

CHAPTER 7 EVALUATION ON THE PROJECT

For the effective utilization of the power station, the transmission lines, substations and distribution lines in the power system shall be in good condition on their proper functions. The 115 kV transmission lines between the first Nam Ngum power station and Vientiane area are presently in their proper service without serious troubles. Networks of 22 kV distribution lines in Vientiane and its suburban areas are expanded and improved under the fund of the World Bank.

However, as mentioned in the previous chapters, the existing substations in Vientiane area have many troubles on their facilities such as serious deterioration of their equipment, lack of measures to repair damaged equipment or to improve incapable equipment. Those troubles are greatly lowering the functions of those substations and are causing unstable supply of electric power to customers, hindrances to development of agricultural and manufacturing industries and possibility of interruption of electric power export.

The rehabilitation project of substations in the area is expected to solve the above troubles.

Upon completion of the project, the comprehensive functions of the substations will be fully restored, and preventive measures for faults on equipment and mobilization of maintenance works will improve the system; stable and qualified electric power will be supplied with less interruption, less voltage drop and less voltage regulation.

Considering that the existing substations have sufficient capacities to meet increasing demand in the area and expansion and improvement of distribution network are now in progress in the area, it is obvious that the project will greatly contribute to the country's economic development through promotion of agricultural and manufacturing development, improvement of public welfare and continuation of acquisition of foreign currency from the electric power export.

(1) Evaluation on engineering and management

In the basic design, the extremely complicated model of equipment will not be used for the reason of unfamiliar operation and difficulty in maintenance on the part of EDL's workers.

Through the whole project period, the consultant will assist EDL and supervise the work for smooth execution of the project, and conduct a series of training program to EDL's workers for operation and maintenance of substations.

Accordingly, operation and maintenance of substations after completion of the project will be properly continued by the same operators and maintenance crew on the basis of technology transferred by Japanese consultant and contractor.

Since all equipment, ancillaries and materials will be supplied and installed by Japanese consultant and contractor under Japan's Grant Aid Program, no burden will be required on the Lao PDR side for implementation of the project. Costs for operation and maintenance of the substations are considered to be endured by EDL without any difficulty.

(2) Effects of the project

Completion of the project will produce the following direct effects.

- (a) Improvement on operative life of the existing equipment due to prevention of further deterioration.
- (b) Adequate response to increasing demands due to restoration of substation equipment for secondary transmission lines and distribution lines.
- (c) Stable supply of electric power due to repair on failed or faulty substation equipment.
- (d) Reduction of sharp voltage drops and fluctuation of voltage regulation due to improvement on power factor in the system with additional equipment.

- (e) Restoration of synthetical operation due to replacement of the broken tele-supervisory and tele-communication equipment.
- (f) Quick maintenance and repairing work due to mobility under supply of vehicles with radios.
- (g) Effective management of substations and prevention of deterioration of equipment through training to workers.
- (h) Proper repairing and improvement of maintenance works due to provision of maintenance materials, tools and testing equipment.

After completion of the project, no interruption of electric power supply of long duration due to troubles of substation is expected and continuous stable supply is assured.

In addition, following indirect effects will also be expected by the stable electric power supply through restoration of substations functions.

- (a) Stability of agricultural operation through the development of irrigation and drainage facilities.
- (b) Promotion of development of light industries under the reliable supply of electric power.
- (c) Stability of social life and improvement on public welfare through rural electrification in Vientiane area.
- (d) Securing of acquisition of foreign currency through the export of electric power to Thailand.

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

The results of the site survey and analysis on the project concluded that the rehabilitation to the existing six (6) substations in the Vientiane area shall be urgently implemented for maintaining the stable energy supply to the customers in the area, for promoting the rural electrification, for developing the agricultural and industrial schemes and for continuing the stable energy export to Thailand which brings the largest foreign income to the country.

On the other hand, however the deficit-ridden economy of the country makes it difficult to immediately budget the project.

Considering such situation, it is concluded that the request from the Government of Lao PDR to the Government of Japan is reasonable and the project is appropriate for the Grant Aid Program of Japan, because it will give the following indirect effects to the country other than the direct effects for the restoration of comprehensive functions of the substations.

- (1) Promotion of development of agricultural and manufacturing industries by reliable supply of electric power.
- (2) Continuation of stable energy export for acquisition of foreign currency.

Since the functions of the substations are remarkably lowered due to deterioration of the equipment, neglect of repair on the failed equipment and shortage of materials for maintenance as aforementioned, it is recommended that the project should be implemented urgently.

For the purpose, the Government of Lao PDR is expected to urgently implement the following undertakings which will dominate the project period.

- (1) Conclusion of the contracts with a Japanese consultant and a Japanese contractor

- (2) Issue of visas and other necessary certificates for a Japanese consultant and a Japanese contractor engaged in the execution of the project
- (3) Prior arrangement for permit of transportation of cargoes through Thailand for the project use and for custom formalities
- (4) Implementation of the planned shutdowns necessary for the project

In addition, in order to maintain the function of the substations rehabilitated under this project, the following are strongly recommended to be undertaken by EDL.

- (1) To procure tools, spare parts and materials continuously for the operation and maintenance of the substation equipment at EDL's own fund.
- (2) To preserve the drawings and operation and maintenance manuals and to amend the drawings and manuals when the modification was made on the substation.
- (3) To train their operation and maintenance staff continuously.

TABLES

TABLE-1 METEOROLOGICAL DATA IN VIENTIANE

(1.1: Max. Air Temperature °C)

Mth Year	1	2	3	4	5	6	7	8	9	10	11	12
1971	33.0	33.6	36.5	37.5	36.4	33.5	33.5	34.0	33.4	32.0	32.4	30.6
72	33.2	34.3	35.8	37.0	37.6	35.6	34.7	33.4	33.7	33.5	32.4	31.4
73	33.3	36.3	37.3	39.3	35.6	35.5	34.7	33.4	32.7	33.4	32.5	30.2
74	32.1	37.5	35.8	36.8	35.0	34.3	34.8	33.8	33.6	33.2	33.1	32.0
75	31.6	34.6	37.8	40.8	36.0	34.0	34.6	33.5	33.6	33.1	32.5	22.0
76	29.8	35.1	36.6	36.0	34.9	34.4	34.8	33.5	34.6	32.9	31.9	32.4
77	32.7	34.8	37.8	37.9	37.0	37.5	35.9	34.5	33.9	33.0	32.1	32.8
78	33.7	33.6	36.7	38.4	35.8	34.8	34.3	33.4	33.6	33.6	32.3	31.6
79	34.3	36.7	37.9	38.5	36.9	34.3	35.6	33.6	34.0	33.1	32.6	31.2
80	33.3	34.4	37.2	40.8	36.5	35.0	35.0	34.0	32.4	33.9	32.5	30.7
81	37.9	37.0	37.4	37.8	36.2	33.8	33.9	35.0	34.6	34.1	33.1	30.3
82	31.5	35.8	37.7	37.6	38.0	35.2	34.1	34.4	34.4	33.6	32.1	31.0
83	30.2	34.0	38.2	41.5	38.1	36.8	35.7	-	-	-	-	-

(1.2: Min. Air Temperature °C)

Mth Year	1	2	3	4	5	6	7	8	9	10	11	12
1971	7.3	13.1	16.0	21.3	21.6	23.0	22.8	23.2	22.7	16.8	10.6	14.3
72	11.9	15.5	14.2	21.2	22.9	22.6	23.7	22.1	23.0	22.2	19.4	15.5
73	14.8	16.2	19.5	21.9	22.9	22.9	23.0	21.7	23.2	17.7	12.8	7.6
74	4.7	10.7	14.2	20.2	22.5	23.4	22.5	22.9	22.8	21.6	18.0	15.7
75	14.1	15.4	20.1	21.0	22.3	23.5	22.8	22.8	22.0	21.5	11.7	5.3
76	7.3	13.0	16.8	20.3	18.9	21.8	22.8	22.9	23.0	21.9	13.3	12.9
77	15.5	13.9	14.0	20.3	24.8	24.0	22.0	23.0	21.8	20.8	13.1	14.6
78	14.5	15.1	18.8	20.0	21.2	23.4	22.8	23.0	22.7	15.3	15.9	17.8
79	17.2	15.2	19.1	22.3	22.0	22.3	23.5	23.0	23.0	18.6	14.4	12.7
80	14.0	15.2	18.2	18.5	21.0	23.0	22.6	23.2	23.0	18.7	18.7	13.7
81	10.9	16.6	18.7	20.5	22.1	23.1	22.0	23.0	22.4	21.0	15.4	11.8
82	11.4	14.8	20.5	18.8	23.0	23.7	23.3	22.7	22.5	21.8	18.8	9.1
83	10.8	16.4	17.0	22.9	23.8	22.2	22.7	-	-	-	-	-

(1.3: Rainfall mm)

Mth Year	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1971	0	7.3	13.9	34.1	294.0	275.9	289.4	226.4	163.4	103.5	0.8	18.2	1,426.9
72	0	6.8	36.8	167.6	115.6	312.8	246.1	306.7	166.3	184.4	8.2	5.3	1,521.1
73	0	0	37.0	36.4	308.3	200.7	298.6	263.9	361.3	25.7	0	0	1,531.9
74	0	1.6	36.7	97.4	100.5	159.2	255.7	368.4	187.1	92.6	29.7	0.2	1,329.1
75	23.5	26.3	13.2	21.8	347.0	473.9	177.5	430.4	289.4	194.4	8.5	0	2,006.9
76	0	23.0	111.9	126.9	121.7	167.3	167.6	403.1	416.7	76.7	0	0	1,614.9
77	15.2	0	35.1	69.0	151.9	231.0	211.1	174.8	190.3	26.5	16.5	22.8	1,144.2
78	1.6	17.8	51.1	145.9	328.4	254.9	254.6	293.6	381.4	128.9	28.5	0	1,986.7
79	0	21.0	0.1	61.8	344.7	333.3	150.1	117.8	253.1	19.2	0	0	1,301.1
80	0	18.6	68.8	61.0	319.5	611.0	461.5	342.9	353.4	54.7	0	0	2,291.4
81	0	0.3	19.6	124.2	311.1	238.5	635.0	210.0	224.8	117.8	40.5	0	1,921.8
82	0	6.1	60.8	69.6	239.3	95.4	253.8	484.6	319.5	90.2	22.2	0.6	1,629.3
83	53.1	5.7	9.0	58.1	97.6	243.8	-	-	-	-	-	-	-

(1.4: Max. Relative Humidity %)

Mth Year	1	2	3	4	5	6	7	8	9	10	11	12
1971	91	90	85	90	94	96	96	96	95	93	95	94
72	93	92	90	89	93	96	94	95	94	93	90	91
73	91	87	82	81	89	92	95	95	92	91	87	89
74	91	94	86	89	90	92	93	94	93	92	88	90
75	91	88	86	78	93	91	90	92	93	90	88	87
76	90	88	85	90	93	93	92	93	95	93	87	84
77	91	81	81	90	91	89	93	93	94	92	87	92
78	88	87	90	89	93	94	95	94	96	93	92	92
79	93	91	86	86	92	95	93	95	95	90	85	91
80	91	86	79	86	91	95	94	94	95	92	79	91
81	90	87	85	90	92	93	95	93	93	92	88	88
82	94	92	88	90	90	90	90	95	94	95	93	93
83	94	91	86	85	92	94	-	-	-	-	-	-

(Source: Ministry of Agriculture and Irrigation)

TABLE-2 EXISTING ELECTRIC-POWER FACILITIES IN LAO P.D.R (1985)

(2.1 Power Station)

(Type)	(Station)	(Installed Capacity)	(Location)	(Remarks)
Hydro	Nam Ngum No.1	150,000 kW	Vientiane Pref.	2x15MW, 2x40MW & 1x40kW
	Nam Dong	1,008 kW	Luang Prabang Pref.	
	Selabam	2,040 kW	Champassak Pref.	3x680kW
	Total	153,048 kW		
Diesel	Sokpaluang	8,000 kW	Vientiane Pref.	4x2,000kW
	Luang Prabang	600 kW	Luang Prabang Pref.	4x125kW & 1x100kW
	Pakse	50 kW	Champassak Pref.	1x50kW
	Champassak	88 kW	"	1x88kW
	Savannakhet	1,000 kW	Savannakhet Pref.	4x250kW
	Thakhek	400 kW	Khammouane Pref.	1x400kW
	Total	10,138 kW		

(2.2 Substation)

(Station)	(Capacity)	(Location)	(Remarks)
Phone Tong	74,000 kVA	Vientiane City	1x30MVA & 2x22MVA
Thanaleng	10,000 kVA	"	1x10MVA
Sisaket	-	"	22kV Rec./Send.
Thatluang	-	"	"
Sokpaluang	-	"	"
Wattay	-	"	"
52 km	6,300 kVA	Vientiane Pref.	1x 6.3MVA
Total	90,300 kVA		

(2.3 Transmission and Distribution Lines)

115kV (Vientiane Pref.):	Single Cct. 88 km :	88 Circuit-km
	Double Cct. 88 km :	<u>176</u> "
		264 Circuit-km
22 kV (Vientiane City & Pref.)	:	87 km
" (Savannakhet and Khammoune Pref.)	:	<u>32 km</u>
		119 km

TABLE-3 ELECTRIC POWER IN LAO P.D.R

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
^{*2}										
^{*1}										
Energy Generated (GWh)										
Hydro	241.34	232.39	256.14	302.04	898.64	886.20	846.47	910.45	863.37	890.97
Diesel	-	0.38	0.18	0.17	0.01	-	-	-	-	-
Import from Thailand	0.52	0.52	0.14	0.40	-	-	-	-	-	-
Total	241.86	233.29	256.46	302.61	898.65	886.20	846.47	910.45	863.37	890.97
(growth rate)	(-)	(-3.5%)	(9.9%)	(16.4%)	(197%)	(-1.3%)	(-4.5%)	(7.6%)	(-5.2%)	(3.2%)
Local Energy Consumption (GWh)										
Domestic, Commercial & Public	-	-	58.77	58.71	58.78	72.47	92.40	92.33	104.31	114.47
(growth rate)	-	-	-	(0)	(0)	(23.3%)	(27.5%)	(0)	(16.2%)	(9.7%)
Industry	-	-	6.22	4.96	4.63	10.00	10.90	10.58	9.90	9.58
(growth rate)	-	-	-	(-20.3%)	(-6.7%)	(216.0%)	(9%)	(-2.9%)	(-6.0%)	(-3.2%)
Agriculture	-	-	-	-	2.49	2.73	2.70	4.46	4.80	5.05
(growth rate)	-	-	-	-	-	(9.6%)	(0)	(65.2%)	(7.6%)	(5.2%)
Total	70.83	61.36	64.99	63.67	65.90	85.20	106.00	107.37	124.08	129.10
(growth rate)	-	(-13.4%)	(5.9%)	(-2.0%)	(3.5%)	(29.3%)	(24.4%)	(1.3%)	(15.6%)	(4.0%)
Energy Export to Thailand (GWh)	153.81	137.14	176.86	221.90	790.66	766.41	708.70	749.76	649.41	709.71
(growth rate)	-	(0)	(12.5%)	(25.5%)	(256.3%)	(-3.1%)	(-7.5%)	(5.8%)	(-13.4%)	(9.3%)
Peak Demand (Domestic) (MW)	17.7	-	13.5	13.2	14.4	17.6	20.0	27.2	29.5	31.8
(growth rate)	-	-	-	(0)	(9.1%)	(22.2%)	(13.6%)	(36%)	(8.5%)	(6.8%)
Annual Average Load Factor (%)	46	-	55	55	52	55	61	45	48	46

Remarks: Records before 1975 are not available.

*1 Two 40 MW units added to Nam Ngum No.1 P/S in Oct. '78

*2 Further 40 MW unit added to the P/S in Dec. '84

TABLE-4 POWER DEMAND FORECAST IN LAO P.D.R

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Forecast of Energy Consumption											
Domestic, Commercial & Public	*1	125.9	132.2	138.8	149.9	161.9	187.1	198.3	208.3	218.7	229.6
Industry	*2	9.8	10.0	10.2	10.6	11.0	12.0	12.6	13.2	13.9	14.6
" (new factory)	*3	-	6.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Agriculture	*4	5.3	5.6	6.0	6.4	6.8	8.0	8.8	9.6	10.6	11.6
Total	*5	141.0	154.3	165.0	176.9	189.7	217.1	229.7	241.1	253.2	265.8
Forecast of Peak Demand (MW)	*6	33.7	36.1	38.6	40.9	43.0	46.9	48.8	50.7	52.8	54.9
Forecast by EDL & ADB Mission											
Energy Consumption (GWh)	*7	147.1	160.1	173.3	184.9	194.5	215.6	236.2	248.5	261.1	274.7
Peak Demand (MW)		30.9	33.9	36.0	37.8	39.9	44.6	48.2	50.1	52.3	54.4

Remarks: *1 : Although the average growth rate for the past 5 years was 14%, the growth rate in 1984 slowed down from the average rate due to faults of substations. The slowed down rate was assumed to continue till completion of rehabilitation of substations. The above stated energy consumption was forecast under the growth rates of 10% for 1985, 5% for '86 and '87 during progress of rehabilitation project and 8% after the completion of the project to be stable with 5% growth rate.

*2 : Growth rate of 2 to 5% was assumed under the Government's promotion policy for industrialization although the rate in the last few years have shown minus growth rate.

*3 : The pharmaceutical factory being constructed under the grant aid of Japanese Government is to start its production in 1986.

*4 : The growth rate is assumed to increase from 5% to 10% gradually under the Government's promotion policy for irrigation.

*5 : The annual growth rates were resulted in 5 to 9%.

*6 : Annual load factors in the last 3 years were lower than 50%. The factor will increase to about 55% following to electrification in suburban area. Under the circumstances, the growth rate of peak demand will increase by 6 to 7% annually and become stable at 4% after 1990.

*7 : This forecast was made by EDL and ADB mission in 1982 for the Xeset hydro-power project in the south of Lao P.D.R.

TABLE-5 FINANCIAL STATE OF EDL

Source: EDL

5.1 Balance Sheet		(Unit: 10 ⁶ Kips)						
		1980	1981	1982	1983	1984	1985	
<u>Income</u>								
	Export Sales	80.4	108.3	835.2	837.1	930.7	976.8	
	Local Sales	2.6	9.4	13.1	45.4	43.4	381.8	
	House-wiring, etc.	9.3	7.0	7.7	55.7	49.8	303.0	
	Total	92.3	124.7	856.0	938.2	1,023.9	1,661.6	
<u>Expenditure</u>								
	Energy Import	-	-	-	-	-	29.8	
	Salaries and Allowances	3.1	4.8	7.8	12.7	17.9	106.2	
	Administrations	3.3	9.0	19.3	21.1	20.4	76.8	
	Operation and Maintenance	5.7	10.7	31.5	86.0	65.9	298.0	
	Depreciation	16.6	16.7	118.2	119.1	119.2	168.5	
	Taxes	1.6	2.2	28.2	30.9	33.7	221.2	
	Total	30.3	43.4	205.0	269.8	257.1	900.5	
Operation Income		62.0	81.3	650.9	668.4	766.8	761.1	
Interest		-	-	9.4	18.3	20.0	68.0	
Provision for Major Repair		3.3	3.3	7.5	59.5	59.5	84.2	
Net Income		58.7	78.0	634.0	590.6	687.3	608.9	
Share of Government		58.7	76.0	624.4	590.6	687.3	489.9	
EDL Staff Welfare		-	2.0	9.5	-	-	-	
Retained by EDL		-	-	-	-	-	119.0	

5.2 Assets & Liabilities

	1980	1981	1982	1983	1984	1985
(Assets)						
<u>Fixed Assets:</u>						
Gross Fixed Assets	262.8	269.6	3,134.6	3,140.5	3,143.7	3,922.7
Accumulated Depreciation	33.8	50.5	614.4	733.5	852.7	1,021.2
Net Fixed Assets	229.0	219.1	2,520.2	2,407.0	2,291.0	2,901.5
Work in Progress	18.8	26.6	91.2	171.0	543.6	112.0
Total Net Fixed Assets	247.8	245.7	2,611.4	2,578.0	2,834.6	3,013.5
<u>Current Assets:</u>						
Cash	4.9	11.2	106.1	90.5	255.4	228.1
Accounts Receivable	20.8	55.5	203.4	229.5	394.2	415.0
Inventory	13.3	18.0	76.4	35.4	83.5	80.5
Prepayment	94.9	170.0	521.5	66.6	66.2	70.0
Total Current Assets	133.9	254.7	907.4	422.0	799.3	793.6
Total Assets:	381.7	500.4	3,518.8	3,000.0	3,633.9	3,807.1
(Liabilities)						
Government Equity Fixed Capital	259.1	264.7	2,821.6	2,772.5	2,611.9	2,534.3
Retained Profit	-	-	-	-	-	119.0
Long Term Debts	-	-	-	8.3	370.9	554.8
Current Liabilities	117.9	227.6	682.5	150.1	522.5	386.1
Provision for Major Repairs	4.7	8.1	14.7	69.1	128.6	212.9
Total Liabilities	381.7	500.4	3,518.8	3,000.0	3,633.9	3,807.1

TABLE-6 POWER TARIFFS IN LAO P.D.R.

6.1 Tariffs for Domestic Consumers

The tariffs were amended in May 1985 as below.

They are not classified into various classes but into only two (2) classes, i.e. for the Government-use and other consumers' use, and such system as different rate for consumed energy amount, or as monthly fixed charge, etc. are not introduced at present.

Tariff for the Government-use : 5 Kips/kWh

Tariff for other consumers' use : 7 "

Those amended tariffs are raised by 50 times for the Government-use and 17.5 times for other consumers' use from the previous tariffs.

6.2 Tariffs for Export to and Import from Thailand

Those tariffs are established in the Agreement concluded by both Governments and to be amended every 5 years.

The latest Agreement was for the years between 1981 and 1986, and the tariffs for each year are applied for the period from 1st October to 30th September next year with an escalation of 9% per annum.

Period	Export (US\$/kWh)	Import (US\$/kWh)
1981 - 1982	0.03100	0.03600
1982 - 1983	0.03379	0.03879
1983 - 1984	0.03683	0.04183
1984 - 1985	0.04014	0.04514
1985 - 1986	0.04376	0.04876

It is noted that import is made through both prefectures of Savannakhet and Khammouane.

Source: EDL

TABLE-7 DEVELOPMENT AND EXPANSION PLAN OF ELECTRIC POWER

7-1 Plan of Hydro Power Station

(Station)	(Installed Capacity)	(Location)	(Expected Completion Year)
Nam Theun	Final 1,250 MW	Kammoune	Not confirmed
Nam Ngum No.2	" 400 MW	Xiengkhouang	"
Xeset	" 44 MW	Saravane	1990
Nam Khan	20 MW	Luang Prabang	Not confirmed
Nam Pa	5.8 MW	"	"
Sam Nua	4 MW	Phongsaly	1986
Se Champone	3.7 MW	Savannakhet	Not confirmed
Nam Ngiou	2.7 MW	Xiengkhouang	"
Houei Champi	0.6 MW	Champassak	"
Houay Nhang	0.6 MW	"	"

7-2 Plan of Rehabilitation

(Station)	(Installed Capacity)	(Location)	(Expected Completion Year)
Selabam P/S	3 x 680 MW	Champassak	1986
Nam Ngum No.1 P/S	2 x 40 MW	Vientiane	"
Vientiane S/S	6 substations	"	1987

7-3 Plan of Rural Electrification

(Project)	(Location)	(Scale)	(Expected Completion Year)
22 kV D/L	Vientiane	100 km	1986 (1st phase)
"	Savannakhet	258 km	1991
"	Champassak	267 km	"
"	Saravane	249 km	"
"	Luang Prabang		Not confirmed
Tha Ngon S/S	Vientiane	10 - 20 MVA	"

(Remarks) P/S: Power Station S/S: Substation D/L: Distribution Line

Source: EDL

TABLE-8 EDL'S OPERATION RECORD - (1)

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<u>Energy Generated & Imported</u>											
Hydro	241,344	232,386	256,141	302,042	898,641	886,196	845,880	910,451	863,378	890,976	761,372
Diesel	-	377	184	167	13	1	-	-	-	-	-
Import	515	524	136	381	-	-	5	14	11	17	7
Total	241,859	233,287	256,461	302,590	898,654	886,197	845,885	910,465	863,389	890,993	761,379
<u>Energy Sent by Nam Ngum</u>											
No.1 P/S (MWh)	237,026	226,910	249,542	294,723	882,456	871,059	831,364	895,141	848,586	874,450	746,576
<u>Energy Received by Phone</u>											
Tong S/S (MWh)	228,633	220,094	240,247	288,308	870,316	858,888	819,552	883,568	838,285	862,328	733,532
<u>Energy Consumed (MWh)</u>											
Vientiane District	70,315	60,836	60,594	64,854	65,900	85,200	106,000	107,356	124,069	129,083	123,770
Southern Area	515	524	136	381	-	-	-	14	11	17	7
Total	70,830	61,360	64,990	63,670	65,900	85,200	106,000	107,370	124,080	129,100	123,777
<u>Energy Exported (MWh)</u>											
Energy Exported (MWh)	155,805	157,142	176,858	222,891	787,969	766,405	708,709	749,776	697,428	709,734	600,343
<u>Energy Loss</u>											
Transmission Line Loss (MWh)	8,393	6,816	9,295	6,415	12,140	12,171	11,812	11,573	10,301	12,122	13,044
" (%)	3.54	3.00	3.72	2.18	1.38	1.40	1.42	1.29	1.21	1.39	1.75
Distribution Line Loss (MWh)	2,513	2,493	2,979	730	16,460	7,283	4,843	26,436	16,788	23,511	9,419
" (%)	1.10	1.13	1.24	0.25	1.89	0.85	0.60	2.99	2.00	2.73	1.28
Total (MWh)	10,906	9,309	12,274	7,145	28,600	19,454	16,655	38,009	27,089	35,633	22,463
" (%)	4.60	4.10	4.92	2.42	3.24	2.23	2.00	4.25	3.19	4.07	3.01

TABLE-8 EDL'S OPERATION RECORD - (2)
(Peak Demand of Each Feeder in 1984 & 1985: MW)

Substation	PHONE TONG					SISAKET					THATLUANG					WATPAI					THANALENG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
	MSH	MSH	MSH	MSH	MSH	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS

(Remarks) OFF: Black-out due to faults of equipment
N.A: Record is not available.

TABLE-9 FORECAST OF ENERGY SALES OF EDL

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Energy Production by Nam Ngum No.1 P.S.	900	900	900	900	900	900	900	900	900	900
System Loss	54	54	54	54	54	54	54	54	54	54
Consumable Energy	846	846	846	846	846	846	846	846	846	846
Energy consumed locally	154	165	177	190	204	217	230	241	253	266
Surplus Energy for Export to Thailand	692	681	669	656	642	629	616	605	593	580
<hr/>										
Tariff for Local-sale (Kip/kWh)*4	7.0	7.7	8.5	9.3	10.2	11.3	12.4	13.6	15.0	16.5
Income from Local-sale (10 ⁶ Kips)	1,078	1,271	1,505	1,767	2,081	2,452	2,852	3,278	3,795	4,389
Tariff for Export (\$/GWh)*5	43,760	47,698	51,991	56,670	61,771	67,330	73,390	79,995	87,195	95,042
Income from Export (10 ³ \$)	30,280	32,480	34,780	37,180	39,660	42,350	45,210	48,400	51,710	55,120

Note: *1 Average Annual Production except for dry year.

*2 Energy Loss on transmission and distribution lines and Energy consumed by P.S. and S.S.: 6%.

*3 From TABLE-7.

*4 Tariff increment assumed at 10% annum.

*5 Present annual increment rate of 9% assumed to be maintained.

FIGURES

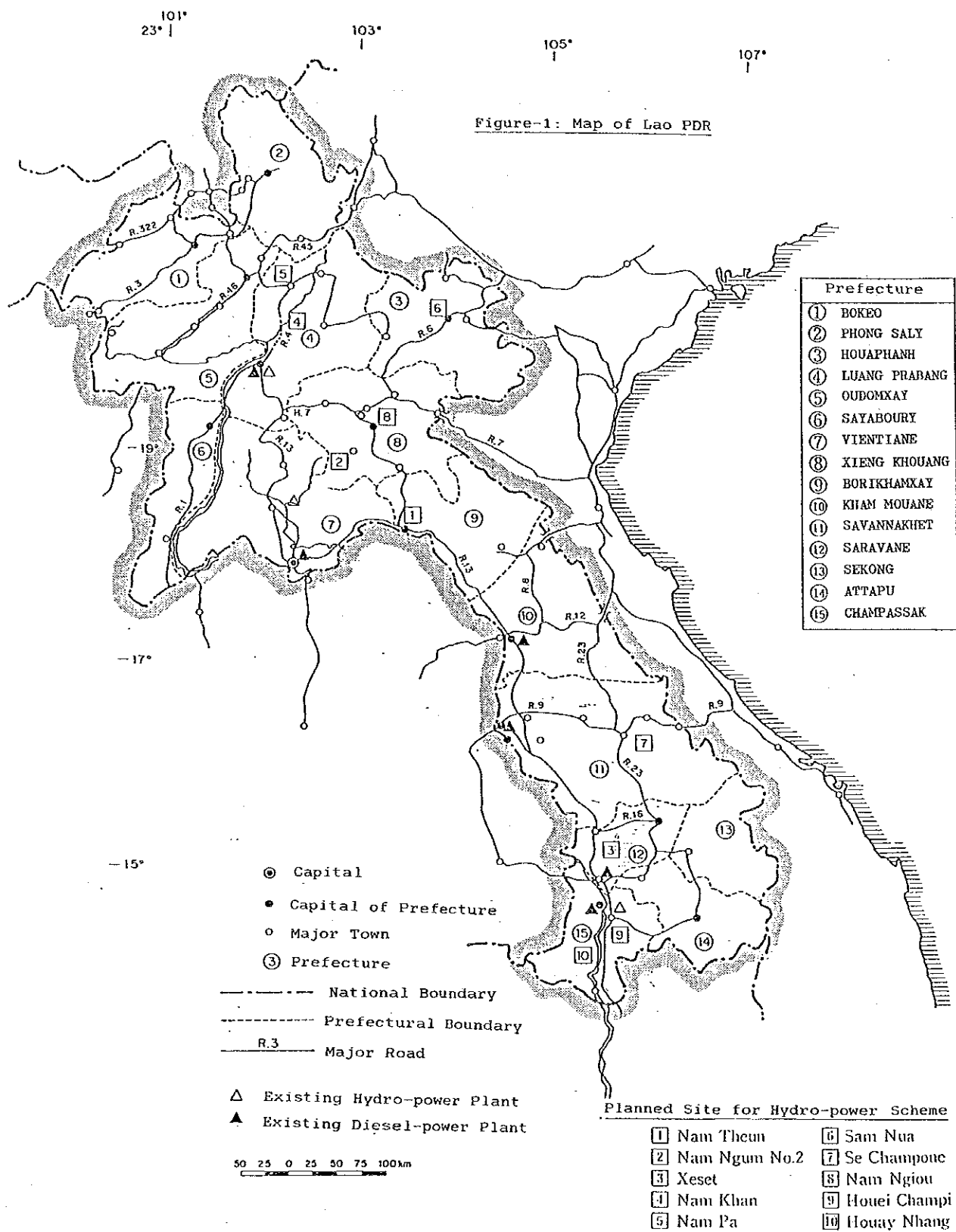
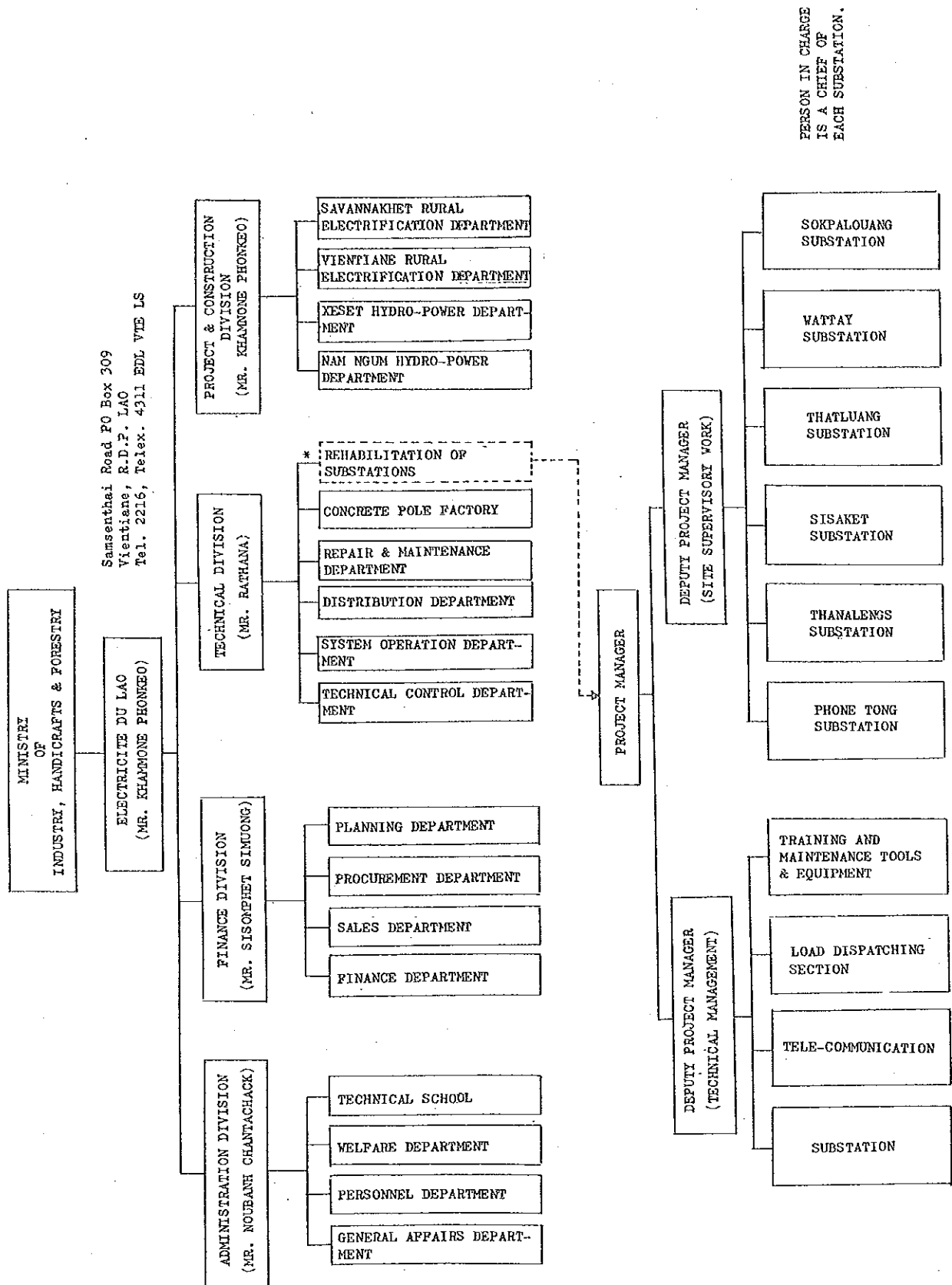
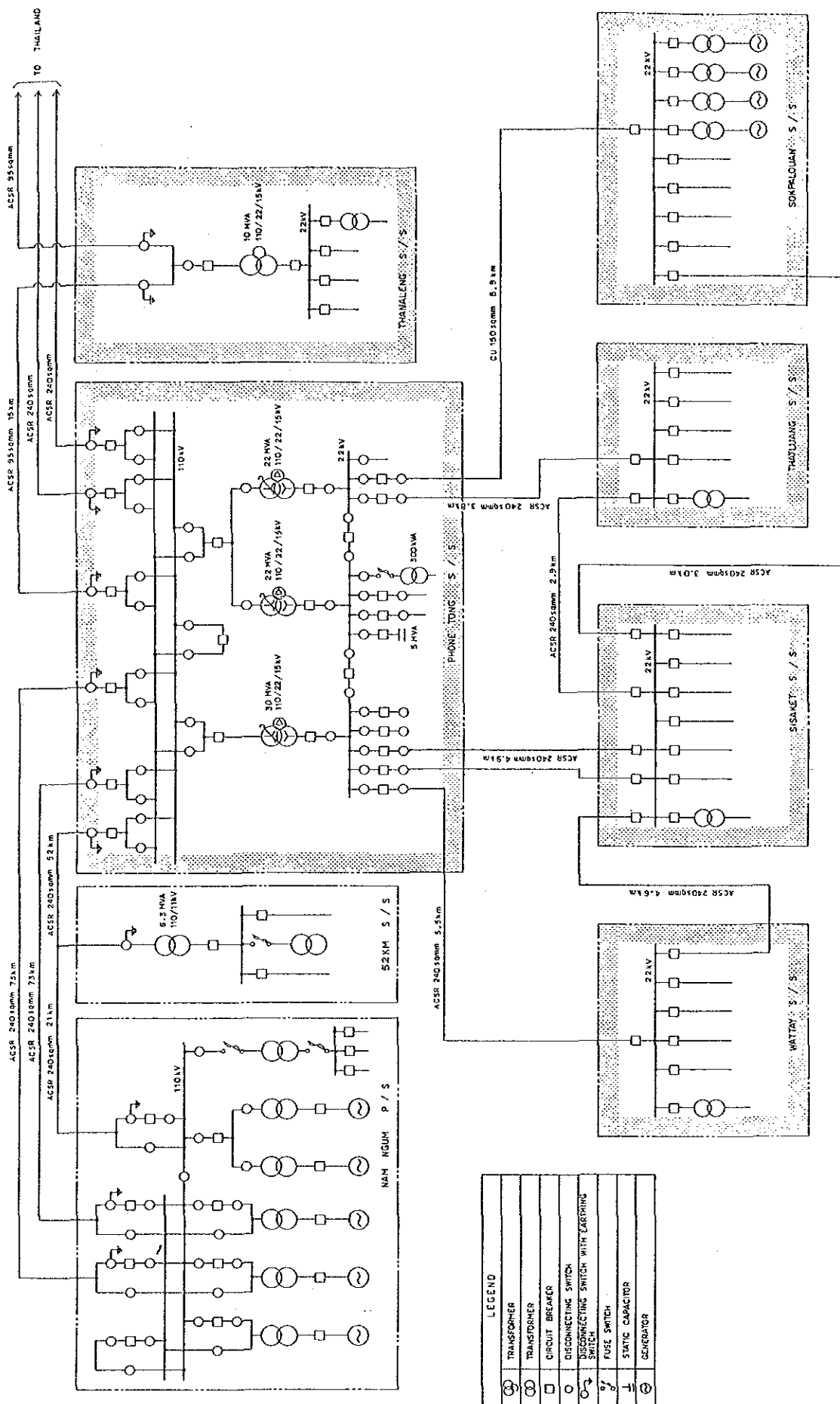


Figure- 2 Organization of Whole EDL & Rehabilitation Project





POWER SYSTEM OF
NAM NGUM

Figure- 3

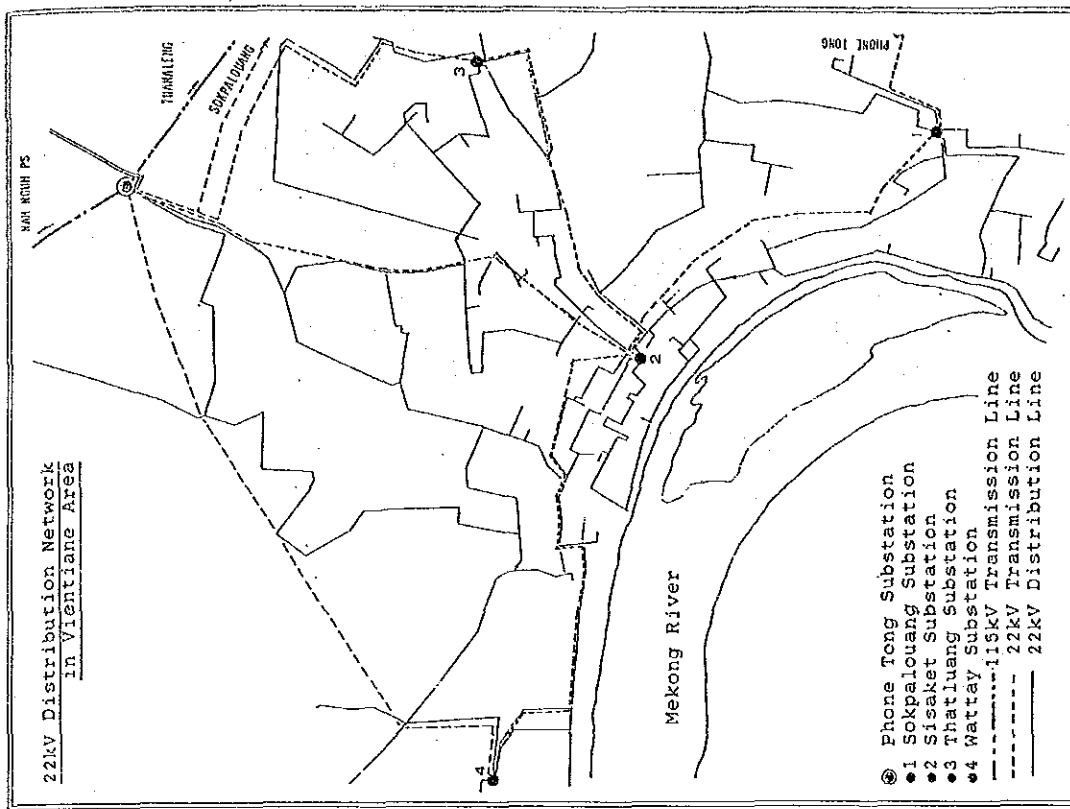
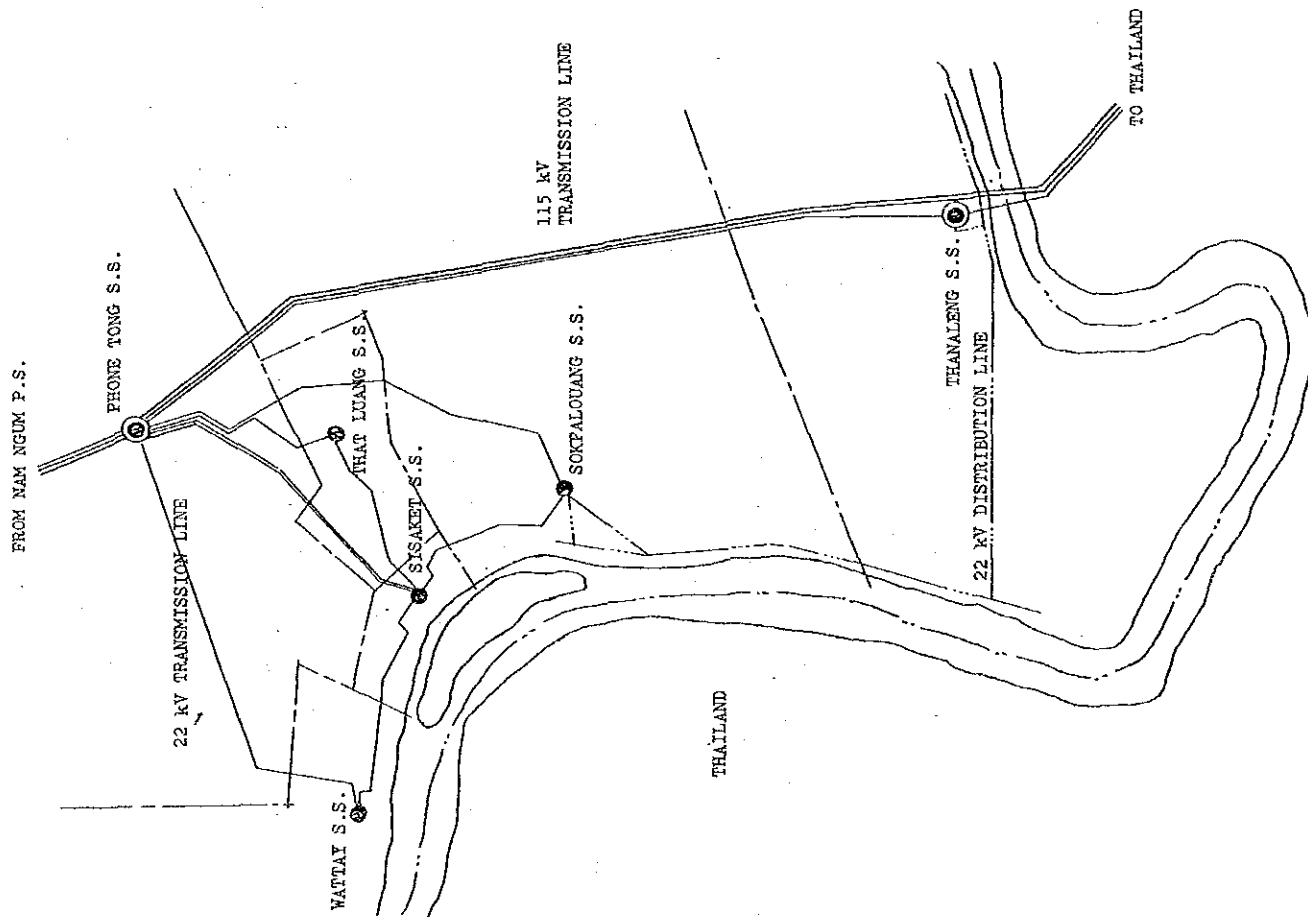


Figure- 4-1 Distribution Network in Vientiane



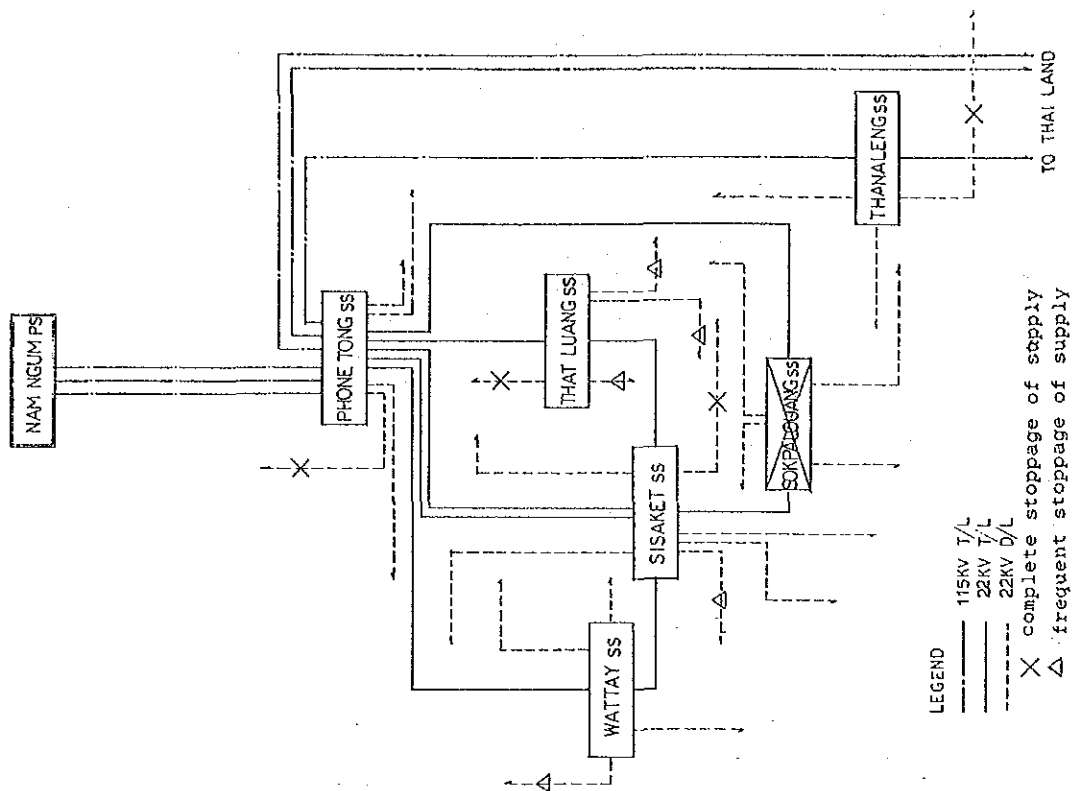
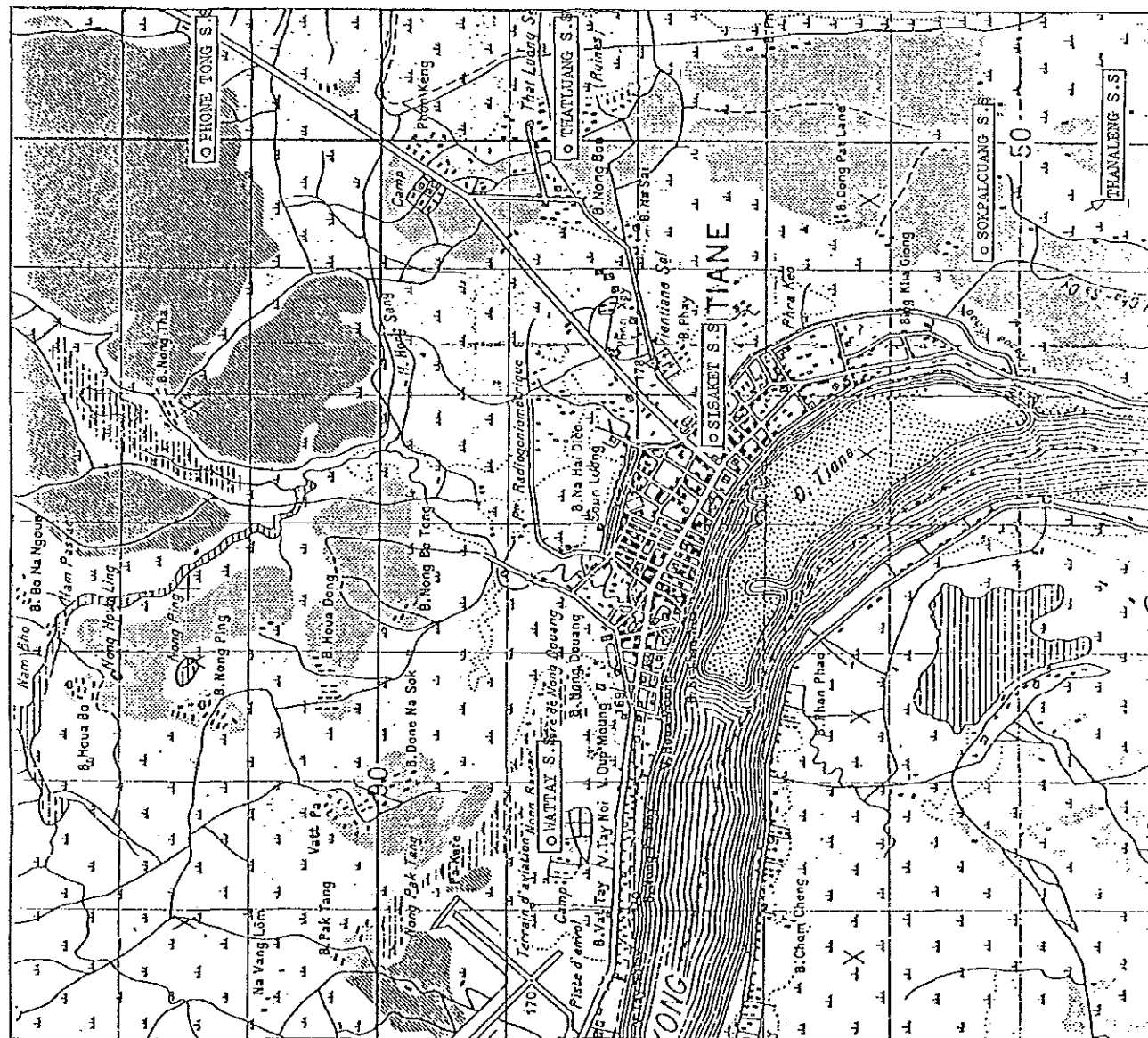
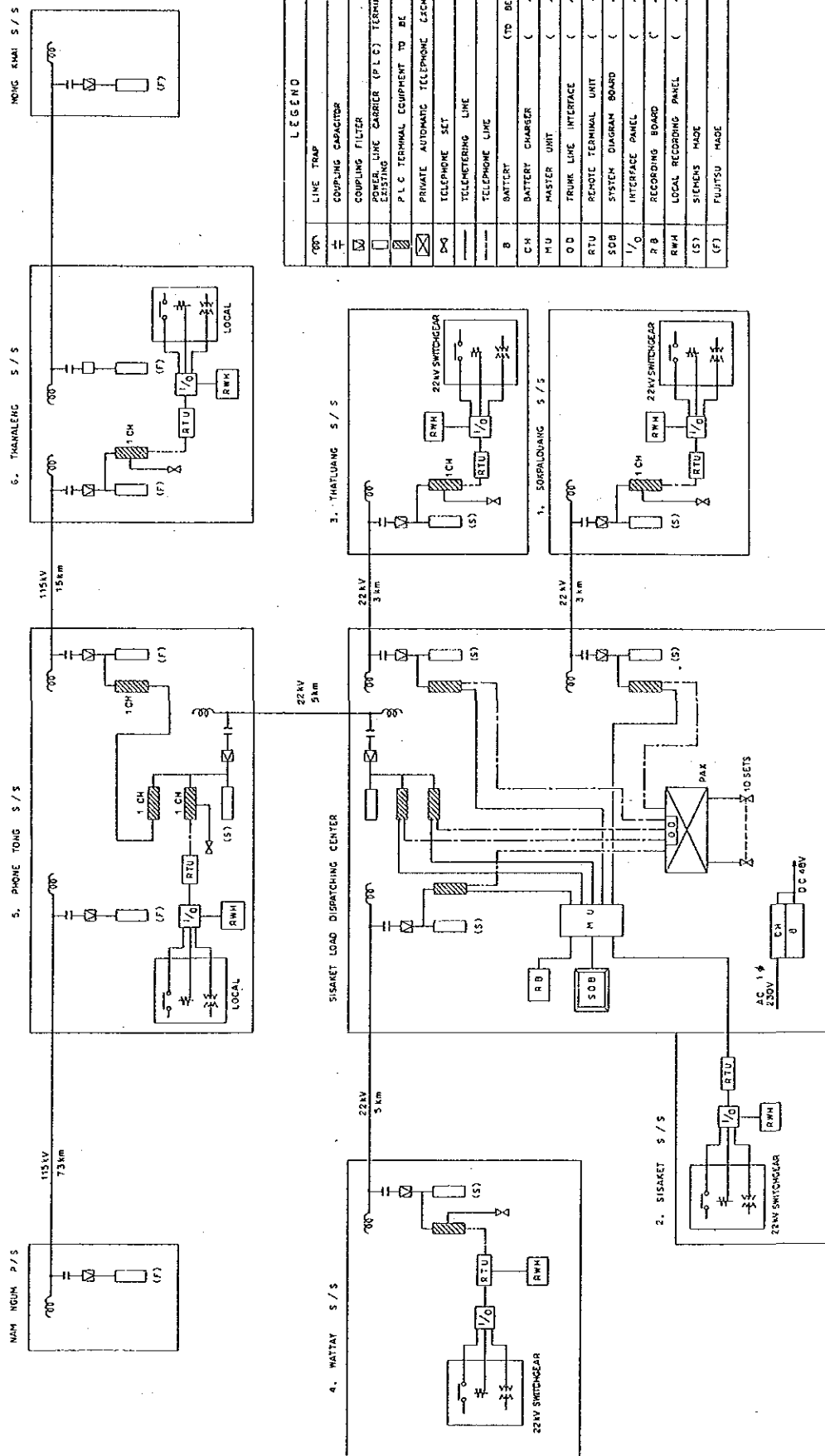


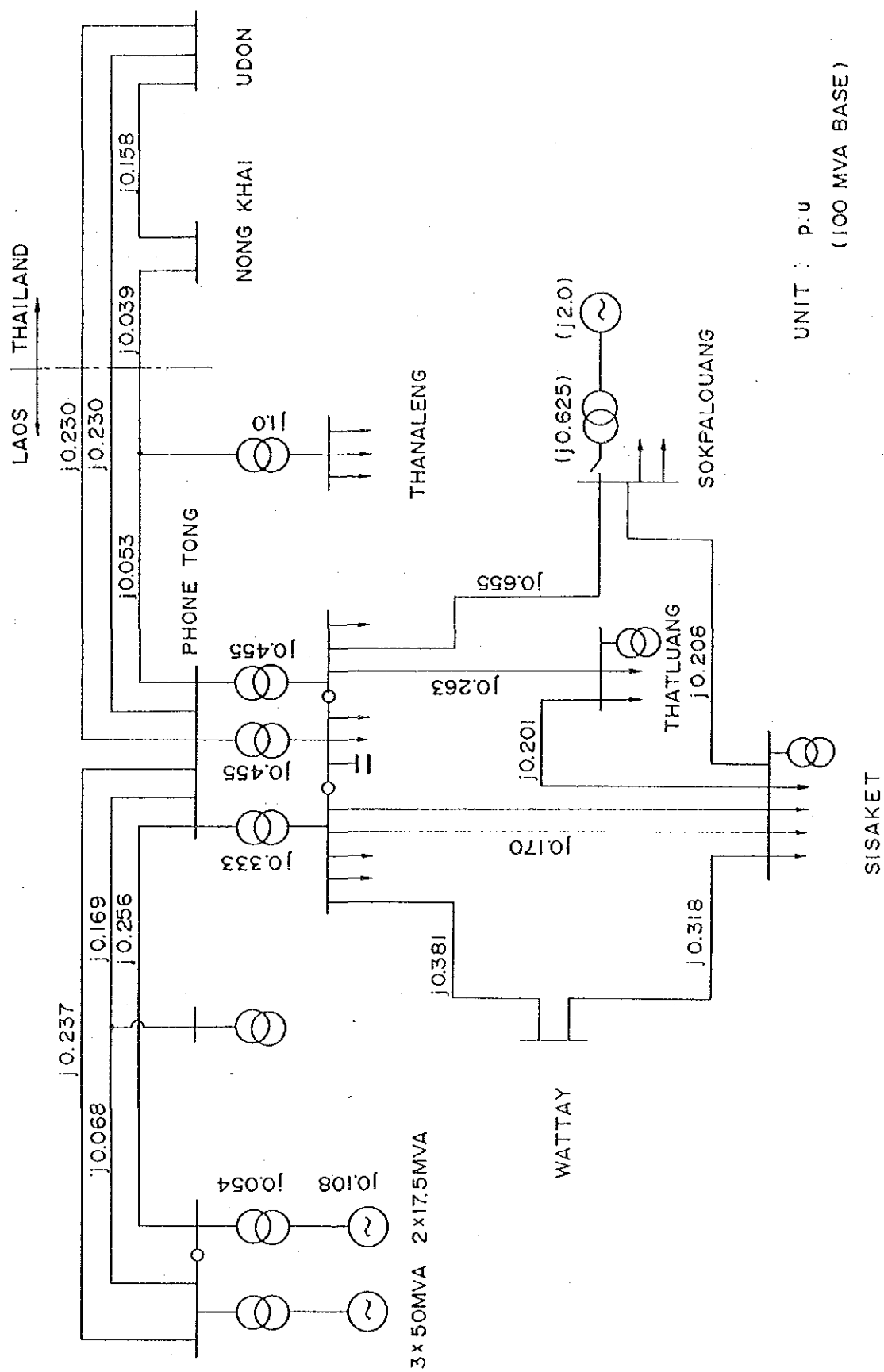
Figure- 4-2 Power System in Vientiane Area



LEGEND	
	LINE TRAP
	COUPLING CAPACITOR
	COUPLING FILTER
	POWER LINE CARRIER (PLC) TERMINAL EQUIPMENT
	PRIVATE AUTOMATIC TELEPHONE EXCHANGE
	TELEPHONE SET
	TELEMETRY LINE
	TELEPHONE LINE
	BATTERY
	BATTERY CHARGER
	MASTER UNIT
	TRUNK LINE INTERFACE
	REMOTE TERMINAL UNIT
	SYSTEM DIAGRAM BOARD
	INTERFACE PANEL
	RECORDING BOARD
	LOCAL RECORDING PANEL
	SIEMENS MADE
	FUJITSU MADE

TELE-SUPERVISION AND
COMMUNICATION SYSTEM
DIAGRAM

Figure- 5



IMPEDANCE MAP OF POWER SYSTEM FOR SHORT CIRCUIT CALCULATION

Figure- 7 Daily Load Curve

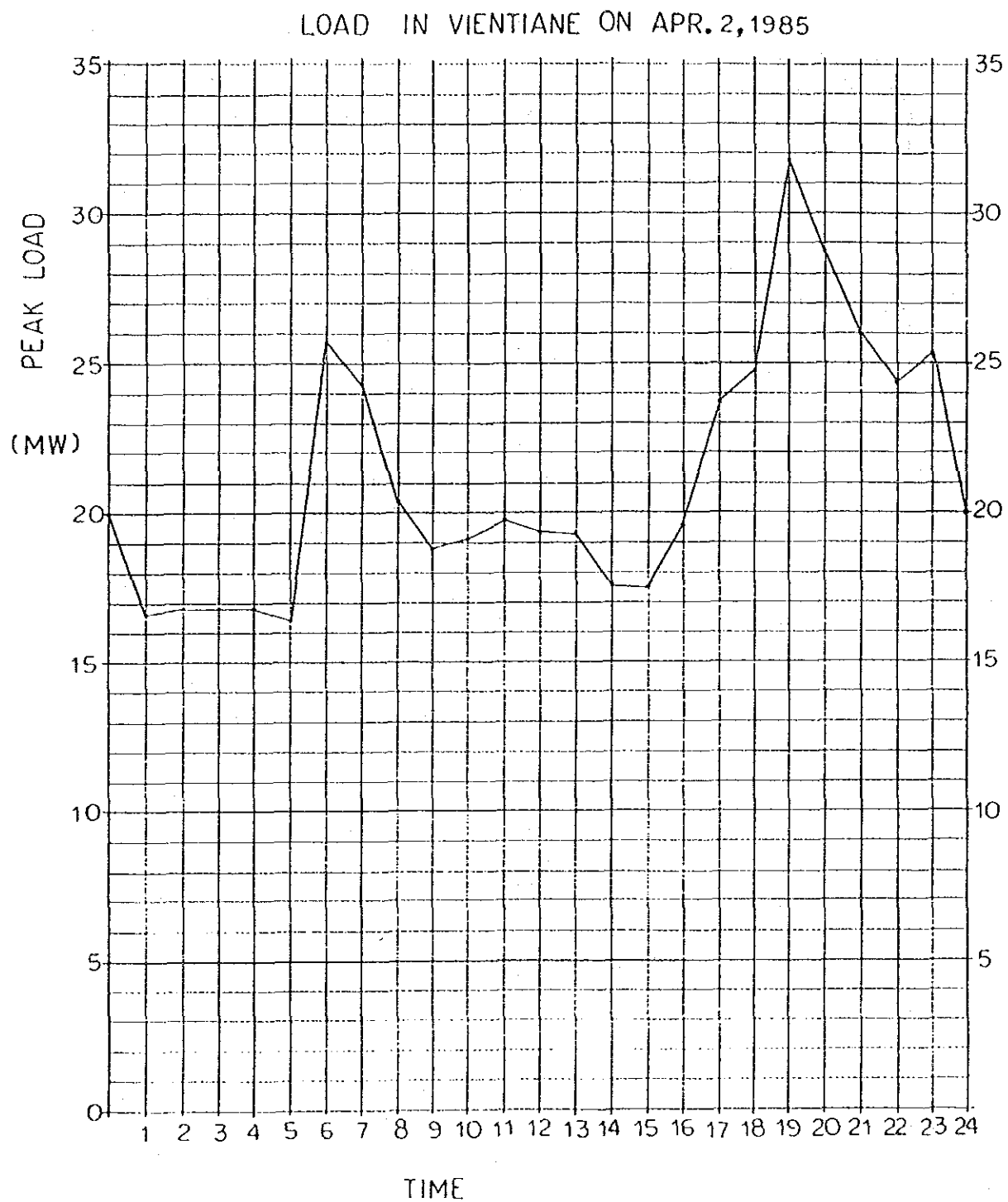


Figure- 8 Annual Load Curve

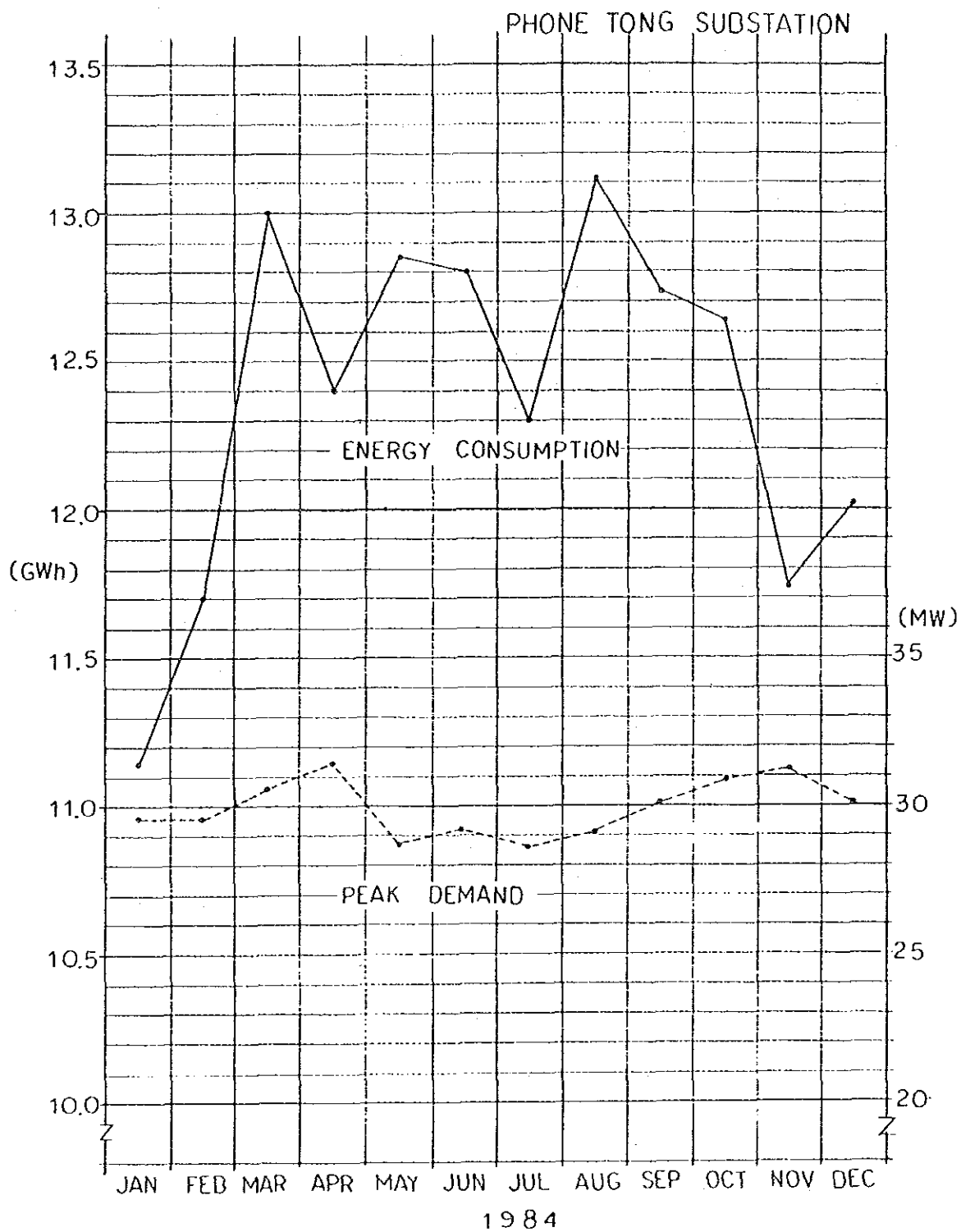


Figure- 9 Power Demand and Forecast

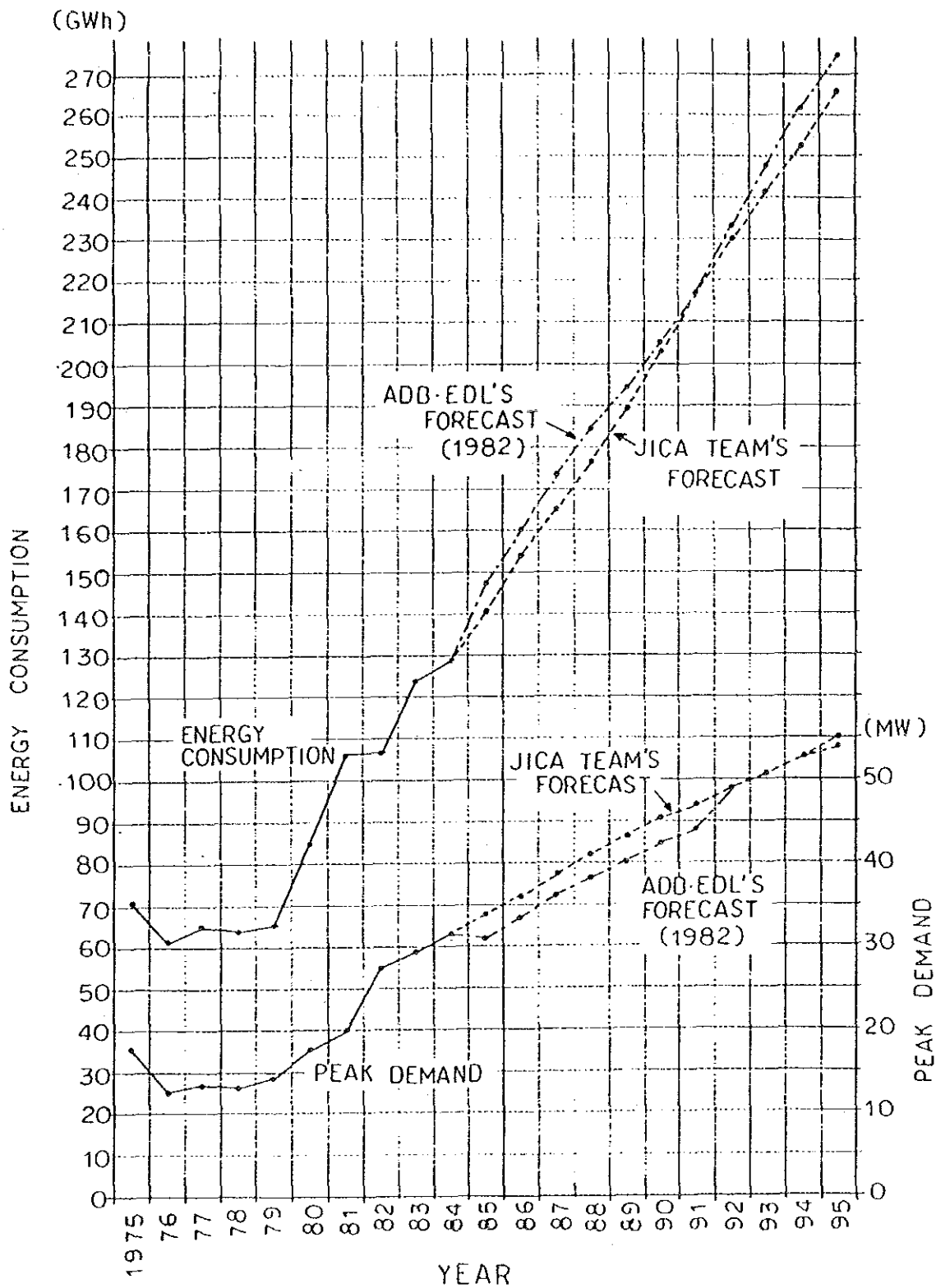
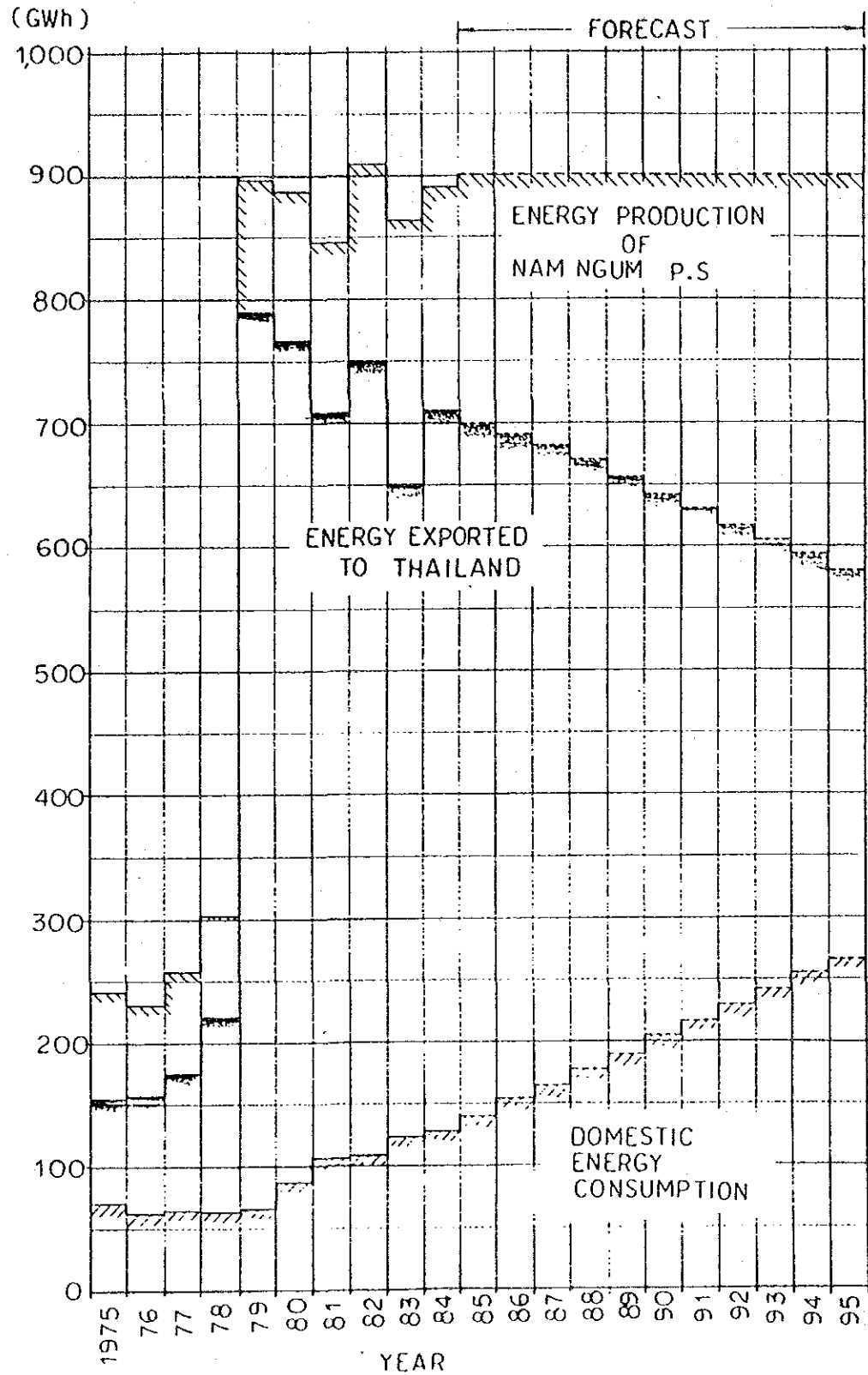
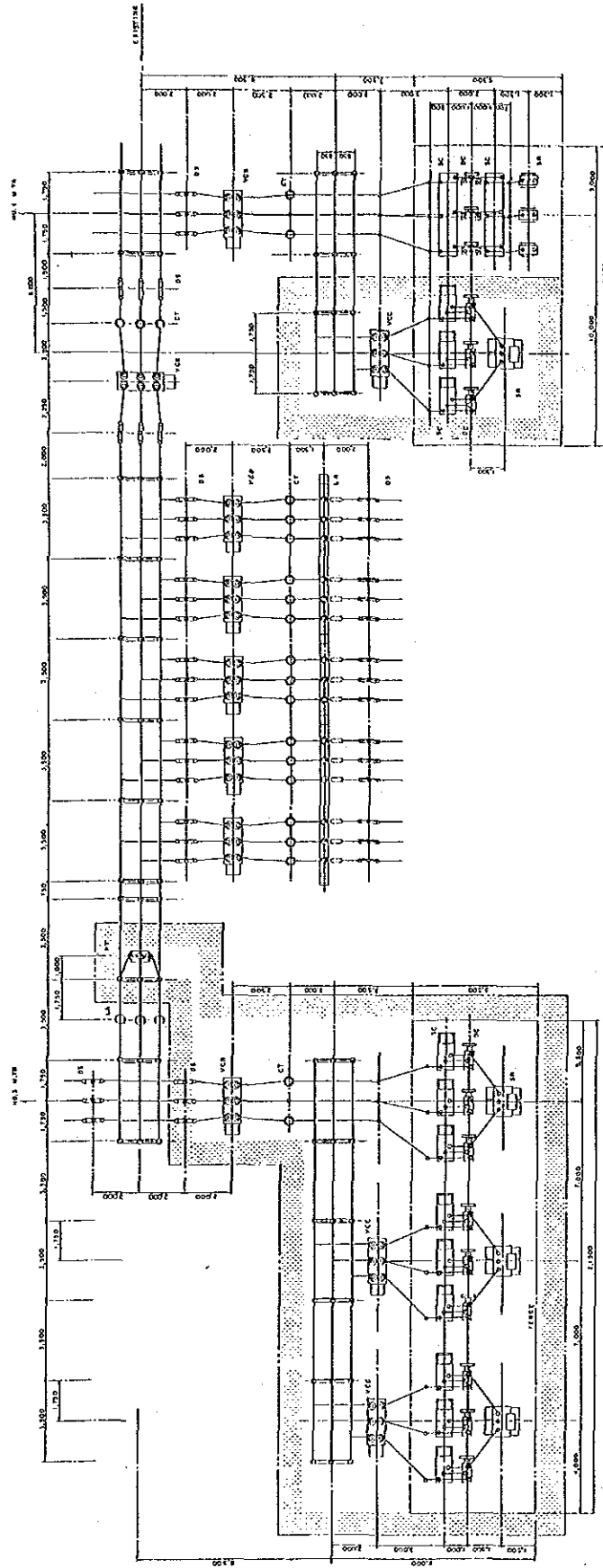


Figure-10 Record of Annual Energy Export





LAYOUT OF 22KV YARD
IN
PHONE TONG SUBSTATION

Figure-12

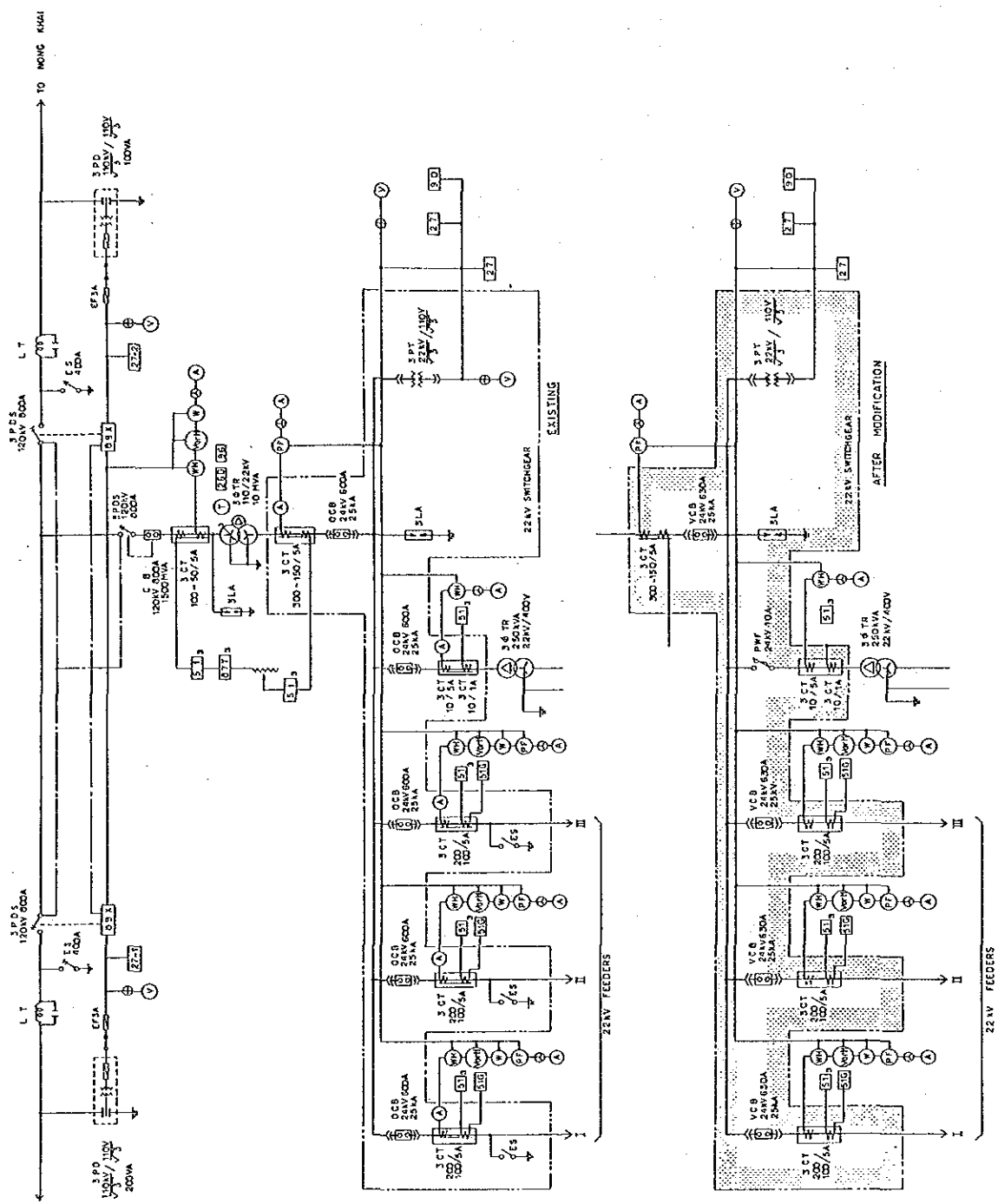
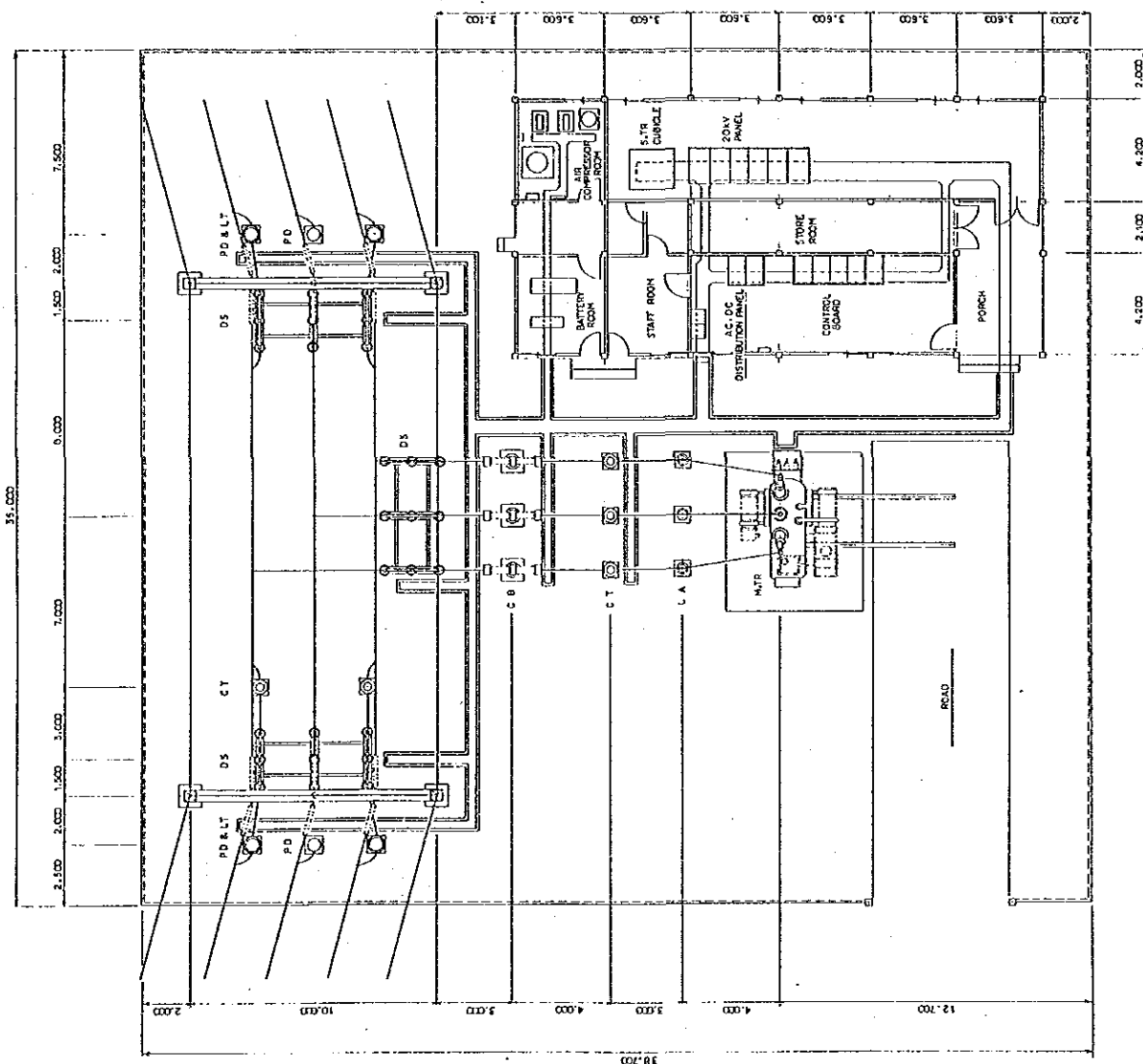
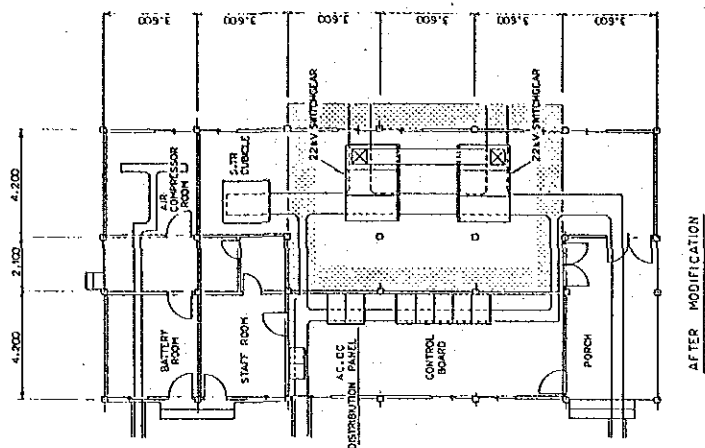


Figure-13

SINGLE LINE DIAGRAM
OF
THANALENG SUBSTATION



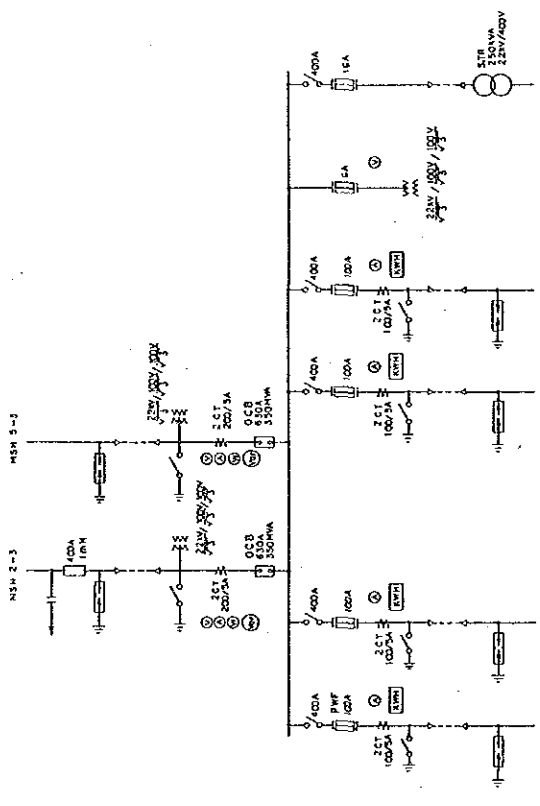
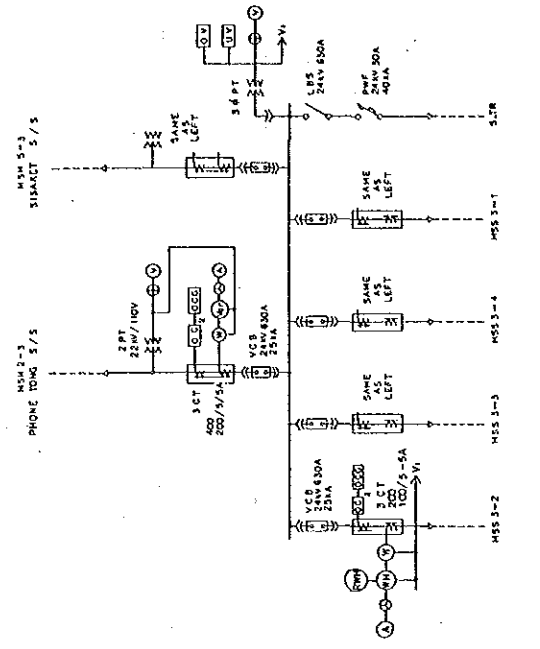
EXISTING



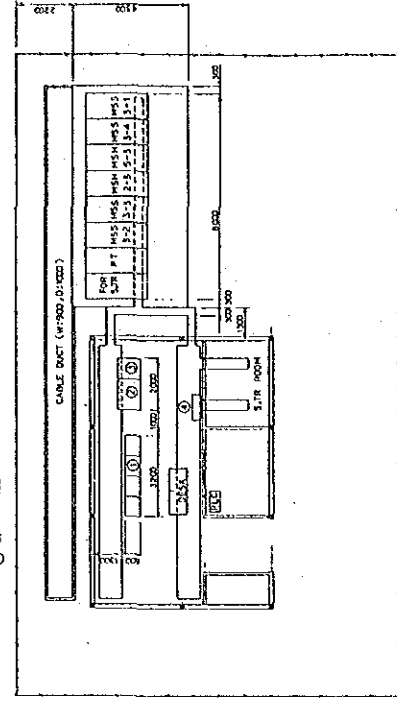
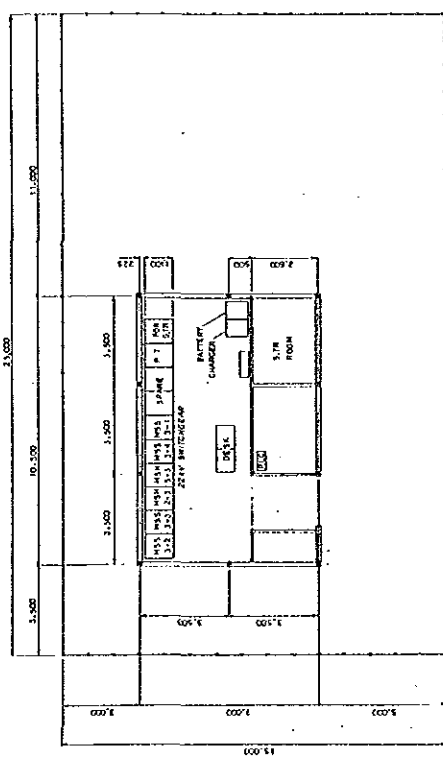
AFTER MODIFICATION

LAYOUT OF THANALENG
SUBSTATION

Figure-14



- ① CONTROL AND RELAY PANEL
- ② DC 100V BATTERY AND CHARGER
- ③ DC 48V BATTERY AND CHARGER
- ④ L/V PANEL



EXISTING

AFTER MODIFICATION

Figure-15
SINGLE LINE DIAGRAM AND
LAYOUT OF
THATLUANG SUBSTATION

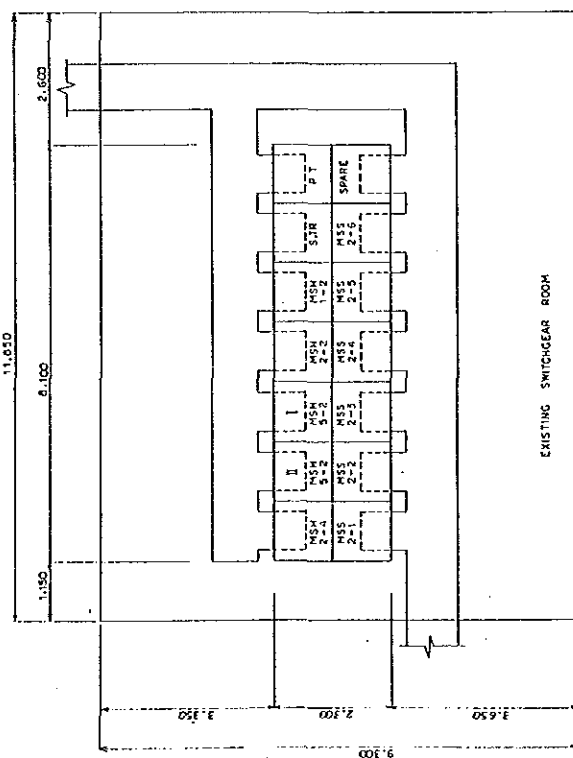
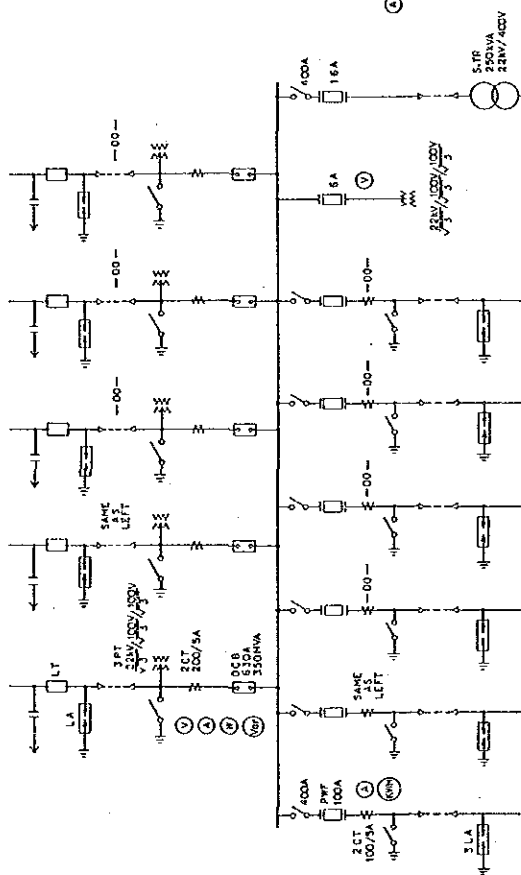
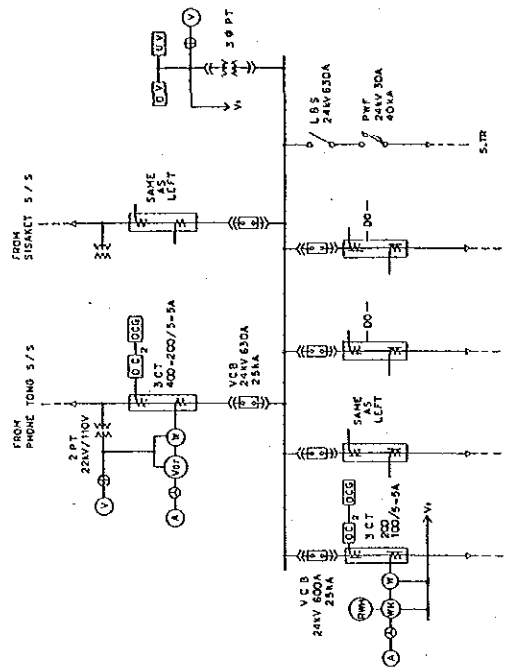
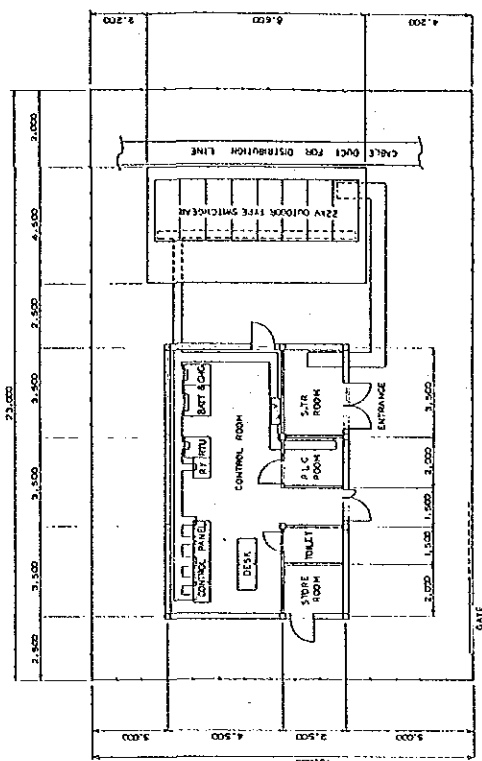


Figure-16



AFTER MODIFICATION

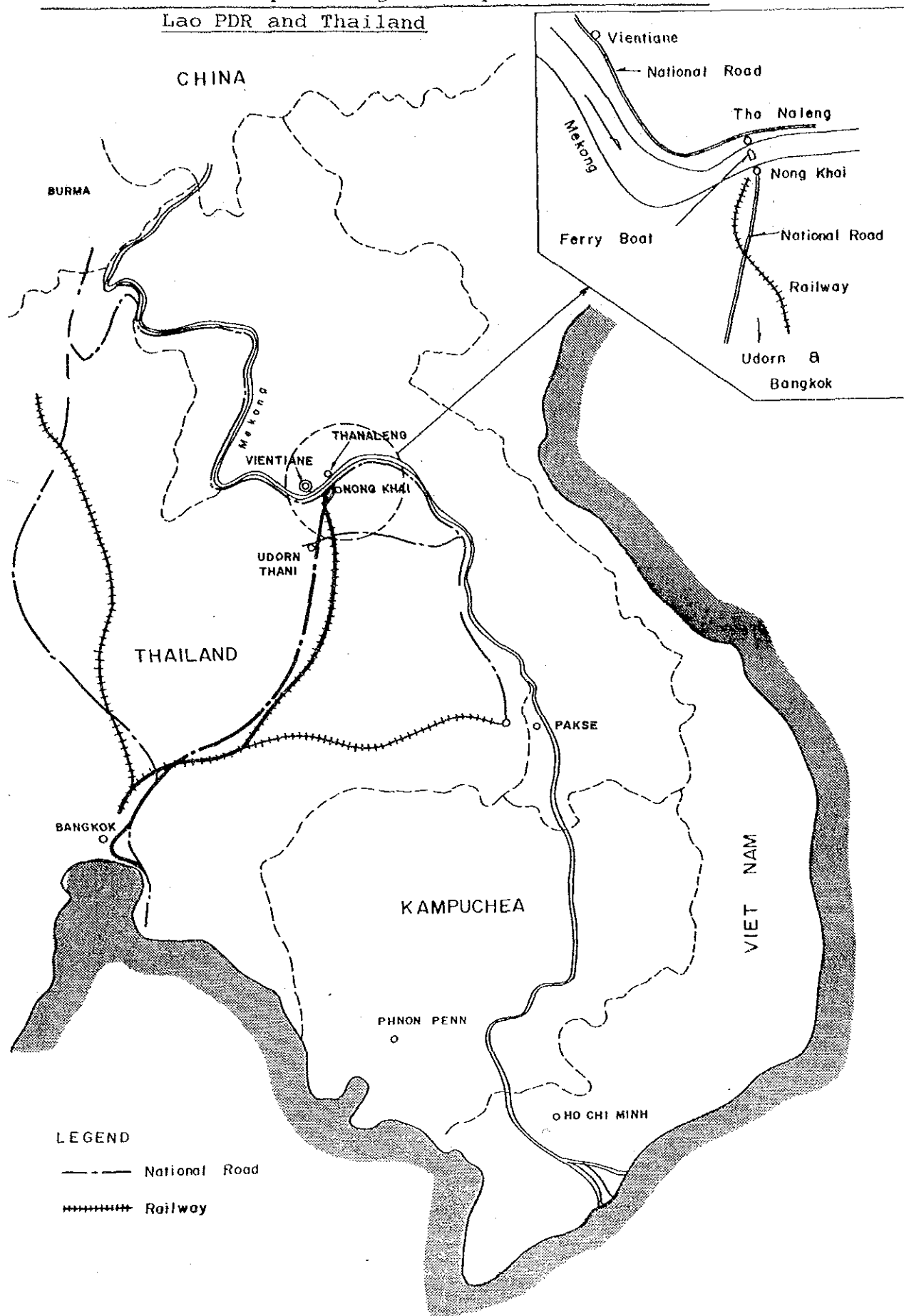


AFTER MODIFICATION

SINGLE LINE DIAGRAM AND LAYOUT OF WATTAY SUBSTATION

75-10417

Figure-18 Route Map of Cargo Transportation between
Lao PDR and Thailand



APPENDICES

APPENDIX - 1
GENERAL AND SOCIAL SITUATION OF LAO PDR

(1) General Situation

Lao PDR is situated at the center of Indo-China Peninsula and landlocked in the extent of 1,000 km north-southward being surrounded by Vietnam, Cambodia, China, Thailand and Burma.

Most of the country's territory in 236,800 km² is covered by the Annan mountains stretched southward from the Yunnan Heights and her plain exists only around the basins of the Mekong river and its tributaries. The highland in the northern area of the country is on the altitude of about 2,000 m, but the southern area is on the gently sloped highland.

Vientiane, capital of Lao PDR, facing to Thailand beyond the Mekong river is situated at the center of Vientiane plain and also of the country.

The climate of the country is the tropical monsoon and distinctly divided into two seasons of dry and rainy. The rainy season is normally from May to October giving an annual average rainfall of 1,600 mm.

The highest shade temperature is recorded in April, exceeding, in some years 40°C. Minimum shade temperatures are normally recorded in November to February and the lowest temperature ever recorded was 4.7°C in 1974. There is not a big difference in the maximum temperature of each month, while considerable difference is recorded in the minimum temperature of each month.

Agriculture is one of the principal industries mainly producing rice, maize, cotton and tobacco by peoples equivalent to 73% of the total working population, of 1,830,000 in 1982. Especially, rice is produced in about 90% area of the total cultivated land and the growth of rice production has been significant. It's production reached 1,180,000 tons in 1982 which has almost achieved 100 per cent of self-sufficiency.

Manufacturing industry of the country is mainly a light industry, producing consumable goods and daily necessities.

Table 1 Production of Agriculture and Forestry

	1978	1980	1982
<u>Area of Land (1,000 ha)</u>			
Territory	23,680	23,680	23,680
Land	23,080	23,080	23,080
Cultivated land	865	880	890
Grassland	800	800	800
Forest	13,200	13,000	12,800
Others	8,215	8,400	8,590
<u>Agricultural Products (1,000 ton)</u>			
Rice	735	1,053	1,184
Maize	30	28	38
Potato	28	34	40
Cassava	55	68	72
Sweet potato	22	28	30
Peanut	7	8	9
Cotton	2	10	11
<u>Livestock (1,000)</u>			
Horse	28	32	36
Cattle	389	447	473
Pig	823	1,111	1,223
Goat	40	49	56
Water buffalo	685	853	897
Chicken	4,400	4,601	5,863
Duck	190	210	230
Goose	47	53	58
<u>Wood (1,000 cu.m)</u>			
Industry	228	223	225
Fuel	3,240	3,436	3,585

Source: Report of FAO (1984)

(2) Social Situation

Population of Lao PDR is recorded at 3,584,800 in census of Mar. 1985 and its average annual growth rate was 2.9 per cent. Density of population per km² is 15 persons.

Population (March 1, 1985)

Total population	3,584,803 Female 1,827,688 ; Male 1,757,115	
Vientiane municipality	377,409	10.53%
Vientiane prefecture	264,277	7.37%
Phongsaly prefecture	122,984	3.43%
Luang Namtha prefecture	97,028	2.71%
Oudomxay prefecture	187,115	5.22%
Bokeo prefecture	54,925	1.53%
Luang Prebang prefecture	295,475	8.24%
Houaphanh prefecture	209,921	5.86%
Sayaboury prefecture	223,611	6.24%
Xieng Khouang prefecture	161,589	4.51%
Borikhamxay prefecture	122,300	3.41%
Khammouane prefecture	213,462	5.96%
Savannakhet prefecture	543,611	15.16%
Saravane prefecture	187,415	5.23%
Sekong prefecture	50,909	1.42%
Champassak prefecture	403,041	11.24%
Attapu prefecture	69,631	1.94%

Population by age:	0 - 15	47%
	16 - 60	47%
	61 and over	6%

Increase rate	:	Birth	46 per 1,000 persons
		Death	17 per 1,000 persons
		Increase	29 per 1,000 persons (2.9%)

Source: Report on the Economic and Social Situation Development
Strategy and Assistance Requirements, UNDP Vientiane 20.9.'85.

Most of Governmental offices are founded in Vientiane city which is inhabited by 11% of total population. Thus, Vientiane is a center of politics, culture, commerce and traffic in the country.

A pharmaceutical development center is being constructed under Japan's grant aid program, and other projects such as a rural electrification in Vientiane area, repair of roads, irrigation, etc. are also under way with financial assistances of ^{the} World Bank and other countries.

There are four hospitals in Vientiane city and a hospital with 150 beds is being constructed.

APPENDIX - 2

POWER DEMAND FORECAST

Power demand forecast for the area was conducted over analysis on tendency of the past demand growth rates of various sectors in Vientiane area. A new large demand confirmed to be connected to the existing system was separately added to the forecast conducted as above. As the results, it was forecasted that total energy demand in the area will increase at an annual growth rate of 7 per cent, which is almost the same as was forecasted by a mission of ADB and EDL in 1982 (Table - 4).

Demand sectors in the area were classified into three (3);

- (1) General, commercial and public, (2) industry and (3) agriculture.

Demands for general, commercial and public use were forecasted in combination because of no records for separate demand in EDL, although those demands are usually separated.

- (1) General, commercial and public demands

An average annual growth rate during the last 5 years (1980 - 1984) was 14 per cent. Meanwhile, the rate in 1984 dropped down to 10 per cent due to failures of substations.

Energy tariffs of the country were revised in 1985 to 50 times as high as the previous tariff for public demand and to 17.5 times for other demands.

Under such circumstances, the growth rate at a level of 14 per cent will not be expected to be maintained even after completion of projects for the substation rehabilitation and the rural electrification.

In the forecast, the annual growth rate for 1985 was assumed to be 10 per cent, leveled with that in 1984, while 5 per cent growth is assumed for 1986 and 1987 (project execution period) and 8 per cent growth from 1988 through 1990 during which increased demand is expected to appear as effects of the projects. In and after 1991, the growth rate are expected to fall gradually to 5 - 6 per cent unless a rapid growth occurs in the national income.

(2) Industrial demand

The growth rates of the sector were negative during the period from 1982 to 1984.

Assuming that the demand will gradually increase following the Government policy for promotion of industrial development, 2 per cent growth till 1987, 4 to 5 per cent growth in and after 1988 owing to the effects of the projects were assumed.

The pharmaceutical development center under the Japan's Grant Aid Program is scheduled to complete its first phase in 1986 and its second phase in 1987. The center is to be connected to the system with the peak demand of 3,000 kW and accordingly the demand was separately added to the forecast.

(3) Agricultural demand

The average growth rate after 1980 was 15 per cent per annum. The rate fluctuated widely and the average annual growth was 6 per cent in the last 2 years.

In this forecast, expecting gradual growth on the promotion of development policy of the Government, the rates of 5 to 7 per cent for the years from 1985 to 1989, 8 per cent for the years of 1990 and 1991, and 10 per cent for the years in and after 1992 were assumed.

The above forecasts resulted in the estimate of an average annual growth rate of total electric power demand to be 7 per cent.

APPENDIX-3 MEMBER OF BASIC DESIGN STUDY TEAM

Member of the basic design study team are as below:-

Leader : Mr. H. Manabe

Members : Mr. K. Nakajima & Mr. H. Kodama

The team leader was mainly engaged in the following tasks;

- explanation of the team's purpose for study to the Government of Lao PDR
- explanation of Japan's Grant Aid Program to the Government of Lao PDR
- review of the study results and discussion with the Government of Lao PDR

The members were mainly engaged in the following tasks;

- detailed technical discussions with the staff of EDL
- inspection on the equipment and materials in each substation for the project
- inspection on the equipment, materials and tools kept by EDL
- preparation of the Basic Design Report for the Project

APPENDIX-4 SCHEDULE OF BASIC DESIGN STUDY TEAM

NRT : Narita, Japan
BKK : Bangkok, Thailand
VTE : Vientiane, Lao PDR

DATE	Mr. H. Manabe	Mr. K. Nakajima	Mr. H. Kodama
Dec. 8 (Sun.)		NRT - BKK	
Dec. 9 (Mon.)		BKK - VTE	
Dec. 10 (Tue.)		Courtesy call and explanation of the project to Japanese Embassy	
Dec. 11 (Wed.)		Courtesy call on the Ministry of Foreign Affairs, Lao PDR and EDL General Survey to Phone Tong, Thanaleng, Sokpalouang and Thatluang substations	
Dec. 12 (Thu.)		Explanation of the inception report to EDL and detailed survey at Phone Tong substation	
Dec. 13 (Fri.)		Detailed survey at Phone Tong substation	
Dec. 14 (Sat.)		Detailed survey at Phone Tong substation	
Dec. 15 (Sun.)		Visit to Nam Ngum No.1 Power Station and 52 km substation	
Dec. 16 (Mon.)		Drafting of "minutes of discussions"	
Dec. 17 (Tue.)		Meeting with EDL on the draft minutes of discussions	Detailed survey at Thanaleng and Thatluang substations
Dec. 18 (Wed.)		Technical discussions with EDL. Minutes signing between EDL and the Team. Report on Minutes of Discussions to Japanese Embassy	
Dec. 19 (Thu.)	VTE - BKK	Collection of records of substations and power statistics	
Dec. 20 (Fri.)	BKK - NRT	Technical discussion with EDL	Survey on warehouses at Phone Tong and Sokpalouang substations
Dec. 21 (Sat.)	-	Market price survey	Technical discussion with EDL
Dec. 22 (Sun.)	-	Survey on Thadua port and concrete pole factory of EDL	Collection of substations records
Dec. 23 (Mon.)	-	Collection of records of substations and discussion with EDL on implementation program	
Dec. 24 (Tue.)	-	Collection of records and drawings, and discussion on rehabilitation items	
Dec. 25 (Wed.)	-	Final discussion with EDL and report the survey results to Japanese Embassy	
Dec. 26 (Thu.)	-	VTE - BKK	
Dec. 27 (Fri.)	-	BKK - NRT	

APPENDIX-5 NAMES OF LAO PDR OFFICIALS WITH WHOM THE
TEAM DISCUSSED

The Ministry of Foreign Affairs:

Mr. Phuiphan	:	Director of the 2nd Bureau
Mr. Akhom	:	Chief of Section

Electricite du Lao:

Mr. Khammone Phonekeo	:	General Manager
Mr. Sisomphet Simuong	:	Deputy General Manager
Mr. Noubanh Chanthachack	:	Deputy General Manager
Mr. Khamphone Saignasane	:	Manager of Technical Control Department
Mr. Bountheo Phommaseisy	:	Manager of System Operation Department
Mr. Houm Phone	:	Manager of Nam Ngum Hydro-Power Department
Mr. Vattana	:	Manager of Planning Department
Mr. Phayline	:	Deputy Manager of Finance Department

APPENDIX-6 MINUTES OF DISCUSSIONS

MINUTES OF DISCUSSIONS

ON

the Rehabilitation project of substations

In Vientiane Area.

LAO PEOPLE'S DEMOCRATIC REPUBLIC


In response to the request made by the Government of the Lao People's Democratic Republic for a grant aid of the rehabilitation project of substations in Vientiane area (hereinafter referred to as «The Project»), the Government of Japan has dispatched, through the Japan International Cooperation Agency (JICA), a survey team headed by Mr. Hiroshi MANABE, official of the Ministry of Foreign Affairs, Japan (hereinafter referred to as «The team») to conduct the basic design study on the Project for 18 days from December 9; to December 26, 1985.

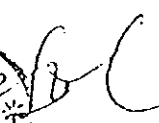
The Team has carried out a field survey, had a series of discussions and exchanged views with the Laotian authorities concerned of the Project.

As a result of the survey and discussions, the Team and the Laotian authorities have agreed to recommend to their respective Governments that the results of the discussions attached herewith should be examined toward the realization of the Project.

Vientiane, December 18, 1985

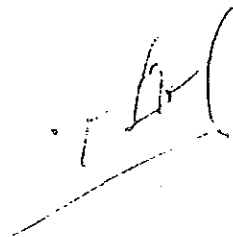



Mr. Hiroshi MANABE
Team Leader
Japanese Survey Team


Sisomphet SIMUONG
Deputy General Manager
ELECTRICITE DU LAOS

ATTACHEMENT

1. The objective of the Project is to provide equipments and vehicles for implementation of the stable and reliable operation of the substations in Vientiane area so as to improve the public welfare in Lao People's Democratic Republic and the power supply to Thailand.
2. Laotian authorities concerned will have total responsibility to implement the Project in the Laotian side.
3. The team will convey the desire of the Government of Lao People's Democratic Republic to the Government of Japan that the Government of Japan will take necessary measures to cooperate in implementing the Project within the scope of Japan's Economic Cooperation Program in grant form.
4. The Laotian authorities concerned have confirmed that the Government of Lao People's Democratic Republic will take necessary measures as listed in Annex II on condition that the grant aid by the Government of Japan is extended to the Project.
5. The Laotian authorities concerned have understood and confirmed Japan's Grant Aid System explained by the Team.
6. The objective facilities of the Project are Phone Tong, Thanaleng, Thatluang, Sisaket, Wattay and Sokpalouang substations.
7. Equipments and vehicles to be provided will be finalized by the Government of Japan based on the request of the Laotian side and the result of the study.



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ANNEX I

Equipments, vehicles and services requested by the Government of Lao People's Democratic Republic whose cost will be borne by the Government of Japan are :

1. Phone Tong Substation

1-1. 115 KV Transformer and 115 KV Switchgears

- a) Repair of oil leakage and addition and purification of oil
- b) Repair and replacement of auxiliary equipment and accessories

1-2. 22 KV Switchgears

- a) Replacement of oil circuit breakers
- b) Addition of lightning arresters and static condensers
- c) Repair and replacement of auxiliary equipment and accessories

1-3. Control Room and Air-compressor

- a) Repair of control desks and boards
- b) Repair and replacement of air-compressors and panel
- c) Addition of batteries

2. Thanaleng Substation

2-1. Repair of 115 KV transformer and switchgears including oil purification

2-2. Repair of distribution panel and other accessories

3. Thatluang, Sisaket and Wattay Substations

3-1. Repair or replacement of distribution panels

3-2. Replacement of batteries

4. Repair of total system telemetering and telecontrol panels including Sokpalouang substation

5. Repair of PLC telecommunication system

6. Spare parts of switchgears and testing-measuring apparatus

7. Spare for 22 KV power cable and control cables

8. 4 units of vehicles for maintenance-use with mobile radio and one base-station radio

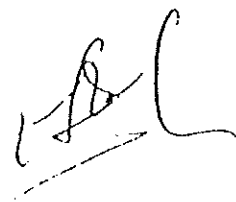
9. Training of operators for operation and maintenance of substations



ANNEX II

Following measures are to be undertaken by the Government of Lao People's Democratic Republic

1. To provide data and information necessary for basic design.
2. To ensure prompt unloading, tax exemption, and customs clearance at the port of disembarkation in Lao People's Democratic Republic and prompt internal transportation of the imported equipments, vehicles and materials for the Project.
3. To exempt Japanese nationals concerned from customs duties, internal taxes and other fiscal levies which may be imposed in Lao People's Democratic Republic with respect to the supply of the products and services under the verified contracts.
4. To provide and accord necessary permission, licences and other authorization required for the Project.
5. To bear all the expenses other than those to be borne by the grant, necessary for the execution of the Project.
6. To maintain and use properly and effectively the equipment and vehicles for the Project.



APPENDIX-7 INSPECTION ITEMS ON EQUIPMENT

I. MAIN TRANSFORMERS

(1) Main tank

damages, deformation, corrosion on body and accessories, and loosening or missing of bolts and nuts

(2) Measurement of insulation resistance for

- main circuit : between primary and secondary winding
between primary winding and earth
between secondary winding and earth
- control circuit : between circuit and earth

(3) On-load tap-changer:

- damages or deterioration on the mechanism
- loosening, missing or breakage of bolts and nuts
- damages, deformation or defacement of contacts
- operation of change-over motion
- resistance of insulation oil for judging replacement of oil and leakage of insulation oil
- damages or deterioration of insulating materials
- breakage, damages or connection to terminals of wires

(4) Motor-driven mechanism

- loosening, missing or breakage of bolts and nuts
- damages or deterioration of each part and oil circulation
- insulation resistance of motor and electro-magnetic brake
- defacement, loosening or tightening of shoes of electro-magnetic brake
- vibration of bearing, operation of gears and decomposing inspection, if necessary
- operation and contacting condition of electro-magnetic switch
- trial operation of mechanism by manual and motor-driving for confirmation of proper operation
- confirmation of proper operation of tap indicator and recorder

(5) Insulation oil in main tank

- purification and deairing
- measurement of acid value and resistance

- (6) Bushing
 - damages and cracks, and cleaning
 - confirmation of oil level
- (7) Main terminal and earth terminal
 - corrosion and connection of conductor
- (8) Radiator
 - oil leakage and painting
- (9) Bushing type current transformer
 - measurement of insulation resistance, including conductors
- (10) Cooling fan
 - decomposition inspection on blower, motor and others
 - all bearing parts

II. CIRCUIT BREAKERS

Inspection is mainly carried out on the breaking parts, after decomposing.

- (1) Body
 - defacement, corrosion, damage, deformation and moisture absorption
 - loosening, missing or breakage of bolts and nuts
- (2) Operation mechanism
 - damages, defacement and deterioration of plinth, packing, cylinder, spring, piston, etc., after decomposing valves
 - moisture absorption, loosening, rust and falling-off of operation rod, crank, pin, spring, etc.
- (3) Breaking part
 - defacement and deterioration of contacts
 - defacement, deterioration and rust of arc extinguish chamber
 - contacting conditions on opening and closing operation

- (4) Shock-absorber device
 - quantity and quality of oil in dash-pot
- (5) Operation of mechanism
 - time measurement of closing and tripping after
 - measurement of minimum voltage and pressure for closing and tripping
- (6) Insulation resistance
 - measurement of the resistance between phases, between poles, between phase and earth
- (7) Auxiliary switches
 - condition of contacts and wiring
- (8) Bushing
 - damages and cracks, and cleaning
- (9) Others
 - operation of pressure gauge and pressure relay
 - inspection and insulation resistance of control circuit

III. DISCONNECTING SWITCHES

- (1) Operation mechanism
 - lubricating on movable parts
- (2) Contacts
 - damages, defacements and oxidized film on contact makers
 - blade closing condition
- (3) Earthing device
 - loosening of wire connection, breakage of individual wires of earthing conductor
 - clamping condition of earthing conductor
 - working condition of protection mechanism of mis-operation

(4) Others

- insulation measurement of all insulated parts
- working conditions of cylinder, box, magnetic valve, air pipe and electro-magnetic switch
- locking device on operation box
- damages or cracks on support insulators and cleaning
- damages on supporting structures and galvanized surface

IV. CURRENT TRANSFORMERS AND POTENTIAL TRANSFORMERS

(1) Body and terminals

- damages, deterioration and rust
- loosening, missing and breakage of bolts and nuts

(2) Bushing

- damages and cracks, and cleaning

(3) Insulation resistance

- measurement of the resistance between windings and between winding and earth

(4) Insulation oil

- measurement of insulation resistance and acid value, and exchange of oil, if required

(5) Others

- damages and galvanized surface on supporting structures
- breakage of individual wires of and damages on connecting wires and earthing conductors

V. STATIC CONDENSERS

(1) Insulation resistance

- measurement of the resistance between terminals and metal case

(2) Condensers

- damages and cracks on insulators, and cleaning
- connecting condition between conductor and terminal and between condenser and foundation
- damages and oil leakages of condenser tank

VI. LIGHTNING ARRESTERS

(1) Insulation resistance

- measurement of the resistance of series gap, characteristic element, shielding resistance and insulation base
- measurement of leakage current

(2) Body

- damages or cracks on insulators and porcelain tube after cleaning
- connection of bolts, nuts and conductors

(3) Auxiliary apparatus

- operating condition of indicator and recorder

(4) Others

- damages, bolt-tightening, rust, etc. of steel supports
- damages or breakages of connecting conductors and earthing conductor

VII. MAIN CIRCUITS

(1) Bus

- damages, deformation, rust or loosening of clamps, connection, bolts and nuts
- damages or breakages of bus conductors and damages, deformation or rust on bus bars

(2) Support

- connection of bus bars, conductors and earthing conductors

VIII. CUBICLES

(1) Panels and control equipment

- damages, missing, loosening or rusts on bolts, nuts fuses and earthing conductors
- moisture in equipment
- damages, rusts, deterioration of panels, switches, meters and wiring

- (2) Recording equipment
 - damages, missing of parts, jolt or twist
 - working condition of pen, ink pot and recording and revolving mechanism
 - measurement of insulation resistance
- (3) DC sequence
 - working condition of indication and alarming including relative circuits
- (4) Calibration of measuring instruments
 - damages, missing of parts, jolt or twist
 - working condition of measuring instruments under input
 - measurement of minimum operation and reset values together with characteristic test

IX. AIR COMPRESSORS

- (1) Motors
 - measurement of insulation resistance and working condition
- (2) Compressors
 - working condition and defacement or damages on valves
- (3) Pressure switches and safety valves
 - measurement of working and reset pressure
 - damages, defacement or rusts on valves, sheets and guide
- (4) Air pipes
 - damages, deformation or rusts on pipes
 - air-leakage at joints of pipes
- (5) Others
 - contacting condition of electro-magnetic switches
 - control panels under the same inspection items for cubicles

APPENDIX-8 LIST OF COLLECTED MATERIALS

I. GENERAL INFORMATION

- (1) Report on the economic and social situation development strategy and assistance requirements
(1983 issue and 1985 draft issue)
- (2) Climatic records in Vientiane
- (3) Statistics on population (as of March, 1985)
- (4) Market prices for labours, materials and other goods

II. ELECTRIC POWER RECORDS

- (1) Energy statistics of EDL (1975 - 1985)
- (2) Electric power facilities of EDL
- (3) Development and expansion program of electric power facilities of EDL
- (4) Operation records of power stations and substations of EDL
- (5) Electric power tariff in Lao PDR
- (6) Electric power tariff exchanged between Lao PDR and Thailand
- (7) Statistics of power demand and forecast of power demand
- (8) Organization chart of EDL (1985)
- (9) Organization chart for the substation rehabilitation project
- (10) Financial statements of EDL
- (11) Extract of ADB report for Xeset hydro-power project

III. DRAWINGS

- (1) Power system in Lao PDR
- (2) Communication network among substations in Vientiane district
- (3) Connection diagram of Phone Tong substation
- (4) Partial layout drawing of Phone Tong substation
- (5) Partial 22 kV distribution network in Vientiane district

JICA