Basic Design Study
on
Establishment Project
of
The Electric Power Distribution Network
in kathmandu Valley
in
The Kingdom of Nepal
(Second Phase)

September 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of His Majesty's Government of Nepal, the Government of Japan decided to conduct a survey on Establishment of Kathmandu Valley Electric Power Distribution Network Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Nepal a survey team from June 19th to July 13th, 1982.

The team had discussions with the officials concerned of the Government of Nepal and conducted a field survey in Kathmandu Valley.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation extended to the team.

September, 1982

Keisuke Arita
President
Japan International Cooperation Agency

TABLE OF CONTENTS

APPENDIX

MAPS AND DRAWINGS

SUMMARY

SUMMARY

The first phase of the first stage of the Kathmandu Valley Transmission and Distribution Network Project was completed in March, 1982 as scheduled, before the commissioning of the Kulekhani No.1 Power Station.

With the completion of the Kulekhani No.1 Power Station, this project is now being used for the delivery of the increased power supply.

However, the distribution systems completed in the first phase cover mainly the central and western part of the Kathmandu Valley. The distribution system in the other parts of the Kathmandu Valley, the load centers in the eastern part and in rural areas, are still to be extended.

At present, even in the Kathmandu city area, the increase of supply capacity is required in order to meet the increasing power demand and other intent demands.

The second phase of the First Stage Development of the Kathmandu Valley Transmission and Distribution Network Project aims at the construction of the remaining distribution system in the First Stage Development which were not included in the first phase of the project.

Discussion was made with the officials of His Majesty's Government of Nepal (HMG) for deciding the set of priority in view of the urgency to realise the distribution lines. The total figures of the selected distribution system for urgent implementation are as given below;-

(1)	11 kV new extension:-	70.8 km
(2)	Upgrading of voltage and conductor size:-	11.7 km
(3)	Distribution transformer:-	27,075 kVA
(4)	400/230 V low tension lines:-	144.53 km
(5)	Watthour meter and others:-	1 lot
(6)	Maintenance tools:-	1 lot
(7)	Thapathali switching station:-	1 lot

Necessary fund for the detailed design, supply and erection of the selected distribution system will be covered from Japanese Government aid. However, local currency necessary for management and acquisition of right of way shall be arranged by HMG.

The project will be completed by the middle of March, 1984 as given on Appendix X tentative Implementation Program of the Kathmandu Valley Distribution Network Project, Second Phase of the First Stage.

By implementing the above reinforcement project of the Kathmandu Valley Distribution System, the generated power of the Kulekhani No.1 power station will be fully consumed and power demand of the Kathmandu Valley can be met up to 1985/86.

The project will involve reinforcement and improvement of the existing system in the city areas and extension to rural areas which are not supplied with power at present. Thus, the power supply to waiting consumers and to new coming consumers will be met and service conditions to the present consumers will be greatly improved.

The necessity to implement the second phase of the first stage of the Project is quite high. When the planned Project is implemented, the completed project will improve the power supply situation in the Valley, enhancing the living standard and promoting economic activities of the capital city. From such reasons, the Project is considered to be a worthwhile grant-aid from the Government of Japan to Nepal.

I. INTRODUCTION

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As reported in the Feasibility Report (Report No. MPN, CR(2), 78-79 dated January, 1979), the Kathmandu Valley is confronted with serious shortage of power supply capacity and insufficient facilities in districation for the past several years. The immediate reinforcement of the power supply systems is necessary in order to meet the consumers' demands waiting for power supply.

The Kulekhani No.1 Power Station was constructed to increase the power supply capacity in the Valley.

For the effective utilization of the electric power to be generated in the Kulekhani No.1 Power Station scheduled for completion by the beginning of 1982, a feasibility study was realized to extend and reinforce the existing transmission and distribution network in the Kathmandu Valley. The Kathmandu Valley Transmission and Distribution Network Project as it is called will be referred hereinafter as the "Project".

According to the Feasibility Report, it is recommended to implement the Project stage-wise; the first stage program to be completed by the completion of the Kulekhani No.1 Power Station and the second stage program by the completion of the Kulekhani No.2 Power Station.

However, it was necessary to implement the first stage program in two phases due to the limitation of available fund. The first phase of the first stage of the Project, which covers the most important parts of the Kathmandu Valley was implemented with the Japanese Government's grant aid to HMG in March, 1982, in time for the commissioning of the Kulekhani No.1 Power Station.

The works completed in the first phase of this stage are mainly concentrated in the western part of the Kathmandu Valley. They are not sufficient enough to deliver the power to the load centers in the eastern part of the valley and other rural areas.

Under such circumstances, HMG requested the Government of Japan to implement urgently the remaining portions with some additional proposals.

In response to this request, the Government of Japan had decided to take up the second phase program, and entrusted the JICA with the execution of the Project.

JICA dispatched a basic design study team to Kathmandu from June 19 to July 13, 1982, in order to survey the Project area and to discuss the plan and basic design criteria with the officials of HMG.

This report was prepared by the team on the basic design and the implementation program as the results of analysis of the data and information obtained through the field investigation and discussion with the officials of Nepal.

II. BACKGROUND

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1. General Power Situation

In Nepal, main load centers are located in Central Region; 70% of total energy generated in Nepal is consumed in Kathmandu, Phokhara and Hetauda-Birganj area. Central Nepal Power System (CNPS) is interconnecting these load centers.

Table 2.1 shows the past record of energy generation and sales in CNPS of NEC.

Table 2.1 Energy Generation and Sales in CNPS

(Unit: GWh)

Year	Energy Generation				Energy Sales
	Hydro	Diesel	Purchase	Total	
1970/71	53.57	0.08	-	53.65	36.76
71/72	65.87	0.08	-	65.95 (22.9)	46.53 (26.5)
72/73	81.27	0.004	-	81.27 (23.2)	59.08 (26.9)
73/74	95.71	0.50	-	96.21 (18.4)	64.72 (50.0)
74/75	108.66	0.89	-	109.55 (13.8)	75.79 (17.0)
75/76	123.84	1.01	-	124.85 (13.9)	87.42 (15.3)
76/77	133.23	4.63	-	137.86 (10.4)	93.57 (7.0)
77/78	148.31	4.24	2.90	155.45 (12.0)	104.44 (12.6)
78/79	166.69	6.07	9.20	181.97 (17.1)	123.19 (17.0)
79/80	184.46	5.83	9.00	199.29 (9.5)	141.02 (14.5)
80/81	175.02	13.58	9.47	198.07 (-5.1)	133.32 (-5.5)

Note: Figures in parentheses show percentage increase over the previous year.

As shown on Table 2.1, most of the energy is supplied by the hydro power stations.

Although total hydro-potentiality in whole Nepal is said to be 83 million kW by a preliminary estimate, installed capacity of the existing hydro power stations is only 110 MW in total, including Kulekhani No.1 power station. Most of them are located in Central Region.

However, all these hydro power stations, other than the Kulekhani No.1 power station, are run-of-river type and the available power output drops in the winter dry season, when the peak load becomes highest, as shown in Table 2.2.

Table 2.2 Installed & Generating Capacity of Existing Power Stations in Kathmandu Area

Power Stations	Installed Capacity in kW	Generating Capacity in kW	Available output in Winter in kW	Annual Generating Capability in MWH
A. Hydro P/S				
1. Kulekhani	60,000	60,000	60,000	165,000
2. Trisuli	21,000	18,000	18,000	105,120
3. Sunkosi	10,050	10,050	6,500	62,726
4. Surajpura (Gandak)	15,000	15,000	7,500	106,800
5. Panauti	2,400	2,400	2,000	6,123
6. Sundarijal	640	640	600	5,105
7. Pharping	500	500	400	1,364
Total Hydro	109,590	106,590	95,000	452,238
B. Diesel P/S				
1. Mahendra	1,728	1,400		
2. Patan	1,490	1,200		
3. Hetauda	14,470	12,300		
Total Diesel	17,688	14,900		
Grand Total:-	127,278	121,490		

Since no new power station has been constructed after the completion of the Surajpura (Gandak) power station in 1978, the power supply capacity of the system has been insufficient to meet the growing demand, in spite of the extension of the Hetauda diesel power station by 10 MW capacity. As shown on Table 2.1, the energy sales in 1980/81 dropped to 133 GWh from 141 GWh of 1979/80. This was caused by the shortage in power supply capability. About 5% of the sold energy was supplemented by purchase from India.

On the other hand, the distribution system in each load center had also been quite poor, being insufficient to deliver the generated power. No substantial reinforcement had been made in the distribution system in Kathmandu since the first improvement in 1965. The service condition was very poor, being unable to maintain normal voltage and frequency and supply was frequently shutdown due to faults on the lines. The capacity of distribution transformers was also not sufficient to deliver the required power.

Under such situation, the extension and reinforcement of the distribution system are seriously required to receive the power from Kulekhani No.1 power station and effectively distribute it to the consumers where demands are increasing.

2. Demand Forecast

Table 2.3 shows the power demand forecast in the Kathmandu valley projected by NEC for the period upto 1986/87 and modified by the JICA Team for the period upto 1989/90, assuming that the distribution system would be reinforced as scheduled.

Table 2.3 Power Demand Forecast for Kathmandu Valley (in kW)

	JICA	NEC /1
1978/79	36930	45849
79/80	40450	50888
80/81	43090	59600
81/82	43090	65774
82/83	53400	71313
83/84	64110	77143
84/85	74370	84249
85/86	85500	91446
86/87	95800	99389
87/88	107300	
88/89	117600	
89/90	129600	

Remark: /1 NEC forecast was given from NEC in June, 1982.

In the above demand forecast, the construction of the following power source is considered to supply power to meet the demand growth in CNPS.

Power Station	Output	Completion	Remarks
Devighat H.P.S.	14,400 kW	1984/85	Under construction
Marsyangdi H.P.S.	66,000 kW	1985/86	Under detailed design
Kulekhani No.2 H.P.S.	32,000 kW	1986/87	Under detailed design under finance by Japan.

Table 2.4 and Fig. 2.1 show the estimation of growth of peak loads on the outgoing feeders of each substation in Kathmandu.

Table 2.4 Peak Load Forecast of Each Substation in Kathmandu Valley

(Unit: KW)

Substation		1980/81	1982/83	1984/85	1986/87	1989/90
K2	NEC	14,853	18,687	21,797	25,249	
	JICA	10,750	10,430	7,160	8,950	12,110
Lainchour	NEC		0	0	0	
	JICA		4,630	6,370	8,110	10,970
Teku	NEC	13,487	16,026	19,443	23,977	
	JICA	9,750	6,680	9,850	13,800	18,670
Patan	NEC	9,431	11,001	12,831	14,966	
	JICA	6,820	8,240	11,355	14,370	19,680
Thapathali	NEC	0	0	0	0	
	JICA	0	0	7,145	9,200	12,200
Balaju	NEC	7,524	8,777	10,560	12,316	
	JICA	5,440	6,570	9,320	11,870	16,060
Chabel	NEC	6,116	7,134	8,321	9,704	
	JICA	4,420	5,340	7,350	9,350	12,650
Maharajganj	NEC	4,119	4,939	5,758	6,515	
	JICA	2,970	2,630	3,610	4,600	6,220
Siuchatar	NEC		0	8,287	9,666	
	JICA		5,320	7,320	9,320	12,610
Thimi	NEC	1,488	1,736	2,025	2,362	
	JICA	1,080	1,300	1,790	2,280	3,090
Bhaktapur	NEC	2,582	3,013	3,514	4,100	
	JICA	1,860	2,260	3,100	3,950	5,340
Total	NEC	59,600	71,313	84,249	99,389	
	JICA	43,090	53,400	74,370	95,800	129,600

Fig. 2 – 1a

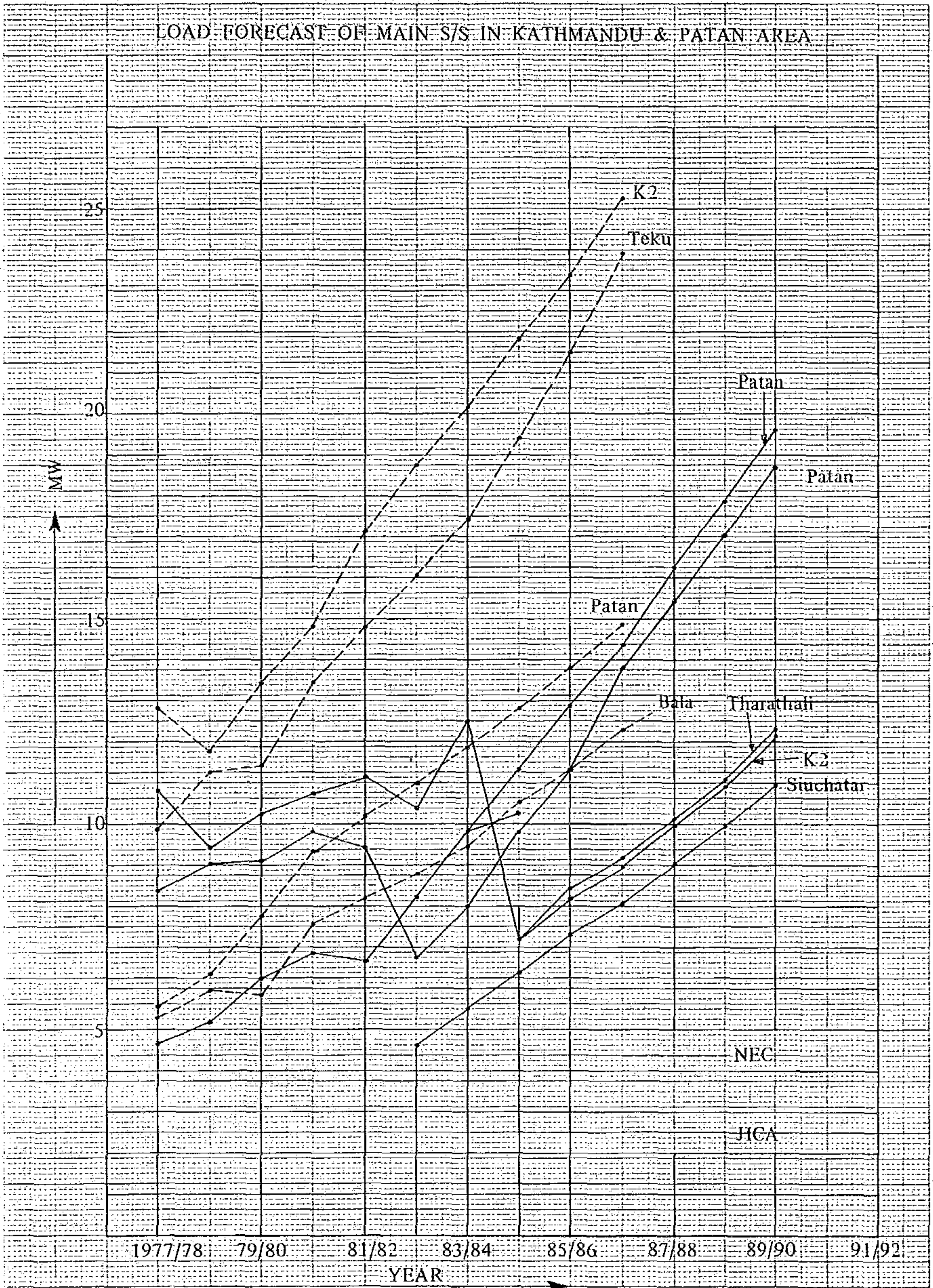

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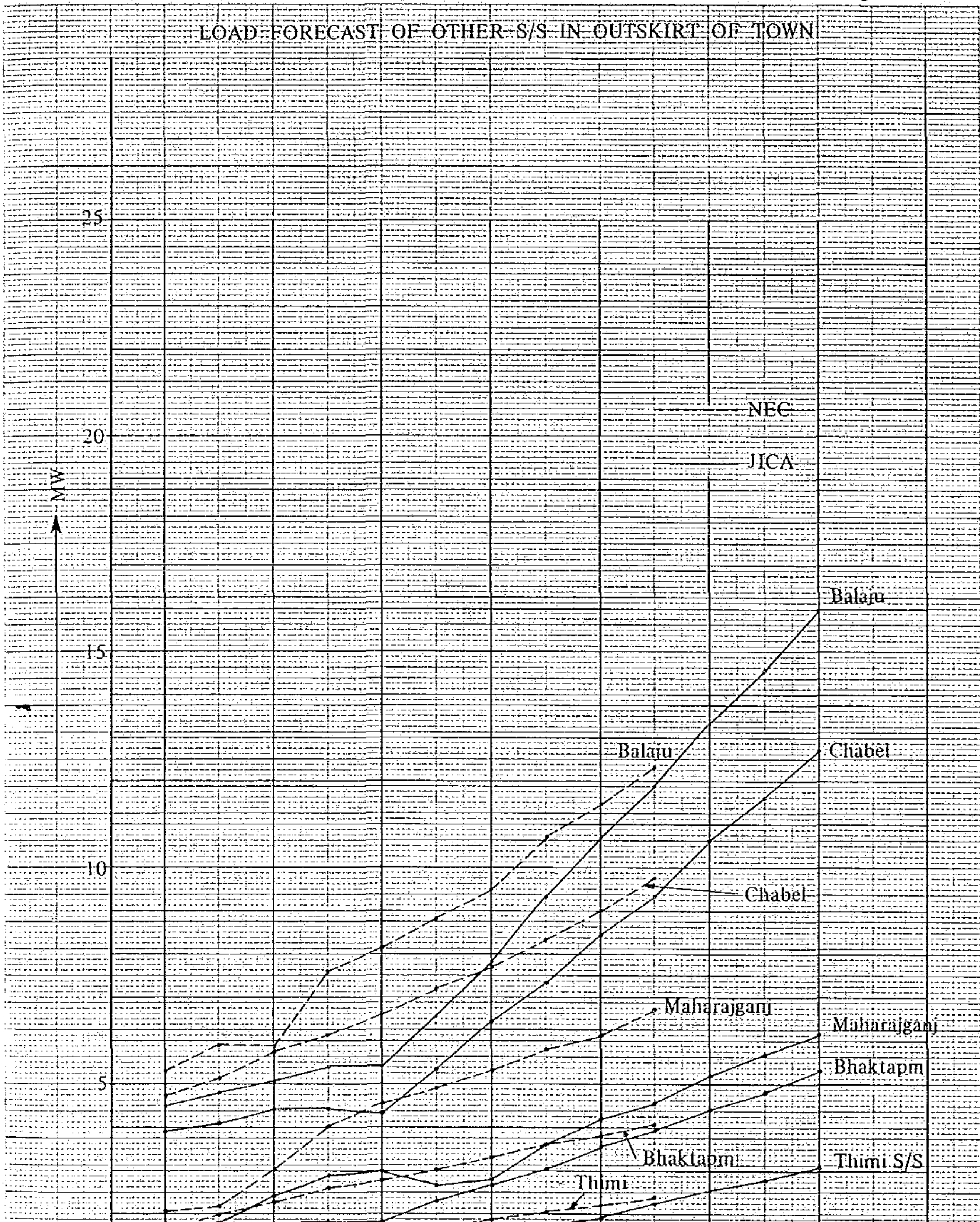
Fig. 2 – 1b



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As for the load sharing by each substation in NEC estimation, the construction of new lines and feeders from the Lainchour switching station, which was newly constructed under the first phase of first stage program of the Project, was not taken into account. Therefore the Team prepared a revised demand forecast for each substation considering the rearrangement of networks as proposed in the next section.

3. Power Administration System

The organization of the electric power administration system is shown in APPENDIX II, comprising the organization chart of the HMG, Ministry of Water Resources, Electricity Department (ED) and Nepal Electricity Corporation (NEC).

As shown in the organization chart, ED is under control of the Ministry of Water Resources. The ED has the responsibility for the planning of electricity supply in whole Nepal and the execution of construction of electrical facilities such as power stations, transmission lines and substations. ED is also directly managing the power supply system in the Far Western Regions.

NEC has the franchise to supply electricity in the major portion of Nepal, the Western, Central and Eastern Regions.

The duty of the NEC covers only the maintenance and operation of the existing power stations, transmission lines, substations and distribution systems, including power supply business to their consumers. The development of new power project is not their responsibility.

4. Electricity Tariff Rate

The current electricity tariff rate is as shown in APPENDIX-III. The tariff is classified into the following eight categories.

1. Domestic Consumers
2. Industrial Consumers
3. Commercial Consumers
4. Street Light

5. Irrigation and Drinking Water Supply
6. Transportation
7. Temporary Supply
8. Bulk Supply to India

According to this tariff, even the rate for the domestic consumers is only 0.4 to 0.5 Rupees (equivalent to US$0.03 to 0.04) per unit.

Considering the fact that the fuel cost for energy generation by diesel plant amounts to 1.5 Rupees per kWh, the current rates seem not reasonable for the sound management of the power supply organizations.

According to the annual report of NEC, the business fell down to deficit in 1978/79, although it got back to profit again in 1979/80 as shown below. (Detail is shown in APPENDIX-IV)

	1977/78	1978/79	1979/80
Revenue	40,954	49,298	62,985
Expenditure	39,381	55,812	45,898
Balance	1,573	-6,514	17,087

(in 1,000 Rupees)

It must be noticed that the expenditure in 1979/80 extremely decreased compared with the previous year. It seems that the reinforcement of the distribution system by NEC has curtailed the expenditure.

Under such situation, it will be inevitable to revise the tariff in near future, otherwise it will be difficult for NEC to provide source for repayment of the construction fund of Kulekhani No.1 power station after it will be transfered to NEC.

III. PROJECT DESCRIPTION

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1. General

ED's proposal for requirement for reinforcement of the distribution system was as shown in Appendix V. Priority study was made with the officials of HMG of Nepal referring to the present situations of the distribution system and demand forcast for each of the area on each of the item included in the above proposal. As a result the work items to be implemented under the second phase of the first stage program of the Project were settled as given in Appendix VI. The total work items of Appendix V are summarized as follows:-

1. New 11 kV Line	98.89 km
a) Overhead line	86.46 km
b) Underground cables	12.43 km
2. Upgrading of voltage and conductor size	27.50 km
a) Overhead line	9.50 km
b) Underground cables	18.00 km
3. Distribution transformers	46,100 kVA
4. 400/230 V Lines	206.46 km
a) Overhead lines	201.46 km
b) Underground cables	5.00 km
5. Watthour meter and others	1 lot
6. Maintenance tools	1 lot
7. One new 66/11 kV substation with 66 kV line	1 lot

The location of each work is indicated on the attached Map. M-1 and M-2, and the relation between new lines and the existing lines is illustrated on the attached Drawing No. D-1, D-2, D-3, D-4 and D-5 Single Line Diagram of Distribution System.

Countermeasures for avoiding overloading of the K2 substation were studied. Though there was an idea to construct an additional 66/11 kV substation, it was decided to extend and rearrange the distribution network and construct a new switching station at Thapathali. By realiging such improvement, the load of the K2 substation and the Lainchour substation is expected to be limited to less than 12 MW until 1989/90 as shown in Table 2.4.

2. Detailed Discription

2-1 New 11 kV Lines

1) New 11 kV lines in city areas of Kathmandu, Patan and Bhaktapur

In recent years, the number of consumers and power requirement have rapidly increased by the development of the city areas, Kathmandu, Patan and Bhaktapur. In order to improve the service conditions to consumers, the length of low tension lines should be limited within a reasonable distance. For shortening low tension, distribution lines, extension of 11 kV lines and installation of distribution transformers are necessary. In addition, after the completion of the Ring Road and its branch roads, construction of new houses along the roads has been booming and many houses are now under construction. Power supply to these houses is also necessary.

The location of the new lines and new transformers are shown in the attached Map M-2.

Total length of 11 kV overhead lines is 24.5 km and length of underground lines is 11.6 km.

2) 11 kV lines to rural areas

Construction of new 11 kV lines is required for the power supply to rural areas that are now not electrified. There are many waiting consumers in these areas. The number of selected areas to be electrified is 16 and the lines composed of overhead lines of 33.7 km and underground lines (ring line crossing only) of 1 km in total.

Necessary number of transformers will be installed at suitable places for feeding to low tension lines.

2-2 Upgrading of line voltage and conductor

The distribution systems of 3.3 kV exist only in the old town areas of Kathmandu and Patan. At present the power is supplied through the tie transformers of 11/3.3 kV, 750 kVA capacity, two sets in the Patan area and nine sets in the Kathmandu area.

In the Kathmandu area, some of 3.3 kV lines will be graded up to 11 kV and larger size conductors will be used for increasing the power supply capacity. Thus, the load of the tie transformers will be changed over to direct supply from 11 kV lines. The location of 3.3 kV lines to be changed over to 11 kV lines shown in Drawing No. M-2.

There are also some 11 kV lines whose conductors will be replaced with larger size ones in order to increase the power supply capacity.

Total length of such improvement is 3.0 km of overhead lines and 4.8 km of underground lines.

In the Patan area, all of the 3.3 kV lines will be graded up to 11 kV. At the same time, the size of conductors will also be graded up in order to increase its power supply capacity. The total length of lines is 0.2 km of overhead line and 3.7 km of underground cables.

2-3 Interconnection Lines

In order to improve present power supply conditions, the following interconnection lines will be constructed:-

1) Chabel-Gokarna Lines

At present, power to the Gokarna and Sakhu areas are supplied from the Sundarijal P/S. This power station is operated mainly by the water discharge of the drinking water to the Kathmandu City, however the output of this power station is not sufficient for power supply to these areas. The power supply for these areas will be switched and will come from the Chabel S/S in order to improve supply conditions to these areas. Reference is made to the single line diagram in Drawing No. D-2.

2) Patan-Nepal Radio Station

The broadcasting station of Radio Nepal is receiving power from Patan S/S through Godawali distribution line which is extended to wide rural area.

The broadcasting station has suffered so many times from disturbance due to faults of the distribution line. The power supply can be changed over to receive the power directly from the Patan S/S by extension of a short length of existing distribution as shown in Fig. 3-1.

3) Bhaktapur-Sanga Line

The Sanga village is located in the eastern suburb of Bhaktapur along the Arniko highway. At present, the power to this village is supplied from the Panauti P/S with the 11 kV distribution line of about 20 km in length. Bhaktapar-Sanga line is planned in order to improve power supply conditions to the Sanga village. The existing 11 kV line from Panauti P/S will be used to the eastern areas such as Banepa, Dhulikel, etc. which are outside the Kathmandu Valley.

The required power in the valley had better be supplied from the Kathmandu Valley system, but not from outside. According to this principle, the eastern area of Bhaktapur is planned to be supplied power from the Valley system, by extending from Bhaktapur.

By such extension of 11 kV system, power supply conditions in the eastern end area of the valley will be much improved. Reference is made to single line diagram in Drawing No. D-5.

The total length of the interconnection lines is 11 km, and all of which are overhead lines.

2-4 Rearrangement of 11 kV outgoing lines

At present, the Jawalakhel line is supplying power to wide area in the western parts of Patan city. Many houses are now under construction in the western area along the ring road and the capacity of the existing line seems not enough for supplying to increasing power demand in the area.

In order to meet such increasing power demand, it was planned to divide the supply area. A new line will be constructed for power supply to Pulchok and Kopundol areas. The existing line will be used for power supply to Jawalkhel, Santa Bhawan and Sapena areas. The new line will consist of an underground line of 1.9 km with an overhead branch line of 0.14 km.

In relation to the construction of the Thapatali switching station, the construction of an 11 kV line between the Teku S/S and the Thapatali switching station, require the installation of switches on the lines and rearrangement of the existing 11 kV lines near the Thapatali switching station.

2-5 Extension of 400/230 V low tension lines

The extension of low tension lines is required in the city areas and construction of low tension lines is required in the rural areas for delivering power to scattered consumers.

However, it is noted that the scope of works of this project is limited only to construct distribution lines, but not include the erection of the drop wire to the consumers.

The total length of low tension lines is 144.8 km, 23 km in city areas, 18 km of overhead lines and 5 km of underground cables and 121.8 km in rural areas, overhead lines only.

2-6 Construction of Thapatali switching station

At present the K2 S/S is heavily loaded and further increase of load is expected in future. In order to cope with the load increase in the central Kathmandu, reinforcement of power supply capacity to this area is required. For this purpose two countermeasures were considers, one is to construct Thapatali switching and to shift a part of the K2 substation load to this switching station and the other is to construct an additional 66/11 kV substation of 18 MVA capacity at K2 or Lainchour substation site.

As the cheapest solution, the construction of the Thapatali substation was proposed. The power to this switching station will mainly be supplied from the Patan substation by the double circuit 11 kV lines through the Teku substation. The Singha Darbar, Tripreswar and Kopundol areas will be supplied from this station. Thus, load of K2 S/S can be greatly decreased and the present facilities of the K2 S/S will meet the power demand up to 1989/90 as seen in Fig. 2-1a.

Another merit of constructing the Thapatali switching station instead of constructing an additional 66/11 kV substation is the effective utilization of existing and planned substations around Kathmandu as mentioned below:-

1) Siuchatar substation

   The installed capacity of the Siuchatar substation is 36 MVA, but the present load is only 20 MVA, being limited by the capacity of the existing lines on secondary side. Under this condition, if an additional 66/11 kV substation is constructed in the center of Kathmandu, one set of 18 MVA transformer at the Siuchatar S/S will not be used effectively for a long time.

2) Patan substation

   The present load of the Patan S/S is about 13 MVA, which will decrease appreciately if this 66/11 kV substation is constructed due to the decrease of the power flow of the 11 kV line to the Teku S/S. Thus, the present installed capacity of 48 MVA (2 x 18 MVA + 12 MVA) will not be utilized for a long time.

3) New Chabel Substation

   The New Chabel substation is under construction to receive the output of the 14.4 MW Devighat Power Station under another project. Though the plan of the 11 kV distribution system is uncertain, it seems that this substation has some allowance to supply power to the city center area in addition to supplying the 11 kV Chabel S/S. These allowance may not be able to be effectively utilized if this 66/11 kV substation is constructed.

2-7 Distribution transformers

Distribution transformers of 27,075 kVA in total will be supplied and installed mainly for increasing power supply capacity in the city area and for new power supply to rural areas.

2-8 Watthour meters and others

Watthour meters of 9,650 nos. in total will be supplied but their installation will be done by the Nepalese side.

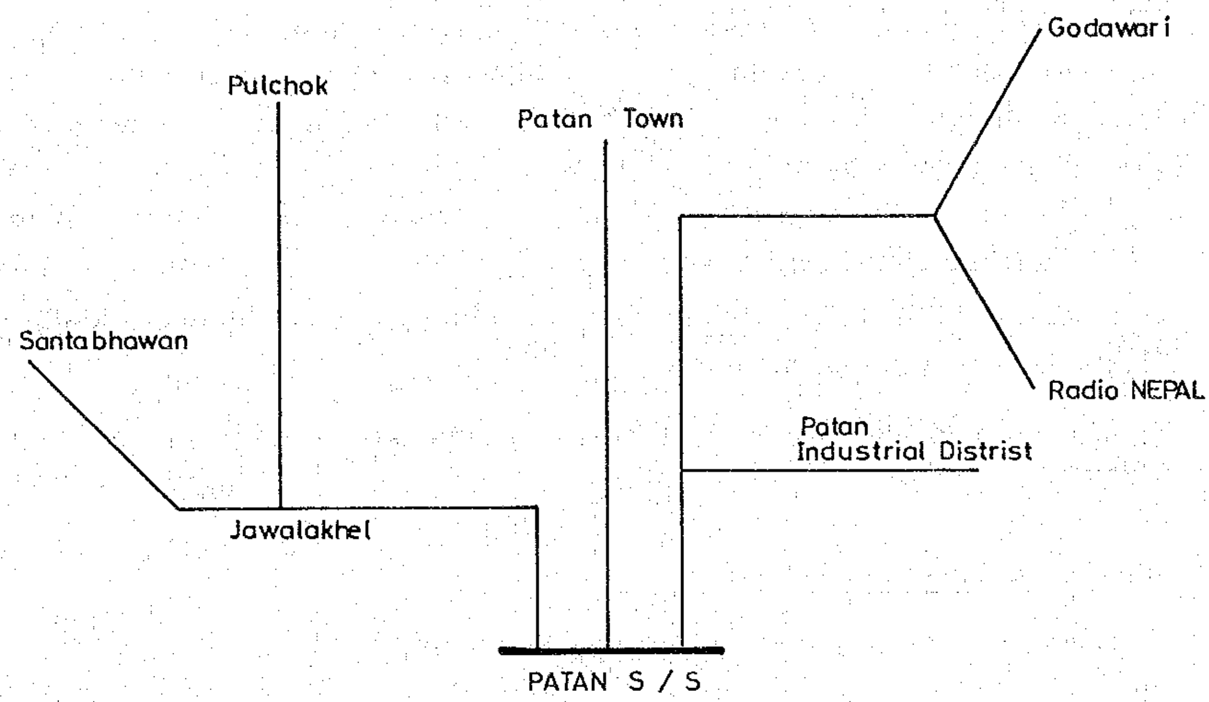
50 sets of 11 kV sectionalizing switches and 600 sets of 11 kV cutout switches will also be supplied.

2-9 Maintenance tools

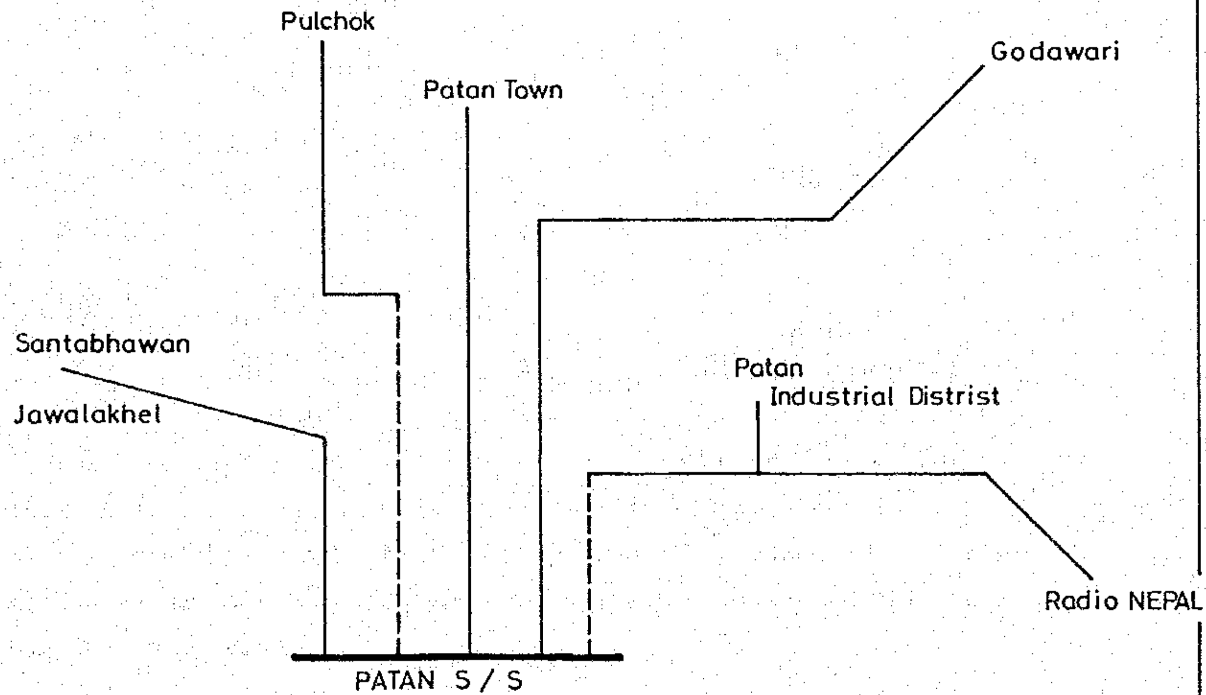
Maintenance tools as listed in Appendix VI will be supplied for maintenance of the distribution lines after completion.

SCHEMATIC DIAGRAM OF PATAN S / S

Fig. 3—1



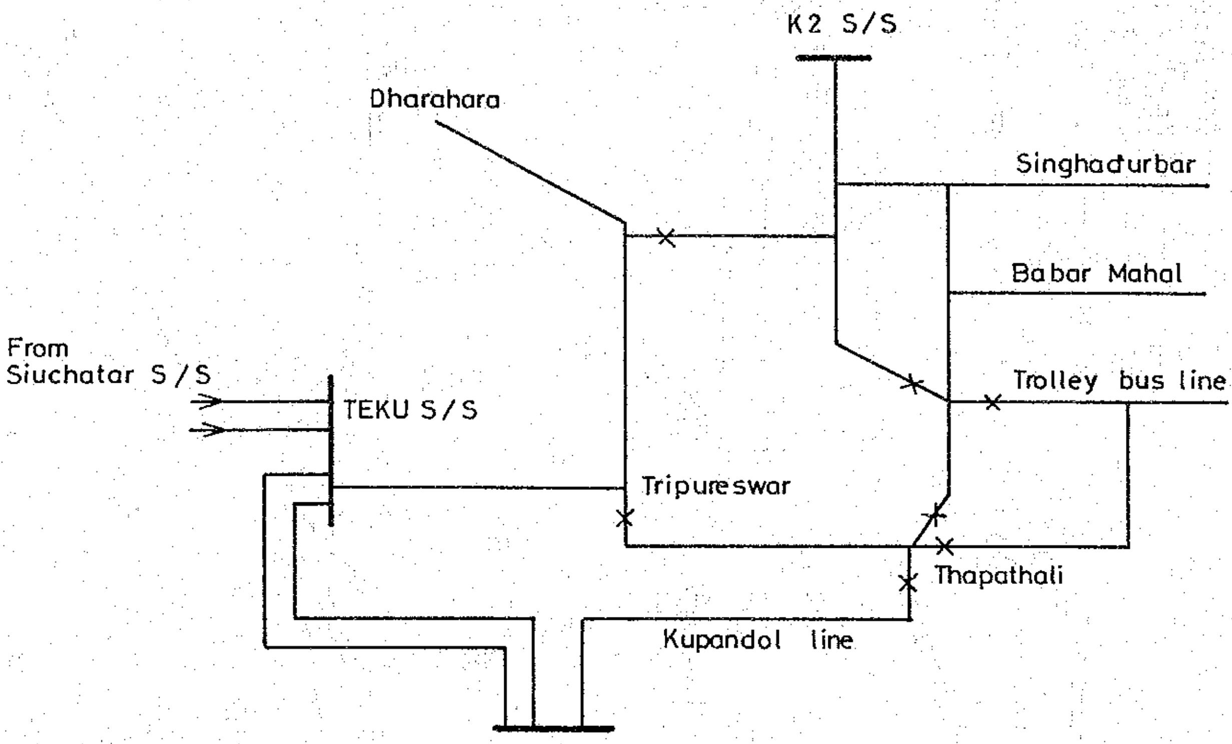
Existing Network



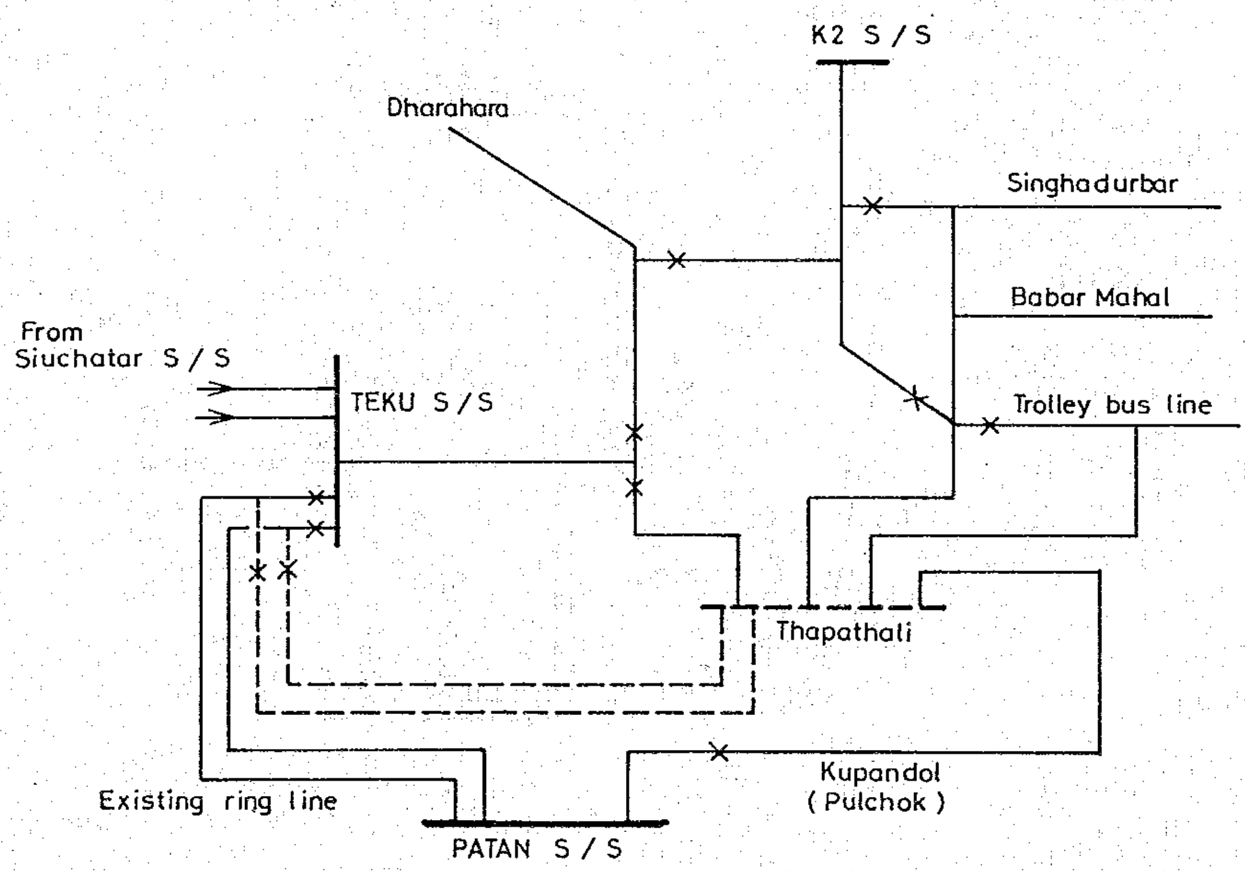
Proposed Network

New Line – – – – – – –

Fig. 3-2 SCHEMATIC DIAGRAM OF THAPATHALI S/S

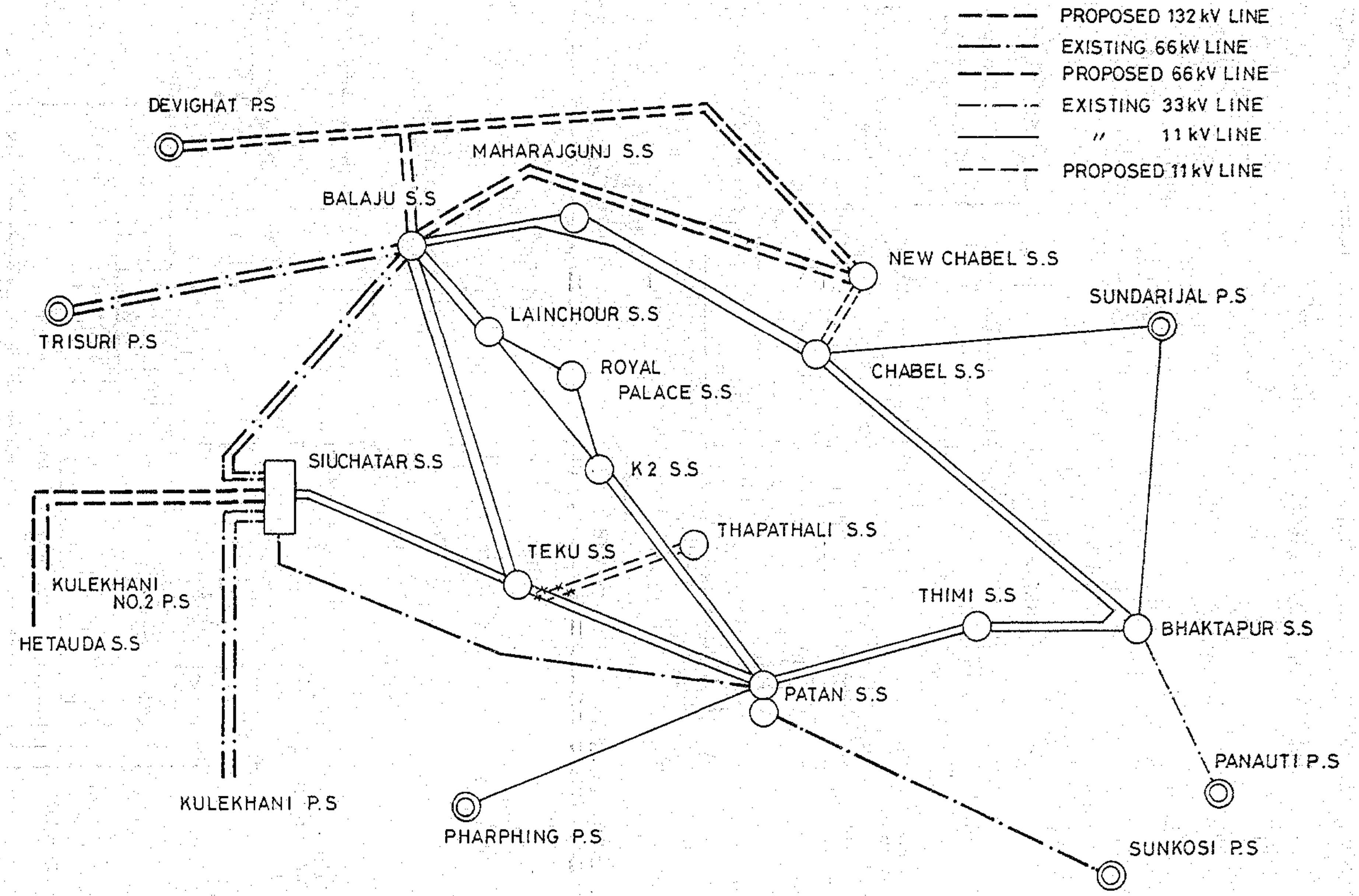


Existing Network



Proposed Network

FIG. 3-3 TRANSMISSION AND RING MAIN LINE OF KATHMANDU VALLEY



IV. BASIC DESIGN

IV. BASIC DESIGN

1. Basic Design Policy

System construction is planned so as to be able to distribute the power received at each substation effectively to each load point. The route of lines and the location of distribution transformers are selected taking into account of the present situation as well as the future extension of the residential and industrial areas.

The size of conductors is decided taking into account of the voltage drop and loss by the load current of the line. The capacity of distribution transformers is selected to meet the load in each area.

Principally, in the system design, the practice and standard applied in the NEC system are to be referred to.

For materials and equipment to be provided under the project, Japanese standards or equivalent are to be applied.

The design criteria are generally in accordance with the criteria applied on the design of the facilities provided in the first phase implementation of the project.

2. Basic Loads to Conductors and Supports

Maximum wind pressure on conductors, poles, etc. will be taken as follows:-

1) conductors: 35 kg/m^2 on the project area

2) supports: 31 kg/m^2 on the project area

3) insulators: 55 kg/m^2 on the project area

The abovementioned wind pressures were obtained basing on the wind velocity of 25 m/s specified in BS being applied in Nepal. Although the extremely highest wind velocity recorded in Kathmandu international airport was 52 Knots (equivalent to 26.75 m/s), the velocity of 25 m/s for the design of distribution lines is considered to be reasonable.

According to the record on the climate in Kathmandu during the period of 1961-75 shown on APPENDIX-VII, the highest and lowest air temperature in Kathmandu are as shown below:

1) monthly mean maximum temperature: 29.5°C

2) extremely highest temperature: 36.6°C

3) monthly mean minimum temperature: 1.5°C

4) extremely lowest temperature: -3.3°C

For sag calculation of conductors, the maximum temperature of the conductors will be assumed at 70°C taking into account of temperature rise due to current flow under the recorded extremely highest air temperature and temperature rise of the wires under the direct sunshine.

The recorded extremely lowest air temperature was minus 3.3°C in December, while the highest wind velocity was recorded in April. Since the extremely lowest air temperature and the highest wind velocity will not occur simultaneously, the minimum temperature of the conductors was assumed at 0°C for sag calculation.

3. Details of Facilities

3-1 Supports

The existing supports are made of steel tubular poles, concrete poles and wooden poles. Supports for this project will be made of steel tubes for easy transportation and erection. Since traffic roads from Raxual to Kathmandu limits the allowable maximum length of cargo to about 7 m, the poles will be devided in three pieces which will be jointed by conventional welding at the site.

Design criteria for the steel tubular poles are as follows:-

1) Span Length

The maximum span length for 11 kV overhead lines will be 150 m, however most of span length for new lines will be 50 to 80 m in accordance with the results of field survey by JICA's team.

2) Ground Clearance

Standard ground clearance of the conductors to be applied are as follows:-

	11 kV	400/230 V
Road crossing	6.0 m	4.8 m
Along road	5.8 m	4.8 m
Other areas	5.2 m	4.8 m

3) Conductor Arrangement

Conductors for the 11 kV overhead lines will be erected in triangular configuration with approximately 120 cm spacing as shown on Drawing No. D-6.

4) Safety Factor

Safety factors for mechanical strength should be more than 2.5 against the ultimate strength of steel poles.

5) Soil Bearing Capacity

Soil bearing capacity for pole foundations will be assumed as follows referring to the field test results carried out at Siuchatar and Patan substations under the Kelekhani Hydroelectric Project.

Ultimate bearing capacity:	40 t/m^2
Angle of repose of soil:	20 degrees
Unit weight of soil:	1.5 t/m^3

6) Type of Pole

Steel tubular poles will be classified as follows:-

Type A: to be applied at straight line section and light angle point up to 15 degrees, provided with pin type insulators Light angle poles for 5 to 15 degrees will be reinforced by applying guy wire assemblies.

Type B: to be applied at heavy angle point over 15 degrees, provided with suspension insulators and pin type insulators for jumpers, and reinforced with guy wire assemblies.

Type D: to be applied at dead end, provided with suspension insulators with guy wire assemblies.

Type T: to be applied for installing a pole mounted distribution transformer with cutout fuses, lightning arresters and secondary switch box, etc., with guy wire assemblies.

The above types of poles will further be classified depending on the kind of conductors and standard span length. The typical drawings of steel tubular poles are as shown in Drawing No. D-6, D-7.

3-2 Conductors

Conductors for new 11 kV overhead lines will be Aluminium Conductor Steel Reinforced (ACSR). Underground cables will be Aluminium and Copper Cored, Cross-linked Polyethylene Insulated, PVC Sheathed and Steel Tape Armoured Cable (AL-CVTAZV). Conductors for 400/230 V low tension lines will also be Aluminium Conductor Steel Reinforced (ACSR).

1) Safety Factor

Safety factors should be more than 2.5 for ACSR against their ultimate breaking strength.

2) Underground Cable

Underground cables will be directly buried at deeper than 70 cm below the ground surface. The buried cables will be protected by covering with bricks in order to protect against traffic loads.

3-3 Insulators

Pin type and 10-inch dia. suspension insulators will be used for 11 kV overhead lines.

1) Materials & Type

Insulators for the 11 kV lines will be made of porcelain glazed and brown coloured. Spool insulators will be employed for low tension lines. Suspension insulator discs will be of clevis-tongue type.

2) <u>Number of Insulator Disc per String</u>

One (1) suspension type insulator disc per string will be applied for 11 kV overhead lines at every heavy angle and dead-end poles. However, heavy angle poles for crossing over heavy traffic roads will be provided with two (2) serial discs string.

3) <u>Safety Factor</u>

Electro-mechanical safety factor of insulators shall be more than 2.5 against the ultimate strength.

4) <u>Electrical Characteristics</u>

Electrical characteristics of insulators will be as follows:-

	Pin-type	Suspension type
Dimension:	7-1/2" x 5-3/4"	10" x 5-3/4"
Leakage distance:	13"	11-1/2"
Low frequency flashover voltage, dry:	95 kV	80 kV
" wet:	60 kV	50 kV
Impulse flashover voltage, positive:	150 kV	125 kV
" , negative:	190 kV	130 kV
Low frequency puncture voltage:	130 kV	110 kV

3-4 <u>Pole-mounted Distribution Transformers</u>

1) The transformers will be of three (3) phase, oil immersed, natural cooled, outdoor use and pole-mounted type.

2) The secondary side of the transformers will be rated at 400/230 V, 3-phase, 4-wire.

3) Voltage tap range on the primary side of the transformers will be +5% to -10% of the rating at 11 kV with 2.5% step.

4) Unit capacity of transformers will be 25 kVA, 50 kVA, 100 kVA and 250 kVA.

5) Vector group of the transformers will be Dy-11.

6) The distribution transformer will be provided with a distribution switch box on their secondary side.

3-5 Equipment for Switching Station

1) Switching station to be located at Thapathali will be provided with:

   Two (2) sets of incoming line panel

   Six (6) sets of outgoing feeder panel

   One (1) set of station service transformer panel

   One (1) set of battery/battery charger panel

2) Each panel will be of indoor cubicle type provided with the equipment and instruments as shown on the connection diagram of Dwg. No. D.9.

3) The circuit breakers for incoming lines and outgoing feeders will be of draw-out type rated at 11 kV, 400 MVA, 800 A (incoming) and 600 A (outgoing).

4) The power fuse on the primary side of station service transformer will be of 11 kV, 10 A.

5) The station service transformer to be contained in the transformer panel will be of three phase, dry epoxy-resin molded, self-cooled type, rated at 11 kV/400-230 V, 50 kVA.

6) The incoming line panel will be equipped with measuring instruments for voltage, current, power factor and maximum demand, and protective relays for over-current and earth fault.

7) The feeder panel will be equipped with measuring instruments for current and maximum demand, and protective relays for over-current and earth fault. The automatic recloser will be provided for each feeder.

8) The station service transformer panel will be equipped with measuring instruments for bus voltage and current.

9) The battery/charger panel will contain 32 volt nickel-cadmium alkaline, enclosed battery set and charger complete with necessary accessories.

10) The switching station will be connected to the Teku substation with two circuits of 11 kV underground cable line which will be branched from the Teku-Patan line at the terminal structure of Teku substation.

11) The feeder line will be led out by an underground cable up to the terminal pole of each feeder line.

V. PROJECT EXECUTION SYSTEM

V. PROJECT EXECUTION SYSTEM

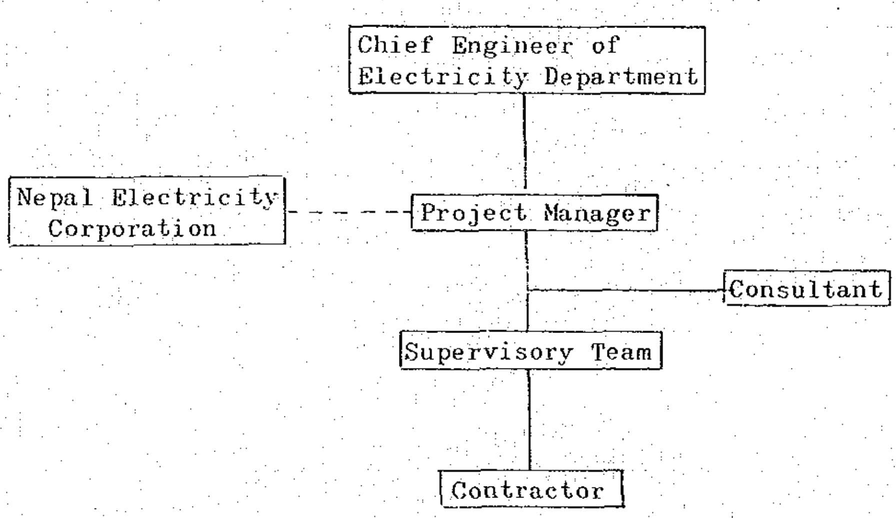
In execution of the planned distribution system, ED will act as an executing agency representing HMG of Nepal. However, the distribution system will be transfered to NEC for operation and maintenance.

The planned distribution system will be implemented by a Japanese contractor including erection and commissioning. Though erection by local party is possible, the work by the Japanese contractor will be selected in order to shorten the construction period.

The supervision team will be composed of consultant staff and ED's counterparts. Supervision of the erection work will be performed by the consultant staff with assistance by the ED's counterparts. Land problems, etc. will be settled by the ED's staff.

Overall organization of the project execution is shown as below:-

ORGANIZATION CHART FOR PROJECT EXECUTION



This is just same as that for the first phase which was already executed.

Though NEC will not officially be involved in the project, close contact with NEC is required for de-energizing of the lines for improvement of the lines, connection to the live lines, construction of Thapathali switching station, etc. Without close cooperation of NEC, execution of the project will be impossible.