

## **Thailand “Bhumibol Hydroelectric Project Unit 8”**

Report Date: March 1999

Field Survey: December 1998

### **Project Summary**

Borrower:	Electricity Generating Authority of Thailand (Guarantor: Government of Thailand)
Executing Agency:	Electricity Generating Authority of Thailand
Exchange of Notes:	September 1991
Date of Loan Agreement:	September 1991
Final Disbursement Date:	January 1998
Loan Amount:	¥7,854 million
Loan Disbursed Amount:	¥5,335 million
Procurement Conditions:	General Untied
Loan Conditions:	
Interest:	3.0%
Repayment Period:	25 years (7 years grace period)

## Reference

(1) Currency: Baht (B)

(2) Exchange Rate and Consumer Price Index

	1991	1992	1993	1994	1995
JP¥ / US\$	134.71	126.65	111.20	102.21	94.06
B / US\$	25.47	25.39	25.35	25.00	25.14
CPI	105.7	110.0	113.7	119.5	126.4

	1996	1997
JP¥ / US\$	108.78	120.99
B / US\$	25.49	40.66
CPI	133.8	141.3

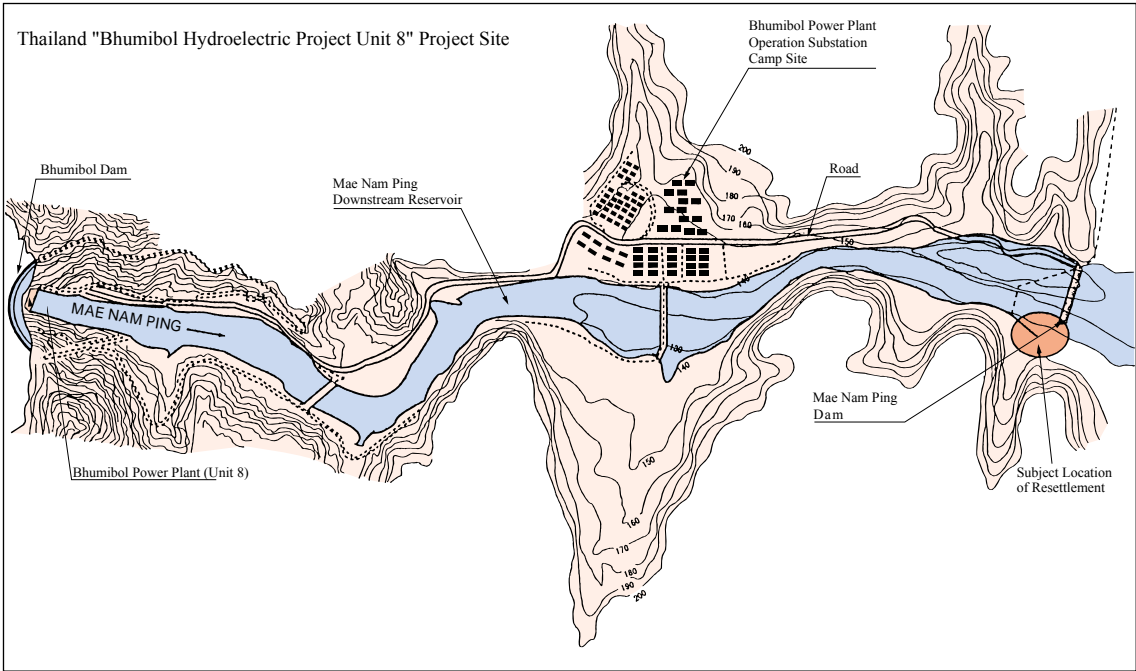
(3) Fiscal Year: October 1 ~ September 30

(4) Unit     1kW     = 1,000W output  
               1MW     = 1,000KW  
               1kMh     = 1kW × 1hr (1 hour) power consumption  
               1MWh     = 1,000kWh  
               1GWh     = 1,000MWh  
               1kVA (kilo/volt/ampere)  
               1MVA     = 1,000kVA

(5) Terminology

EGAT     : Electricity Generating Authority of Thailand  
 MEA     : Metropolitan Electricity Authority  
 PEA     : Provincial Electricity Authority  
 EGCO    : Electricity Generating Co.  
 COCO    : Cogeneration Co. Ltd.  
 IPP      : Independent Power Producer  
 SPP      : Small Power Producer  
 PDP      : Power Development Plan  
 NEPC    : National Energy Policy Council  
 NEPO    : National Energy Policy Office  
 NESDB   : National Economic Social Development Board  
 AAM     : Automatic Adjustment Mechanism  
 TLFS    : Thailand Load Forecast Subcommittee  
 BOI      : Board of Investment

# Project Location



## **Executive Summary**

### **1. Project Summary**

#### **(1) Project Location**

This project is located in the Bhumibol Hydro Power Plant in the Tak Province of Northern Thailand, some 400 km north-west of Bangkok. (See Figure S-1.)

#### **(2) Project Summary and JBIC Portion**

This project is designed to install a pumped-storage type power generation unit (Unit 8) at the Bhumibol Hydro Power Plant in order to increase the installed capacity of this power plant and improve its peak response capability, thereby securing adequate power for Thailand.

The contents of this project consist in the installation of Unit 8, construction of lower reservoir facilities and consulting services. The ODA loan covers all foreign-currency denominated costs except for consulting services related to detailed design.

### **2. Project Evaluation**

#### **(1) Evaluation on Project Plan**

The project was implemented as planned, without major changes in the project contents. The project contents were appropriate for the intended aims and the project aims were achieved.

#### **(2) Evaluation on Project Implementation**

With regard to the implementation schedule, the project started in January 1991 as planned, and was completed in December 1995. Operations began in March 1996.

Compared to the initially planned ¥7,974 million in foreign currency (of which ¥7,854 million covered by JBIC) and ¥3,664 million in local currency (691 million baht), actual project costs were ¥5,429 million in foreign currency (of which ¥5,335 million covered by JBIC) and ¥5,129 million (1,193 million baht), which is a reduction of 32% for the foreign currency portion and an increase of 40% for local the currency portion. This resulted in a 9.3% cost underrun in total foreign and local currencies.

The executing agency for this project was the Electricity Generating Authority of Thailand (EGAT). Preparatory work was done in part directly by EGAT, and the remainder was done through domestic competitive bidding. Civil work was done based on specifications prepared by consultants on a unit price contract base, and the delivery and installation of the equipment was performed on a turn-key basis by the contractors. Construction management was performed by foreign consultants working in coordination with EGAT. The performance of the parties involved was good and no problems in particular were noted concerning the implementation scheme.

#### **(3) Evaluation on Operations and Maintenance**

Adequately experienced engineers were assigned to operations and maintenance management following completion of the project, and there are no problems regarding the operations and

maintenance scheme.

The operating status of this project is good. The maintenance management status is also good and there are no problems in spare parts maintenance and replacement. However, the operation of this project (pumped-storage power generation) has been interrupted from April 1998 due to a drop in the water level caused by an atypical drought.

#### **(4) Evaluation on Project Effects and Impacts**

Following the commencement of operations, pumped-storage power generation has been performed as planned, and the aimed peak response capability has been achieved. The financial internal rate of return (FIRR) has been reevaluated at 11.6% versus the initially planned 13%. This reduction in the rate of return is mainly caused by a downward revision of the electric power sales forecast. Regarding the project's impact on society and the environment, no particular problems are judged to have occurred based on the facts that the resettlement of residents was achieved without problems and that there was no negative impact on water quality at the downstream water reservoir.

#### **(5) Overall Evaluation**

There have been no major changes in the project's contents, and the implementation was done on schedule without problems including cost overruns. The peak response capability was greatly improved following the start of operations, contributing to stable supply of electric power in Thailand. The operation status is also good, operations and maintenance are free of problems, and the objectives of the projects are considered to have been achieved.

## **1. Evaluation on Project Plan**

### **1.1 Objectives**

#### **1.1.1 Background and its Necessity**

During the second half of the 1980's, when this project was planned, Thailand was experiencing a period of high economic growth, and electric power demand was increasing rapidly. The annual growth rate of peak demand was 13% in 1987, 15% in 1988, and 15% in 1989, considerably exceeding projections. The capability margin of the Electricity Generating Authority of Thailand (EGAT) fell from 52.3% in 1986 to 14.4% in 1990, and it was just a matter of time until the capability margin would fall under the lower limit set by EGAT. Peak demand was predicted to continue increasing based on the electric power load at the time, so that it was an urgent task to restore the capability margin of the EGAT system by strengthening the equipment output to meet capability margin requirements, and to avoid overload operation of power plants.

Based on these circumstances, EGAT set forth to expand the electric power generation capacity to 14.79 million kW and the generated energy to 76,172 GWh by the year 2001 as part of the Power Resources Development Plan (1988 to 2001).

#### **1.1.2 Objectives**

The objectives of this project were to expand the pumped-storage type power generation facilities at the Bhumibol Hydro Power Plant in the Tak Province in Northern Thailand (175 MW plan, 171 MW actual), to increase facilities output at the same power plant, and to raise the peak response capacity in order to secure adequate power for Thailand.

### **1.2 Contents**

The contents of this project consisted of three components: expansion of Bhumibol Power Plant Unit 8 (installation of reversible pump-turbine and generator), construction of the lower reservoir (approximately 5 km downstream from the existing Bhumibol Dam), and consulting services. Table 1-1 compares the planned components and the actual results.

With the exception of the addition of an overhead traveling crane (2 x 235 tons) and computer control equipment in the power plant, there were no major changes in the components. The addition of the overhead traveling crane was made necessary by the fact that the capacity of the existing crane at Unit 8 was insufficient. The actual equipment capacity is 171 MW, or slightly under the planned figure of 175 MW. This is the result of accurate calculation at the time of detailed design but does not represent a large change in the scope.

The ODA loan covered the entire foreign currency portion except Portion I of the consulting services (detailed design).

Following the start of operation, this project has demonstrated its specified performance, providing the required peak response capability, so that the project's contents are considered to be adequate for the project's aims.

### 1.3 History

The history of this project is shown as below.

December	1984	Completion of Feasibility Study (prepared by EGAT)
November	1985	Completion of “Report on Downstream Weir of the Mae Nam Ping River” (Review of above F/S)
November	1990	Request of this project by Thai Government as one of the 16th Year Loan Package
January	1991	Japanese Government Mission
February	1991	JBIC Appraisal Mission
July	1991	Prior Notification on provision of the 16th ODA loan by Japanese Government
September	1991	Exchange of Notes
September	1991	Signing of Loan Agreement
December	1992	Start of civil works
April	1996	Start of commercial operation

Table I-1 Comparison of Original Plan and Actual Status

Item	Plan	Actual	Difference
1. Installation of pump-turbine and generator	Expansion of power plant building	Same as planned	4MW
	Partial replacement and set-up of pipe line	Same as planned	
	Installation of pump-turbine	Same as planned	
	Installation of generator (generating capacity 175MW)	Same as planned (generating capacity 171MW)	
	Installation of main transformer (195MVA)	Same as planned	
	Installation of other equipment		
	- Outdoor switchgear	Same as planned	
	- A set of gates	Same as planned	
	- A set of other auxiliary machine	Same as planned	
		• 2 × 235 tons Overhead travelling crane	
	• Computer control device	Addition	
2. Construction of lower reservoir	Mae Nam Ping Dam (earth-fill type, 12m high × 200m embankment length, 287,000m³ embankment volume )	Same as planned	
	Flood spillway (including 10 gates with 3,842cm capacity, 10.5m wide × 7m high)	Same as planned	
3. Consulting service	Detailed design, preparation of bidding documents	Same as planned	
	Bidding evaluation support, construction management	Same as planned	



## **2. Evaluation on Project Implementation**

### **2.1 Implementation Schedule**

Figure II-1 consists of a flowchart comparing the planned and achieved results of the implementation schedule. The implementation was started and completed as planned.

Preparation work was implemented as planned. Portion I of the consulting services (detailed design) started as planned and was completed 8 months ahead of schedule. Construction work was tendered and subcontracted in 5 contract lots (1 civil work, 1 machinery contract, and 3 electric equipment contracts). The bidding procedure was delayed by 5 months, but the last lot's bidding closing date was 2 month ahead of schedule. Moreover, while civil work started 1 month late, machinery work started 7 months ahead of schedule, and in the end all contract lots were completed as initially scheduled.

### **2.2 Project Cost**

Table II compares the planned contents and the achieved results.

Under the original plan, it was estimated that ¥7,974 million would be required for foreign currency costs (of which ¥7,854 million covered by JBIC) and ¥3,664 million (691 million baht, entirely covered by EGAT) for local currency costs. Actually, at ¥5,429 million, foreign currency expenses (¥5,335 million covered by JBIC) were 32% lower than planned. On the other hand, at ¥5,129 million (1,193 million baht), local currency expenses were 40% over the planned amount. Total foreign and local currency expenses combined amounted to ¥10,558 million, or 9.3% lower than the planned amount of ¥11,638 million.

A comparison of planned and actual expenses for major items shows that, among equipment costs, the bid price for electric equipment-related costs was considerably lower than the initially planned amount due to the use of competitive bidding. On the other hand, civil work was considerably higher, but this was due to the fact that the work quantity was actually greater than the planned amount. Moreover, the reason consulting service expenses were considerably lower than planned can be explained by the fact that part of the work that was initially planned to be contracted to consultants was actually performed by EGAT itself.

Of the project costs, JBIC disbursed the entire foreign currency portion except for Portion I (detailed design) of consulting services. The remaining portion of foreign currency costs, i.e. Portion I of the consulting services, was financed by EGAT itself. The local currency costs were procured by EGAT (including loans from foreign banks and bond issue).

### **2.3 Implementation Scheme**

#### **2.3.1 Executing Agency**

The executing agency for this project is the Electricity Generating Authority of Thailand (EGAT). EGAT is a public enterprise that handles power generation and primary power transmission. Based on EGAT regulations, the organization was established through the merger of Thailand's existing three power authorities in 1969. It has over 30,000 employees and is the largest public enterprise in Thailand. EGAT's organization chart is shown in Figure II-2.

As of September 1998, the equipment capacity of EGAT's power plants was 18,176 MW, and the

annual power generation capacity reached 107,442 GWh. In fiscal 1998 (October 1997 to September 1998), EGAT generated 14,180 MW at peak demand and produced 92,134 GWh (see Table II-2).

The generated electric power is transmitted over 23,000 km of power lines via 180 transforming stations. EGAT's power transmission capability is 38,000 MVA. EGAT's main buyers are the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). These two companies account for 98% of EGAT's total power sales.

This project was implemented by the Civil Work Project Division, Mechanical Project Division, Electric Project Division, Field Engineering Project Division, Administration Project Division, and Bhumibol Dam Site Office, under the review and coordination of the Hydro Power Construction Department of EGAT. Figure II-3 shows EGAT's implementing organization for this project. At the peak of this project, over 200 EGAT employees (including rehabilitation works for Units 1 and 2) were involved in this project.

The implementation scheme was as follows. Part of the preparatory work was performed directly by EGAT, and the remainder was assigned through competitive bidding within Thailand. This project's work was done based on the specifications drafted by consultants, and the civil work was done on a unit price contract base, with the delivery and installation of equipment done on a turn-key basis by private contractors. Supervision was done by consultants in coordination with EGAT.

This project was completed within the planned time frame, despite the fact that the nature of the work was made difficult by the necessity of deep foundation excavation of hard rock. This demonstrates that EGAT, the consultants and the contractors all provided good performance, for which they are highly evaluated.

### **2.3.2 Consultant**

The following consultants were hired as TOR for this project.

Portion 1: Detailed design, preparation of bidding supervision

Portion 2: Bidding evaluation assistance and construction management

Regarding Portion 1 (portion not covered by ODA loan), EGAT hired the consultant who worked on the F/S of this project. For Portion 2, covered by the ODA loan, the consultant who worked on Portion I (associates from 3 companies from Canada, Thailand, and U.S.) was hired.

According to EGAT, the performance of the consultants was "Good", and no problems caused by consultants were identified in this evaluation.

### **2.3.3 Contractor**

This project's work was divided into 5 contract lots (1 civil work, 1 machinery contract, and 3 electric equipment contracts) and assigned to the contractors listed in Table II-3 through international bidding.

According to EGAT, the performance of the contractors was "Good" for civil work, "Average" for the electric equipment work, and no problems caused by contractors regarding project implementation and maintenance were identified.

Figure II-1 Project Implementation Schedule

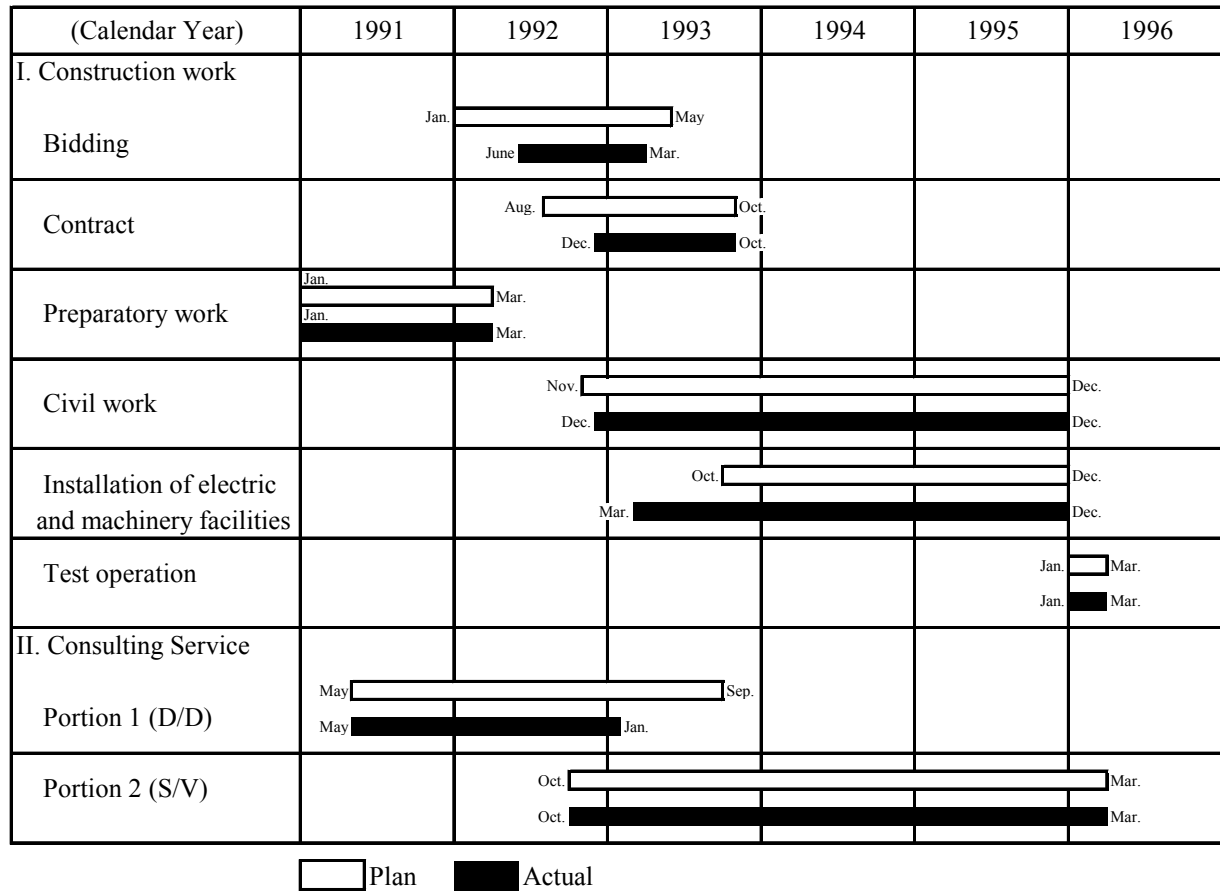


Table II-1 Comparison of Original Plan and Actual for Project Cost

Unit: ¥ million

Item	Plan			Actual			Difference ( - )		
	Foreign currency		Local currency	Foreign currency		Local currency	Foreign currency		Local currency
	Total	JBIC portion		Total	JBIC portion		Total	JBIC portion	
1. Preparatory work	0	0	311	0	0	300	0	0	11
2. Compensation and land acquisition	0	0	80	0	0	91	0	0	+ 11
3. Civil works	1,000	1,000	818	1,192	1,192	2,087	+ 192	+ 192	+ 1,269
4. Equipment installation work	5,053	5,053	620	3,837	3,837	636	1,216	1,216	+ 16
(1) Hydraulic facilities	295	295	74	323	323	136	+ 28	+ 28	+ 62
(2) Electrical equipment	4,520	4,520	502	3,294	3,294	473	1,226	1,226	29
(3) Transformer etc.	238	238	44	220	220	27	18	18	17
5. Consulting service	526	418	120	399	306	185	127	112	+ 65
(1) Portion 1 (D/D)	108	0	49	93	0	0	15	0	49
(2) portion 2 (S/V)	418	418	71	306	306	185	112	112	+ 114
6. EGAT management fee	0	0	630	0	0	808	0	0	+ 178
7. Import tax	0	0	329	0	0	326	0	0	3
8. Price escalation	670	669	432	-	-	-	-	-	-
9. Physical contingency	725	714	333	-	-	-	-	-	-
10. Interest rate	-	-	-	-	-	697	-	-	-
Total	7,974	7,854	3,664	5,429	5,335	5,129	2,545	2,519	+ 1,465

(Note) Exchange rate: B1 = ¥5.3 at the time of planning Actual B1 = ¥4.3

Table II-2 EGAT Actual Results of Generation

TOTAL EGAT GENERATION REQUIREMENT  
(Moderate Economic Recovery Case)

Fiscal Year	Peak Generation			Energy Generation			Load Factor %
	MW	Increase		GWh	Increase		
		MW	%		GWh	%	
				<u>Actual</u>			
1987	4,733.90	553.00	13.23	28,193.16	3,413.63	13.78	67.99
1988	5,444.00	710.10	15.00	31,996.94	3,803.78	13.49	67.09
1989	6,232.70	788.70	14.49	36,457.09	4,460.15	13.94	66.77
1990	7,093.70	861.00	13.81	43,188.79	6,731.70	18.46	69.50
1991	8,045.00	951.30	13.41	49,225.03	6,036.24	13.98	69.85
1992	8,876.90	831.90	10.34	56,006.44	6,781.41	13.78	72.02
1993	9,730.00	853.10	9.61	62,179.73	6,173.29	11.02	72.95
1994	10,708.80	978.80	10.06	69,651.14	7,471.41	12.02	74.25
1995	12,267.90	1,559.10	14.56	78,880.37	9,229.23	13.25	73.40
1996	13,310.90	1,043.00	8.50	85,924.13	7,043.76	8.93	73.69
1997	14,506.30	1,195.40	8.98	92,724.66	6,800.53	7.91	72.97
1998	14,179.90	-326.40	-2.25	92,134.44	-590.22	-0.64	74.17
<u>Average Growth</u> 1988~1998	-	858.73	10.49	-	5,812.84	11.37	-
				<u>Forecast</u>			
1999	14,499.00	319.10	2.25	93,178.00	1,043.56	1.13	73.36
2000	15,254.00	755.00	5.21	97,858.00	4,680.00	5.02	73.23
2001	16,214.00	960.00	6.29	103,685.00	5,827.00	5.95	73.00
2002	17,308.00	1,094.00	6.75	110,436.00	6,751.00	6.51	72.84
2003	18,399.00	1,091.00	6.30	117,341.00	6,905.00	6.25	72.80
2004	19,611.00	1,212.00	6.59	124,532.00	7,191.00	6.13	72.49
2005	20,818.00	1,207.00	6.15	132,228.00	7,696.00	6.18	72.51
2006	22,168.00	1,350.00	6.48	141,300.00	9,072.00	6.86	72.76
2007	23,728.00	1,560.00	7.04	151,322.00	10,022.00	7.09	72.80
2008	25,450.00	1,722.00	7.26	162,438.00	11,116.00	7.35	72.86
2009	27,232.00	1,782.00	7.00	173,532.00	11,094.00	6.83	72.74
2010	28,912.00	1,680.00	6.17	184,213.00	10,681.00	6.16	72.73
2011	30,587.00	1,675.00	5.79	194,930.00	10,717.00	5.82	72.75
<u>Average Growth</u>							
1982~1986	-	318.44	10.06	-	1,763.91	9.20	-
1987~1991	-	772.82	13.99	-	4,889.10	14.71	-
1992~1996	-	1,053.18	10.60	-	7,339.82	11.79	-
1997~2001	-	680.62	4.02	-	3,552.17	3.83	-
2002~2006	-	1,190.80	6.46	-	7,523.00	6.39	-
2007~2011	-	1,683.80	6.65	-	10,726.00	6.65	-

Thailand Load Forecast Subcommittee  
September 1998

Table II-2    Organization Chart of EGAT

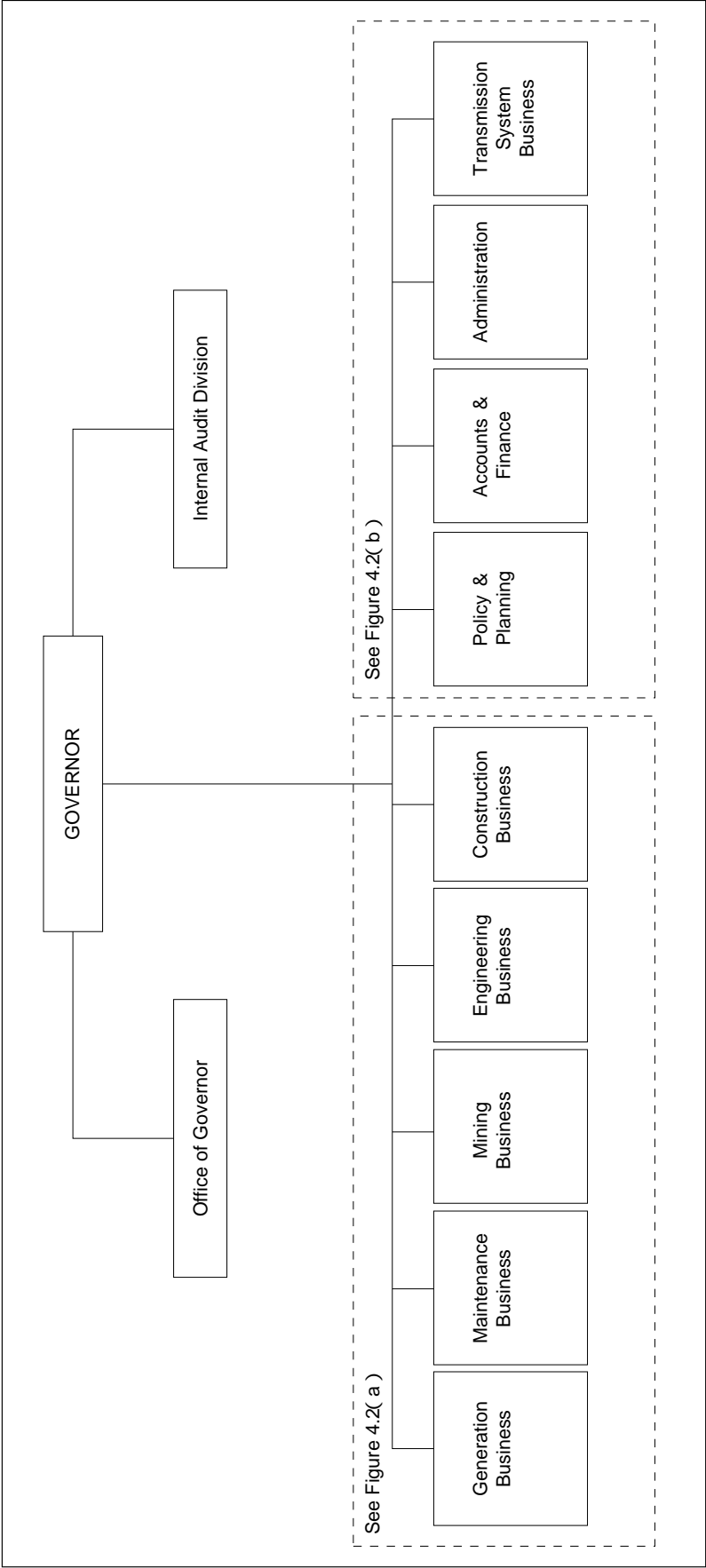


Table II-2 Organization Chart of EGAT (continued)

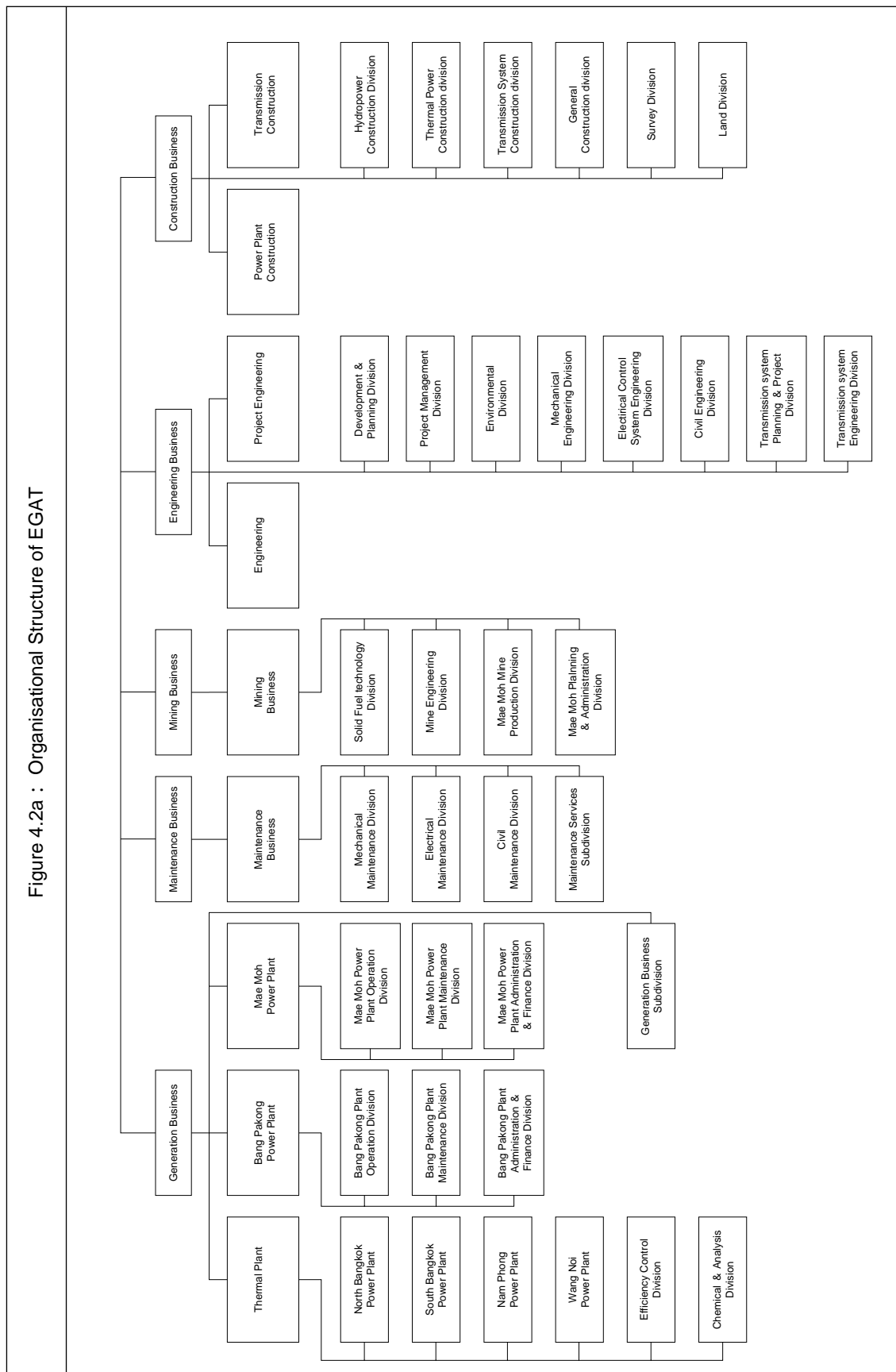


Table II-2 Organization Chart of EGAT (continued)

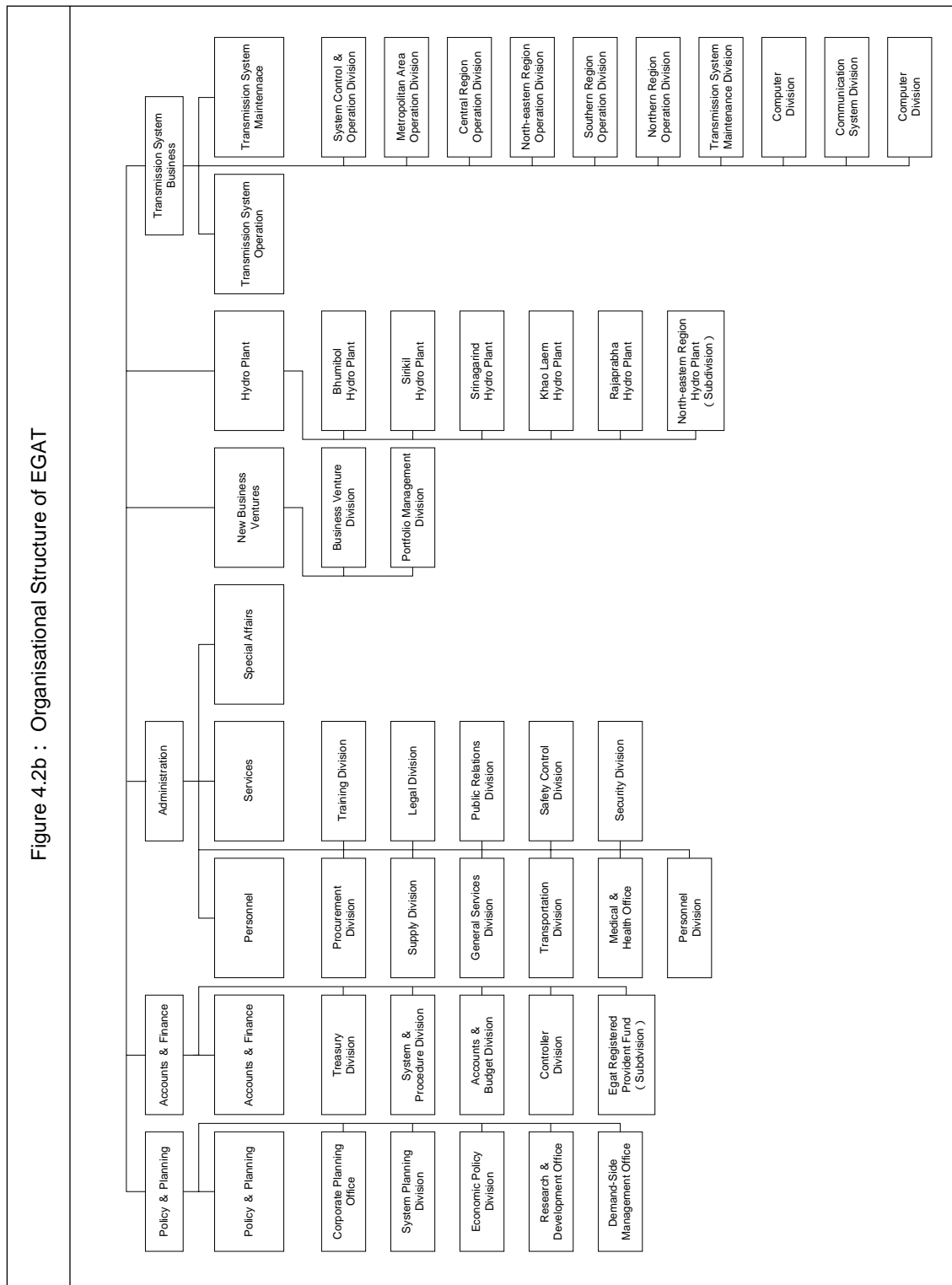
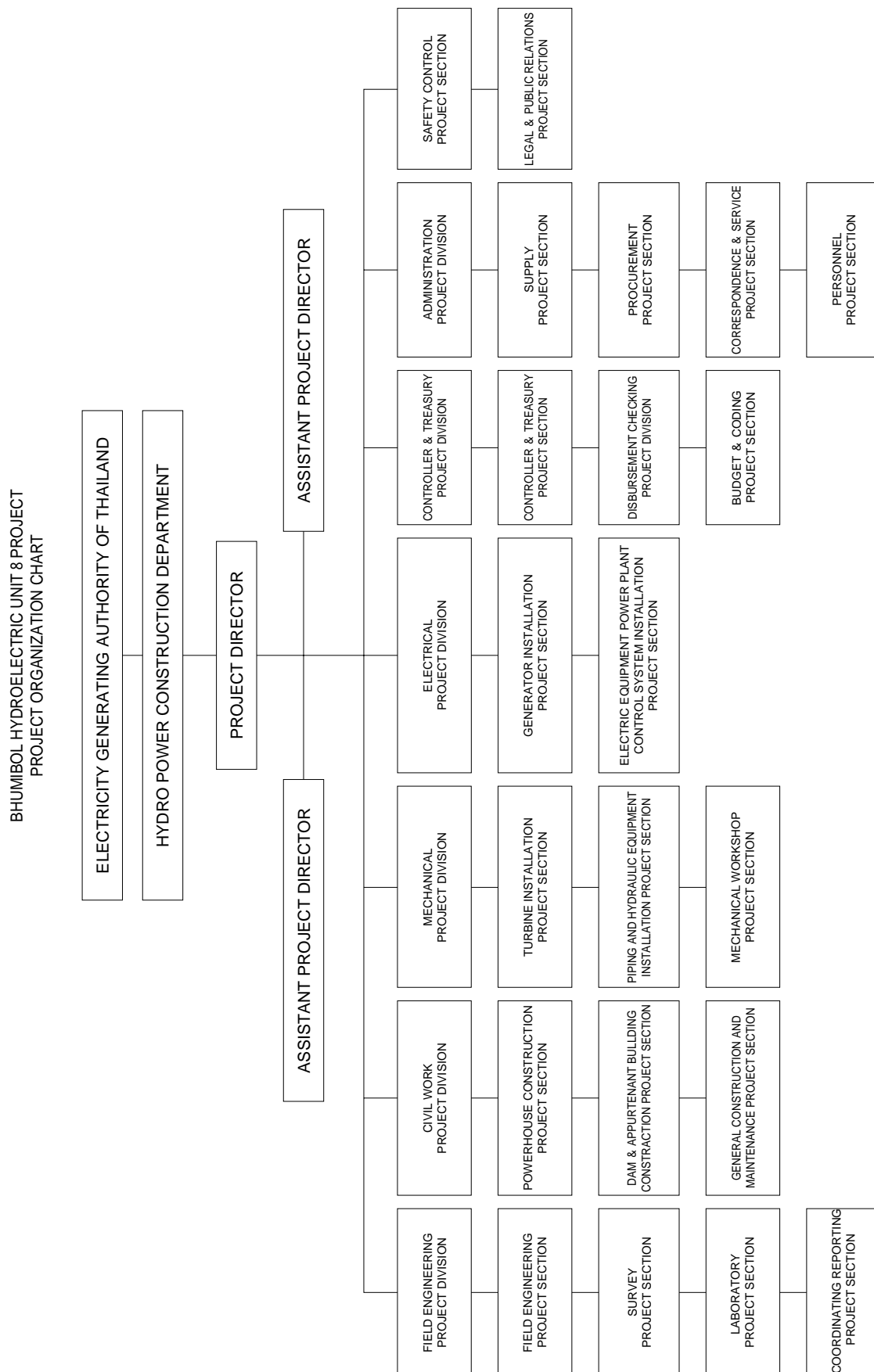




Table II-3 Organization Chart of EGAT Project Implementation



### 3. Evaluation on Operations and Maintenance

#### 3.1 Operations and Maintenance Scheme

The operations and maintenance of this project (Unit 8) were performed by the EGAT Bhumibol Power Plant Branch along with the existing power plants Units 1 ~ 7. As of November 1998, Power Plant Unit 8 had 641 employees, including 108 assigned to the Operation Division, 102 to the Equipment Maintenance Division, 181 to the Civil Engineering Maintenance Division, and 132 to the Administrative Division, as part of the operational departments. (See Figure III-1.)

A total of 44 electrical engineers working in three shifts round the clock are responsible for daily maintenance at the power plant. Adequately experienced technical personnel has also been assigned to operation and maintenance, and there are no problems in these areas.

#### 3.2 Operations and Maintenance

##### 3.2.1 Operating Status

This project (Power Plant Unit 8) began commercial operation in April 1996. Figure III-2 shows pumping and power generation patterns for December 1, 1997. That day, the excess electric power during low-load period from late night to early morning was used (A in figure) for pumping water from the lower reservoir to the Bhumibol dam reservoir, and water was released during the day and during peak load at night, generating a maximum of 120 MW (B in figure).

The pumping and power generation results following the start of commercial operation of this project (Power Plant Unit 8) are indicated in Table III-1. Until now, there have been no major problems and the operating status is good.

Table III-1 Operation Results of Pumping and Power Generation for Unit 8

Fiscal Year <sup>(Note 1)</sup>	Pumping		Power generation	
	Pumping energy (MWh)	Pumping time (hr)	Power generation volume (MWh)	Power generation time (hr)
FY1996	163.525	1,063.1	369.997	2,613.0
FY1997	207.881	1,327.8	434.142	3,160.0
FY1998 <sup>(Note 2)</sup>	85.992	544.9	200.972	1,595.6

Note 1 The fiscal year is from October the previous year to September of that year.

Note 2 The operating results were lower than usual due to a severer water shortage than usual during fiscal 1998.

Due to unusual drought in fiscal 1998 (the amount of precipitation during fiscal 1997 was 620 mm, the lowest in 25 years), the level dropped below EL230 m, and Unit 8 temporarily stopped pumping from April of that year.

##### 3.2.2 Maintenance

The Equipment Maintenance Department (102 employees) of the Bhumibol Power Plant Branch is in charge of daily maintenance inspections and the strage section of the Administrative Department

(Store Section, 20 employees) is in charge of spare parts storage. The status of spare parts storage is extremely good, and parts that are particularly sensitive to high humidity and temperature, such as electronic components, micro processors, and rubber seals, are stored in air-conditioned rooms. The replacement of spare parts is done according to the following system.

- Consumables such as fuses and pumps, are raised to the stock level of commissioning when it is consumed by up to 20 to 40%, depending on the item.
- Major parts are replaced as they are used, in order to maintain them or the commissioning level.

On the other hand, maintenance inspections of power generation equipment are implemented periodically using three methods: Minor Inspections (MI), Major Overhaul (MO), and Preventive Maintenance (PM).

PM is being performed as planned, and corrective maintenance records are also kept. According to these records, no problems have occurred in Unit 8 following the start of commercial operation.

As described previously, Unit 8 stopped pumping operations since April 1998. There have been no problems in equipment maintenance following the start of operations, and pumping operations can be resumed as soon as the water level is restored.

### **3.2.3 Financial Status of EGAT**

According to EGAT regulations, EGAT's operating income is used to pay for expenses, and the balance remaining after the deduction of expenses must be paid to the national treasury as yearly revenue. When revenue after deducting legal reserves does not suffice for the payment of expenses and it is difficult to allocate funds from other funds, the government bears the deficit.

The most recent 5-year financial status reported in EGAT's annual report (Fiscal 1997 edition) is shown in Table III-2. The financial status shows a firm undertone, but in fiscal 1997, various indexes worsened slightly compared to previous years.

The financial target of EGAT is to set power rates to a level where it can raise its profitability sufficiently compared to investments and secure a healthy financial state. EGAT's current financial targets are a rate of return on re-valued assets of 8% or higher and a self-financing ratio of 25% or higher.

These financial targets are also maintained by the automatic adjustment methods (AAM) for power charges. Through the AAM, EGAT is now able to adjust power charges in order to compensate for fluctuations in specific cost items (imported fuel, etc.) without receiving prior authorization from the government.

Table III-1 Organization Chart of Bhumibol Power Plant

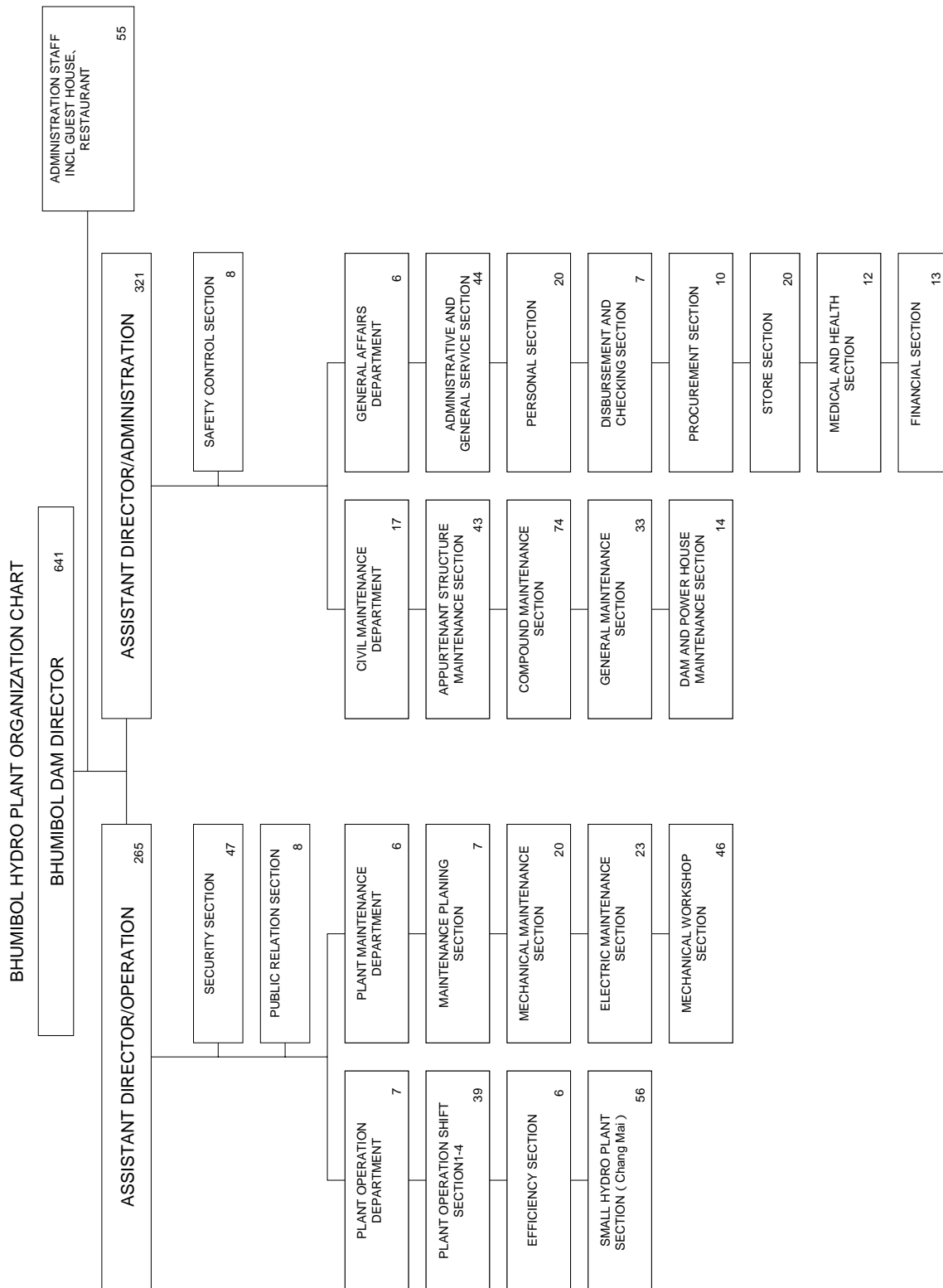


Table III-2 Pumping and Power Generation Operation Patterns of Bhumibol Power Plant Unit 8

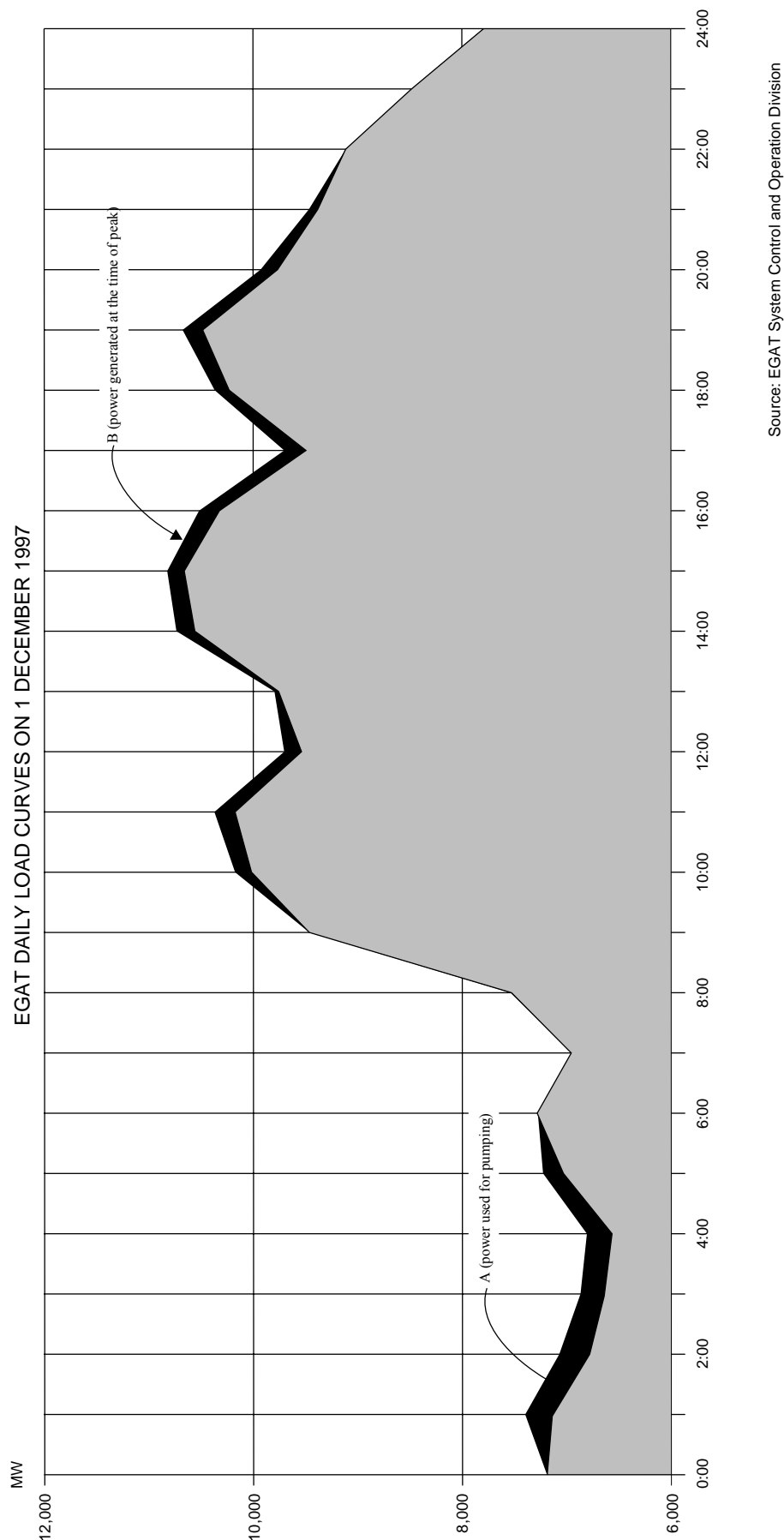


Table III-2 EGAT Financial Status

ELECTRICITY GENERATING AUTHORITY OF THAILAND					
FIVE YEAR SUMMARY					
For the years ended September 30:	1997	1996	1995	1994	1993
	Baht	Baht	Baht	Baht	Baht
	(Millions)	(Millions)	(Millions)	(Millions)	(Millions)
<b>Assets:</b>					
Current assets	38,407	48,280	30,337	17,310	16,277
Fixed assets – Net	249,698	220,685	216,869	209,288	189,839
Sinking funds	8,376	6,804	5,948	5,389	4,917
Other assets (Note 1)	19,579	20,207	16,150	13,110	9,692
<b>Total assets</b>	<b>316,060</b>	<b>295,976</b>	<b>269,304</b>	<b>245,097</b>	<b>220,725</b>
<b>Liabilities and equity</b>					
<b>Liabilities:</b>					
Current liabilities (Note 2)	52,924	45,419	35,929	34,007	24,046
Long-term debt (Note 3)	153,310	126,731	131,326	126,125	117,237
Sinking funds	8,376	6,804	5,948	5,389	4,917
Other liabilities	404	198	173	179	199
	<b>215,014</b>	<b>179,152</b>	<b>173,376</b>	<b>165,700</b>	<b>146,399</b>
<b>Equity:</b>					
Capital:					
Contribution from the Government	10,708	10,755	10,817	10,876	10,935
Surplus from contributions	2,797	2,614	2,476	2,247	2,043
Retained earnings:					
Capital expenditure appropriation	95,718	75,659	75,659	75,410	71,201
Unappropriated	15,876	33,177	16,546	5,538	4,271
Deferred foreign exchange adjustment	(24,053)	(5,381)	(9,570)	(14,674)	(14,124)
<b>Total equity</b>	<b>101,046</b>	<b>116,824</b>	<b>95,928</b>	<b>79,397</b>	<b>74,326</b>
<b>Total liabilities and equity</b>	<b>316,060</b>	<b>295,976</b>	<b>269,304</b>	<b>245,097</b>	<b>220,725</b>
	<b>kWh</b>	<b>kWh</b>	<b>kWh</b>	<b>kWh</b>	<b>kWh</b>
	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>
Electricity generated and purchased	92,725	85,920	78,880	69,651	62,180
Electricity sales	85,896	79,451	72,780	63,643	56,558

**Notes:** 1. Includes investment in associated company  
2. Includes current portion of long-term debts  
3. Excludes current portion of long-term debts

Table III-2 EGAT Financial Status (continued)

<b>For the years ended September 30:</b>	<b>1997</b>	<b>1996</b>	<b>1995</b>	<b>1994</b>	<b>1993</b>
	<b>Baht</b>	<b>Baht</b>	<b>Baht</b>	<b>Baht</b>	<b>Baht</b>
	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>	<b>(Millions)</b>
Electricity sales (Note 4)	<b>125,376</b>	108,835	95,247	76,190	67,798
Operating expenses (Note 5)	<b>105,716</b>	80,745	72,717	58,400	51,072
Net income before interest charges	<b>21,420</b>	35,396	25,854	18,455	17,391
Interest charges	<b>8,592</b>	8,303	6,894	6,422	6,048
Net income	<b>12,828</b>	27,093	18,960	12,033	11,343
Remittance to Ministry of Finance (paid)	<b>8,449</b>	6,387	4,099	4,637	2,468
Loan repayment (Note 6)	<b>18,018</b>	9,509	11,157	8,119	8,853
Capital expenditure (Note 7)	<b>34,083</b>	28,433	30,592	27,596	31,786
Net income as a percentage of sales	<b>10.23%</b>	24.89%	19.91%	15.79%	16.73%
Net income before interest charges as a percentage of sales	<b>17.08%</b>	32.52%	27.14%	24.22%	25.65%
Net income as percentage of equity (Note 8)	<b>10.25%</b>	22.17%	17.97%	12.79%	12.82%
Net income before interest charges as a percentage of equity (Note 8)	<b>17.12%</b>	29.03%	24.51%	19.62%	19.66%
Net income as a percentage of total assets	<b>4.06%</b>	9.15%	7.04%	4.91%	5.14%
Net income before interest charges as a percentage of total assets	<b>6.78%</b>	11.96%	9.60%	7.53%	7.88%
Operating ratio	<b>84.32%</b>	74.19%	76.35%	76.65%	75.33%
Current ratio (Note 9)	<b>0.73:1</b>	1.10:1	0.88:1	0.59:1	0.68:1
Debt equity ratio	<b>1.23:1</b>	1.04:1	1.24:1	1.34:1	1.33:1
Debt service coverage	<b>1.05</b>	1.91	1.64	1.53	1.40
Self financing ratio					
- Annual	<b>14.29%</b>	61.53%	36.52%	35.85%	31.89%
- 3 years average	<b>13.91%</b>	50.10%	31.03%	27.33%	32.60%

- Notes:**
4. After deducting promotion of exports, industrial estate discount and natural disaster discount
  5. Includes losses/(gains) from foreign exchange
  6. Excludes loan refinancing and roll over
  7. Excludes mine development expenditures
  8. Includes deferred foreign exchange adjustment
  9. Excludes current portion of loan repayments to be paid out of sinking fund

## **4. Evaluation on Project Effects and Impacts**

### **4.1 Classification and Organization of Effects and Impacts**

At the time of the appraisal, the project's FIRR was calculated based on revenues from power generation as quantitative economic results.

Moreover, qualitative economic results consisted in the stabilization of the life of people in general and the growth of the local economy through extra power generation capacity and stable power supply.

### **4.2 Economic Effects**

At the time of the appraisal, the project's FIRR was calculated as 13%.

(premise)

<1> Benefit: Revenue from power generation

<2> Expenses: Project costs, maintenance costs, pumping costs, and equipment renovation costs

<3> Project life: 50 years

Based on actual expenses and forecast revenue, a recalculation of the FIRR taking into consideration the above, yields a figure of 11.6%, which is slightly lower than the 13.0% calculated at the time of the appraisal. The major reason for this discrepancy is that future projections of power sales amount have been revised downward compared to those obtained at the time of the appraisal. This downward revision was due to a revision of electric power demand resulting from a slowing down of the Thai economy following the economic crisis of 1997.

### **4.3 Impact on the Environment**

#### **4.3.1 Resettlement of Residents**

At the time of the appraisal, regarding the implementation of this project, the relocation of approximately 10 households within the planned construction area for the downstream Mae Nam Ping Dam was considered necessary. Actually a total of 15,000 m<sup>2</sup> of land was marked for expropriation, and 21 households had to be resettled. EGAT provided adequate compensation based on Thai government laws (approximately 2.4 million baht) and the expropriation procedures were completed without particular problems during the negotiation stage.

The resettled persons were almost all farmers, who received sufficient agricultural land, as compensation, at the resettlement destination, and went on to engage in agriculture.

#### **4.3.2 Environmental Monitoring**

Regarding the impact on the natural environment of the Mae Nam Ping downstream sluices, concerns on the impact on the water quality of the reservoir had been pointed out from the time of the appraisal. For this reason, EGAT has implemented water monitoring of the downstream reservoir 3 times a year (rainy season/dry season/winter).



Currently, this water quality monitoring is being implemented as planned. Samplings were performed, the first time on November 17, 1997 (Winter), the second time on March 10, 1998 (dry season), and the third time on September 17, 1998 (rainy season). The measured locations consisted of 5 locations at the Bhumibol dam reservoir, 2 locations at the downstream reservoir, thus a total of 7 locations. At each location, samplings were taken at three depths (1 meter, 5 to 10 meters, and 15 to 20 meters). According to the monitoring report, no worsening in the water quality was detected at any time.

## **5. Lessons Learned**

Nothing in particular.



Inside of Bhumbol Hydro Plant



Bhumbol Power Plant