 10 5 kV Due to HT line drop, the voltage available at the existing distribution transformer HT side is 6 1-7 6 kV Currently, due to LT line drop motor terminal voltage is in the range of 200 V and 350 V By adopting this option, this LT line drop will be reduced to nil and if the proposed option for HT network modification is adopted, the motor will have an available voltage between 320 V and 415 V However, the energy efficient motor would ideally require voltage between 350 V and 450 V to run efficiently **Therefore, we suggest that all the pole mounted transformer have a 11 kV / 415 V with a tap changer of 450 V This will help in maintaining the motor terminal voltage between 340 - 450 V**

6 1 3 2 Grouping configuration (less LT)

The existing 63/100 kVA transformer will be replaced by a number of 25kVA transformers The 11 kV line is to be extended to the new location of the

transformers where 2-3 number of pump-sets ,depending on HP rating, can be fed from the transformer For this the existing LT line is to be converted to HT line For this purpose, the same conductor and poles will be used The investment will be for cross-arms and higher voltage grade insulator

In case of LT lines, some of the existing LT lines are reused along with new LT lines that are connected radially The new LT line will consist of conductor, pole, insulator, cross-arm and accessories which accounts for some portion of investment The major investment will be for 25kVA transformers

The maximum loading capacity of the transformers is 80% It means that 25 kVA transformers can be loaded upto 20 kVA (i e, upto16 kW considering power factor of 0 8) From the study, it is found that most of the pump-sets are of 5-10 HP rating Therefore, not more than two pump-sets of 10 HP rating can be fed by a 25 kVA transformer

In actual condition, the voltage available at the sub-station is in the range of 9 - 10 5 kV instead of 11 kV Also, due to HT line drop, the terminal voltage available at the motor will be in the range of 200 - 350 V Hence, to meet the required demand the motor will draw more power from the transformer From analysis, it is seen that one 25 kVA transformer can feed to one 10 HP motor instead of two or three motors In such situations, the 25 kVA transformer gets under loaded without utilisation of its full capacity In cases, where the pump-sets ratings are high such that 2 pump-sets cannot be grouped then each pump-set is fed by an individual 25 kVA transformer

The following table provides information about the number of transformers required for the proposed grouping option

Sl No	Transformer Rating (kVA)	No of transformers required
1	25	295

Table 6 5 Number of transformers required for grouping configuration

Line loss

In existing system, the LT distribution loss of the selected 77 feeders under study is 444 75 kW Upon implementation of this option the energy loss will be 40 28 kW (1 06 % of total power demand) The distribution transformer loss is considered to be same as the existing system

The energy savings for 77 feeders under study is as given in the following table

System Considered	Line Losses (kW)	Pump-sets Demand* (kW)		Net Energy Savings (kW)
		85 Feeders*	77 Feeders*	
Existing system (415 V)	444 75	2406	2359 6	-
Proposed Grouping option	40 28	2406	2359 6	404 47

* The demand of pump-sets considering all pump-sets are in operation

Table 6 5 Energy savings for grouping configuration

Considering that,

The power is fed to distribution lines of 77 feeders for 2000 hrs per annum, the net savings of energy will be = 404 47 * 2000 kWhr

= 808 94 MW hr/annum

Voltage profile

On implementation of this option, the voltage scenario will be improved by a large extent In the existing scenario, the average voltage drop is in the range 40 - 60 V Upon adopting this option, the voltage drop will be within 1 - 5 0 V Here, the voltage availability in the motor terminal will be 98% of the distribution transformer output voltage

The voltage available at the sub station is between 9- 10 5 kV Due to HT line drop, the voltage available at the existing distribution transformer HT side is 6 1 - 7 6 kV Currently, due to LT line drop motor terminal voltage is in the range of 200 V and 350 V By adopting this option, the LT line drop will be reduced to 1 - 5 V and if the proposed option for HT network modification is adopted, the motor will have a voltage between 320 V and 415 V The energy efficient motor would ideally require voltage between 350 V and 450 V to run efficiently **Therefore, we suggest that all the pole mounted transformer have a 11 kV / 415 V rating with a tap changer of 450 V This will help in maintaining the motor terminal voltage between 340 - 450 V**

The details of requirements regarding the HT line for conversion new LT line required the number of new transformers required along with their kVA ratings for the 2 proposed options are provided in the Annexure D, Table - 4

6 2 PROPOSED OPTIONS FOR HT NETWORK

As explained in the previous section, since the main common load carrying segment and its branches contribute to 95 % of total HT loss, the modification in these segments will result in considerable reduction in HT loss

Options Proposed are

1 To run another HT Line of same specification (as existing) along the above mentioned segments
2 To **replace** the above mentioned segments with **Coyote Conductor** and **run a parallel line** of the same conductor type along these segments

6 2 1 Analysis of Proposed Options

1 By adopting the **first proposed option i e ,** running another HT Line of same specification (as existing) along with the existing There will be two main trunks starting from the sub-station will be equally loaded The line loss occurring in these segments(16 2 kilometers) will be 374 25 kW as compared to existing 748 52 kW This will reduce the total HT Network loss to 410 75 kW as compared to existing 785 kW In addition, the HT voltage drop at the farthest load point will be 1 6 kV as compared to 2 9 kV of existing case and there by the voltage scenario is improved by 1 3 kV

In summary,

- Existing HT loss 785 kW
- HT Loss after implementation 410 75 kW
- Savings in power 374 25 kW

Considering that, the power is fed to the HT network from the sub-station for 2000 hrs per annum, the Net Savings of Energy will be

= 374 25 * 2000 kWhr
= **748 5 MW hour/annum**

2 By adopting the **second proposed option, replacing** the existing line with **Coyote Conductor** and **run a parallel line** of the same conductor type along these lines The main reason for suggesting the usage of Coyote conductor is that its resistance is as low as 0 246 ohms / Km Also by incorporating parallel lines the loss in the segments will be further reduced The new line loss in these segments (total 32 4 kilometers) will be 151 92 kW as compared to existing 748 52 kW This reduces the total HT network loss to 188 42 kW as compared to existing 785 kW In addition, the HT voltage drop at the farthest load point will be 0 9 kV as compared to 2 9 kV of existing case and there by the voltage scenario is improved by 2 kV

In summary,

- Existing HT loss 785 kW
- HT Loss after implementation 188 42 kW
- Savings in power 596 58 kW

Considering that the power is fed to the HT network from the sub-station for 2000 hrs per annum, the Net Savings of Energy will be

= 596 58 * 2000 kWhr
= **1193.16 MW hour/annum**

Note *After the analysis of the coyote conductor option it was found that it is not economically viable In a detail engineering study this option along with other suitable conductors may be considered on a broader basis*

6 3 ADDITIONAL REQUIREMENTS FOR THE PROPOSED OPTIONS

- In the proposed options, lightning arrestors will be provided with each transformer for protection against lightning strikes
- In the HT side of the pole mounted transformer pole drop-out fuse will be used for operation of 450 V tap changer On economical viability off load tap changers may be replaced by on load tap changers
- Gang operated switches (GOS) will not be required for transformer capacity less than 100 kVA Therefore, for proposed LT Less and grouping options, no GOS switch will be required
- The existing GOS can be used according to the group demand of the farmers
- This analysis is done assuming that the existing single pole can withstand the weight of the pole mounted transformers

CHAPTER 7

7. FINANCIAL ANALYSIS

7 1 UPGRADATION OF DISTRIBUTION NETWORK

7 1 1 Introduction

A detailed financial analysis of the proposed options for upgradation of distribution network by reducing the HT and LT line losses and improving the voltage is discussed in this chapter Two options each have been envisaged in this report for reduction of LT line losses and reduction of HT line losses

7 1 2 LT Line Losses

The two options studied for reduction of LT Line losses are
1) LT Less System with three phase pole mounted transformer
2) Connection of two or three pump sets to 25 kVA transformers by the method of grouping

The *first option* envisages installation of 15/25 kVA maintenance free pole mounted transformers at each motor end points These transformer will be mounted on a pole and would supply power to individual pump sets

The *second option* envisages installation of 25 kVA maintenance free transformer to which two or three pump sets will be connected This 25 kVA transformer will cater to the load of the pump sets

7 1 3 HT Line Losses

It has been proposed to reduce HT Line losses by incorporating another parallel line with the existing line , along the common load carrying segment where the maximum loss occurs
The option proposed in this study is incorporating another parallel line with the existing line , along the common load carrying segment where the maximum loss occurs ,with the existing type of conductors

7 1 4 Combined options for reducing both LT and HT Line losses

Based on the above , *two cases* for upgradation of distribution network by reducing both LT and HT line losses in the system have been discussed financially in this chapter They are as below

1) LT Less System with three phase pole mounted transformer and incorporating parallel HT line with existing type of conductors (hereinafter referred to as Case *1*)
2) Connection of two or three pump sets to 25 kVA transformers by the method of grouping and incorporating parallel HT line with existing type of conductors (hereinafter referred to as Case *2*)

7 1 5 Project Cost

The project cost envisaged for each of the two cases are as below

in rupees

	Case 1	*Case 2*
1) LT Upgradation Project Cost		
a) Transformers cost	9,305,000	7375000
b) Transformer installation costs	2,319,500	1,622,500
c) Conversion charges from LT to HT Lines	1344655	1,082,703
d) Cost of new LT Lines	0	1,000,000
e) Miscellaneous Expenditure	648,458	554,010
Total Project Cost	13,617,613	11,634,213
Less Resale value of existing Transformers	788,750	788,750
Project Cost	**12,828,863**	**10,845,463**
2) HT Upgradation Project Cost		
Cost of new HT Line	**2,430,000**	**2,430,000**
Total Project Cost	**15,258,863**	**13,275,463**

Table 7 1 Project cost for upgradation of distribution network

The details of the project cost are as per Table 1(i) in attachment provided at the end of the chapter 9 of the report No foreign exchange component is involved as all the equipment are available within India

7 1 6 Debt Equity

It is envisaged that the 75 % of the project cost will be financed through bank loan The balance 25 % will be funded by HVPN through equity The source of funds are as shown in the table below

in rupees

Particulars	Case 1	Case 2
Bank Finance	11,444,147	9,956,597
Equity	3,814,716	3,318,866

Table 7 2 Debt Equity for upgradation of distribution network

7 1 7 Savings

Savings has been calculated based on the assumption that power availability in the system is for 2000 hours Savings in rupee terms includes both savings on account of energy savings and savings on account of lower transformer maintenance costs

Particulars	Case 1	Case 2
In million units (MU)	1 63	1 56
In million Rs	4 478	4 296

Table 7 3 Savings for upgradation of distribution network

The details of above calculations are as per Table 1(ii) to Table 1(iii) provided as an attachment at the end of chapter 9 of the report

7 1 8 Financial Indicators

The details of workings of the financial indicators are provided in Annexure E

7 1 8 1 Payback period

The simple payback period for both the cases is as per table below

in years

Case 1	Case 2
3 41	3 09

Table 7 4 Payback period for upgradation of distribution network

7 1 8 2 Net present value

The Net Present value for both the cases at a discounted rate of 12% is as per table below

in million rupees

Case 1	Case 2
9 55	10 34

Table 7 5 Net Present Value (NPV) for upgradation of distribution network

7 1 8 3 Internal Rate of Return

The Internal Rate of Return for both the cases are as per table

Case 1	Case 2
26%	29%

Table 7 6 Internal Rate of Return for upgradation of distribution network

7 1 8 4 Debt Service Coverage Ratio

The DSCR for both the cases are as per table below

Case 1	Case 2
3 32	3 34

Table 7 7 Debt Service coverage Ratio for upgradation of distribution network

The DSCR is well above the required norms of 2 in both the cases

7 1 8 5 Total Returns

The Total Returns for 15 year period for both the cases are as per table

in million rupees

Case 1	Case 2
35 62	35 59

Table 7 8 Total Returns for upgradation of distribution network

7 1 9 Sensitivity analysis

Sensitivity analysis was done for the above cases to know the impact of the adverse factors on the above financial indicators for HVPN

7 1 9 1 Case 1

Particulars	Payback Period	Net Present Value (Rs in million)	Internal Rate of Return
Project Cost increases by 10%	3 75	8 23	23%
Pump running hours reduces to 1500 Hours	4 41	4 36	18%
Pump running hours reduces to 1200 Hours	5 37	1 24	14%
Weighted tariff rate is Rs 3 11	2 78	14 65	33%
Weighted tariff rate is Rs 1 95	4 27	4 96	19%
Worst Scenario (Project Cost increases by 10%, pump running hours reduces to 1200 hours and weighted Tariff rate is 1 95	7 29	-2 82	8%

Table 7 9 Sensitivity Analysis for Case 1

7 1 9 2 Case 2

Particulars	Payback Period	Net Present Value (Rs in million)	Internal Rate of Return
Project Cost increases by 10%	3 40	9 19	26%
Pump running hours reduces to 1500 Hours	4 00	5 39	21%
Pump running hours reduces to 1200 Hours	4 85	2 42	16%
Weighted tariff rate is Rs 3 11	2 53	15 20	37%
Weighted tariff rate is Rs 1 95	3 86	5 96	22%
Worst Scenario (Project Cost increases by 10%,pump running hours reduces to 1200 hours and weighted Tariff rate is 1 95)	6 57	-1 34	10%

Table 7 10 Sensitivity Analysis for Case 2

The savings and investment was also analysed with regard to current prices It was assumed that the current tariff rates will rise by 10% each year over that of previous year and financial indicators were arrived at accordingly

The key financial indicators at current rates for HVPN are as per table below

Particulars	Payback Period	Net Present Value (Rs in million)	Internal Rate of Return
Case 1	3 41	22 37	34%
Case 2	3 09	22 56	38%

Table 7 11 Financial Indicators at Current Prices

CHAPTER 8

8. RECOMMENDED SOLUTIONS

After analysing the existing HT and LT distribution network, the solutions are recommended to improve the present scenario This chapter discusses in brief, the modifications required for the recommended solutions and benefits that can be obtained to the HVPN in terms of energy savings

8 1 LT DISTRIBUTION NETWORK

The technical and financial analysis have been done for the different proposed options for the LT distribution network From the analysis, it is found that the proposed option of ' **LT less system with three phase 11kV / 415 V with a tap changer of 450 V, maintenance free pole mounted transformer,** is appropriate for Palra feeder

Modifications to Existing System

Some modifications to the existing system are required for effective implementation of the proposed solution These modifications are ,

- The removal of existing 11 kV / 415 V, 100 kVA, 63 kVA, 25 kVA, distribution transformers connected to two or more pumps
- Extending the 11 kV HT lines upto the pole which is closest to each motor end point
- Addition of strain and pin insulators of 12 kV voltage grade
- Extension of the pole top and width of the cross-arm
- Installation of 463 numbers of 11 kV / 415 V with a tap changer of 450 V maintenance free pole mounted transformers of various rating of 15/25/40 kVA near each motor end
- Suitable arrangement for fixing the pole mounted transformer

As per the financial analysis, discussed in Chapter 7, the total **investment** will be **Rs 12 83 million**

Benefits

By implementing this recommended solution, the HVPN and the farmers will be benefited in many ways

A HVPN

- Reduction of huge amount of line loss from 444 75 kW to 1 9 kW per hour
- The HVPN can save **0 886 MU of energy per annum**

- Maintenance work will be reduced to a great extent as the transformers will be of maintenance free type
- The failure rate of the transformer will be reduced as the transformers will be new and good quality
- The future extension of the network will be easier as the 11 kV line can be extended by taking a tap from the termination point of the HT line
- The HVPN can gain a lot in terms of money by supplying the saved energy to other revenue earning sectors

B Farmers

- Quality power will be available at the motor terminal as the LT line drop can be eliminated almost completely
- As the available voltage at the motor terminal will be improved a lot in comparison to the present scenario, the pump can run efficiently
- Optimum irrigation practices can be encouraged among the farmers
- Pump-sets maintenance requirement will be reduced

8 2 HT DISTRIBUTION NETWORK

Another recommendation is for modification of HT network in which another parallel new line of 16 2 km (as discussed in Chapter 6), starting from the sub-station end is required to be drawn along with the existing line

Modification to Existing System

- A new 11 kV line of 16 2 km length will be required
- To draw the above mentioned line, conductor, poles, cross-arms, and 12 kV grade pin and strain insulators will be required

As per the financial analysis, discussed in Chapter 7, the total **investment** will be **Rs 2 43 million**

Benefits

- There will be improvement in HT voltage scenario Reduction in HT line loss from 785 kW to 410 75 kW per hour
- The **savings** of energy to HVPN, after adopting this, will be **0 749 MU per annum**

8 3 BENEFITS BY ADOPTING THE RECOMMENDATIONS FOR BOTH LT AND HT NETWORK

Thus, by implementing the recommended solutions for both LT and HT network, HVPN can **save** upto **1 634 MU of energy per annum**

8 4 TECHNICAL MERITS OF LT LESS OVER GROUPING

- In the proposed LT less, each pump-sets is fed by a single transformer, whereas in grouping one to three pump-sets will be fed from a single transformer
- In case of future demands, under the LT less 11 kV lines can be extended to meet the new demand points Whereas in case of grouping the farmers may tend to take the line connection from the existing transformers instead of drawing new 11 kV line for their pump-sets
- The irregular line lengths drawn in case of grouping leads to further increase in line loss and voltage drop In case of the LT less option the transformers will be located near to each motor end points, hence, line losses and voltage drop are negligible
- In case of LT less, the charge of the transformer lies in the hands of the farmers Hence, the farmers will be conscious about the loading of the transformer Whereas in the grouping option individual farmers will be careless of the overloading condition There is every possibility that the transformer gets overloaded

8 5 CONCLUSION

The study as clearly brought out technical and economic viability of complete upgrading of the existing distribution network to a LT less distribution network along with the proposed modification for HT network The energy savings that are realised from this upgrading is **1634 2 MWhr** per annum for an investment **of Rs 15 26 Million** In addition, HVPN will have a monetary savings of **Rs 4 48 Million** Further, the farmers will be ensured a good quality of input power to their pump-sets

CHAPTER 9

9. IMPLEMENTATION

From the analysis of the two options for LT distribution network, it is seen that both LT less and Grouping options are financially more or less similar Therefore, it is suggested that both the options be implemented on two different feeders for demonstration purposes This will help in selecting the better option after implementation

Detailed engineering is necessary as the next step before implementing the demonstration projects

ATTACHMENT

i) Project Cost

a) LT Less System

1) Transformers

Transformer Rating (kVA)	Numbers	Cost (Rs)	Total Cost (Rs)
15	454	20,000	9,080,000
25	9	25,000	225,000
40	0	30,000	0
Total	**463**		**9,305,000**

2) Transformer Installation Costs

Particulars	Cost/Item	Cost/Transformer (Rs)	Total Cost (Rs)
Lightning Arrestors	1000	3,000	1,389,000
Installation Costs	---	10 % of transformer cost	930,500
Total			**2,319,500**

3) Pole Top Extension Costs (Conversion charges from LT to HT lines)

Particulars	Cost/Pole	Cost/Km (Rs)	Kms	Total Cost (Rs)
Replaced Cross Arm	180	3,060	82 85	253,521
11 KV Grade Strain Insulator	300	5,100	82 85	422,535
11 KV Grade Pin Insulator	210	3,570	82 85	295,775
Erection Costs	---	4,500	82 85	372,825
Total				**1,344,655**

4) Miscellaneous Expenditure	648,458
Total Project Cost	**13,617,613**
Less Resale value of existing transformers *(@25 % of the current cost)*	788,750
Project Cost	**12,828,863**

b) Grouping System

1) Transformers

Transformer Rating (kVA)	Numbers	Cost (Rs)	Total Cost (Rs)
25	295	25,000	7,375,000
40	0	30,000	0
Total	**295**		**7,375,000**

2) Transformer Installation Costs

Particulars	Cost/Item	Cost/Transformer (Rs)	Total Cost (Rs)
Lightning Arrestors	1000	3,000	885,000
Installation Costs	---	10 % of transformer cost	737,500
Total			**1,622,500**

3) Pole Top Extension Costs (Conversion changes from LT to HT lines)

Particulars	Cost/Pole	Cost/Km (Rs)	Kms	Total Cost (Rs)
Replaced Cross Arm	180	3,060	66 71	204,133
11 KV Grade Strain Insulator	300	5,100	66 71	340,221
11 KV Grade Pin Insulator	210	3,570	66 71	238,155
Erection Costs	---	4,500	66 71	300,195
Total				**1,082,703**

4) Cost of new LT Line	8 00	1,000,000
5) Miscellaneous Expenditure		554,010
Total Project Cost		**11,634,213**
Less Resale value of existing transformers *(@25 % of the current cost)*		788,750
Project Cost		**10,845,463**

c) HT Line Loss reduction

Particulars	Cost/Km (Rs)	Kms	Total Cost (Rs)
Cost of new HT Line	1,50,000	16 20	2,430,000

Savings in Line Losses

ii) LT Less System

1) Savings in Line Losses

a)	Reduction in LT Line Losses	KW	442 85
b)	Reduction in LT Line Losses	Units	885 700
c)	Savings	Rs	2,214,250

2) Savings in Transformer Maintenance

a) Existing maintenance cost

No of Transformers connected to agricultural load	85
Current Average failure rate	38 %
Average Maintenance Cost/transformer	Rs 15,000
Total Current Maintenance cost	**Rs 484,500**

b) Projected maintenance cost

Proposed Transformers	463	
Existing transformers	8	471
Average failure rate of existing transformers		38 %
Average failure rate for new transformers		2 %
Average maintenance cost/ new transformers		25 % of cost
Projected Total Maintenance Cost		**Rs 92,125**

c) Avoided Cost of maintaining existing transformers

Current Maintenance Cost (Rs)	484,500
Projected Maintenance Cost (Rs)	92,125
Avoided Cost of maintaining existing transformers (Rs)	**392,375**

iii) Grouping System

1) Savings in Line Losses

a)	Reduction in LT Line Losses	KW	404 47
b)	Reduction in LT Line Losses	Units	808,940
c)	Savings	Rs	2,022,350

2) Savings in Transformer Maintenance

a) Existing maintenance cost

No of Transformers connected to agricultural load	85
Current Average failure rate	38 %
Average Maintenance Cost/transformer	Rs 15,000
Total Current Maintenance cost	**Rs. 484,500**

b) Projected maintenance cost

Proposed Transformers	295	
Existing transformers	8	303
Average failure rate of existing transformers		38 %
Average failure rate for new transformers		2 %
Average maintenance cost/ new transformers		25 % of cost
Projected Total Maintenance Cost		**Rs 82,475**

c) Avoided Cost of maintaining existing transformers

Current Maintenance Cost (Rs)	484,500
Projected Maintenance Cost (Rs)	82,475
Avoided Cost of maintaining existing transformers (Rs)	**402,025**

iv) HT Line Loss reduction with existing conductors

1) Savings in Line Losses

a)	Reduction in LT Line Losses	KW	374 27
b)	Reduction in LT Line Losses	Units	748,540
c)	Savings	Rs	1,871,350

ANNEXURES

ANNEXURE-A

MODEL DATA SHEET

ANNEXURE - A

MODEL DATA SHEET

Village Name	Transformer Name	Rating kVA	Voltage Volts			Current Amps			Name of the Field Officer	Date

	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	PS10
IP Set Owner Name										
Make										
HP										
Voltage										
Current										
kW										
P F										
X - axis (inches)										
Y - axis (inches)										
Static Head (ft)										
Pipe length (ft)										
Pipe Dia (inches)										
Material										
No of Bends										
No optn Hrs/day										
Dist from the Tr (m)										
Remarks										

ANNEXURE-B

DETAILS OF FIELD OBSERVED ELECTRICAL DATA

FOR MOTOR PUMPSETS

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
1	1	Dharam Singh	25	1	10 0	367 7	11 9	0 8	6 08	8 15
2	2	L D System	100	1	7 5				0 00	
3	3	Indeerjeet	25	1	10 0	355 3	12 3	0 8	6 07	8 14
4				2	7 5	346 0	12 1	0 8	5 82	7 80
5				3	7 5	340 0			0 00	
6	4	Jile Singh	100	1	10	314 3	12 3	0 8	5 34	7 16
7				2	10 0	313 0	11 8	0 8	5 12	6 86
8				3	7 5	317 7	10 9	0 8	4 80	6 43
9				4	10 0	315 3	10 6	0 8	4 65	6 23
10				5	10 0	336 3			0 00	
11				6	7 5	322 0	10 8	0 8	4 80	6 44
12				7	7 5	305 0			0 00	
13				8	7 5				0 00	
14				9	7 5	314 7	10 4	0 8	4 55	6 10
15	5	Hemraj	40	1	10 0	339 7	23 6	0 8	11 11	14 89
16				3	10 0			0 8	0 00	
17	6	Bansal	100	1	10 0				0 00	
18				2	5 0				0 00	
19				3	7 5				0 00	
20				4	7 5	287 7	17 6	0 87	7 61	10 21
21				5	7 5	268 0	16 7	0 88	6 85	9 18
22				6	7 5	269 0	16 0	0 85	6 34	8 49
23				7	7 5	281 7	16 3	0 88	6 99	9 36
24	7	Jantafarm	100	1	12 5				0 00	
25				2	10 0	313 3	13 6	0 83	6 09	8 16
26				4	10 0	299 0	18 4	0 88	8 40	11 26
27				5	7 5	360 7	14 1	0 80	7 06	9 47
28				6	10 0	293 3	24 5	0 80	9 94	13 33
29				7	7 5	291 3	21 4	0 80	8 64	11 58
30				8	7 5			0 80	0 00	
31	8	Prahlad Singh	25	1	12 5	323 7	15 2	0 8	6 80	9 12
32				2	12 5	330 0	16 5	0 83	6 80	9 12
33	9	Anand Singh	63	1	10 0	344 7	22 0	0 84	11 06	14 82
34				2	10 0	324 7	22 0	0 83	10 29	13 80
35				3	10 0	319 7	10 8	0 84	5 04	6 75
36				4	10 0	321 7	21 9	0 8	9 76	13 08
37				5	7 5				0 00	
38				6	7 5				0 00	
39	10	Anoop Singh/	100	1	7 5	298 0	14 3	0 8	5 92	7 93
40		Dulichand		2	7 5	319 7	16 3	0 80	7 21	9 66
41				3	7 5	292 0	27 2	0 8	11 02	14 77
42				4	7 5	287 7	23 3	0 8	9 27	12 43
43				5	7 5	285 7	14 6	0 8	5 77	7 73
44				6	5 0	269 7	23 1	0 8	8 63	11 57
45	12	Sube Singh	63	1	7 5				0 00	
46	14	TC-20	100	1	7 5	273 0	14 6	0 84	5 79	7 76

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
47				2	7 5	287 0	19 6	0 85	8 30	11 13
48				3	7 5	282 7	15 5	0 85	6 46	8 67
49				4	7 5				0 00	
50				5	7 5	286 0	16 5	0 90	7 38	9 90
51				6	7 5				0 00	
52				7	7 5	256 3	13 7	0 8	5 15	6 90
53				8	7 5	248 3	13 2	0 8	4 82	6 46
54				9	7 5	237 3	13 2	0 92	5 00	6 71
55				10	7 5	237 0	21 0	0 88	7 57	10 15
56				11	7 5				0 00	
57				12	7 5	225 0	16 6	0 88	5 70	7 64
58				13	7 5				0 00	
59	14A	Ram Kumar	40	1	7 5	280 7	14 3	0 8	5 55	7 44
60				2	7 5	271 7	13 9	0 8	5 24	7 03
61				3	7 5	262 7	17 7	0 8	6 43	8 62
62				4	7 5				0 00	
63				5	7 5				0 00	
64	14B	Jai Kumar	25	1	7 5				0 00	
65				2	7 5	255 3	11 5	0 8	4 07	5 45
66				3	7 5				0 00	
67	15	Ohola	100	1	10 0	237 7	17 1	0 8	5 63	7 55
68				2	10 0	226 7	15 4	0 8	4 85	6 50
69				3	10 0	245 0	14 5	0 8	4 92	6 60
70				4	10 0				0 00	
71				5	10 0				0 00	
72				6	10 0				0 00	
73				7	7 5				0 00	
74				8	7 5				0 00	
75	15A	Ramsarup	25	1	10 0	307 3	14 1	0 8	6 00	8 05
76	16	Kirn Chand	63	1	7 5	284 7	12 0	0 8	4 75	6 36
77				2	5 0	277 0	17 6	0 8	6 77	9 07
78				3	10 0	263 0	16 0	0 8	5 82	7 80
79				4	7 5	242 7	17 3	0 8	5 82	7 80
80				5	7 5	244 0	15 8	0 8	5 35	7 18
81				6	7 5	235 0	16 5	0 8	5 37	7 20
82				7	7 5	237 0	16 9	0 8	5 55	7 44
83	17	Daya Nanda	25	1	7 5				0 00	
84				2	5 0				0 00	
85	17A	Bhagwan	63	1	7 5	339 5	22 1	0 8	10 38	13 91
86				2	7 5	249 3	11 0	0 8	3 80	5 09
87				3	7 5	242 7	15 0	0 8	5 04	6 76
88				4	7 5	244 3	16 6	0 8	5 63	7 55
89				5	7 5	270 7	12 0	0 8	4 49	6 02
90				6	7 5	284 0	11 0	0 8	4 33	5 80
91	18	Ram Swaroop	25	1	7 5	471 1	14 8	0 8	9 66	12 95
92				2	10 0	246 0	19 9	0 8	6 77	9 08
93	19	Meer Chand Meha	100	1	5 0	277 7	15 8	0 91	6 94	9 30
94				2	7 5	273 3	16 3	0 94	7 26	9 74

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
95				3	7 5				0 00	
96				4	7 5				0 00	
97				5	7 5	260 3	14 9	0 85	5 72	7 67
98				6	7 5	267 3	15 4	0 8	5 69	7 63
99				7	7 5	257 7	14 7	0 8	5 24	7 02
100				8	7 5	253 7	13 5	0 8	4 76	6 38
101	20	Jaghir Singh	25	1	7 5	285 7	11 2	0 85	4 72	6 33
102				2	7 5	275 7	12 1	0 85	4 92	6 60
103				3	7 5	274 0	14 2	0 85	5 74	7 70
104	21	Puran Chand	63	1	7 5	277 3	13 9	0 92	6 16	8 25
105				2	7 5	242 0	11 2	0 8	3 74	5 02
106				3	10 0	232 0	11 9	0 8	3 83	5 13
107				4	10 0	255 7	15 1	0 93	6 25	8 38
108				6	7 5	168 7	10 2	0 93	2 78	3 73
109				7	7 5	165 0	9 3	0 94	2 52	3 37
110	22	TCA-22	100	1	7 5	222 3	16 0		0 00	0 00
111				2	5 0				0 00	
112				3	7 5				0 00	
113				4	7 5				0 00	
114				5	7 5				0 00	
115				6	7 5				0 00	
116				7	5 0				0 00	
117				8	7 5				0 00	
118				9	7 5				0 00	
119				10	7 5				0 00	
120				11	7 5				0 00	
121	23	Hari Singh	25	1	7 5			0 0	0 00	
122				2	7 5			0 0	0 00	
123				3	7 5			0 0	0 00	
124	24	Kartar Singh	100	1	7 50	284 7	13 5	0 85	5 67	7 60
125				2	7 5	279 7	14 0	0 85	5 75	7 71
126				3	7 50	276 0	15 2	0 85	6 19	8 30
127				4	7 50	274 7	13 8	0 85	5 57	7 46
128				5	7 50	263 0	14 3	0 85	5 54	7 42
129				6	15	262 3	11 4	0 85	4 42	5 92
130				7	7 5	257 7	14 2	0 85	5 39	7 22
131				8	7 5	275 7	15 0	0 85	6 07	8 14
132	25	Puran Singh	63	1	7 5	302 7	16 2	0 75	6 41	8 59
133				2	7 5	256 7	16 4	0 89	6 49	8 70
134				3	7 5	256 7	14 1	0 85	5 34	7 16
135	26	Nemichand	63	1	10	274 7	15 0	0 87	6 22	8 34
136				2	7 5	265 0	14 5	0 9	5 66	7 58
137				3	7 5				0 00	
138				4	7 5				0 00	
139				5	7 5				0 00	
140				6	7 5				0 00	
141				7	7 5				0 00	
142	27	Nemichand	63	1	7 5	256 3	11 4	0 88	4 45	5 97
143				2	7 5				0 00	

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
144				3	10	227 3	23 6	0 86	7 97	10 69
145				4	10				0 00	
146				5	7 5				0 00	
147				6	7 5				0 00	
148				7	10				0 00	
149	28	Ravinder Singh	63	1	7 5	265 7	16 6	0 90	6 86	9 20
150				2	7 5	257 7	16 0	0 85	6 07	8 14
151				3	7 5	251 3	17 4	0 85	6 43	8 61
152				4	7 5	260 0	16 9	0 84	6 38	8 55
153				5	7 5				0 00	
154				6	7 5				0 00	
155				7	7 5				0 00	
156	30	Hosiyra Singh	63	1	7 5	249 7	16 0	0 8	5 54	7 42
157				2	7 5	248 0	21 1	0 8	7 25	9 72
158				3	7 5	239 3	21 4	0 8	7 11	9 53
159				4	5				0 00	
160				5	7 5				0 00	
161				6	7 5				0 00	
162				7	7 5				0 00	
163				8	7 5				0 00	
164	31	Sarichand	100	1	7 5	229 3	10 6	0 8	3 37	4 52
165				2	5	223 7	11 6	0 8	3 60	4 82
166				3	5	225 3	11 5	0 8	3 59	4 81
167	32	Masroom Form	100	1	7 5	239 3	10 5	0 8	3 48	4 67
168				2	7 5	240 7	10 1	0 8	3 36	4 50
169				3	7 5	235 7	12 3	0 8	4 01	5 37
170				4	7 5				0 00	
171				5	7 5				0 00	
172				6	7 5				0 00	
173				7	5				0 00	
174				8	10				0 00	
175	33	63	63	1	7 5	230 7	16 4	0 85	5 54	7 42
176				2	5	233 3	13 8	0 85	4 74	6 35
177				3	5	244 3	13 5	0 86	4 88	6 54
178				4	7 5	260 7	10 7	0 89	4 30	5 77
179				5	7 5	254 7	18 9	0 88	7 36	9 87
180				6	7 5	261 0	11 5	0 83	4 33	5 80
181				7	7 5	242 0	10 8	0 85	3 83	5 14
182				8	5				0 00	
183	34	Dayanand	63	1	7 5	257 3	11 3	0 85	4 28	5 74
184				2	7 5	242 7	12 0	0 85	4 29	5 75
185				3	7 5	234 0	12 0	0 85	4 13	5 54
186				4	7 5	254 0	10 1	0 85	3 79	5 08
187				5	7 5	241 7	12 5	0 85	4 45	5 96
188				6	7 5	236 0	11 5	0 85	4 00	5 36
189	35	Balichand	100	1	5	185 3	10 5	0 80	2 70	3 61
190				2	5				0 00	
191				3	7 5	178 3	21 4	0 77	5 07	6 79
192				4	7 5	188 0	21 5	0 80	5 60	7 51
193				5	10	177 0	20 2	0 83	5 17	6 93

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
194				6	10	185 0	21 1	0 80	5 41	7 25
195				7	10	195 0	21 5	0 85	6 14	8 23
196				8	7 5	176 0	27 0	0 80	6 58	8 82
197				9	7 5	171 0	12 2	0 8	2 89	3 87
198	35A	Hawa Singh	25	1	7 5	249 3	21 7	0 80	7 49	10 03
199				2	7 5	260 3	11 1	0 87	4 35	5 84
200	35B	Dariyab Singh	63	1	7 5	230 0	17 5	0 80	5 59	7 49
201				2	7 5	228 0	12 7	0 80	4 00	5 36
202				3	7 5	152 3	15 5	0 80	3 28	4 40
203				4	7 5	206 0	13 8	0 80	3 93	5 27
204				5	7 5	207 3			0 00	
205				6	7 5				0 00	
206	36	Devi Singh	63	1	7 5	281 3	14 5	0 8	5 65	7 58
207				2	7 5	268 3	11 2	0 8	4 15	5 57
208				3	7 5	230 0	13 5	0 8	4 30	5 77
209				4	7 5				0 00	
210				5	7 5				0 00	
211				6	7 5				0 00	
212	37	Davia Singh	100	1	7 5	195 3	16 4	0 8	4 43	5 94
213				2	7 5	194 7	14 5	0 8	3 91	5 24
214				3	7 5	201 3	13 5	0 8	3 77	5 05
215				4	7 5				0 00	
216				5	7 5	235 0	25 6	0 8	8 33	11 16
217				6	10	217 3	18 1	0 8	5 46	7 32
218				7	7 5	198 7	18 1	0 8	4 99	6 69
219				8	7 5	205 3	17 9	0 8	5 08	6 81
220				9	7 5	225 7	17 9	0 8	5 59	7 49
221				10	7 5	227 7	18 7	0 8	5 89	7 89
222	38	Dhan Singh	63	1	7 5	182 7	17 0	0 8	4 29	5 76
223				2	7 5	178 0	16 8	0 8	4 14	5 54
224				3	12 5				0 00	
225				4	7 5	164 7	27 7	0 8	6 32	8 47
226				5	10	138 3	20 0	0 8	3 83	5 14
227				6	10	150 3	20 2	0 8	4 20	5 63
228				7	10	152 0	21 2	0 8	4 46	5 98
229				8	7 5	177 3	15 7	0 8	3 85	5 16
230	38A	Mehtab Singh	25	1	10	304 7	17 7	0 8	7 49	10 04
231	39	Channi Lal	63	1	7 5				0 00	
232				2	10				0 00	
233				3	10				0 00	
234				4	7 5				0 00	
235				5	7 5				0 00	
236				6	7 5	278 3	16 9	0 8	6 53	8 75
237				7	7 5	248 7	15 6	0 8	5 38	7 21
238	40	Jai Chand	25	1	7 5				0 00	
239				2	7 5				0 00	
240				3	7 5				0 00	
241				4	5	240 7	12 8	0 8	4 26	5 71

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
242	41	Absul	63	1	10	233 0	15 1	0 86	5 25	7 04
243				2	7 5	243 0	11 2	0 8	3 78	5 07
244	42	Her Kishan	100	1	7 5	375 0	9 2	0 8	4 76	6 38
245				2	7 5	371 3	11 1	0 8	5 69	7 63
246				3	10	325 7	14 4	0 8	6 50	8 71
247				4	7 5	292 3	15 5	0 8	6 28	8 42
248				5	7 5				0 00	
249				6	5				0 00	
250				7	7 5				0 00	
251				8	7 5				0 00	
252				9	7 5				0 00	
253				10	7 5				0 00	
254	43	Pradap Singh	100	1	7 5	259 0	16 6	0 8	5 97	8 00
255				2	7 5	238 3	15 0	0 8	4 96	6 66
256				3	7 5	267 7	14 8	0 8	5 48	7 34
257				4	7 5	258 0	17 6	0 86	6 76	9 07
258				5	7 5	254 0	17 4	0 8	6 14	8 22
259				6	7 5	236 0	11 0	0 83	3 74	5 02
260				7	7 5	194 3	13 7	0 84	3 87	5 19
261				8	7 5	210 0	18 9	0 86	5 91	7 93
262				9	7 5	189 0	19 1	0 87	5 44	7 29
263				1	7 5				0 00	
264	45	Jai Prakash	100	2	7 5	257 3	9 1	0 9	3 64	4 88
265				3	7 5	218 7	13 9	0 86	4 52	6 05
266				4	5				0 00	
267	46	Sube Singh	25	1	5				0 00	
268				2	7 5				0 00	
269				3	7 5				0 00	
270	46A	Dhanpati Chand	25	1	7 5	312 7	10 6	0 88	5 04	6 75
271				2	7 5	286 0	10 7	0 83	4 40	5 90
272	47	Karan Singh	100	1	7 5				0 00	
273				2	7 5				0 00	
274				3	10				0 00	
275				4	7 5				0 00	
276				5	7 5				0 00	
277				6	7 5				0 00	
278				7	7 5	400 7	13 7	0 55	5 23	7 01
279				8	7 5	212 3	15 3	0 85	4 77	6 40
280	48	Randhir Singh	63	1	7 5				0 00	
281				2	7 5				0 00	
282				3	7 5				0 00	
283				4	7 5				0 00	
284	49	zile Singh	63	1	7 5				0 00	
285				2	7 5	329 0	14 2	0 8	6 46	8 66
286				3	7 5	359 3	8 1	0 8	4 05	5 43
287				4	7 5				0 00	
288				5	7 5				0 00	
289				6	7 5				0 00	
290				7	7 5				0 00	

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
291				8	7 5				0 00	
292				9	7 5				0 00	
293	50	Dharam Singh	25	1	7 5				0 00	
294	51	Kamnya	63	1	10	357 7	13 8	0 8	6 82	9 15
295				2	7 5	213 3	16 5	0 8	4 88	6 54
296				3	7 5	245 3			0 00	
297				4	7 5				0 00	
298				5	7 5				0 00	
299				6	7 5				0 00	
300				7	7 5				0 00	
301				8	7 5				0 00	
302				9	7 5				0 00	
303				10	7 5				0 00	
304				11	7 5				0 00	
305	52	Shanti Devi	63	1	7 5	279 7	9 8	0 81	3 86	5 17
306				2	7 5	269 0	10 1	0 82	3 85	5 16
307				3	7 5				0 00	
308				4	7 5				0 00	
309				5	7 5				0 00	
310				6	7 5				0 00	
311	53	Satyanarayan	63	1	7 5				0 00	
312				2	7 5				0 00	
313				3	10				0 00	
314				4	7 5				0 00	
315	54	T C A 28	100	1	7 5	283 0	11 6	0 8	4 54	6 08
316				2	7 5	279 3	10 8	0 8	4 19	5 62
317				3	12 5	260 3	7 6	0 8	2 73	3 66
318				4	7 5	256 3	13 2	0 8	4 69	6 28
319				5	7 5				0 00	
320				6	7 5				0 00	
321				7	7 5	205 0	17 9	0 8	5 09	6 83
322				8	7 5				0 00	
323				9	7 5				0 00	
324	55	Mange Ram	63	1	7 5				0 00	
325				2	5				0 00	
326				3	7 5				0 00	
327				4	5				0 00	
328				5	7 5				0 00	
329				6	7 5				0 00	
330	56	Dayanand	100	1	7 5	234 7	15 1	0 8	4 90	6 57
331				2	10	236 0	14 4	0 8	4 70	6 30
332				3	10	211 0	15 9	0 8	4 64	6 22
333				4	7 5				0 00	
334				5	7 5	199 3	18 9	0 8	5 21	6 99
335				6	7 5	216 0	15 1	0 8	4 51	6 04
336				7	5	169 3	8 7	0 8	2 05	2 75
337				8	7 5	179 7	10 7	0 8	2 66	3 56
338				9	7 5	157 3	23 0	0 8	5 01	6 72
339				10	5	171 7	16 3	0 8	3 87	5 19
340				11	7 5				0 00	

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
341	56A	Mahender	63	1	5				0 00	
342				2	5				0 00	
343				3	7 5				0 00	
344				4	7 5				0 00	
345				5	7 5				0 00	
346				6	7 5				0 00	
347	58	W/Supply	25	1	5	305 7	11 8	0 82	5 14	6 89
348				2	15				0 00	
349	60	Kartar	100	1	7 5	269 3	8 1	0 9	3 38	4 53
350				2	7 5	309 7	9 8	0 8	4 22	5 66
351				3	7 5	234 0	14 6	0 82	4 84	6 49
352				4	7 5	179 0	15 0	0 8	3 72	4 99
353				5	10	176 0	21 1	0 84	5 39	7 23
354				6	5	182 7	12 3	0 84	3 27	4 38
355				7	5				0 00	
356				8	7 5				0 00	
357				9	5				0 00	
358				10	7 5				0 00	
359	61	Ajeet Singh	100	1	7 5	239 0	12 1	0 8	4 01	5 37
360				2	7 5				0 00	
361				3	10				0 00	
362				4	7 5	267 7	7 4	0 8	2 76	3 70
363	62	Surat Singh	100	1	7 5	272 0	10	0 8	3 77	5 05
364				2	10	286 7	9 4	0 8	3 75	5 02
365				3	7 5	303 7	11	0 8	4 63	6 20
366				4	7 5				0 00	
367				5	10				0 00	
368	63	Jasal	100	1	7 5	270 7	9 8	0 82	3 77	5 05
369				2	7 5	257 3	10 8	0 8	3 84	5 15
370				3	7 5	239 7	11 2	0 8	3 71	4 97
371				4	7 5	234 0	11 0	0 8	3 56	4 77
372	64	TC 21	63	1	10	258 7	15 7	0 8	5 63	7 54
373				2	7 5	245 3	17 2	0 8	5 84	7 82
374				3	10	251 7	15 9	0 8	5 56	7 45
375				4	7 5	254 3	23 1	0 8	8 15	10 93
376				5	7 5				0 00	
377				6	7 5	267 3	14 3	0 8	5 31	7 12
378				7	7 5	268 3	16 5	0 8	6 13	8 22
379				8	10				0 00	
380				9	10				0 00	
381	65	Dharm Singh	100	1	7 5				0 00	
382				2	10				0 00	
383				3	10				0 00	
384				4	7 5				0 00	
385				5	7 5				0 00	
386				6	7 5				0 00	
387				7	7 5				0 00	
388				8	7 5				0 00	
389				9	7 5	188 3	20 0	0 8	5 21	6 98

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
390				10	7 5				0 00	
391				11	5	230 3	7 6	0 8	2 41	3 24
392				12	10	145 7			0 00	
393				13	7 5	237 0			0 00	
394	66	Ranbir Singh	25	1	5				0 00	
395				2	5				0 00	
396				3	5				0 00	
397				4	5				0 00	
398	67	Balder	63	1	7 5	259 3	16 5	0 86	6 37	8 54
399	70	Kawar Bhan	63	1	7 5				0 00	
400				2	7 5				0 00	
401				3	7 5				0 00	
402				4	5				0 00	
403				5	7 5				0 00	
404	71	Sube Singh	25	1	5	272 0	10 8	0 8	4 06	5 44
405				2	7 5				0 00	
406				3	7 5				0 00	
407	72	Abdul	63	1	5				0 00	
408				2	7 5				0 00	
409				3	5				0 00	
410				4	5				0 00	
411				5	7 5				0 00	
412				6	10				0 00	
413				7	5				0 00	
414	73	BS-D27	25	1	7 5	253 3			0 00	
415				2	7 5	268 3	9 8	0 8	3 63	4 87
416	73A	Jai Prakash	25	1	7 5				0 00	
417				2	7 5				0 00	
418	75	Palda Village	100	1	5	184 3	6 2	0 85	1 68	2 26
419				2	5	189 3	8 8	0 69	2 00	2 68
420				3	5	211 3	9 4	0 86	2 96	3 97
421				4	5	193 3	12 6	0 78	3 28	4 40
422				5	7 5	200 3	22 4	0 85	6 60	8 84
423				6	7 5				0 00	
424				7	7 5	244 0	13 1	0 86	4 75	6 37
425	76	W/Supply	25	1	15	293 0	19 9	0 9	9 09	12 18
426	77	Phool Kanwar	25	1	7 5				0 00	
427				2	7 7				0 00	
428				3	7 5				0 00	
429	79	Rattan Singh	100	1	7 5	288 3	8 8	0 85	3 72	4 99
430				2	7 5	153 7	11 8	0 8	2 52	3 38
431	80	Ram Kumar	63	1	7 5				0 00	
432				2	7 5	247 0			0 00	
433				3	5				0 00	
434				4	10				0 00	

Sl No	Tr No	Transformer Name	Transformer Rating	Number of pumpset	Declared HP Rating	Voltage V	Current A	P Factor PF	Pump Input kW	Actual HP Rating
435				5	7 5				0 00	
436	81	Manji Ram	63	1	7 5				0 00	
437				2	10				0 00	
438				3	5				0 00	
439				4	5				0 00	
440				5	5				0 00	
441				6	7 5				0 00	
442	82	Ishwar	63	1	5	289	8 6	0 8	3 43	4 60
443				2	5	281	8 6	0 8	3 36	4 51
444				3	5				0 00	
445				4	5				0 00	
446				5	5	263 6667	8 1	0 8	2 95	3 95
447				6	7 5				0 00	
448	83	Tekchand	100	1	5	286	10 5	0 84	4 37	5 86
449				2	7 5	257	15 7	0 88	6 16	8 26
450				3	7 5	251	14 8	0 85	5 48	7 35
451				4	7 5	247	9 8	0 85	3 58	4 79
452				5	5	255	11 8	0 86	4 48	6 01
453				6	10				0 00	
454				7	5				0 00	
455				8	7 5				0 00	
456	84	Har Ram	100	1	7 5				0 00	
457				2	7 5				0 00	
458				3	7 5				0 00	
459				4	7 5	249	11 0	0 8	3 81	5 10
460				5	7 5	269	6 9	0 8	2 57	3 45
461				6	7 5				0 00	
462				7	5				0 00	
463				8	7 5				0 00	
464				9	7 5	294	10 0	0 8	4 09	5 49
465	85	Hari Ram	100	1	7 5	185	12 7	0 8	3 25	4 36
466				2	10	223	17 2	0 86	5 70	7 65
467				3	7 5				0 00	
468				4	10	214	12 4	0 8	3 67	4 92
469				5	5	170	7 2	0 8	1 71	2 29
470				6	5	165	11 6	0 8	2 67	3 57
471				7	7 5	163	13 3	0 8	2 99	4 01

PUMP DEMAND OF WORKING PUMPSETS **1306 85 kW**

PUMP DEMAND OF NOT WORKING PUMPSETS **1099 49 kW**

TOTAL PUMP DEMAND **2406 34 kW**

NOTE

1 For the pumpsets which were not working the current and the volatge values were not available and hence have not been indicated
2 The pump demand for the non working pumpsets has been arrived at by considering a loading factor of 67% of the rated capacity of the pumpset
3 The transformer kVA ratings suggested in the proposed options for LT distribution Network are based on the actual HP of the pumpsets

ANNEXURE - C

TYPICAL CALCULATIONS

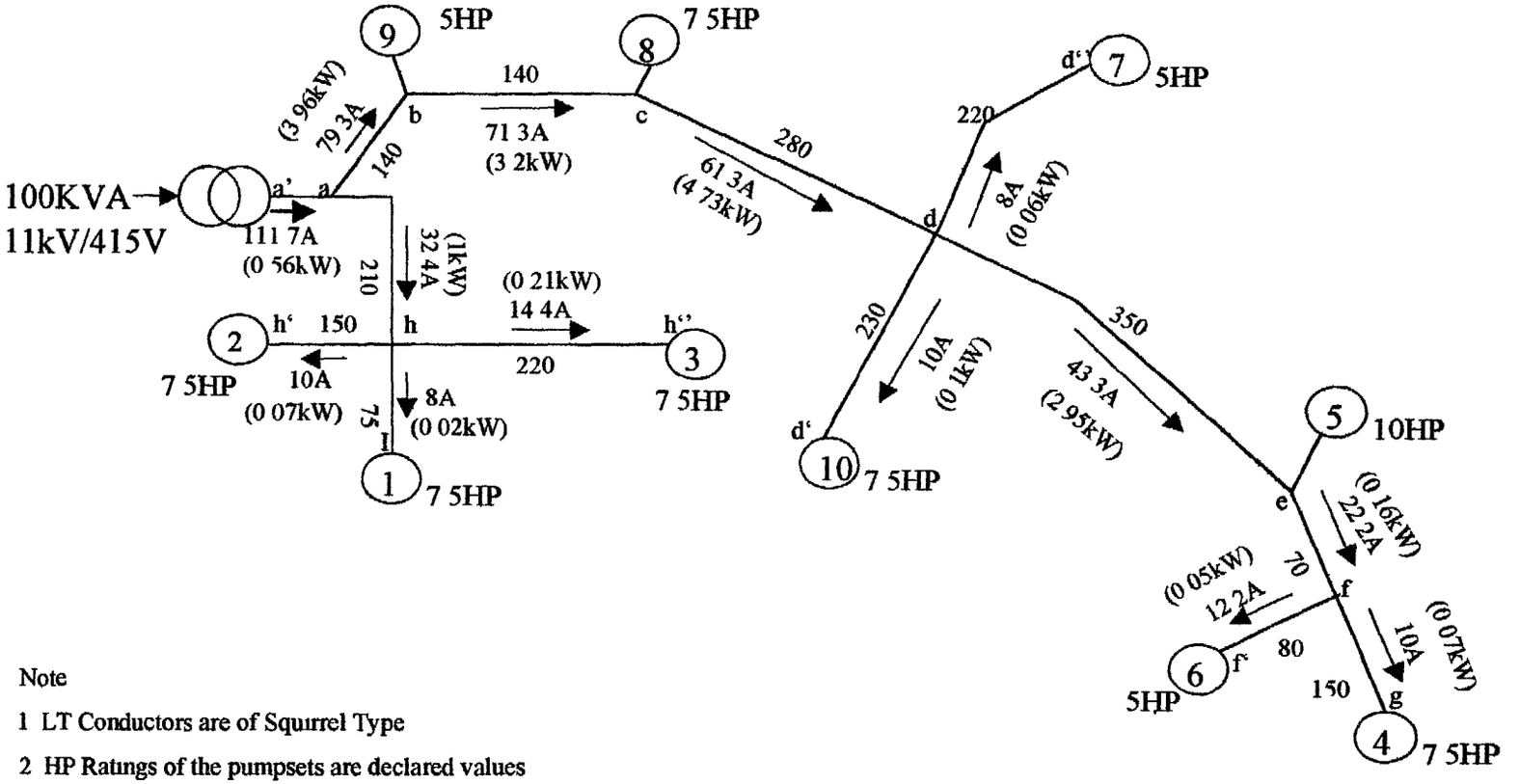
C.1. Existing System

C.2. Proposed LT less Option

C.3. Proposed Grouping Option

Tr Name Inder Singh

Tr-60



Note

1 LT Conductors are of Squirrel Type

2 HP Ratings of the pumpsets are declared values

3 Voltage Values are arrived from calculations

Not To Scale
All Dimensions in meters

	CALCULATION FOR LINE-LOSS AND VOLTAGE PROFILE						
			FOR THE EXISTING CASE				
FEEDER- PALRA, HARYANA							
TRANSFORMER NO -60							
OWNER OF TRANSFORMER INDER SINGH							
VOLTAGE			415	Volts			
TRANSFORMER CAPACITY			100	KVA			
NO OF IP SETS CONNECTED			10	Nos			
LINE SEGMENT							
a' a			10	Meters			
a-b			140	Meters			
b-c			140	Meters			
c-d			280	Meters			
d-d'			230	Meters			
d-d"			220	Meters			
d-e			350	Meters			
e-f			70	Meters			
f-f'			80	Meters			
f-g			150	Meters			
a-h			210	Meters			
h-h'			150	Meters			
h-h"			220	Meters			
h-I			75	Meters			
TYPE OFCONDUCTOR			SQUIRREL				
CONDUCTOR RESISTANCE			1 5	OHMS/KM			
				----------	SEGMENT DETAILS		- - - -
LINE SEG	PMPNO	LENGTH IN (METER	CURRENT IN (AMPS)	VOLTAGE IN (VOLTS)	P F	LOSS IN SEG(kW)	PMP DMND IN (kW)
a'-a		10	111 7	278 91		0 56	0 00
a-b	9	140	79 3	250 06	0 8	3 96	2 77
b-c	8	140	71 3	224 13	0 8	3 20	3 11
c-d		280	61 3	179 54		4 73	0 00
d-d'	10	230	10	173 56	0 8	0 10	2 40
d-d"	7	220	8	174 97	0 8	0 06	1 94
d-e	5	350	43 3	140 17	0 8	2 95	4 10
e-f		70	22 2	136 13		0 16	0 00
f-f'	6	80	12 2	133 59	0 8	0 05	2 26
f-g	4	150	10	132 23	0 8	0 07	1 83
a-h		210	32 4	261 23		0 99	0 00
h-h'	2	150	10	257 33	0 8	0 07	3 57
h-h"	3	220	14 4	253 00	0 8	0 21	5 05
h-1	1	75	8	259 67	0 8	0 02	2 88
		2325			0 8	17 14	29 90
VOLTAGE AT TRANSFORMER LT END						281 809	Volts
CURRENT AT TRANSFORMER LT END						111 7	Amps
POWER DELIVERED BY TRANSFORMER						58 81	kVA
LOSS AS A PERCENT OF POWER TRANSFER						**36 44**	**%**
NOTE	**1 The calculations was based on the field observed data**						
	2 Refer attached network drawing of transformer feeder for the segmental details						

CALCULATION FOR LINE-LOSS AND VOLTAGE PROFILE IN PROPOSED LT LESS OPTION

FEEDER PALRA, HARYANA
TRANSFORMER NO -60
OWNER OF TRANSFORMER INDER SINGH

VOLTAGE	11000	Volts
TRANSFORMER CAPACITY	100	KVA
NO OF IP SETS CONNECTED	10	Nos
LINE SEGMENT		
a'-a	10	Meters
a-b	140	Meters
b-c	140	Meters
c-d	280	Meters
d-d'	230	Meters
d-d"	220	Meters
d-e	350	Meters
e-f	70	Meters
f-f'	80	Meters
f-g	150	Meters
a-h	210	Meters
h-h'	150	Meters
h-h"	220	Meters
h-I	75	Meters
TYPE OFCONDUCTOR	SQUIRREL	
CONDUCTOR RESISTANCE	1 5	OHMS/KM

LINE SEG	PMPNO	LENGTH IN (METER	CURRENT FOR 11kV(AMPS)	VOL LVL	SEGMENT DETAILS VOLTAGE IN 11kV(kV)	P F	LOSS IN SEG (kW)	PMP DMND IN (kW)
a'-a		10	4 468	11kV	7 045		0 00090	0 00
a-b	9	140	3 172	11kV	7 041	0 8	0 00634	2 50
b-c	8	140	2 852	11kV	7 038	0 8	0 00512	3 75
c-d		280	2 452	11kV	7 033		0 00758	0 00
d-d'	10	230	0 40	11kV	7 032	0 8	0 00017	3 75
d-d"	7	220	0 32	11kV	7 032	0 8	0 00010	2 50
d-e	5	350	1 732	11kV	7 028	0 8	0 00472	5 39
e-f		70	0 888	11kV	7 028		0 00025	0 00
f-f'	6	80	0 488	11kV	7 027	0 8	0 00009	3 27
f-g	4	150	0 4	11kV	7 027	0 8	0 00011	3 72
a-h		210	1 296	11kV	7 043		0 00159	0 00
h-h'	2	150	0 4	11kV	7 042	0 8	0 00011	4 22
h-h"	3	220	0 576	11kV	7 042	0 8	0 00033	4 84
h-ı	1	75	0 32	11kV	7 042	0 8	0 00003	3 38
		2325				0 8	0 027	37 32

VOLTAGE AT TRANSFORMER LT END	7045	Volts
CURRENT AT TRANSFORMER LT END	4 468	Amps
POWER DELIVERED BY TRANSFORMER	46 68	kVA
LOSS AS A PERCENT OF POWER TRANSFER	**0 07**	%

NOTE 1 THE 11kV LINES ARE TO BE EXTENDED NEAR TO EACH PUMPSET

2 NEAR TO EACH PUMPSET 11kV/415V POLE MOUNTED TRANSFORMER WITH A TAP CHANGER OF 450V IS TO BE INSTALLED

CALCULATION FOR LINE-LOSS AND VOLTAGE PROFILE
FOR THE PROPOSED GROUPING OPTION

FEEDER PALRA, HARYANA
TRANSFORMER NO -60
OWNER OF TRANSFORMER INDER SINGH

VOLTAGE	11000/415	Volts
TRANSFORMER CAPACITY	100	KVA
NO OF IP SETS CONNECTED	10	Nos
LINE SEGMENT		
a'-a	10	Meters
a-b	140	Meters
b-c	140	Meters
c-d	280	Meters
d-d'	230	Meters
d-d"	220	Meters
d-e	350	Meters
e-f	70	Meters
f-f'	80	Meters
f-g	150	Meters
a-h	210	Meters
h-h'	150	Meters
h-h"	220	Meters
h-I	75	Meters
TYPE OFCONDUCTOR	SQUIRREL	
CONDUCTOR RESISTANCE	1 5	OHMS/KM

					SEGMENT DETAILS					
LINE SEG	PMPNO	LENGTH IN (METER	CUR F0R415V IN(AMPS)	CURRENT FO 11kV(AMPS)	VOL LVL	VOLTAGE I 11kV(kV)	VOLTAGE IN 415V(VOLTS)	P F	LOSS IN SEG (kW)	PMP DMND IN (kW)
a'-a		10		4 468	11kV	7 045			0 001	0 00
a-b	9	140		3 172	11kV	7 041		0 8	0 006	2 50
b-c	8	140	10	2 452	11kV+415	7 039	281 211	0 8	0 067	3 75
c-d		280		2 452	11kV	7 033			0 008	0 00
d-d'	10	230		0 40	11kV	7 032		0 8	0 0002	3 75
d-d"	7	220		0 32	11kV	7 033		0 8	0 0001	2 50
d-e	5	350		1 732	11kV	7 028		0 8	0 005	5 39
e-f		70		0 888	11kV	7 028			0 0002	0 00
f-f'	6	80	12 2		415V	7 028	280 814	0 8	0 054	3 27
f-g	4	150	10		415V	7 028	280 651	0 8	0 068	3 72
a-h		210		1 296	11kV	7 043			0 002	0 00
h-h'	2	150	10		415V	7 043	281 234	0 8	0 068	4 22
h-h"	3	220	14 4		415V	7 043	280 714	0 8	0 205	4 84
h-ı	1	75	8		415V	7 043	281 514	0 8	0 022	3 38
		2325						0 8	0 504	37 32

VOLTAGE AT TRANSFORMER LT END	7045	Volts
CURRENT AT TRANSFORMER LT END	4 468	Amps
POWER DELIVERED BY TRANSFORMER	47 20	kVA
LOSS AS A PERCENT OF POWER TRANSFER	**1.33**	**%**

NOTE 1 FOR THIS TRANSFORMER FEEDER , THE PUMPS RATING & LOCATION ARE SUCH THAT 1,2&3, 4,5&6, AND 8&9 CAN BE GROUPED TOGETHER TO FEED FROM THE TRANSFORMER. ONLY PUMP 7,10 WILL BE FED BY SEPARATE TRANSFORMERS DUE TO THEIR REMOTE LOCATION

2 THE 11kV LINES ARE TO BE EXTENDED NEAR TO THE GROUP OF PUMPSETS

ANNEXURE -D

TABLES

TABLE - 1

TECHNICAL DFTAILS OF LT DISTRIBUTION NETWORK UNDER STUDY

TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	LOSS IN TRF FDR IN KW	TOTAL PUMP DEMAND(KW)	TOTAL (KVA) O/P FROM TRF	LOADING OF TRF IN %	LOSS IN TRF FDR IN (%)	VOL AT TRF LT SIDE (V)	LEAST VOL AT MOTOR END(V)	MAX DROP IN TRAFO FDR. (V	MAX DROP IN TRAFO FDR. (%)
3	INDERJEET	25	3	4 42	17 67	27 20	170 0	20 32	436 18	340 00	96 18	22 05
4	JILE SINGH	100	9	8 98	50 25	77 87	121 67	19 28	351 53	277 50	74 03	21 06
5	HEMRAJ	40	2	0 53	21 45	27 48	107 32	2 39	351 20	340 00	11 20	3 19
6	TOKEYBL/BANSAL	100	7	13 05	46 26	72 12	112 69	23 49	368 38	292 38	76 00	20 63
7	JANTA FARM	100	7	8 38	59 2	83 43	130 36	12 40	357 53	313 00	44 53	12 45
8	PRAHLAD SINGH	25	2	0 65	13 9	18 19	113 7	4 44	337 80	323 30	14 50	4 29
9	ANAND SINGH	63	6	3 89	49 44	64 64	160 40	7 29	340 73	303 43	37 30	10 95
10	ANUP SINGH/D CHAND	100	6	9 94	50 43	74 53	116 45	16 46	324 39	277 55	46 84	14 44
14	TC20	100	13	18 77	83 3	120 08	187 63	18 39	329 65	231 15	98 50	29 88
14-A	RAM KUMAR	40	5	3 16	28 32	39 35	153 71	10 03	287 49	262 00	25 49	8 87
14-B	JAI KUMAR	25	3	0 42	15 95	20 46	127 9	2 54	261 59	246 17	15 42	5 89
15	BHOLA	100	8	7 77	57 43	81 50	127 34	11 90	309 71	256 00	53 71	17 34
16	KERU CHAND	63	7	3 89	39 21	52 95	131 39	9 02	280 43	255 72	24 71	8 81
17	DAYANANDA	25	2	0 43	12 12	15 69	98 0	3 40	301 50	278 70	22 80	7 56
17-A	BHAGWAN	63	6	8 79	30 82	49 51	122 86	22 21	292 21	208 67	83 54	28 59
18	RAM SWAROOP	25	2	0 61	12 83	16 80	105 0	4 47	273 30	256	17 30	6 33
19	MEHAR CHAND	100	8	3 42	49 55	62 69	97 95	6 46	293 28	255 00	38 28	13 05
20	JAGHIR SINGH	25	3	0 31	15 2	18 25	114 0	1 99	279 28	274 00	5 28	1 89
21	PURAN CHAND	63	6	9 23	36 47	50 78	126 00	20 20	372 88	275 00	97 88	26 25

TABLE - 1

TECHNICAI DETAII S OF LT DISTRIBUTION NETWORK UNDER STUDY

TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	LOSS IN TRF FDR IN KW	TOTAL PUMP DEMAND(KW)	TOTAL (KVA) O/P FROM TRF	LOADING OF TRF IN %	LOSS IN TRF FDR IN (%)	VOL AT TRF LT SIDE (V)	LEAST VOL AT MOTOR END(V)	MAX DROP IN TRAFO FDR (V	MAX DROP IN TRAFO FDR (%)
22	TCA-22	100	11	9 42	43 91	65 84	102 87	17 66	238 94	184 03	54 91	22 98
23	HARI SINGH	25	3	1 22	18 07	24 11	150 7	6 34	309 72	291 71	1 04	0 36
24	KARTAR SINGH	100	8	5 46	43 46	57 55	89 93	11 16	292 75	246 08	54 52	18 14
25	PURAN SINGH	63	3	1 94	18 18	24 54	60 88	9 66	300 60	264 22	36 38	12 10
26	NEMI CHAND	63	7	4 49	27 26	38 96	96 67	14 14	276 03	215 97	60 06	21 76
27	NEMI CHAND	63	7	5 08	36 26	50 41	125 10	12 29	249 50	206 37	43 13	17 29
28	RAVINDER SINGH	63	7	7 15	43 67	61 23	151 93	14 07	312 43	255 00	57 43	18 38
30	H SINGH	63	8	11 39	48 38	70 32	174 49	19 05	271 13	185 79	85 34	31 48
31	SARI CHAND	100	3	0 84	10 84	13 74	21 47	7 19	242 21	225 71	16 50	6 81
32	MUSHROOM FARM	100	8	4 85	30 54	43 16	67 44	13 71	258 63	201 00	57 63	22 28
33	CHETRAM	63	8	5 63	37 54	51 21	127 07	13 05	273 44	215 73	57 71	21 11
34	DAYANAND	63	6	2 21	26 17	35 48	88 03	7 79	282 09	256 11	25 98	9 21
35	DULI CHAND	100	9	17 22	44 95	76 75	119 93	27 69	248 64	173 75	74 89	30 12
35-A	HAWA SINGH	25	2	0 19	12 97	15 48	96 8	1 48	261 63	254 58	7 05	2 69
35 B	DARIYAB SINGH	63	6	8 99	27 74	44 96	111 56	24 48	271 28	186 95	84 33	31 09
36	DEVI SINGH	63	6	3 66	27 21	38 58	95 73	11 86	270 16	228 74	41 42	15 33
37	DARIYA SINGH	100	10	17 8	55 86	86 66	135 40	24 17	273 37	180 24	93 13	34 07
38	DHAN SINGH	63	8	23 96	57 72	99 71	247 41	28 48	377 49	226 75	150 74	39 93
39	CHUNNI LAL	63	7	5 08	47 24	65 40	162 28	9 71	315 88	277 00	38 88	12 31

TABLE 1

TECHNICAL DETAILS OF LT DISTRIBUTION NETWORK UNDER STUDY

TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	LOSS IN TRF FDR IN KW	TOTAL PUMP DEMAND(KW)	TOTAL (KVA) O/P FROM TRF	I OADING OF TRF IN %	LOSS IN TRF FDR IN (%)	VOL AT TRF LT SIDE (V)	LEAST VOL AT MOTOR END(V)	MAX DROP IN TRAFO FDR (V	MAX DROP IN TRAFO FDR (%)
40	JAI CHAND	25	4	1 18	19 5	25 85	161 6	5 71	255 68	240 00	15 68	6 13
41	ABSUL	63	2	1 32	8 79	12 64	31 36	13 08	266 17	235 00	31 17	11 71
42	HARKISHEN	100	10	5 36	46 11	66 25	103 52	10 11	348 38	280 34	68 04	19 53
43	PRATAP SINGH	100	9	18 53	38 56	67 14	104 91	34 51	277 67	191 08	86 59	31 18
45	JAI PRAKASH	100	4	1 41	14 57	19 02	29 72	8 84	264 29	235 00	29 29	11 08
46	SUBE SINGH	25	3	0 33	11 10	14 29	89 3	2 92	298 25	287 79	10 46	3 51
46A	MANGE RAM	25	2	0 17	10 06	12 04	75 2	1 68	316 86	310 40	6 46	2 04
47	KARAN SINGH	100	9	8 83	46 03	71 25	111 32	16 10	394 59	331 00	63 59	16 12
48	RANDHIR SINGH	63	4	2 17	15 90	22 59	56 05	12 03	318 19	280 00	38 19	12 00
49	ZILE SINGH	63	9	12 76	40 08	66 05	163 90	24 15	403 31	297 83	105 48	26 15
51	DARIYA SINGH	63	11	11 05	84 73	119 73	297 08	11 54	416 31	337 76	78 55	18 87
52	SHANTI DEVI	63	6	1 21	22 63	29 80	73 95	5 08	269 01	254 94	14 07	5 23
53	SATYA NARAYAN	63	4	0 97	20 38	26 69	66 22	4 56	339 36	320 00	19 36	5 70
54	TCA - 28	100	9	3 78	25 81	36 99	57 79	12 78	219 69	185 63	34 06	15 50
55	MANGE RAM	63	6	0 44	23 06	29 38	72 89	1 88	307 73	300 00	7 73	2 51
56	DAYANANDA	100	11	20 89	48 67	86 95	135 86	30 04	292 72	152 75	139 97	47 82
56-A	MAHINDER	63	6	0 64	23 18	29 78	73 88	2 70	310 91	300 00	10 91	3 51
58	WATER SUPPLY	25	2	0 46	10 35	13 51	84 5	4 44	307 55	291 50	16 05	5 22
60	INDER SINGH	100	9	17 14	29 9	58 80	91 88	36 44	281 81	132 20	149 61	53 09
61	AJEET SINGH	100	4	5 46	16 02	26 85	41 95	5 41	283 30	203 63	79 67	28 12

TABLE - 1

TECHNICAI DETAILS OF LT DISTRIBUTION NFTWORK UNDER STUDY

TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	LOSS IN TRF FDR IN KW	TOTAL PUMP DEMAND(KW)	TOTAL (KVA) O/P FROM TRF	LOADING OF TRF IN %	LOSS IN TRF FDR IN (%)	VOL AT TRF LT SIDE (V)	LEAST VOL AT MOTOR END(V)	MAX DROP IN TRAFO FDR (V	MAX DROP IN TRAFO FDR. (%)
62	SATYABIR SINGH	100	5	2 27	23 34	32 01	50 02	8 87	299 16	268 25	30 91	10 33
63	JAJAL	100	4	1 62	14 72	20 43	31 91	9 91	277 85	248 18	29 67	10 68
64	TCA-21	100	9	18 03	58 52	95 69	149 51	25 55	340 71	251 23	89 48	26 26
65	DHARAM SINGH	100	13	28 51	36 76	81 59	127 48	43 68	232 00	106 84	125 16	53 95
66	RANBIR SINGH	25	4	0 33	13 19	16 90	105 6	2 47	308 48	300 00	8 48	2 75
70	KAWAR BHAN	63	5	1 98	20 51	28 11	69 76	8 82	318 03	289 84	28 19	8 86
71	SUBE SINGH	25	5	0 65	15 73	20 48	128 0	3 96	290 49	276 00	14 49	4 99
72	ABDUL	63	7	2	27 40	36 75	91 19	6 79	312 35	287 78	24 57	7 87
73	BSD 27	25	2	1 077	7 88	11 20	70 0	12 00	277 57	253 00	24 57	8 85
73A	JAI PRAKASH	25	2	0 11	11 20	14 02	87 6	1 00	300 78	296 90	3 88	1 29
75	PALDA VILLAGE	100	7	9 53	20 29	37 28	58 24	31 96	271 49	181 88	89 61	33 01
77	PHOOL KANWAR	25	3	0 19	10 09	12 85	80 3	1 85	307 89	300 00	7 89	2 56
79	RATTAN SINGH	100	2	0 219	11 20	14 27	22 30	1 90	288 70	153 70	135 00	46 76
80	RAM KUMAR	63	6	1 45	17 6	23 81	59 09	7 61	246 65	220 13	26 52	10 75
81	MANJI RAM	63	6	1 28	30 67	39 94	99 10	4 02	317 67	300 00	17 67	5 56
82	ISHWAR	63	6	2 71	21 85	30 70	76 18	11 05	302 86	281 00	21 86	7 22
83	TEKCHAND	100	8	3 38	39 98	54 20	84 69	7 80	321 81	286 00	35 81	11 13
84	HARI RAM-I	100	9	3 33	26 85	37 73	58 95	11 02	280 48	234 18	46 30	16 51
85	HARI RAM-II	100	7	8 76	13 92	28 34	44 28	38 63	252 15	158 83	93 32	37 01

TABLE - 1

TECHNICAL DETAILS OF LT DISTRIBUTION NETWORK UNDER STUDY

TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	LOSS IN TRF FDR IN KW	TOTAL PUMP DEMAND(KW)	TOTAL (KVA) O/P FROM TRF	LOADING OF TRF IN %	LOSS IN TRF FDR IN (%)	VOL. AT TRF LT SIDE (V)	LEAST VOL AT MOTOR END(V)	MAX DROP IN TRAFO FDR (V	MAX DROP IN TRAFO FDR (%)
85	HARI RAM-II	100	7	8 76	13 92	28 34	44 28	38 63	252 15	158 83	93 32	37 01
TOTAL LOSS IN THE TRANSFORMER FEEDER										444 75	kW	
AVERAGE VOLTAGE DROP IN THE TRANSFORMER FEEDER										16 4	%	
AVERAGE LOSS IN TRANSFORMER FEEDERS w r t TOTAL POWER SUPP FROM SUBSTATION										11 7	%	

NOTE 1 Transformer Nos 13,59,74,86,44 and 68 cater to purely Domestic load

2 Transformer No 11 caters to purely Domestic Water Supply

3 Transformer Nos 79 and 85 caters to both agricultural and domestic load

4 However for our study purposes only agricultural load is accounted

5 Considering that the existing transformers are running for several years and are rewound at least once, their permissible loading limit has been taken as 64% of the transformer rated capacity

The % loading of existing transformers has been arrived on this basis

TABLE - 2

DETAILS OF TRANSFORMER FEEDER UNDER STUDY

SL NO	TR. NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	TOTAL PUMP DEMAND(KW)	OTAL O/P WITH ALL UMPS RUNNING (kW	TOTAL DISTANCE COVERED BY TRF FEEDER (M)
1	3	INDERJEET	25	3	17 67	22 09	805 00
2	4	JILE SINGH	100	9	50 25	59 23	2180 00
3	5	HEMRAJ	40	2	21 45	21 98	190 00
4	6	TOKEYBI/BANSAL	100	7	46 26	59 31	1880 00
5	7	JANTA FARM	100	7	59 2	67 58	1635 00
6	8	PRAHLAD SINGH	25	2	13 9	14 55	595 00
7	9	ANAND SINGH	63	6	49 44	53 33	705 00
8	10	ANUP SINGH/D CHAND	100	6	50 43	60 37	960 00
9	14	TC20	100	13	83 3	102 07	2130 00
10	14A	RAM KUMAR	40	5	28 32	31 48	635 00
11	14B	JAI KUMAR	25	3	15 95	16 37	465 00
12	15	BHOLA	100	8	57 43	65 2	1195 00
13	16	KERU CHAND	63	7	39 21	43 1	895 00
14	17	DAYANANDA	25	2	12 12	12 55	105 00
15	17A	BHAGWAN	63	6	30 82	39 61	1220 00
16	18	RAM SWAROOP	25	2	12 83	13 44	310 00
17	19	MEHAR CHAND	100	8	49 55	52 97	1215 00
18	20	JAGHIR SINGH	25	3	15 2	15 51	395 00
19	21	PURAN CHAND	63	6	36 47	45 7	1190 00
20	22	TCA-22	100	11	43 91	53 33	1805 00
21	23	HARI SINGH	25	3	18 07	19 29	385 00
22	24	KARTAR SINGH	100	8	43 46	48 92	1155 00
23	25	PURAN SINGH	63	3	18 18	20 12	455 00
24	26	NEMI CHAND	63	7	27 26	31 75	1040 00
25	27	NEMI CHAND	63	7	36 26	41 34	790 00
26	28	RAVINDER SINGH	63	7	43 67	50 82	975 00
27	30	H SINGH	63	8	48 38	59 77	1455 00
28	31	SARI CHAND	100	3	10 84	11 68	435 00
29	32	MUSHROOM FARM	100	8	30 54	35 39	1245 00
30	33	CHETRAM	63	8	37 54	43 17	1065 00

TABLE - 2

DETAILS OF TRANSFORMER FEEDER UNDER STUDY

SL NO	TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	TOTAL PUMP DEMAND(KW)	OTAL O/P WITH ALL UMPS RUNNING (kW	TOTAL DISTANCE COVERED BY TRF FEEDER (M)
31	34	DAYANAND	63	6	26 17	28 38	1205 00
32	35	DULI CHAND	100	9	44 95	62 17	1910 00
33	35A	HAWA SINGH	25	2	12 97	13 16	305 00
34	35B	DARIYAB SINGH	63	6	27 74	36 73	730 00
35	36	DEVI SINGH	63	6	27 21	30 87	925 00
36	37	DARIYA SINGH	100	10	55 86	73 66	2085 00
37	38	DHAN SINGH	63	8	57 72	81 68	1540 00
38	39	CHUNNI LAL	63	7	47 24	52 32	1225 00
39	40	JAI CHAND	25	4	19 5	20 68	590 00
40	41	ABSUL	63	2	8 79	10 11	740 00
41	42	HARKISHEN	100	10	46 11	51 47	1670 00
42	43	PRATAP SINGH	100	9	38 56	57 09	1740 00
43	45	JAI PRAKASH	100	4	14 57	15 98	805 00
44	46	SUBE SINGH	25	3	11 10	11 43	465 00
45	46A	MANGE RAM	25	2	10 06	10 23	245 00
46	47	KARAN SINGH	100	8	46 03	54 86	1780 00
47	48	RANDHIR SINGH	63	4	15 90	18 07	840 00
48	49	ZILE SINGH	63	9	40 08	52 84	1640 00
49	51	DARIYA SINGH	63	11	84 73	95 78	2305 00
50	52	SHANTI DEVI	63	6	22 63	23 84	775 00
51	53	SATYA NARAYAN	63	4	20 38	21 35	360 00
52	54	TCA - 28	100	9	25 81	29 59	1370 00
53	55	MANGE RAM	63	6	23 06	23 5	535 00
54	56	DAYANANDA	100	11	48 67	69 56	1955 00
55	56A	MAHINDER	63	6	23 18	23 82	760 00
56	58	WATER SUPPLY	25	2	10 35	10 81	450 00
57	60	INDER SINGH	100	10	29 9	36 51	2325 00
58	61	AJEET SINGH	100	4	16 02	21 48	840 00
59	62	SATYABIR SINGH	100	5	23 34	25 61	1125 00
60	63	JAJAL	100	4	14 72	16 34	1060 00

TABLE - 2

DETAILS OF TRANSFORMER FEEDER UNDER STUDY

SL NO	TR NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRAFO	NO OF IP SETS CONNECTED	TOTAL PUMP DEMAND(KW)	OTAL O/P WITH ALL UMPS RUNNING (kW	TOTAL DISTANCE COVERED BY TRF FEEDER (M)
61	64	TCA-21	100	9	58 52	76 55	1700 00
62	65	DHARAM SINGH	100	13	36 76	65 27	2640 00
63	66	RANBIR SINGH	25	4	13 19	13 52	585 00
64	70	KAWAR BHAN	63	5	20 51	22 49	790 00
65	71	SUBE SINGH	25	3	15 73	16 38	430 00
66	72	ABDUL	63	7	27 40	29 4	1575 00
67	73	BSD 27	25	2	7 88	8 957	1270 00
68	73A	JAI PRAKASH	25	2	11 20	11 2	90 00
69	75	PALDA VILLAGE	100	7	20 29	29 82	1980 00
70	77	PHOOL KANWAR	25	3	10 09	10 28	370 00
71	79	RATTAN SINGH	100	2	11 20	11 2	340 00
72	80	RAM KUMAR	63	5	17 6	19 05	735 00
73	81	MANJI RAM	63	6	30 67	31 95	1005 00
74	82	ISHWAR	63	6	21 85	24 56	1380 00
75	83	TEKCHAND	100	8	39 98	43 36	760 00
76	84	HARI RAM-I	100	9	26 85	30 18	2110 00
77	85	HARI RAM-II	100	7	13 92	22 68	1280 00

TOTAL POWER O/P FROM THE TRANSFORMER FEEDER UNDER STUDY **2758 79 kW**

TOTAL POWER DEMAND OF THE IP SETS UNDER STUDY **2359 6 kW**

TOTAL DISTANCE COVERED BY THE TRANSFORMER FEEDER **82 85 KM**

NOTE

1 Transformer Nos 13,59,74,86,44 and 68 cater to purely Domestic load

2 Transformer No 11 caters to purely Domestic Water Supply

3 Transformer Nos 79 and 85 caters to both agricultural and domestic load

4 How ever for our study purposes we have considered agricultural load alone

TABLE - 3

DETAIL OF TRANSFORMER FEEDERS FEEDING ONE PUMP

SL NO	TRAFO NO	OWNER OF THE TRANSFORMER	KVA RATING OF TRANSFORMER	NO OF IP SETS CONNECTED	TOTAL PUMP SET DEMAND(KW)	TOTAL LOAD ON TRF (KW)	TOTAL DISTANCE COVERED BY TRF FDR(METER)
1	1	DHARAM SINGH	25	1	6 08	6 20	7
2	2	LD SYSTEM	100	1	3 8	3 88	35
3	12	SUBE SINGH	63	1	3 8	3 88	25
4	15-A	RAM SARUP	25	1	6 00	6 12	350
5	38-A	MEHTAB SINGH	25	1	7 49	7 64	10
6	50	DHARAM SINGH	25	1	3 8	3 88	80
7	67	BALDEV/ LD SYSTEM	25	1	6 37	6 50	360
8	76	GOVT	25	1	9 09	9 27	10

TOTAL POWER O/P FROM TRANSFORMERS UNDER STUDY **47 36 kW**

TOTAL POWER DEMAND OF THE IP SETS **46 4 kW**

DISTANCE COVERED BY TRANSFORMER FEEDERS **877 0 METER**

TABLE 4
DETAILS OF REQUIREMENTS OF PROPOSED OPTIONS

Trf No	Trf Rating (KVA)	Proposed LT Less Option			Proposed Grouping Configuration			
		HT Line for Conversion(Meter)	New Trf Required Nos	kVA	HT Line for Conversion (Meter)	New LT Line Reqd (Meter)	New Trf Required Nos	kVA
3	25	805	3	15	685	0	2	25
4	100	2180	9	15	1670	60	6	25
5	40	190	1	15	160	0	2	25
			1	25				
6	100	1880	7	15	1855	0	6	25
7	100	1635	6	15	1400	0	5	25
			1	25				
8	25	595	2	15	595	0	2	25
9	63	705	3	15	625	0	5	25
			3	25				
10	100	960	5	15	815	80	5	25
			1	25				
14	100	2130	13	15	1800	200	8	25
14-A	40	635	5	15	565	140	3	25
14-B	25	465	3	15	455	110	2	25
15	100	1195	8	15	840	0	5	25
16	63	895	7	15	620	190	4	25
17	25	105	2	15	0	0	1	25
17-A	63	1220	5	15	865	170	4	25
			1	25				
18	25	310	1	15	310	0	2	25

TABLE 4
DETAILS OF REQUIREMENTS OF PROPOSED OPTIONS

Trf No	Trf Rating (KVA)	Proposed LT Less Option			Proposed Grouping Configuration			
		HT Line for Conversion(Meter)	New Trf Required Nos	kVA	HT Line for Conversion (Meter)	New LT Line Reqd (Meter)	New Trf Required Nos	kVA
			1	25				
19	100	1215	8	15	855	95	5	25
20	25	395	3	15	125	0	2	25
21	63	1190	6	15	1120	250	4	25
22	100	1805	11	15	1590	140	7	25
23	25	385	3	15	300	70	2	25
24	100	1155	8	15	790	330	4	25
25	63	455	3	15	460	0	2	25
26	63	1040	7	15	810	370	4	25
27	63	790	7	15	565	80	4	25
28	63	975	7	15	750	70	4	25
30	63	1455	8	15	1235	130	5	25
31	100	435	3	15	300	0	2	25
32	100	1245	8	15	875	185	5	25
33	63	1065	8	15	865	70	5	25
34	63	1205	6	15	905	190	4	25
35	100	1910	9	15	1470	230	5	25
35-A	25	305	2	15	70	70	1	25
35-B	63	730	6	15	575	70	3	25

TABLE 4
DETAILS OF REQUIREMENTS OF PROPOSED OPTIONS

Trf No	Trf Rating (KVA)	Proposed LT Less Option			Proposed Grouping Configuration			
		HT Line for Conversion(Meter)	New Trf Required Nos	kVA	HT Line for Conversion (Meter)	New LT Line Reqd (Meter)	New Trf Required Nos	kVA
36	63	925	6	15	775	60	4	25
37	100	2085	10	15	1685	220	6	25
38	63	1540	8	15	1220	0	5	25
39	63	1225	7	15	1145	150	5	25
40	25	590	4	15	590	0	3	25
41	63	740	2	15	740	0	2	25
42	100	1670	10	15	1430	0	6	25
43	100	1740	9	15	1390	0	6	25
45	100	805	4	15	620	0	2	25
46	25	465	3	15	290	0	2	25
46A	25	245	2	15	155	110	1	25
47	100	1780	8	15	1570	530	4	25
48	63	840	4	15	560	110	2	25
49	63	1640	9	15	1425	140	6	25
51	63	2305	11	15	1780	0	7	25
52	63	775	6	15	635	140	4	25
53	63	360	4	15	220	70	2	25
54	100	1370	9	15	1090	70	6	25

TABLE 4

DETAILS OF REQUIREMENTS OF PROPOSED OPTIONS

Trf No	Trf Rating (KVA)	Proposed LT Less Option			Proposed Grouping Configuration			
		HT Line for Conversion(Meter)	New Trf Required Nos	kVA	HT Line for Conversion (Meter)	New LT Line Reqd (Meter)	New Trf Required Nos	kVA
55	63	535	6	15	150	0	3	25
56	100	1955	11	15	1570	140	7	25
56-A	63	760	6	15	220	0	3	25
58	25	450	1	15	450	0	2	25
			1	25				
60	100	2325	10	15	1870	210	6	25
61	100	840	4	15	840	210	2	25
62	100	1125	5	15	1015	0	5	25
63	100	1060	4	15	780	110	2	25
64	100	1700	9	15	1100	320	5	25
65	100	2640	13	15	2290	645	8	25
66	25	585	4	15	440	140	2	25
70	63	790	5	15	470	105	3	25
71	25	430	3	15	345	70	2	25
72	63	1575	7	15	1030	70	5	25
73	25	1270	2	15	1270	140	1	25
73A	25	90	2	15	0	0	1	25
75	100	1980	7	15	1840	70	5	25

TABLE 4

DETAILS OF REQUIREMENTS OF PROPOSED OPTIONS

Trf No	Trf Rating (KVA)	Proposed LT Less Option			Proposed Grouping Configuration			
		HT Line for Conversion(Meter)	New Trf Required Nos	kVA	HT Line for Conversion (Meter)	New LT Line Reqd (Meter)	New Trf Required Nos	kVA
77	25	370	3	15	290	70	2	25
79	100	340	2	15	340	0	2	25
80	63	735	5	15	735	120	3	25
81	63	1005	6	15	795	250	3	25
82	63	1380	6	15	1000	140	4	25
83	100	760	8	15	450	140	5	25
84	100	2110	9	15	1975	70	6	25
85	100	1280	7	15	1205	80	5	25

NOTE

LT LESS OPTION

1 Total Length for HT Line Conversion in proposed LT Less Option is **82 85 KM**

2 Total number of Transformers required for the Proposed LT Less Option is **463**

a) 15 kVA **454**

b) 25 kVA **9**

GROUPING OPTION

1 Total Length for HT Line Conversion in proposed Grouping Option is **66 71 KM**

2 Total Length of New LT Line required for the proposed Grouping Option is **8 00 KM**

3 Total number of Transformers required for the Proposed Grouping Option is

a) 25 kVA **295**

ANNEXURE-E

FINANCIAL ANALYSIS FOR DISTRIBUTION NETWORK

ANNEXURE - F

DRAWINGS FOR DISTRIBUTION NETWORK

LT NETWORK DRAWINGS

F 1 REPRESENTATIONS OF THE PROPOSED OPTIONS IN THE LT DRAWINGS

F 2 DISTRIBUTION TRANSFOMERS WITH 2 PUMPSETS CONNECTED ALONG WITH THE PROPOSED OPTIONS

F 3 DISTRIBUTION TRANSFORMERS WITH MORE THAN 2 PUMPSETS CONNECTED WITH THE PROPOSED OPTIONS

F 4 DISTRIBUTION TRANSFORMERS WITH 1 PUMPSET CONNECTED (NOT UNDER STUDY)

HT NETWORK DRAWING

PALRA FEEDER **CASE 1** **PROPOSAL FOR LT LESS SYSTEM WITH HT SYSTEM WITH EXISTING TYPE OF CONDUCTORS**

PROJECTED PROFIT AND LOSS ACCOUNT FOR TEN YEARS

at constant prices

(ALL FIG ARE IN Rs MILLIONS UNLESS STATED OTHERWISE)

YEAR		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
REVENUE											
ENERGY SAVINGS		4 086	4 086	4 086	4 086	4 086	4 086	4 086	4 086	4 086	4 086
AVOIDED COST IN TRANSFORMER MAINTENANCE		0 392	0 392	0 392	0 392	0 392	0 392	0 392	0 392	0 392	0 392
		4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478
EXPENDITURE		0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
PROFIT BEFORE INTEREST AND DEPRECIATION (PBID)		4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478	4 478
INT ON DEBT		1 516	1 287	1 059	0 830	0 601	0 372	0 143	0 000	0 000	0 000
DEPRECIATION		3 815	2 861	2 146	1 609	1 207	0 905	0 679	0 509	0 382	0 286
PROFIT BEFORE TAX (PBT)		-0 853	0 329	1 274	2 039	2 670	3 201	3 656	3 969	4 096	4 192
TAXES	35%	0 000	0 000	0 000	0 000	0 000	1 120	1 280	1 389	1 434	1 467
PROFIT AFTER TAX (PAT)		-0 853	0 329	1 274	2 039	2 670	2 081	2 376	2 580	2 662	2 725
CASH ACCRUALS (DEPR + NET PR)		2 962	3 191	3 419	3 648	3 877	2 986	3 055	3 089	3 044	3 011
REPAYMENT		1 635	1 635	1 635	1 635	1 635	1 635	1 635	0 000	0 000	0 000
NET CASH ACCRUALS		1 327	1 556	1 785	2 013	2 242	1 351	1 420	3 089	3 044	3 011
D S C R		1 421	3 310	3 560	3 860	4 210	3 270	3 590	---	---	---
Avg D S C R		3 32									
IRR CASH FLOW RATE	-15 259	4 478	4 478	4 478	4 478	4 478	3 228	3 148	3 089	3 044	3 011

PALRA FEEDER **CASE 2** **PROPOSAL FOR GROUPING SYSTEM WITH HT SYSTEM WITH EXISTING TYPE OF CONDUCTORS**

PROJECTED PROFIT AND LOSS ACCOUNT FOR TEN YEARS

at constant prices

(ALL FIG ARE IN Rs MILLIONS UNLESS STATED OTHERWISE)

YEAR		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
REVENUE											
ENERGY SAVINGS		3 894	3 894	3 894	3 894	3 894	3 894	3 894	3 894	3 894	3 894
AVOIDED COST IN TRANSFORMER MAINTENANCE		0 402	0 402	0 402	0 402	0 402	0 402	0 402	0 402	0 402	0 402
		4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296
EXPENDITURE		0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
PROFIT BEFORE INTEREST AND DEPRECIATION (PBID)		4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296	4 296
INT ON DEBT		1 319	1 120	0 921	0 722	0 523	0 324	0 124	0 000	0 000	0 000
DEPRECIATION		3 319	2 489	1 867	1 400	1 050	0 788	0 591	0 443	0 332	0 249
PROFIT BEFORE TAX (PBT)		-0 342	0 686	1 508	2 174	2 723	3 185	3 581	3 853	3 963	4 047
TAXES	35%	0 000	0 000	0 000	0 000	0 000	1 115	1 253	1 348	1 387	1 416
PROFIT AFTER TAX (PAT)		-0 342	0 686	1 508	2 174	2 723	2 070	2 327	2 504	2 576	2 630
CASH ACCRUALS (DEPR + NET PR)		2 976	3 176	3 375	3 574	3 773	2 858	2 918	2 947	2 909	2 879
REPAYMENT		1 422	1 422	1 422	1 422	1 422	1 422	1 422	0 000	0 000	0 000
NET CASH ACCRUALS		1 554	1 753	1 952	2 152	2 351	1 435	1 496	2 947	2 909	2 879
D S C R		1 567	3 310	3 560	3 860	4 210	3 270	3 590	---	---	---
Avg D S C R		3 338									
IRR CASH FLOW RATE	-13 275	4 296	4 296	4 296	4 296	4 296	3 068	2 999	2 947	2 909	2 879

ANNEXURE - F

DRAWINGS FOR DISTRIBUTION NETWORK

LT NETWORK DRAWINGS

F 1 REPRESENTATIONS OF THE PROPOSED OPTIONS IN THE LT DRAWINGS

F 2 DISTRIBUTION TRANSFOMERS WITH 2 PUMPSETS CONNECTED ALONG WITH THE PROPOSED OPTIONS

F 3 DISTRIBUTION TRANSFORMERS WITH MORE THAN 2 PUMPSETS CONNECTED WITH THE PROPOSED OPTIONS

F 4. DISTRIBUTION TRANSFORMERS WITH 1 PUMPSET CONNECTED (NOT UNDER STUDY)

HT NETWORK DRAWING

LT NETWORK SKETCHES

LEGEND

———— Existing LT network

⊛ Existing pumpset * The No of pumpset

 Incoming HT line and existing distribution transformer (This transformer is removed in both proposed options)

- - - - - - - - Conversion of existing LT lines to 11kV HT line for the proposed options

 New pole mounted transformers for proposed options

═══ Reusing the existing LT line in the proposed grouping configuration

— — New LT line as per requirements of proposed grouping configuration

 Represents the reusing of the existing Transformers for single pumpsets

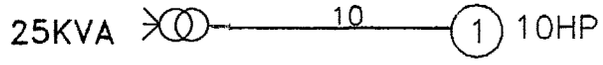
Note

1 All LT Conductors are of "Squirrel type"
2 HP values mentioned for Pump Sets are based on the declared HP ratings
3 The proposed options are based on the actual pump HP
4 For proposed LT Less and grouping option, all the pole mounted transformers will be of 11kV/450V,* maintenance free type
5 The grouping is done on the following
  i The total HP of grouped pumps not to exceed 20HP
  ii The distance between the pumps not to exceed 150Mts
6 All the LT Network Diagrams are based on field observations

* Trf Rating to be read as 11 kV/415 V, with a tap of 450V

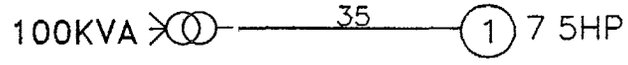
DISTRIBUTION TRANSFORMERS WITH 1 PUMPSET

CONNECTED (NOT UNDER STUDY)



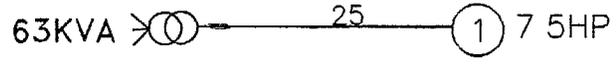
Tr Name Dharam Singh
Tr Capacity 25KVA

HCL\HVPN\PF\Tr-1



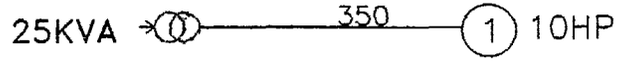
Tr Name LD system
Tr Capacity 100KVA

HCL\HVPN\PF\Tr-2



Tr Name Sube Singh
Tr Capacity 63KVA

HCL\HVPN\PF\Tr-12



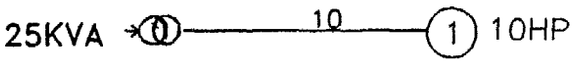
Tr Name Ramsarup
Tr Capacity 25KVA

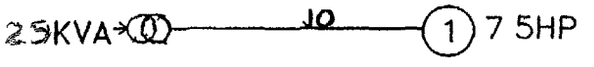
HCL\HVPN\PF\Tr-15-A

All Dimensions Are In Metres
Not To Scale
Drawn By BVN

Project Name DSM Study-HVPN
Feeder Name Palra

3EC
Energy Economy & Environmental Consultants



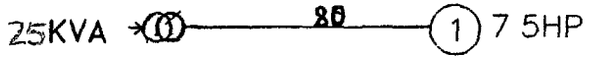


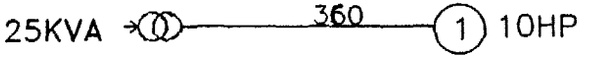
Tr Name Mehtab Singh
Tr Capacity 25KVA

HCL\HVPN\PF\Tr-38-A

Tr Name GOVT
Tr Capacity : 25KVA

HCL\HVPN\PF\Tr-76





Tr Name Dharam Singh
Tr Capacity 25KVA

HCL\HVPN\PF\Tr-50

Tr Name Baldev/LO system
Tr Capacity 25KVA

HCL\HVPN\PF\Tr-67

All Dimensions Are In Metres
Not To Scale
Drawn By : BVN

Project Name DSM Study-HVPN
Feeder Name Palra

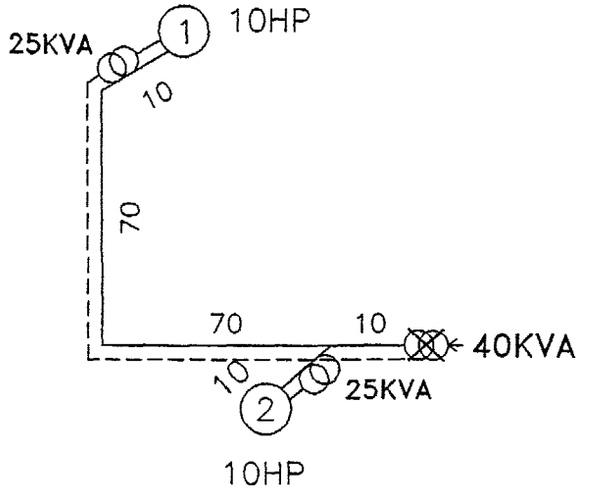
3EC
Energy Economy & Environmental Consultants

DISTRIBUTION TRANSFOMERS WITH 2 PUMPSETS

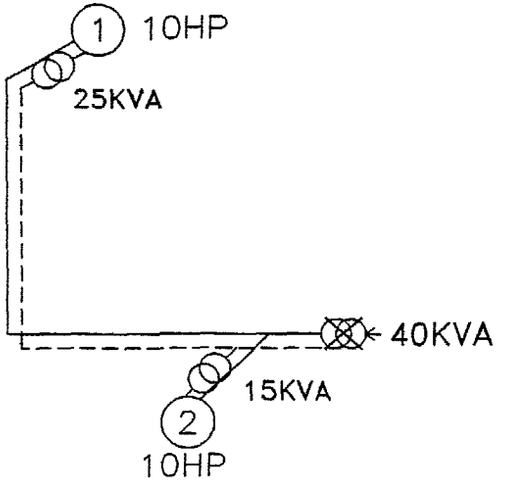
CONNECTED ALONG WITH THE PROPOSED

OPTIONS

Grouping Option



LT Less option



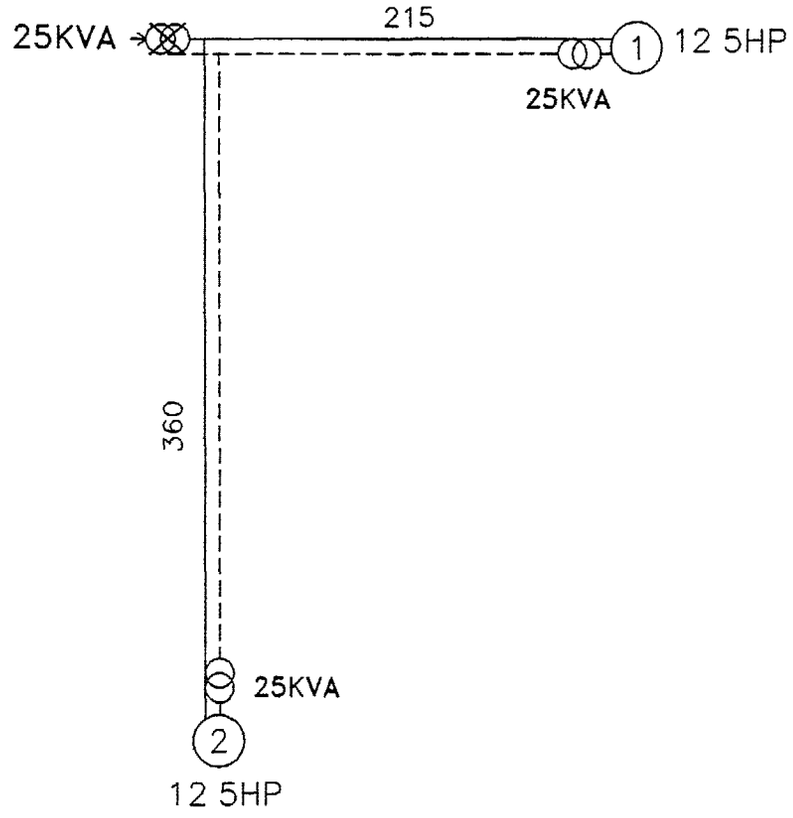
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-5

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Hemraj

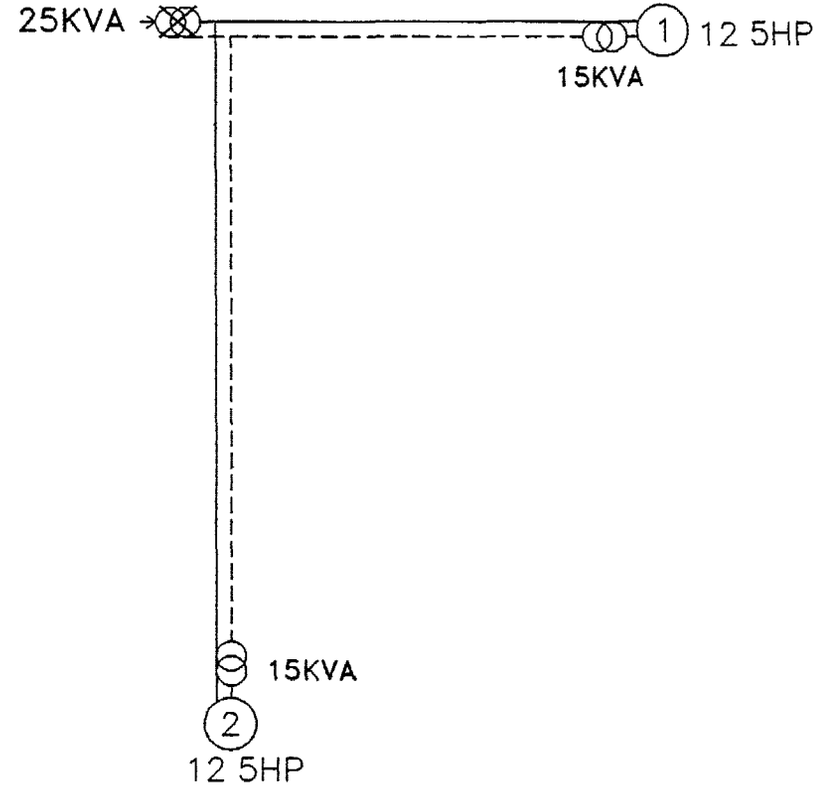
Tr Capacity 40KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less option



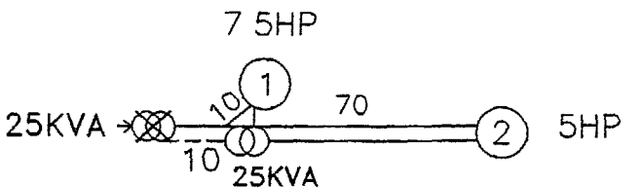
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-8

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Prahlad Singh

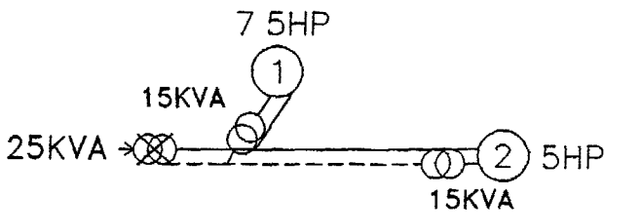
Tr Capacity 25KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

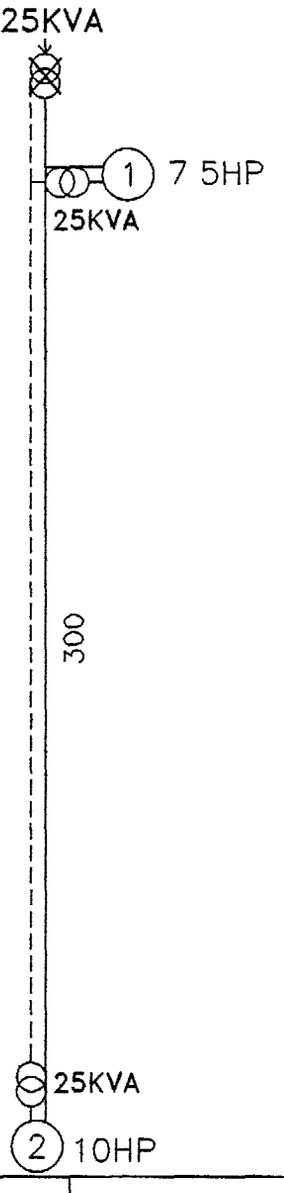


LT Less option

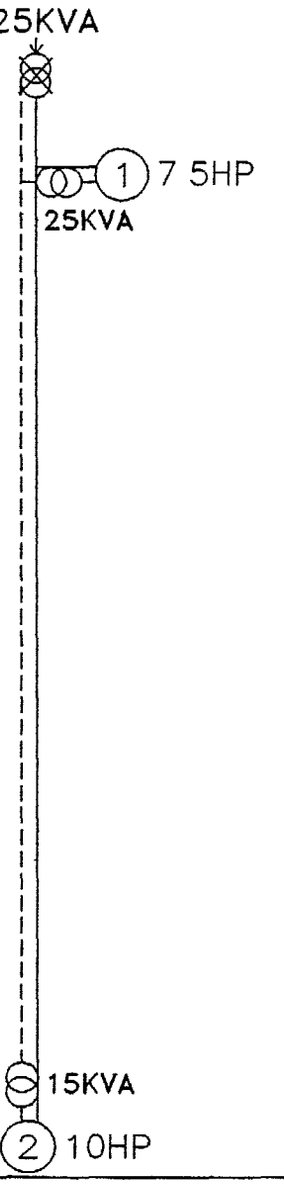


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-17	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Dayananda Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less option



All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-18

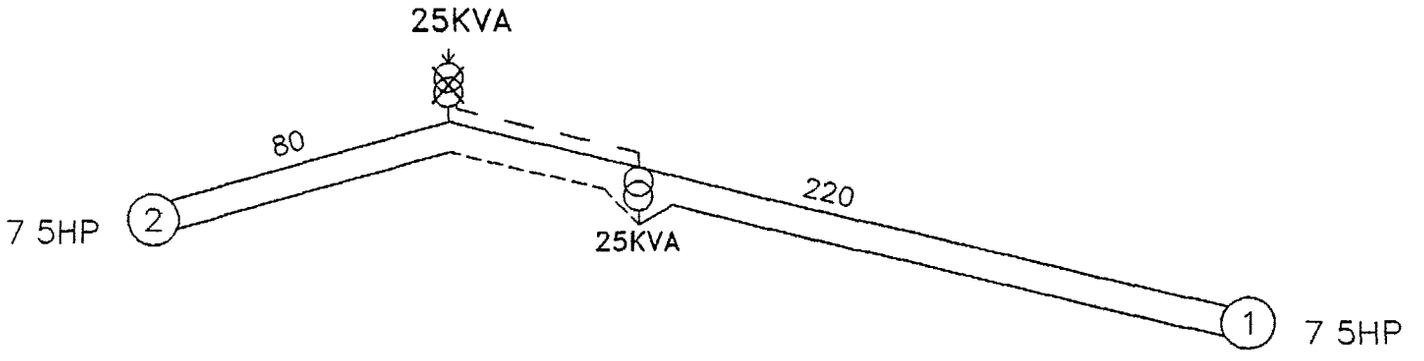
Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Ram Swaroop

Tr Capacity 25KVA

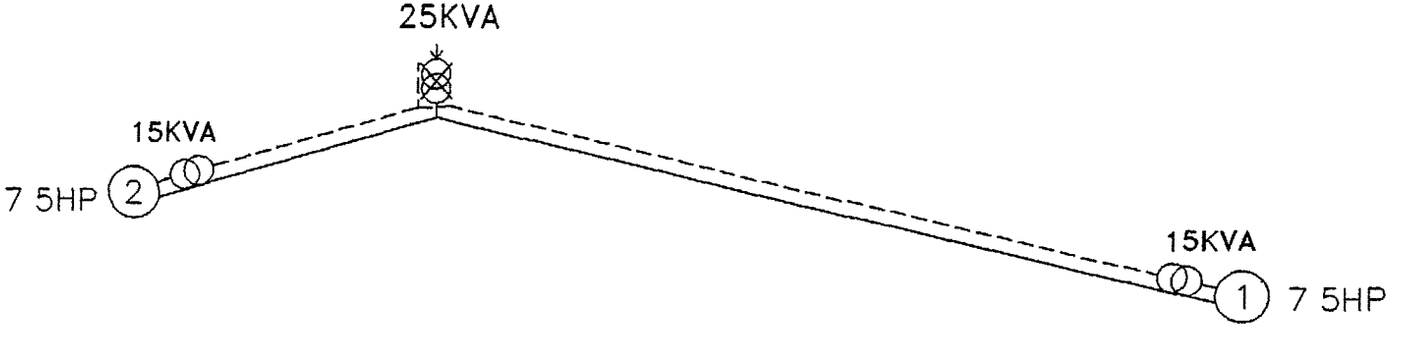
3EC
Energy Economy & Environmental Consultants

18

Grouping Option

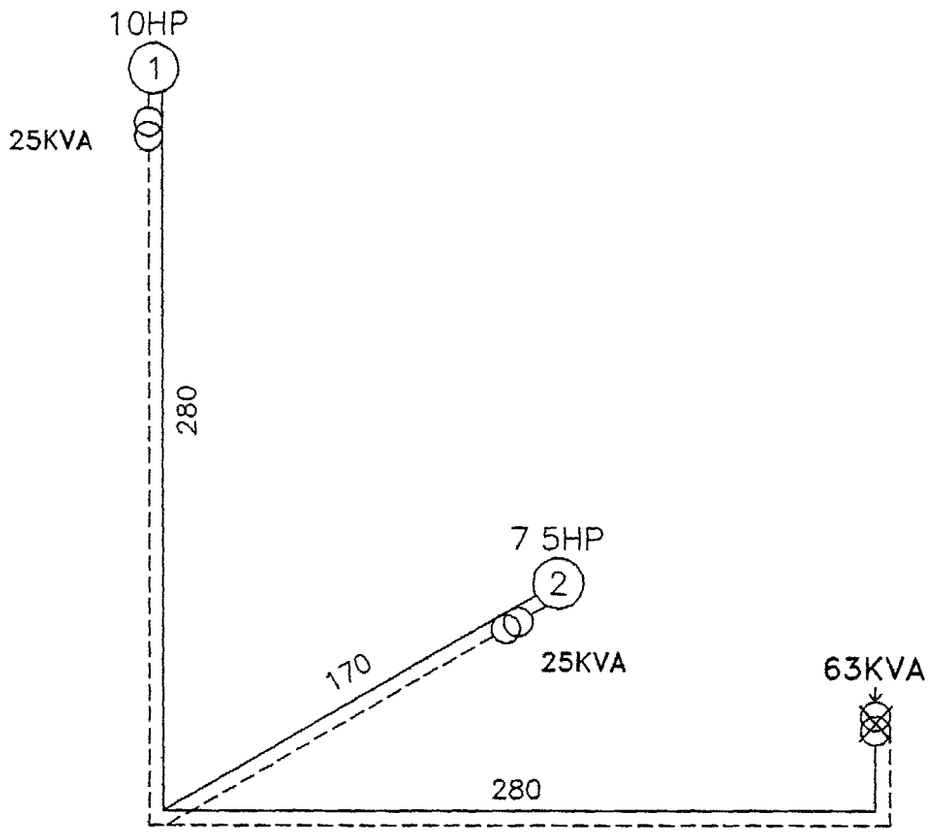


LT Less Option

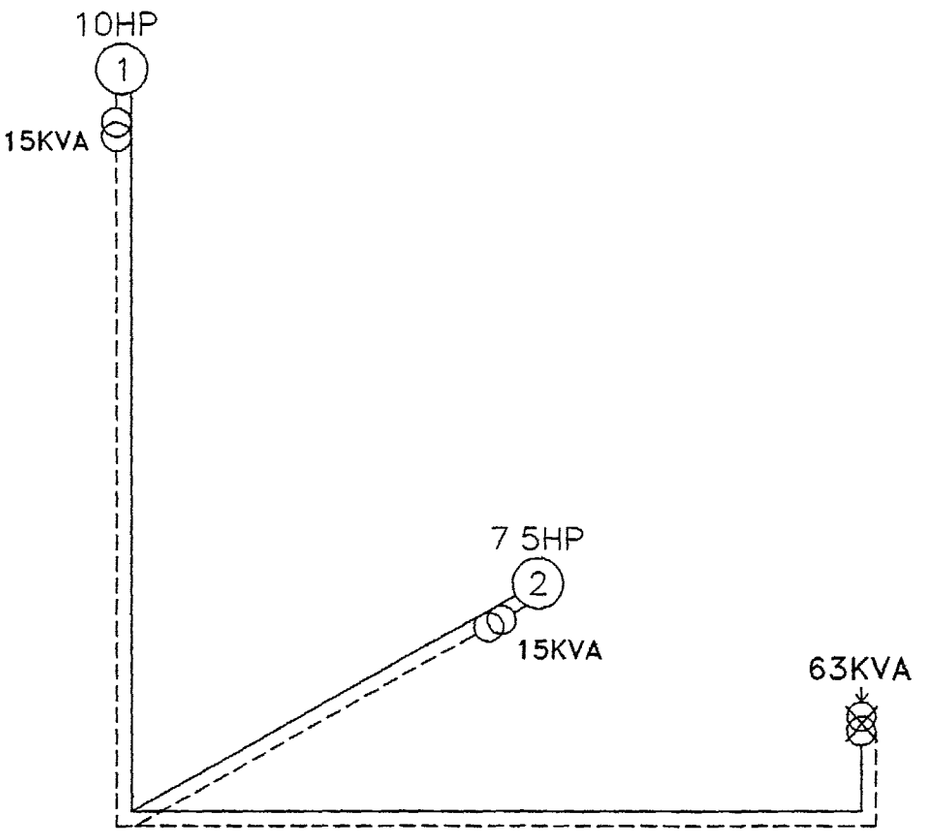


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-35A	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Hawa Singh Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



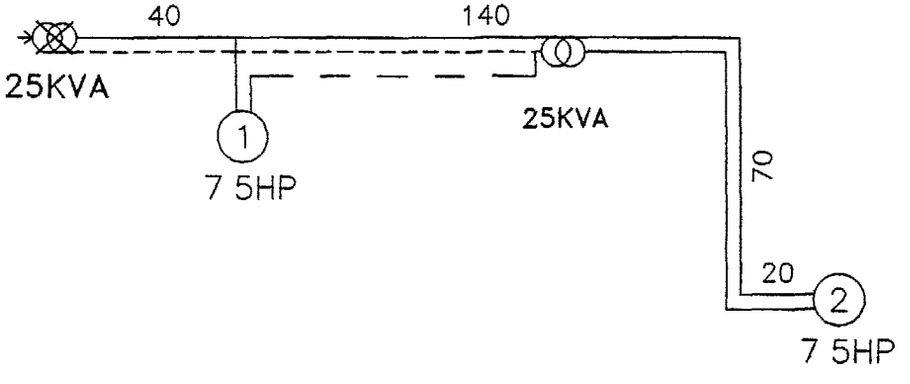
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-41

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Absul

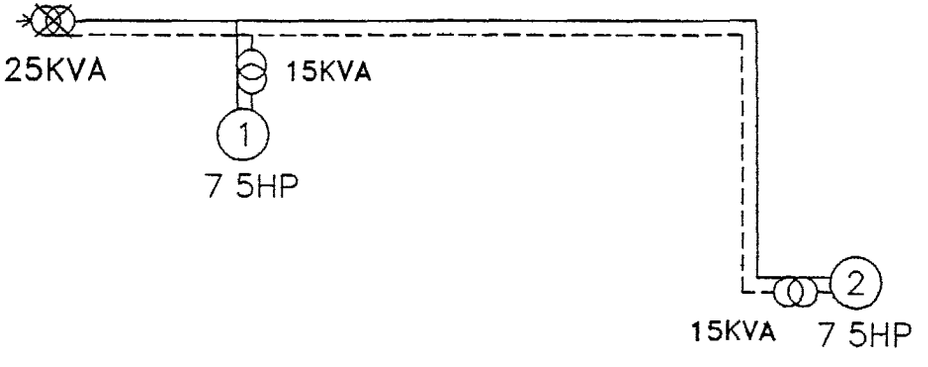
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



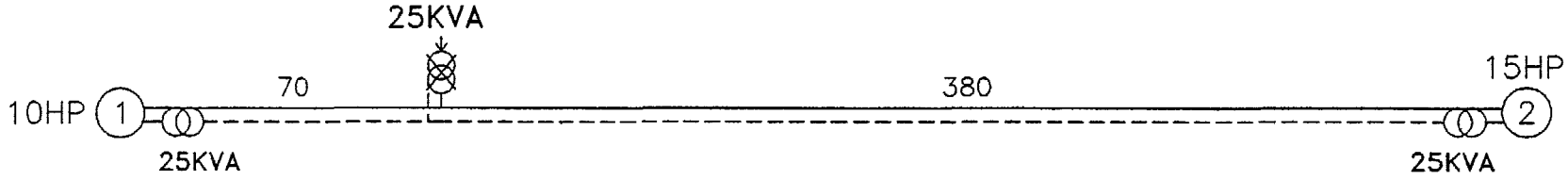
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-46A

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Mange Ram

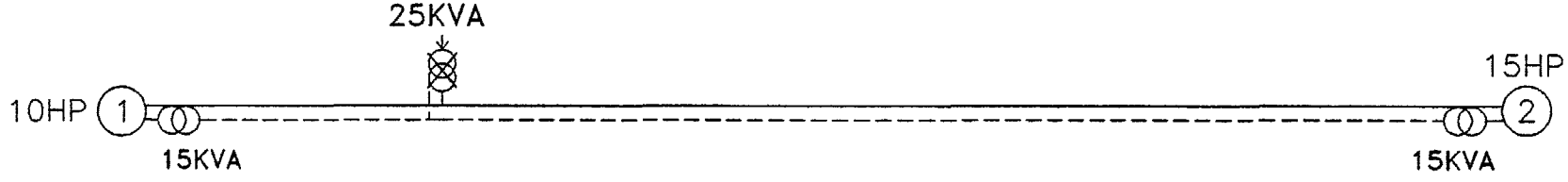
Tr Capacity 25KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

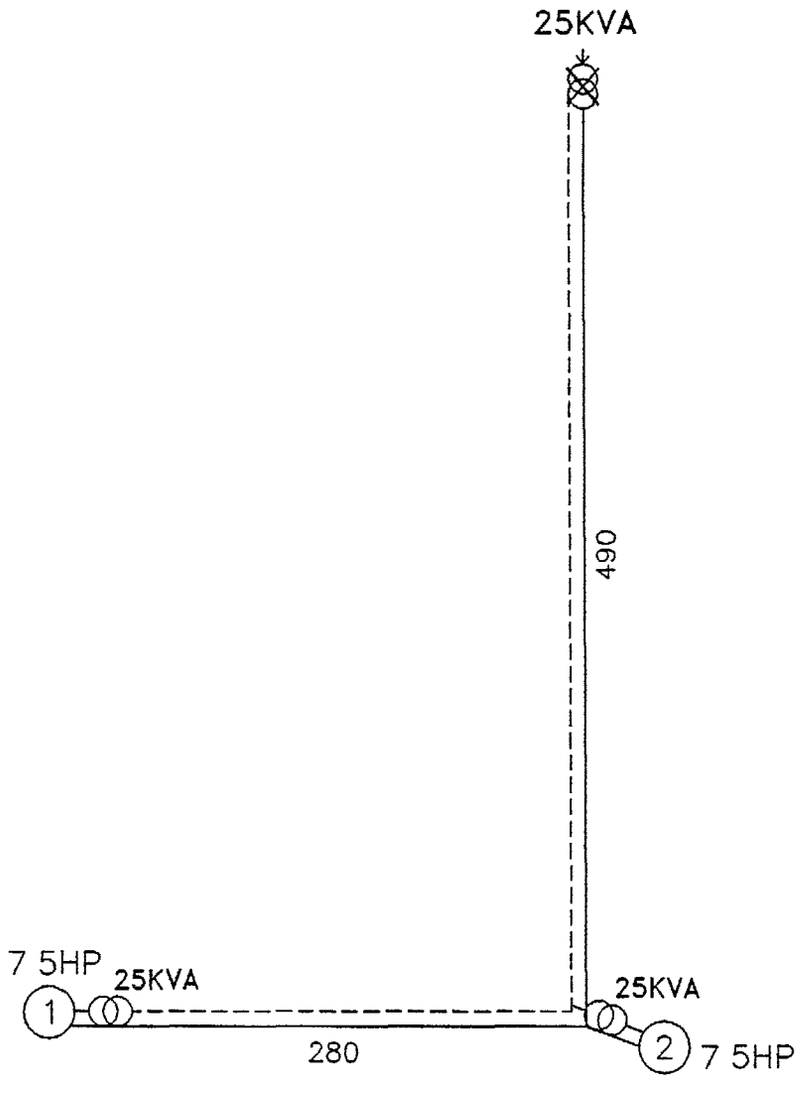


LT Less Option

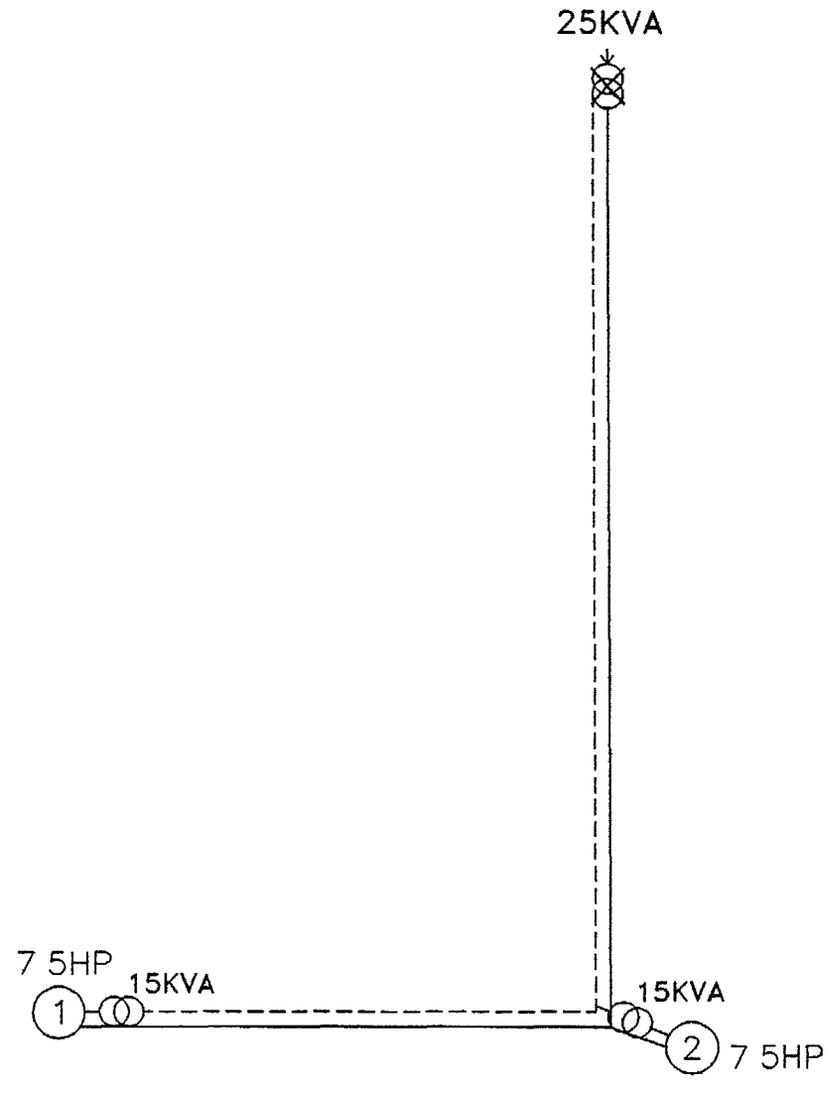


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-58	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Water Supply Tr Capacity 25kVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



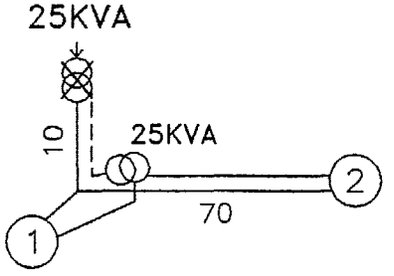
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-73

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name bsd-27

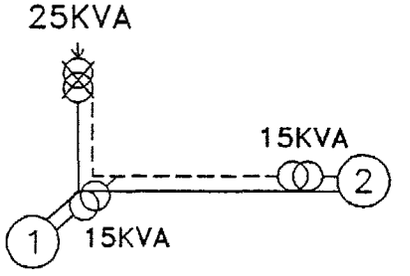
Tr Capacity 25KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



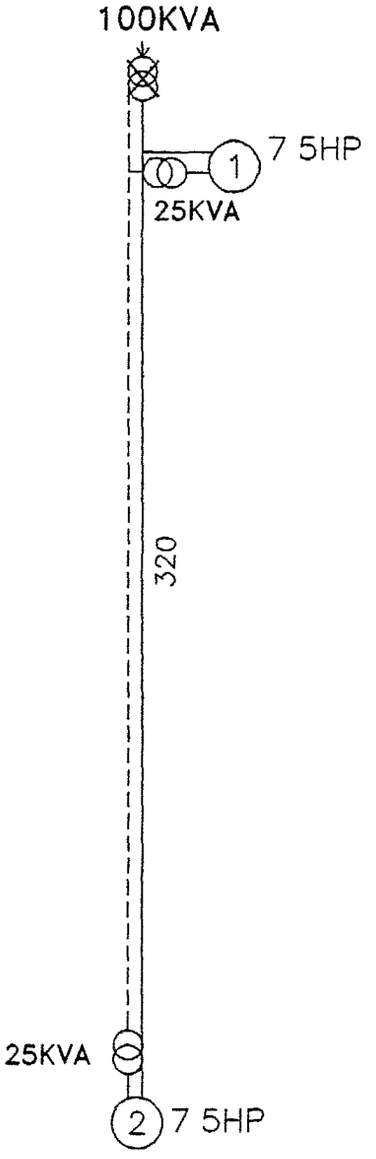
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-73A

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Jai prakash

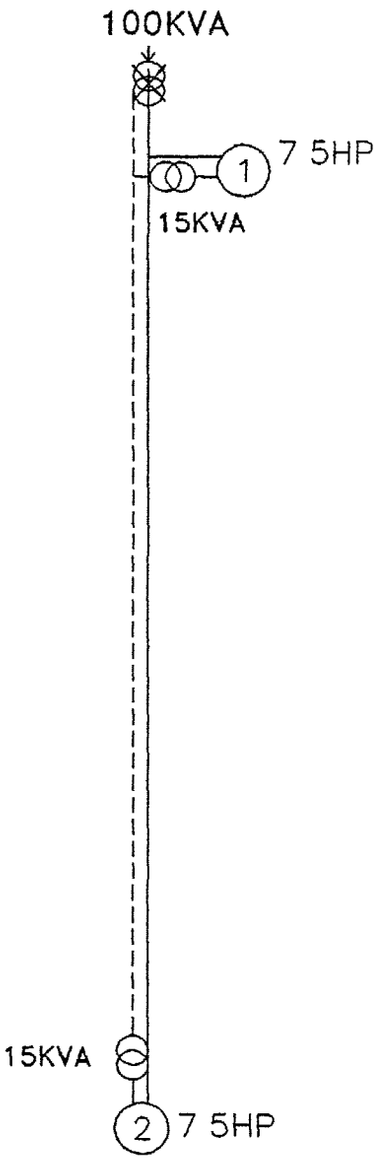
Tr Capacity 25KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-79

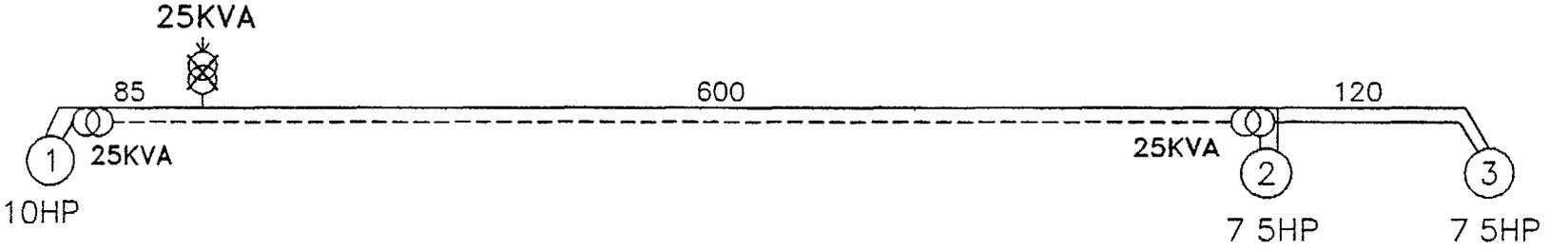
Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Rattan Singh

Tr Capacity 100KVA

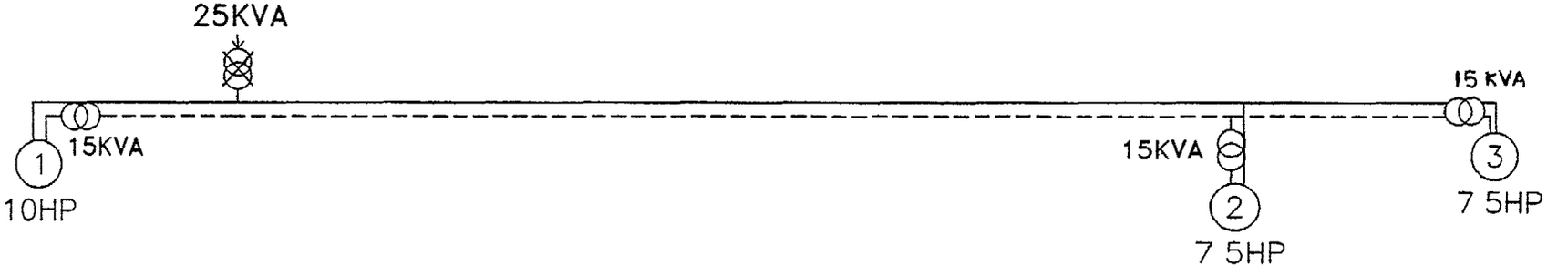
3EC
Energy Economy & Environmental Consultants

DISTRIBUTION TRANSFORMERS WITH MORE THAN 2 PUMPSETS CONNECTED WITH THE PROPOSED OPTIONS

Grouping Option

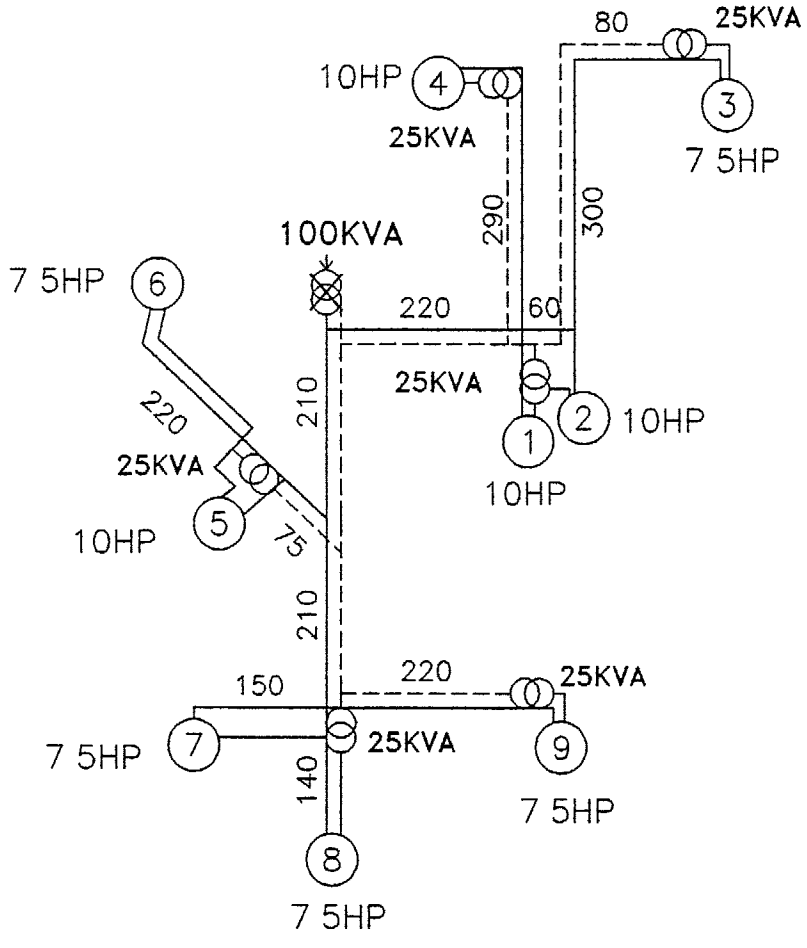


LT Less Option

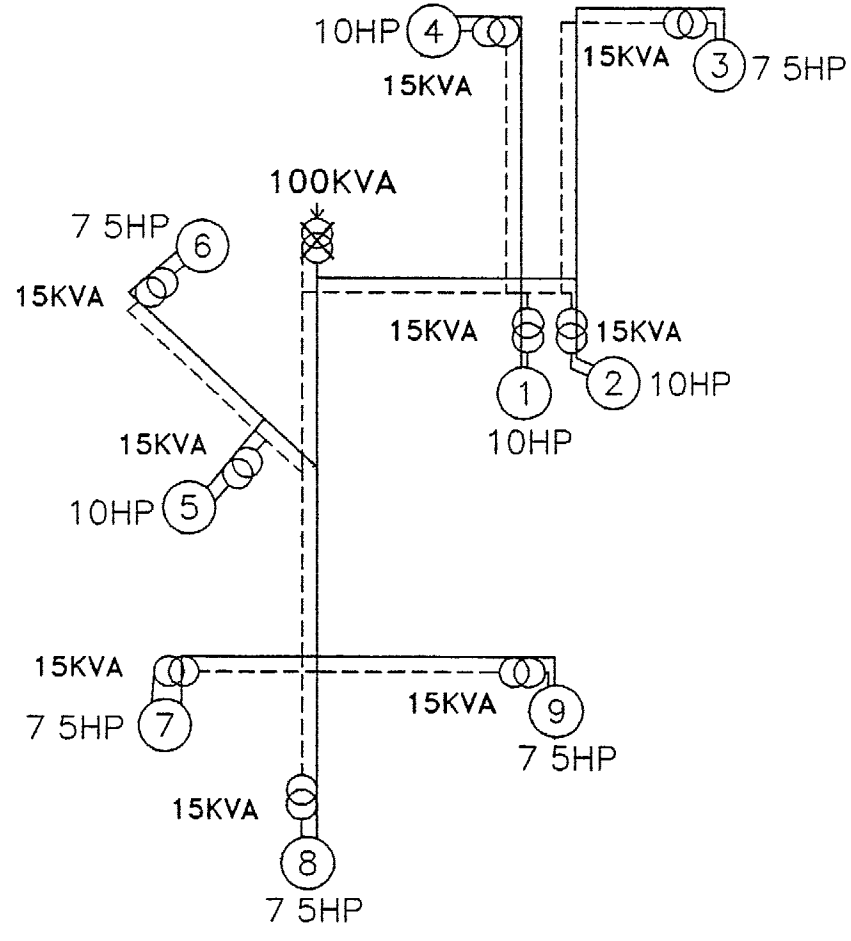


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-3	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Indeer Jeet Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

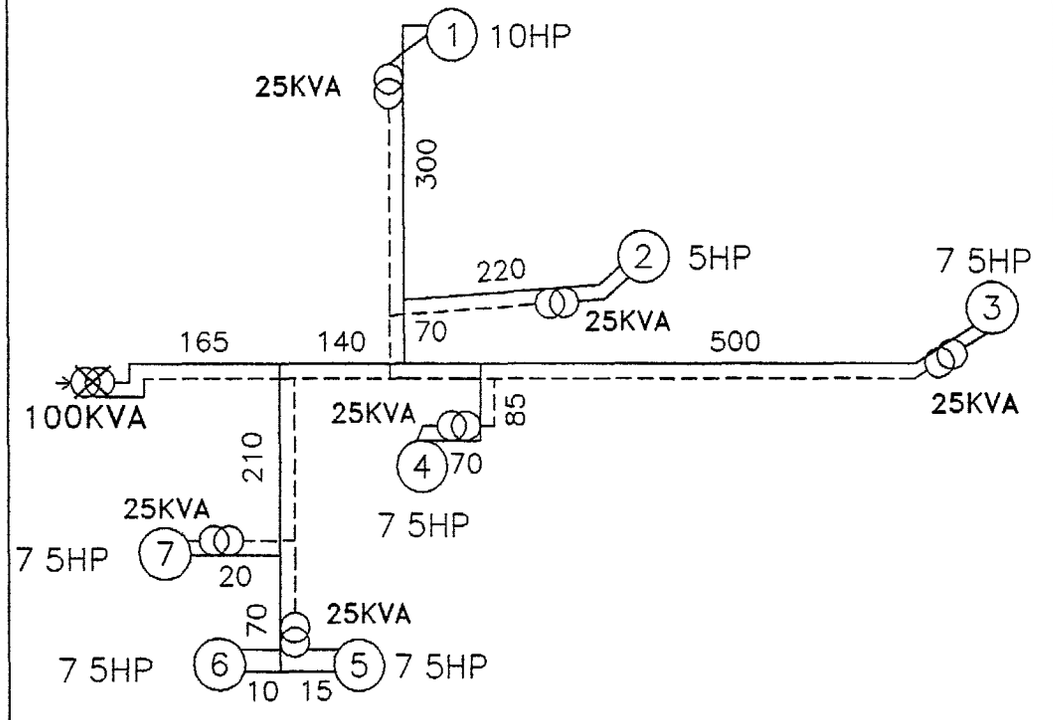


LT Less Option

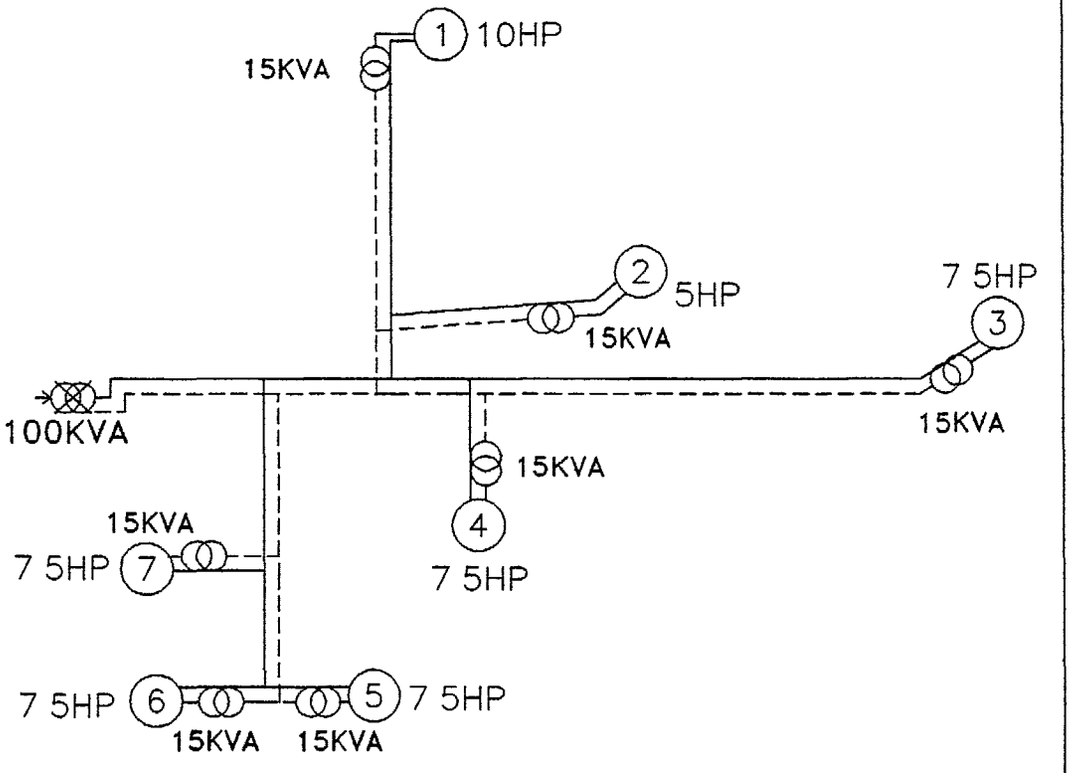


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-4	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Jile Singh Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less option



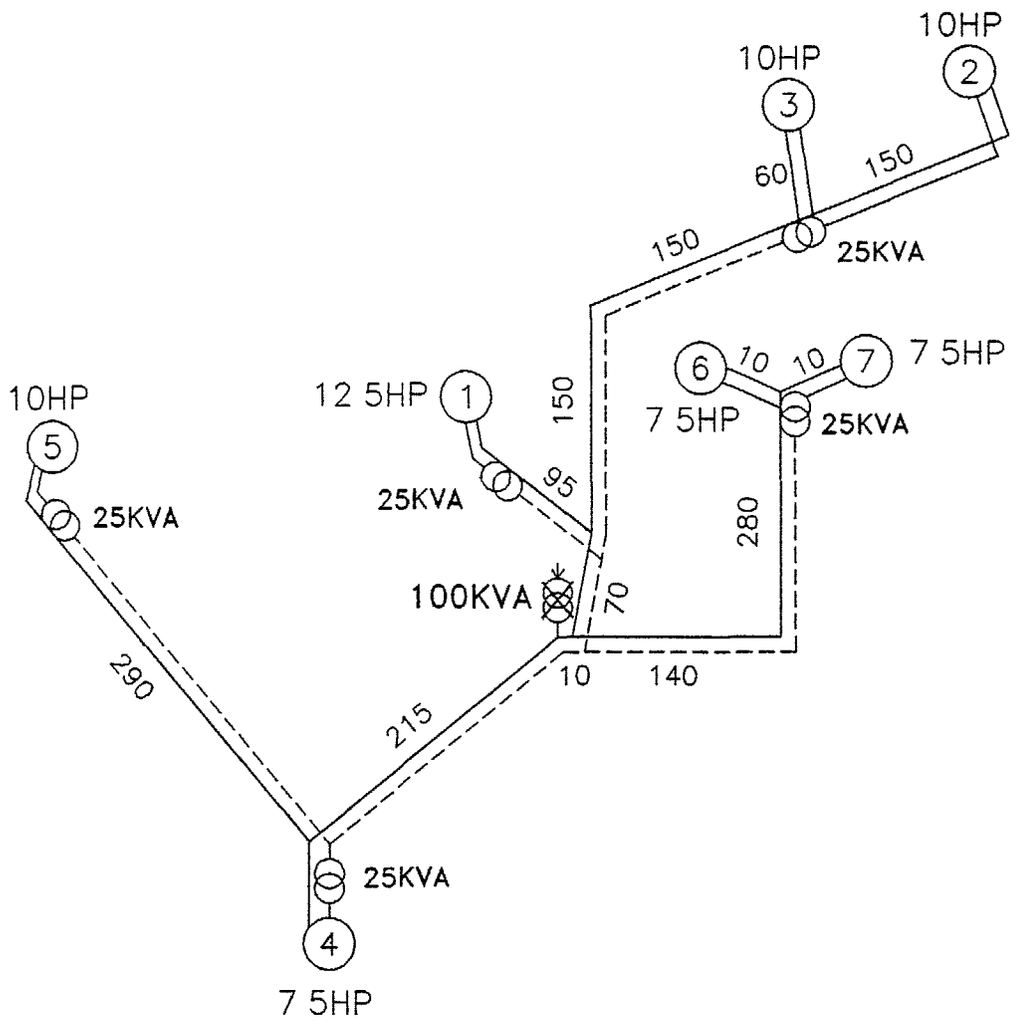
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-6

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Tokeybi/ Bansal

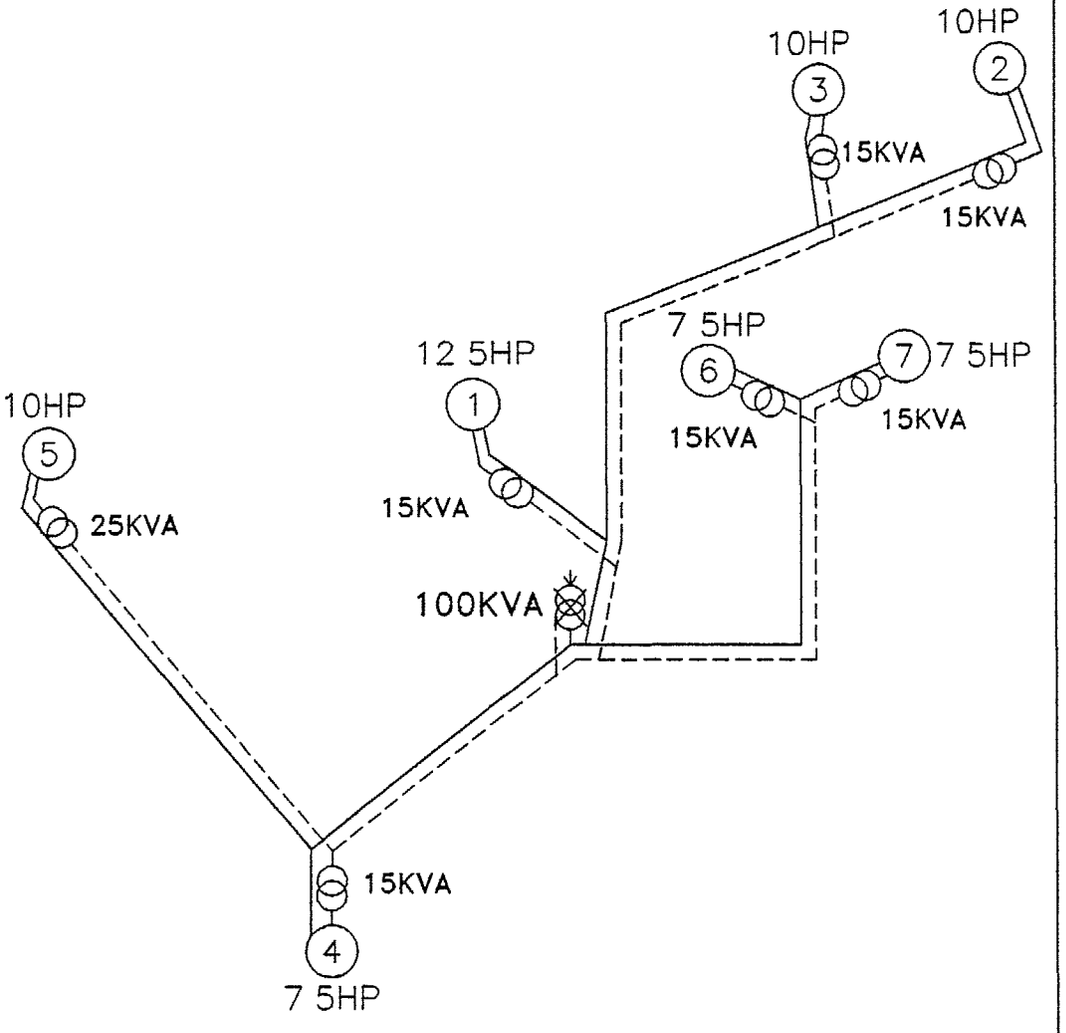
Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

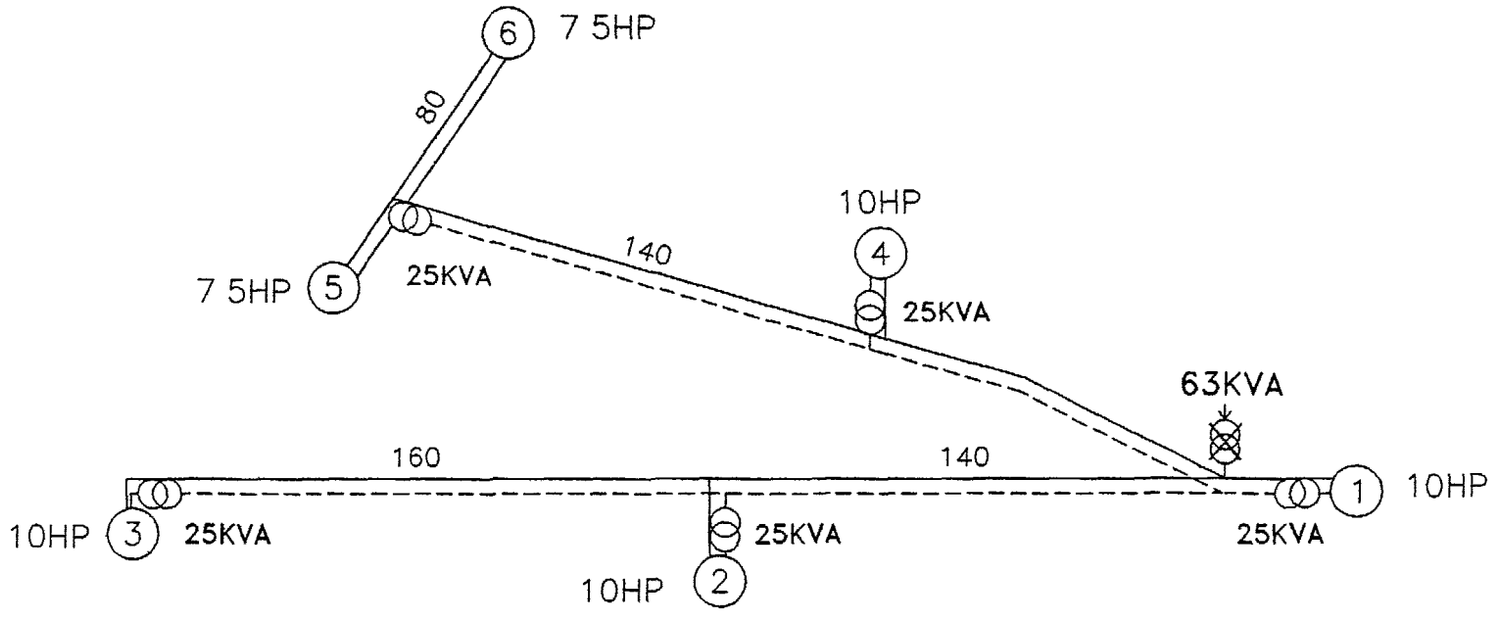


LT Less option

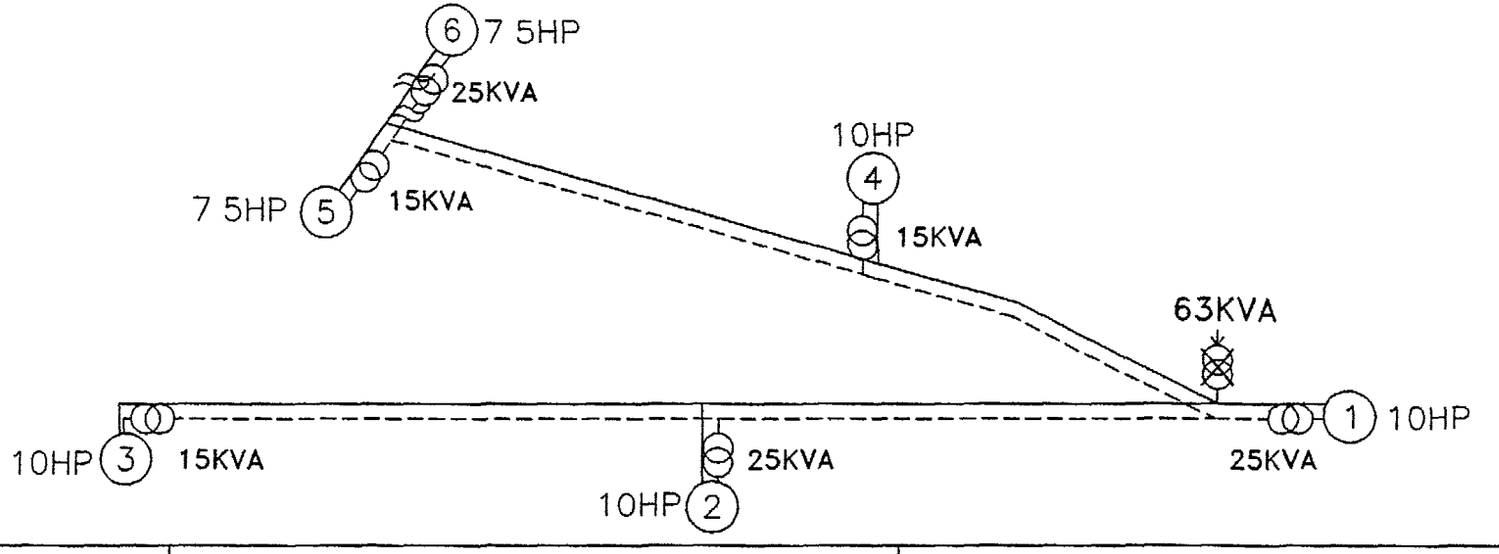


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-7	Project Name : DSM Study-HVPN Feeder Name Palra Tr Name Janta Farm Tr. Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

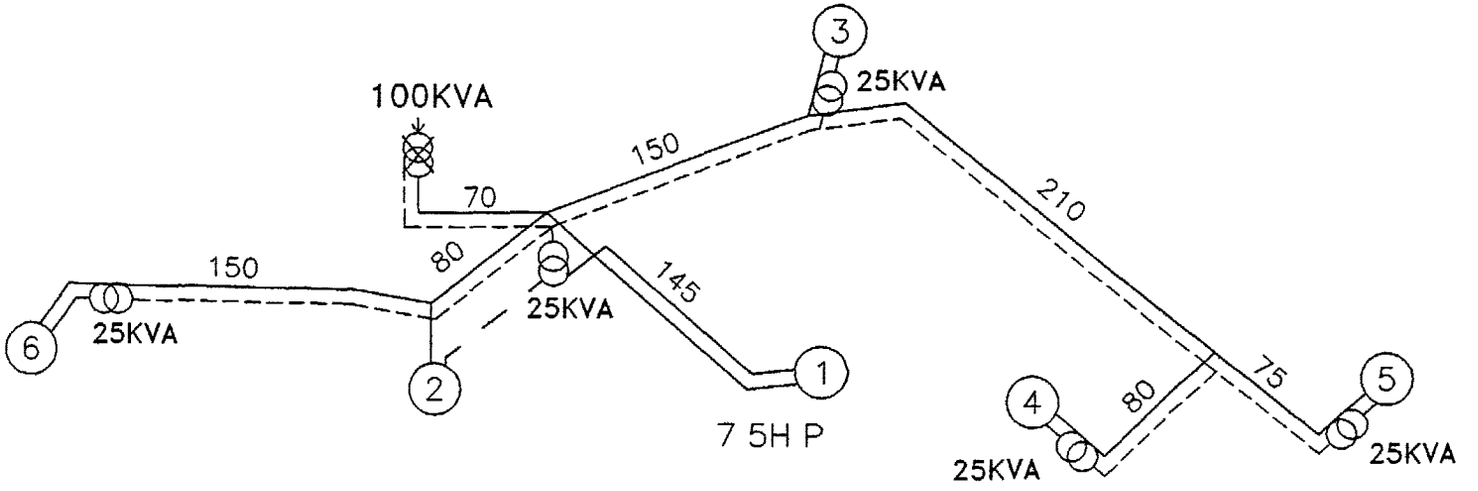


LT Less Option

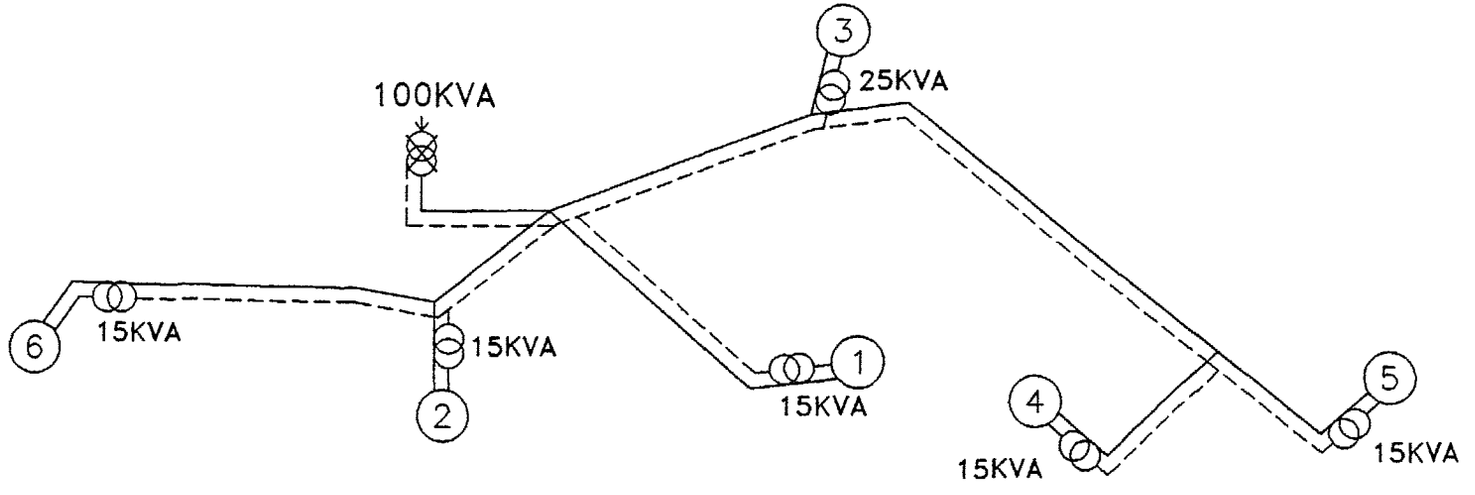


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-9	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Anand Singh Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

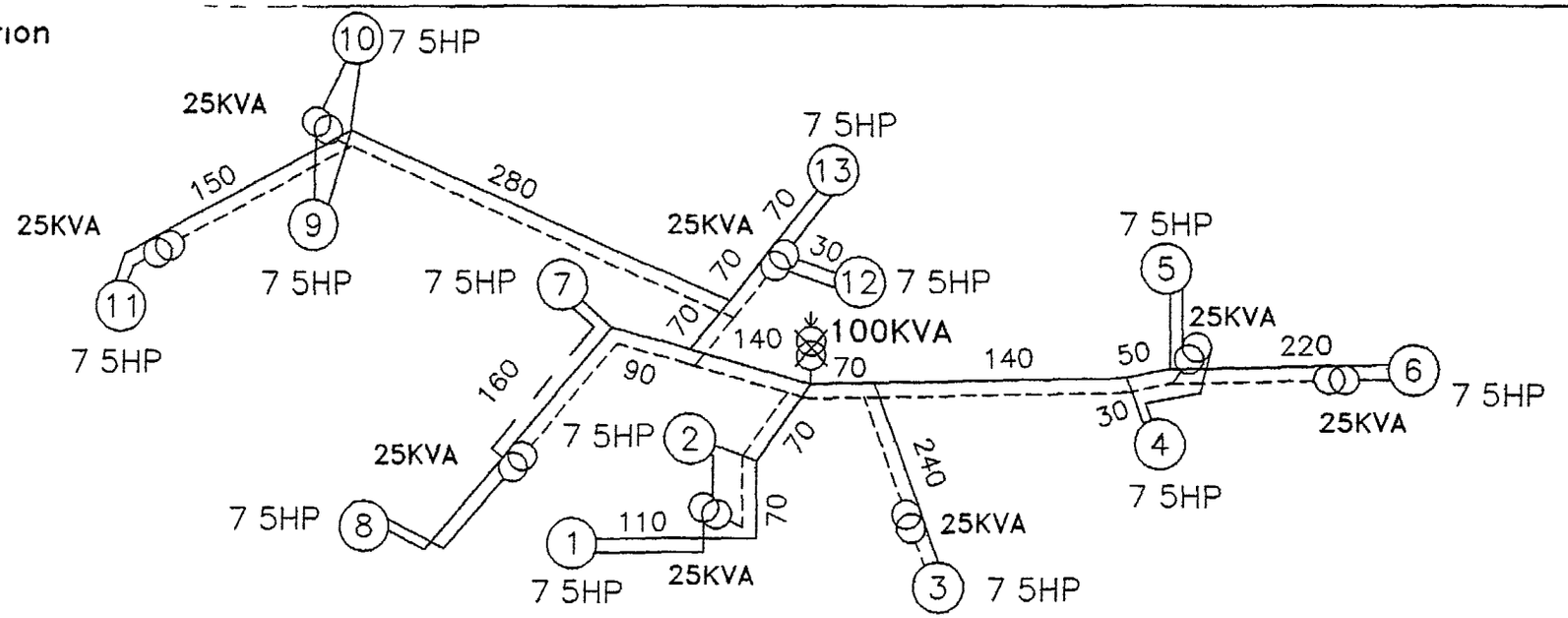


LT Less option

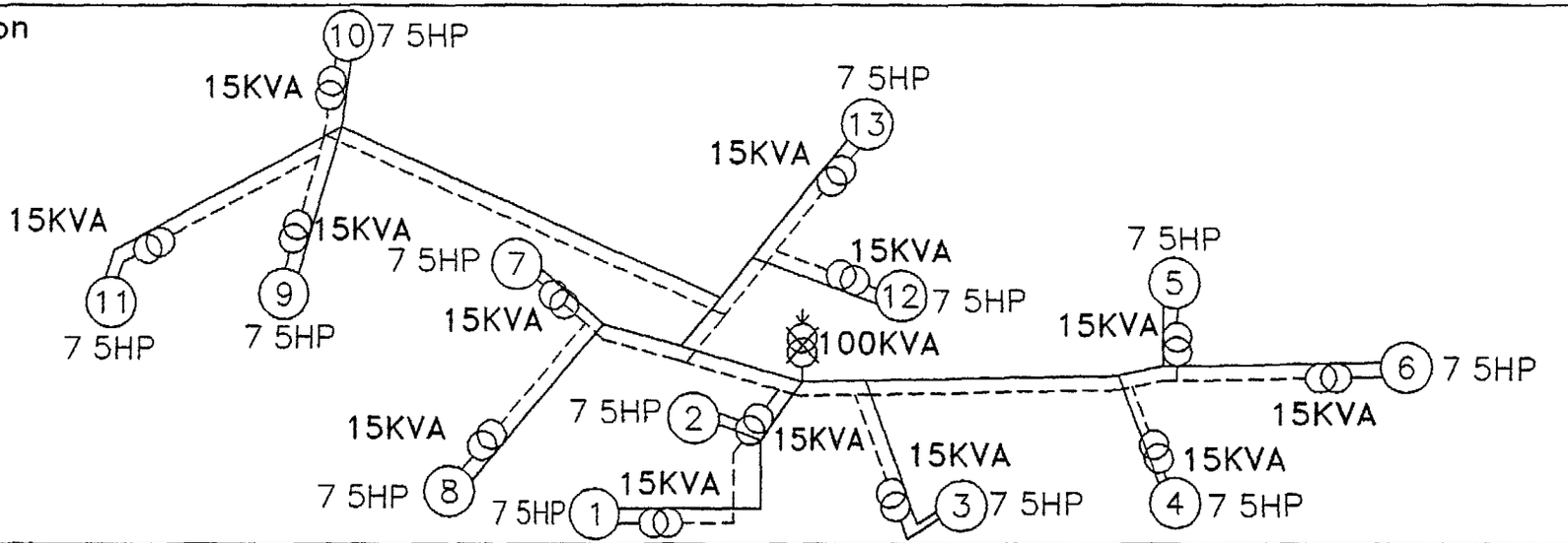


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-10	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Anup Singh /Duliehand Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



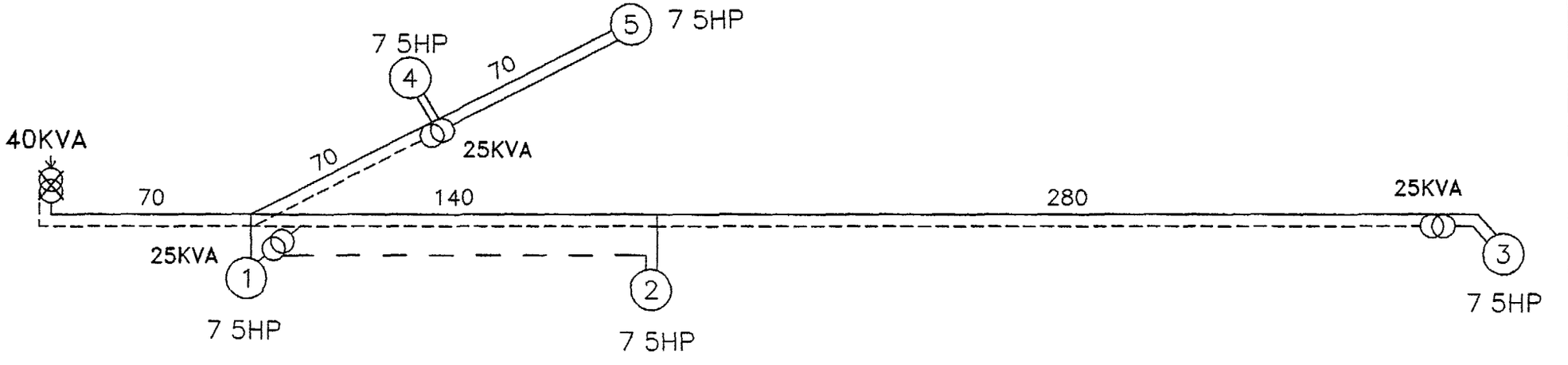
LT Less Option



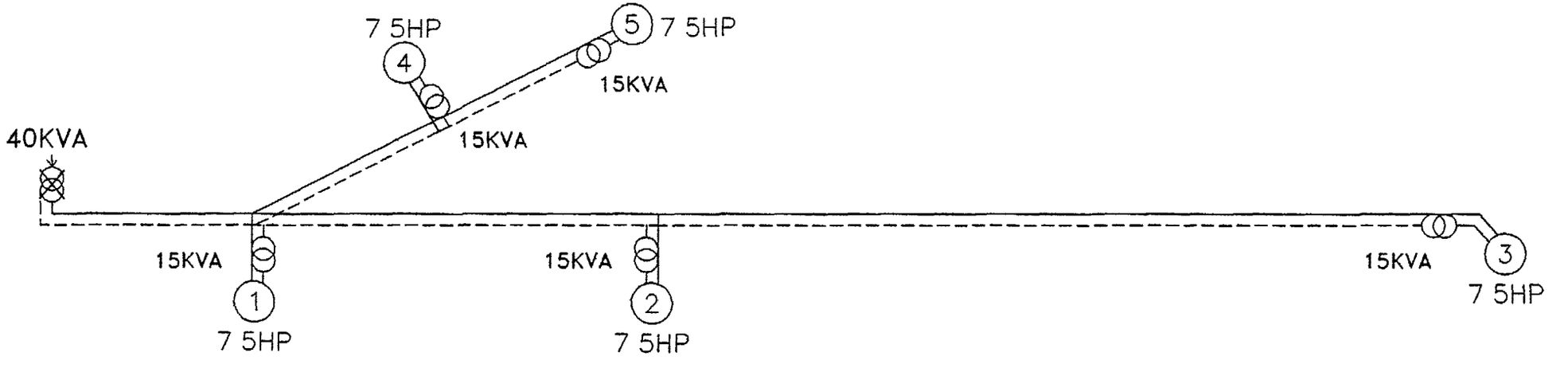
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-14	Project Name DSM Study-HVPN Feeder Name Palra Tr Name TC-10 Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

201

Grouping Option

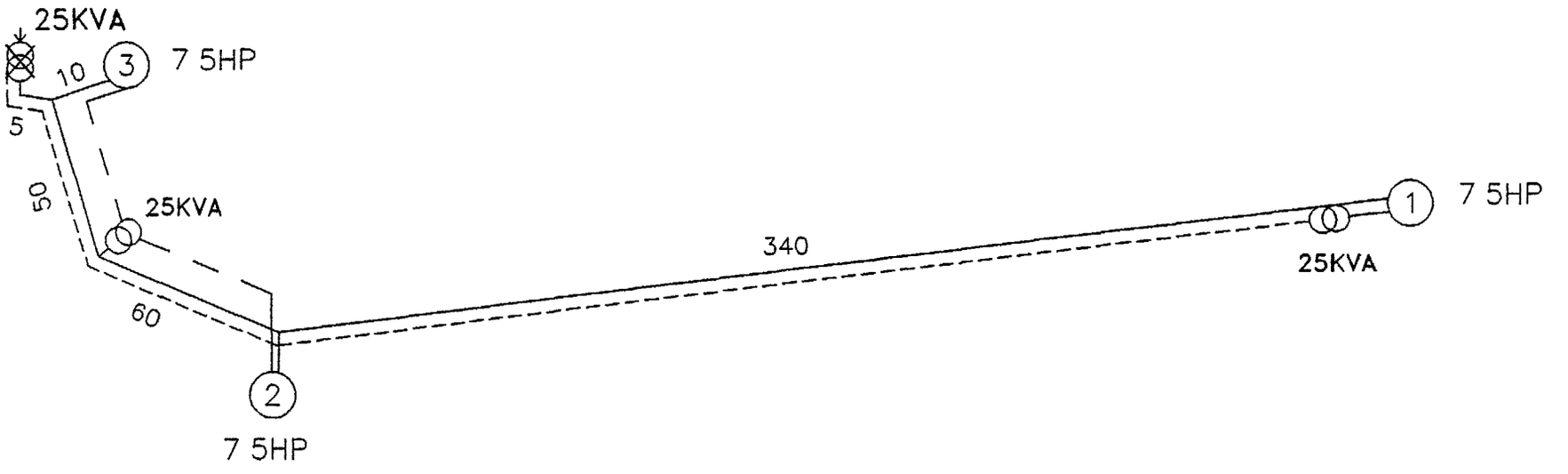


LT Less option

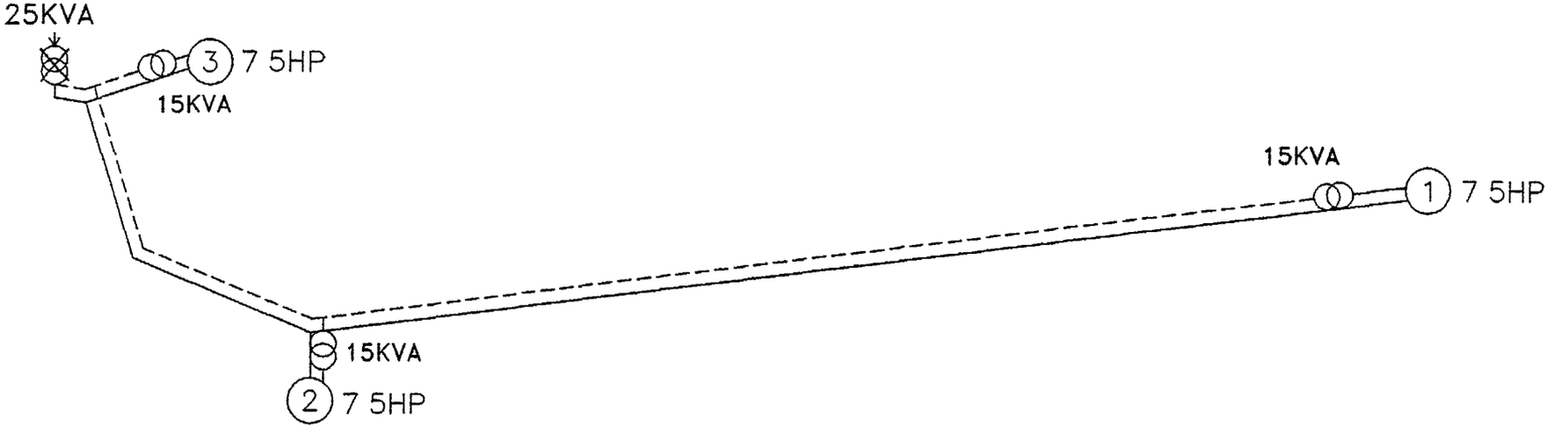


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-14A	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Ram Kumar Tr Capacity 40KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

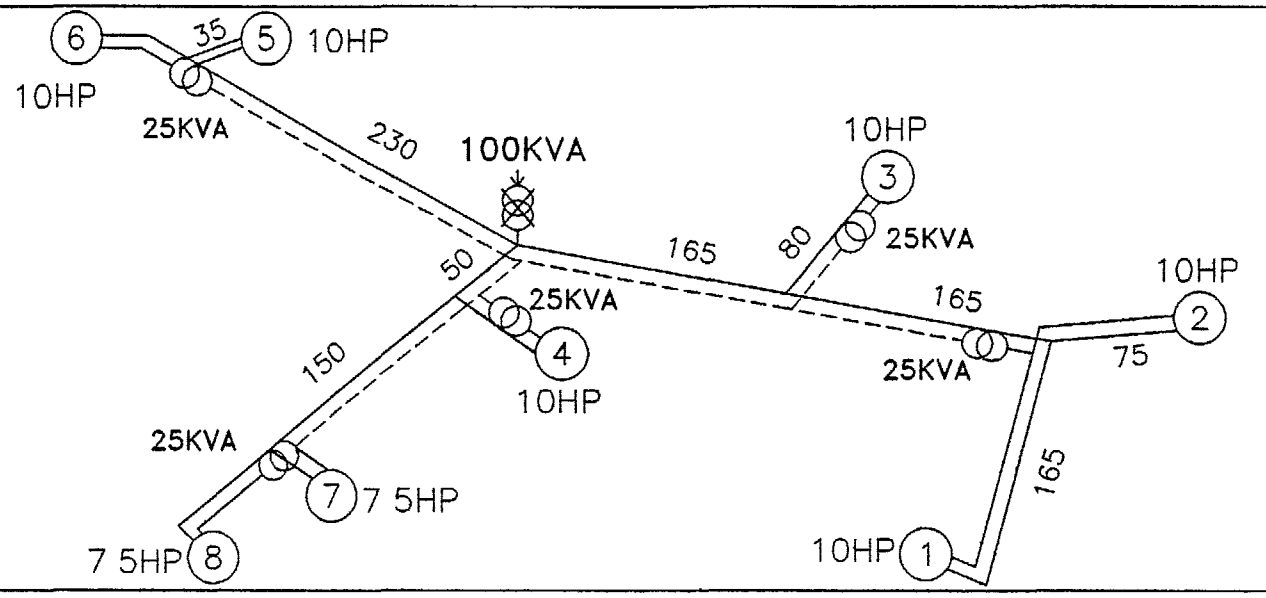


LT Less option

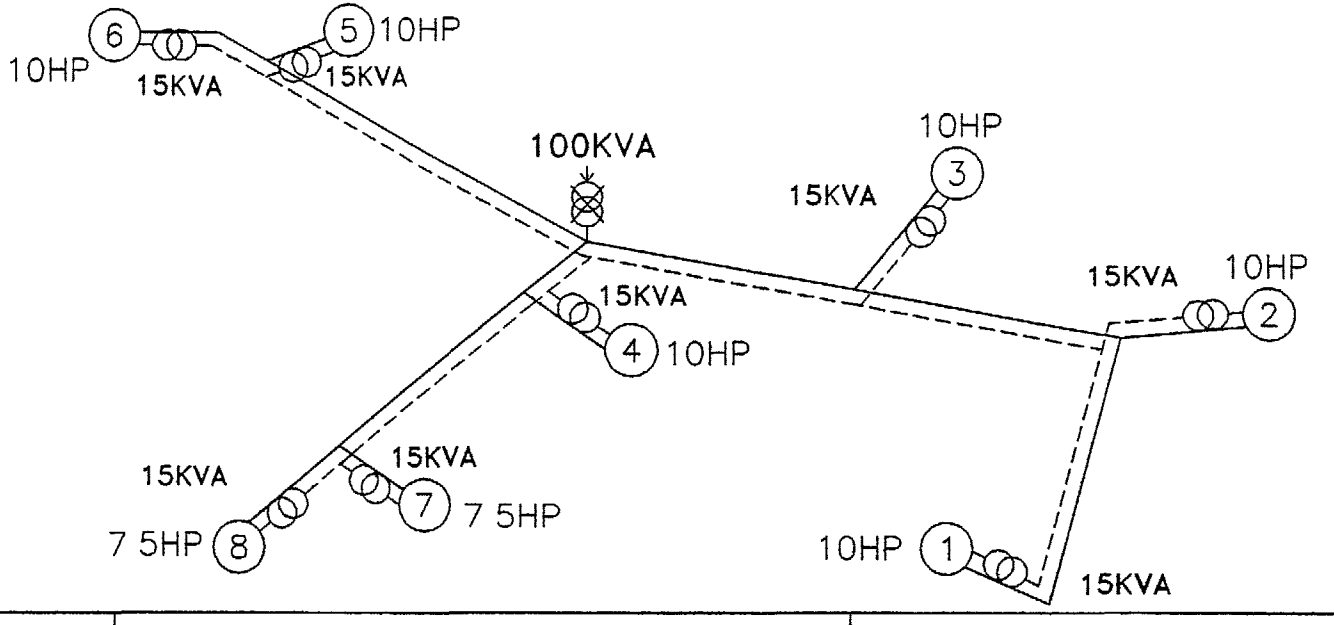


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-14B	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Jai Kumar Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

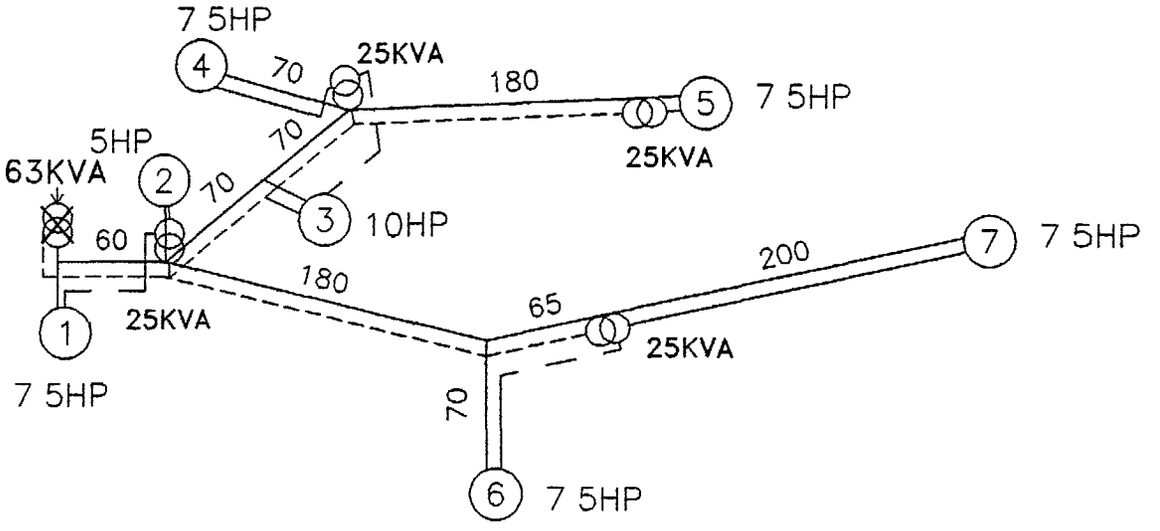


LT Less option

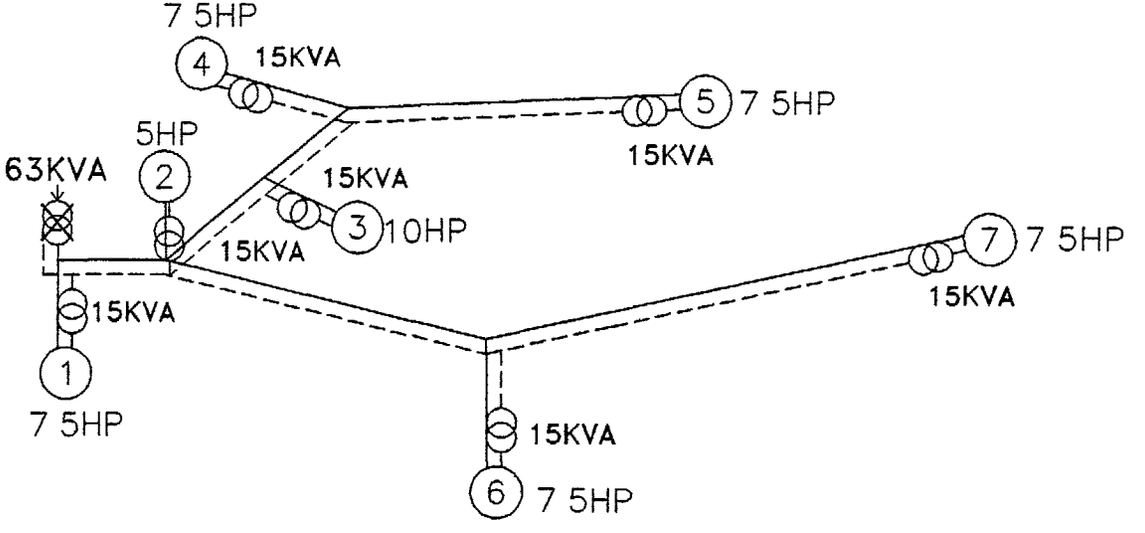


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-15	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Bhol Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping option

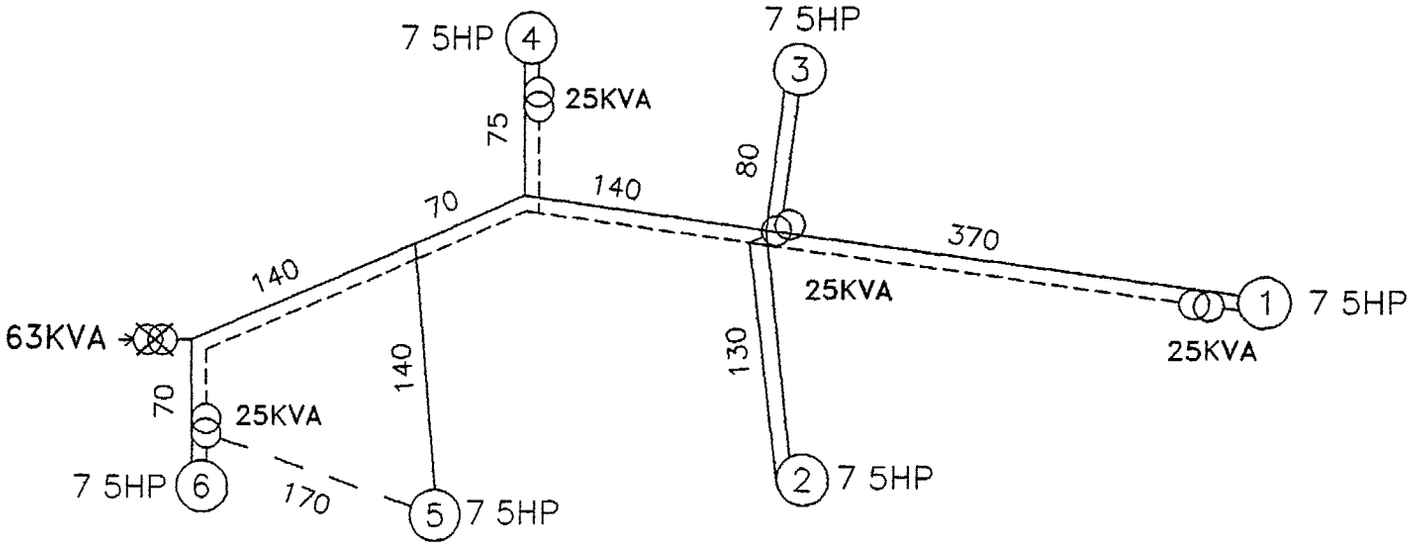


LT Less option

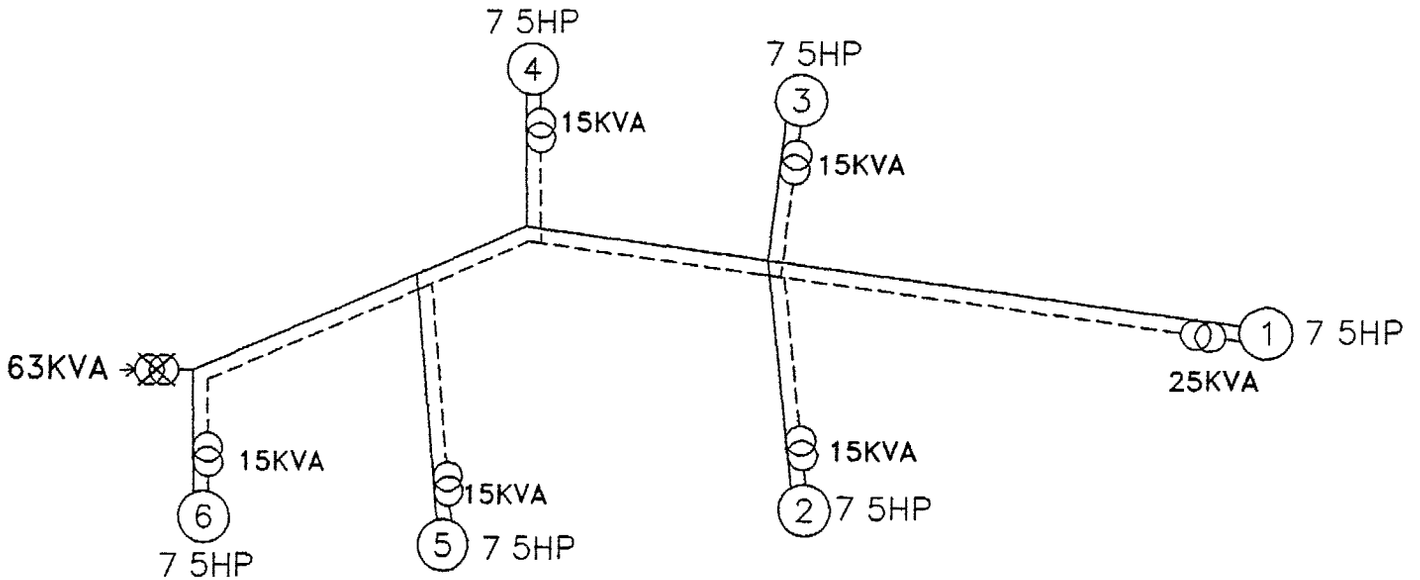


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-16	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Keru Chand Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

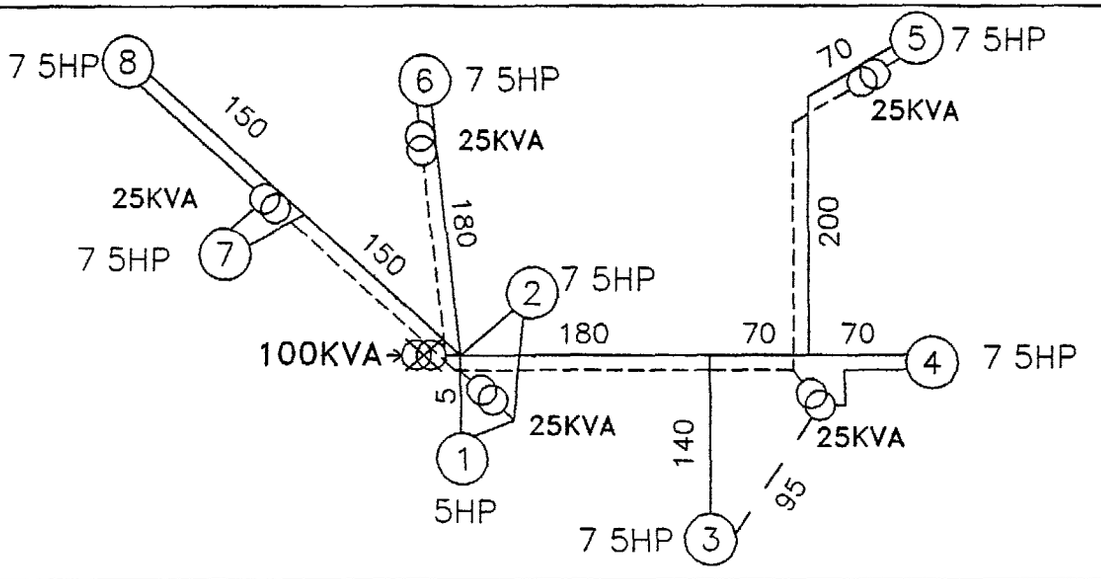


LT Less option

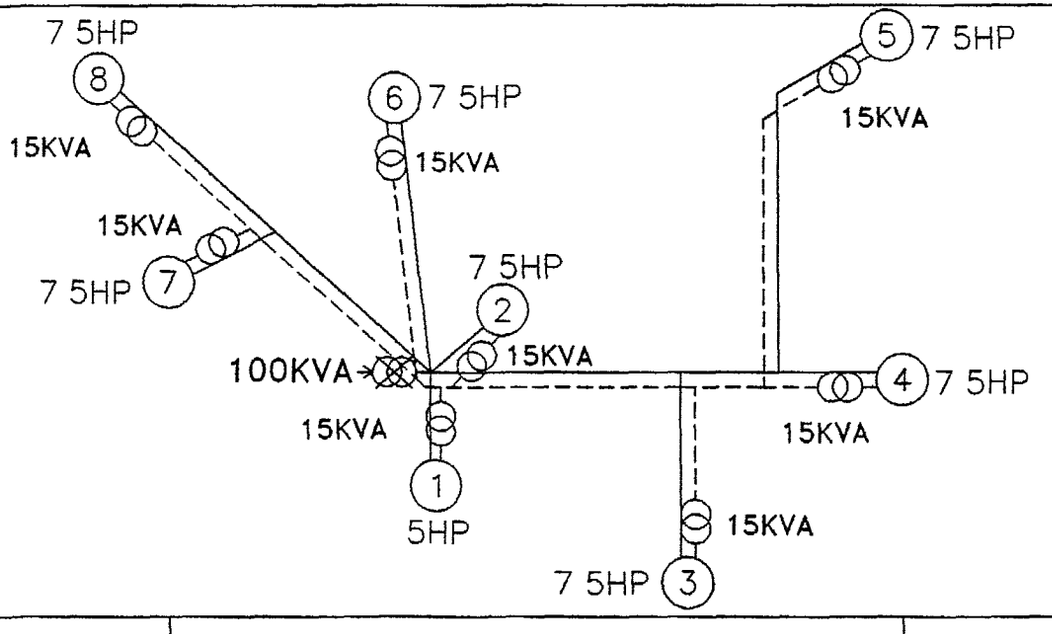


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-17A	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Bhagwan Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less option



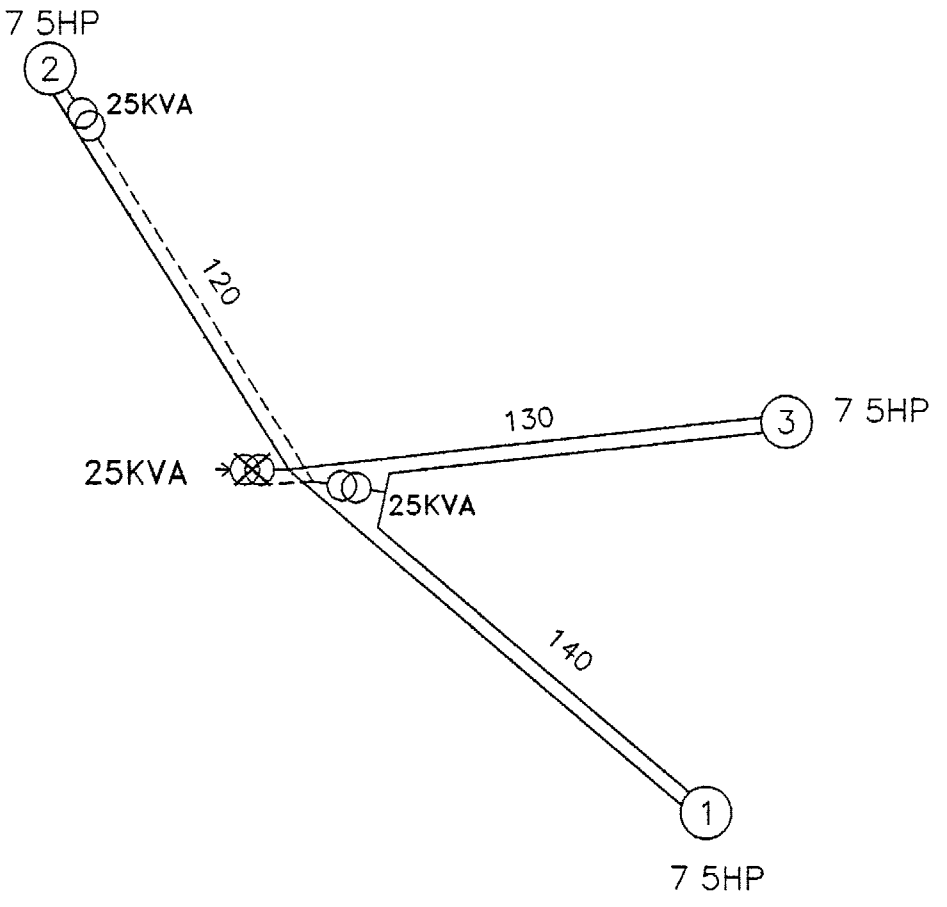
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-19

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Mehar Chand

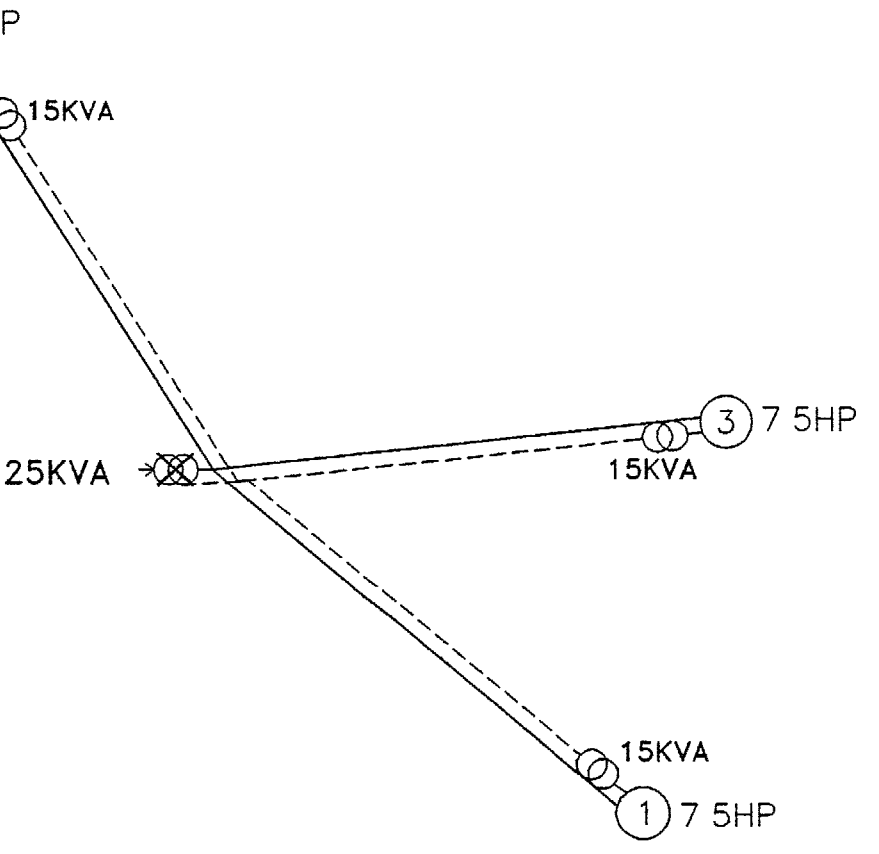
Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

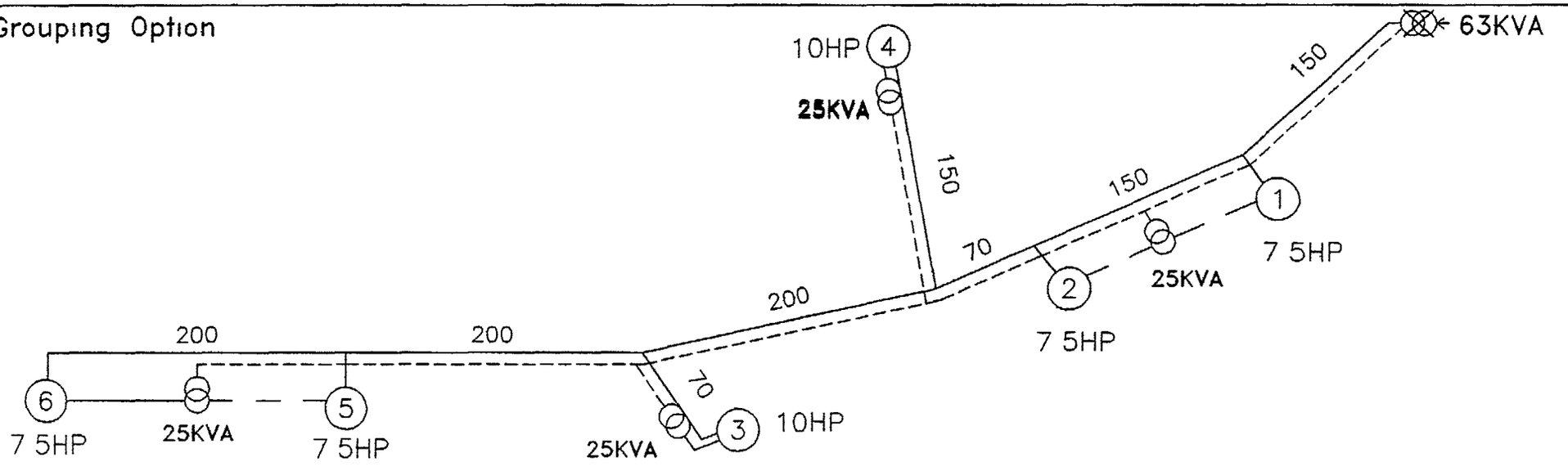


LT Less option

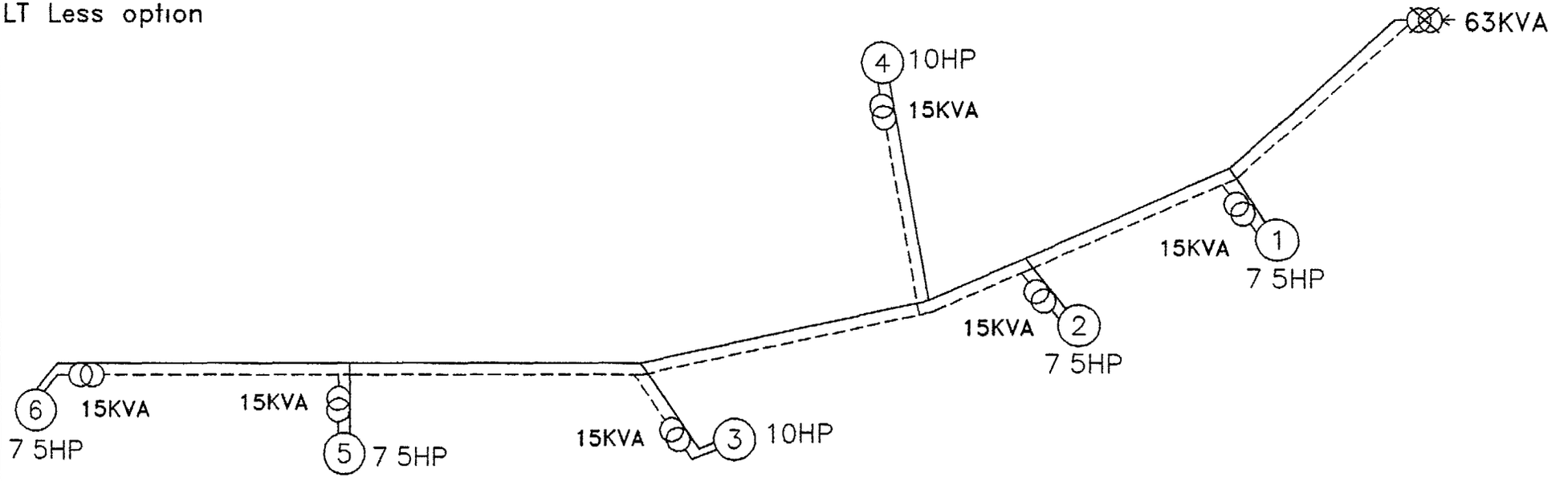


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-20	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Jaghir Singh Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



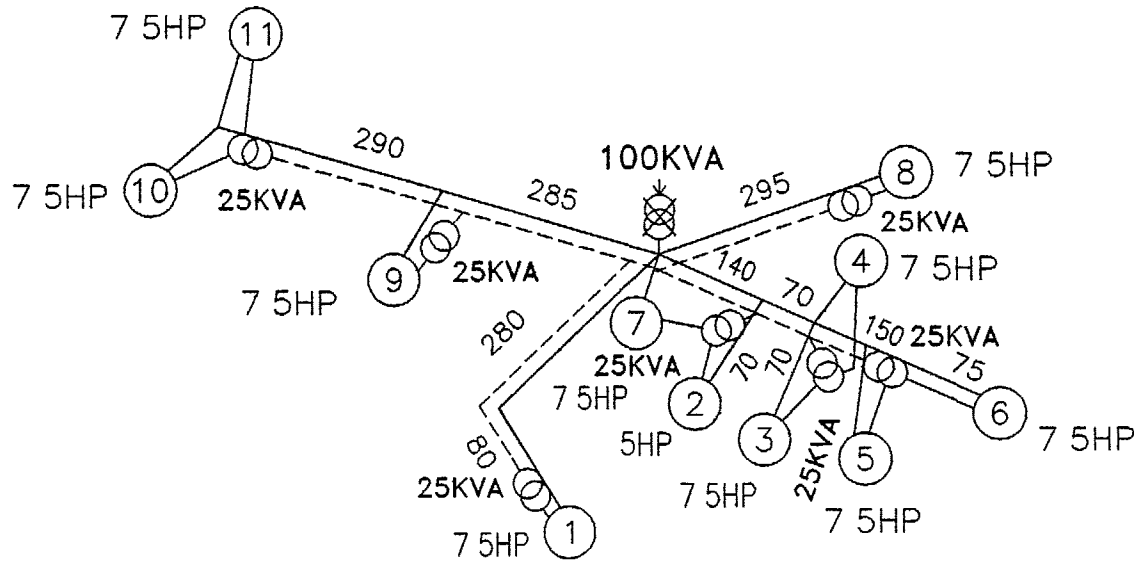
LT Less option



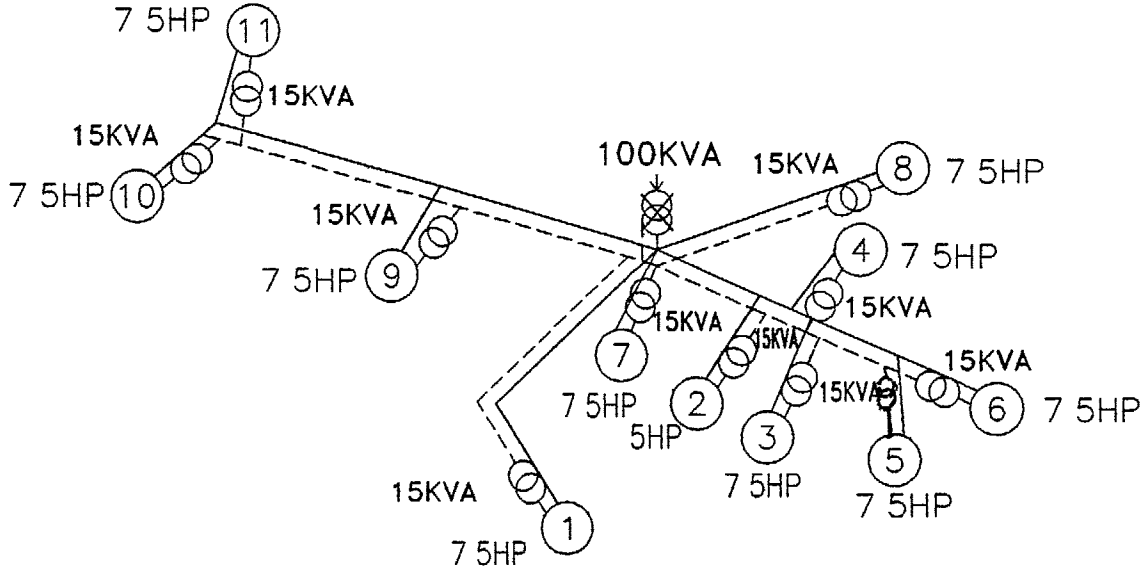
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-21	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Puran Chand Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

a11

Grouping option

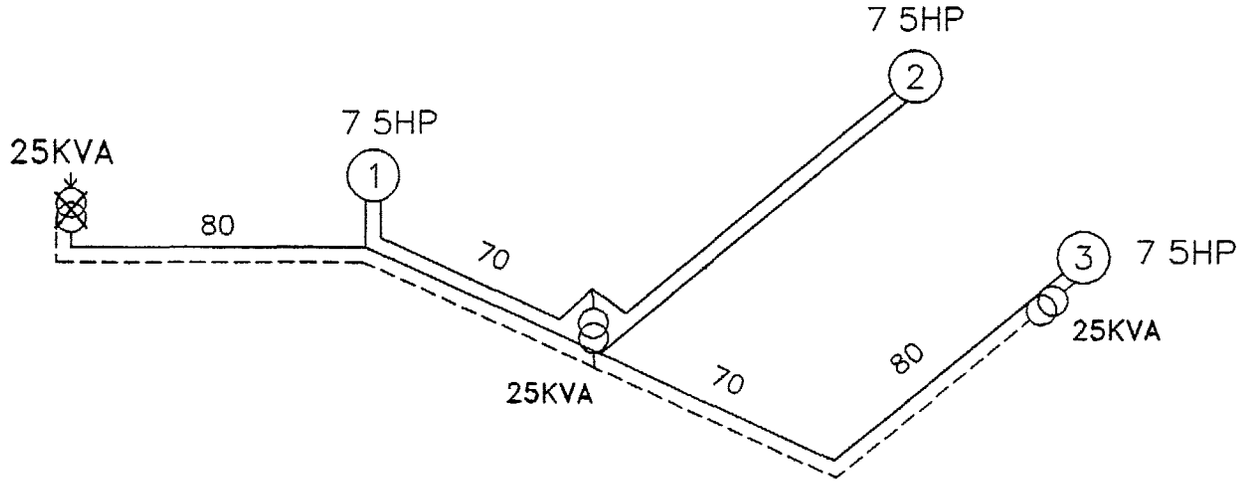


LT Less option

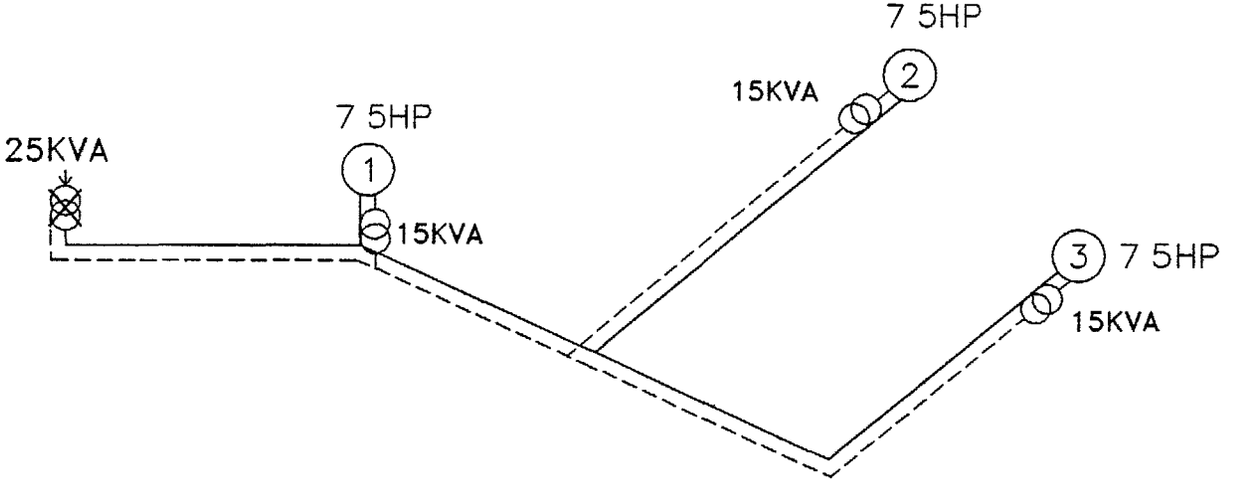


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-22	Project Name DSM Study-HVPN Feeder Name Palra Tr Name TCA-22 Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

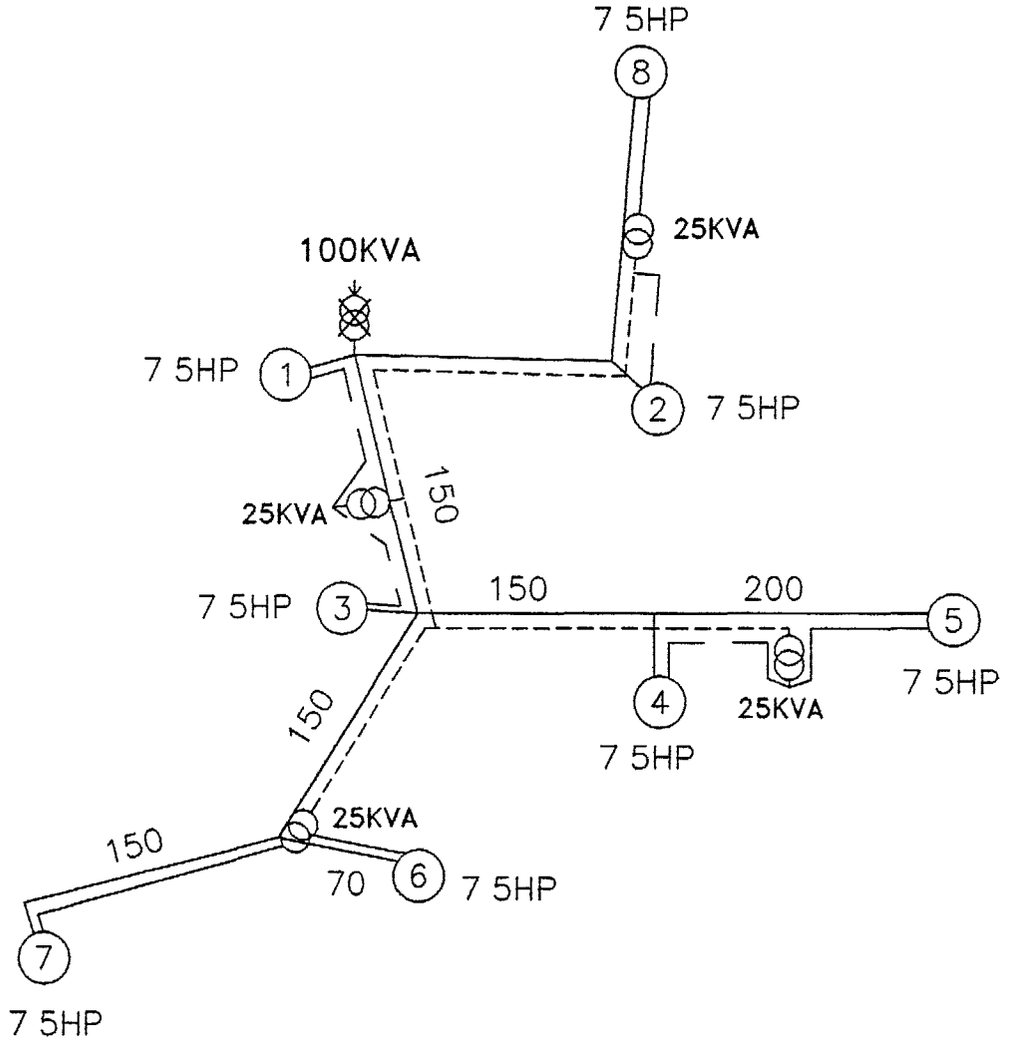


LT Less option

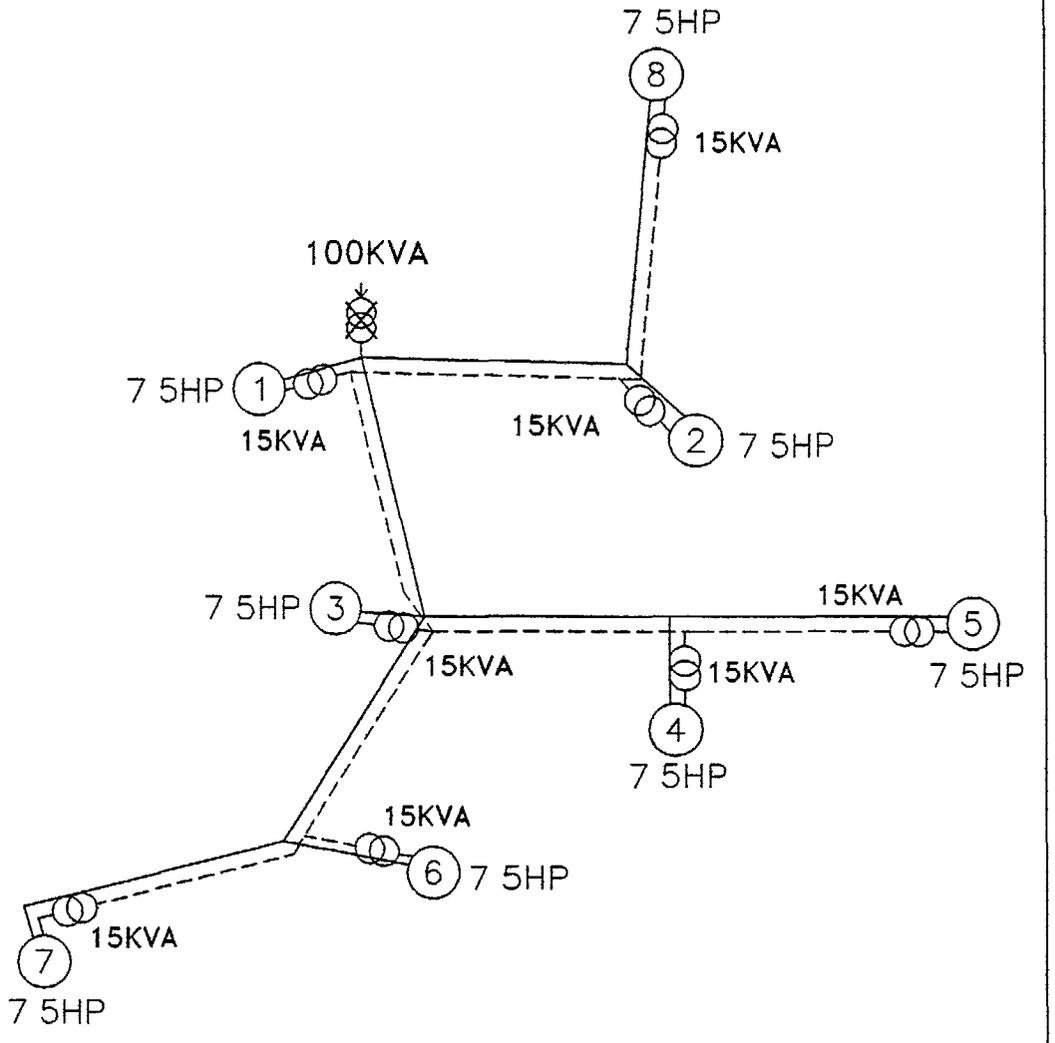


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-23	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Hari Singh Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less option

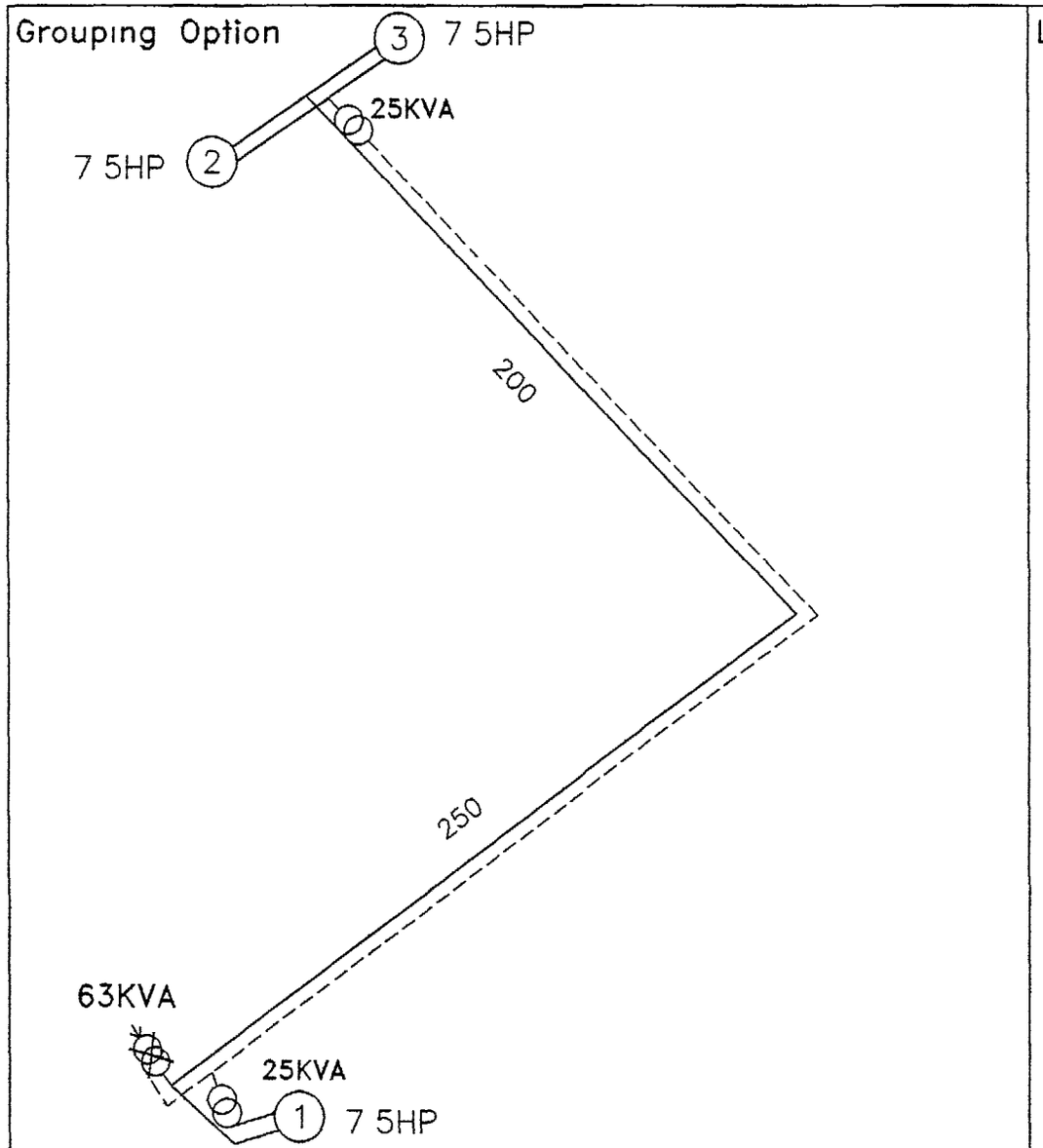


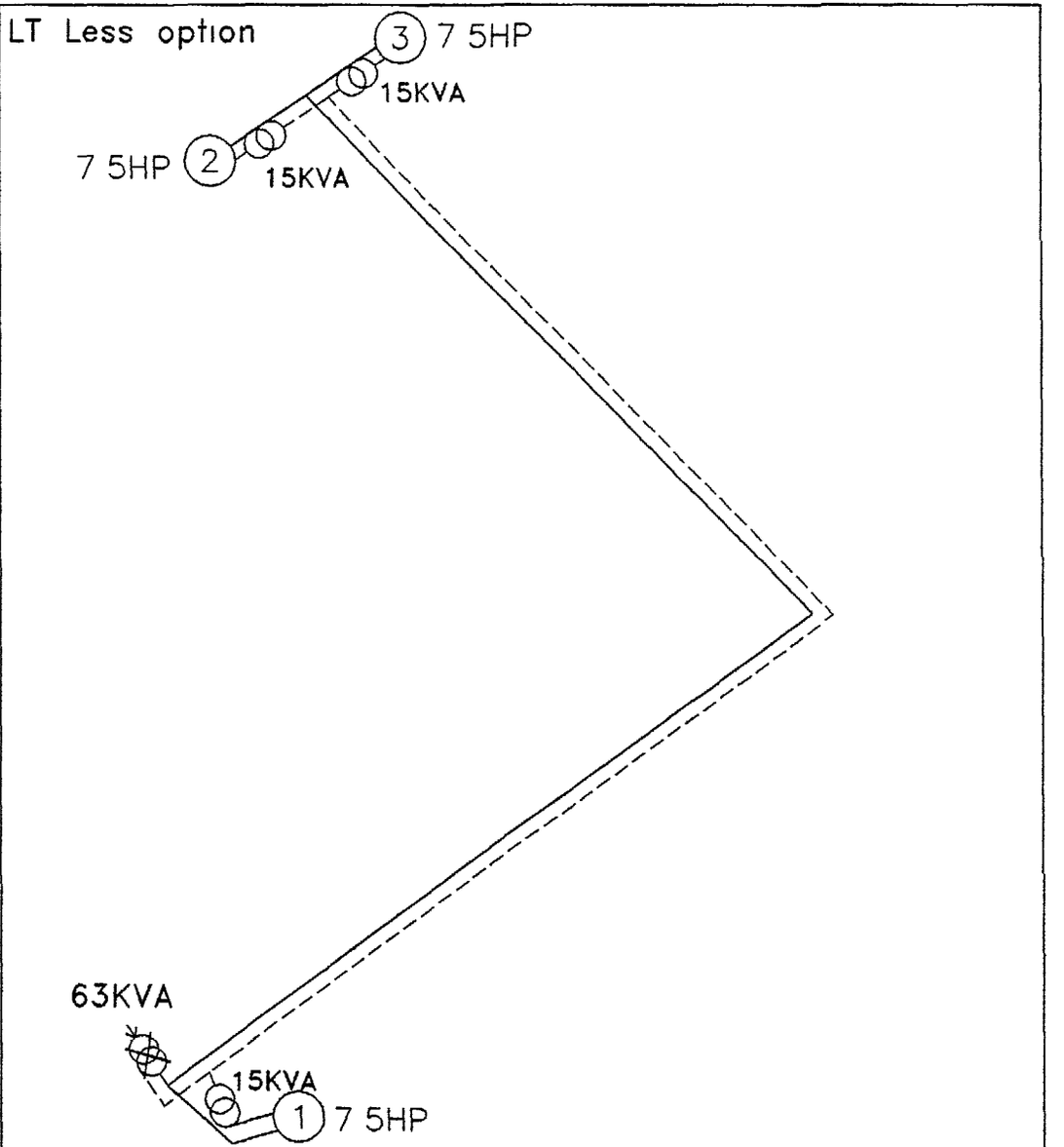
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-24

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Kartar Singh

Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants





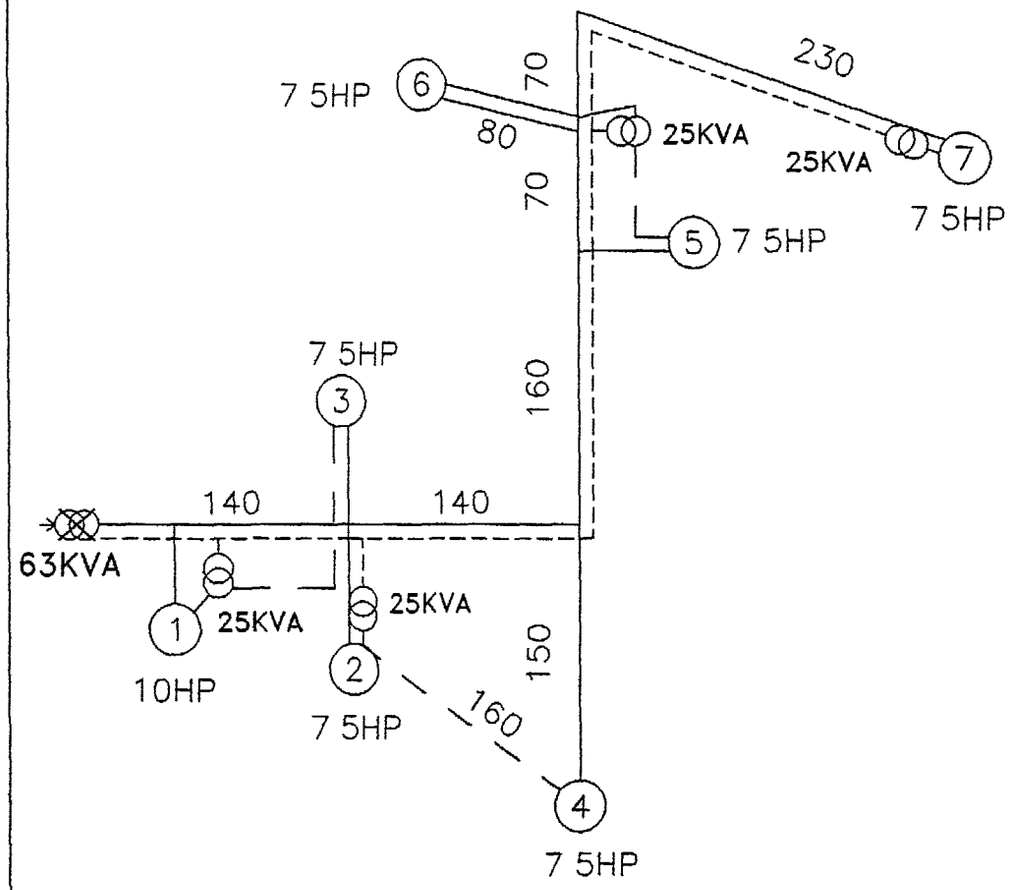
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-25

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Puran Singh

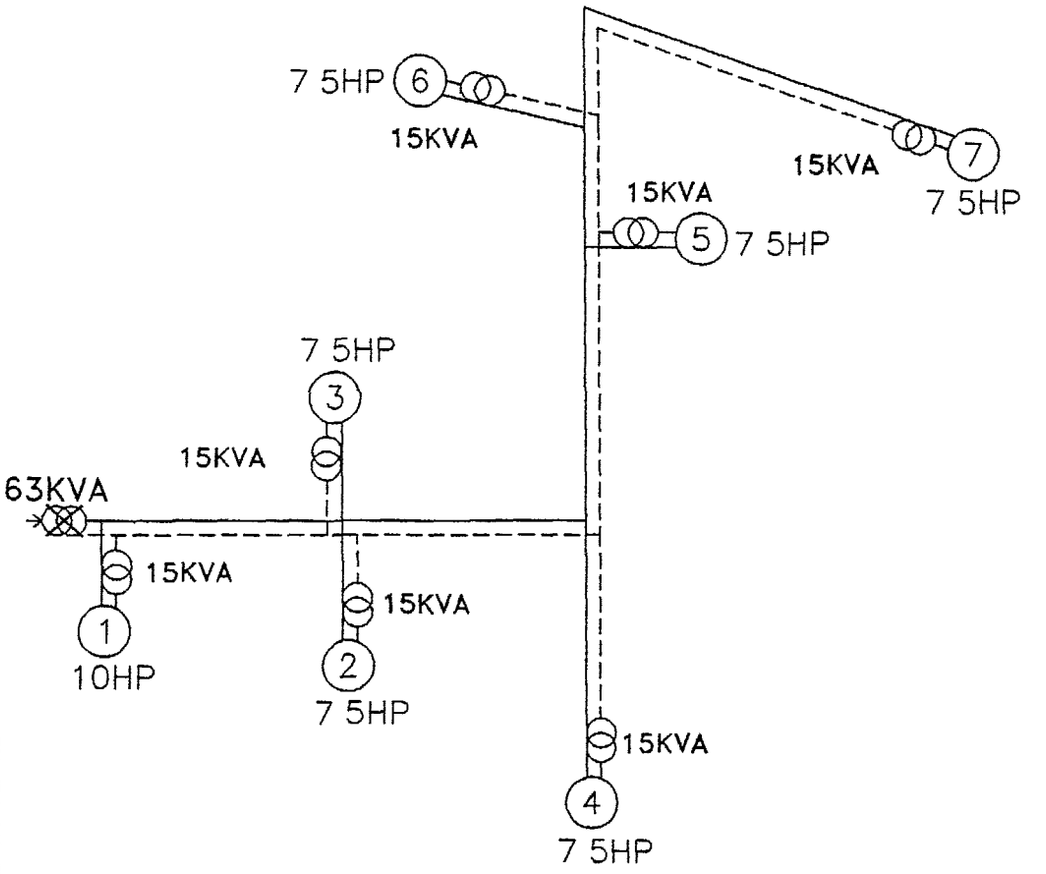
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less option



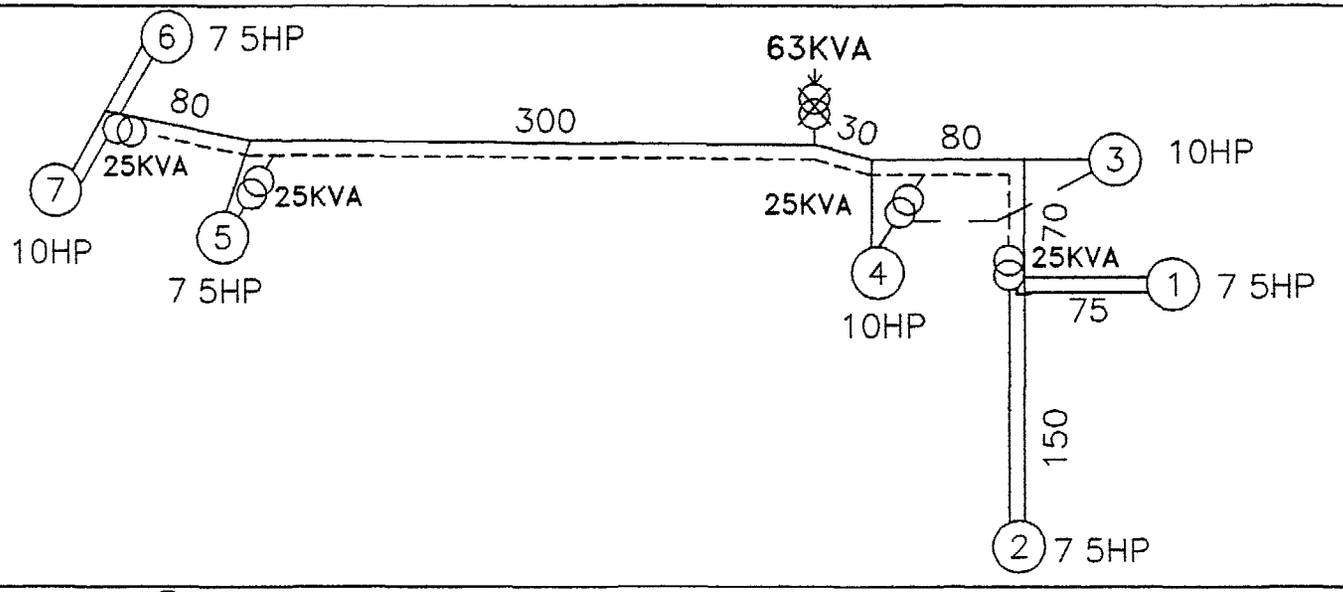
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-26

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Nemi Chand

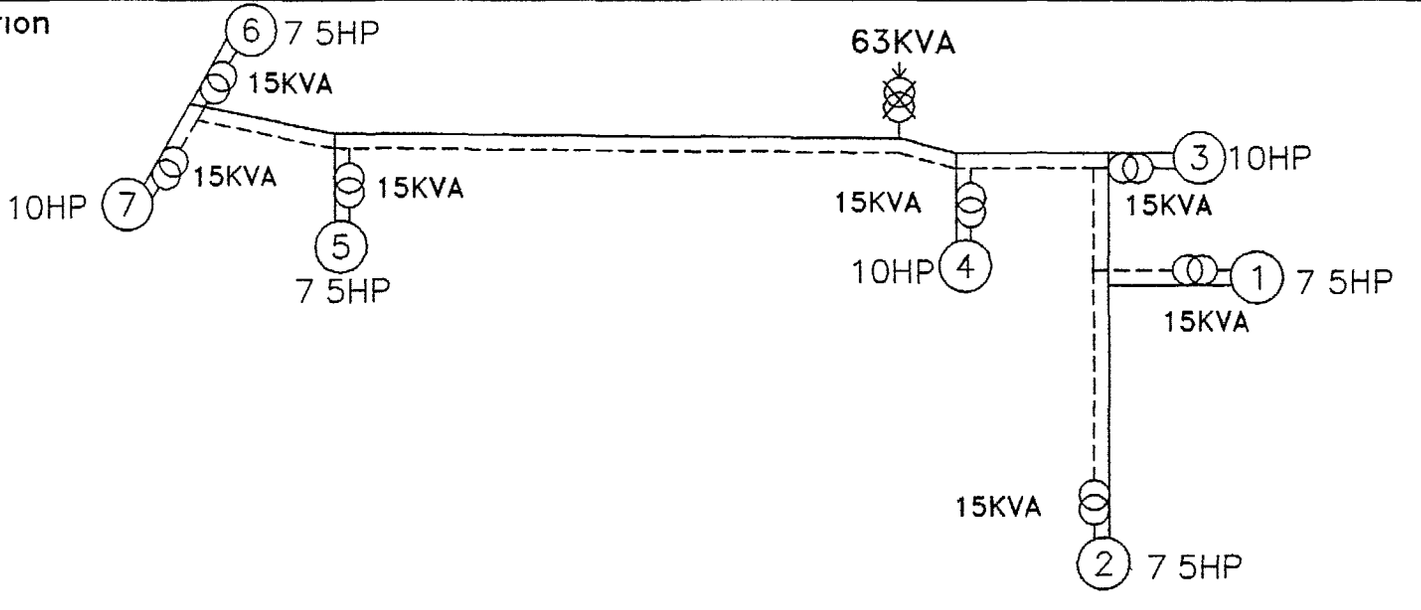
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

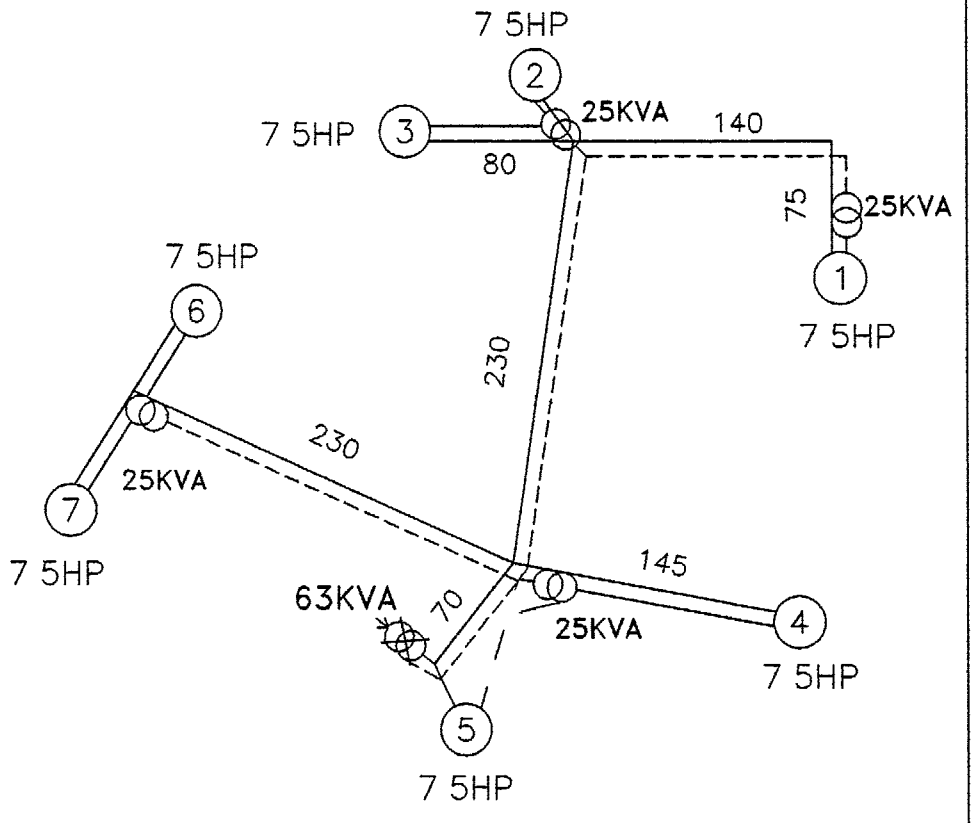


LT Less option

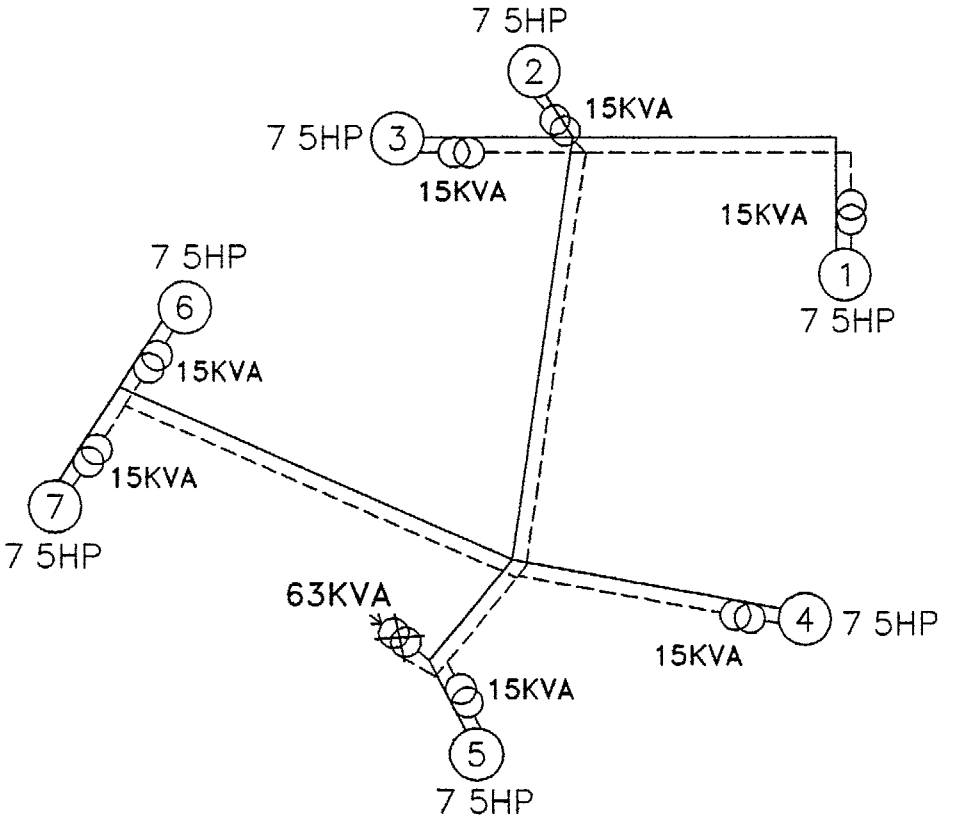


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-27	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Nemi chand Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less option



All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-28

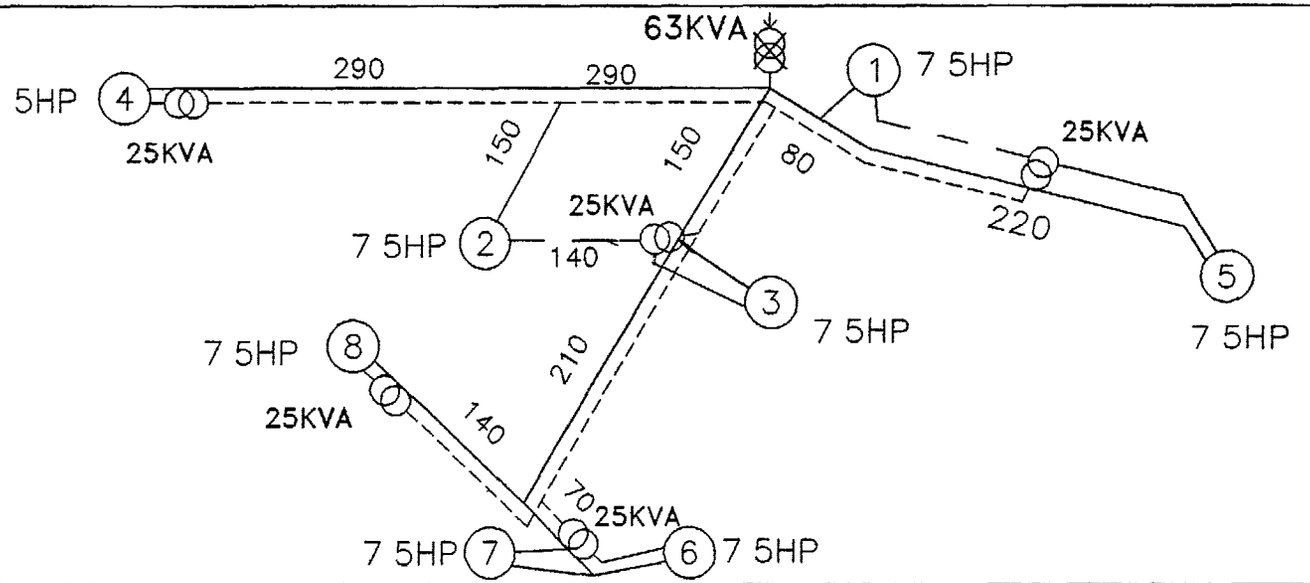
Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Ravinder Singh

Tr Capacity 63KVA

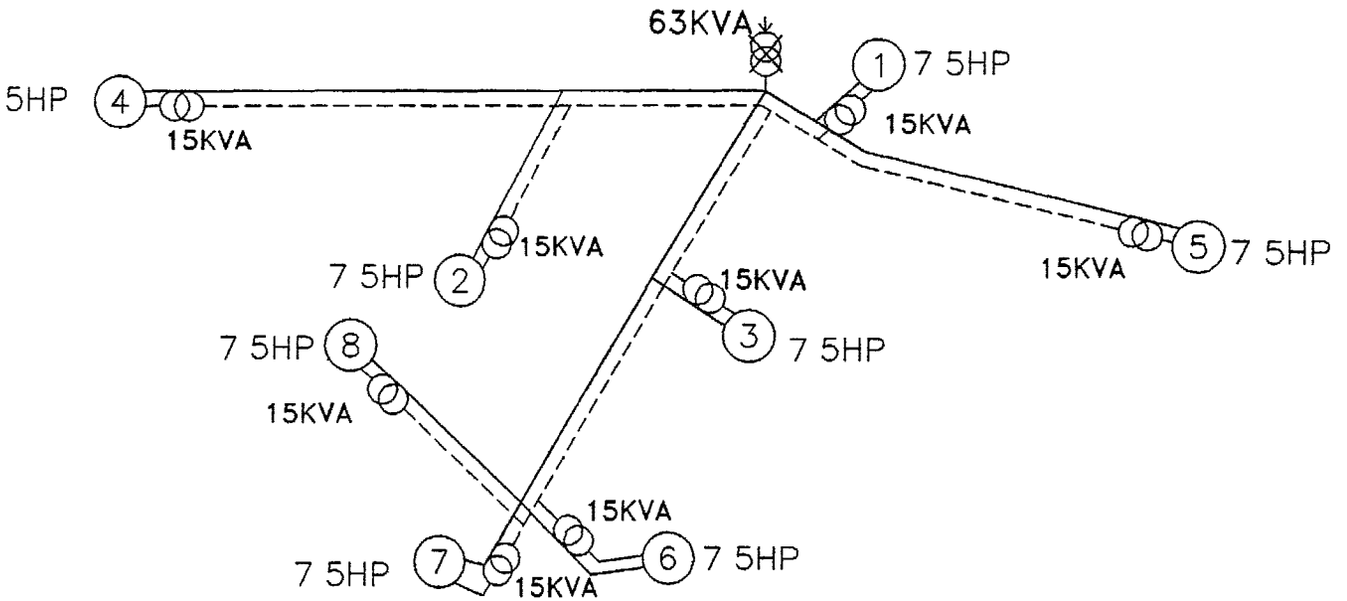
3EC
Energy Economy & Environmental Consultants

bA

Grouping Option



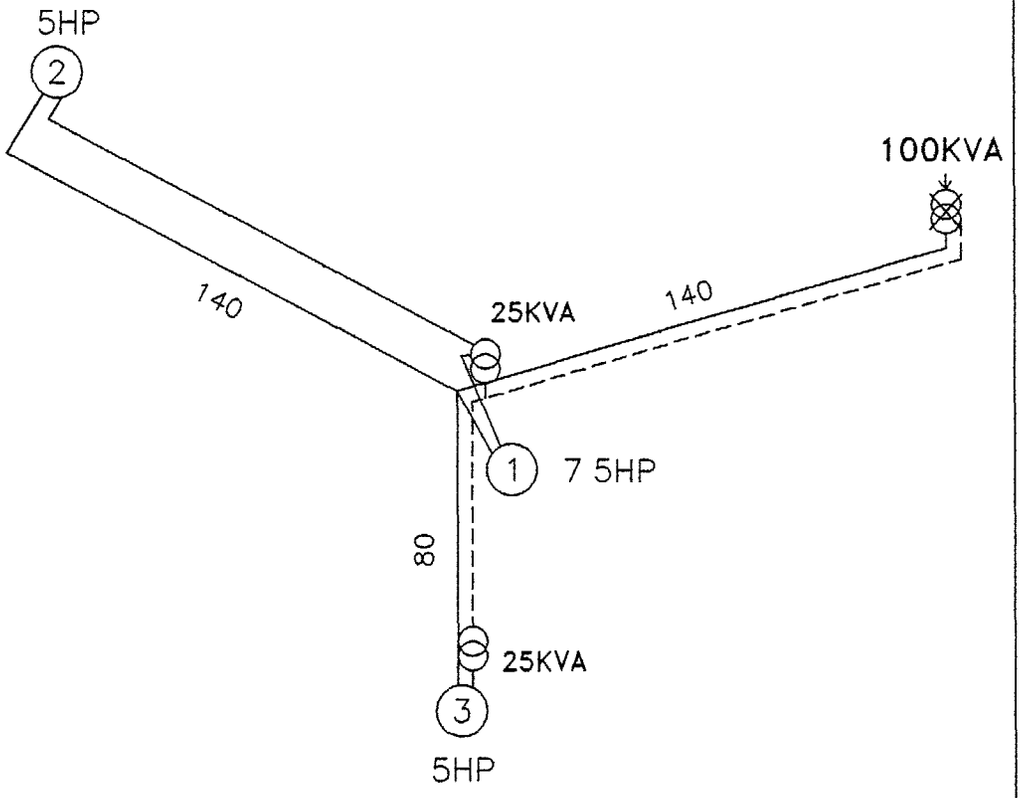
LT Less option



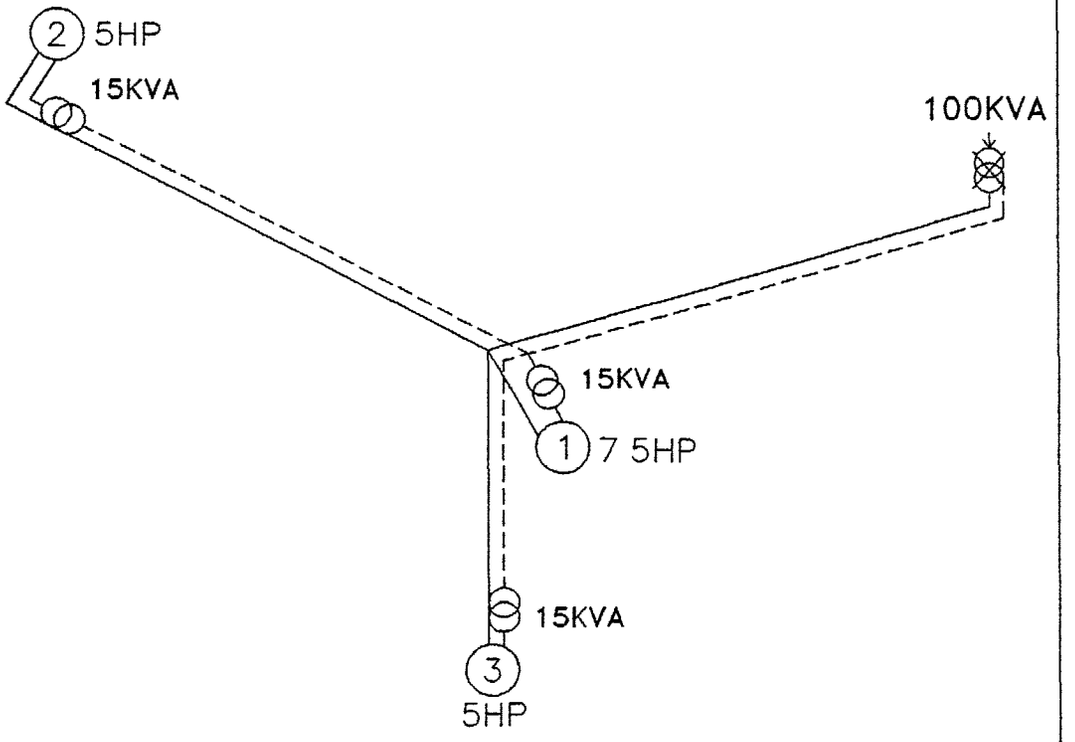
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-30	Project Name DSM Study-HVPN Feeder Name Palra Tr Name H Singh Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

811

Grouping Option



LT Less option



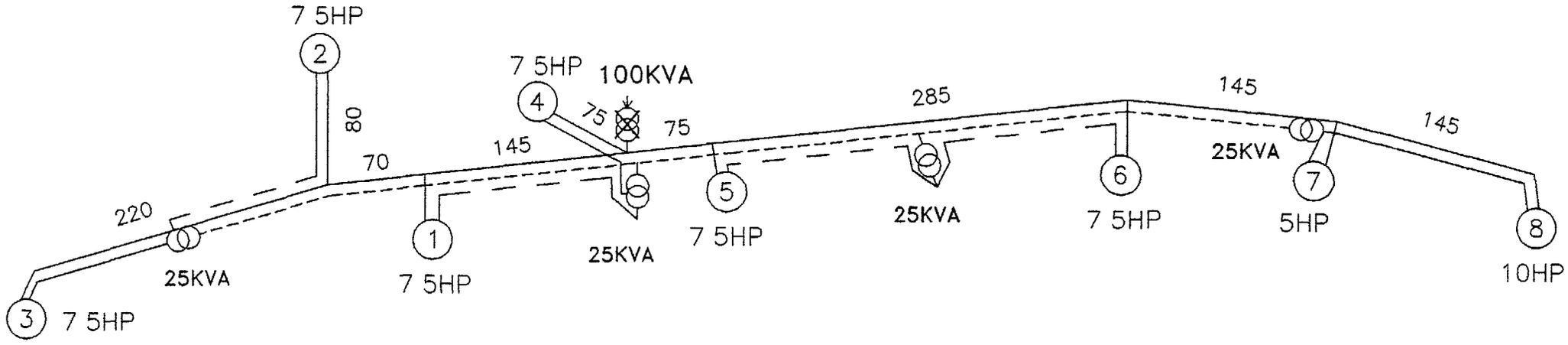
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-31

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Sari Chand

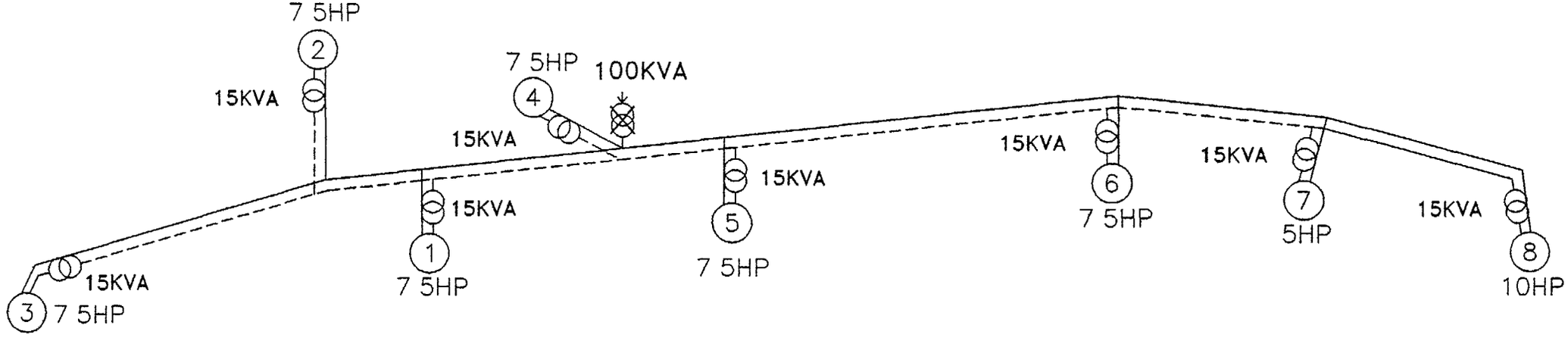
Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



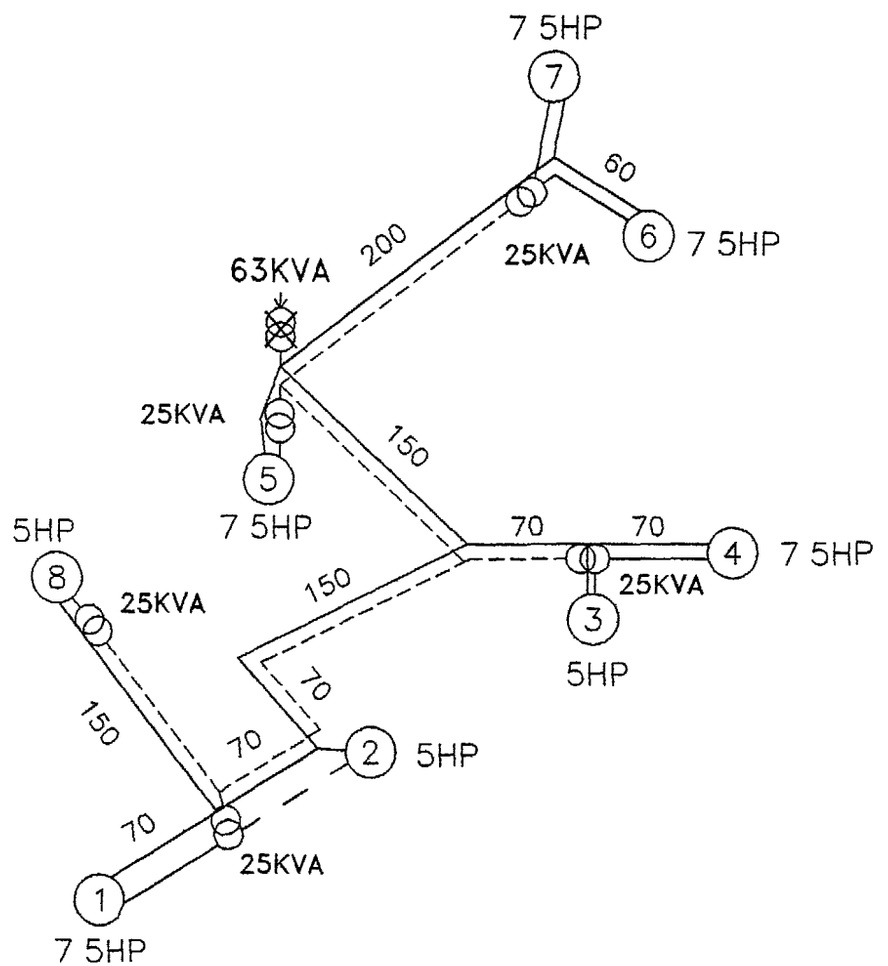
LT Less option



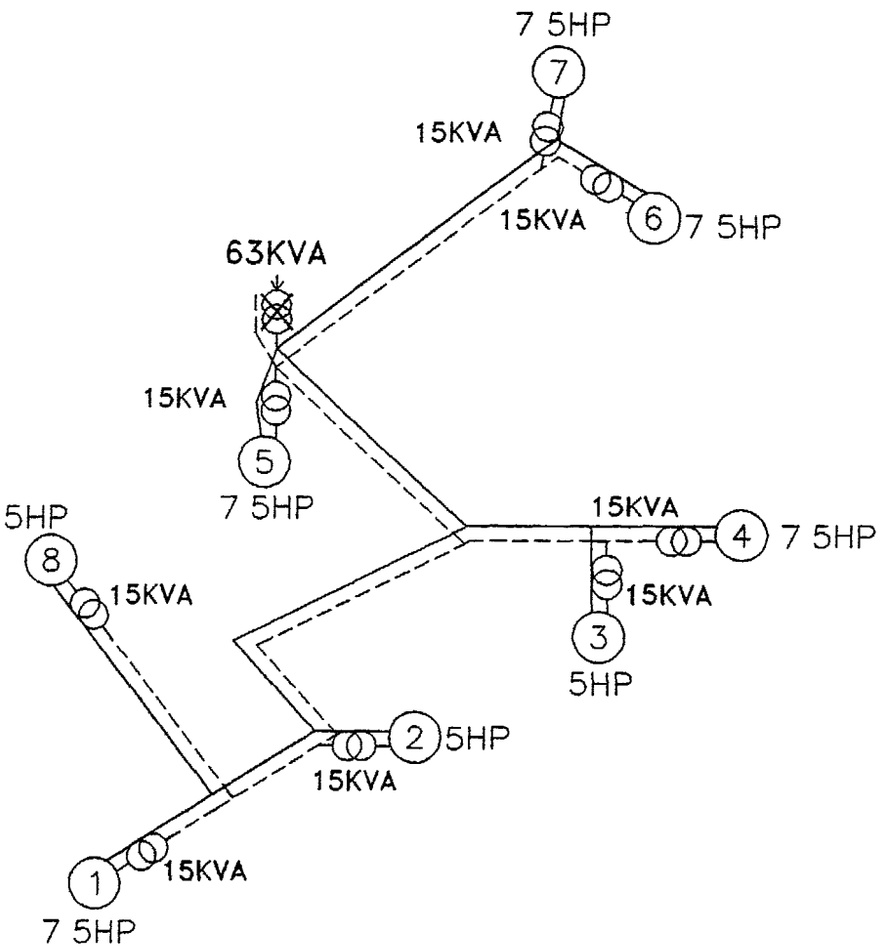
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-32	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Mushroom Farm Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

a1

Grouping Option



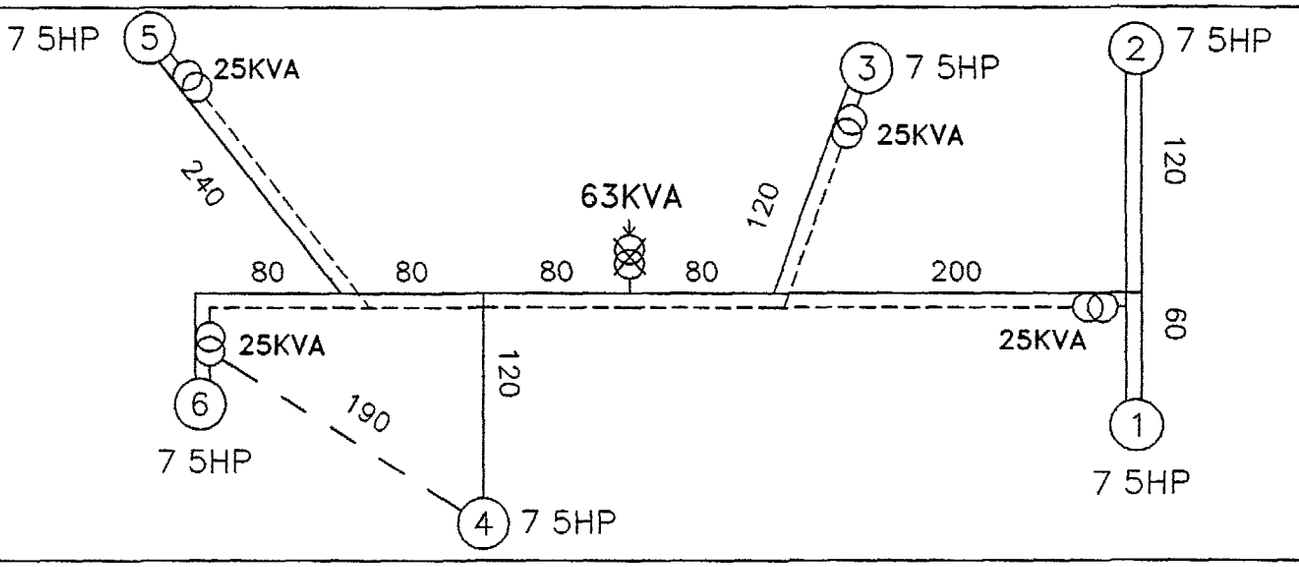
LT Less option



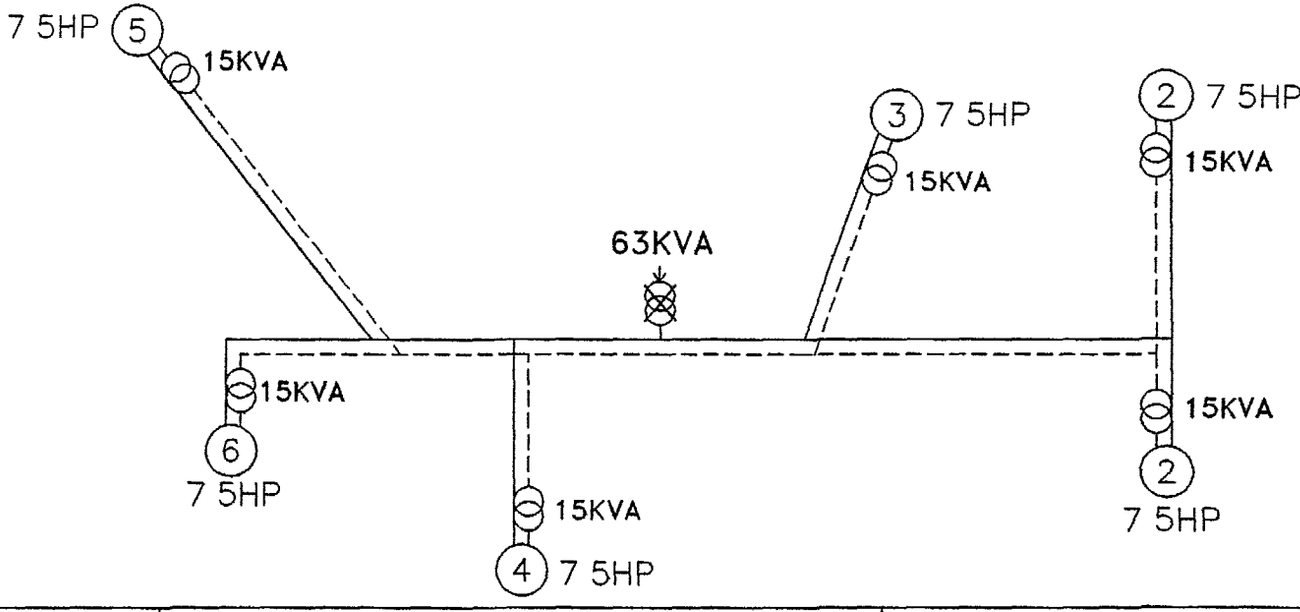
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-33	Project Name DSM Study-HVPN Feeder Name . Palra Tr Name Chetram Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

121

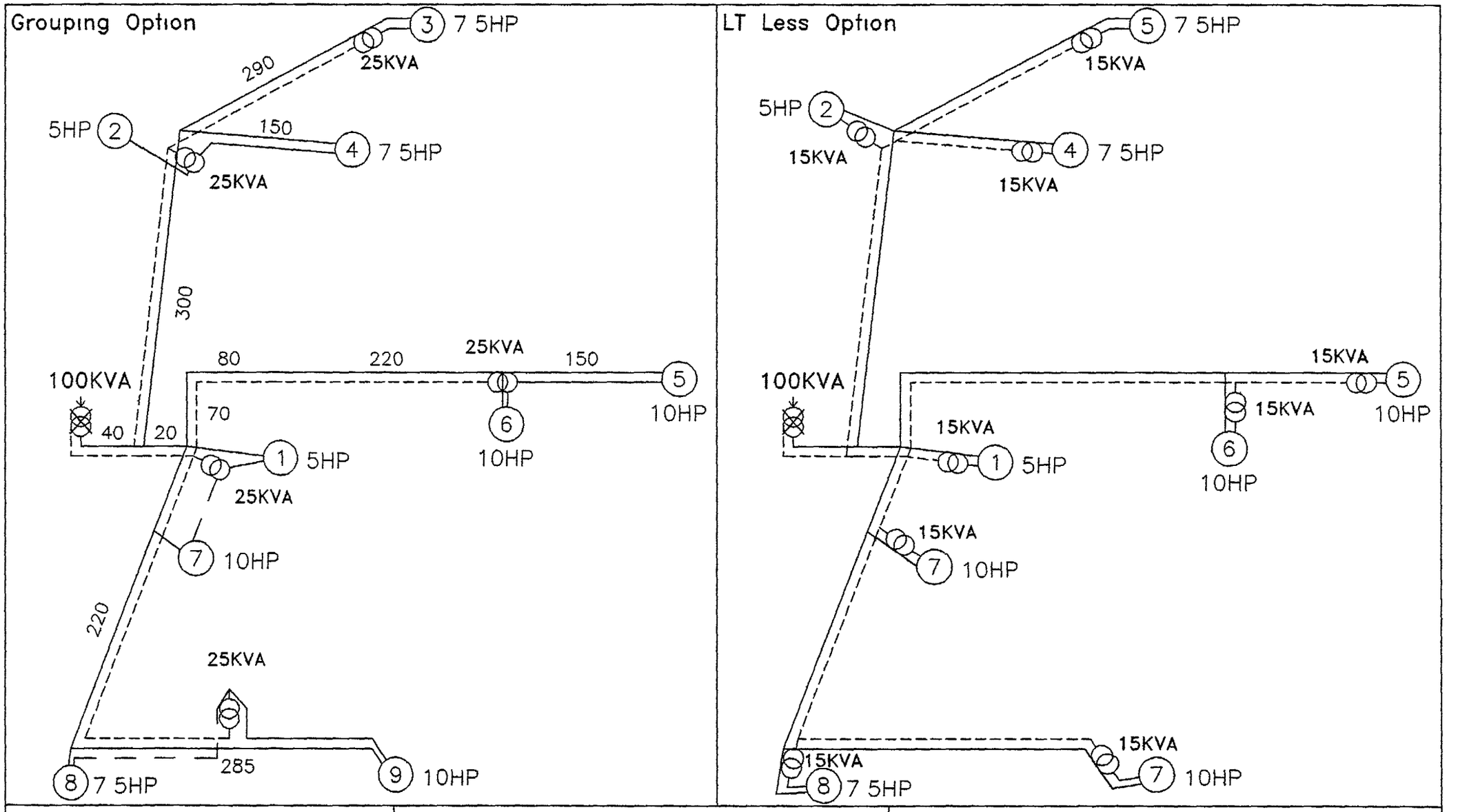
Grouping Option



LT Less option

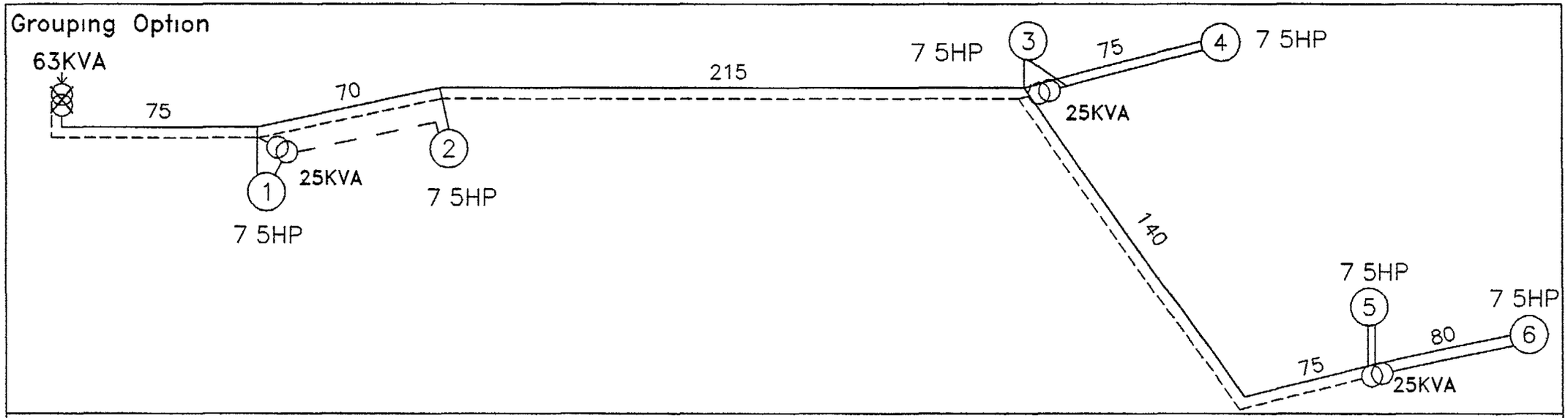


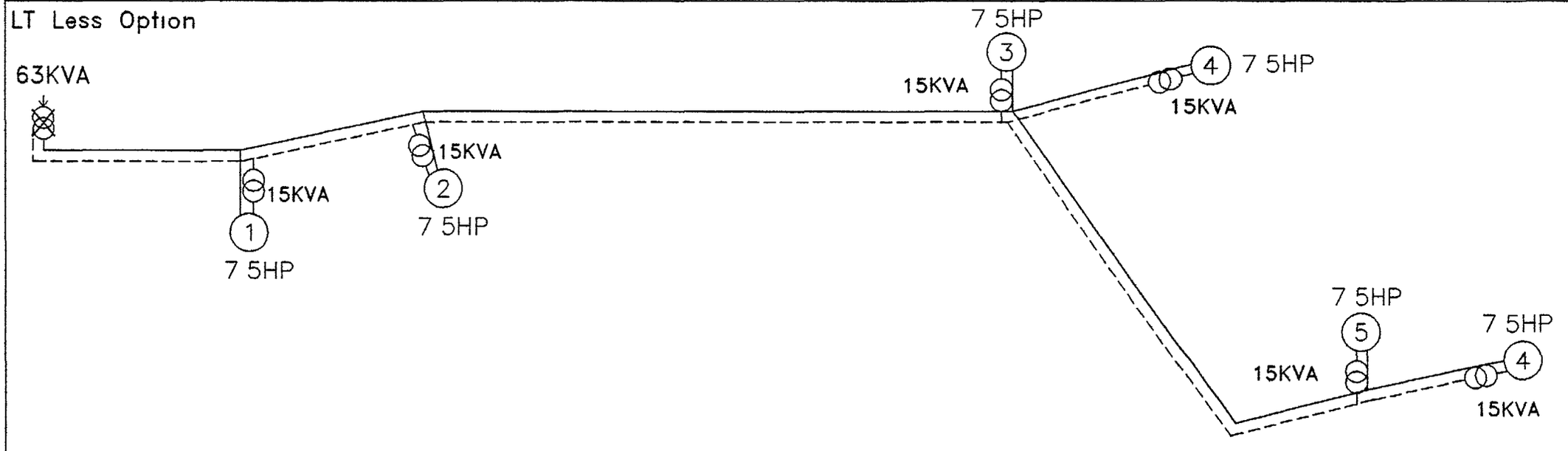
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-34	Project Name DSM Study-HVPN Feeder Name Palra Tr. Name Dayanand Tr. Capacity 63KVA	3EC Energy Economy & Environmental Consultants



All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-35	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Dulichand Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

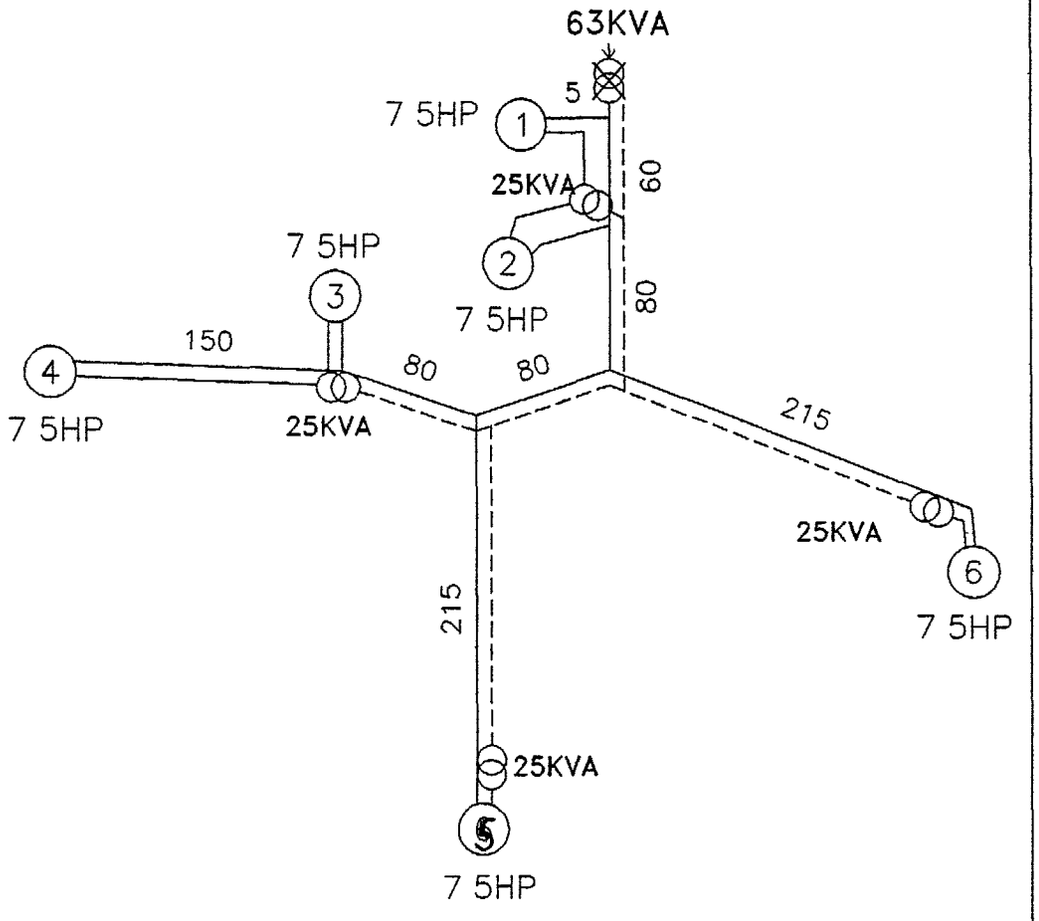
23



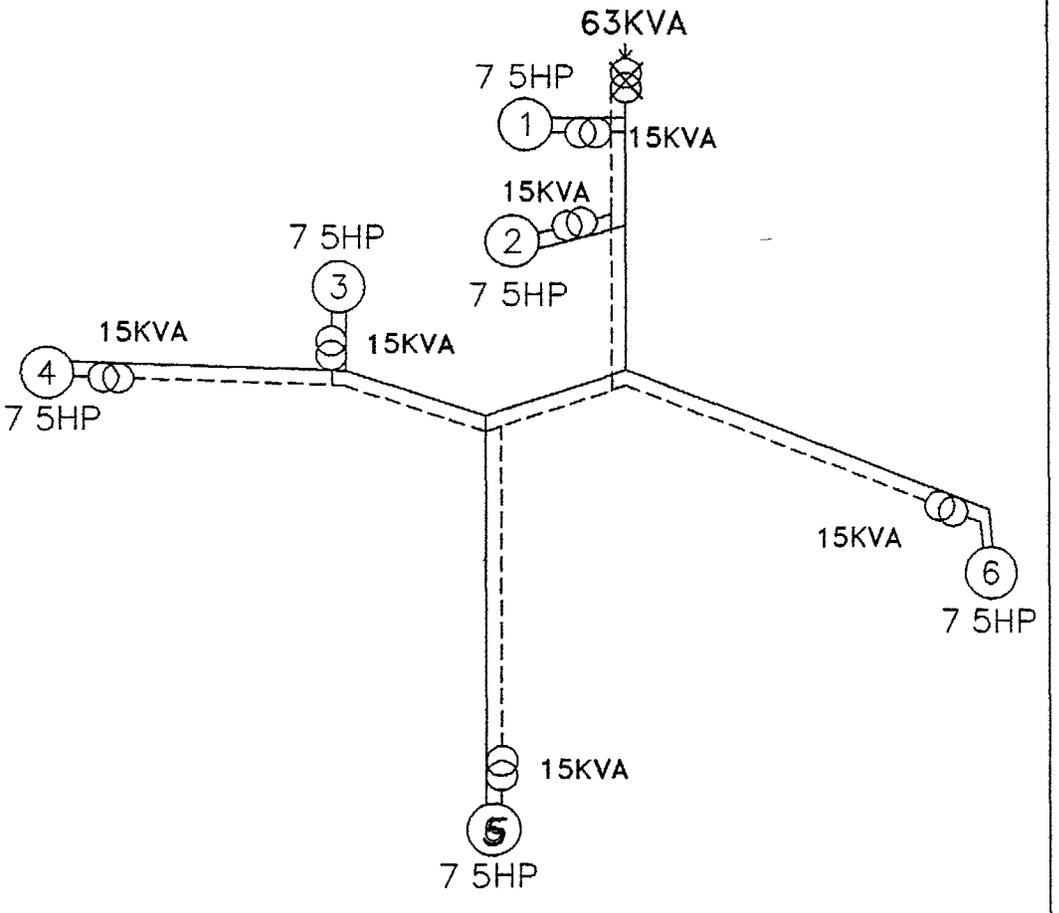


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-35B	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Dariyab Simgh Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



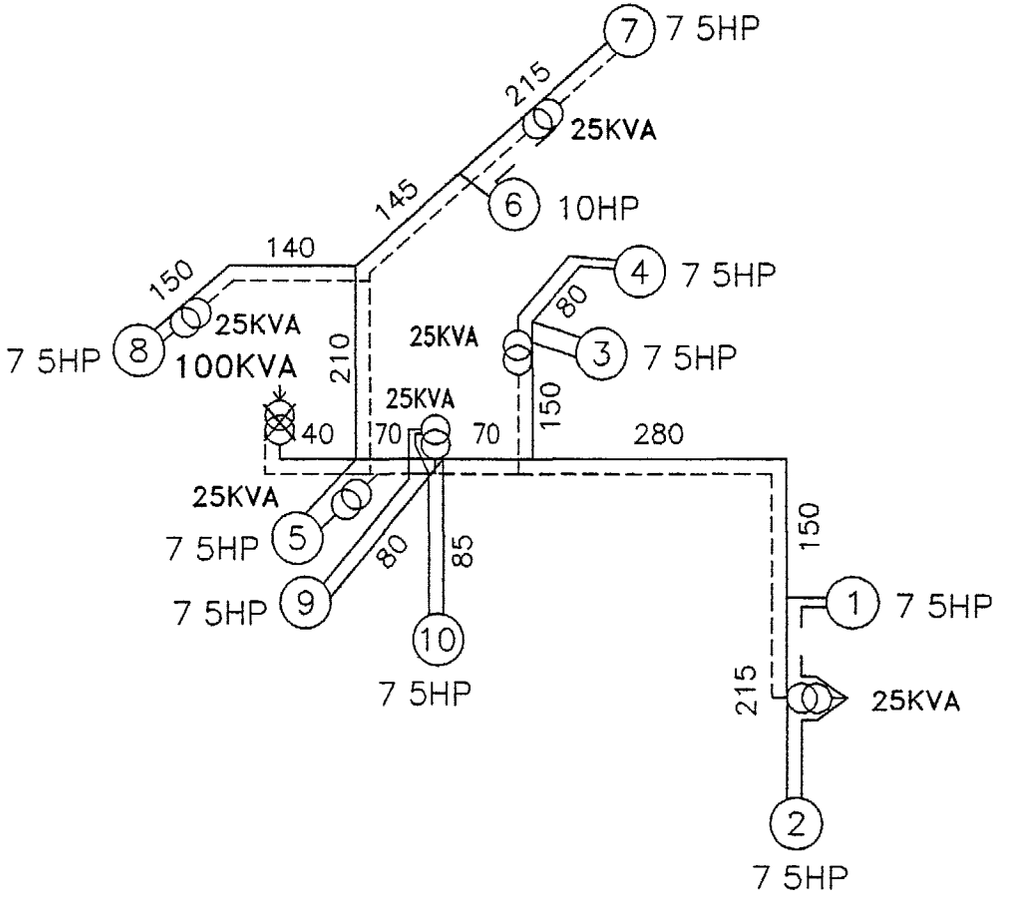
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-36

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Devi Singh

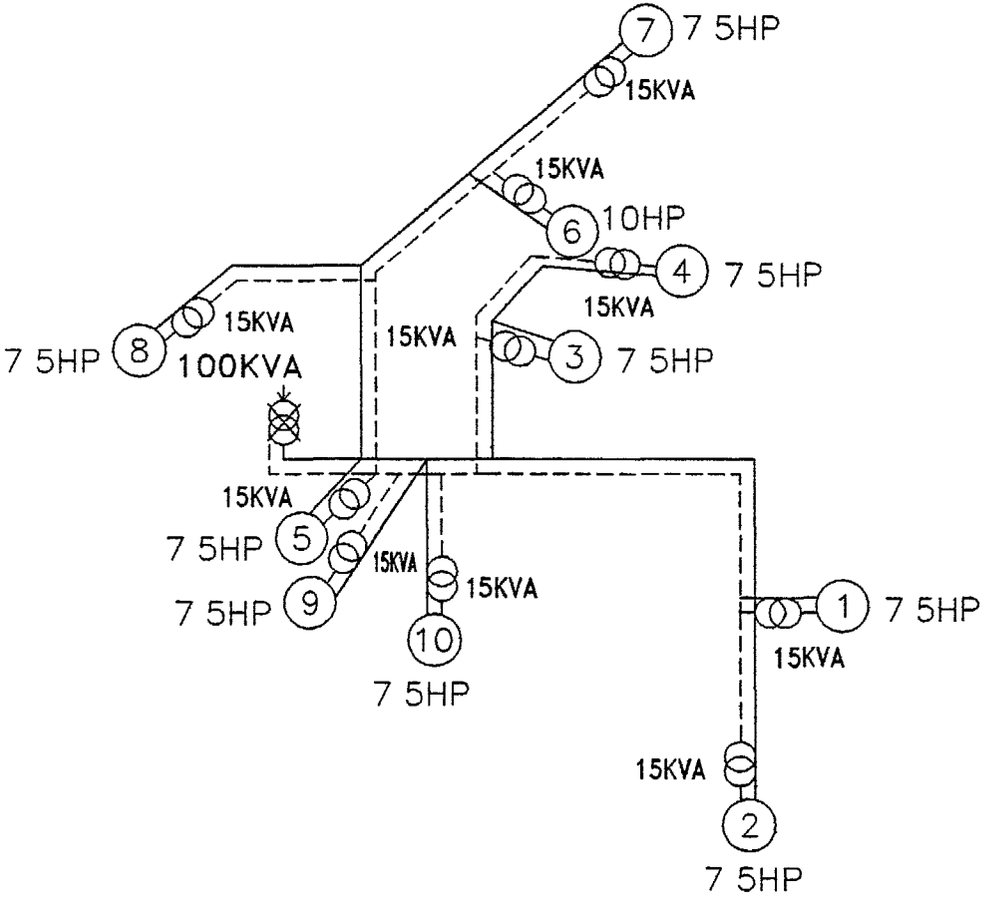
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



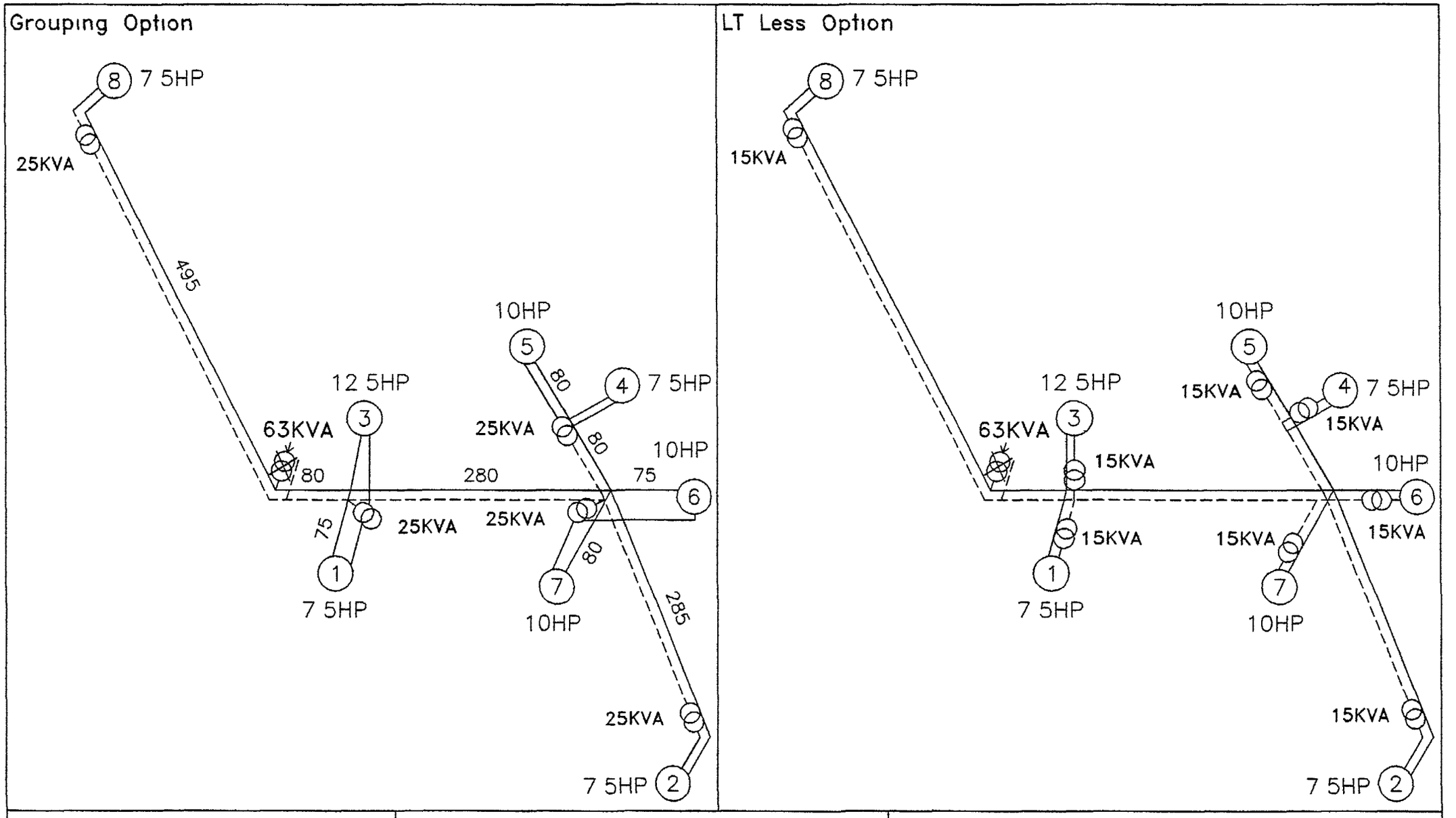
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-37

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Dariya Singh

Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

126



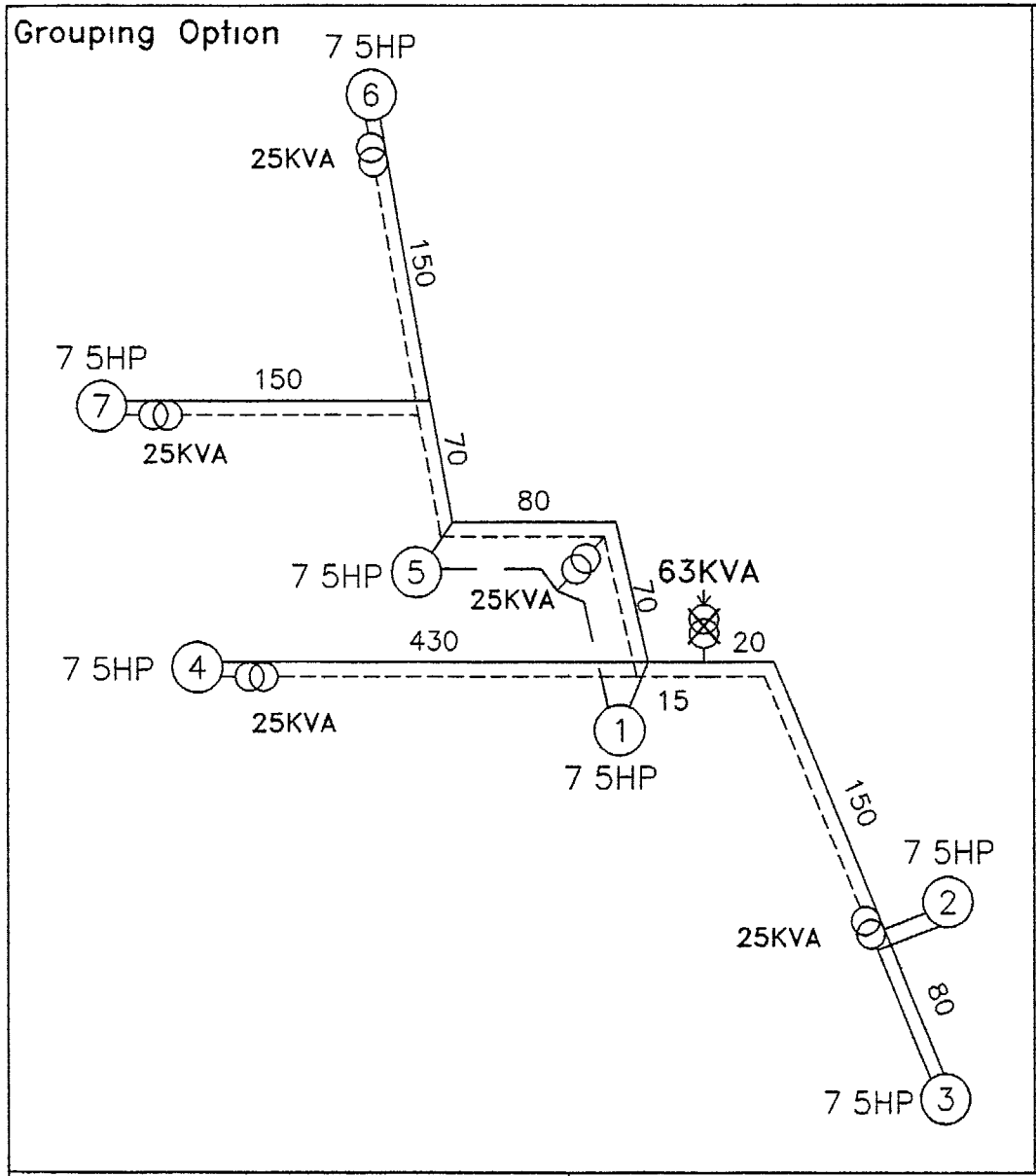
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-38

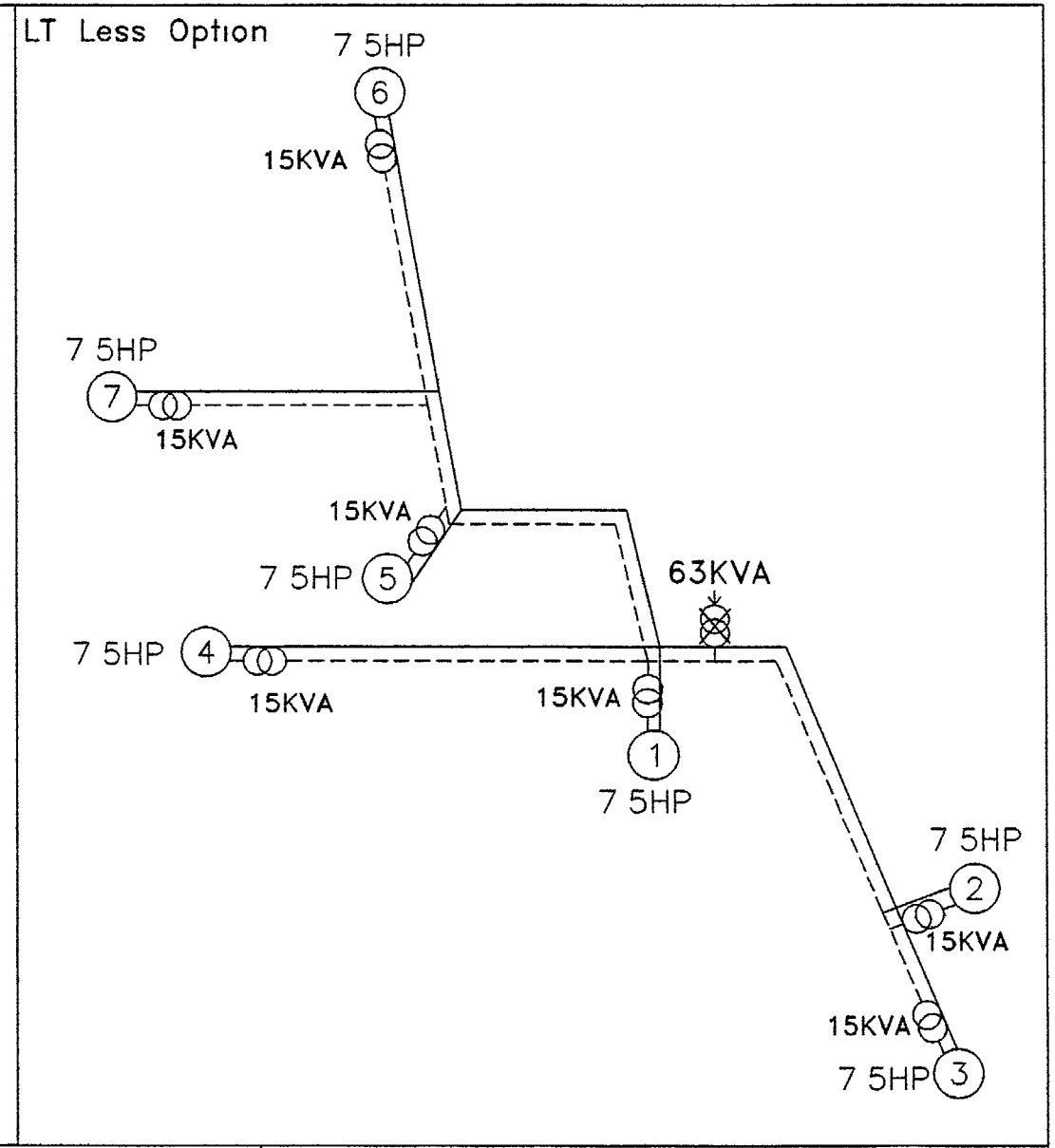
Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Dhan Singh

Tr. Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

121





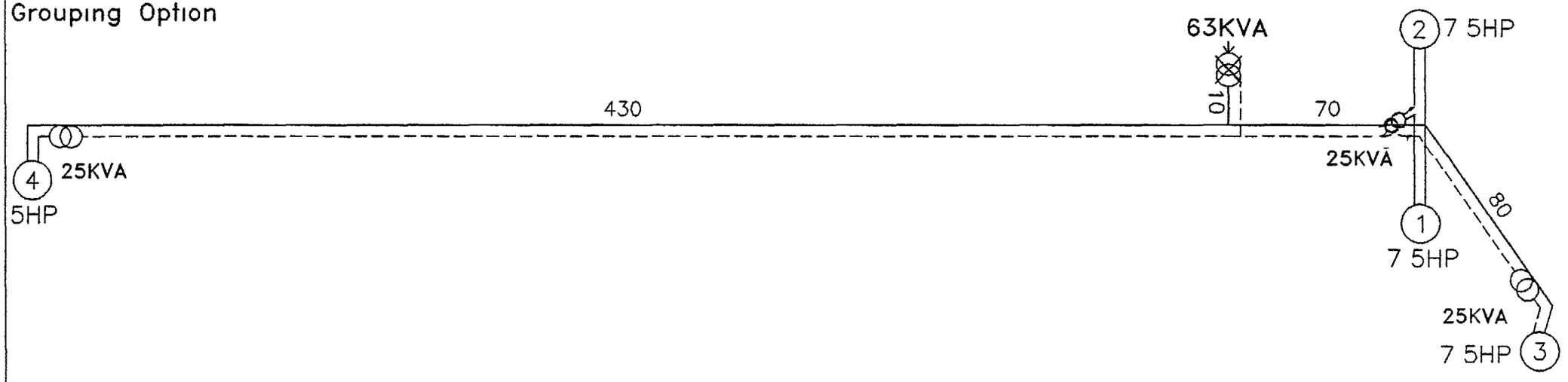
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-39

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Chunni lal

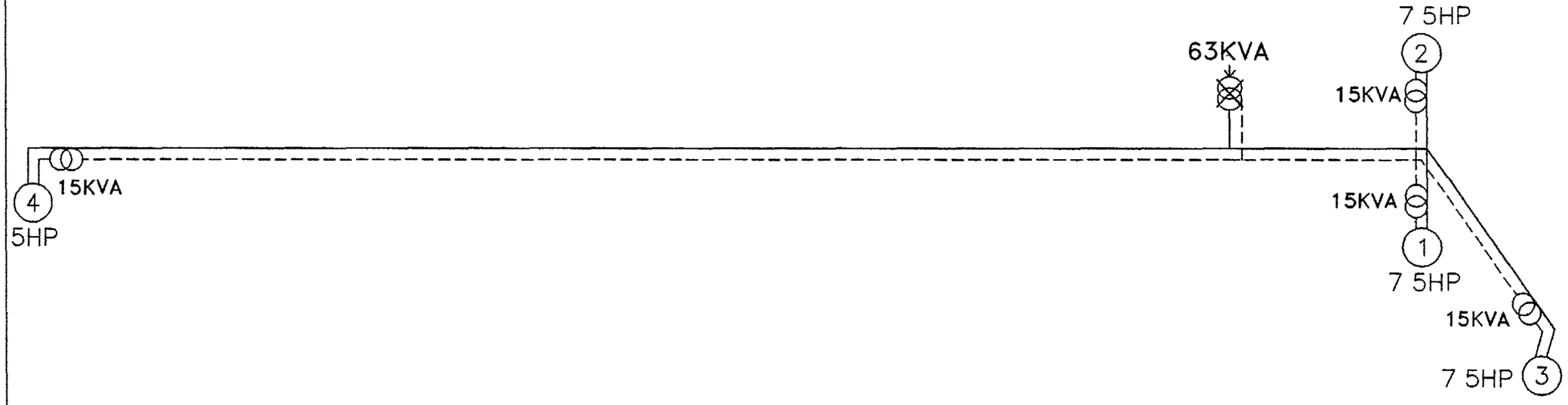
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

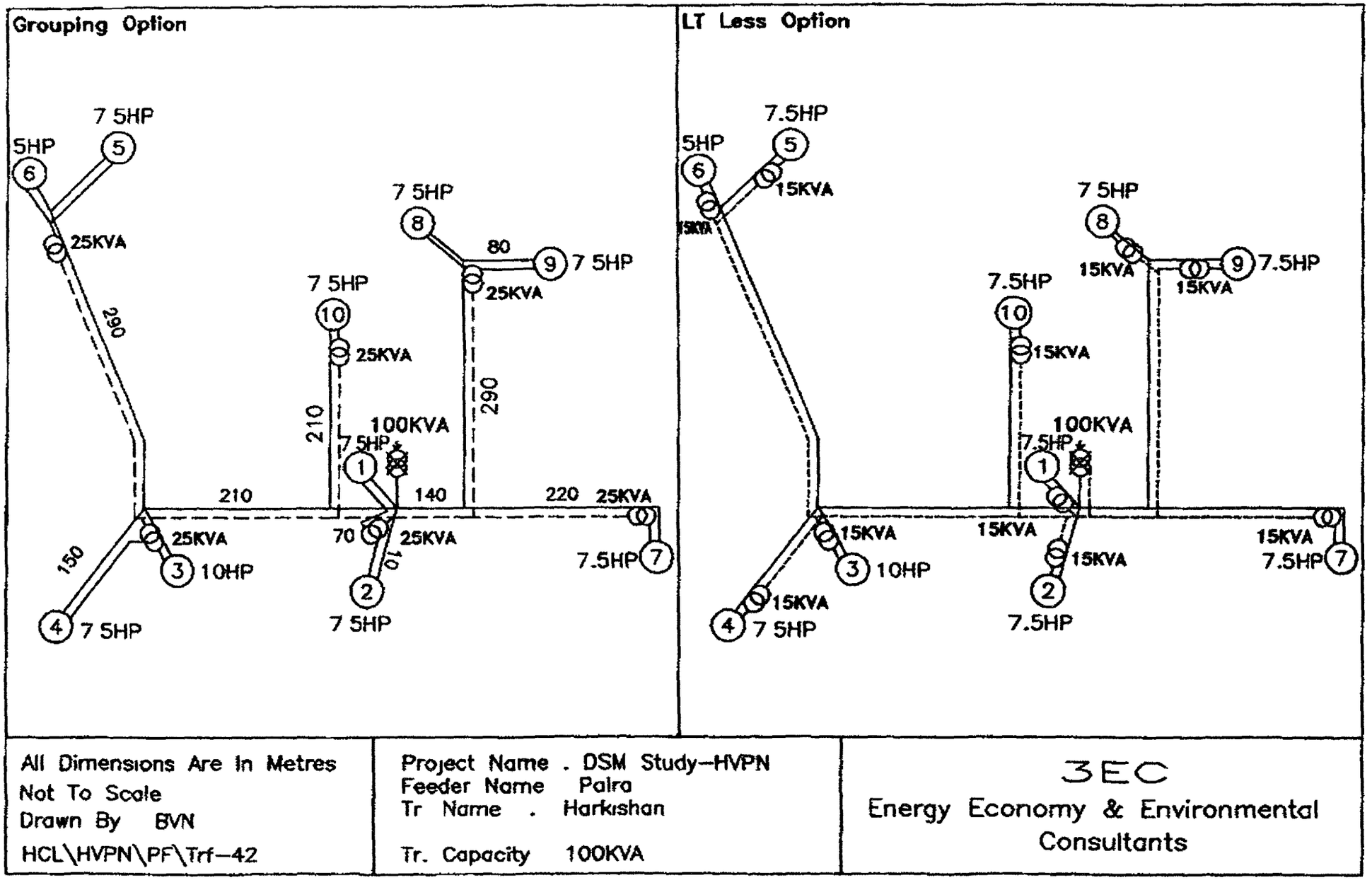


LT Less Option



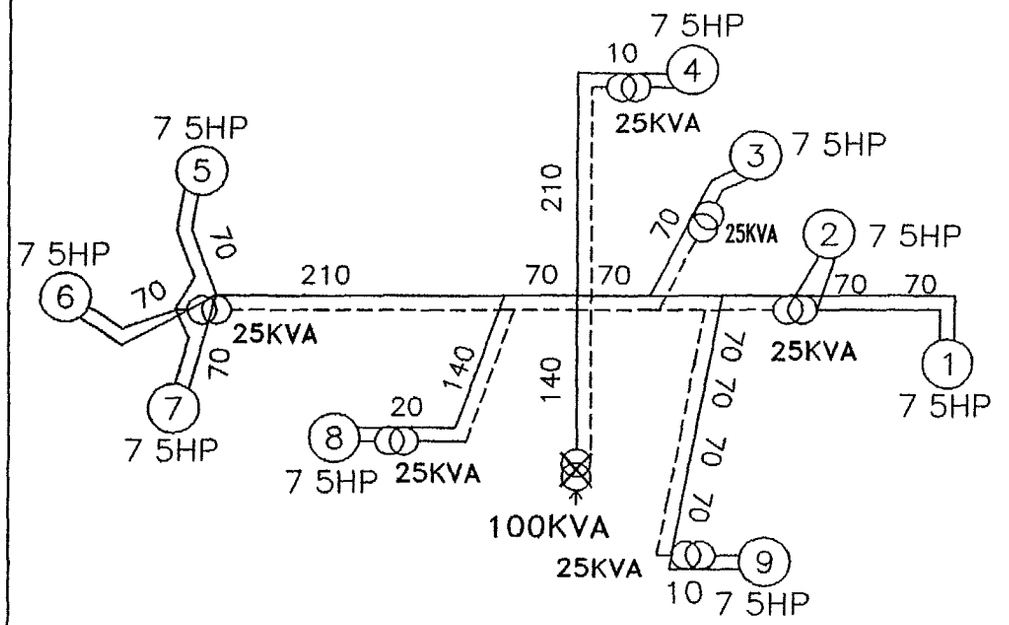
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-40	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Jai Chand Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

174

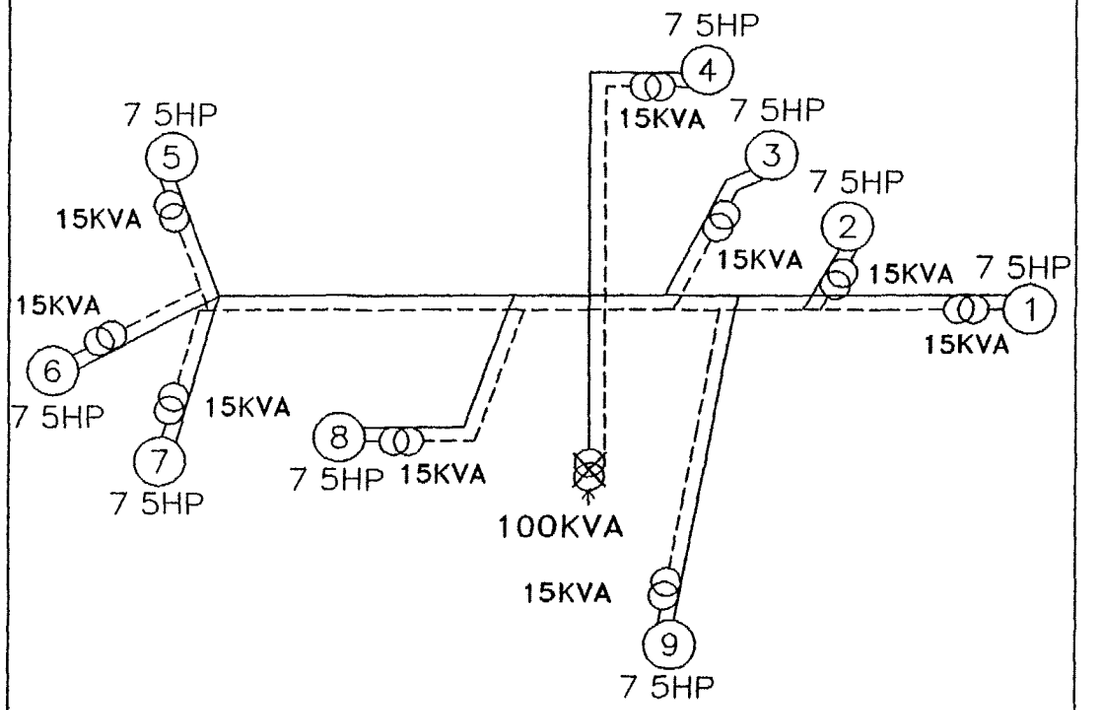


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf–42	Project Name . DSM Study–HVPN Feeder Name Palra Tr Name . Harkishan Tr. Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

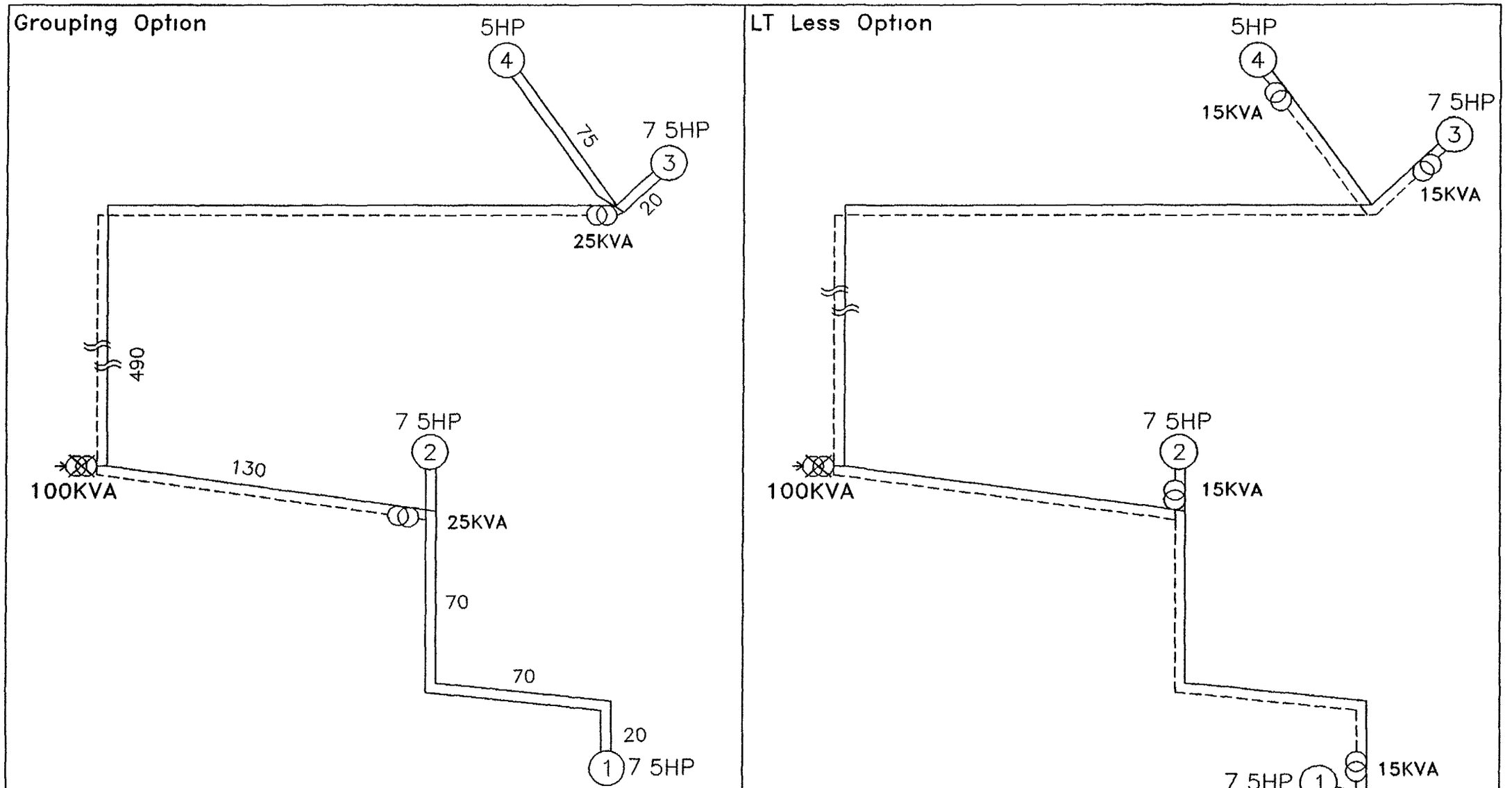


LT Less Option



All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-43	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Pratap Singh Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

121



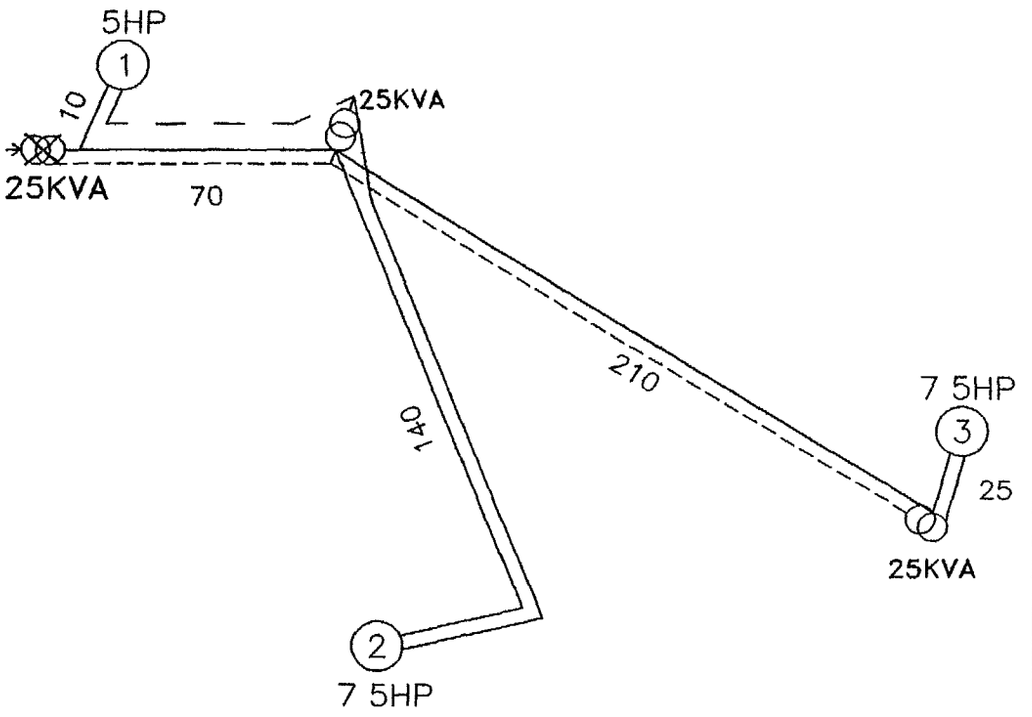
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-45

Project Name : DSM Study-HVPN
Feeder Name Palra
Tr Name Jai Prakash

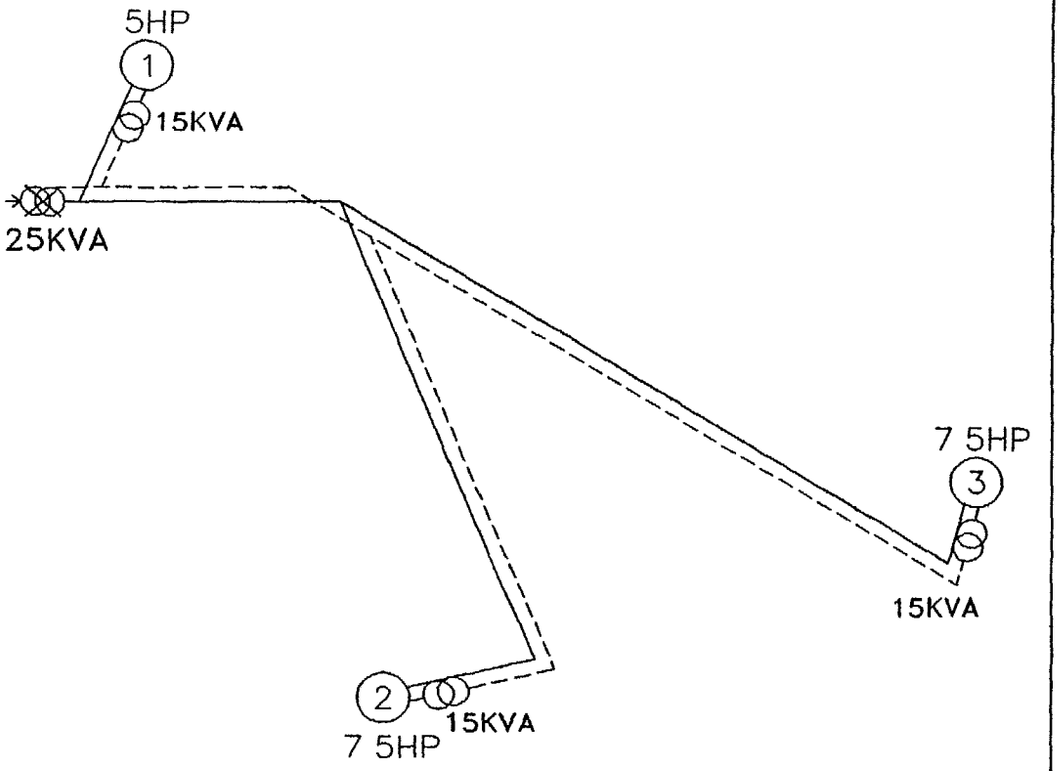
Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

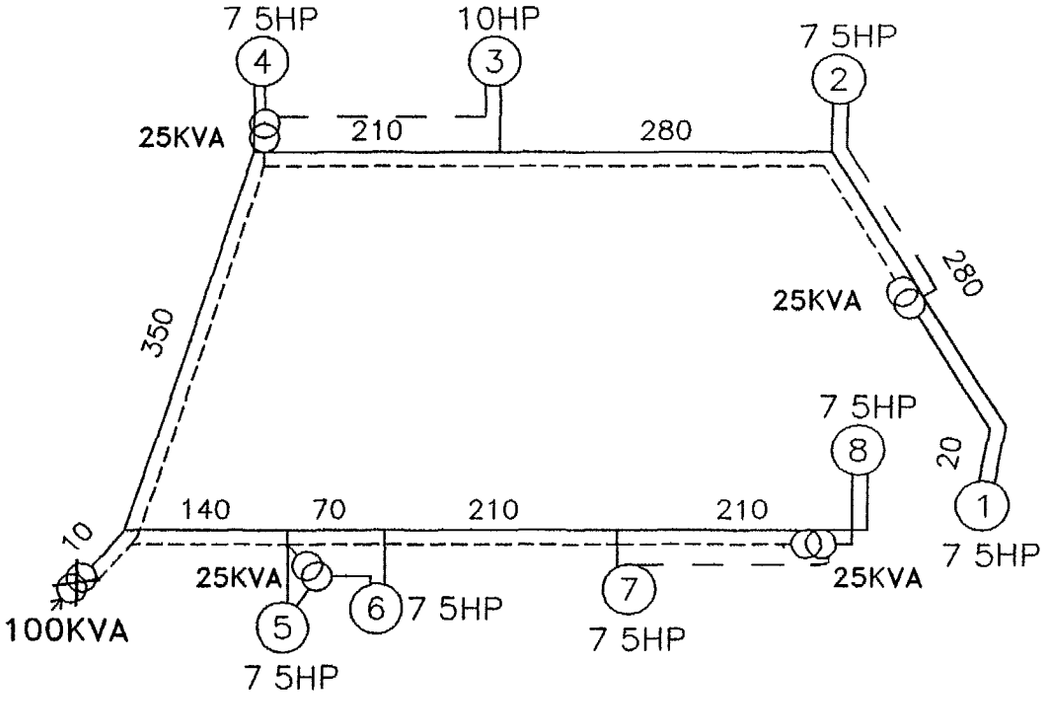


LT Less Option

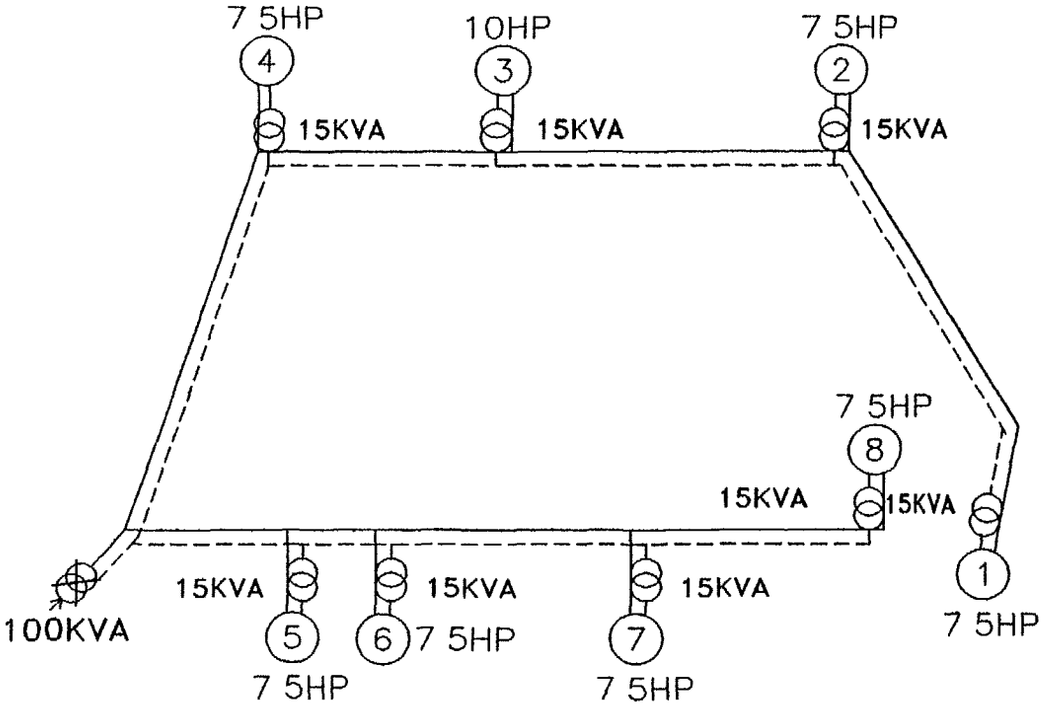


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-46	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Sube Singh Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-47

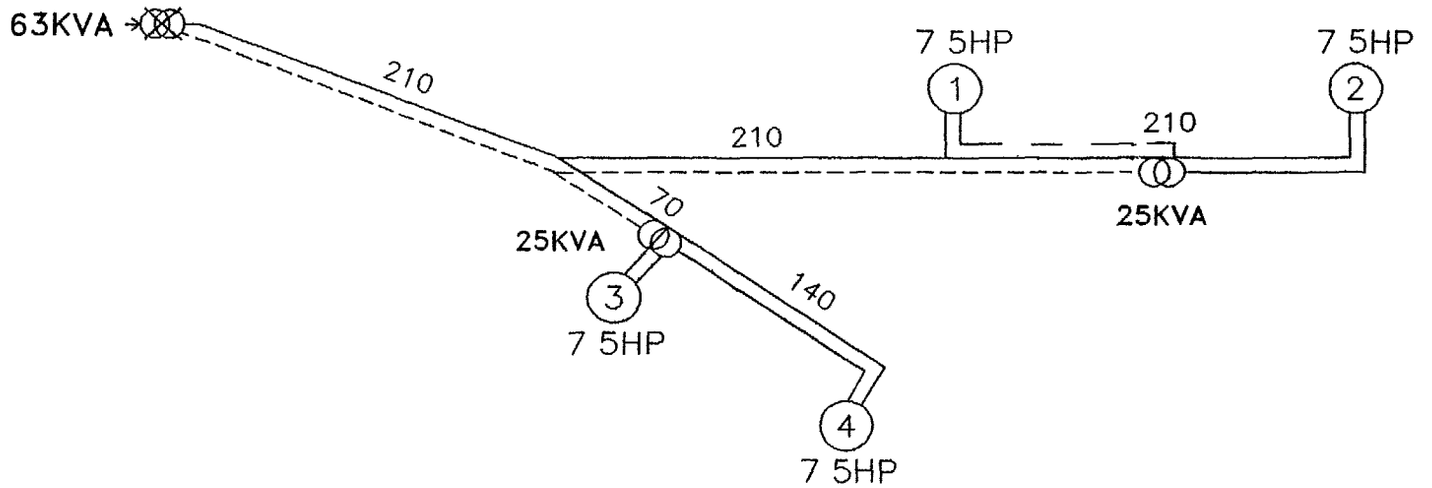
Project Name : DSM Study-HVPN
Feeder Name Palra
Tr Name Karan Singh

Tr Capacity 100KVA

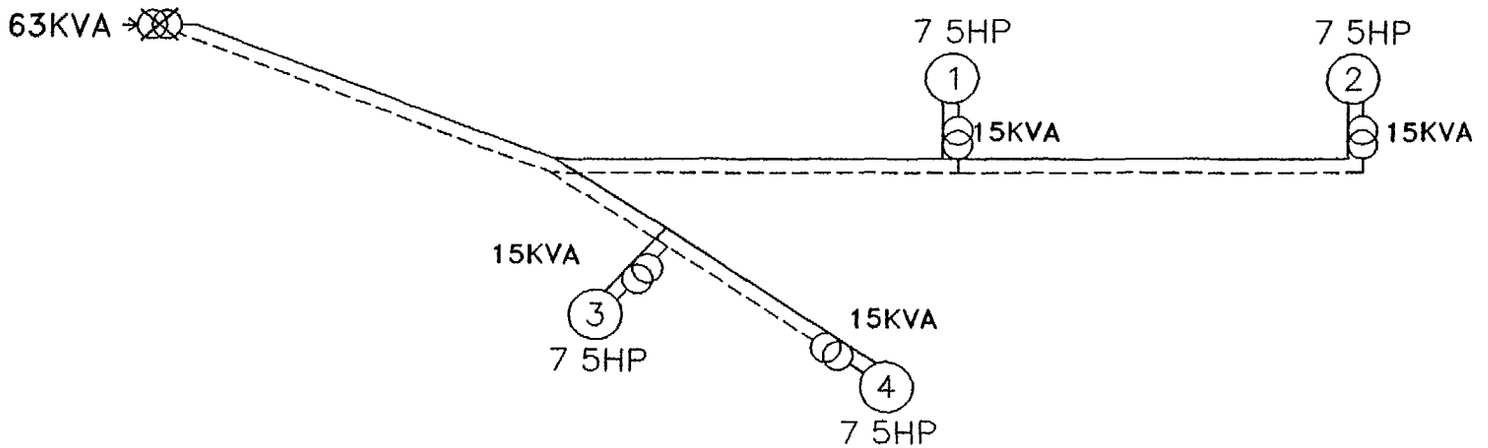
3EC
Energy Economy & Environmental Consultants

134

Grouping Option

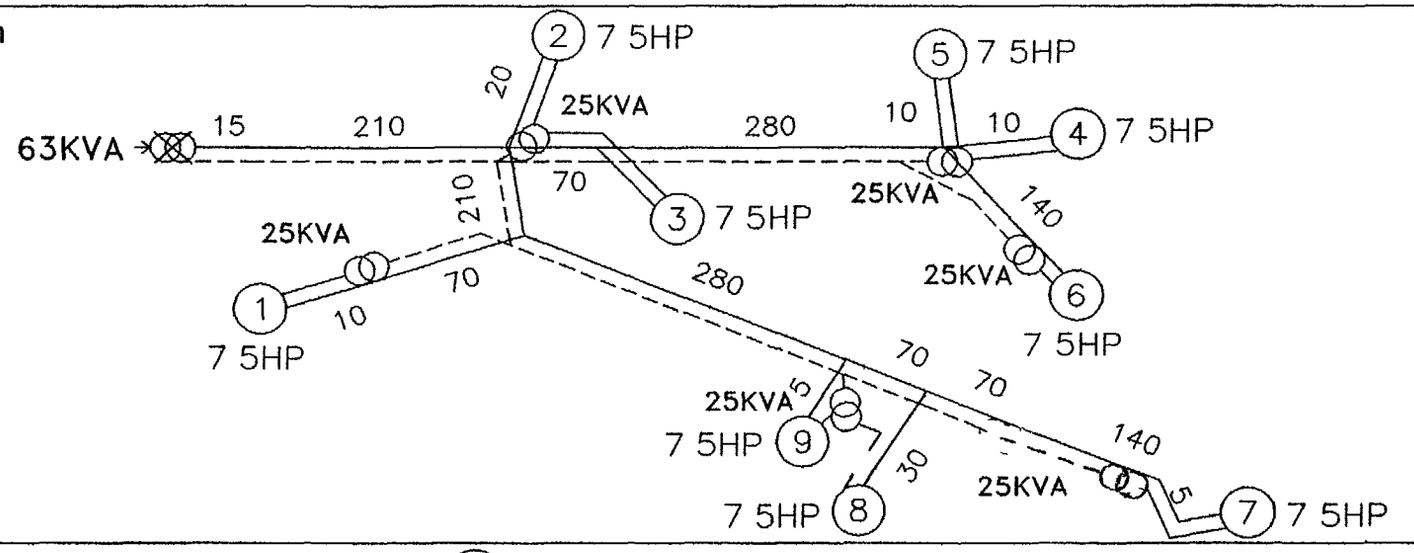


LT Less Option

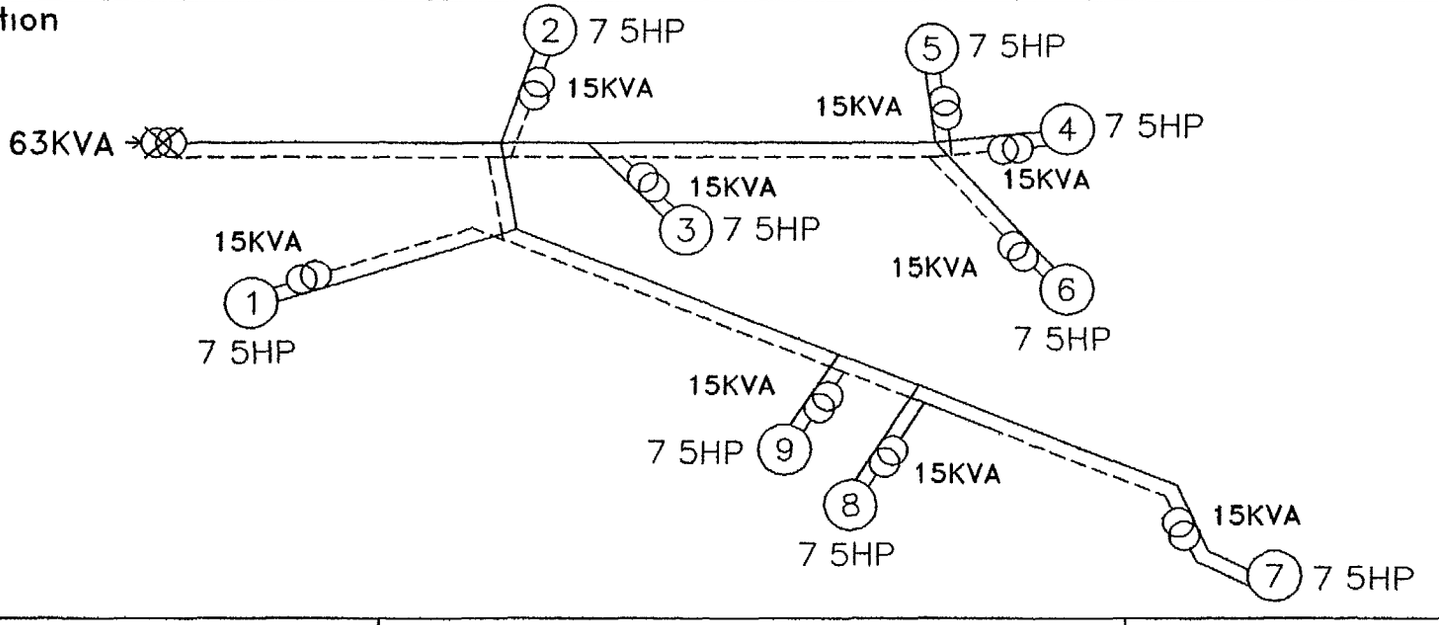


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-48	Project Name DSM Study-HVPN Feeder Name Palra Tr Name : Randhir Singh Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

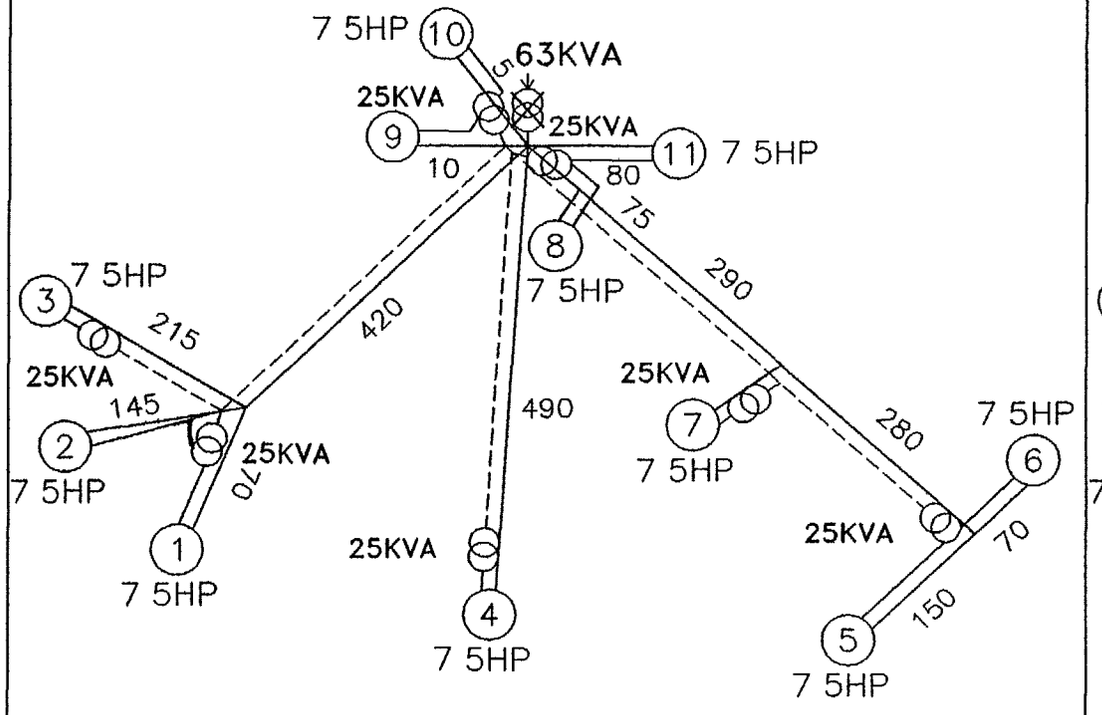


LT Less Option

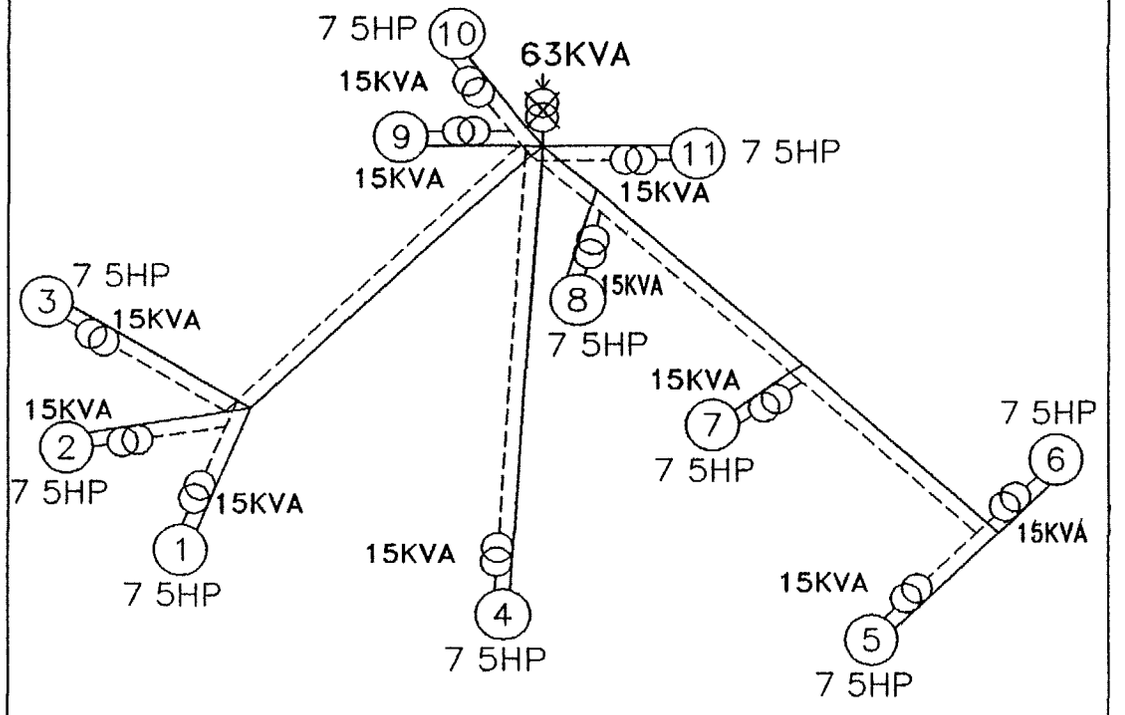


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-49	Project Name DSM Study-HVPN Feeder Name Palra Tr Name : Zile Singh Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



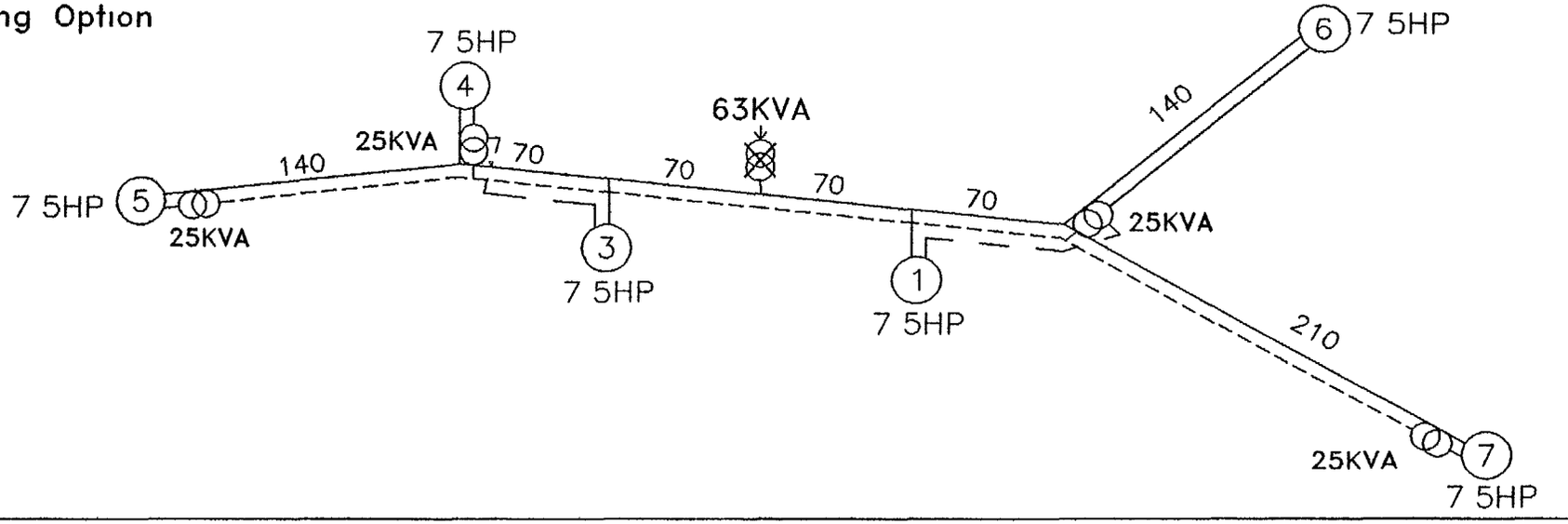
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-51

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Kannya

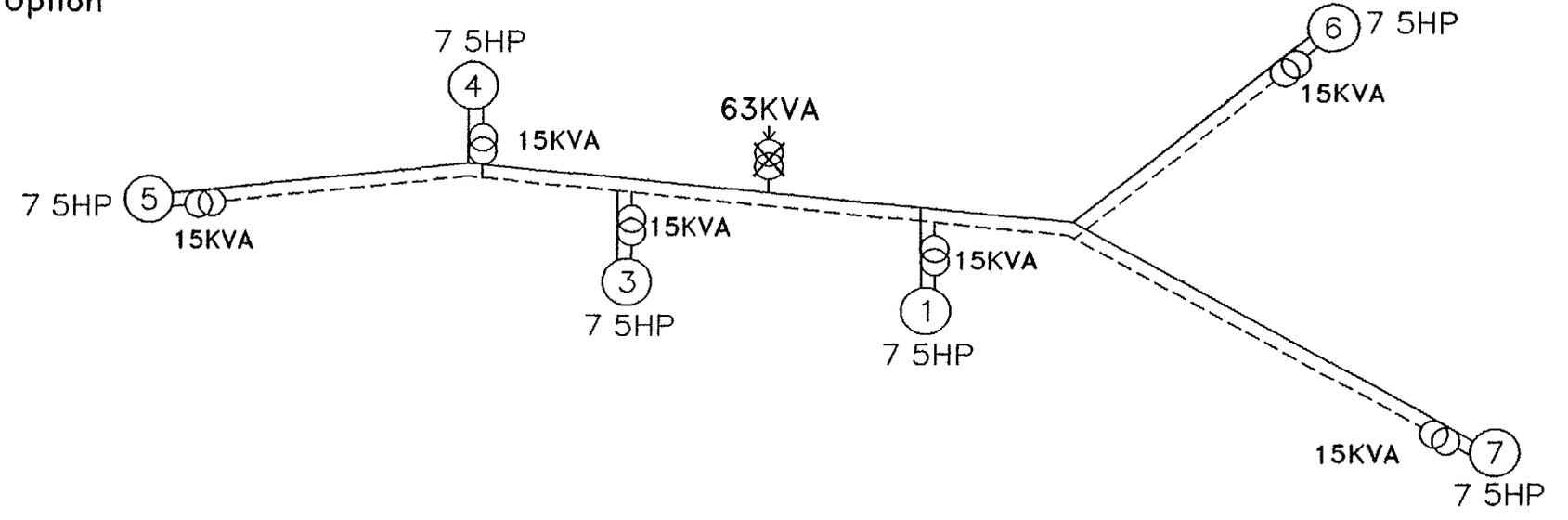
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

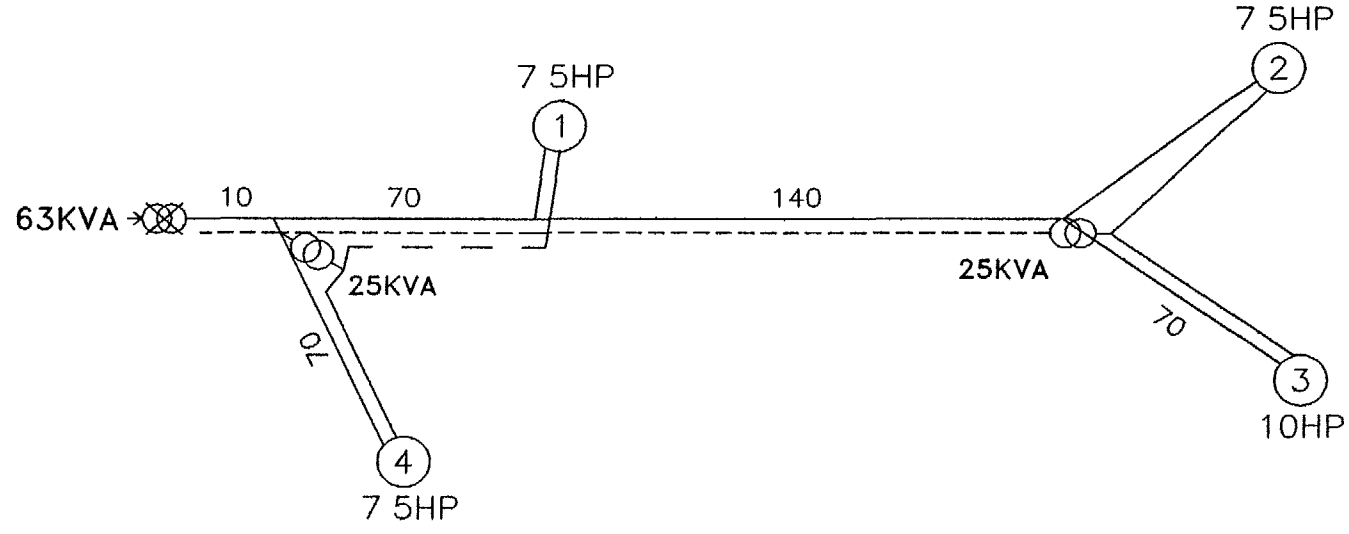


LT Less Option

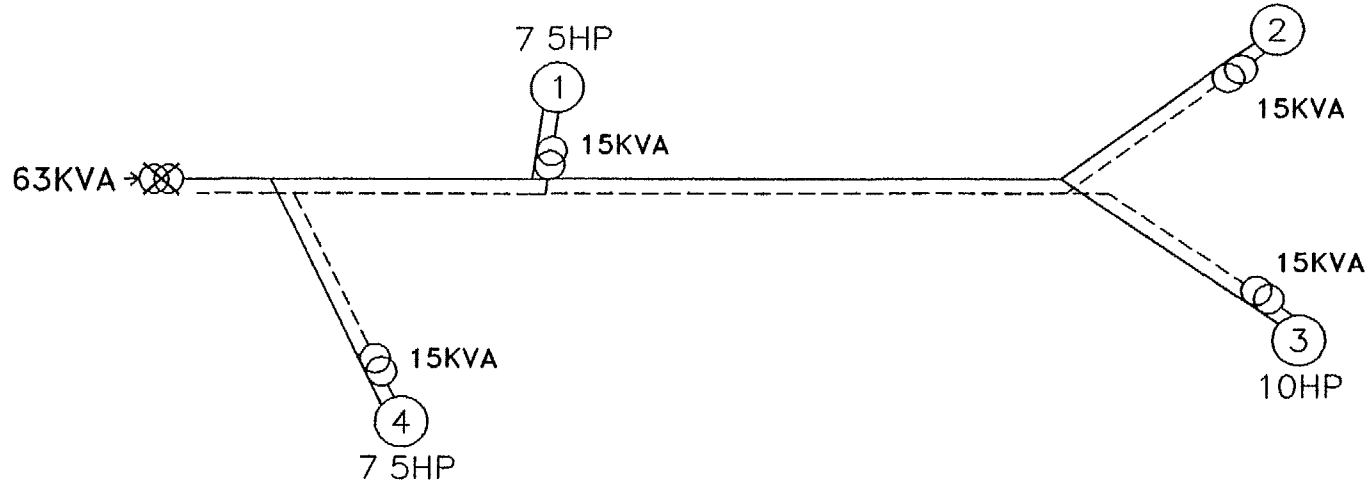


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-52	Project Name : DSM Study-HVPN Feeder Name Palra Tr Name Shanti Devi Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

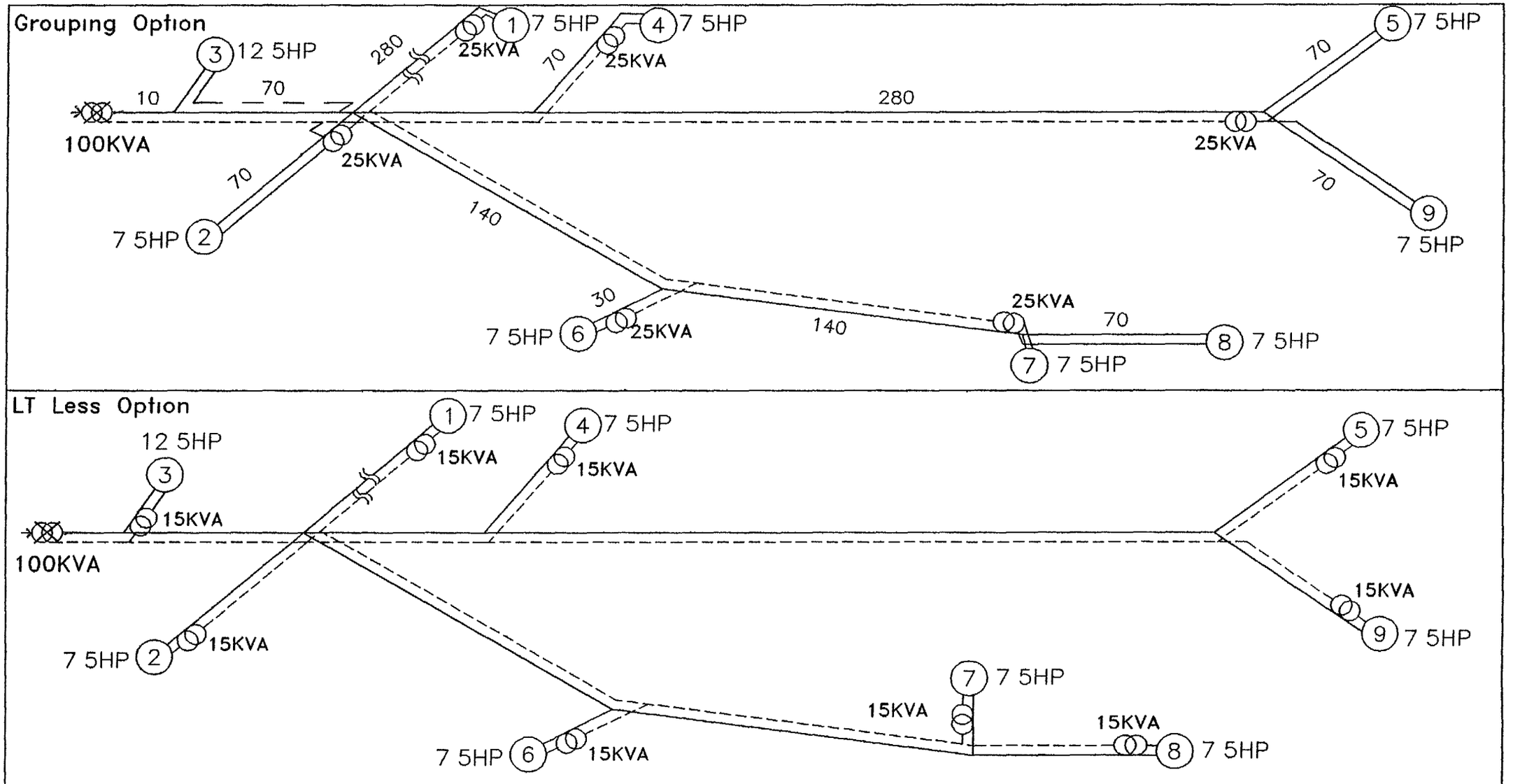
Grouping Option



LT Less Option

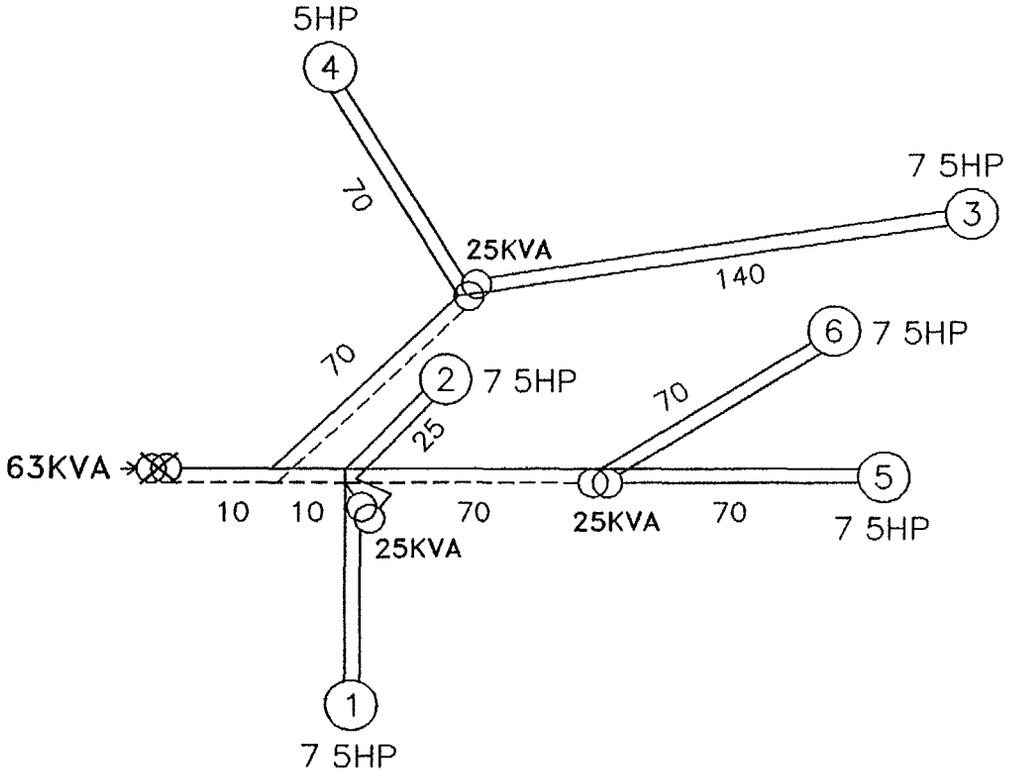


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-53	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Satya Narayan Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

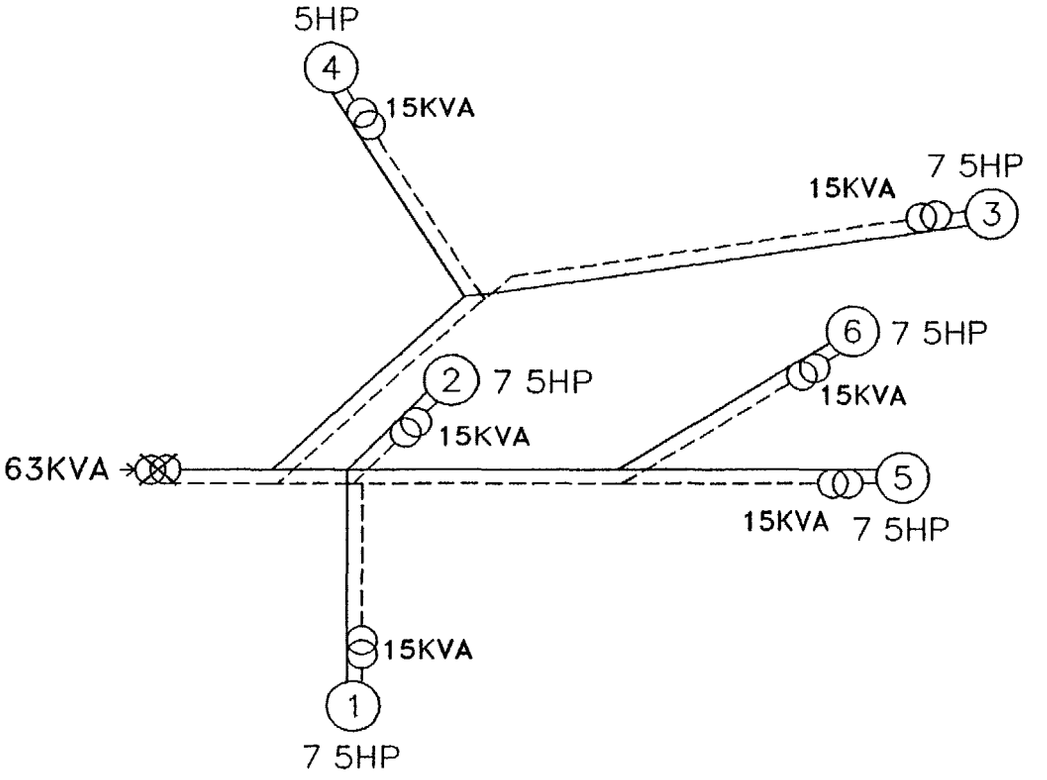


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-54	Project Name DSM Study-HVPN Feeder Name Palra Tr Name TCA-28 Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

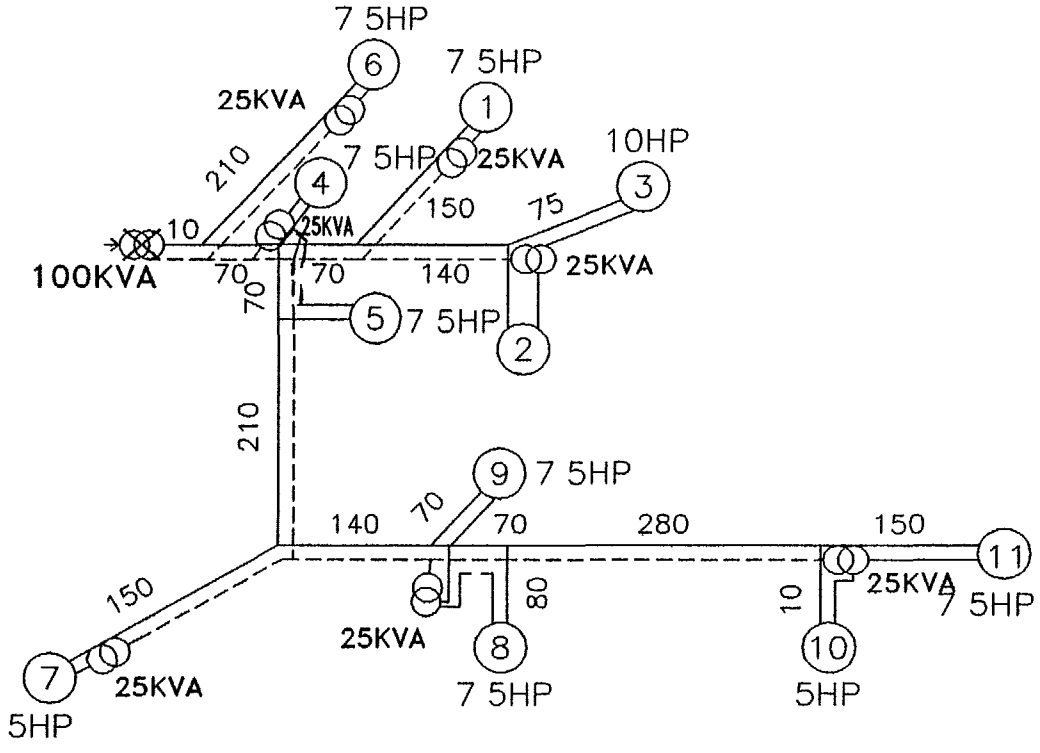


LT Less Option

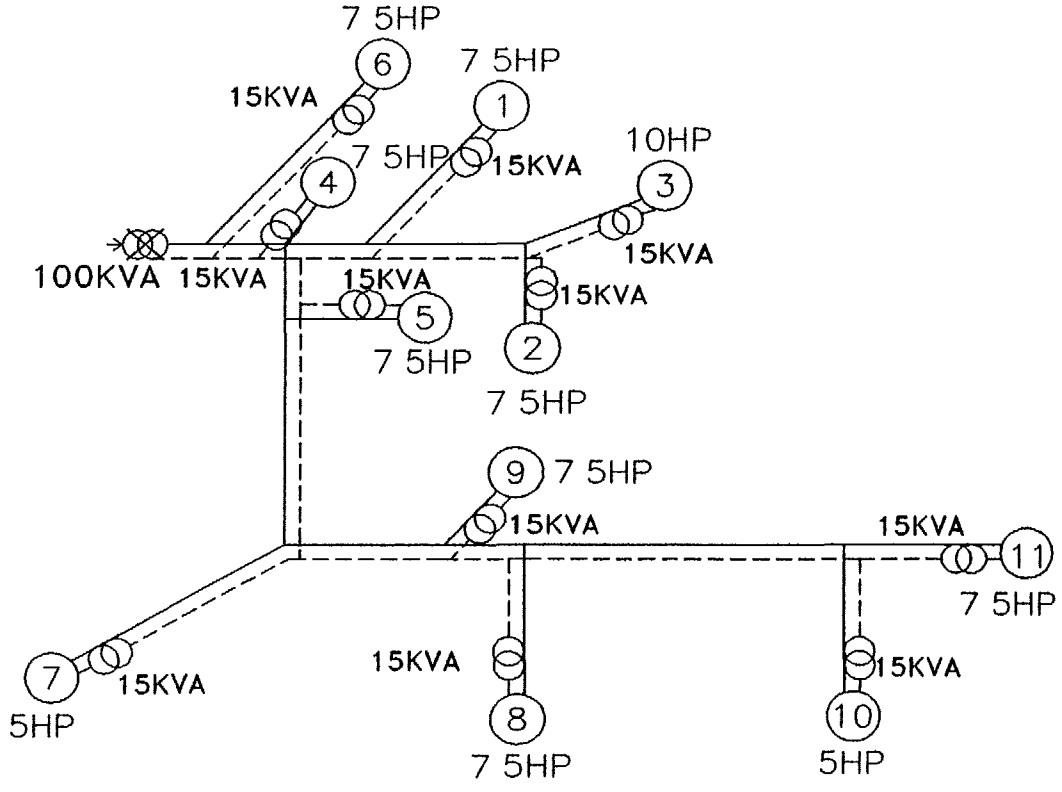


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-55	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Mange Ram Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

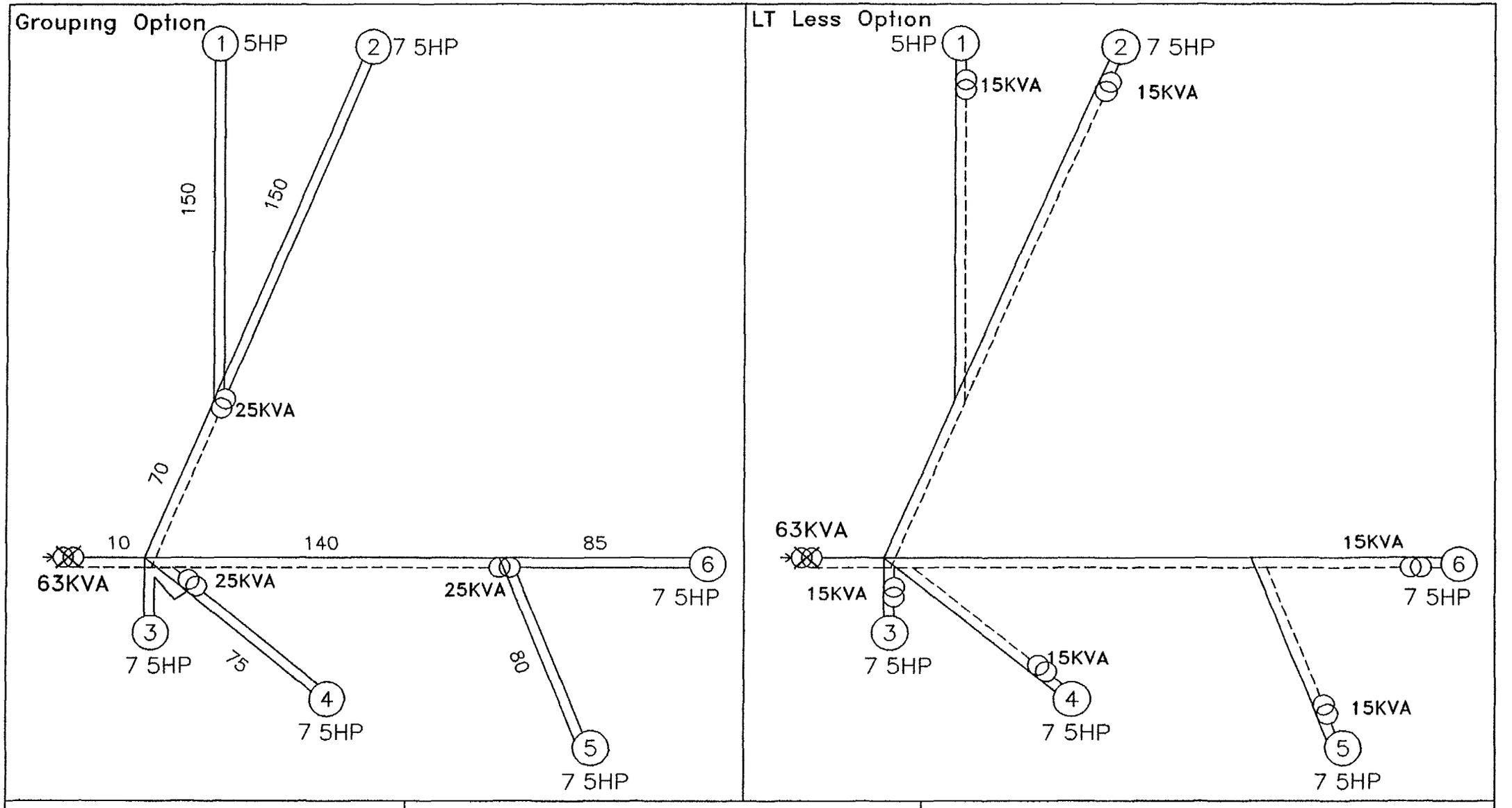
Grouping Option



LT Less Option



All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-56	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Dayananda Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

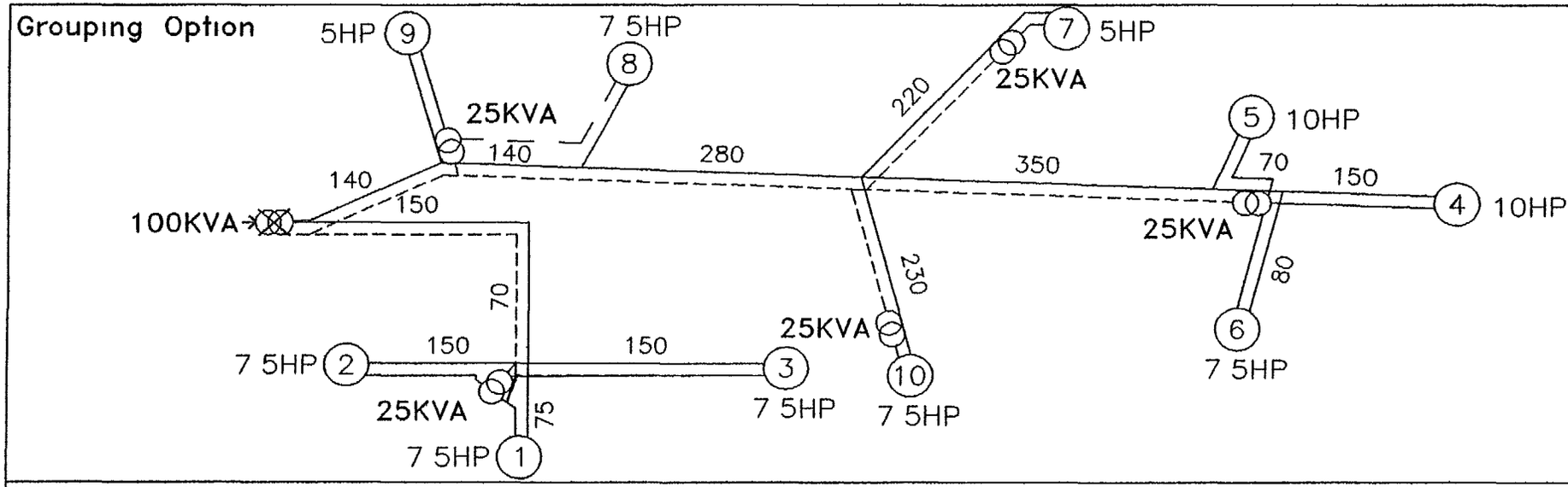


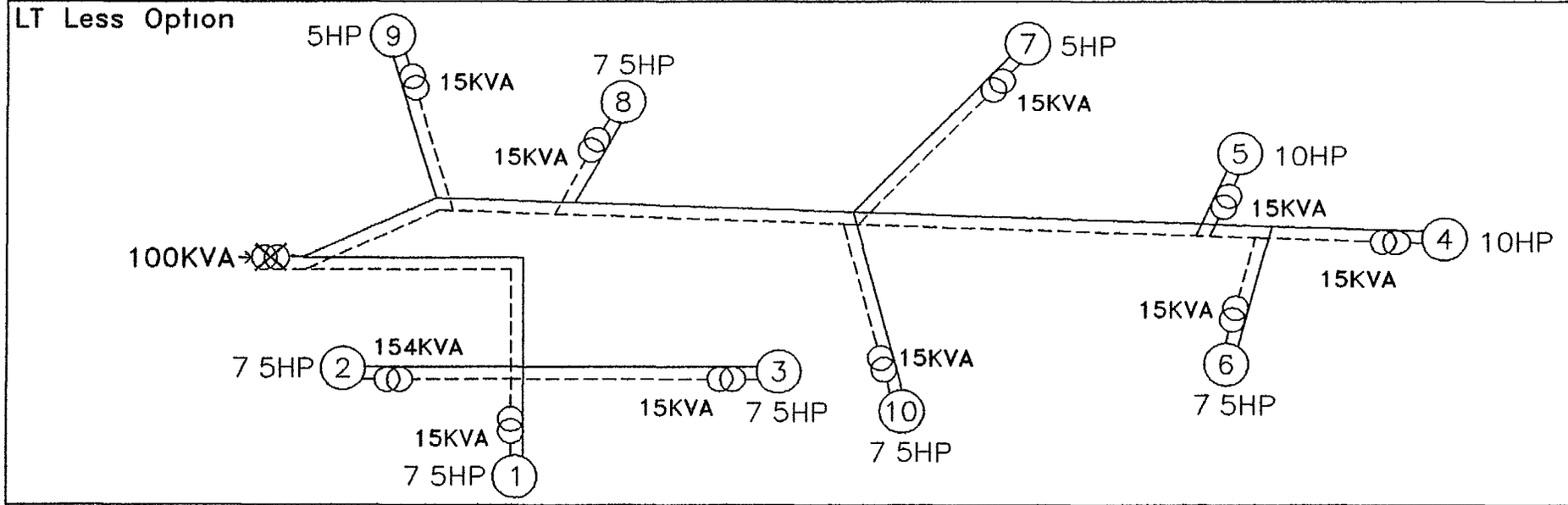
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-56A

Project Name : DSM Study-HVPN
Feeder Name Palra
Tr Name : Mahinder

Tr Capacity 63KVA

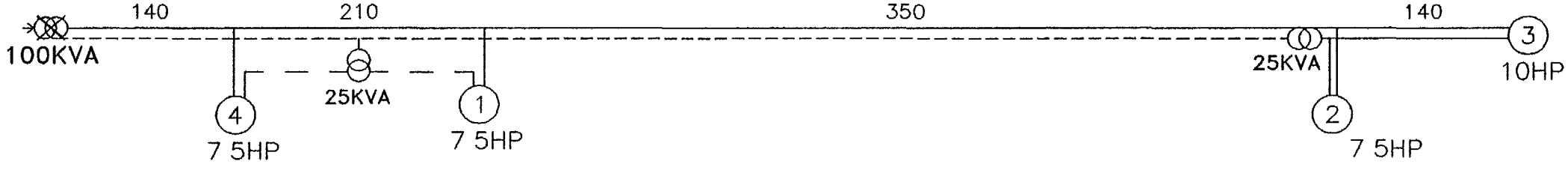
3EC
Energy Economy & Environmental Consultants



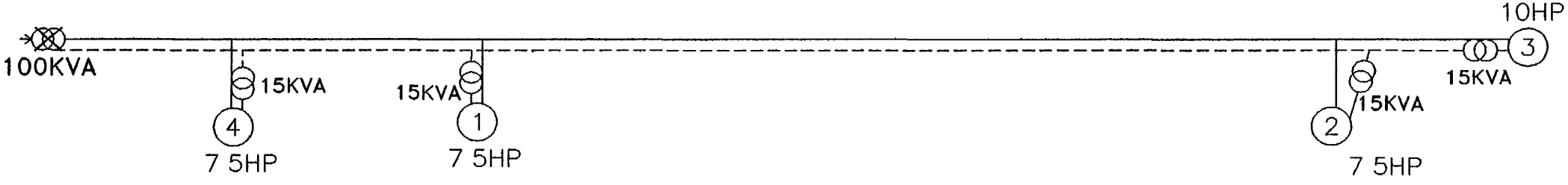


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-60	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Inder Singh Tr Capacity 100kVA	3EC Energy Economy & Environmental Consultants

Grouping Option

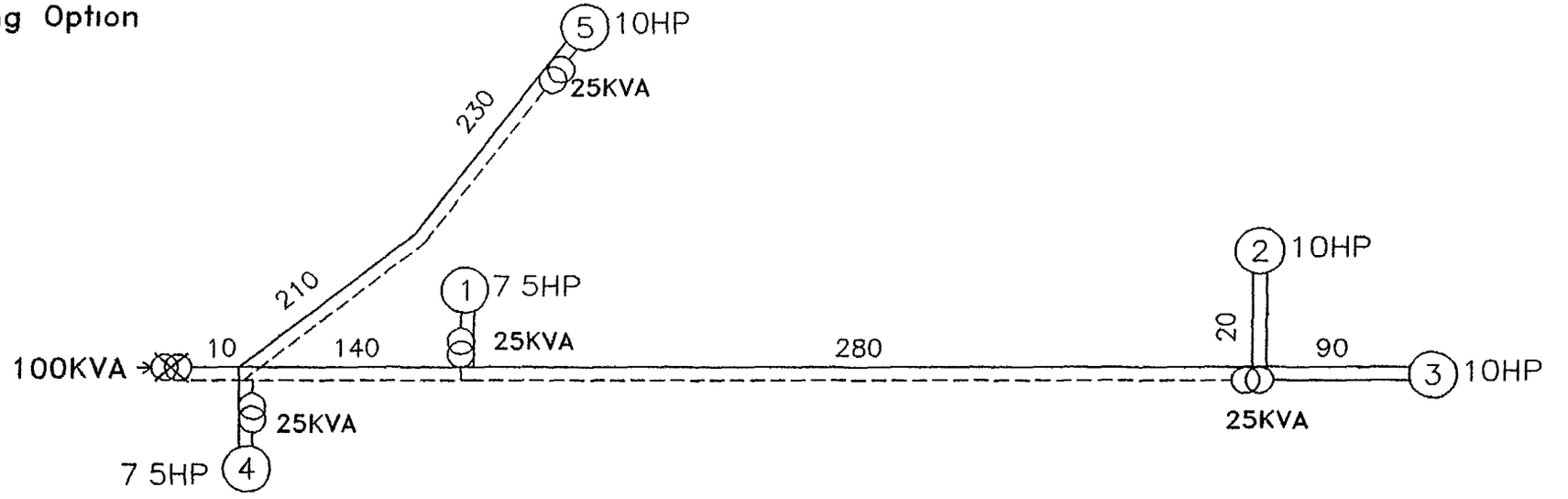


LT Less Option

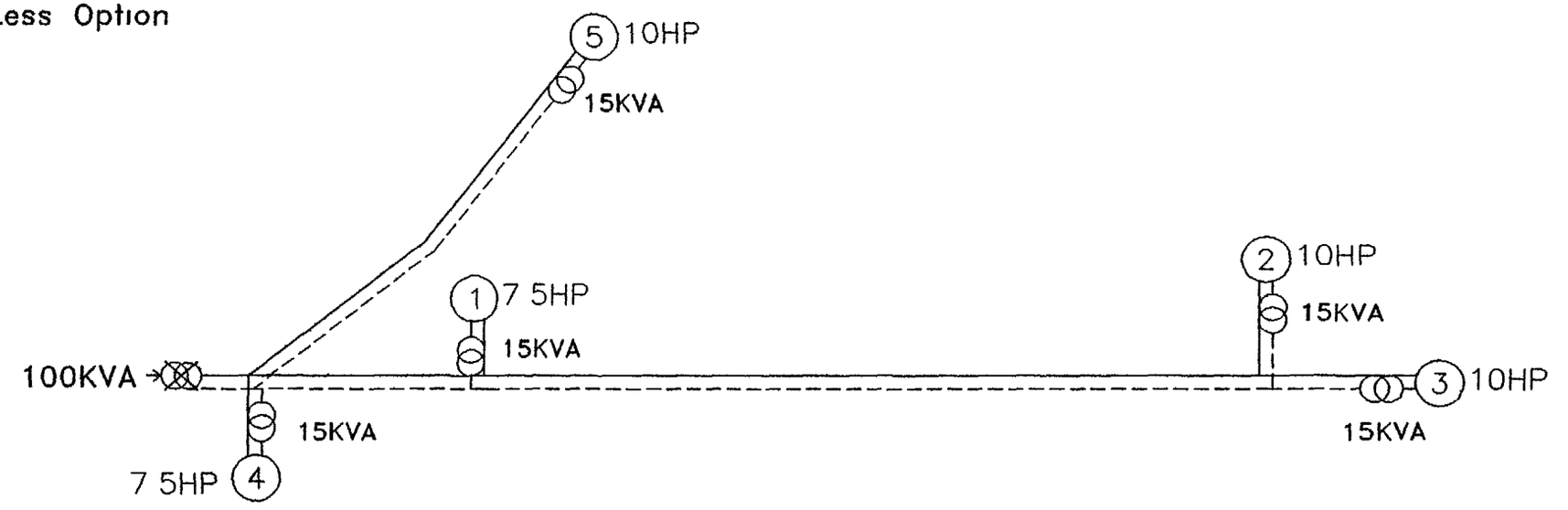


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-61	Project Name : DSM Study-HVPN Feeder Name Patra Tr Name Ajeet Singh Tr Capacity 100kVA	3EC Energy Economy & Environmental Consultants

Grouping Option

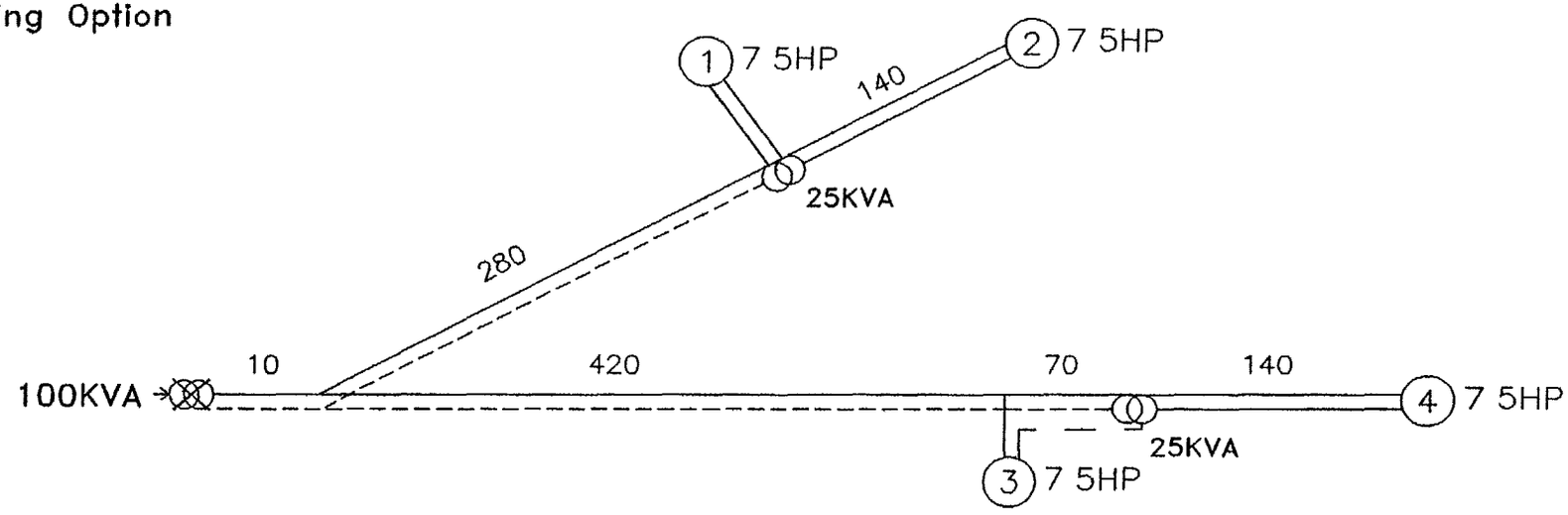


LT Less Option

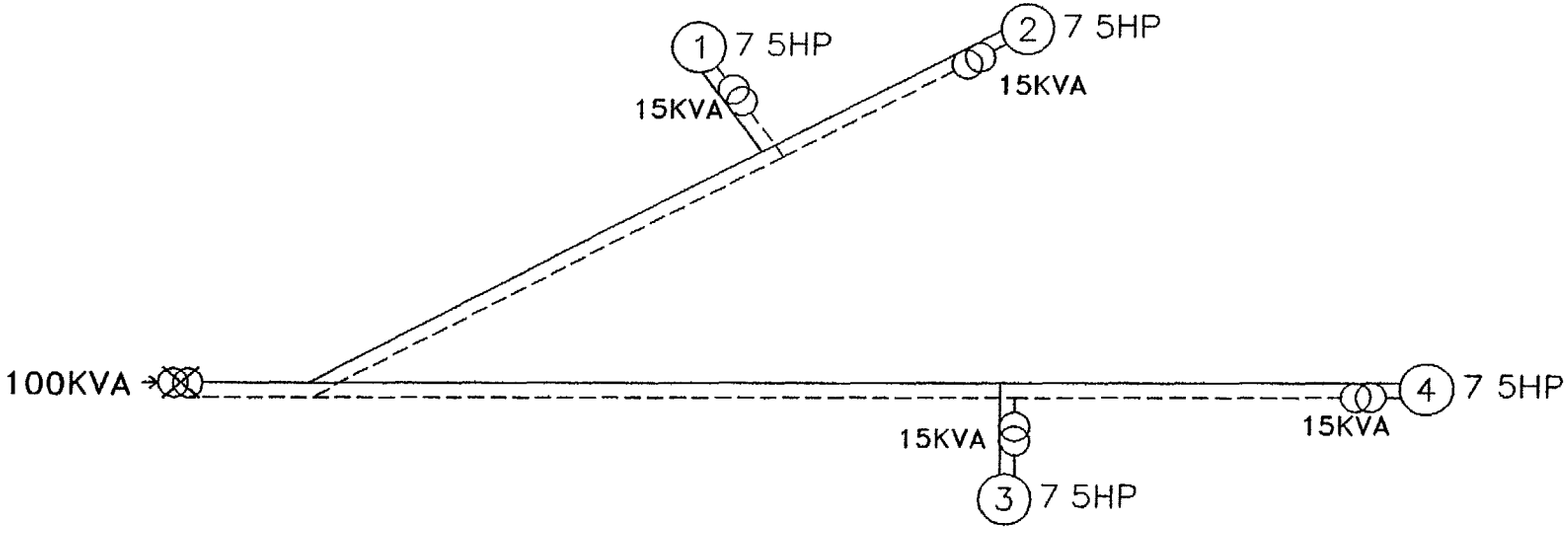


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-62	Project Name DSM Study-HVPN Feeder Name : Palra Tr Name Satyabir Singh Tr Capacity 100kVA	3EC Energy Economy & Environmental Consultants

Grouping Option

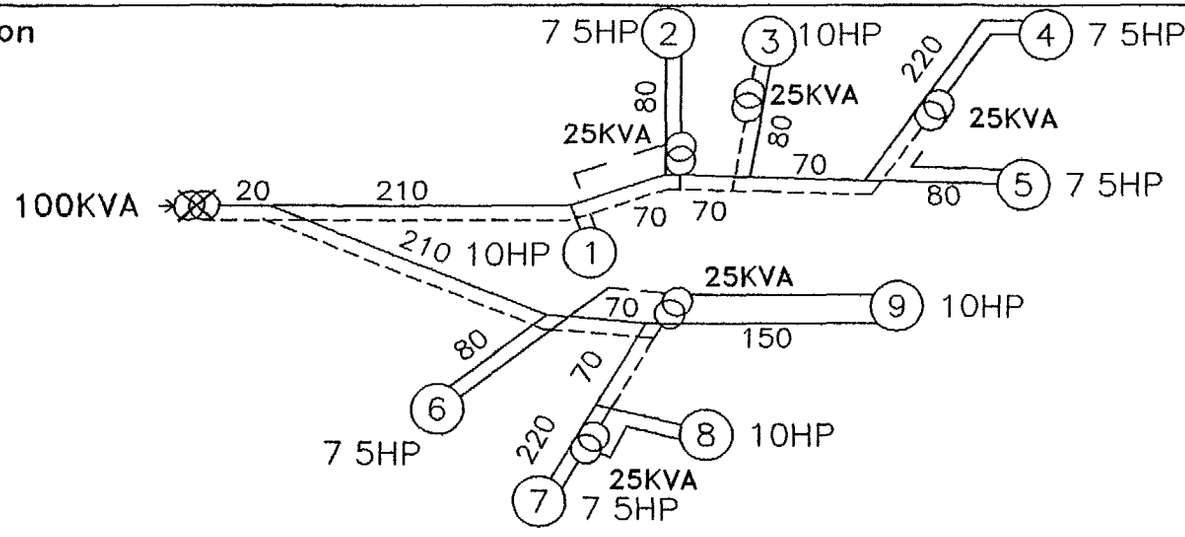


LT Less Option

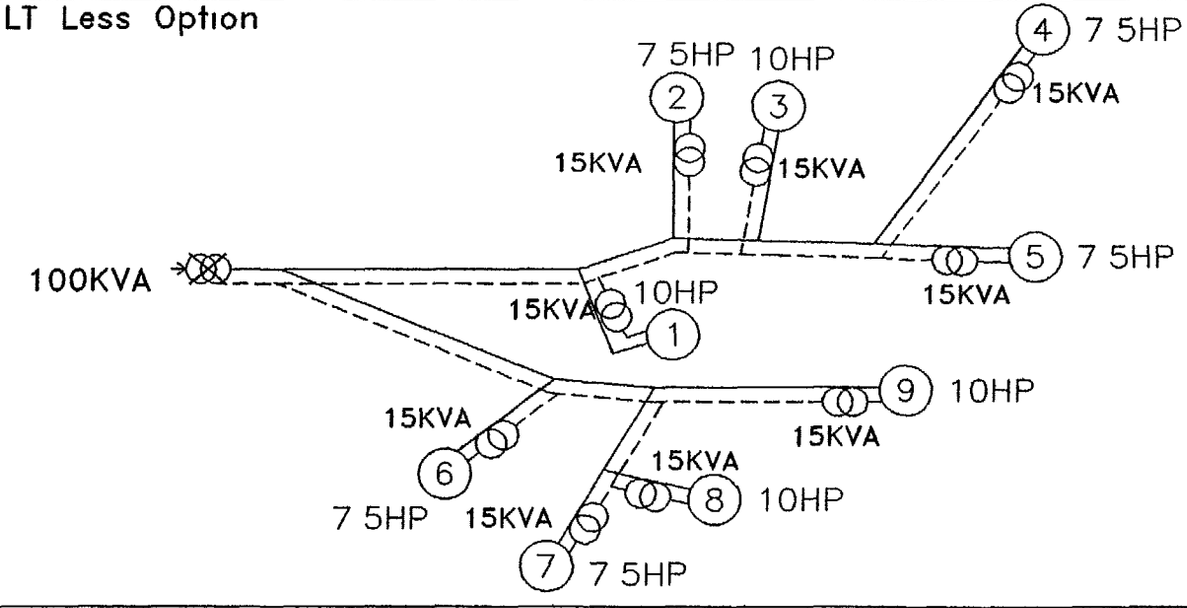


All Dimensions Are In Metres Not To Scale Drawn By · BVN HCL\HVPN\AF\Trf-63	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Jajal (LD SYSTEM) Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

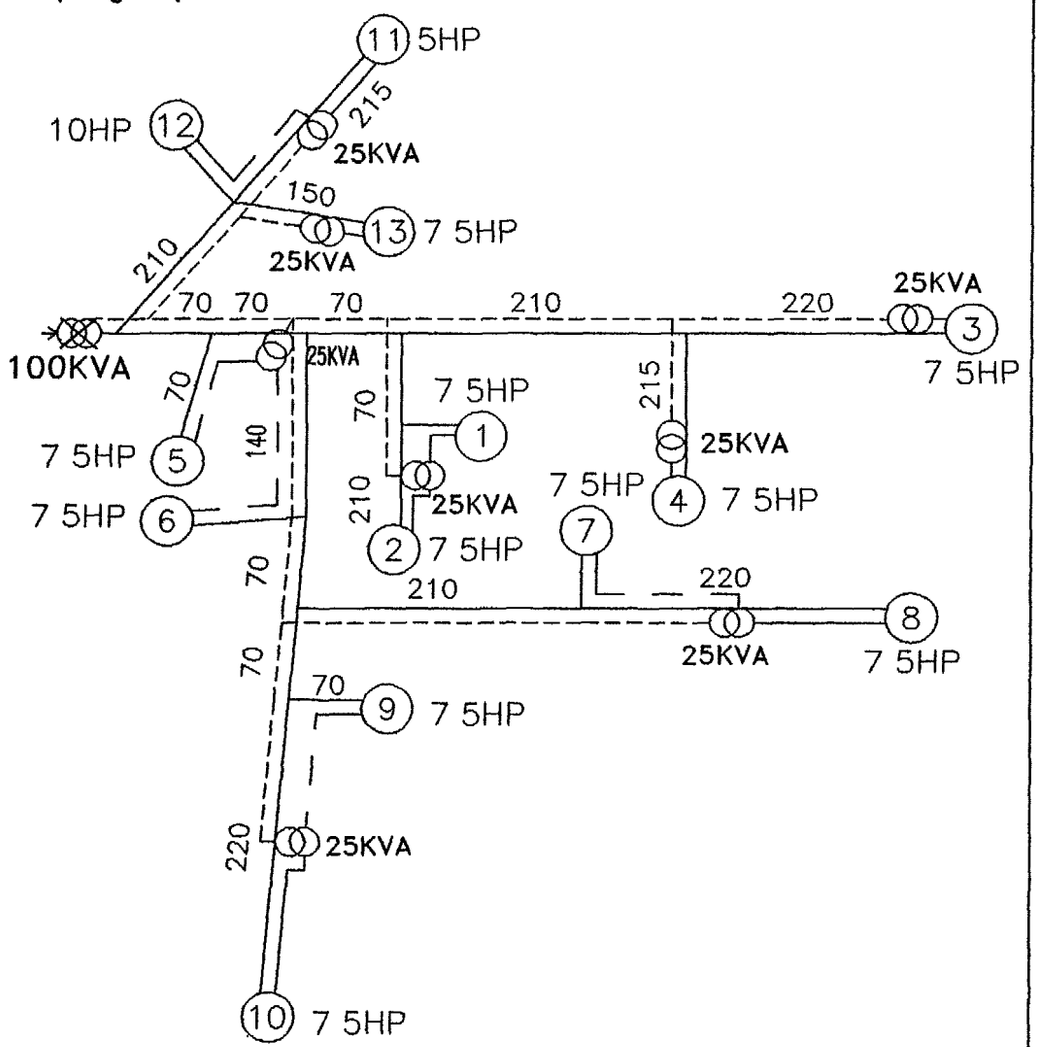


LT Less Option

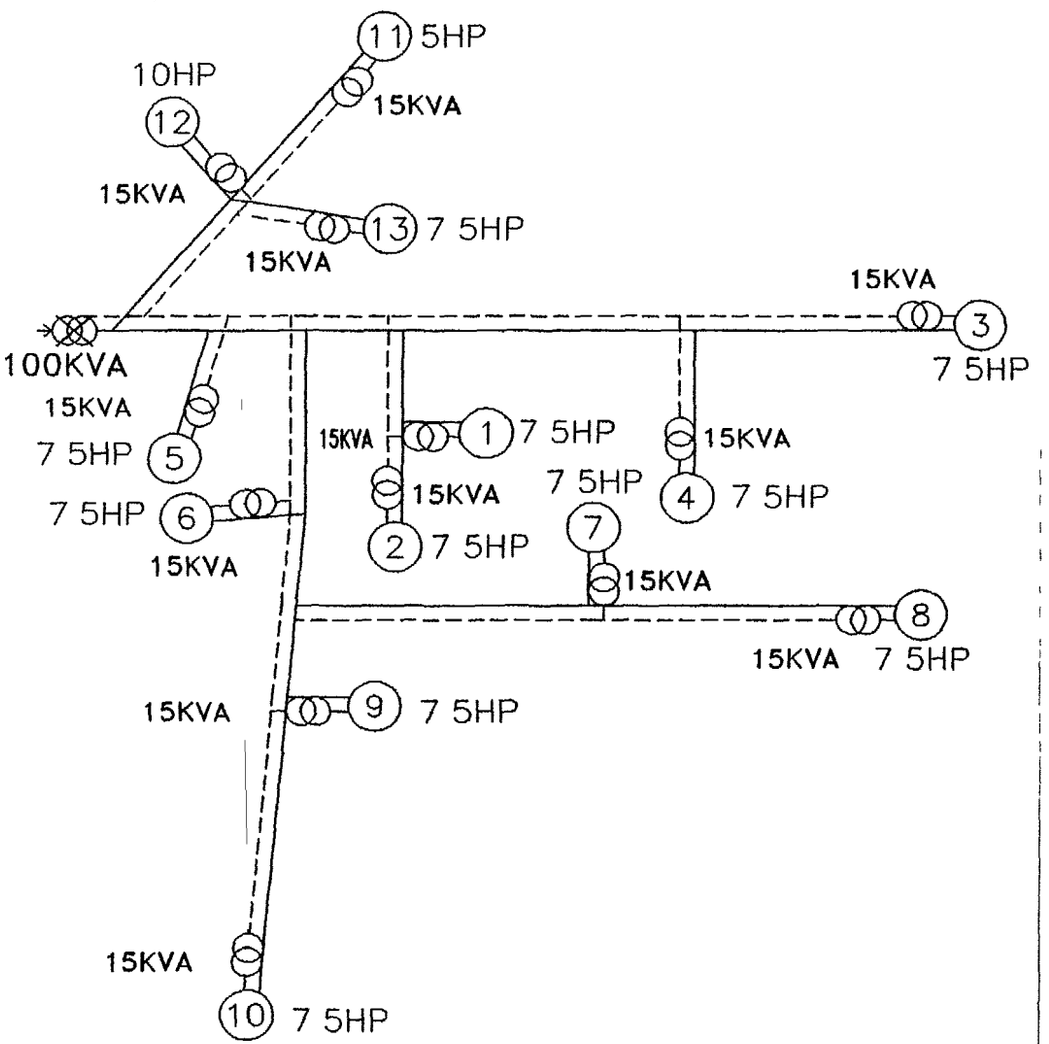


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-64	Project Name : DSM Study-HVPN Feeder Name Palra Tr Name TCA-21 Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



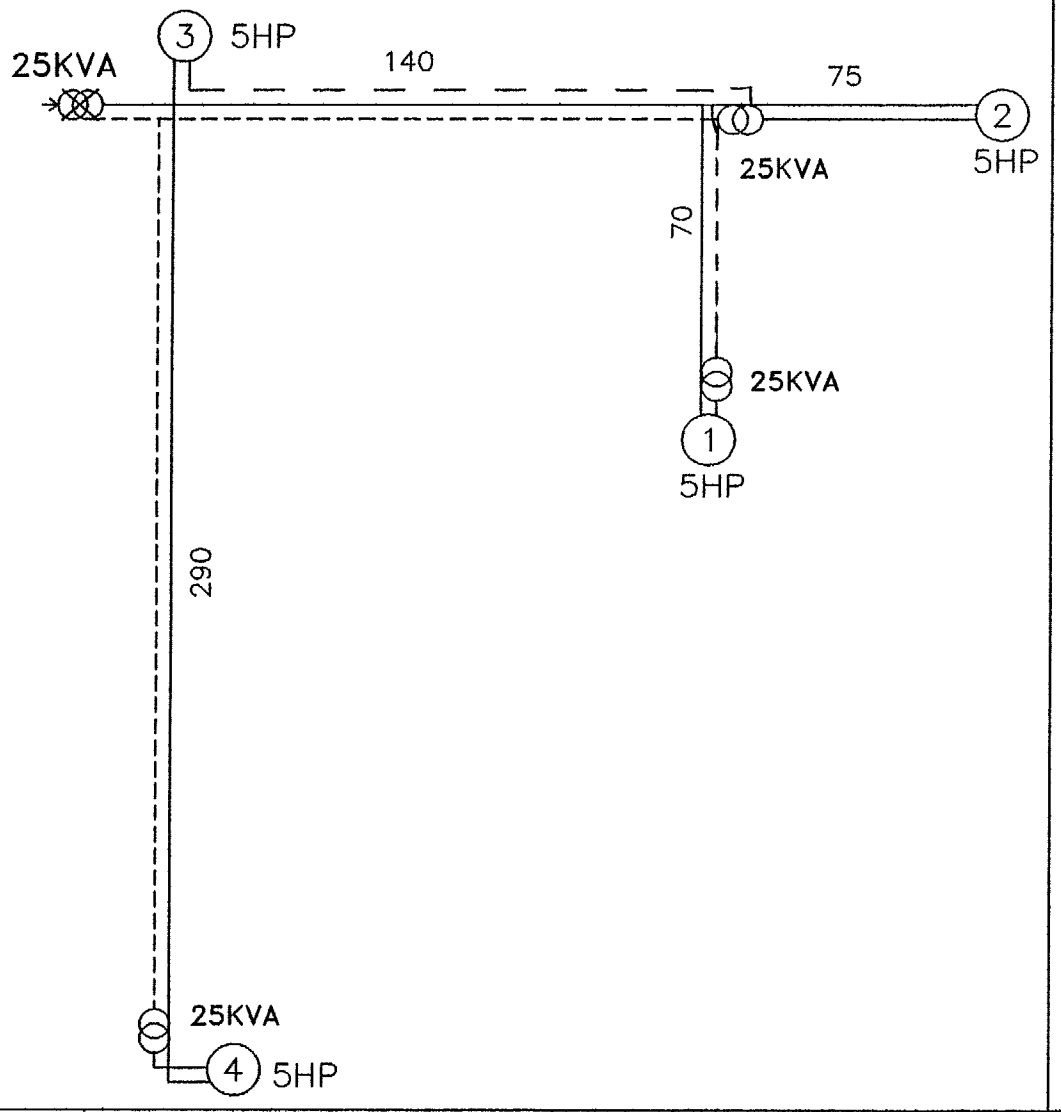
All Dimensions Are In Metres
Not To Scale
Drawn By BVN
HCL\HVPN\PF\Trf-65

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Dharam Singh

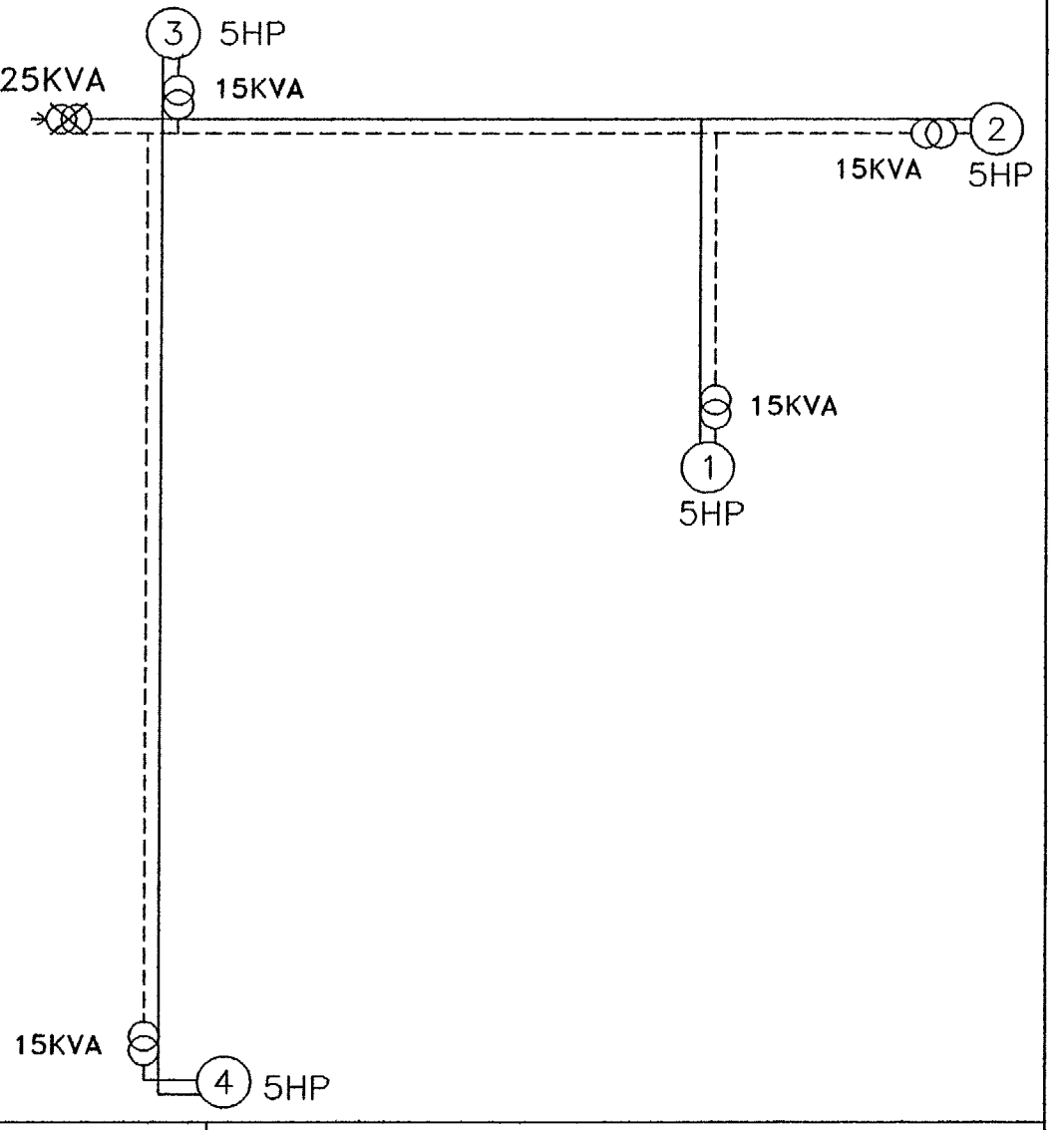
Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



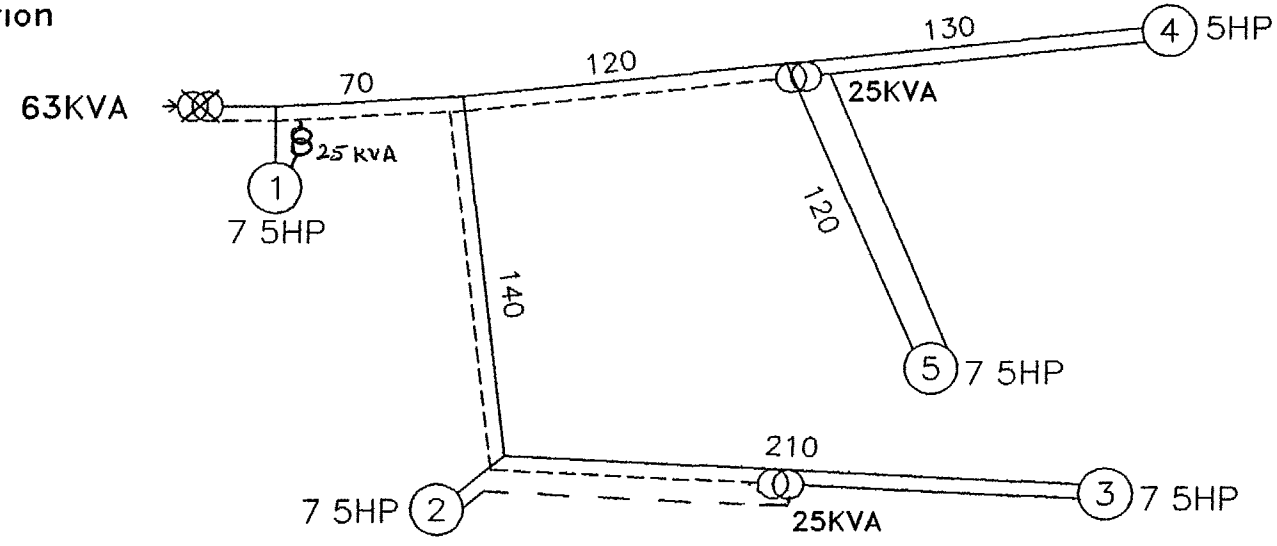
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-66

Project Name DSM Study-HVPN
Feeder Name : Palra
Tr Name Ranbir Singh

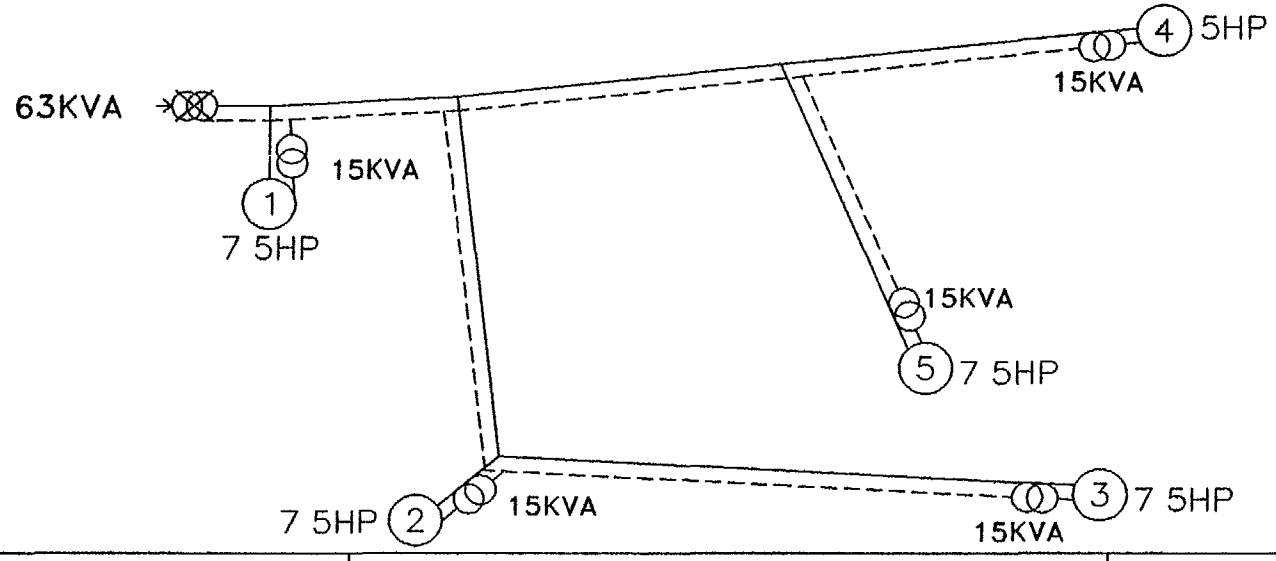
Tr Capacity 25KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option



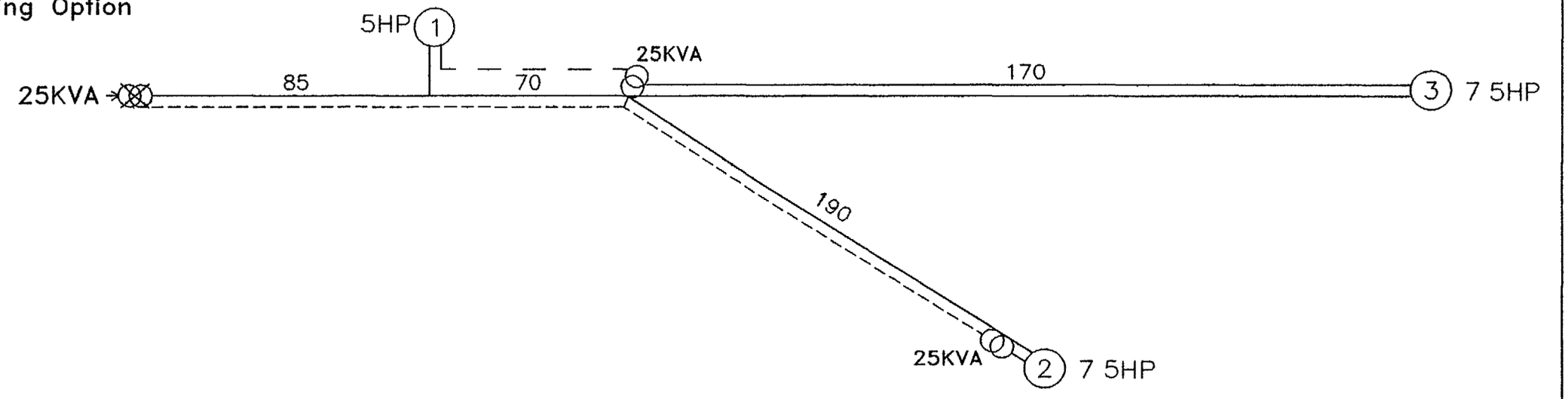
LT Less Option



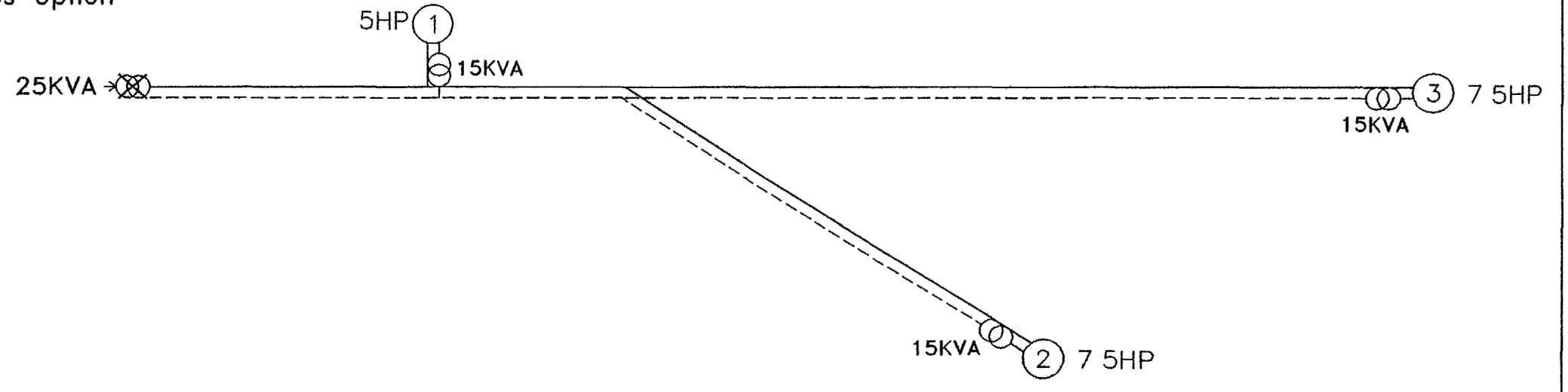
All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-70	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Kawar Bhan Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

51

Grouping Option



LT Less Option

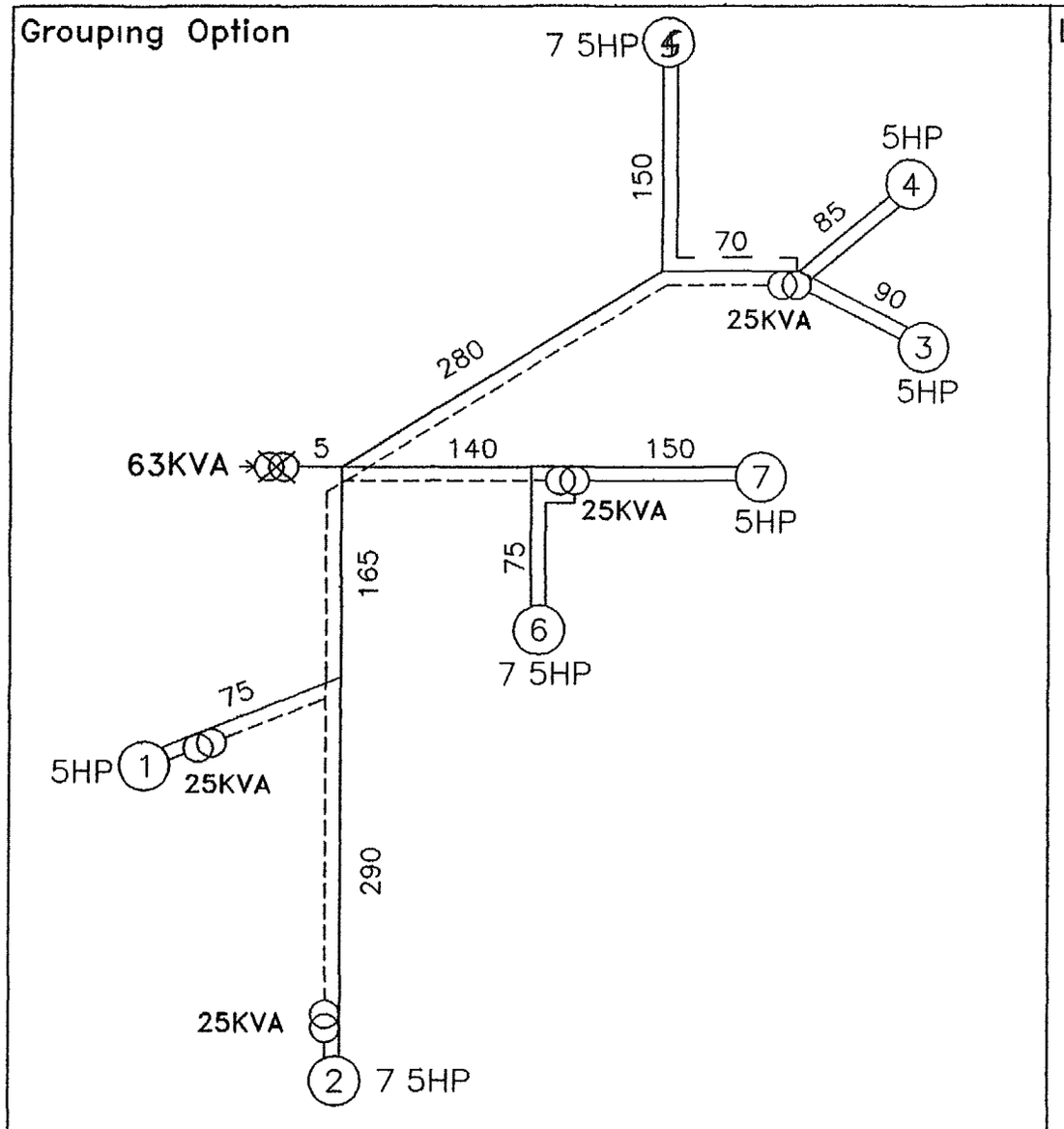


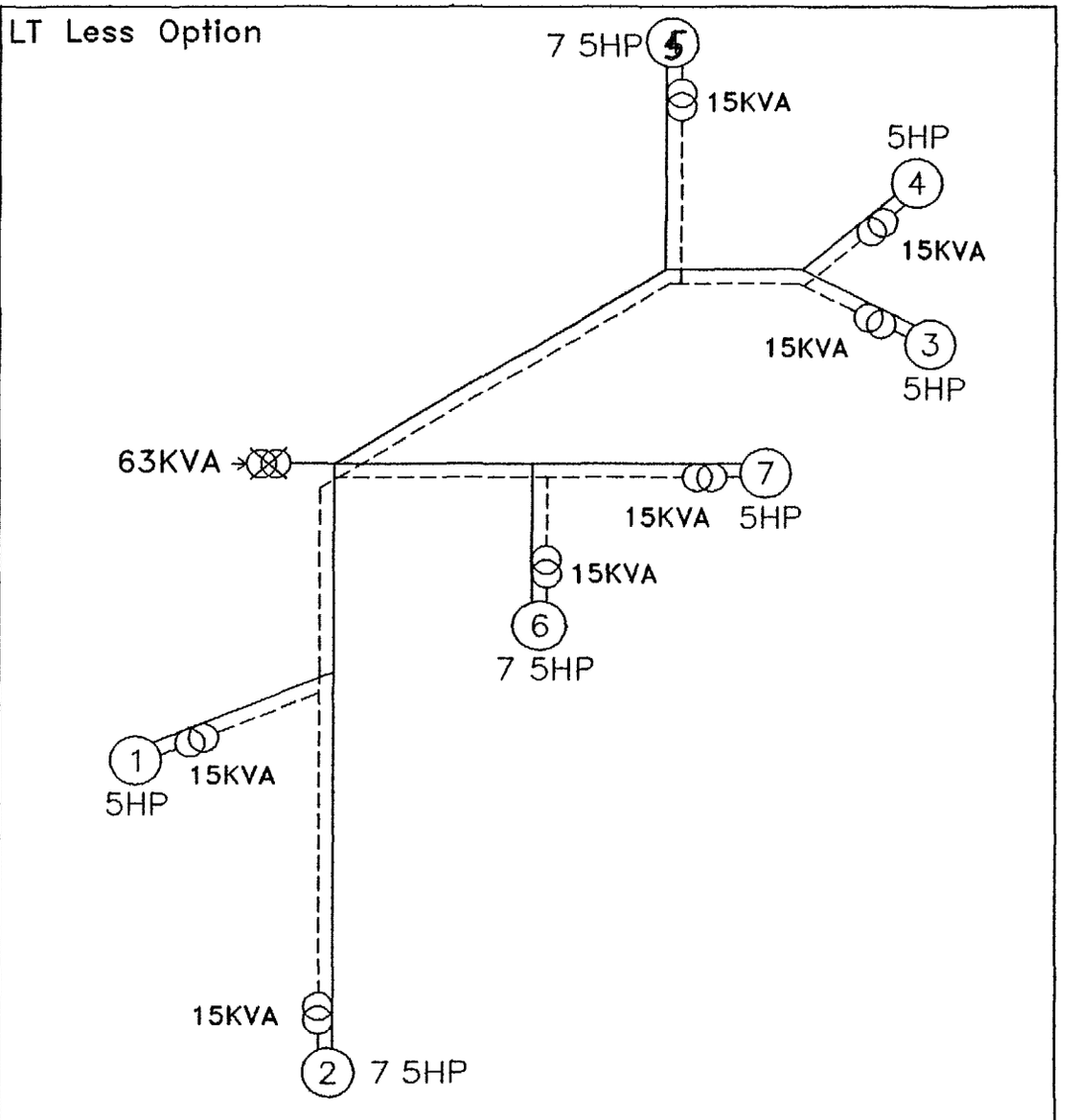
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-71

Project Name DSM Study-HVPN
Feeder Name : Palra
Tr Name : Sube Singh

Tr Capacity 100KVA

3EC
Energy Economy & Environmental Consultants





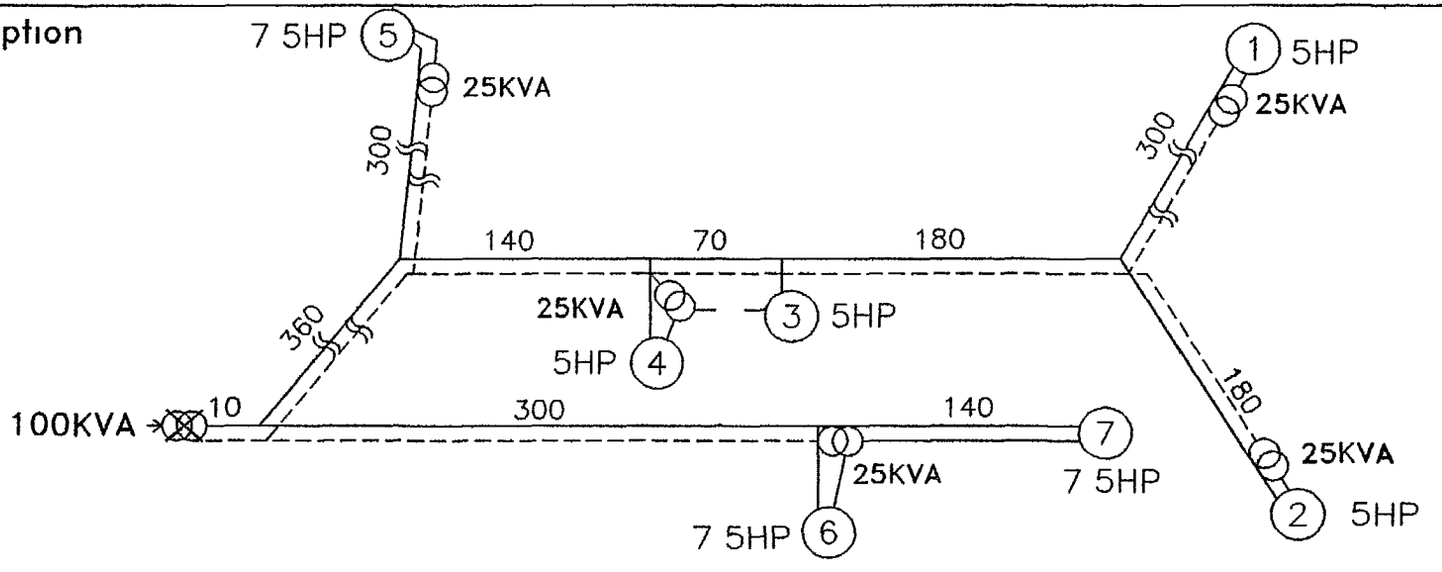
All Dimensions Are In Metres
Not To Scale
Drawn By : BVN
HCL\HVPN\PF\Trf-72

Project Name DSM Study-HVPN
Feeder Name Palra
Tr Name Abdul

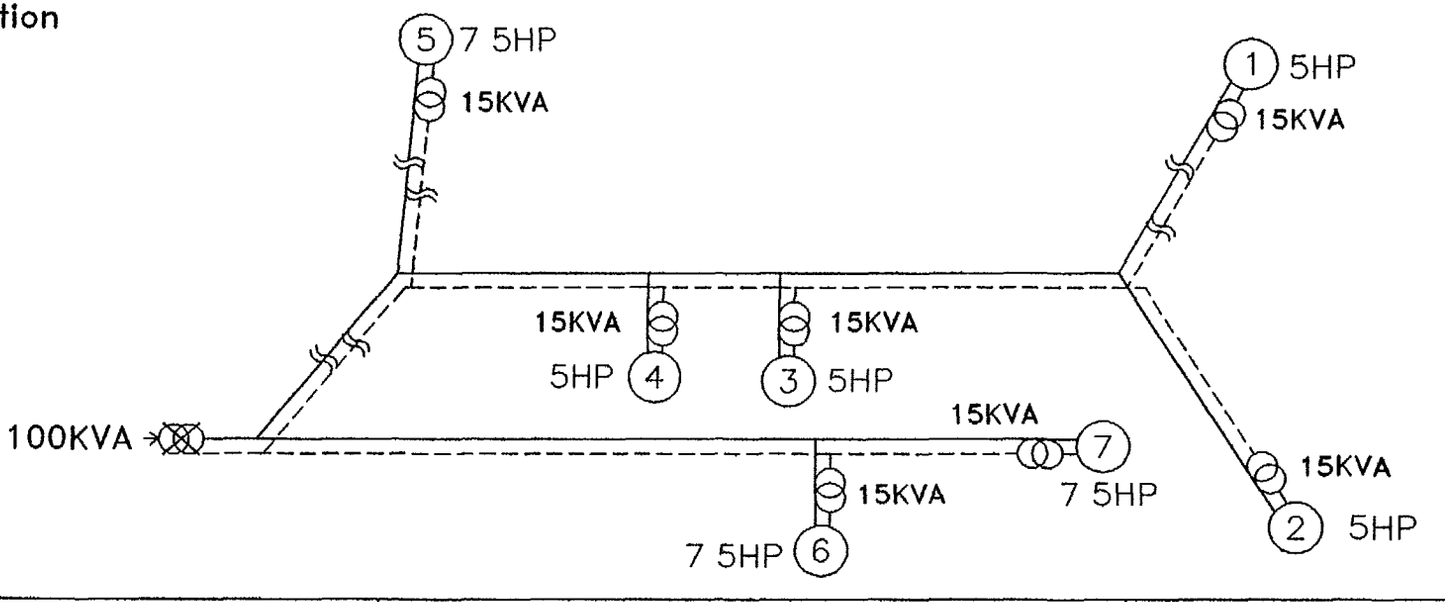
Tr Capacity 63KVA

3EC
Energy Economy & Environmental Consultants

Grouping Option

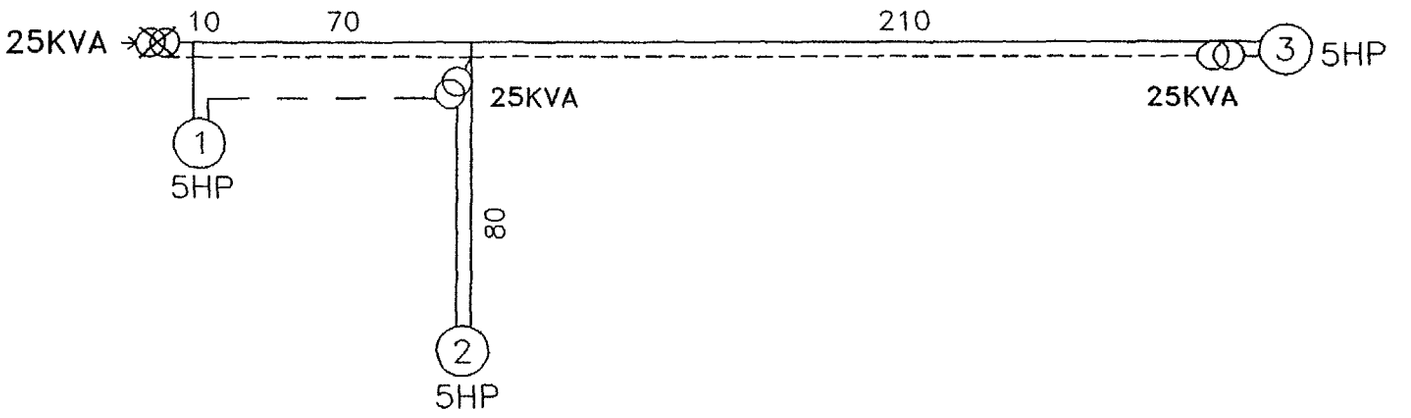


LT Less Option

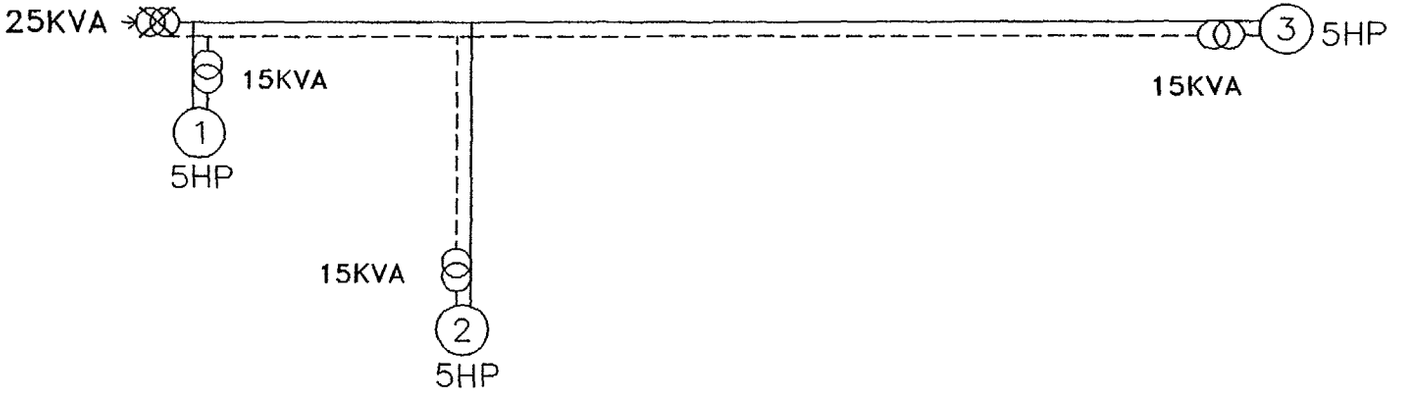


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-75	Project Name : DSM Study-HVPN Feeder Name Palra Tr Name Palda Village Tr Capacity : 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

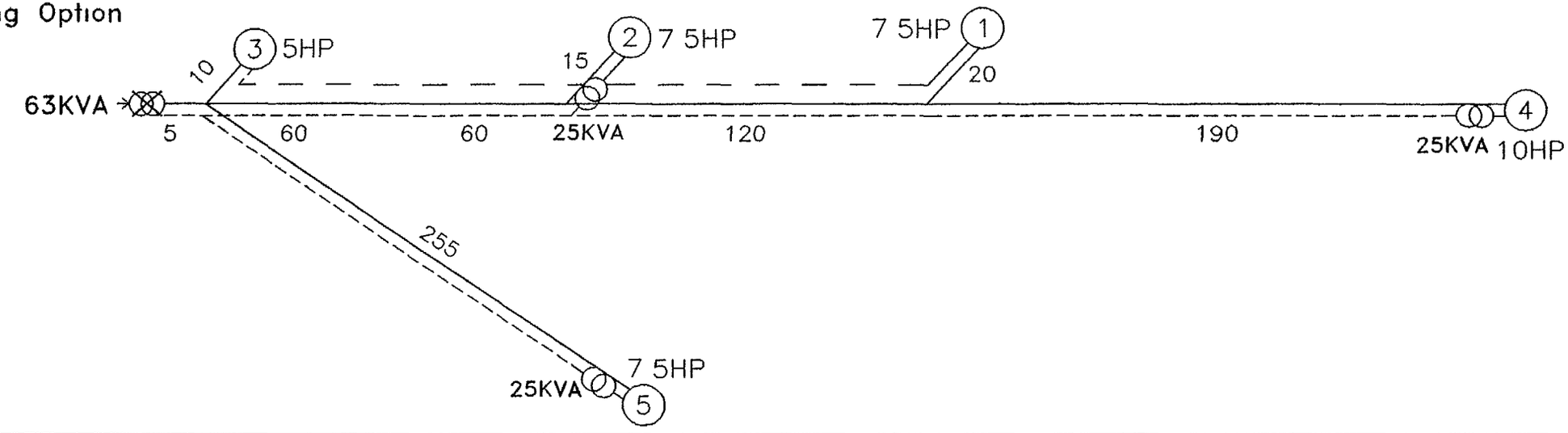


LT Less Option

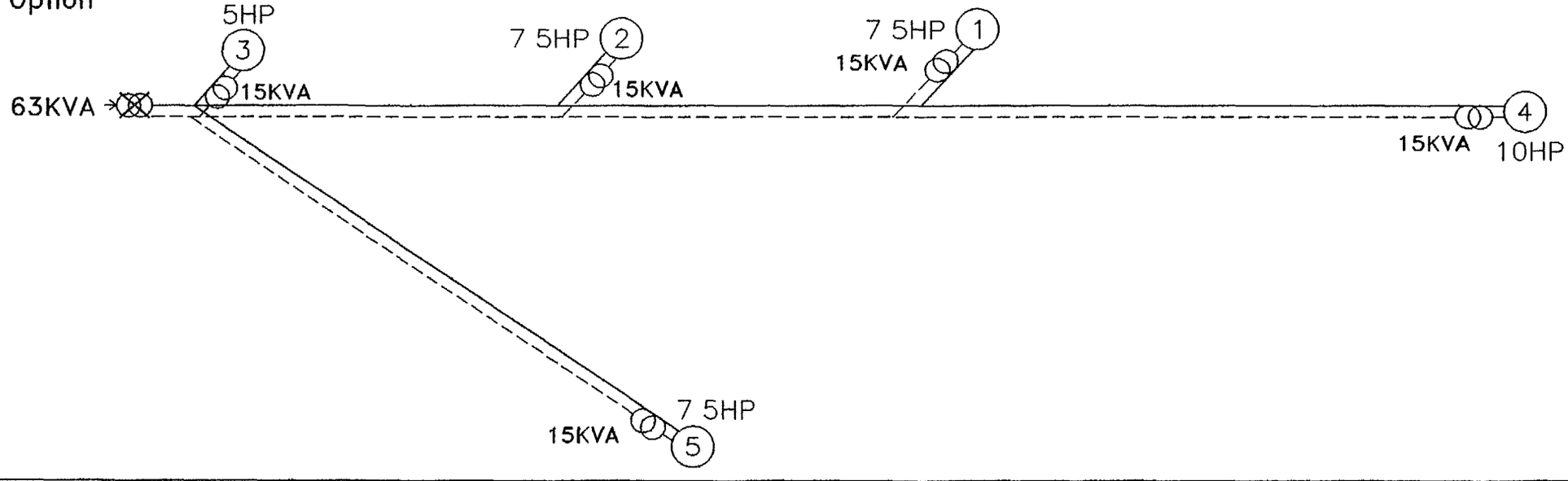


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-77	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Phool Kanwar Tr Capacity 25KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

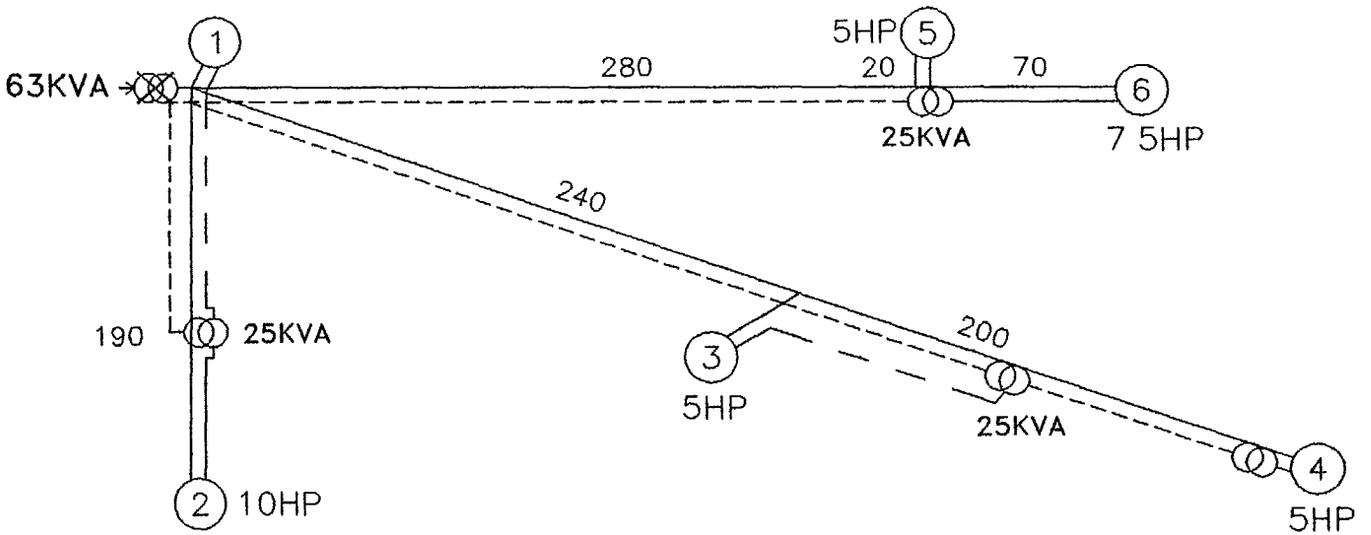


LT Less Option

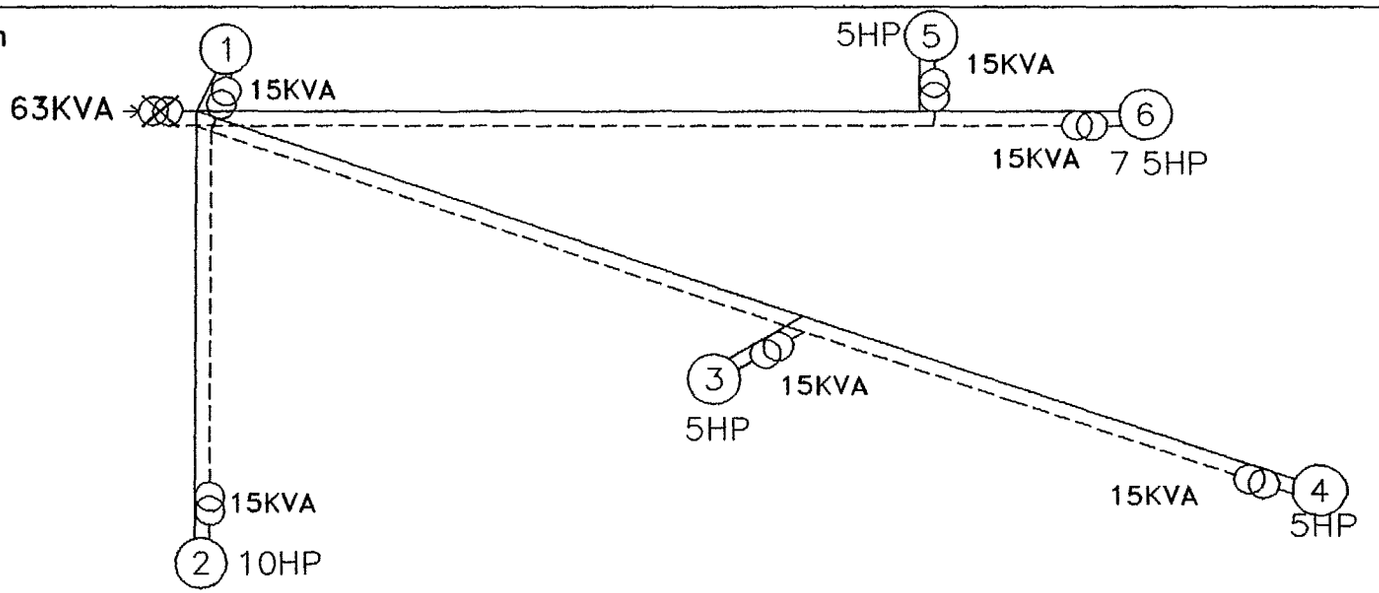


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-80	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Ram Kumar Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

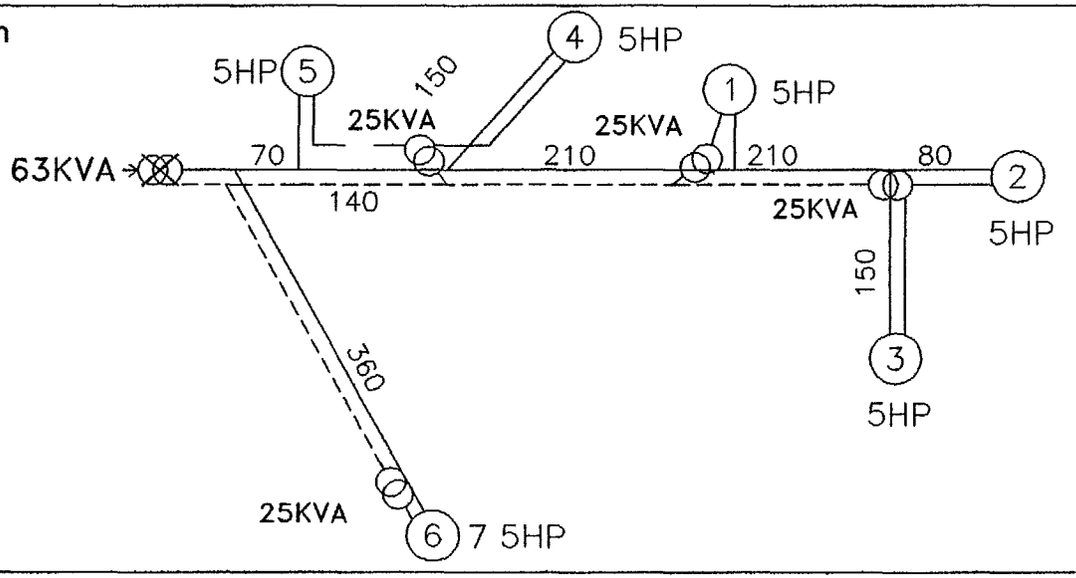


LT Less Option

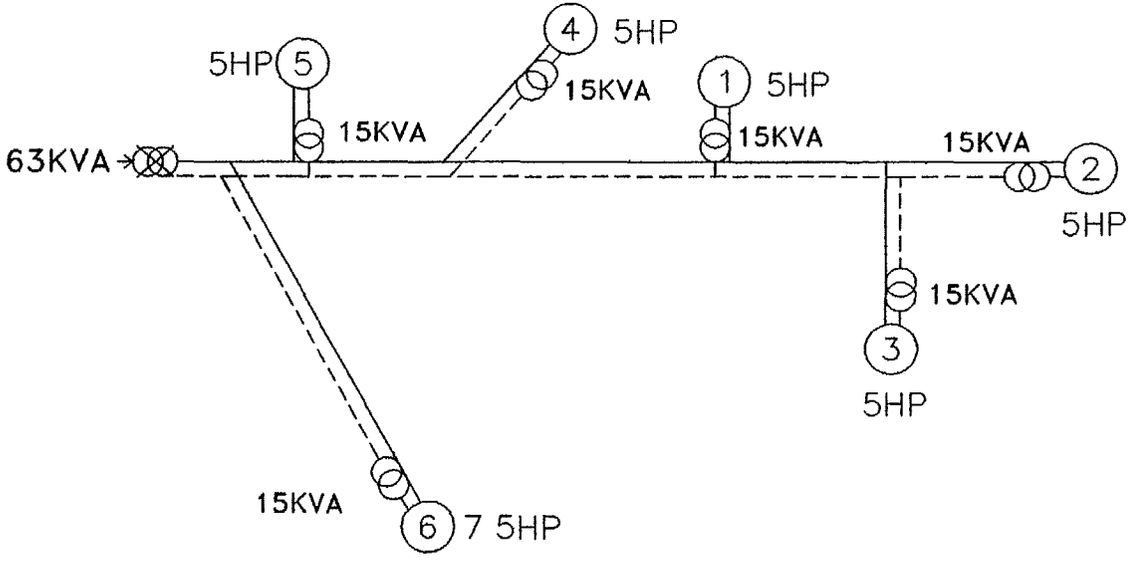


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-81	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Manji Ram Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

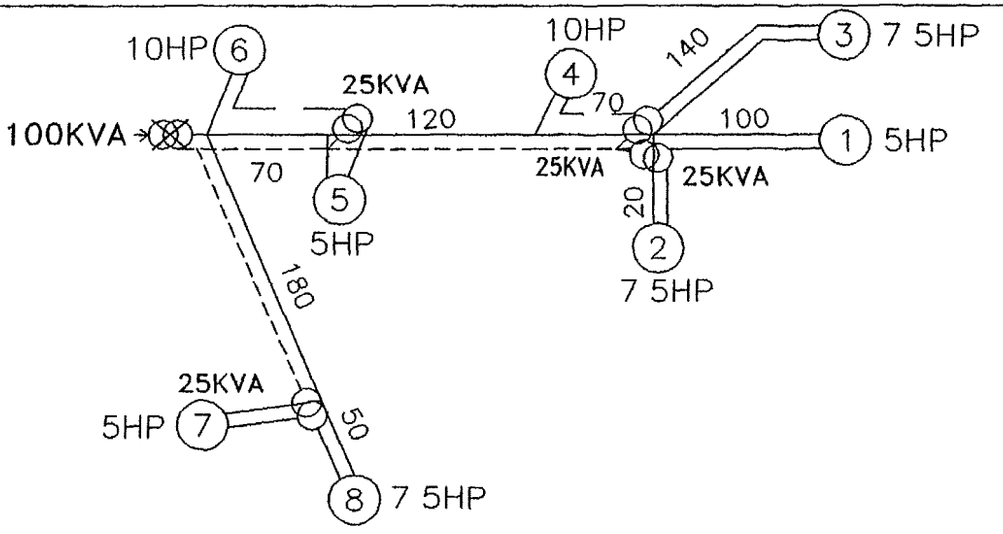


LT Less Option

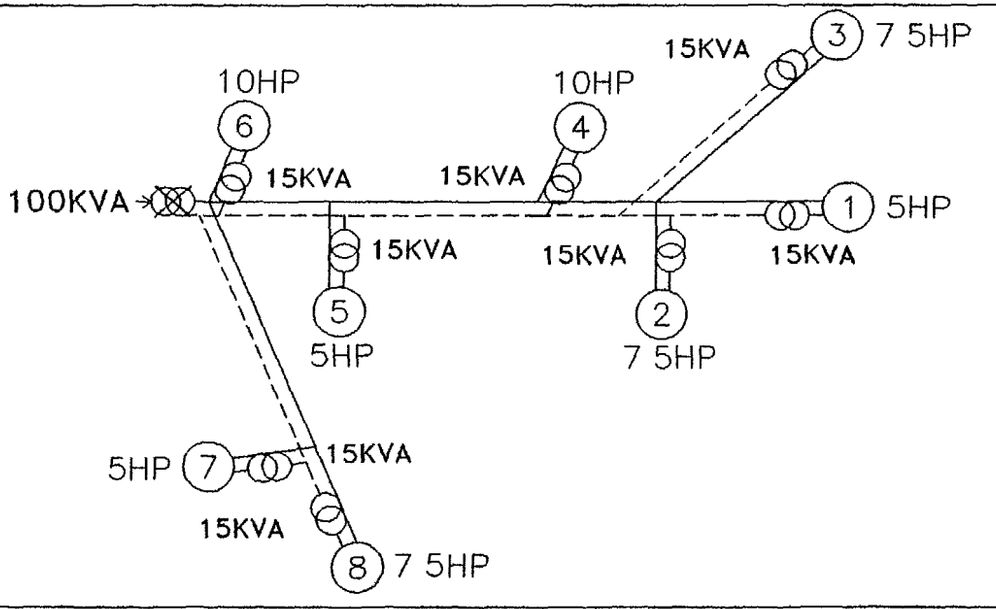


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-82	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Ishwar Tr Capacity 63KVA	3EC Energy Economy & Environmental Consultants

Grouping option

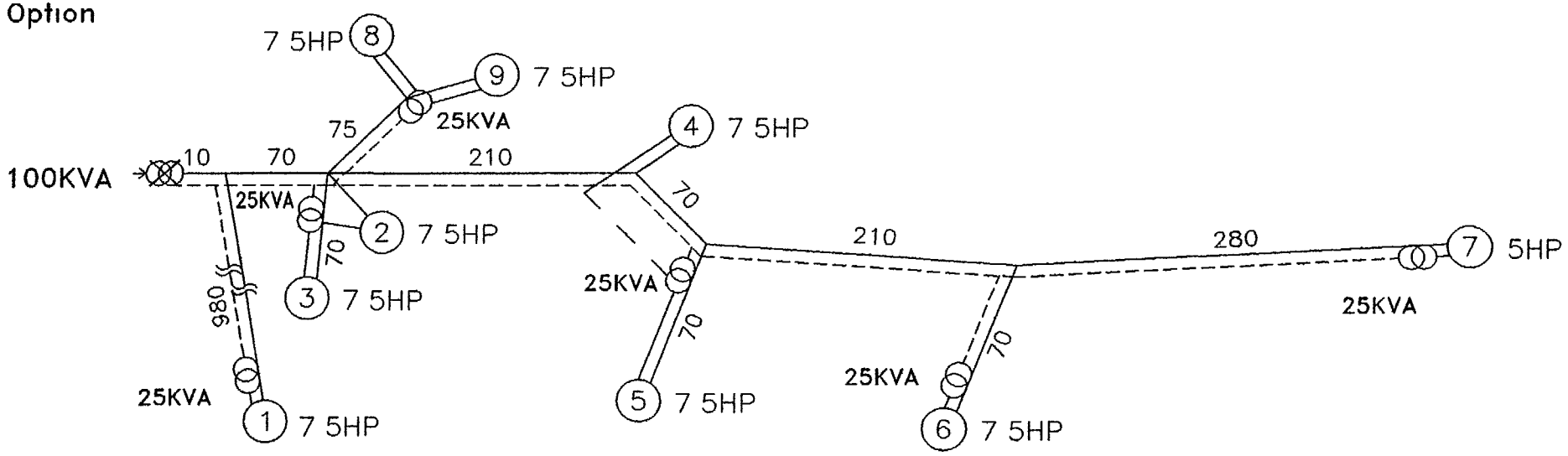


LT Less Option

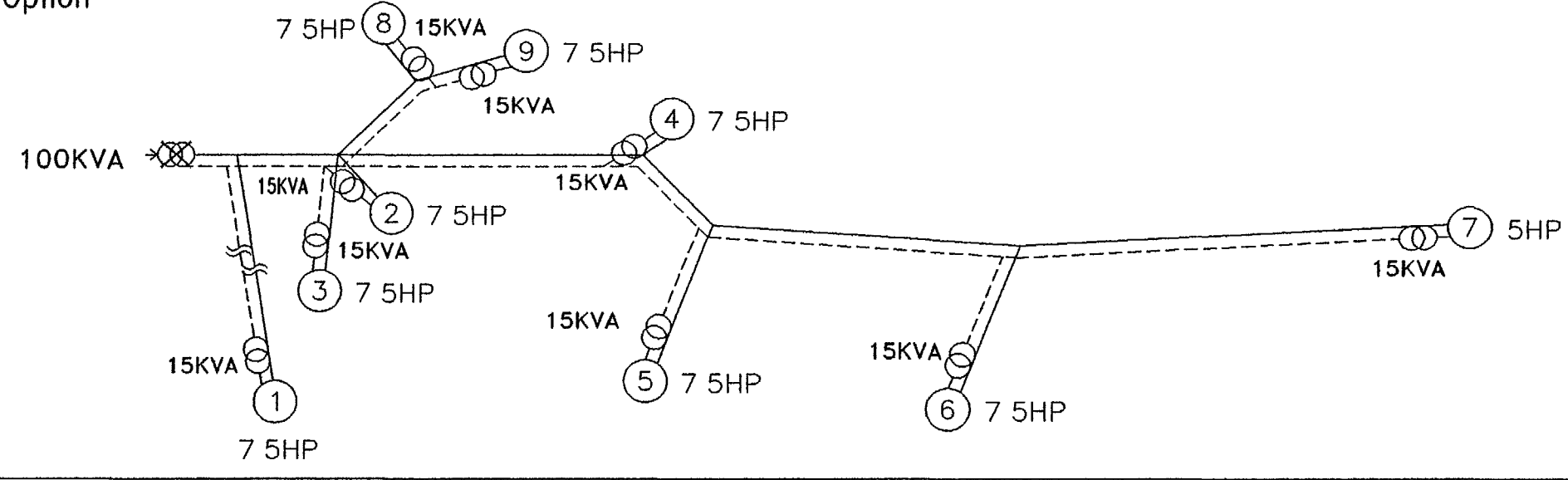


All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-83	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Tekchand Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option

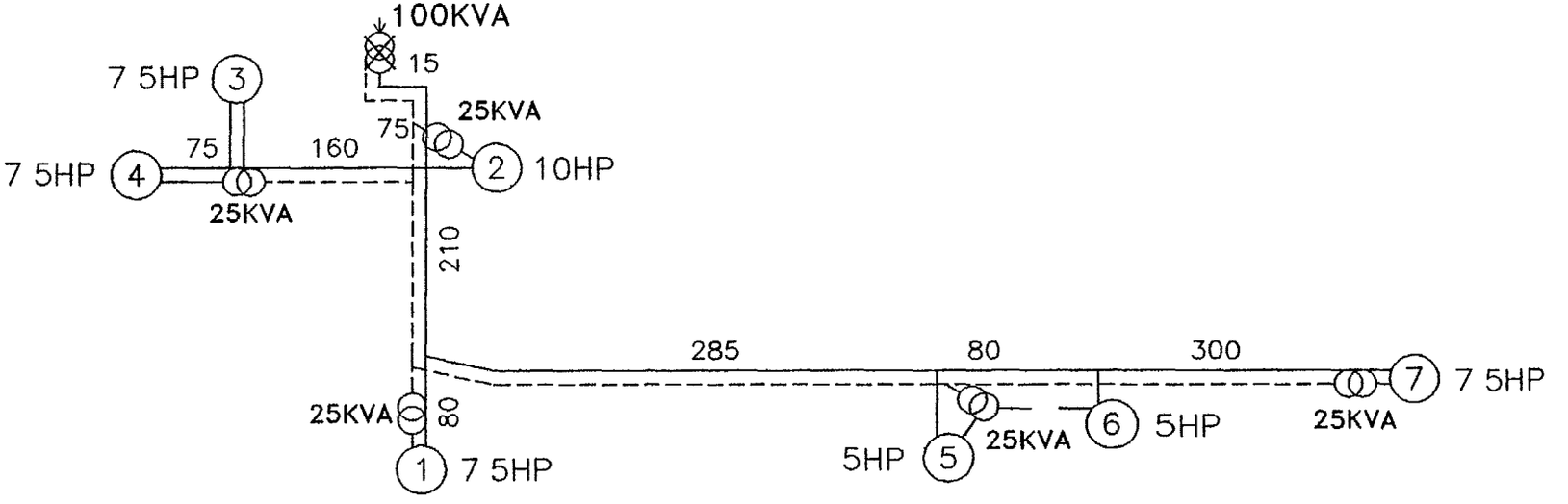


LT Less Option

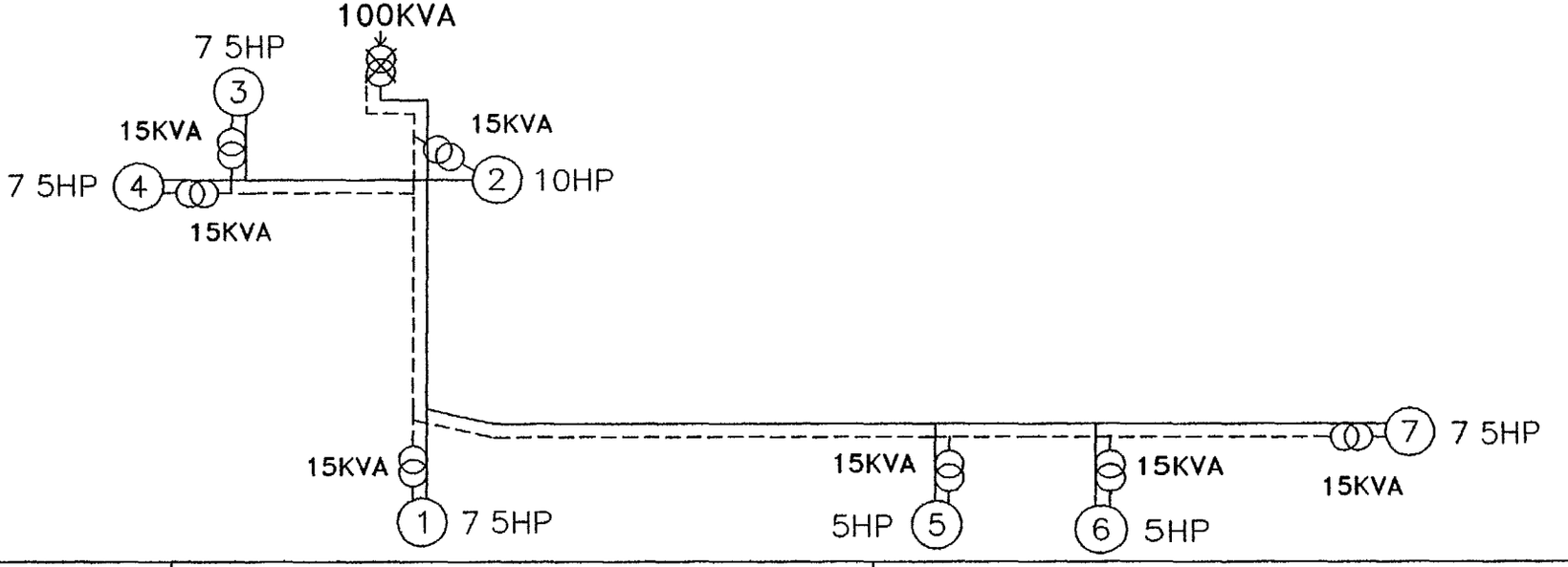


All Dimensions Are In Metres Not To Scale Drawn By : BVN HCL\HVPN\PF\Trf-84	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Hari Ram Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants

Grouping Option



LT Less Option



All Dimensions Are In Metres Not To Scale Drawn By BVN HCL\HVPN\PF\Trf-85	Project Name DSM Study-HVPN Feeder Name Palra Tr Name Hari Ram Tr Capacity 100KVA	3EC Energy Economy & Environmental Consultants