ii) Upgrading of voltage .... 2.32 km
- overhead lines .... 0.50 km
- Underground cable lines .... 1.82 km

iii) Distribution transformers .... 8,450 kVA
- 3-phase, 100 kVA 44 nos. .... 4,400 kVA
- 3-phase, 250 kVA 15 nos. .... 3,750 kVA
- 3-phase, 100 kVA 3 nos. (cubicle type) 300 kVA

iv) 400/230 V lines .... 16.70 km
- Overhead lines .... 14.70 km
- Underground cable lines .... 2.00 km

v) Sectionalizing switches .... 20 nos.
- 400 A rating .... 5 nos.
- 200 A rating .... 15 nos.

5.3 Organization for Execution of the Project

5.3.1 Executing Agency

As mentioned in Clause 3.1.1, the present ED and NEC are scheduled to be amalgamated into NEA in 1985. After the establishment of NEA, as same as the case for the load dispatching center, NEA will be in charge of the execution of distribution network. But in case that the operation start of NEA is delayed, NEC will look after the project in cooperation with ED.

5.3.2 Implementation Plan

After the signing of the Note of exchange, the Project will be implemented in the following sequence:

- Signing of the Note of exchange
- Conclusion of a contract with the consultant
- Detailed design and preparation of tender documents
- Tendering and conclusion of contract
- Design by contractor and approval by consultant

- Manufacturing of equipment and inspection
- Ocean and inland transport
- Site erection works

As for the site erection works the following are noted.

(1) Substation Works

The erection of substations will be commenced by the foundation works of both the Baneswar and Patan Substations and construction of the Baneswar Substation building. These works will be executed by local contractors. Then, outdoor erection works will be performed in the sequence of the erection of outdoor steel structures, outdoor stringing and erection of main transformers and outdoor switchgear. The building work is to be completed not later than the completion of the outdoor works. At the last, control boards and cubicles will be erected, and cabling and wiring will be performed. Before the completion and taking over the completed substation shall be tested for acceptance.

For the Patan Substation works, care shall be taken to the coordination with the existing substation, particularly the erection works to be carried out under supply interruption, and to good scheduling with the transmission line works. The work schedule shall be decided under good cooperation with the local authorities.

(2) Transmission Line Works

The contractor is required to carry out check survey and soil test before setting to the erection work in order to confirm correctness of the tower sites and soil conditions at each tower site. The foundation works will be done at first and followed by the tower erection. The stringing work will be performed at the last.

Between the Patan Substation and the ring road, the transmission line is to be constructed within the right of way of the existing 66 kV Sunkosi line. The foundation work and erection of the lower portion of the towers shall be completed at first. Then during interruption of power supply, the existing line will be dismantled, the upper portion of the towers will be erected and the stringing work will be done. These works are to be performed at the same time as the substation works under the supply interruption.

(3) Distribution Line works

Before setting to the erection works, the contractor shall survey along the planned route and prepare the detailed plan of the erection works for consultant's approval.

The distribution line works consist of many of small components of works. Erection will be carried out one by one and each section will be taken over after completion for actual service. In many cases the live portion of the distribution system exists near by and erection works under power interruption are required often. Under such situation, utmost care shall be taken toward safety of workers during the erection work.

Supervision of the site erection works will be performed under good cooperation of the Japanese consultant and NEA. The previous works in 1980 and 1982 were executed with very good results and there will be no problem in this regard.

For the execution of the Patan Substation works and the related transmission line works to be performed under power interruption, the heavy loaded period shall be avoided and consideration shall be given to the conditions of the power station equipment. Therefore, good scheduling will be required for preparation of a detailed construction plan.

The land problem will be a key factor for carrying out the transmission line and distribution line works. Especially for the distribution line works, there are a lot of items to be negotiated by NEA such as preparation of the power interruption plan of the existing line, use of road, buried water supply and sewerage pipe lines, etc. Negotiations within NEA, with the public, with other government authorities, etc. will be performed by NEA with good cooperation by the consultant.

After the signing of Exchange of Notes, the required dates of execution are estimated as follows:

Exchange of Notes		
Consultant Contract	:	1 month
Tender Call	:	3 months
Tender and Evaluation	:	4 months
Construction Contract	:	4.5 months
First Shipment	:	9.5 months
Last Shipment	:	14.5 months
Site Construction	:	8.5-20.5 months

Thus the whole works can be completed within 20.5 months. The implementation schedule is shown in Fig. 4.8.

5.3.3 Operation and Maintenance Plan

The organization of the present NEC for operation and maintenance is as shown in Fig. 3.2. The operation and maintenance of the transmission line and distribution lines under this project will also be executed by NEC.

For operation of the Baneswar Substation, assuming that one shift consists of three members, 12 person for 4 shifts will be required. The transmission line and the distribution lines in the Kathmandu city will be looked after by the Kathmandu Division and distribution line in Patan and Bhaktapur cities will be maintained by the maintenance divisions of the respective cities. It is considered that the minimum of recruitment will be enough for the planned operation and maintenance of the additional lines.

5.3.4 Purchase and Transportation Plan

All the equipments and materials are in principle to be purchased in Japan and the cargoes will be transported on the sea up to the port of Culcutta in India and by road therefrom to Kathmandu. Materials for the civil and building works, however, will be arranged locally. Details are same as given in Clause 4.3.4.

5.4 Contributions by the HMG/N

The contributions which shall be taken by the HMG/N are as follows;

(1) Reinforcement of Destribution Networks in Kathumandu Valley

Acquisition of the site for the Baneswar Substation	NRs.
50(m) X 55(m) x 419(NRs./square m) ≒	1,152,000
Construction of road,land,gate,fence etc. for the Baneswar Substation	216,000
Compensation for the construction of transmission line	144,000
Transfer transportation of the equipment of the Baneswar Substation	144,000
Contingency	144,000
Total	1,800,000

(2) Operation and Maintenance of the Reinforcement of Distribution Networks

Operation and maintenance of the distribution networks will be undertaken by the HMG/N as described in Clause 5.3.3,and the annual cost of them is estimated as shown below;

	NRs./Month		Month		Number		NRs.
Engineers (A)	2,900	x	12	x	5	=	174,000
Engineers (B)	1,800	x	12	x	10	=	216,000
Erectricians	1,100	x	12	x	5	=	66,000
Subtotal							456,000
Overhead(25%)							115,200
Spareparts and others							151,200
Total							722,400

CHAPTER 6 PROJECT EVALUATION

6.1 Necessity of the Project

As already described in the previous Chapter, power supply condition of Kathmandu Valley was significantly improved by the reinforcement of distribution network in 1980 and 1982. These projects were implemented as grant aid programs of Japanese Government subsequent to the "Feasibility Study for the Reinforcement of the Power Transmission and Distribution Systems in Kathmandu Valley" conducted by JICA in 1978. As for power generation facilities, Kulekhani No. 1 Power Station was constructed under the co-finance of OECF and the World Bank. At present Kulekhani No.2 Power Station is under construction and scheduled to be completed in 1986/87. Japanese Government has been, thus, providing assistance to Nepal especially for the improvement of power supply conditions in Kathmandu Valley. Reinforcement of power generation facilities becomes effective when it is accompanied by the reinforcement of distribution network at the end. In this regard, the reinforcement of the distribution network in the Kathmandu Valley has been bearing fruits in concert with the completion of the Kulekani No.1 plant. The present power distribution network in the valley, however, will encounter various problems as already explained in Chapter 3 and hereunder summarized, after Kulekhani No.w plant is completed and starts operation.

1) Lack of the total capacity of 66/11 kV transformers in the Kathmandu Valley after 1987/88.

2) Low reliability of 11 kV substation to meet increasing power demand due to its insufficient rupturing capacity and inappropriate electric circuit arrangement.

3) Necessity of increasing capacity of distribution network to cope with increasing demand and improving reliability of supply.

While the present study proposes the construction of the Baneswar Substation as the solution of the above item 1), the possibility of constructing Lainchaur substation was also studied as another alternative.

Baneswar Substation is directly connected with the Kulekani No.2 power plant, while Lainchaur Substation will be linked to Marsyangdi power plant. Under this condition, Lainchaur Substation as a part of Marsyangdi project, is considered to become necessary after 1988/89. For this reason, the present study does not take into account of the construction of Lainchaur Substation.

Substations described in the above item 2) comprise the K2, Patan and other Substations which are equipped with 11 kV switchgear with 150 MVA rupturing capacity. HMG/N has a plan to replace these equipment with the ones with 400 MVA rupturing capacity. The K2 Substation is selected as a component of the present project, since this substation is located in the city center, furthest from the main substations and judged to possess highest necessity for the improvement and separation from main line.

As for the item 3), design is made so as to increase power supply capacity by replacing the 3.3 kV supply with 11 kV supply to the super-market area, addition of circuit, supply of distribution transformers, etc., and to improve reliability of supply by feeder splitting to ensure stable supply to the airport, supply of sectionalizing switches, etc.

In accordance with the reinforcement of transmission line and increase of power generation capacity, it is becoming increasingly necessary to establish a central load dispatching center to make adjustments of power generation output and to operate the overall power supply system under the centralized control system. For this reason, construction of the load dispatching center is included as a component of the present project. Its scale is planned to be the minimum level in consideration of the present situation of the power supply system in Kathmandu Valley and experience of Nepalese engineers. Specifically the followings are considered.

- Data from remote stations other than major four power stations and sub-stations are planned to be manually indicated.

- Measures for communication is planned to be telephone networks.

- The center is furnished with batteries for operation of the load dispatching facilities.

- No adoption of computer application

With this system, operation and maintenance of the center can be undertaken by Nepalese engineers provided with operation manuals without training in Japan. Construction cost of the center is also maintained at an economical level.

The proposed load dispatching center is so designed as to be able to cope with the possible expansion of the transmission system expected in the near future.

6.2 Benefit of the Project

As already explained in the preceding chapters, reinforcement of the transmission and distribution systems and construction of a load dispatching center are considered inevitable to solve possible problem which the present system will encounter after the completion of the Kulekhani No.2 Power Station. The Project will also contribute to ensuring an appropriate adjustment of power generation and an efficient operation of the power system in parallel with reinforcement of transmission line and increase of power generation facilities. Benefits to be created by the implementation of the Project are expected in three aspects of quantity, quality and reliability in power supply.

Quantity

As described in Chapter 3, power demand in the Kathmandu Valley is estimated to rise 2.2 times in 8 years from 212.5 GWh in 1982/83 to 466.9 GWh in 1990/91. In meeting such increasing power demand, the Project indirectly contribute to an increase in power supply quantity through the reinforcement of substations and distribution network, which is undertaken so as to make the best use of the Kulekhani No.2 power plant.

Quality

Upgrading of quality constitutes the stabilization of voltage and frequency. Frequency of voltage drop has fallen to less than 10% since the two times reinforcements of the distribution network. Most families are able to equip fluorescent lamp, though marginally, and such public facilities as water pumps of hospitals and water works are almost normaly operated. In face of the power demand increase in future, the Project is expected to contribute to maintain the present level of voltage drop or further to improve the situation. Fluctuation of frequency, which is at present between 49.5 Hz and 51.5 Hz, will range within 50$\pm$ 0.5 Hz.

Reliability

Reliability becomes higher through decrease of number of accidents, shortening of power failure and prompt restoration. Construction of the load dispatching center will decrease the number of system faults. Substaion trippings will also be decreased by renewal of the K2 Substation and construction of Baneswar Substation. Though it is difficult to decrease accidents in the distribution system, limiting the affected section in power failure and prompt restoration can be achieved by the separation of important load facilities such as the airport from a long distribution line to rural areas and by the isolation of fault section by the installation of sectionalizing switches and VHF radio communication equipment.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

Installation of the load dispatching center and reinforcement of the distribution network are indispensible to maintain and upgrade the quantity, quality and reliability of power supply to the Kathmandu Valley as explained in Chapter 6. The Project aims at solving the problems of the present power supply system and also meeting the increase of power supply capacity after the completion of the Kulekhani No.2 Power Plant scheduled in 1986/87. The Project is also significant in that it brings the facilities completed by the Japanese aid into full operative and increases their benefit.

In view of the severe economic situation and financial difficulties of Nepal, however, it is considered very difficult for HMG/N to raise capital required for the project. The GNP per capita was $170 in 1983, which was internationally quite low and its growth rate has also been stagnant. Chronic trade balance finally resulted in deficit in balance of payments in 1982/83 and foreign currency reserve is in a tight situation. Moreover, increase of revenue for NEC cannot be expected by the implementation of the Project unlike power generation projects. Under all these circumstances, it is concluded that the Project is well qualified to be implemented as a grant aid program of Japanese government.

In the implementation of the Project, due consideration is to be given to the conveyance of construction equipment and materials and transportation plan. Materials and equipment needed for the Project will be unloaded at Calcutta and carried to Nepal on land. Therfore, long anchorage at Calcutta and security aspects in land transportation are needed to be well considered. It will also be important to take into account of the climatic conditions (dry season and rainy season) and utmost utilization of local workers.

TABLES

Table 2.1 Prospective Hydro Sites in Nepal

Project	Basin	River	Installed Capacity (MW)	Annual Energy (GWh)
Chisapani	Karnali	Karnali	4,600	15,225
Lakhapata (KR-3)	Karnali	Karnali to Bheri	2,341	11,339
Lakhapata (KR-3)	Karnali	Karnali to Bheri	832	4,904
Surkhet (Bheri)	Karnali	Karnali to Bheri	1,200	4,435
Seti	Karnali	Seti	270	1,250
Karnali Bend (KR-1)	Karnali	Karnali	483	2,899
Karnali Bend (KR-1)	Karnali	Karnali	1,600	8,433
Pancheswar	Mahakali	Mahakali (Sarda)	1,691	5,500
Kali Gandaki Scheme A	Gandaki	Kali Gandaki	60-90	385
Kali Gandaki I	Gandaki	Kali	1,600	6,700
Kali Gandaki II	Gandaki	Kali	300	1,240
Sapt Gandaki (Dev-Ghat)	Gandaki	Sapt Gandaki	200	1,416
Buri Gandaki	Gandaki	Buri Gandaki	320	1,353
Bagmati	Bagmati	Bagmati	295	674
Mulghat	Kosi	Tamur	68	425
Kankai	Kankai	Kankai	80	157
Sapt Kosi High Dam	Kosi	Sun Kosi	3,000	13,140
Sun Kosi High Dam	Kosi	Sun Kosi	360	832
Tamba Kosi	Kosi	Kimiti Khola	66	185
Dudh Kosi II	Kosi	Dudh Kosi	170	327
Dudh Kosi III	Kosi	Dudh Kosi	90	174
West Rapti	Rapti	Rapti	279	924
Mugling	Gandaki	Trisuli Ganga	238	510
	Total Installed Capacity:		20,173	

Source: "Nepal: Issues and Options in the Energy Sector"
Aug. 1983, UNDP/World Bank

Table 2.2 Balance of Payment of Nepal (1979/80-1982/83)

(Unit: US$ Million)

	1979/80	1980/81	1981/82	1982/83
Trade Balance	-200.2	-233.9	-266.4	-362.8
Export (F.O.B.)	97.2	133.3	115.4	67.6
Import (C.I.F.)	297.4	367.2	381.8	430.4
Services (Net)	72.8	92.3	106.3	100.2
Transfers (Net)	99.0	117.1	129.8	140.6
Official Grants	63.4	71.1	89.3	102.9
Others	35.6	46.0	40.5	37.7
Current Account Balance	-28.4	-24.5	-30.3	-122.0
Official Capital (Net)	48.1	52.3	59.7	72.7
Miscellaneous Capital (Net)	-17.4	-11.9	9.5	14.5
Change in Reserves (Net)	2.3	15.9	38.9	-34.8

Preliminary Estimate

Source: Economic Survey of Nepal, ADB, July, 1984

Table 2.3 Gross Domestic Products of Nepal (1978/79-1982/83)

(Unit: Rps. Million)

	1978/79	1979/80	1980/81	1981/82	1982/83
GDP (Current Price)	22,215	23,351	27,307	29,234	31,232
Agriculture	13,522	13,683	15,679	16,975	17,942
Others	8,693	9,668	11,628	12,259	13,290
GDP (Constant Price) (1974/75 = 100)	19,048	18,606	20,158	20,926	20,642
Agriculture	11,480	10,933	12,066	12,492	12,175
Others	7,568	7,673	8,092	8,434	8,467

Annual Growth Rate

GDP (Constant)	2.4	-2.3	8.3	3.8	-1.4
Agriculture	3.0	-4.8	10.4	3.5	-2.5
Others	1.4	1.4	5.5	4.2	0.4

Source: Economic Survey of Nepal, ADB, July 1984

Table 3.1 Number of Staffs for Distribution System Maintenance in Kathmandu Valley

	Permanent	Daily Wages
Kathmandu		
1. Deputy Chief	1	-
2. Assistant Engineers	4	-
3. Superintendent Supervisor	1	-
4. Supervisor	9	-
5. Foremen	16	-
6. Linesmen	29	1
7. Helpers & Jr. Electricians	54	13
8. Coolies	62	20
Total	176	34
Patan		
1. Assistant Engineer	1	-
2. Superintendent Supervisor	1	-
3. Supervisor	3	-
4. Foremen	6	-
5. Linesmen	7	4
6. Helpers	17	3
7. Coolies	52	26
Total	87	33
Bhaktapur		
1. Assistant Engineer	1	-
2. Supervisor	6	-
3. Linesmen	4	6
4. Helpers	14	10
5. Coolies	36	19
Total	61	35

Table 3.2 Monthly Power Output of Existing Major Hydro Power Stations

	Power Station	Kulekhani No.1 /1	Trisuli /2	Sunkosi	Gandak
	Installed Capacity (MW)	60.00	21.00	10.05	15.00
Generating Output (MW)	January	60.00	18.00	6.07	11.20
	February	60.00	18.00	5.13	6.87
	March	59.00	18.00	5.03	6.71
	April	57.20	18.00	6.04	6.47
	May	55.00	18.00	8.90	9.30
	June	55.60	18.00	10.05	12.60
	July	58.00	18.00	10.05	13.50
	August	59.80	18.00	10.05	13.50
	September	60.00	18.00	10.05	13.50
	October	60.00	18.00	10.05	13.50
	November	60.00	18.00	10.05	12.44
	December	60.00	18.00	10.05	11.72

Note: /1: Output of Kulekhani No. 1 Power Station goes down during the dry season due to decrease in the reservoir water level.

/2: Seven sets of 3 MW unit are installed but the water way is rated for six sets only, one set being standby unit.

/3: Kulekhani No. 2 Power Station and Devighat Power Station utilize the discharge of Kulekhani No. 1 Power Station and Trisuli Power Station respectively and are dependent on these power stations.

Table 3.3 Installed Capacity of Power Plant Outside Central Region (As of 1982)

Location	Type	Ownership	Installed Capacity (kW)
Eastern Region			
Ilam	Diesel	NEC	200
Bhadrapur	"	"	346
Janakpur/1	"	"	320
Dhankuta	Hydro	"	240
Biratnagar	Diesel	"	2,934
"	"	Private	2,579
"	Steam	"	1,400
	Total:		8,019
Western Region			
Pokhara	Hydro	NEC	1,000
"	Diesel	"	1,068
Tansen	"	"	224
Bhairawa	"	"	500
Taulihawa	"	"	50
Bahadurgunj	"	"	25
Krishnanagar	"	"	112
Butwal	"	"	1,280
"	Diesel	"	225
Various	"	Private	330
"	Steam	"	750
	Total:		5,564
Far Western Region			
Chorahi	Diesel	ED	50
Tulsipur	"	"	75
Surkhet	Hydro	"	345
"	Diesel	"	20
Nepalgunj	"	"	528
Dhangadhi	"	"	25
Mahendrangar	"	"	25
Various	"	Private	534
	Total:		1,602

/1: Janakpur is administratively in the Central Region but is included in the Eastern Region in this table.

Table 3.4 Features of Transmission Lines

Line	Voltage (kV)	SC/DC	Conductor (mm^2)	Length (km)
Hetauda - Bharatpur	132	SC	200 (Panther)	80
Bharatpur - Dumkibas	132	SC	200 (")	52
Dumkibas - Gandak	132	SC	200 (")	32
Bharatpur - Pokhara	132	SC	150 (Wolf)	85
Siuchatar - Kulekhani No.2	132	SC/1	250 (Bear)	36
Kulekhani No.2 - Hetauda	132	SC/1	250 (Bear)	7
Balaju - Siuchatar	66	DC	150 (Wolf)	7
Siuchatar - Kulekhani No.1	66	DC	150 (Wolf)	29
Kulekhani No.1 - Hetauda	66	DC	150 (Wolf)	16
Hetauda - Amlekgunj	66	DC	150 (Wolf)	16
Amlekgunj - Simura	66	DC	150 (Wolf)	10
Simura - Parwanipur	66	DC	150 (Wolf)	9
Parwanipur - Birganj	66	DC	150 (Wolf)	9
Trisuli - Balaju	66	DC	100 ( )	29
Devighat - New Chabel	66	DC	100 ( )	33
Siuchatar - Patan	66	SC/1	150 (Wolf)	4
Patan - Sunkosi	66	DC	120 ( )	58

/1: Double circuit tower

Table 3.5 Present Condition of PLC Communication System

Place	Voltage (kV)	Length (km)	No. of Lines	Type/1	Condi-tion/2
Balaju-Siuchartar	66	7	2	PE	G
Siuchatar-Kulekhani 1	66	29	2	IC	G
Kulekhani 1 - Hetauda	66	16	2	PE	G
Hetauda - Parawanipur	66	35	1	IC	I
Hetauda - Birganj	66	44	1	IC	I
Trisuli - Balaju	66	29	1	IC	NG
Devighat - New Chabel	66	33	1	IC	G
Sunkosi - Patan	66	58	1	PE	NG
Siuchatar - Patan	66	4	2	PE	G
Hetauda - Bharatpur	132	80	1	PP	I
Bharatpur - Gandak	132	84	1	PP	I
Bharatpur - Pokhara	132	85	1	PP	NG

Remarks: /1 PE..... Phase to earth coupling
PP..... Phase to phase coupling
IC..... Intercircuit Coupling

/2 G ..... Good
NG..... Not good, but communication is possible
I ..... Communication is impossible

Table 3.6 Historical Power Demand of Nepal

Energy in MWh
Peak Demand in MW

		1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84
1. CENTRAL REGION/1										
Sales	Total Sales	81,512	87,453	95,436	105,338	120,857	118,855	130,445	165,875	175,021
	Export to India	5,940	6,116	5,970	6,160	5,196	3,765	5,183	5,986	6,032
	Supply to W-Region	0	0	0	0	0	0	3,610	11,000	20,900
	Losses	37,397	41,838	48,726	55,240	59,354	58,698	71,993	99,749	98,134
Supply	Hydro	123,840	133,231	146,631	163,094	168,896	169,835	203,596	280,564	300,087
	Thermal	1,009	2,176	3,501	3,644	15,511	11,483	7,635	2,046	0
	Total	124,849	135,407	150,132	166,738	184,407	181,318	211,231	282,610	300,087
Maximum Demand/2		31.88	34.72	37.90	38.10	42.46	44.46	56.48	66.0	76.0
Annual Load Factor		44.70	44.50	45.20	49.90	49.10	46.60	42.70	48.7	45.1
2. WESTERN REGION										
Sales	Total Sales	6,051	8,001	9,584	10,808	12,020	12,887	13,517	18,308	22,409
	Losses	1,816	2,098	1,626	3,016	3,860	1,696	3,899	5,290	6,475
Supply	Hydro	4,794	5,479	6,561	6,609	7,113	5,281	3,670	4,256	4,338
	Thermal	654	742	882	1,351	1,054	882	740	265	0
	Import from India	2,419	3,878	3,767	5,864	7,713	8,420	9,396	8,077	7,926
	From C-Region	0	0	0	0	0	0	3,610	11,000	20,900
	Total Supply	7,867	10,099	11,210	13,824	15,880	14,583	17,416	23,598	33,164
Maximum Demand		2.30	2.82	3.07	3.47	3.96	3.43	3.50	-	-
3. EASTERN REGION										
Sales	Total Sales	17,044	20,727	21,500	27,109	23,552	25,529	32,456	36,432	37,967
	Losses	3,238	1,161	3,333	73,736	2,853	5,540	7,690	9,628	11,079
Supply	Hydro	180	309	117	369	398	491	614	687	703
	Thermal	302	378	1,795	1,902	1,374	1,625	1,698	2,115	2,440
	Import from India	19,800	21,201	22,957	28,574	24,653	28,953	37,834	43,258	45,903
	Total Supply	20,282	21,888	24,833	30,845	26,423	31,069	40,146	46,060	-
Maximum Demand		5.08	6.75	7.93	8.84	8.34	8.90	9.60	10.78	-
4. MID & FAR WESTERN REGION										
Sales	Total Sales	2,654	3,410	5,135	5,708	5,540	6,626	8,352	9,893	11,161
	Losses	514	692	1,039	996	1,552	1,612	1,673	2,982	2,998
Supply	Hydro	0	0	145	247	271	336	416	512	586
	Thermal	15	40	27	269	185	205	80	207	230
	Import from India	2,153	4,026	6,002	6,189	6,606	7,697	9,529	11,956	13,341
	Total Supply	3,168	4,102	6,174	6,704	7,062	8,238	10,025	12,675	14,159
Maximum Demand		0.99	1.29	1.73	1.93	2.14	2.70	3.30	3.40	4.4
5. TOTAL NEPAL										
Sales	Sales in Nepal	107,261	119,591	131,655	148,963	161,969	163,897	184,770	230,508	246,550
	Export to India	5,940	6,116	5,970	6,160	5,196	3,765	5,183	5,986	10,312
	Losses	42,965	45,789	54,724	62,988	66,609	67,273	85,255	117,449	118,686
Supply	Hydro	128,814	139,019	153,454	170,319	176,678	175,943	208,296	286,019	305,716
	Thermal	1,980	3,336	6,169	7,166	18,124	14,555	10,153	4,633	2,670
	Import from India	25,372	29,141	32,726	40,626	38,972	45,070	56,759	63,291	67,170
	Total Supply	156,166	171,496	192,349	218,111	233,774	235,208	275,208	353,943	375,556
Maximum Demand with Export		40.20	45.60	50.60	52.40	56.90	58.92	72.88	-	-
Annual Load Factor		44.30	43.30	43.30	47.50	46.90	45.60	42.90	-	-

/1: Janakpur Zone (Janakpur, Malangwa and Gaur) is excluded from the Central Region and included in the Eastern Region to facilitate analysis of integrated system load growth.

/2: Maximum demand includes exports and power supply to the Western Region.

Table 3.7 Power Consumption in CNPS for Each Category for 10 years

Unit: MWh

	Category	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
1.	Domestic	52,017	52,720	57,335	64,900	61,723	67,760	77,960	108,995
2.	Non-commercial	-	-	-	-	-	-	-	4,351
3.	Industrial	18,212	22,463	27,087	29,270	35,687	36,137	42,962	69,333
4.	Commercial	8,951	10,133	12,910	18,021	25,286	23,203	18,834	21,343
5.	Irrigation and Water Supply	-	-	-	-	-	-	-	7,209
6.	Bulk Supply	5,940	6,116	5,770	6,196	5,027	2,923	5,130	5,986
7.	Transport	-	-	-	-	-	-	-	1,493
8.	Street Light	893	966	1,161	1,416	3,271	3,766	2,915	3,323
9.	Temporary	-	-	-	-	-	-	-	1,793
10.	NEC Consumption	1,439	1,171	872	3,384	3,721	3,603	3,598	2,735
	Total	87,423	93,569	105,835	123,187	141,015	137,392	151,399	226,561
11.	Net Consumption not incl. Bulk Supply	81,483	87,453	100,065	116,991	136,160	134,469	146,269	200,575
12.	Losses	37,426	41,838	44,097	43,587	43,051	43,084	56,169	65,049
	Total	118,909	129,291	144,162	160,578	179,211	177,553	202,438	265,624

Table 3.8 Numbers of Consumers for Different Categories of Kathmandu Valley, 1983/84

		Kathmandu	Patan	Bhaktapur	Total
1.	Domestic	73,782	19,750	11,701	105,233
2.	Street Light	549	-	3	552
3.	Non-commercial	1,553	387	125	2,065
4.	Commercial (Hotel)	30	3	-	33
5.	Commercial (Others)	373	13	14	400
6.	Industrial	1,385	289	227	1,901
7.	Drinking Water	26	2	-	28
8.	Irrigation	6	-	-	6
9.	Transport	6	1	-	7
10.	Temporary	14	3	-	17
	Total	77,724	20,448	12,070	110,242

Table 3.9 1983 ED Load Forecasts for Integrated Nepal Load

Year	Trend without Price Elasticity/1		Trend without Price Elasticity and Export/2		Trend with Price Elasticity/1		Disaggregate/1		Load Factor
	GWh	MW	GWh	MW	GWh	MW	GWh	MW	
1982-83	284.9	67.8	284.9	67.8	284.9	67.8	281.1	66.9	0.480
1983-84	344.2	81.2	344.2	81.2	328.7	77.5	345.2	81.4	0.484
1984-85	385.5	90.6	407.5	95.7	366.3	86.1	374.1	87.9	0.486
1985-86	431.6	101.0	453.6	106.1	408.0	95.4	421.8	98.7	0.488
1986-87	569.6	132.2	613.6	142.4	535.5	124.2	546.7	126.8	0.492
1987-88	659.9	152.5	725.9	167.7	617.0	142.6	617.6	142.7	0.494
1988-89	742.9	170.5	830.4	190.7	690.6	158.6	675.1	155.1	0.497
1989-90	840.6	192.3	928.6	212.4	777.7	177.9	721.8	165.1	0.499
1990-91	961.5	218.7	1,049.5	238.7	884.9	201.2	793.5	180.4	0.502
1991-92	1,079.8	244.6	1,167.8	264.5	988.4	223.9	872.1	197.5	0.504
1992-93	1,211.4	273.3	1,299.4	293.1	1,102.9	248.8			0.506
1993-94	1,357.6	304.5	1,445.6	324.2	1,229.4	275.7			0.509
1994-95	1,520.0	339.6	1,608.0	359.2	1,376.2	307.4			0.511
1995-96	1,700.0	377.6	1,788.0	397.1	1,538.9	341.8			0.514
1996-97	1,899.4	420.2	1,987.4	439.7	1,719.2	380.3			0.516
1997-98	2,120.4	467.2	2,208.1	486.6	1,918.7	422.8			0.518
1998-99	2,364.0	518.0	2,452.0	537.2	2,139.1	468.7			0.521
1999-00	2,633.2	574.8	2,721.2	594.0	2,382.6	520.0			0.523
2000-01	2,930.2	635.9	3,018.2	655.0	2,651.0	575.3			0.526
2001-02	3,257.5	704.3	3,345.5	723.3	2,946.9	637.1			0.528

Note: /1 Only definitely committed export is taken into account.
/2 Potential exports are taken into account.

Table 3.10 Statistics of System Faults

	1980/81	1981/82	1982/83
System Tripping/1			
1 min. to 10 minutes	8	5	8
10 minutes to 1 hour	17	1	1
Substation Tripping			
1 min. to 10 minutes	89	43	80
10 minutes to 1 hour	4	2	22
Feeder Tripping/2			
1 min. to 10 minutes	2,397	2,929	2,438
10 minutes to 1 hour	76	110	192
More than 1 hour	213	176	146

/1: System tripping means breakdown of the Kathmandu power system.

/2: There have been a lot of feeder trippings for K2 and Teku Substations.

Source: Generation and System Control Division

Table 3.11 Current Power Tariffs
(Effective from 15 April 1983)

Category	Unit Rate
1. Domestic:-	**Unit Rate**
(a) 1 - 25 Units	-/44 Paisa
(b) 26 - 100 Units	-/66 Paisa
(c) 101 - 300 Units	-/80 Paisa
(d) Above 300 Units	-/90 Paisa
Minimum Charge	**Minimum Allowance**
(a) 2.5 amps to 15 amps, Meter - Rs. 11.00 per month	25 units
(b) 16 amps to 30 amps, Meter - Rs. 27.50 per month	50 units
(c) 31 amps to 60 amps, Meter - Rs. 60.50 per month	100 units
(d) 61 amps to 100 amps, Meter - Rs. 100.50 per month	150 units
(e) Above 100 amps, Meter - Rs. 220.50 per month	300 units
2. Commercial:-	**Unit Rate**
(a) Hotels Rs. 50.00 per kW maximum demand per month	70 Paisa
(b) Others Rs. 40.00 per kW installed capacity per month	65 Paisa
3. Non-Commercial Service:- Rs. 41.00 per month (Minimum allowance 50 units)	85 Paisa
4. Industrial:- (For Bagmati, Narayani, Gandaki & Lumbini Zones Only)	
Demand Charge	**Unit Rate**
(a) Small (upto 50 kW) Rs. 18.00 per kW (Installed capacity per month)	56 Paisa
(b) Medium (Upto 500 kW) Rs. 45.00 per kW (Maximum demand per month)	52 Paisa
(c) Large (about 500 kW) Rs. 50.00 per kW (Maximum demand per month)	50 Paisa

For Other Areas

(a)	Small (upto 50 kW) Rs. 18/- Per kW (Installed capacity per month)		-/56 Paisa
(b)	Medium (upto 500 kW) Rs. 40/- Per kW (Maximum demand per month)		-/52 Paisa
(c)	Large (above 500 kW) Rs. 50/- Per kW (Maximum demand per month)		-/50 Paisa
5.	Street Lighting:-		
(a)	Metered	Per unit	-/82 Paisa
(b)	Unmetered	Per watt per month	-/33 Paisa
6.	Drinking Water:-	Rs. 40/- Per kW (Maximum demand per month)	-/45 Paisa
7.	Transport:-	Rs. 40/- Per kW (Maximum demand per month)	-/40 Paisa
8.	Irrigation:-		
(a)	400 Volt	Rs. 35/- per kW (Maximum demand per month)	-/42 Paisa
(b)	11 kV	Rs. 35/- per kW (Maximum demand per month)	-/35 Paisa
9.	Temporary Supply:-		
(a)	Metered	Per unit	Rs. 1.60
(b)	Unmetered	Per watt per month	-/72 Paisa

Table 3.12 Total Income & Expenditure Breakdown of NEC (1982/83)

(in Million Rupees)

		Amount	% of Total Income
A.	Total Income Category-wise		
1.	Domestic	56.238	43.36
2.	Industrial	35.438	27.31
3.	Transport	0.701	0.54
4.	Commercial	19.068	14.70
5.	Irrigation & Water Supply	4.837	3.77
6.	Street Lighting	1.631	1.26
7.	Bulk Supply	1.215	0.94
8.	Temporary	2.032	1.59
9.	Miscellaneous	8.502	6.55
	Total	129.690	100.00
	Less Rebate	0.140	
	Net Income	129.550	
B.	Total Expenditure Category-wise		
1.	Salary, Allowance and Wages	25.155	
2.	Overtime	2.932	
3.	Fuel (Diesel)	7.805	
4.	Depreciation	27.052	
5.	Power Purchase	29.069	
6.	Other Materials	36.729	
	Total	128.742	

Note: The average conversion rate during the period is as follows:
US$ 1.00 = NRs. 15.21

FIGURES

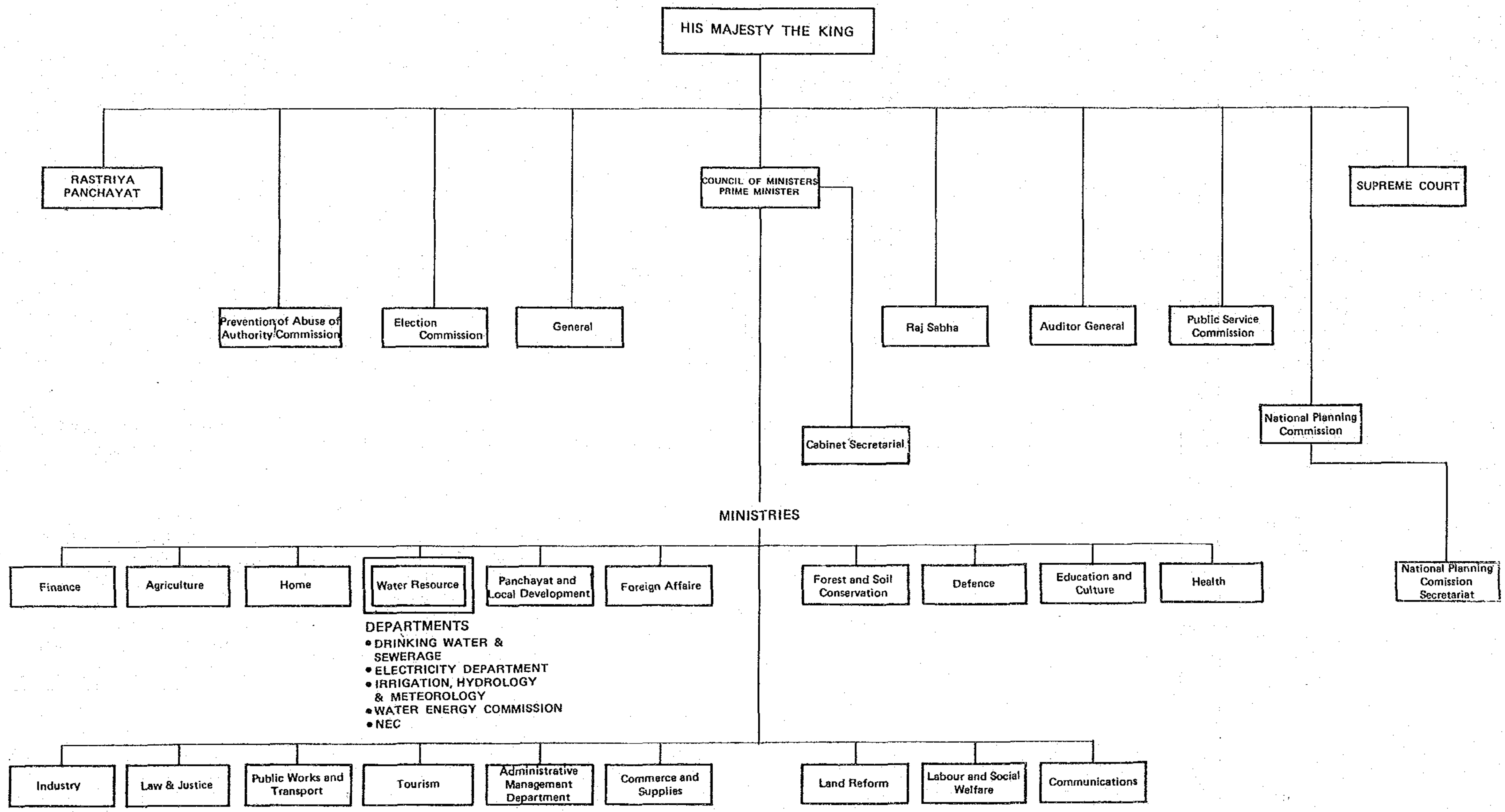


Fig. 3.1

Central Organization of Nepal

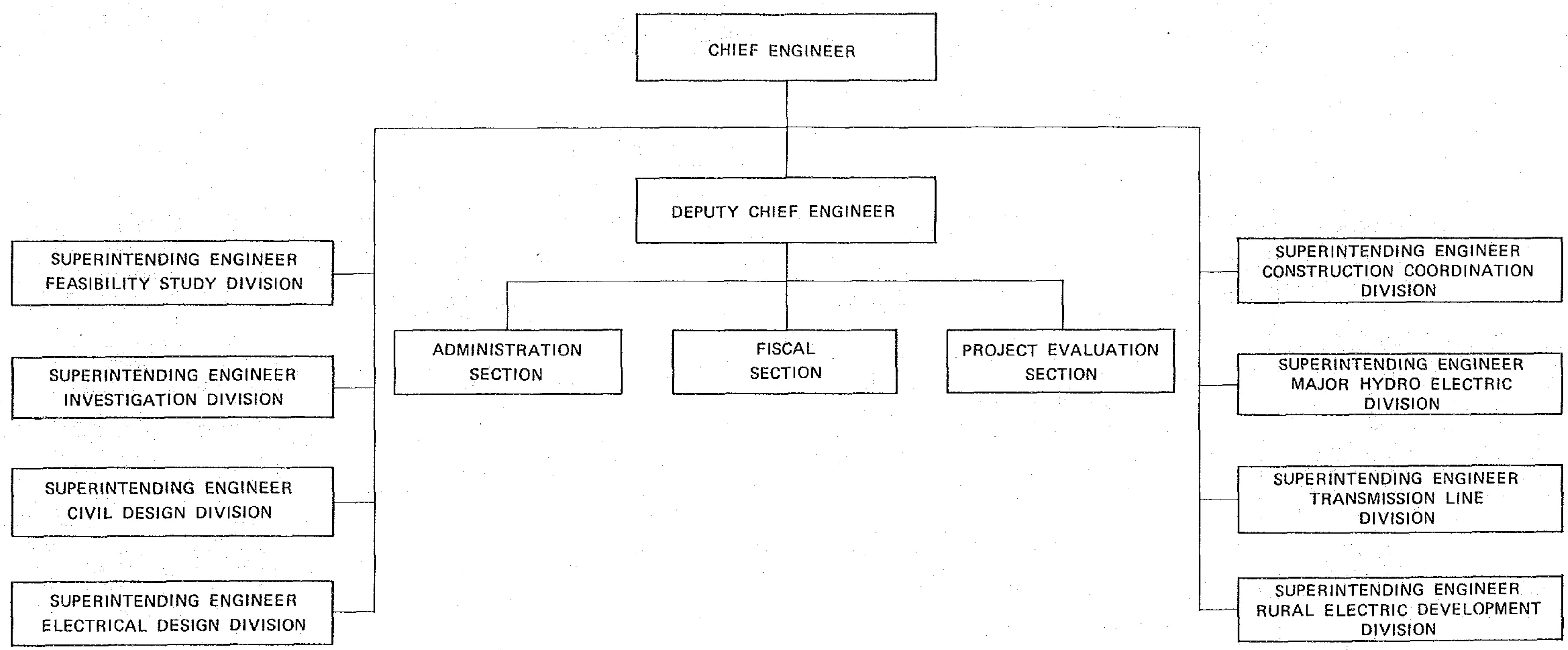


Fig. 3.2 Organization of Nepal Electricity Department

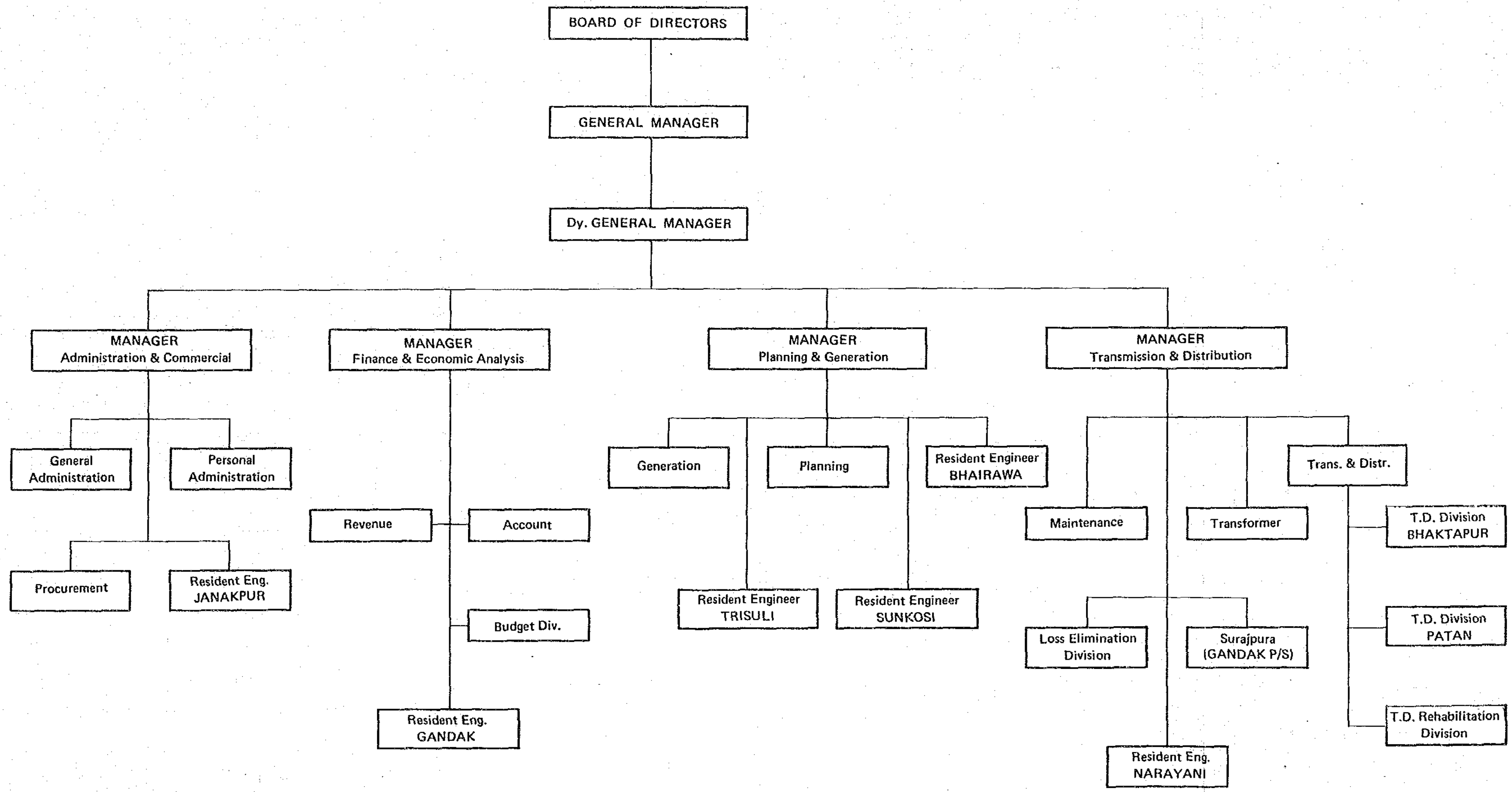


Fig. 3.3 Organization of Nepal Electricity Corporation

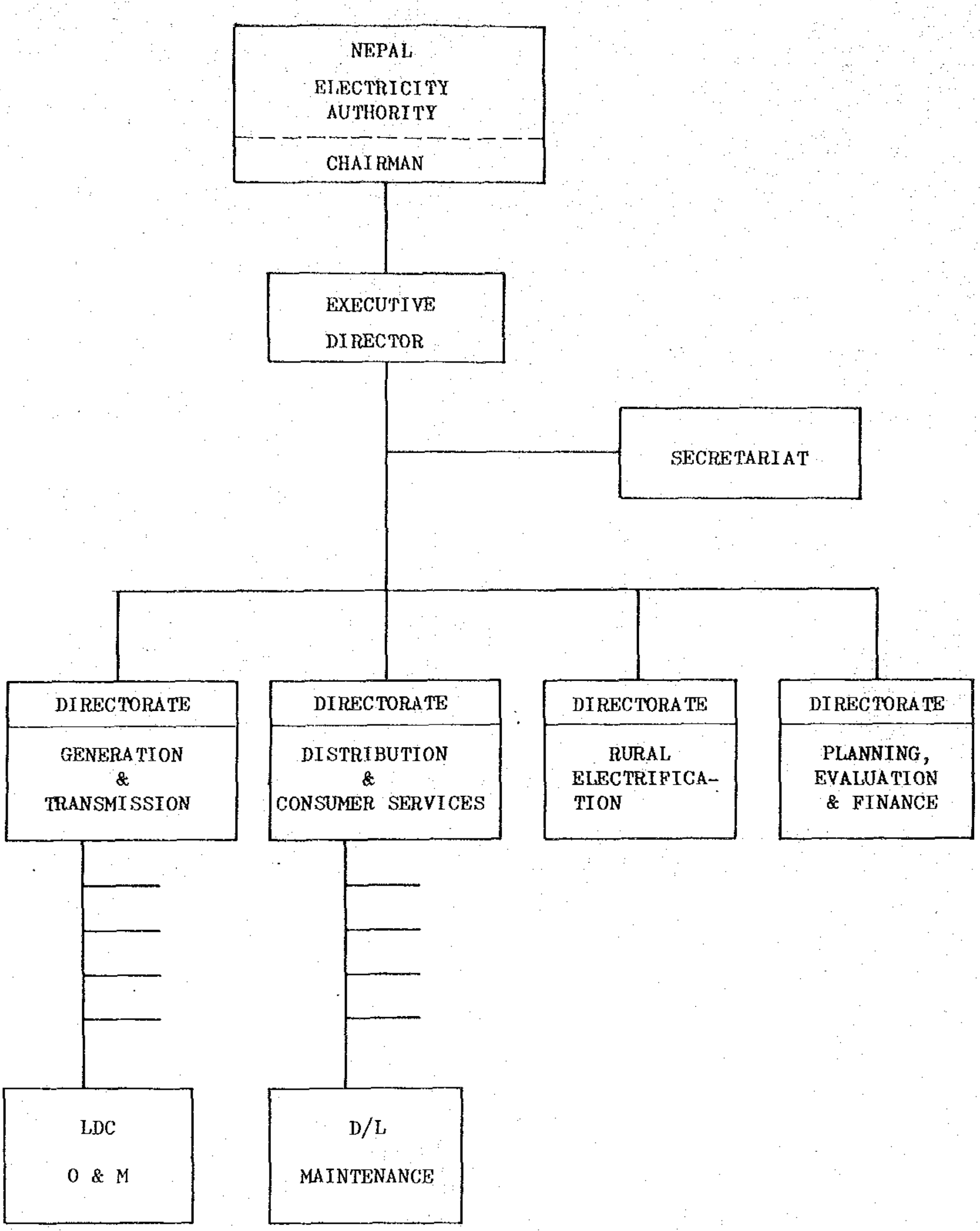


Fig. 3.4 Organization of Nepal Electricity Authority

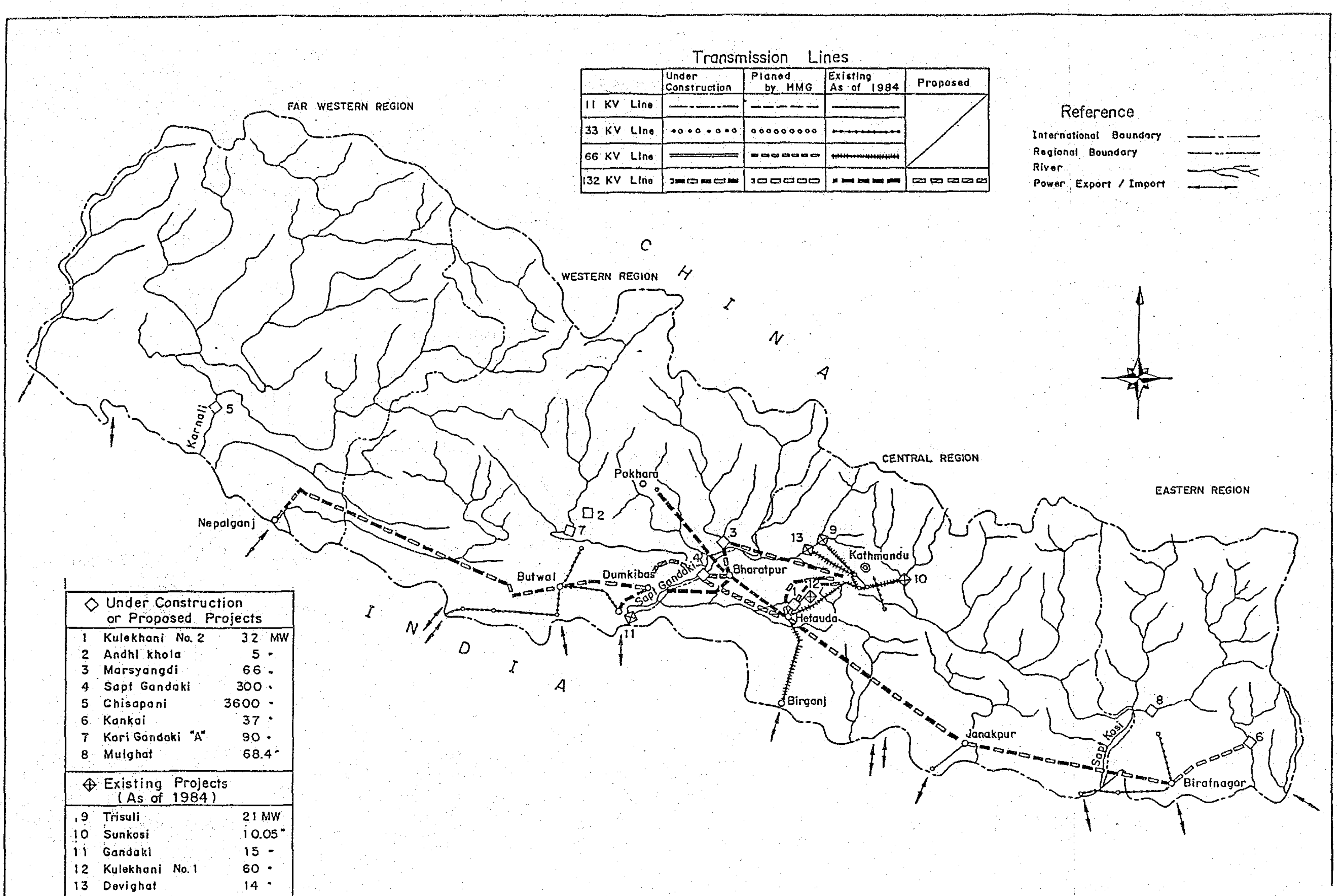


Fig. 3.5 Transmission Line System in Nepal

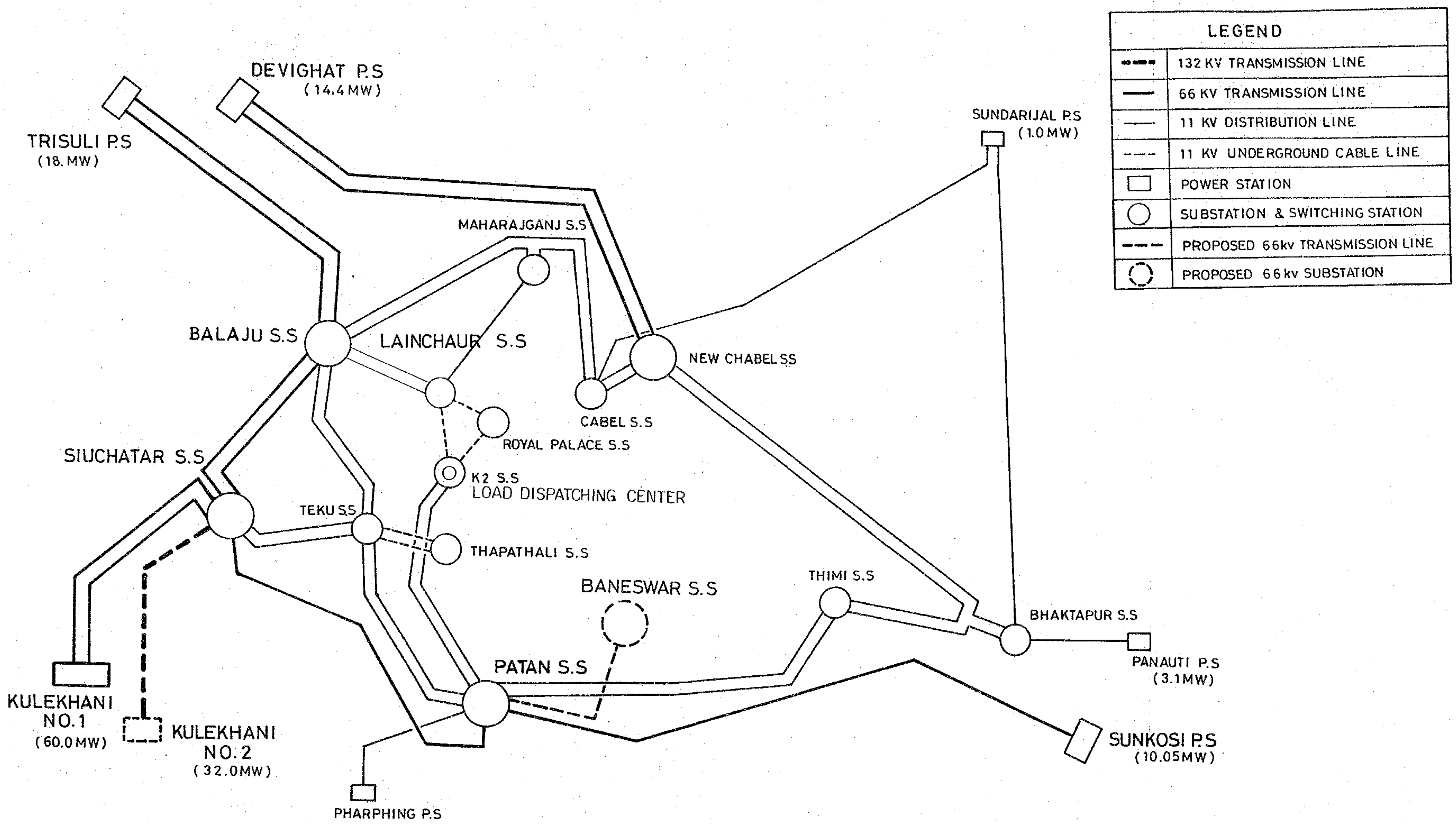


Fig. 3.6 Transmission and Main Ring Line in Kathmandu Valley

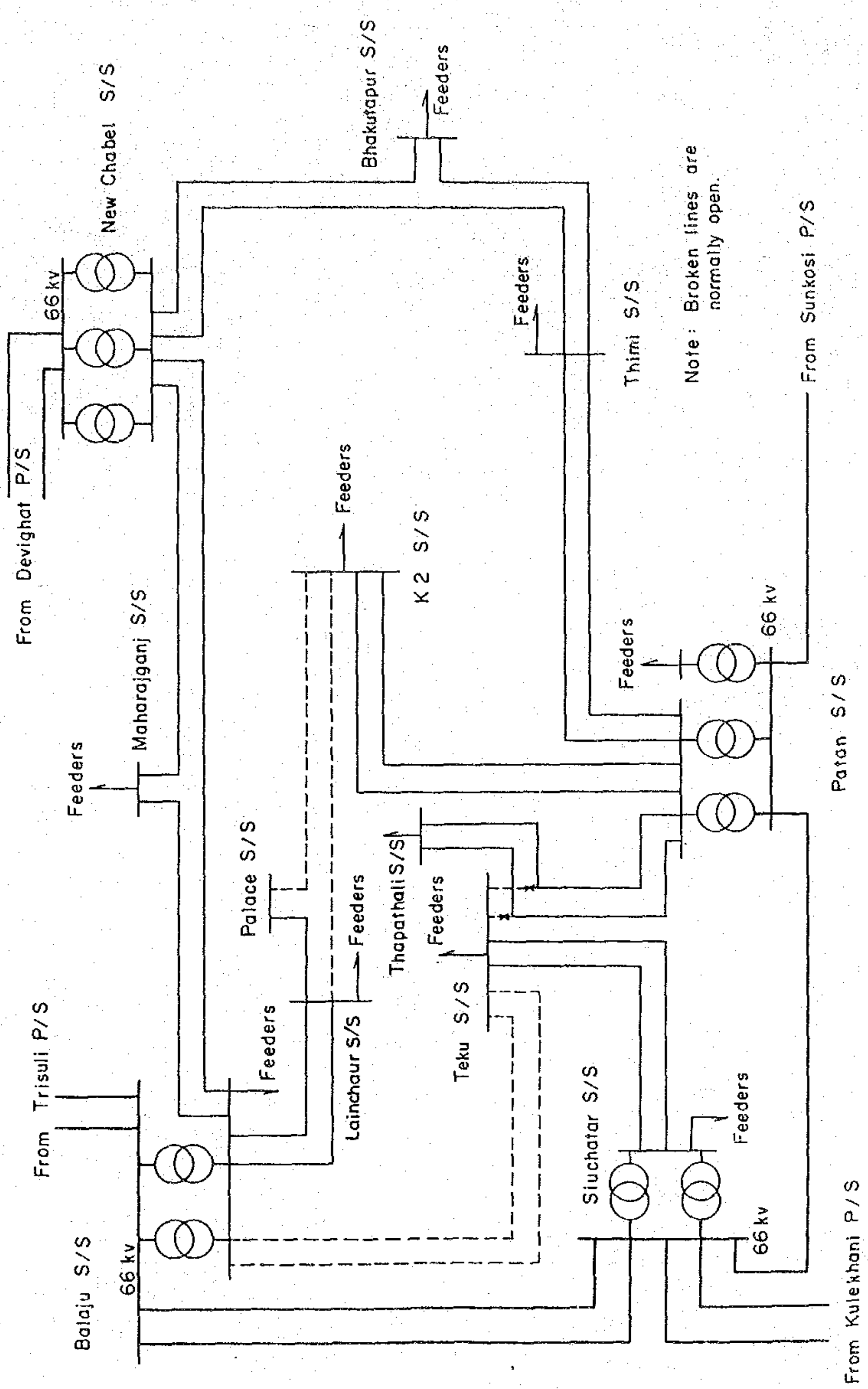


Fig. 3.7

Interconnection of 11 kV Trunk Lines under Normal Operation

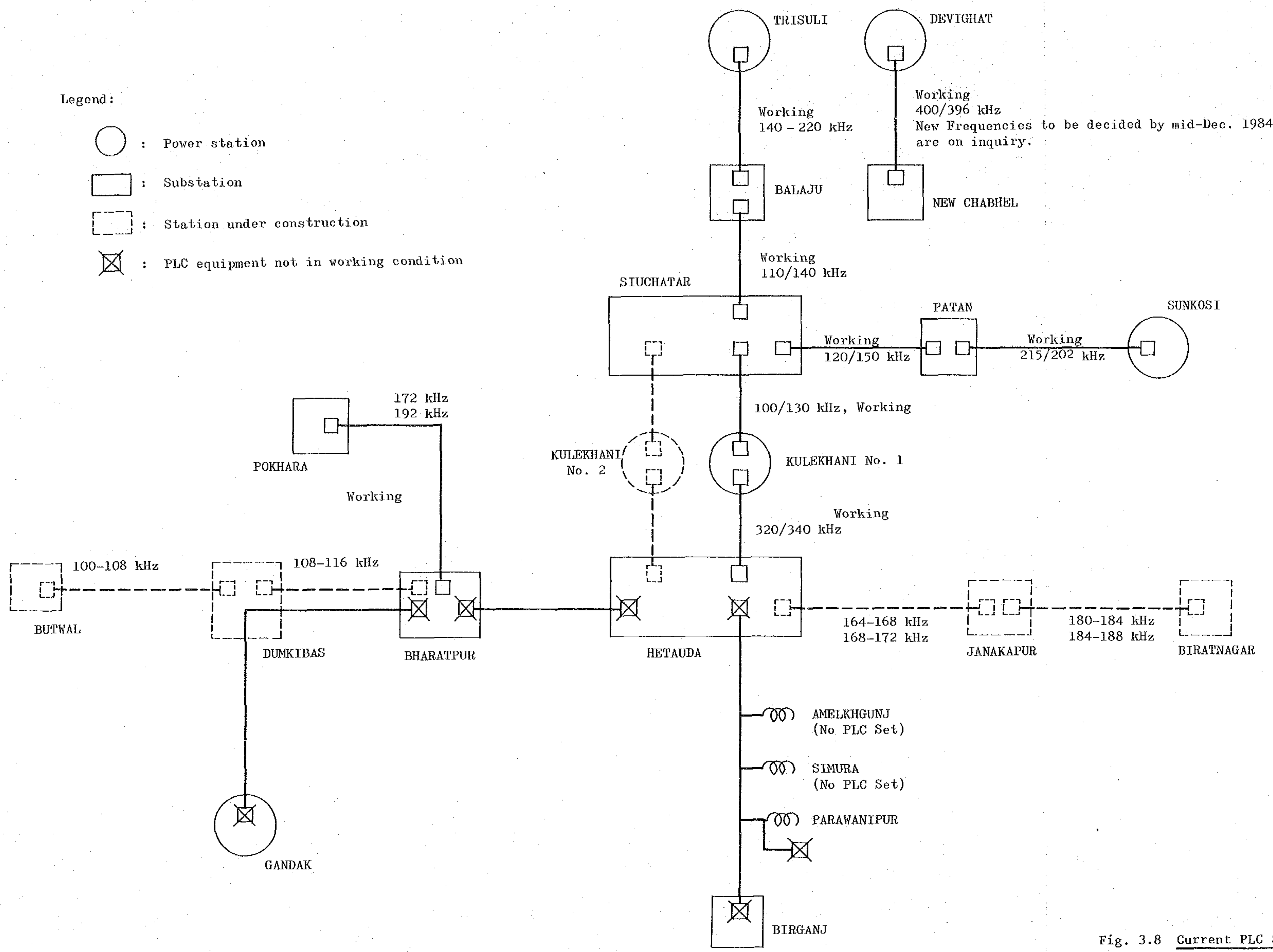


Fig. 3.8 Current PLC System

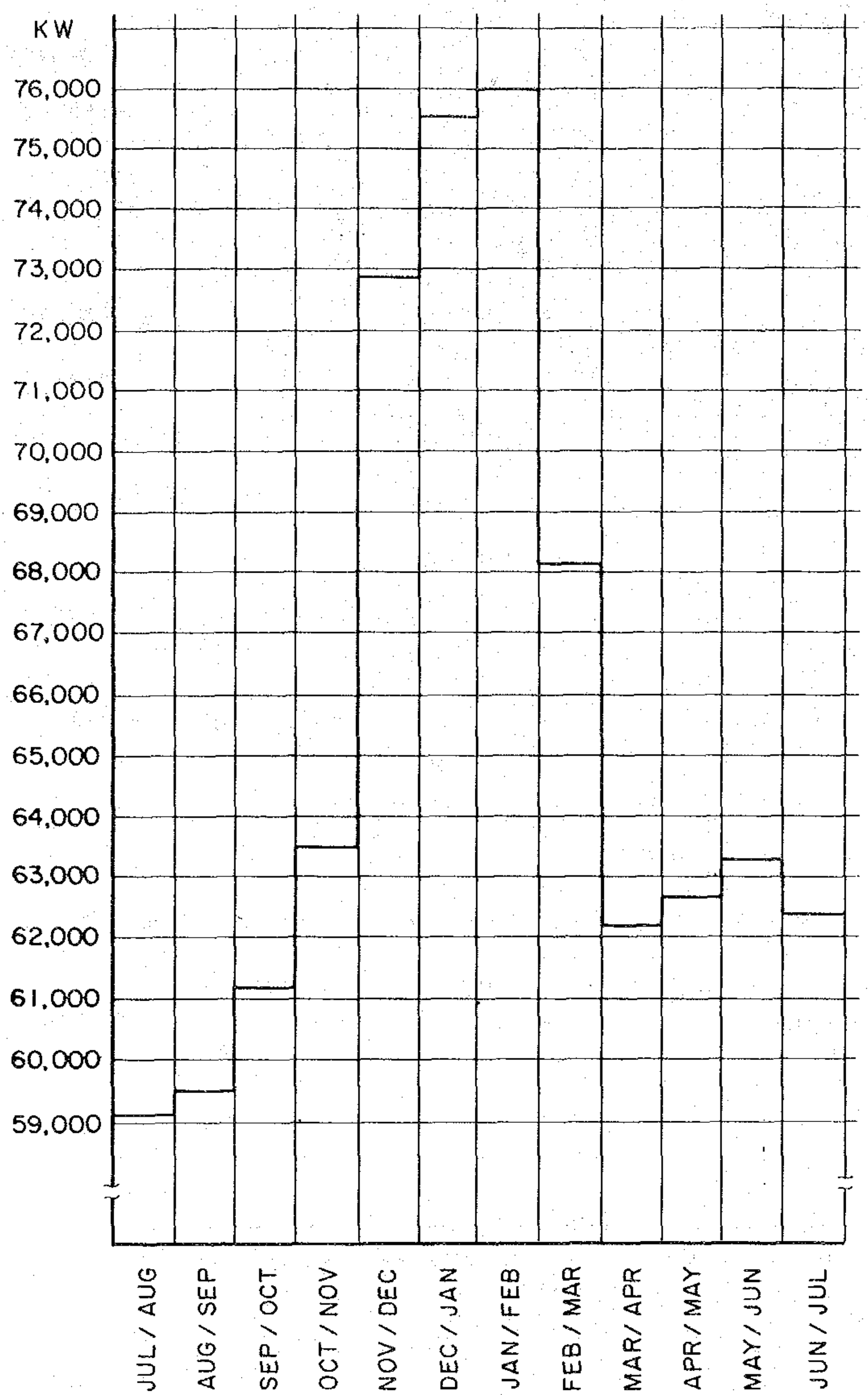


Fig. 3.9 Monthly Peak Demand, 1983/84 (CNPS)

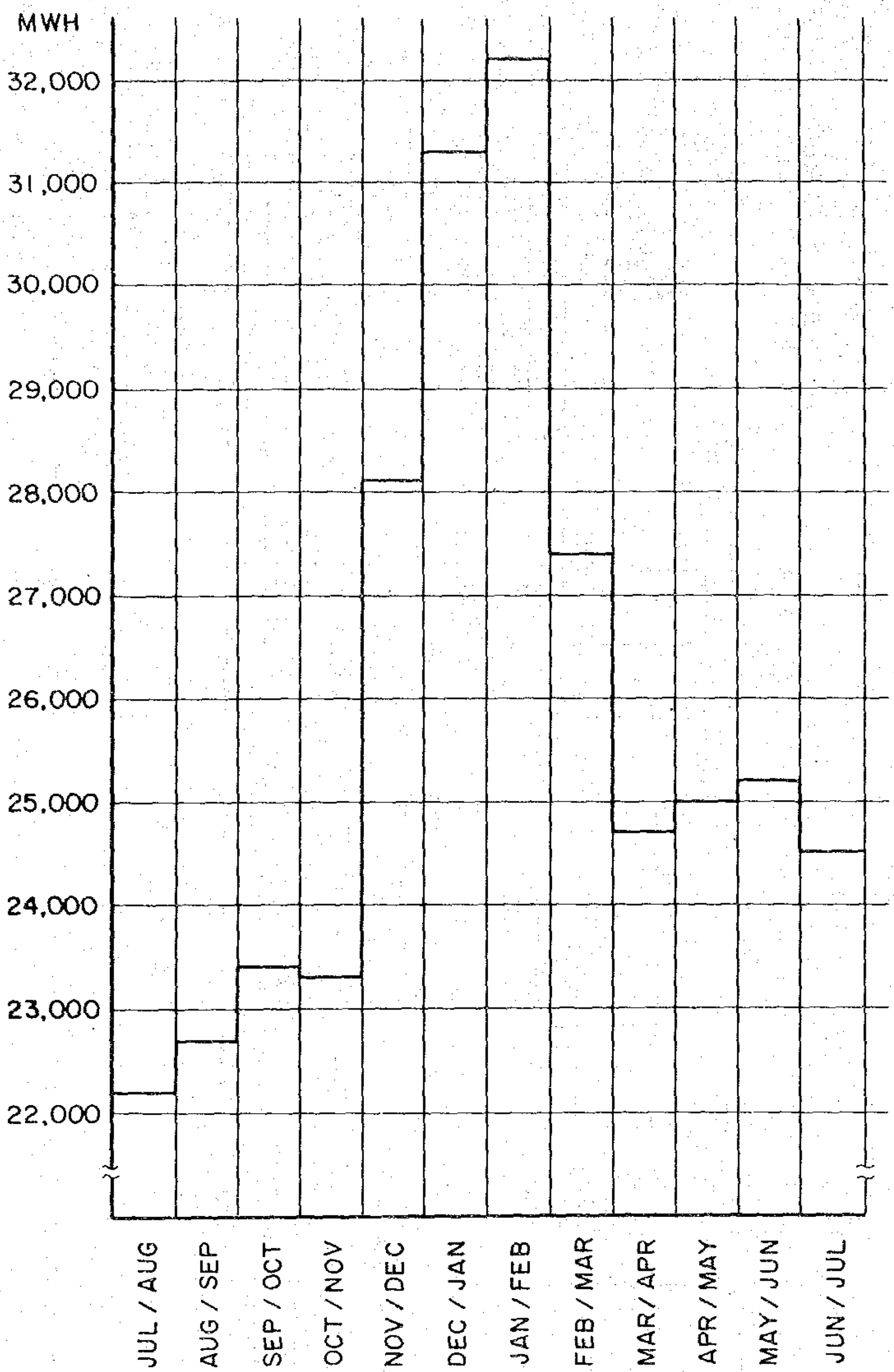


Fig. 3.10 Monthly Energy Production, 1983/84 (CNPS)

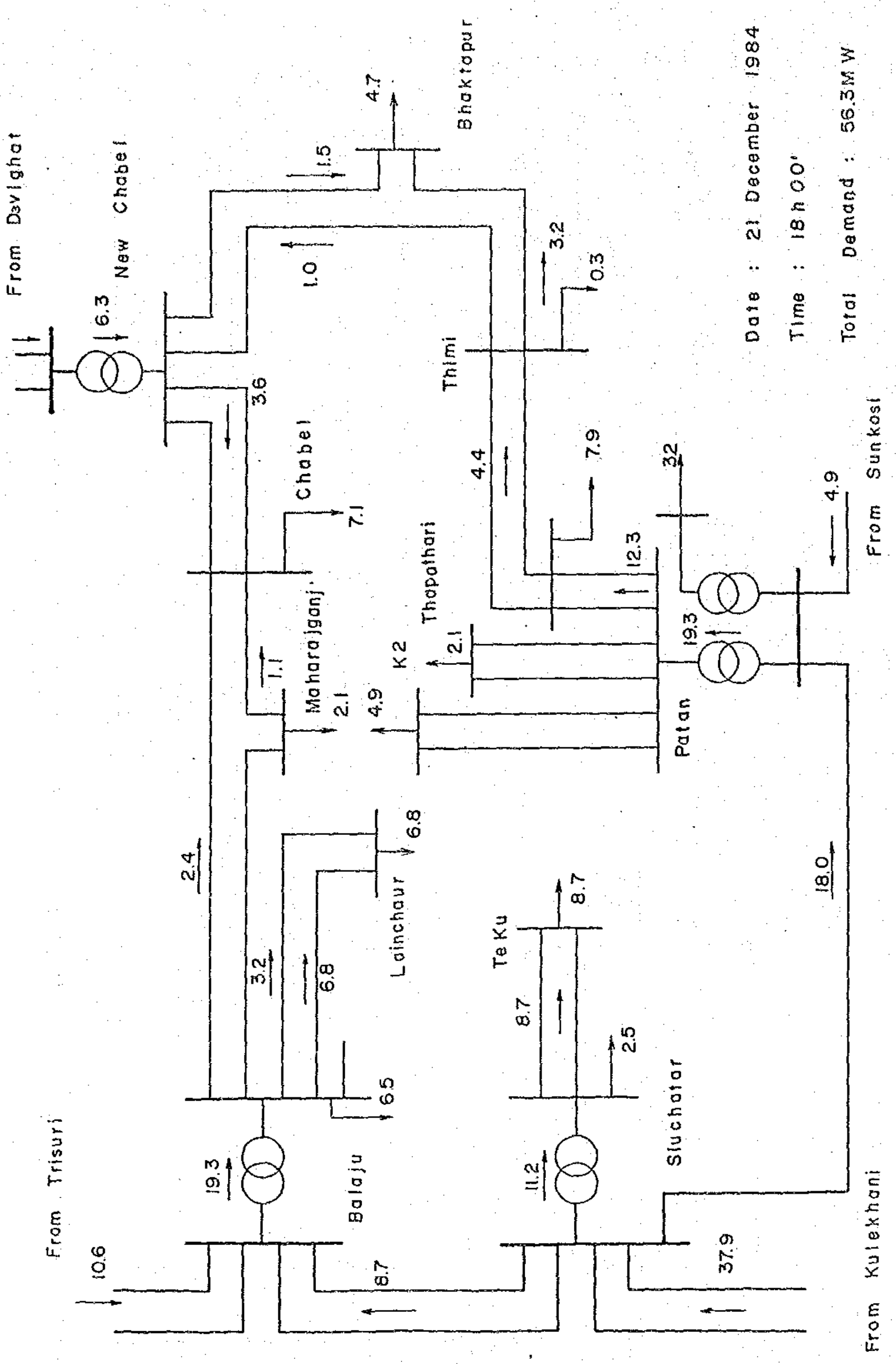
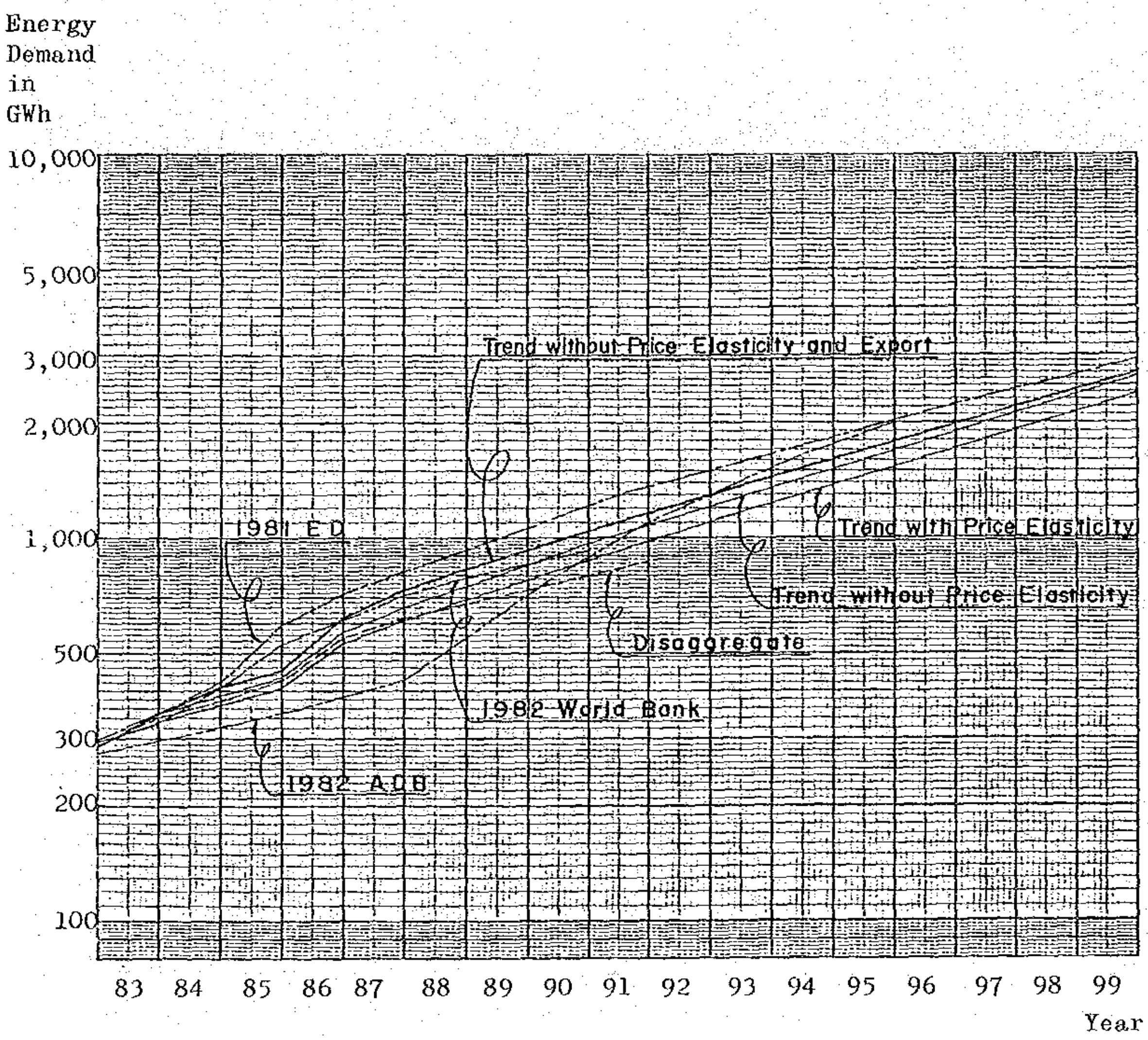


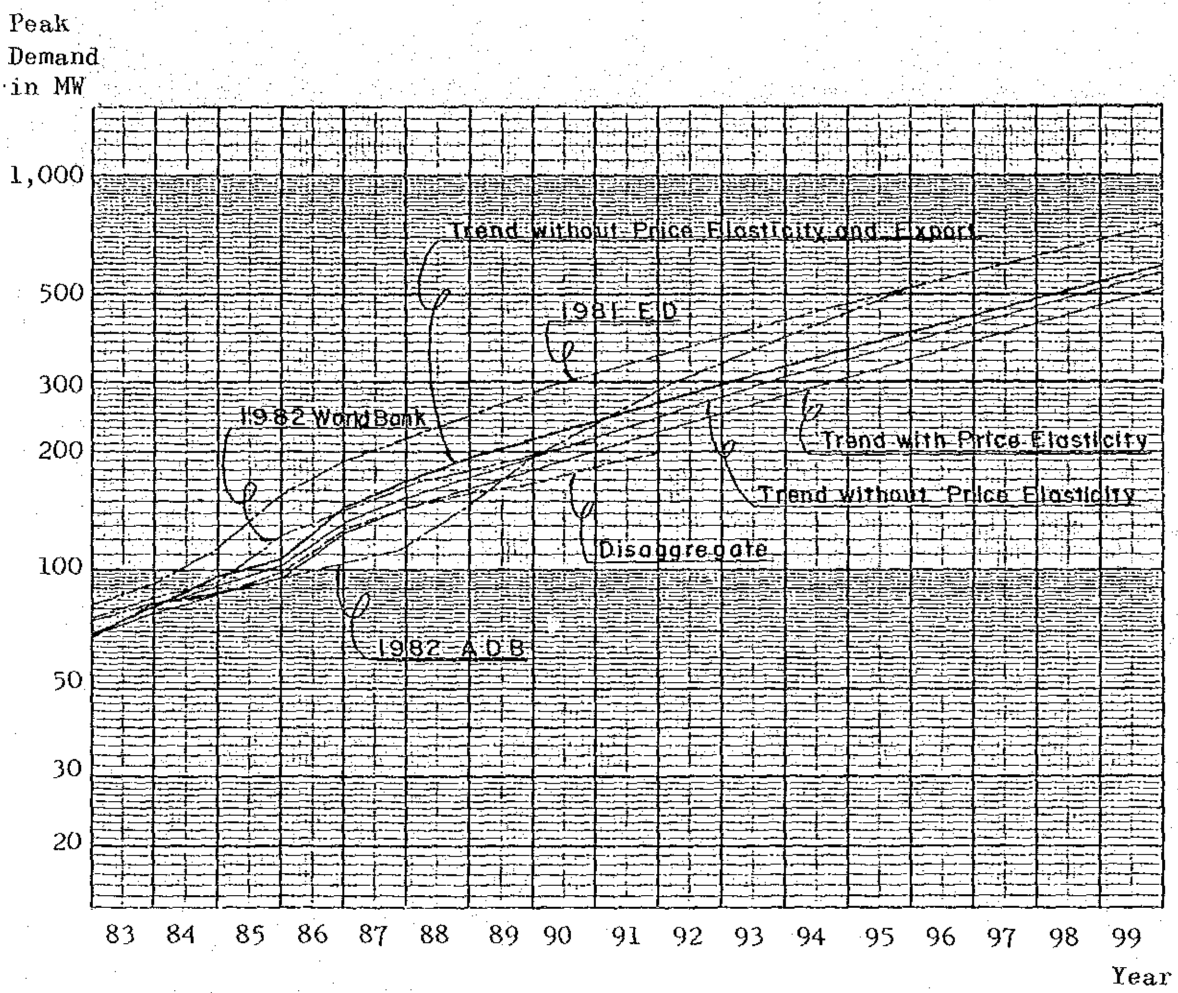
Fig. 3.11 Typical Power Flow

Fig. 3.12 Daily Load Curve



Source: 1983 Load Forecast by ED

Fig. 3.13 Comparison of Various Energy Demand Forecasts



Source: 1983 Load Forecast by ED

Fig. 3.14 Comparison of Various Energy Demand Forecasts

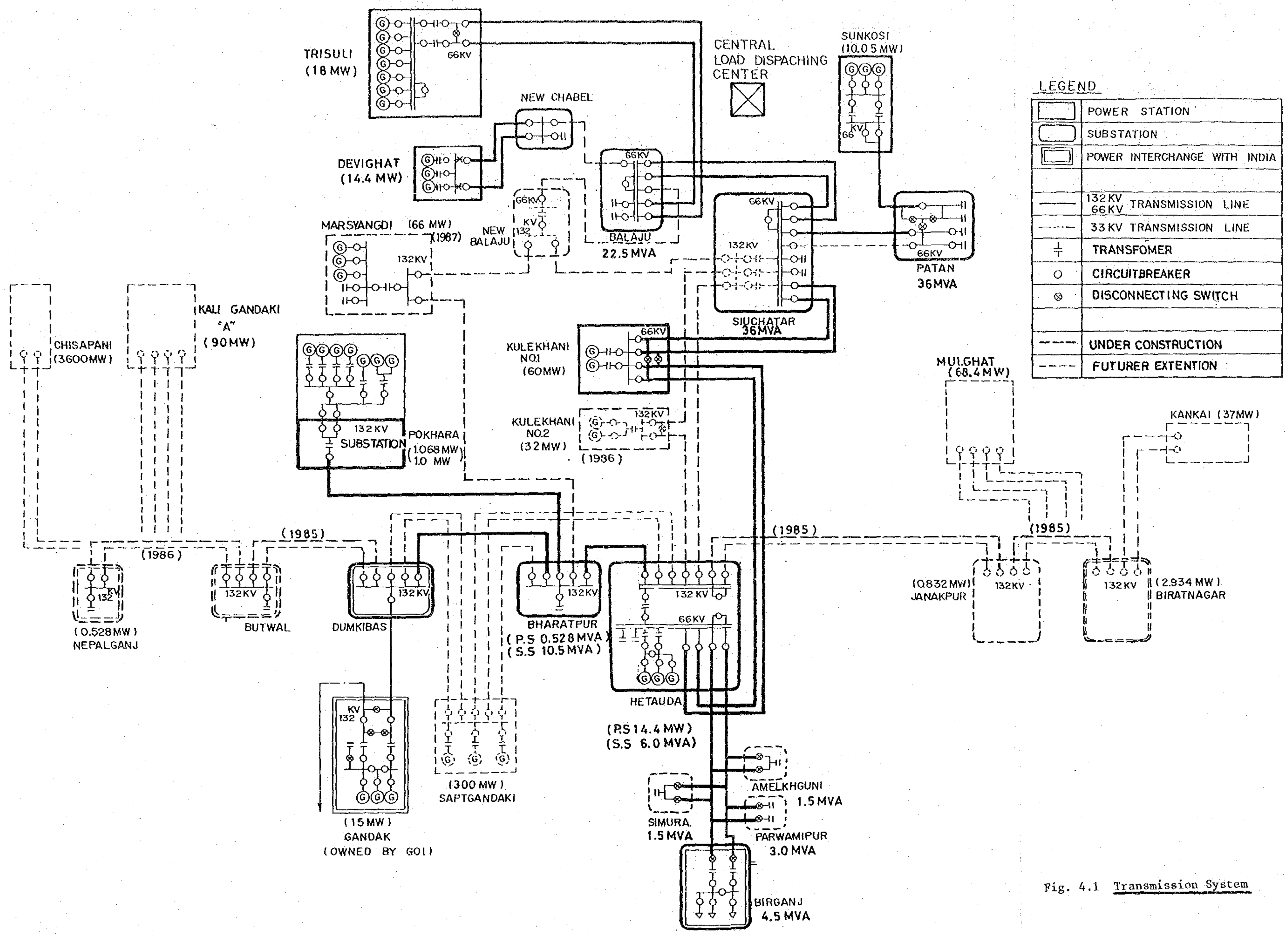
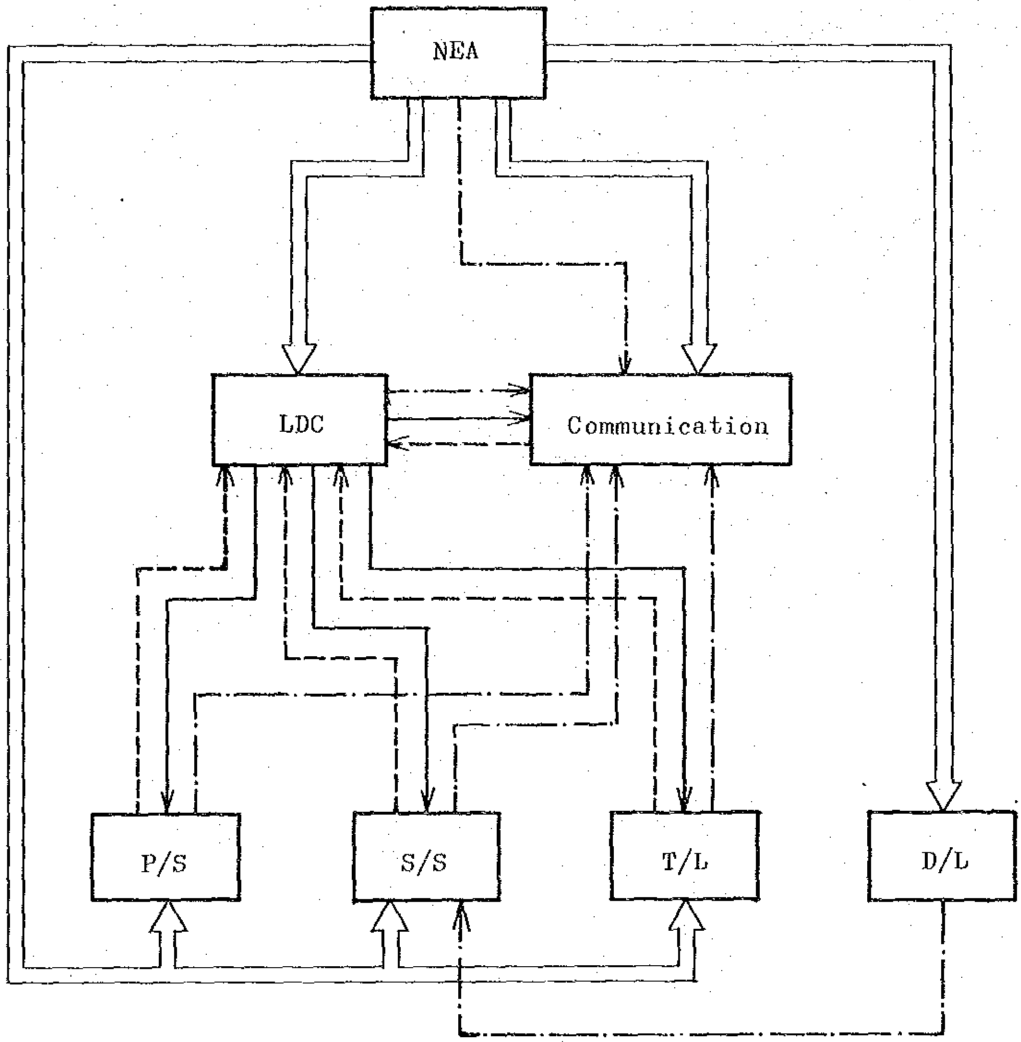


Fig. 4.1 Transmission System



Activities ⇨ Management

→ Load Dispatching Directives

-·→ Requests (Maintenance & Operation)

--→ Reporting, Requests for Scheduled Maintenance

Fig. 4.2 Flow of Activities of Load Dispatching Center

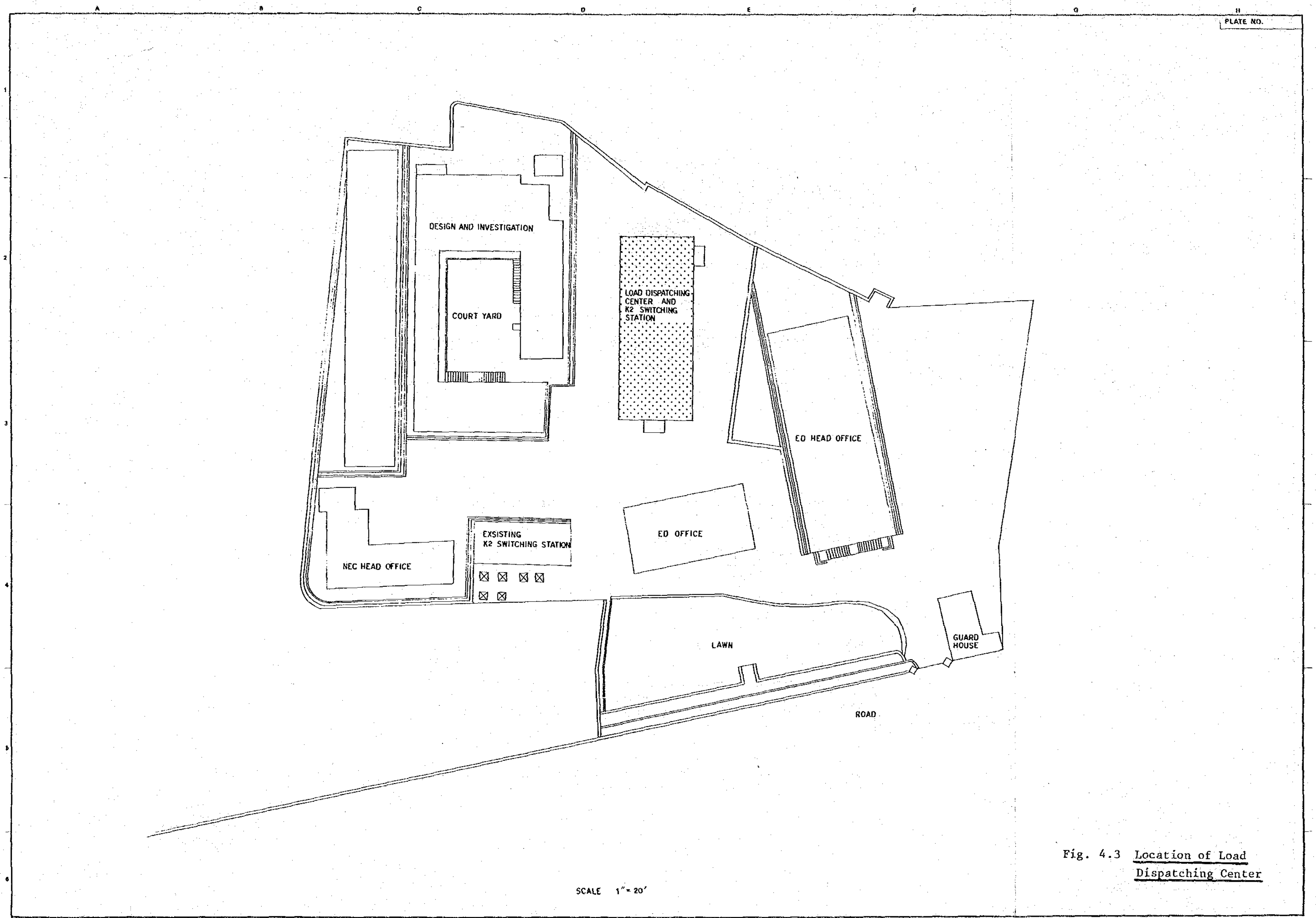


Fig. 4.3 Location of Load Dispatching Center

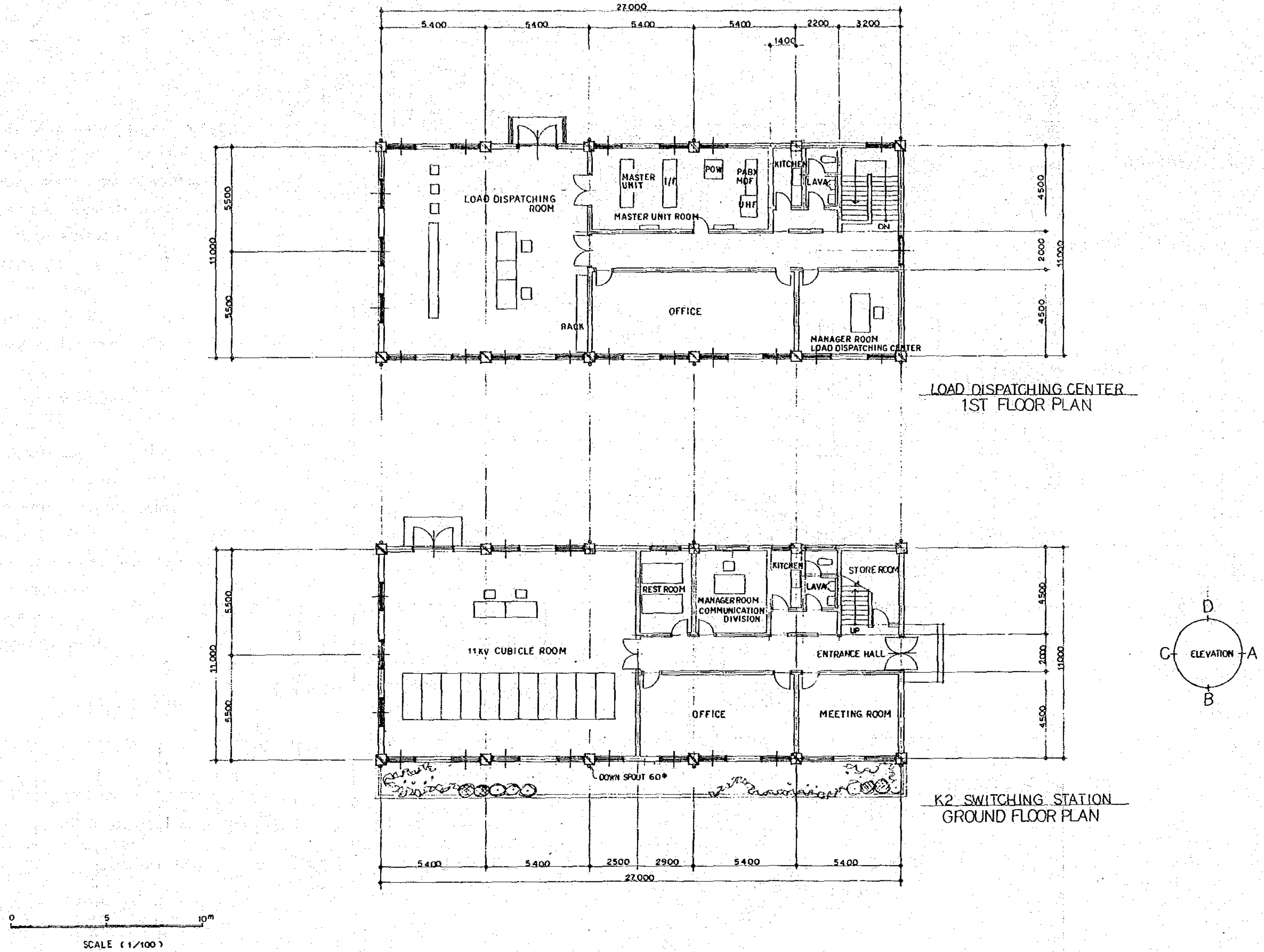


Fig. 4.4 Floor Plan of Load Dispatching Center

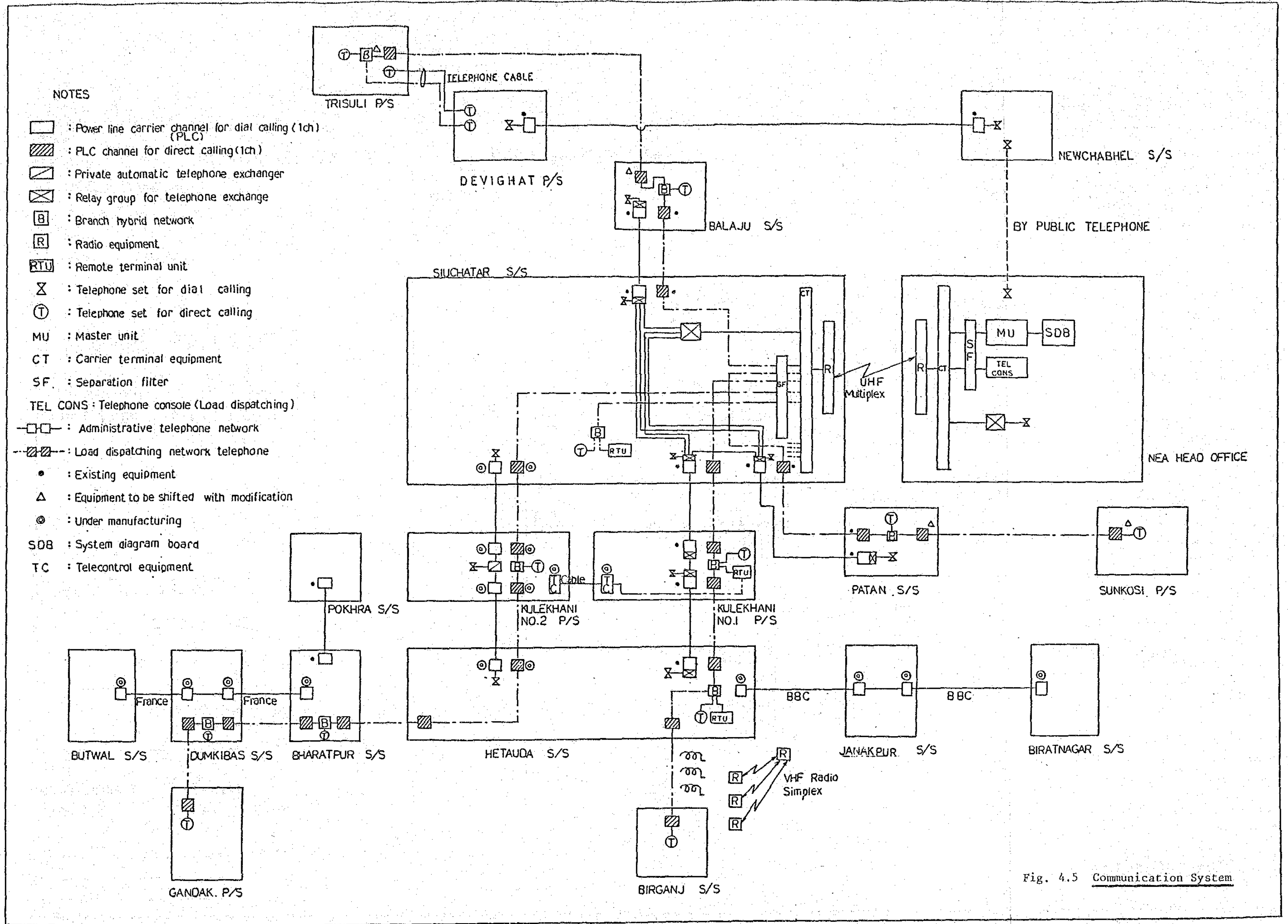


Fig. 4.5 Communication System

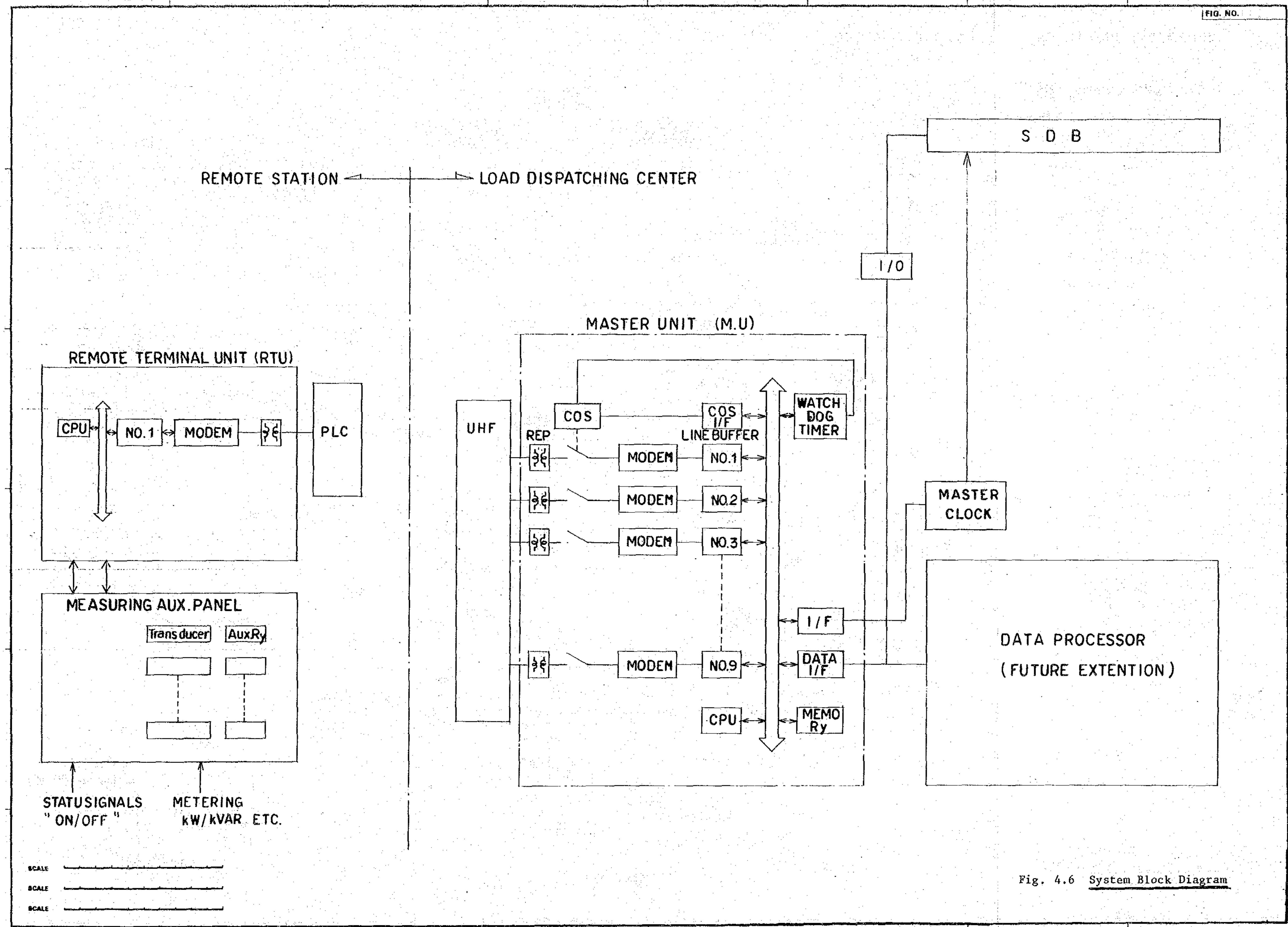


Fig. 4.6 System Block Diagram

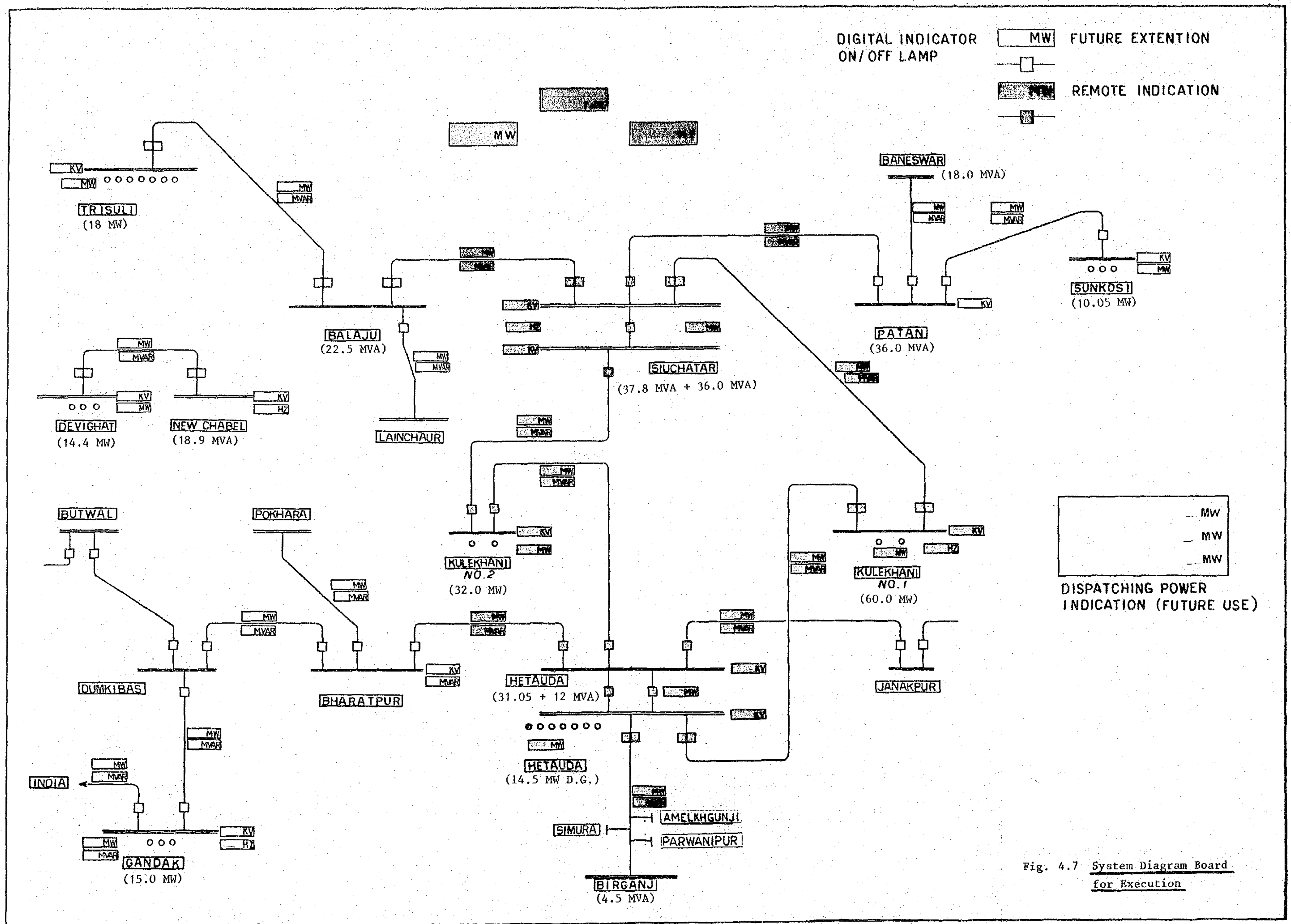


Fig. 4.7 System Diagram Board for Execution

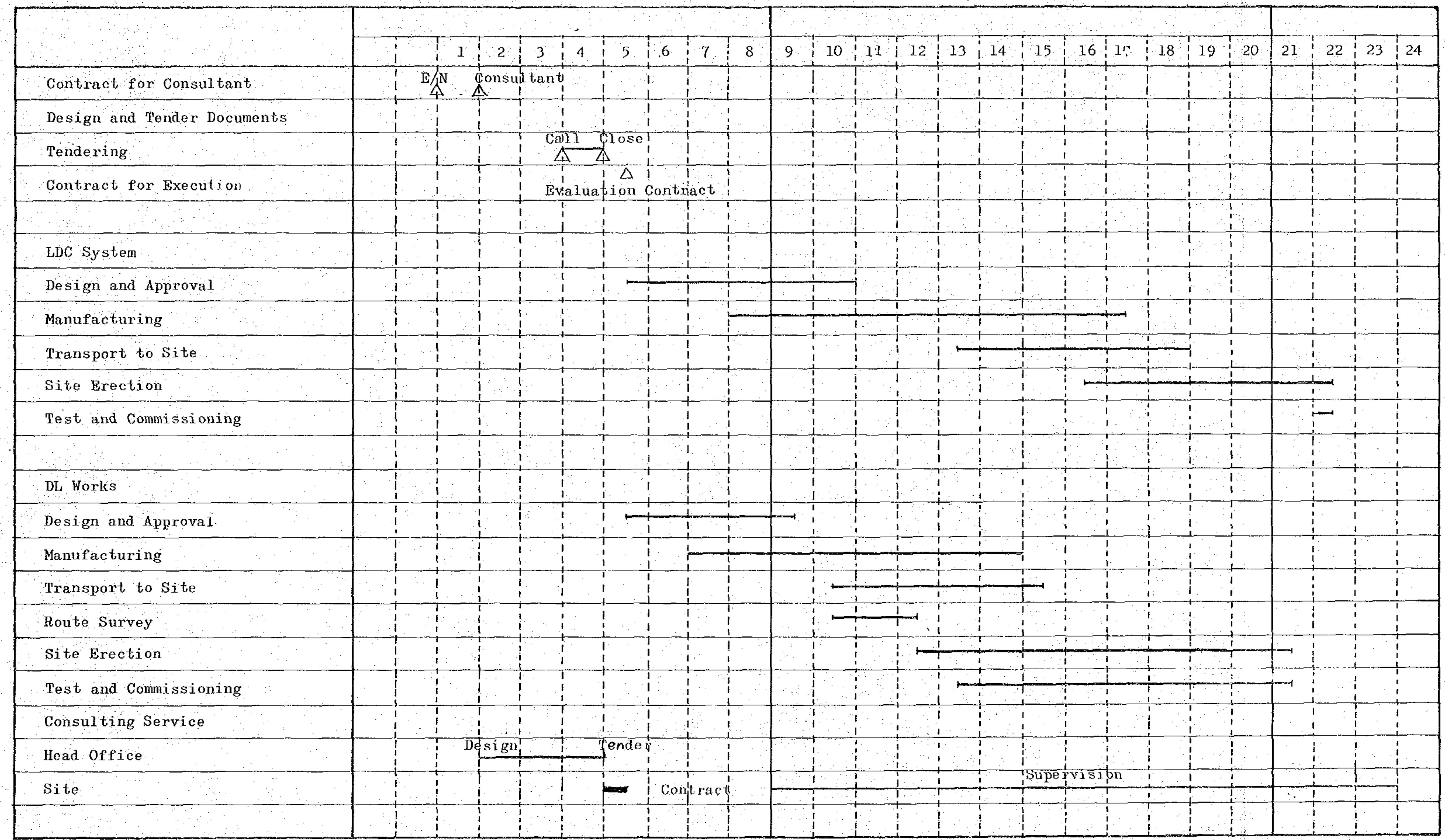


Fig. 4.8

Implementation Schedule for Establishment of Load Dispatching Center and Reinforcement of Distribution Network in Kathmandu Valley

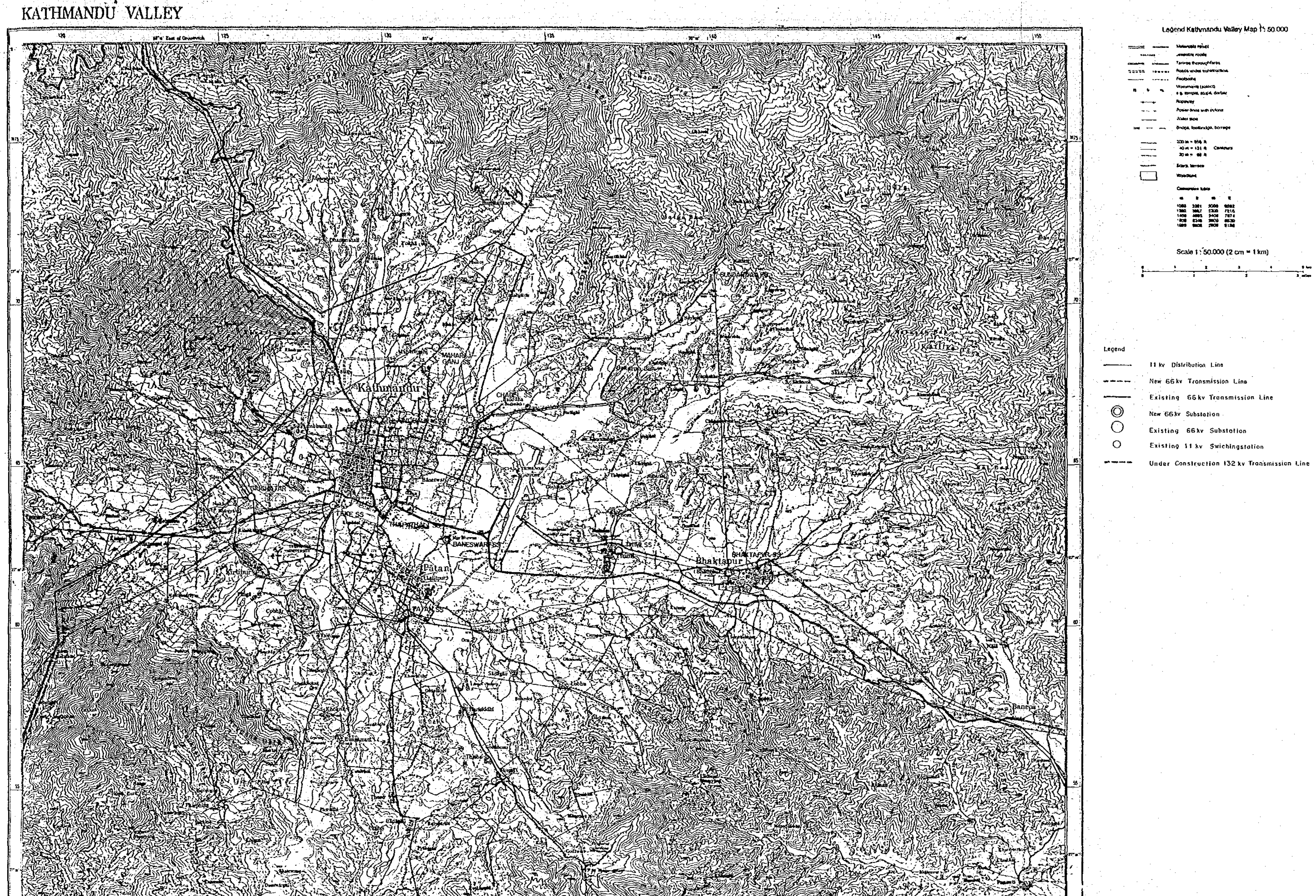


Fig. 5.1

Location Map of Kathmandu Valley

LEGEND	
BCT	BUSHING CURRENT TRANSFORMER
CB	CIRCUIT BREAKER
CCT	COMPENSATING CURRENT TRANSFORMER
CH	CABLE HEAD
CT	CURRENT TRANSFORMER
DS	DISCONNECTING SWITCH
LA	LIGHTNING ARRESTER
MCB	MOLDED CASE CIRCUIT BREKER
M.TR	MAIN TRANSFORMER
PT	POTENTIAL TRANSFORMER
PD	POTENTIAL DEVICE
STR	STATION SERVICE TRANSFORMER
(A)	AC AMMETER
(A)	DC AMMETER
(DA)	AC DEMAND AMMETER
VAR	VAR METER
(PL)	PILOT LAMP
(SY)	SYNCHRONIZER
(V)	VOLT METER
(V)	DC VOLT METER
(W)	WATTMETER
(WH)	WATTHOURMETER
(F)	FREQUENCY METER
27	UNDER VOLTAGE RELAY
51	OVER CURRENT RELAY
51G	OVER CURRENT GROUND RELAY
87	DIFFERENTIAL RELAY
90	VOLTAGE REGULATE RELAY
PWR	PILOT WIRE RELAY

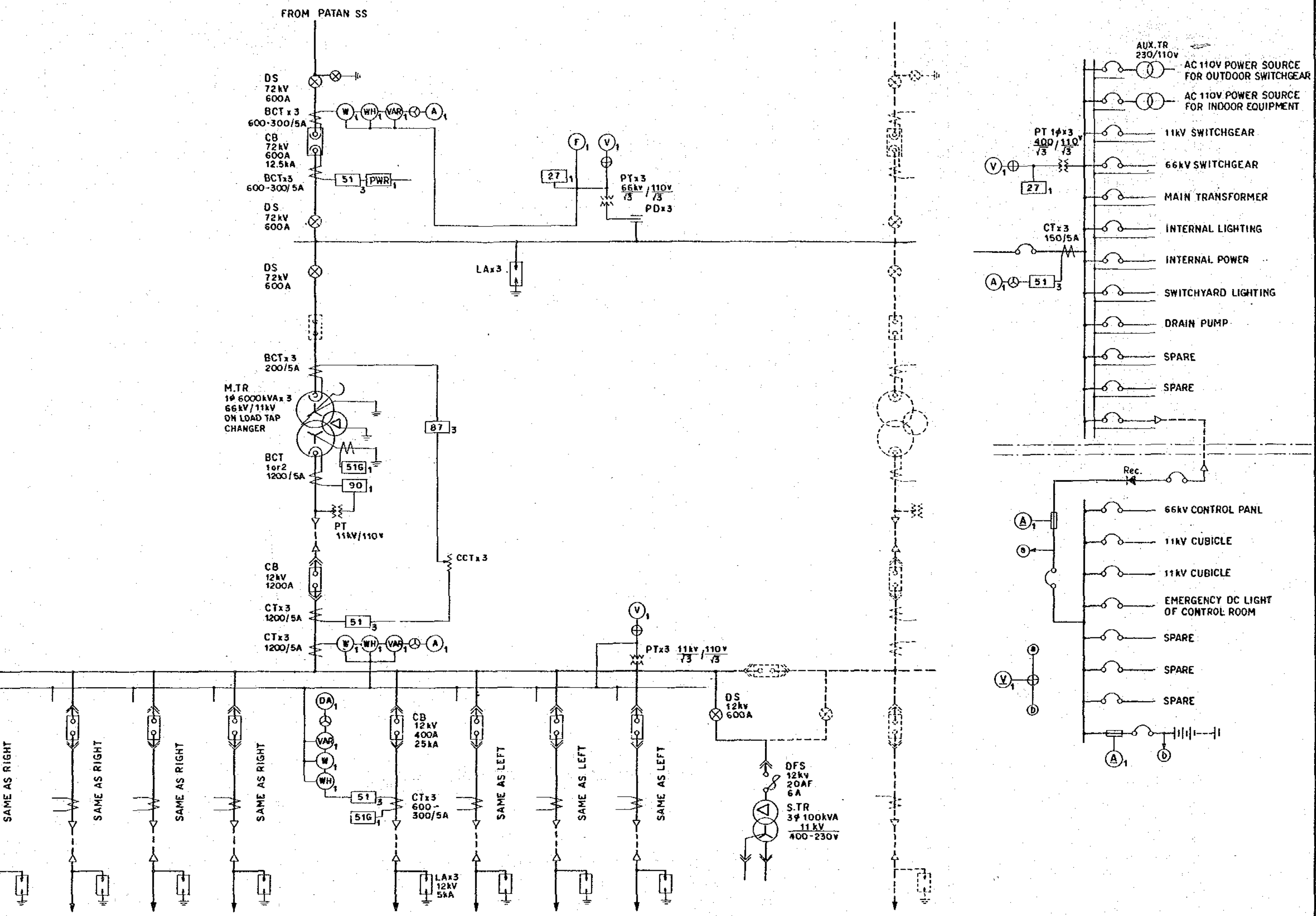


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Fig. 5.2

Baneswar S.S. Single Line Diagram

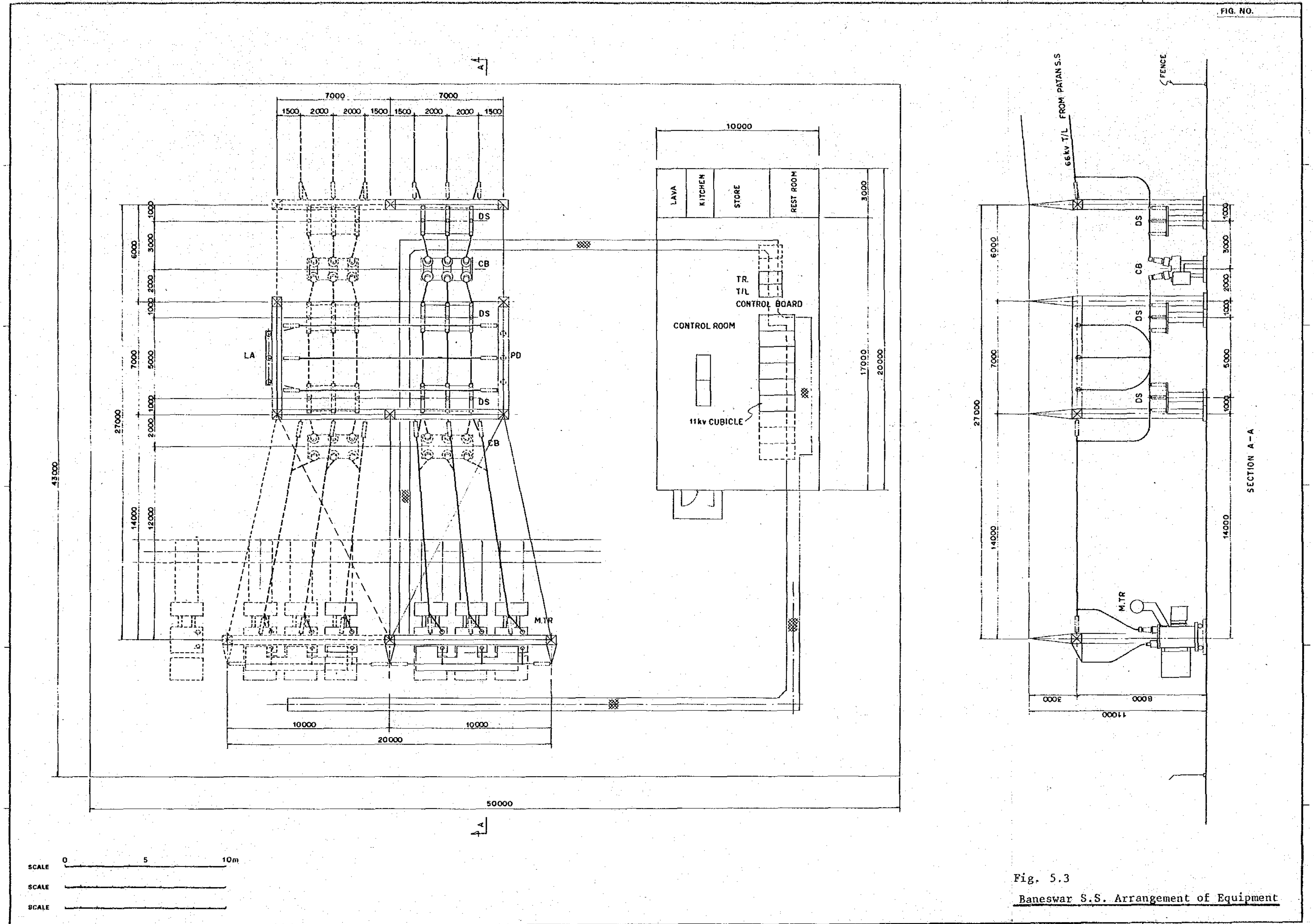
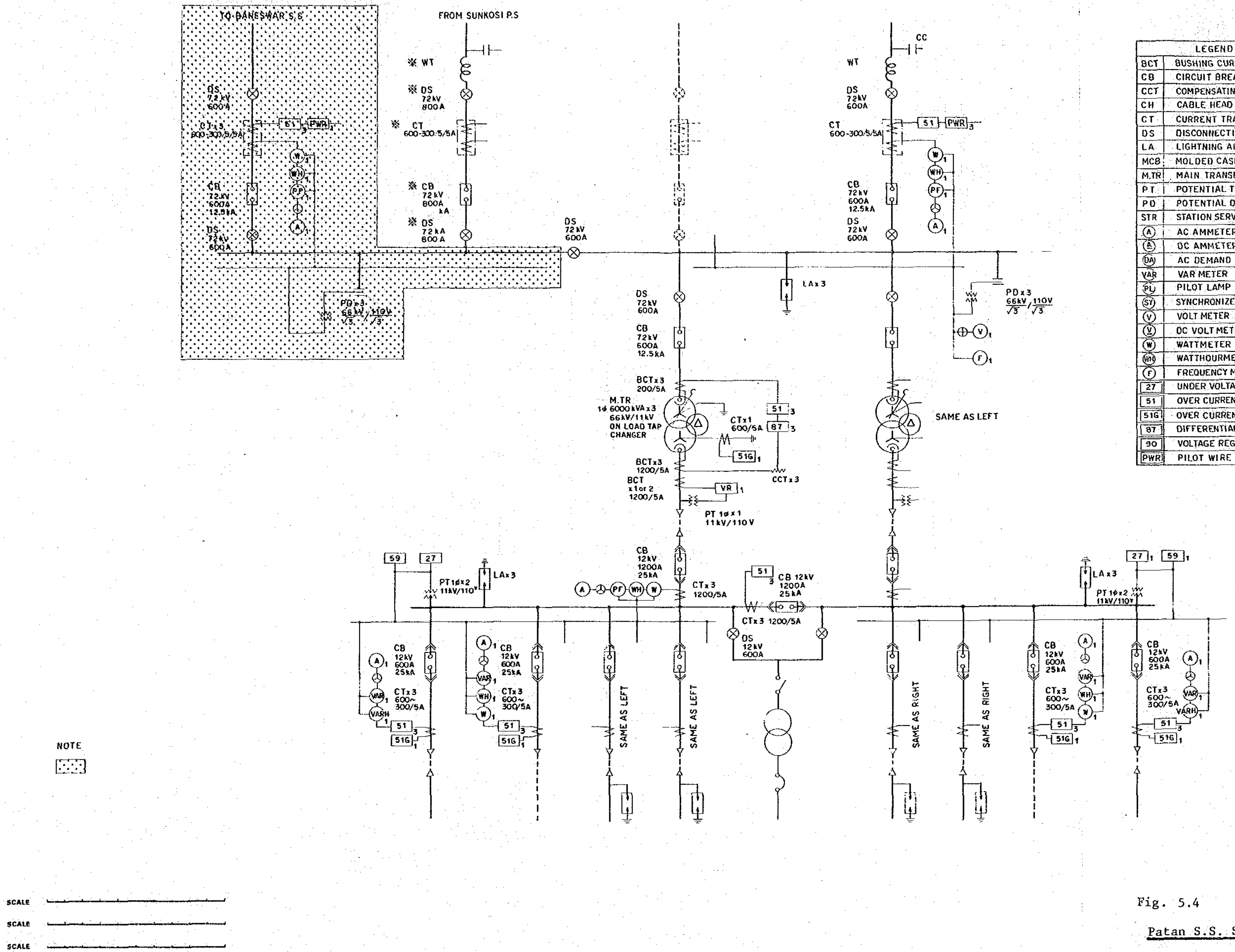


Fig. 5.3

Baneswar S.S. Arrangement of Equipment

FIG. NO.



LEGEND	
BCT	BUSHING CURRENT TRANSFORMER
CB	CIRCUIT BREAKER
CCT	COMPENSATING CURRENT TRANSFORMER
CH	CABLE HEAD
CT	CURRENT TRANSFORMER
DS	DISCONNECTING SWITCH
LA	LIGHTNING ARRESTER
MCB	MOLDED CASE CIRCUIT BREKER
M.TR	MAIN TRANSFORMER
PT	POTENTIAL TRANSFORMER
PD	POTENTIAL DEVICE
STR	STATION SERVICE TRANSFORMER
(A)	AC AMMETER
(A)	DC AMMETER
(DA)	AC DEMAND AMMETER
(VAR)	VAR METER
(PL)	PILOT LAMP
(SY)	SYNCHRONIZER
(V)	VOLT METER
(V)	DC VOLT METER
(W)	WATTMETER
(WH)	WATTHOURMETER
(F)	FREQUENCY METER
27	UNDER VOLTAGE RELAY
51	OVER CURRENT RELAY
51G	OVER CURRENT GROUND RELAY
87	DIFFERENTIAL RELAY
90	VOLTAGE REGULATE RELAY
PWR	PILOT WIRE RELAY

Fig. 5.4

Patan S.S. Single Line Diagram

FIG. NO.

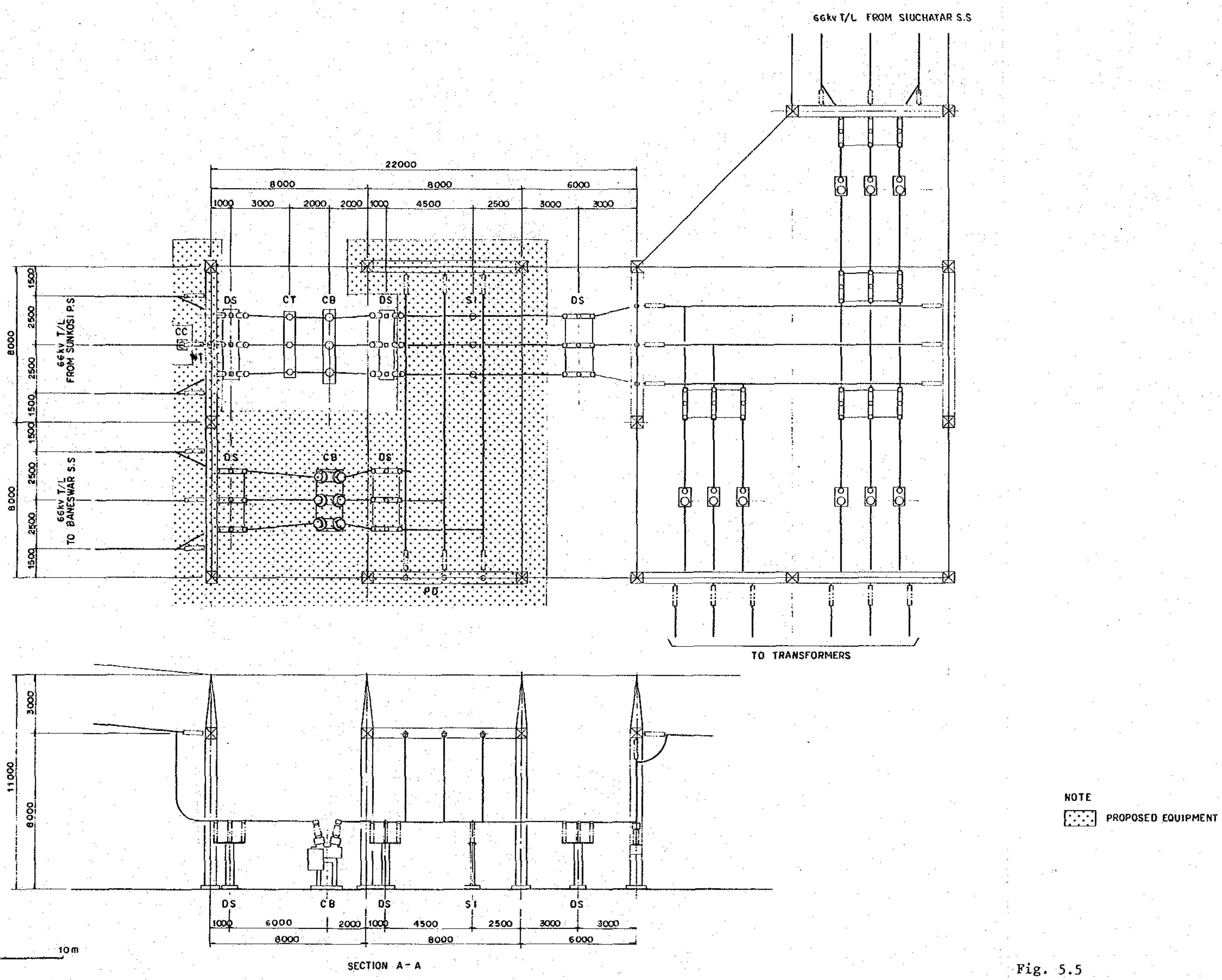


Fig. 5.5

Patan S.S. Arrangement of Equipment

FIG. NO.

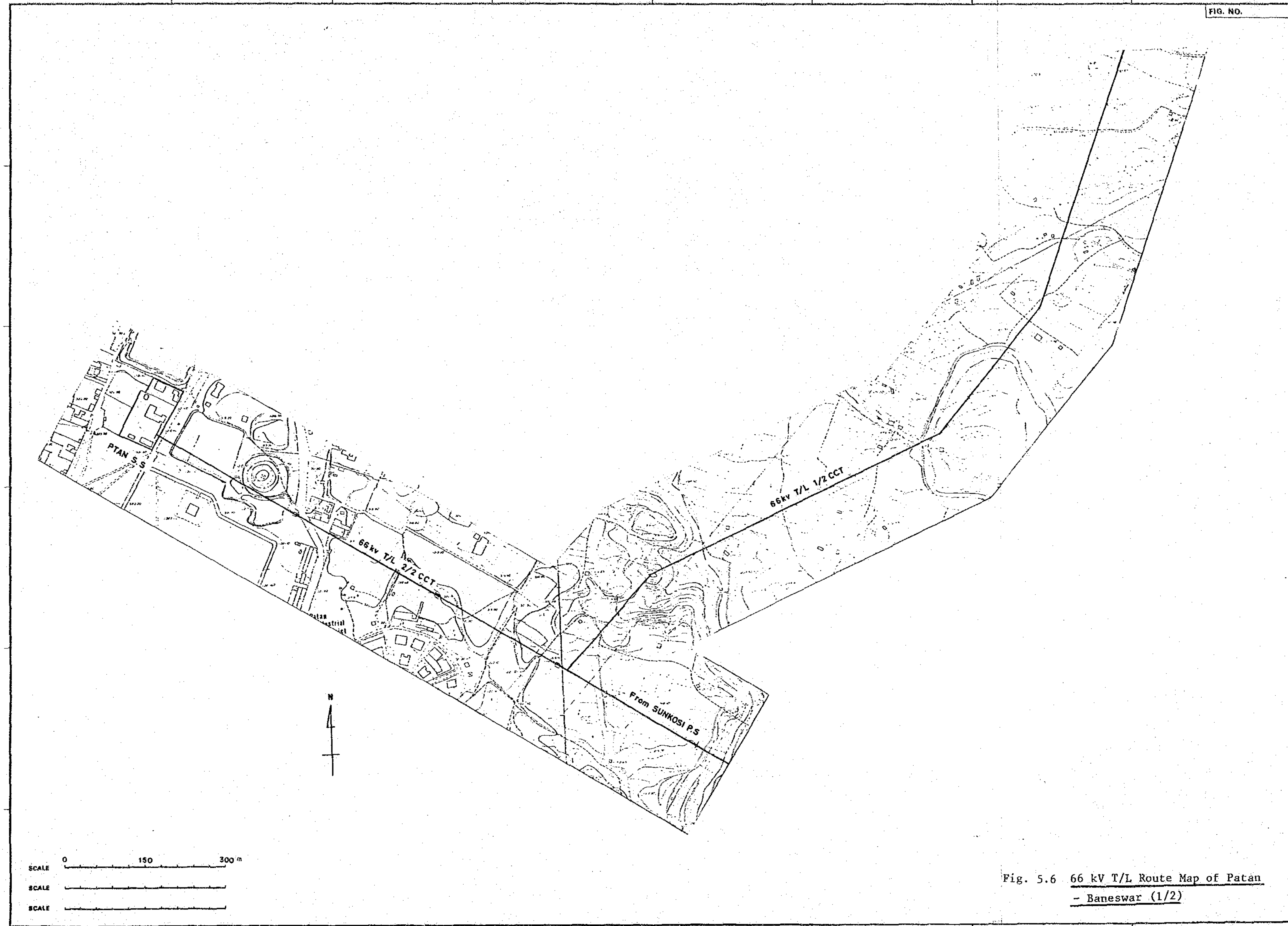


Fig. 5.6 66 kV T/L Route Map of Patan - Baneswar (1/2)

FIG. NO.

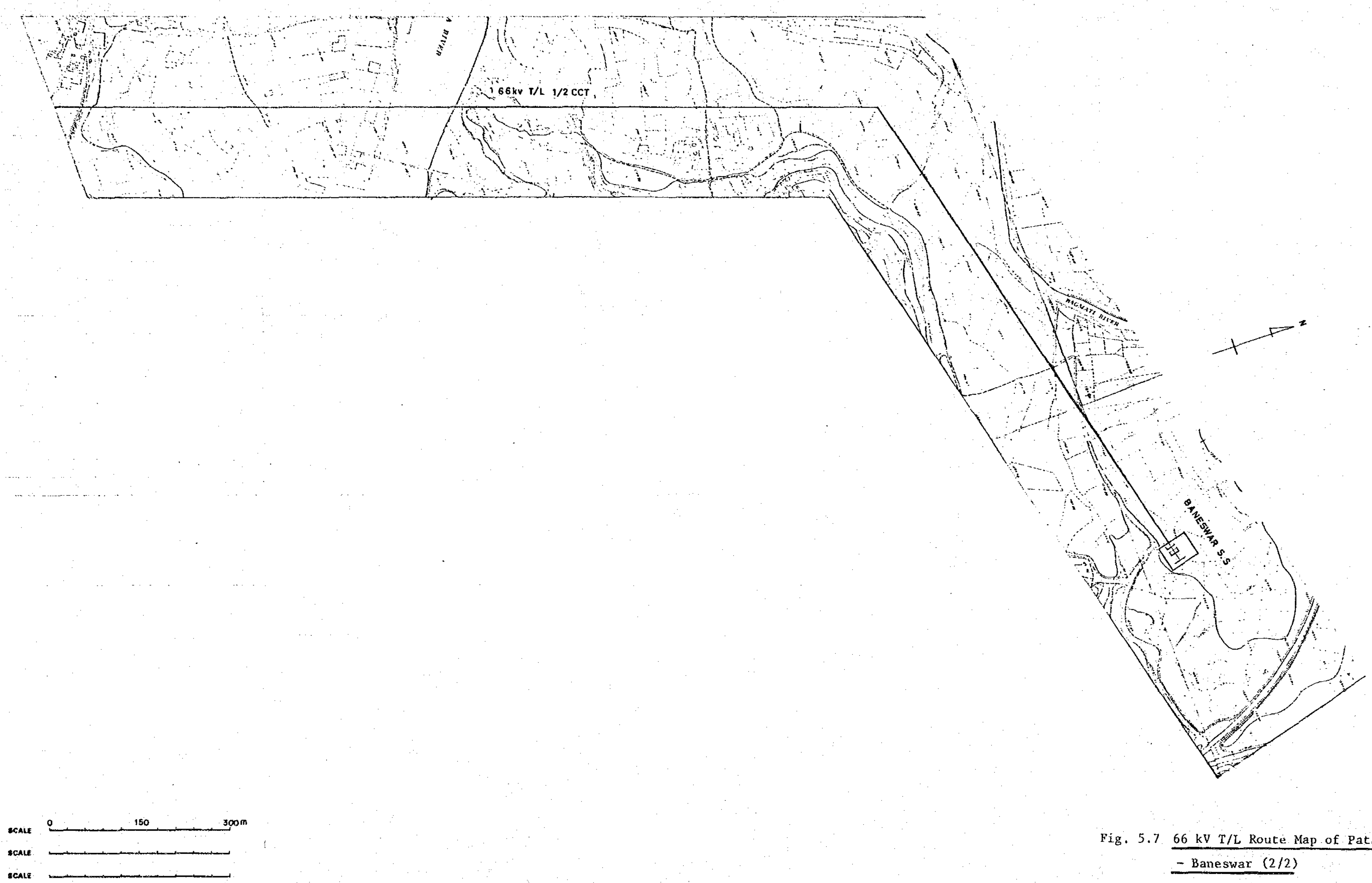


Fig. 5.7 66 kV T/L Route Map of Patan - Baneswar (2/2)

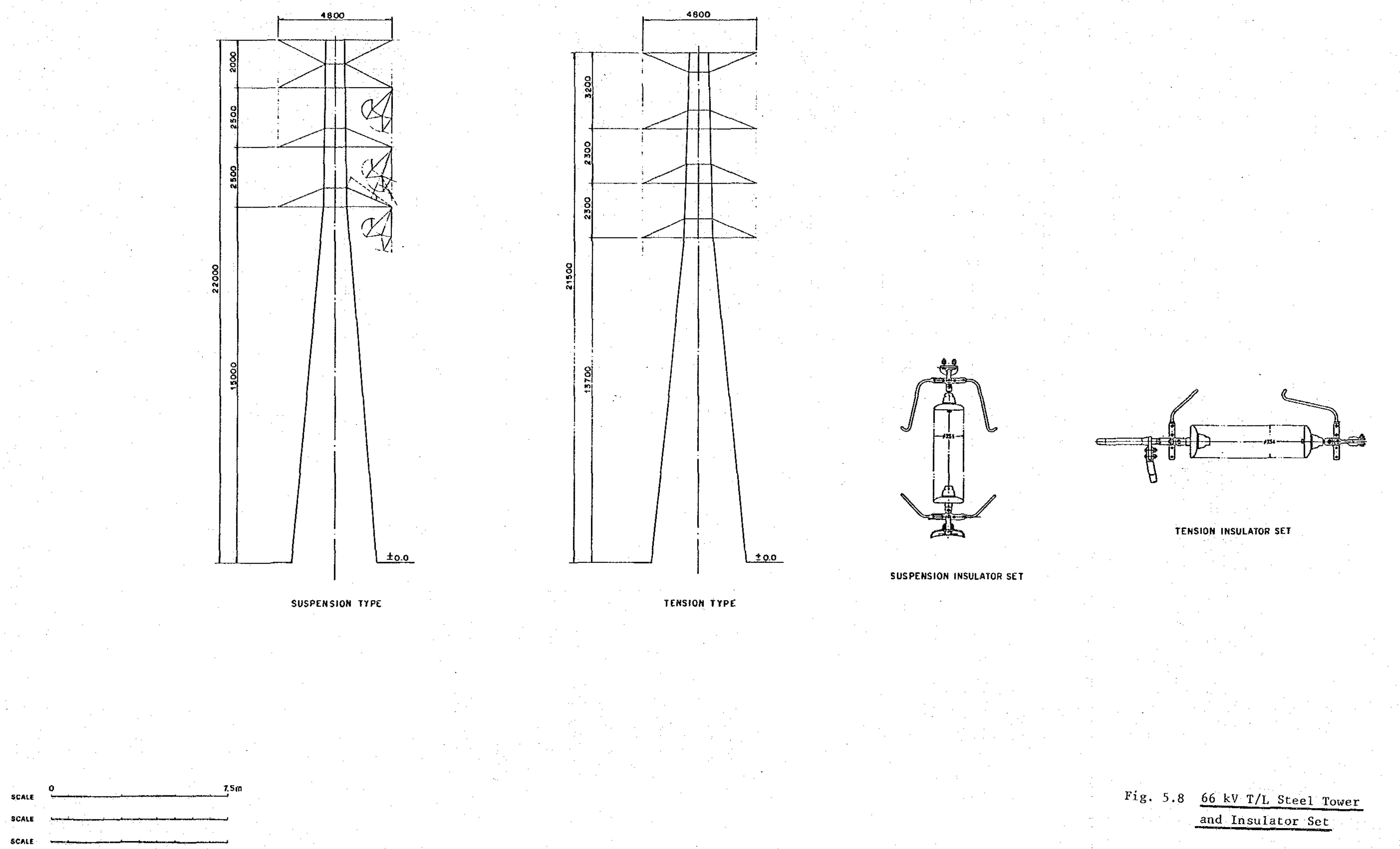
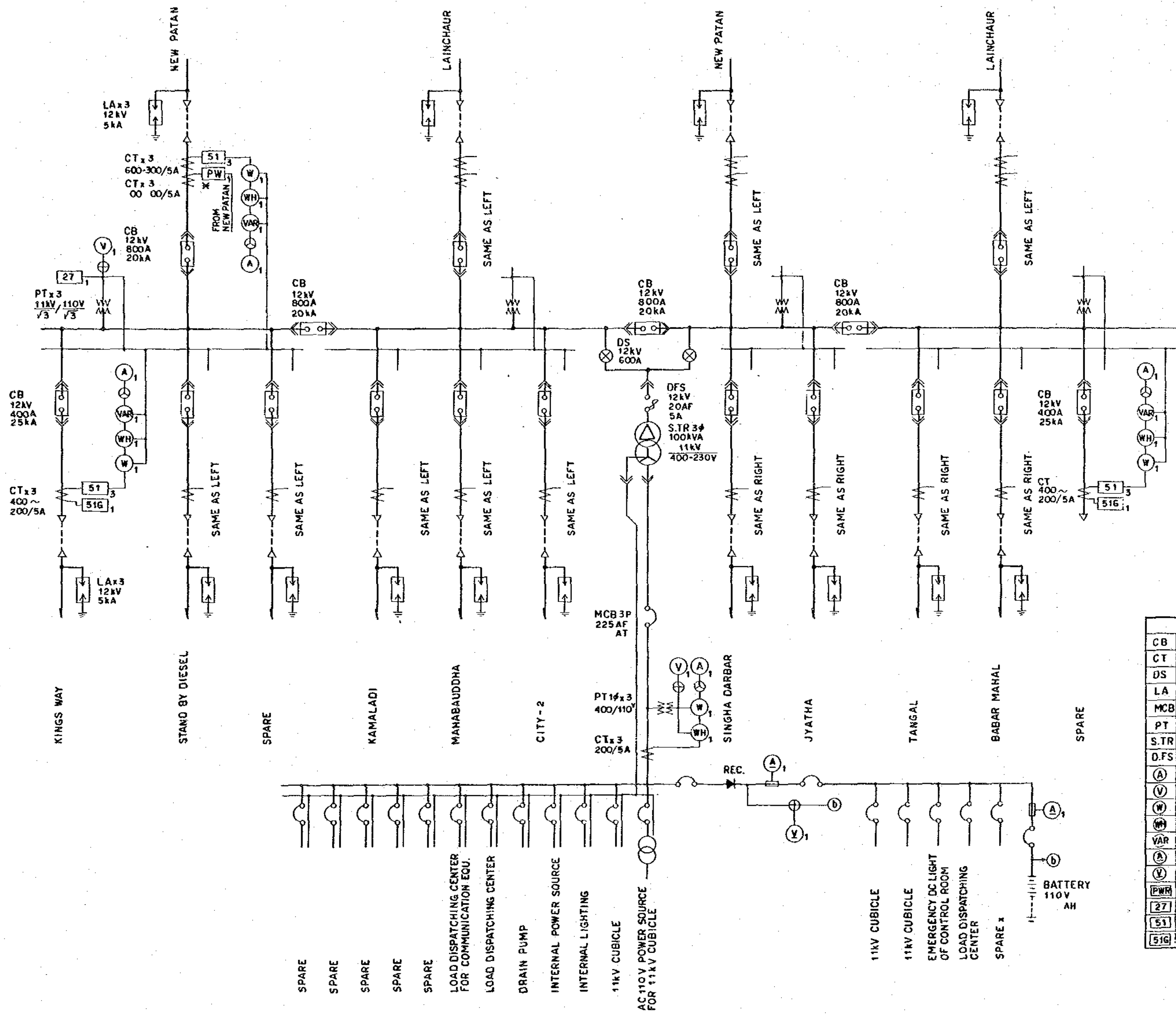


Fig. 5.8 66 kV T/L Steel Tower and Insulator Set

FIG. NO.



LEGEND	
CB	CIRCUIT BREAKER
CT	CURRENT TRANSFORMER
DS	DISCONNECTING SWITCH
LA	LIGHTNING ARRESTER
MCB	MOLDED CACE CIRCUIT BREAKER
PT	POTENTIAL TRANSFORMER
S.TR	STATION SERVICE TRANSFORMER
D.FS	DISCONNECTING FUSE SWITCH
(A)	AC AMMETER
(V)	AC VOLT METER
(W)	WATTMETER
(WH)	WATTHOUR METER
(VAR)	VAR METER
(A)	DC AMMETER
(V)	DC AMMETER
PWR	PILOTE WIRE RELAY
27	UNDER VOLTAGE RELAY
51	OVER CURRENT RELAY
51G	OVER CURRENT RELAY

SCALE

SCALE

SCALE

Fig. 5.9 K2 S.S. Single Line Diagram


N
Basbari
100
Basbari
100
MAHARAJGANJ S.S
Gongabu
100
Soma Khusi
Lazimpat
100
Baluwatar
100
BALAJU S.S
Balaju
100
Baluwater Tukucha
100
Tukucha Khola
Bishal Nagar
100
NEW CHABEL S.S
CHABEL S.S
LAINCHAUR S.S
Kesar Mahal
100
Naran Chaur
100
Kamal Pokuhari
100
Naxal
100
Nabahil Tole
100
Gyaneswar
100
Bhandarkhal
100
Dhobi Khola
Kamlachi
100
Charkhal
250
MAHABOUDHA S.S
K2 SS
Dobikhole
250
Bodhal
100
Chauni
100
ATKONARAYAN
100
SUPERMARKET S.S
HARISANKAR
100
0
500
1000m
SCALE
#1 HANUMANDOKA 100
#2 HOTEL CRYSTAL 250
#3 SHUKRA PATH 250

Fig.

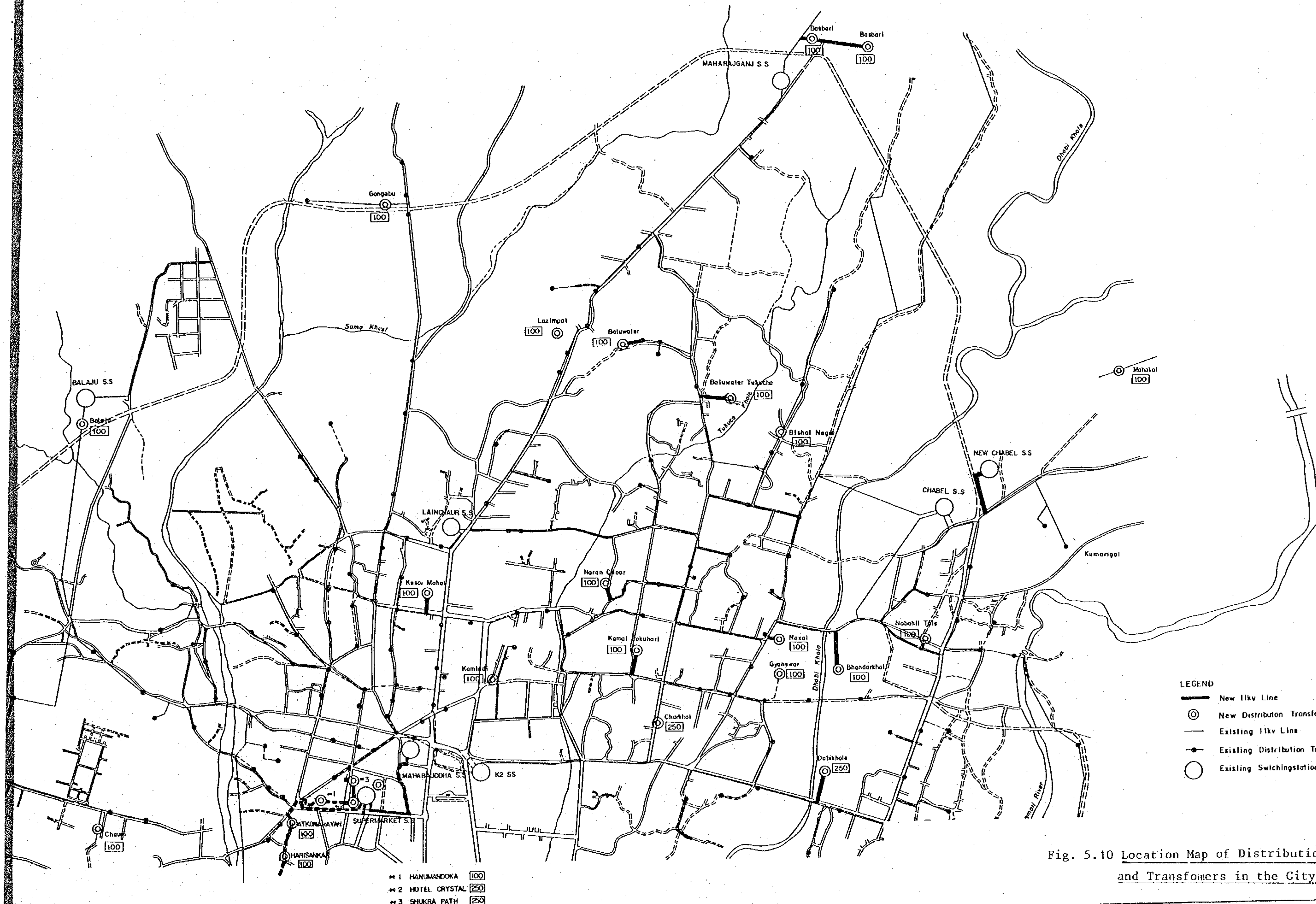


Fig. 5.10 Location Map of Distribution Lines and Transfomers in the City Area (1/2)


N
TEKU S.S
Ravi Bhavan
Teku
100
Kalanku
100
Sunargaon
100
Kalanki
100
250
250
Gatakula
250
THAPATHALI S.S
Kariya Goan
100
Lakhechur
100
Bijuli Bazar
250
Pancha Kumari
100
Baneswar Bhimsen
100
Baneswar
100
100
Dhobi Khola
Bagmati River
Koteswar
100
Bagmati River
Sanepa
Kopundol
100
Nir Bhawan
100
Jhamsikhel
100
Koteswar
Koteswar
100
Sundhare
250
Gwarko
100
Karmanasa Khola
Bagmati River
Thasikhel
100
PATAN S.S
Ring road
Nakhu Khola
0
500
1000m
SCALE

Fig

Fig. 5.11 Location Map of Distribution Lines and Transfomers in the City Area (2/2)

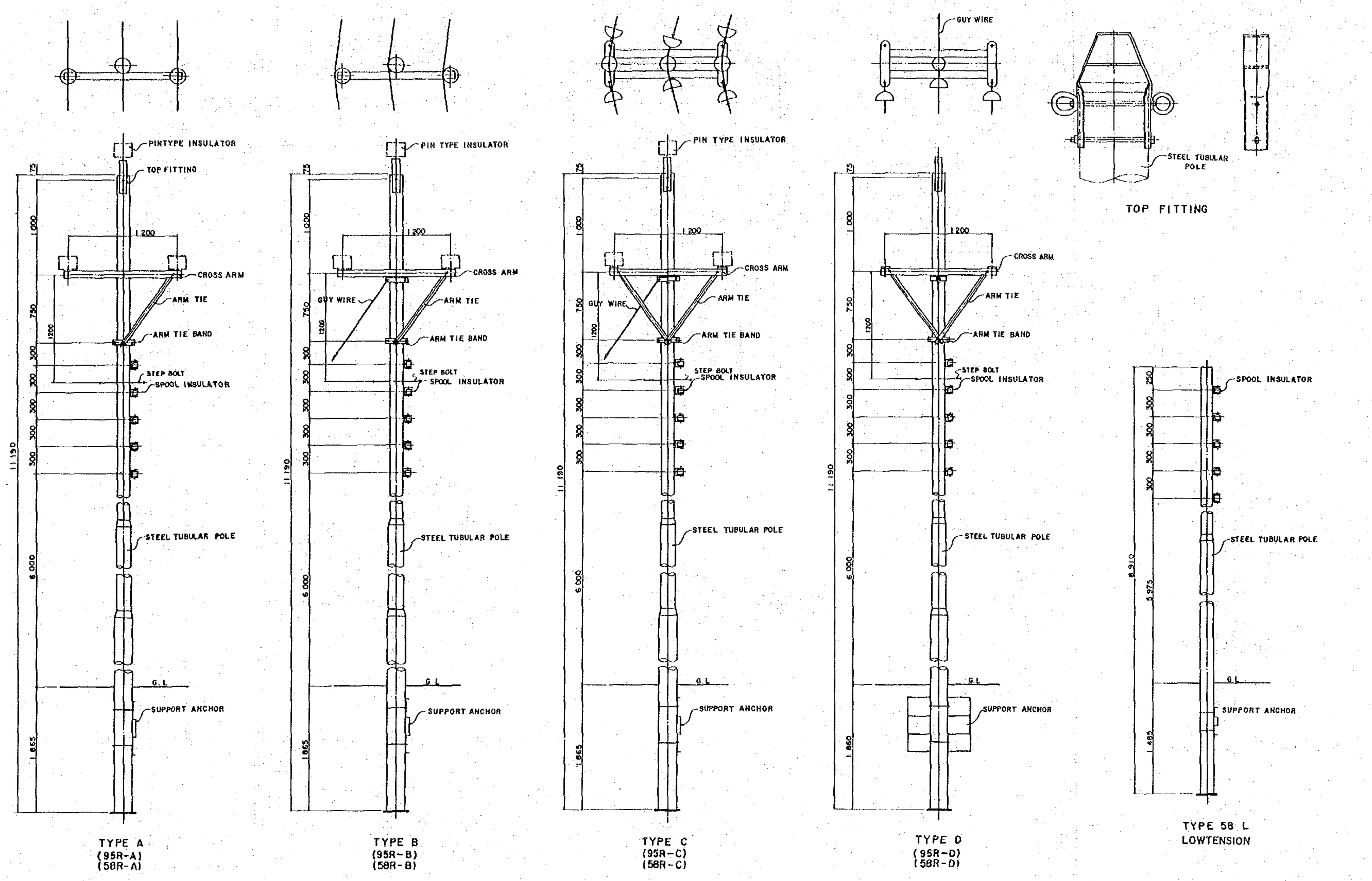


Fig. 5.12 11 kV Steel Tubular Poles