(13) LAT PHRAO

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

Lat Phrao		1997	2001	2006	2011
230 kV	FC	0	0	157553	0
	LC	0	0	64239	0
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		0	0	221792	0

Direct Cost (Cost in 1992, thousand baht)

Lat Phrao		1997	2001	2006	2011
230 kV	FC	0	0	142685	0
	LC	0	0	20768	0
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		0	0	163453	0

Indirect Cost (Cost in 1992, thousand baht)

Lat Phrao	1997	2001	2006	2011
230 kV	0	0	58339	0
500 kV	0	0	0	0
TOTAL	0	0	58339	0

(14) BANG PHLI

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

Bang Phli		1997	2001	2006	2011
230 kV	FC	78777	0	0	38972
	LC	32117	0	0	24064
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		110894	0	0	63036

Direct Cost (Cost in 1992, thousand baht)

Bang Phli		1997	2001	2006	2011
230 kV	FC	71342	0	0	35166
	LC	10384	0	0	8759
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		81726	0	0	43925

Indirect Cost (Cost in 1992, thousand baht)

Bang Phli	1997	2001	2006	2011
230 kV	29168	0	0	19111
500 kV	0	0	0	0
TOTAL	29168	0	0	19111

(15) TEPARAK

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

Teparak		1997	2001	2006	2011
230 kV	FC	397453	0	39388	39388
	LC	261114	0	16058	16058
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		658567	0	55446	55446

Direct Cost (Cost in 1992, thousand baht)

Teparak		1997	2001	2006	2011
230 kV	FC	355067	0	35671	35671
	LC	117709	0	5192	5192
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		472776	0	40863	40863

Indirect Cost (Cost in 1992, thousand baht)

Teparak	1997	2001	2006	2011
230 kV	185791	0	14583	14583
500 kV	0	0	0	0
TOTAL	185791	0	14583	14583

(16) CHAENG WATHANA

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

Chaeng Wathana		1997	2001	2006	2011
230 kV	FC	233899	39388	0	39388
	LC	126419	16058	0	16058
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		360318	55446	0	55446

Direct Cost (Cost in 1992, thousand baht)

Chaeng Wathana		1997	2001	2006	2011
230 kV	FC	211349	35671	0	35671
	LC	44277	5192	0	5192
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		255626	40863	0	40863

Indirect Cost (Cost in 1992, thousand baht)

Chaeng Wathana	1997	2001	2006	2011
230 kV	104692	14583	0	14583
500 kV	0	0	0	0
TOTAL	104692	14583	0	14583

(17) WANG NOI

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

Wang Noi		1997	2001	2006	2011
230 kV	FC	280429	0	760	0
	LC	215873	0	1959	0
500 kV	FC	0	0	1289945	0
	LC	0	0	483849	0
TOTAL		496302	0	1776513	0

Direct Cost (Cost in 1992, thousand baht)

Wang Noi		1997	2001	2006	2011
230 kV	FC	249036	0	655	0
	LC	103851	0	1145	0
500 kV	FC	0	0	1170594	0
	LC	0	0	112340	0
TOTAL		352887	0	1284744	0

Indirect Cost (Cost in 1992, thousand baht)

Wang Noi	1997	2001	2006	2011
230 kV	143415	0	909	0
500 kV	0	0	490860	0
TOTAL	143415	0	491769	0

(18) CHIDLOM

(19) SATU PRADIT

(20) <A> Substation

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

<A>		1997	2001	2006	2011
230 kV	FC	0	302109	0	0
	LC	0	163056	0	0
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		0	465165	0	0

Direct Cost (Cost in 1992, thousand baht)

<A>		1997	2001	2006	2011
230 kV	FC	0	269846	0	0
	LC	0	68792	0	0
500 kV	FC	0	0	0	0
	LC	0	0	0	0
TOTAL		0	338638	0	0

Indirect Cost (Cost in 1992, thousand baht)

<A>	1997	2001	2006	2011
230 kV	0	126527	0	0
500 kV	0	0	0	0
TOTAL	0	126527	0	0

(21) <C> Substation

Construction Cost except Interest during Construction (Cost in 1992, thousand baht)

<C>		1997	2001	2006	2011
230 kV	FC	0	0	0	280437
	LC	0	0	0	225340
500 kV	FC	0	0	0	955751
	LC	0	0	0	356915
TOTAL		0	0	0	1818443

Direct Cost (Cost in 1992, thousand baht)

<C>		1997	2001	2006	2011
230 kV	FC	0	0	0	248859
	LC	0	0	0	108441
500 kV	FC	0	0	0	866715
	LC	0	0	0	87599
TOTAL		0	0	0	1311614

Indirect Cost (Cost in 1992, thousand baht)

<C>	1997	2001	2006	2011
230 kV	0	0	0	148477
500 kV	0	0	0	358352
TOTAL	0	0	0	506829

8.1.4 Transmission Line

The sum of construction cost of transmission lines during each planned year period which is expressed in price level in 1992 is summarized in the following tables.

The exchange rate is 25 Baht per U.S.Dollar.

<POOR SOIL CASE>

Planned Year		1997	2001	2006	2011
Period from the last		5	4	5	5
Total	(mil.US$)	489.29	276.83	193.98	307.83
Annual Invest.	(mil.US$)	97.9	69.2	38.8	61.6

The total transmission line cost accounts for 1267.93 million US$ (poor soil case) in price level in 1992, of which 17.5% (221.88 million US$) is for 500 kV overhead lines, 10.6% (134.58 million US$) for 230 kV overhead lines and the remaining (71.9%) for underground cables, as can be understood from the following tables.

The average investment ranging from 48.8 to 96.5 million US$ (1,221 to 2,411 million baht-poor soil case) per anum, expressed in price level in 1992, is necessary for construction and renovation of transmission lines.

500 kV Transmission Line (Poor soil)

Planned Year		1997	2001	2006	2011
Total	(mil. US$)	123.39	45.37	39.37	13.75
Foreign currency	(mil. US$)	9.38	3.77	3.0	1.35
Local currency	(mil. US$)	114.01	41.6	36.37	12.4

230 kV Overhead Line (Poor soil)

Planned Year	1997	2001	2006	2011
Total (mil. US$)	50.5	15.79	37.15	31.14
Foreign currency(mil. US$)	2.75	0.98	3.17	1.97
Local currency (mil. US$)	47.75	14.81	33.98	29.17

230 kV Underground Cable (Poor soil)

Planned Year	1997	2001	2006	2011
Total (mil. US$)	315.4	215.67	117.46	262.94
Foreign currency(mil. US$)	102.96	87.62	32.16	109.47
Local currency (mil. US$)	212.44	128.05	85.3	153.47

For reference, when the cost of sections of underground cables are estimated by overhead lines, the cost decrease to 1/15.4 of the underground cables as indicated in the following table.

(unit: 1000 US$)

SECTION		OVERHEAD LINE	UNDERGROUND
RANGSIT-CHAENG WATTHANA (500 kV 2cct-9km, 230 kV 2cct-9km, EGAT)	AIRPORT AREA (500 kV)	2,900* (4 km)	46,560
	AIRPORT AREA (230 kV)	1,880	69,100* (4 km)
	OUTSIDE (500/230 kV)	9,410* (5 km)	93,511
SOUTH THONBURI-THANONTOK (230 kV 4cct-10km, MEA)		10,040	162,180* (10 km)
BANG KAPI-KHLONG TOEY (230 kV 6cct-8km, MEA)		11,800	172,320* (8 km)
<A> S.S.-SANAMPAO (230 kV 6cct-9km, MEA)		13,270	197,540* (9 km)
BANGKOK NOI-THONBURI (230 kV 3cct-11km, MEA)		11,050	145,750* (11 km)
ON NUCH-<C> S.S. (230 kV 4cct-22km, EGAT)	AIRPORT AREA	10,040	164,580* (10 km)
	OUTSIDE	10,600* (12 km)	195,220
TOTAL		80,990	1,246,761
RATIO (p.u.)		1	15.4

Note: Figures with asterisk (*) are adopted for cost estimation in this report.

CONSTRUCTION COST (POOR SOIL)

TOTAL - 1000 US$

	1997	2001	2006	2011
NONG CHOK - WANG NOI	59240			
SAI NOI - WANG NOI	51840			
RANGSIT - CHAENG WATTHANA	81410			
RANGSIT - WANG NOI	50200			
SOUTH THONBURI - THANONTOK	136220			
RATCHADAPISEK - LAT PHRAO	150			
RATCHADAPISEK - BANG KAPI	150			
BANG KAPI - KHLONG TOEY	110080			
NONG CHOK - ON NUCH		14850		
SAI NOI - BANGKOK NOI		21420		
NORTH BANGKOK - BANGKOK NOI		23950		
BANG KAPI - KHLONG TOEY		41490		
BANG PHLI - BANG BOR		470		
BANG BOR - BANG PAKONG		470		
<A> - SANAMPAO		174180		
SAI NOI - RANGSIT			17730	
NORTH BANGKOK - <A>			8280	
BANGKOK NOI - SAMPHRAN 1			15080	
BANGKOK NOI -SOUTH THONBURI			4100	
BANGKOK NOI - THONBURI			117460	
SAMPHRAN 1 - SOUTH THONBURI			4100	
BANG KAPI - ON NUCH			8830	
ON NUCH - BANG PHLI			3680	
LAT PHRAO - <A>			1360	
CHAENG WATTHANA - <A>			13360	
NONG CHOK - <C>				16790
NONG CHOK - <C>				13750
BANGKOK NOI - THONBURI				28290
SOUTH THONBURI - THANONTOK				25960
BANG KAPI - KHLONG TOEY				20750
PATANAKAN - BANG KAPI				2350
ON NUCH - <C>				164580
ON NUCH - <C>				10600
<A> - SANAMPAO				23360
<C> - BANG PAKONG 2				1400
	489290	276830	193980	307830

Foreign Currency-1000 US$
1 US$ = 25 BAHT

	1997	2001	2006	2011
NONG CHOK - WANG NOI	4560			
SAI NOI - WANG NOI	3990			
RANGSIT - CHAENG WATTHANA	24160			
RANGSIT - WANG NOI	2730			
SOUTH THONBURI - THANONTOK	44280			
RATCHADAPISEK - LAT PHRAO	10			
RATCHADAPISEK - BANG KAPI	10			
BANG KAPI - KHLONG TOEY	35350			
NONG CHOK - ON NUCH		920		
SAI NOI - BANGKOK NOI		2110		
NORTH BANGKOK - BANGKOK NOI		1660		
BANG KAPI - KHLONG TOEY		21260		
BANG PHLI - BANG BOR		30		
BANG BOR - BANG PAKONG		30		
<A> - SANAMPAO		66360		
SAI NOI - RANGSIT			1750	
NORTH BANGKOK - <A>			480	
BANGKOK NOI - SAMPHRAN 1			1270	
BANGKOK NOI -SOUTH THONBURI			450	
BANGKOK NOI - THONBURI			32160	
SAMPHRAN 1 - SOUTH THONBURI			450	
BANG KAPI - ON NUCH			550	
ON NUCH - BANG PHLI			300	
LAT PHRAO - <A>			150	
CHAENG WATTHANA - <A>			770	
NONG CHOK - <C>				1040
NONG CHOK - <C>				1350
BANGKOK NOI - THONBURI				14500
SOUTH THONBURI - THANONTOK				13320
BANG KAPI - KHLONG TOEY				10630
PATANAKAN - BANG KAPI				150
ON NUCH - <C>				59040
ON NUCH - <C>				660
<A> - SANAMPAO				11980
<C> - BANG PAKONG 2				120
	115090	92370	38330	112790

Local Currency-1000 US$

	1997	2001	2006	2011
NONG CHOK - WANG NOI	54680			
SAI NOI - WANG NOI	47850			
RANGSIT - CHAENG WATTHANA	57250			
RANGSIT - CHAENG WATTHANA	47470			
SOUTH THONBURI - THANONTOK	91940			
RATCHADAPISEK - LAT PHRAO	140			
RATCHADAPISEK - BANG KAPI	140			
BANG KAPI - KHLONG TOEY	74730			
NONG CHOK - ON NUCH		13930		
SAI NOI - BANGKOK NOI		19310		
NORTH BANGKOK - BANGKOK NOI		22290		
BANG KAPI - KHLONG TOEY		20230		
BANG PHLI - BANG BOR		440		
BANG BOR - BANG PAKONG		440		
<A> - SANAMPAO		107820		
SAI NOI - RANGSIT			15980	
NORTH BANGKOK - <A>			7800	
BANGKOK NOI - SAMPHRAN 1			13810	
BANGKOK NOI -SOUTH THONBURI			3650	
BANGKOK NOI - THONBURI			85300	
SAMPHRAN 1 - SOUTH THONBURI			3650	
BANG KAPI - ON NUCH			8280	
ON NUCH - BANG PHLI			3380	
LAT PHRAO - <A>			1210	
CHAENG WATTHANA - <A>			12590	
NONG CHOK - <C>				15750
NONG CHOK - <C>				12400
BANGKOK NOI - THONBURI				13790
SOUTH THONBURI - THANONTOK				12640
BANG KAPI - KHLONG TOEY				10120
PATANAKAN - BANG KAPI				2200
ON NUCH - <C>				105540
ON NUCH - <C>				9940
<A> - SANAMPAO				11380
<C> - BANG PAKONG 2				1280
	374200	184460	155650	195040

8.1.5 Back Data of Cost

(1) Substation

a) Land Acqusition

According to EGAT standard design, 5 price levels per RAI are indicated as shown below.

- Very high 6007 thousand baht
- High 4007 thousand baht
- Midium high 1007 thousand baht
- Midium 357 thousand baht
- Midium low 127 thousand baht
- Low 67 thousand baht

b) Land Improvement

The cost of land improvement per RAI in 1 m depth is 300 thousand baht.

The area required for substation by type of bus system is shown in the table below.

(per 2 lines)

	One and a half Conventional	One and a half Invert	One and a half GIS
230 kV	105m x 15m	45m x 45m	20m x 15m
500 kV	153m x 28m		20m x 28m

c) Foundation Work

The cost of foundation work includes all foundation works of equipment of the substation such as steel structure, transformer bed and cable trench as indicated in the tables and figures below.

BUS FOUNDATION COST (1000 Baht per 2 lines-pad type)

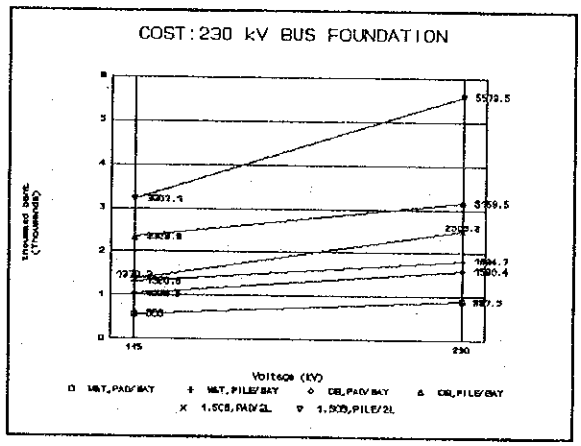
	Main & Transfer Bus	Double Bus	One and a half
230 kV	887.5	1590.4	2506.3
500 kV	1150	2070	3260

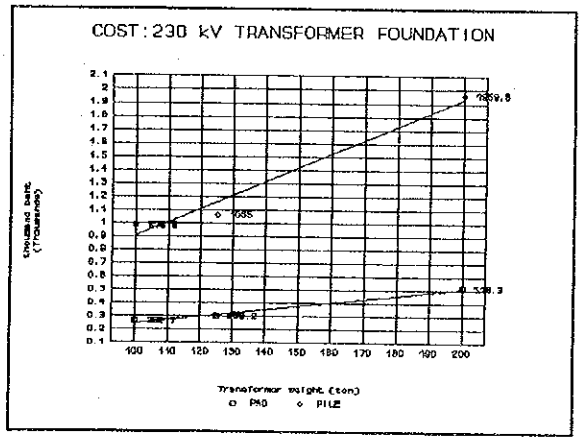
TRANSFORMER FOUNDATION COST (1000 Baht per 3 phase)

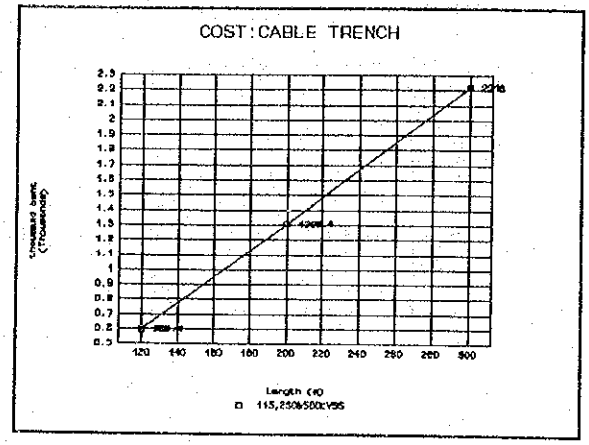
230 kV	1300
500 kV	3900

CABLE TRENCH (1000 BAHT for new construction only)

230 & 500 kV	1306.4







d) Control Building

For new construction, the cost in the following table will be applied for control building and GIS building.

(1000 Baht)

230 kV (15m x 30m)	500 kV (20m x 35m)	Building for GIS
19,200	24,000	4,875

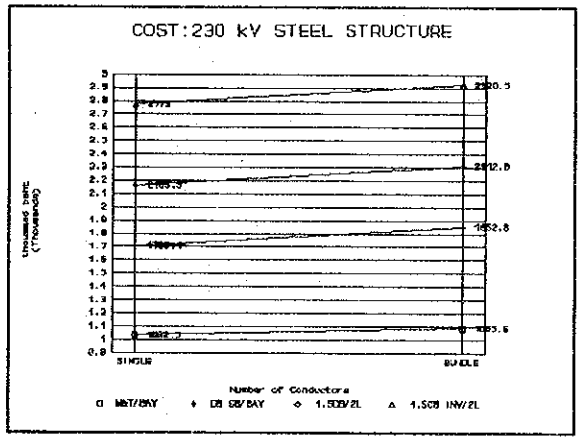
e) Equipment

- Steel Structure

The cost of steel structure includes supply and installation of support structure of disconnecting switches, instrument transformers, bus and take-off structure except those for power circuit breakers.

By type of bus system, cost of one complete set of steel structute per bay or per 2 lines for 230 kV substation based on EGAT standard design is indicated in the figure below.

The rate of import duty is 30% of imported material (all imported).



(1000 Baht per 2 lines)

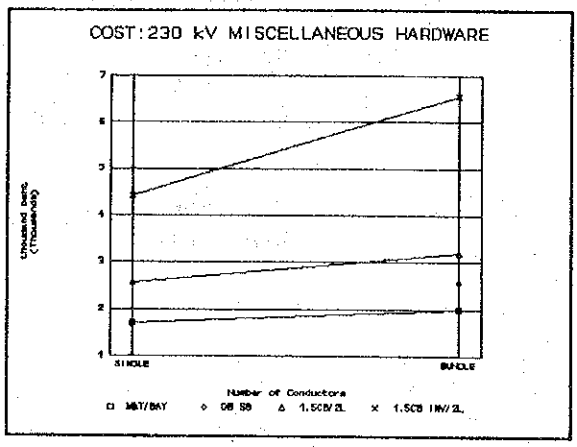
	Main & Transfer	Double Bus	One & a half Conventional	One & a half Invert
230 kV	1095.6	1852.6	2312.8	2920.5
500 kV	1424.3	2408.4	3006.6	3796.7

- Miscellaneous Hardware

The cost of miscellaneous hardware for 230 kV substation includes supply and installation of miscellaneous hardware, which is indicated in the figure below.

The rate of import duty is 35 % of imported material (all imported).

	Main & Transfer	Double Bus	One & a half Conventional	One & a half Invert
230 kV	1445+260.1	2170+390.6	2705+486.9	5550+999
500 kV			12500+3750	

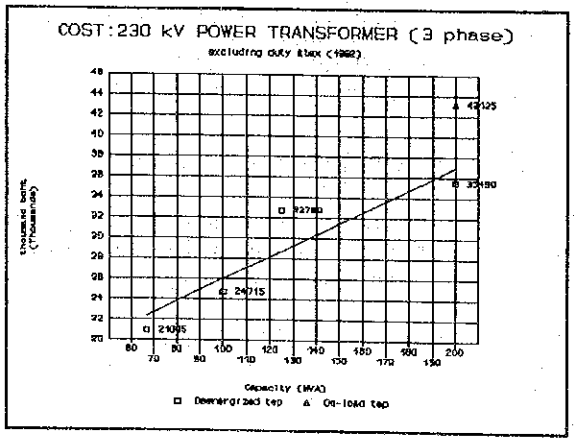


- Power Transformer

The cost of 230 kV power transformer includes supply and installation of power transformer, which is indicated in the figure below as a parameter of it's capacity(MVA).

The rate of import duty is 5% of imported material (all imported).

The cost of transformer bed is estimated all together as foundation work in another section.



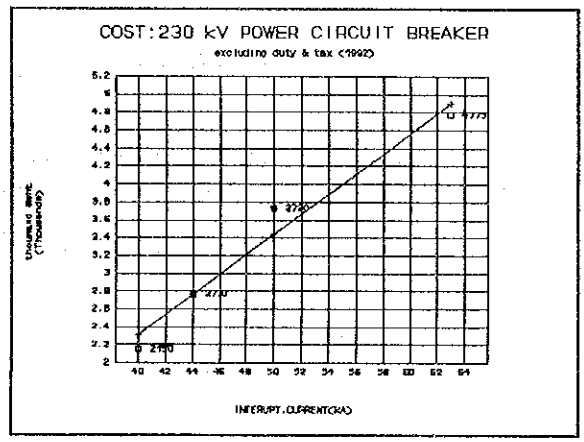
(1000 Baht per 3 phase)

230 kV	500 kV
37,000	111,000

- Power Circuit Breaker

The cost of power circuit breaker includes supply and installation of power circuit breaker and its supporting structure, which is indicated in the figure below as a parameter of interrupting current.

The rate of import duty is 5% of imported material (all imported).



(1000 Baht)

230 kV	500 kV
3520+210	10935+775

- Disconnecting Switch

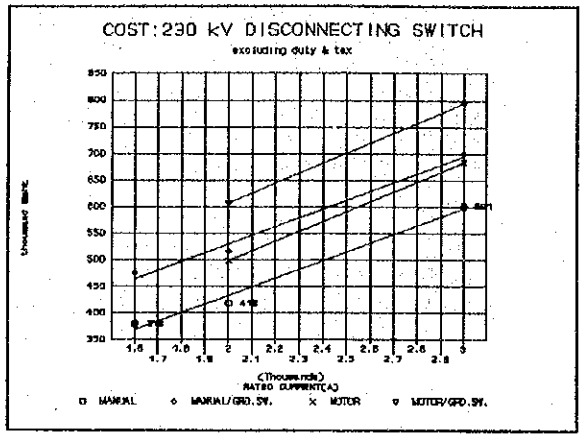
The cost of disconnecting switch includes supply and installation of disconnecting switch, which is indicated by type of operation and equipment of ground switch as in dicated in the figure below.

In accordance with EGAT standard design, the type of disconnecting switch for 230 and 500 kV system will be of motor driven, equipped with ground switch.

The rate of import duty is 5% of imported material (all imported).

(1000 Baht)

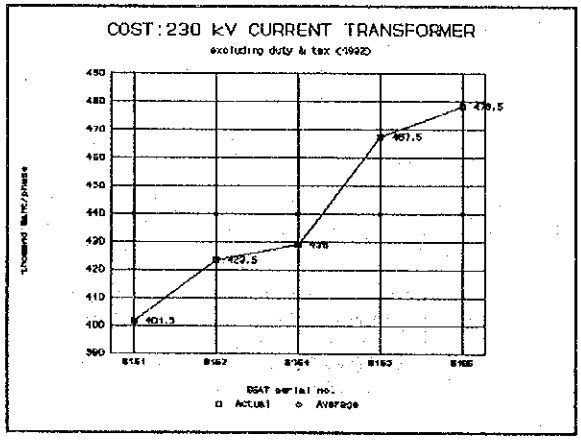
230 kV	500 kV
720+73.5	2500+315

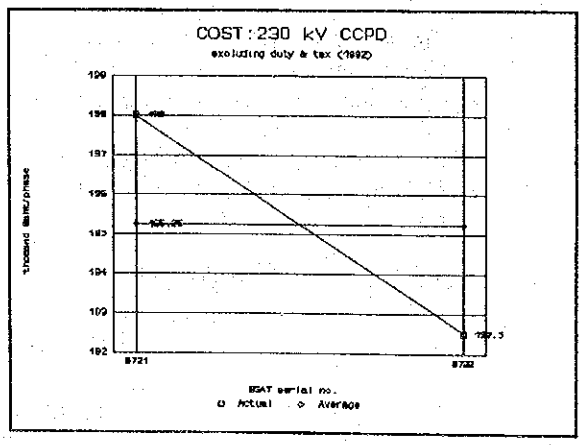


- Instrument Transformer

The cost of instrument transformer include suppy and installation of current transformers and capacitor coupling potential device (CCPD), which is indicated in the figures below.

The rate of import duty is 5% of imported material (all imported).





(1000 Baht per Phase)

	CT	CCPD
230 kV	435+43.5	175+17.5
500 kV	1065+120	430+55

- Miscellaneous Facilities

For new construction, the following is applied.

Import duty is not incurred.

(1000 Baht)

230 kV	500 kV
22,720	28,400

- Main Control Board & Equipment

The following is applied for the cost of main control board and equipment.

The rate of import duty is 35 % of the imported material.

(1000 Baht)

	2 lines	Coupling	Transformer	Bus Protection
230 kV	4170+500.4	805+96.6	1485+178.2	
500 kV	17000+3060		7800+1404	1650+297

- AC & DC Distribution Board

For new construction,the following is applied.

The rate of import duty is 35 % of the imported material.

(1000 Baht)

230 kV	500 kV
	1900+395

- Power & Control Cable

The following is applied.

The rate of import duty is 40 % of the imported material.

(1000 Baht per 2 lines)

230 kV	500 kV
1795+540	6000+2150

(2) Transmission Line

a) Line Route Survey and Soil Investigation

The following price are indicated, according to EGAT price catalog.

- 18 thousand baht/km

b) Right-of-way

The following prices are indicated, according to EGAT price catalog.

- Average	21.5 thousand baht/RAI
- Paddy field and crop area	13.5 thousand baht/RAI
- Mounteneous & forest area	1.5 thousand baht/RAI
- Rubber planted area	36.5 thousand baht/RAI
- Fruit planted area	36.5 thousand baht/RAI
- Suburban area (average)	751.5 thousand baht/RAI

c) Preliminary Work

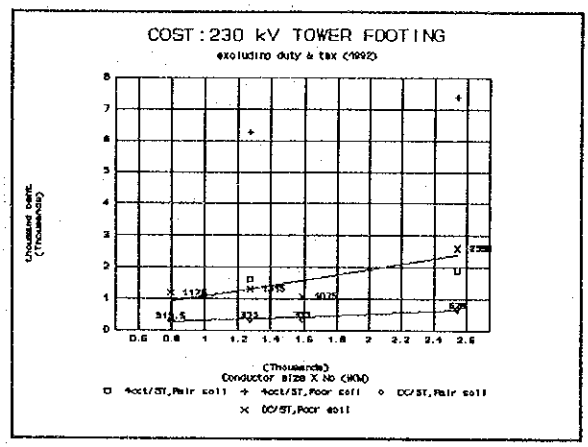
The following prices are indicated, according to EGAT price catalog.

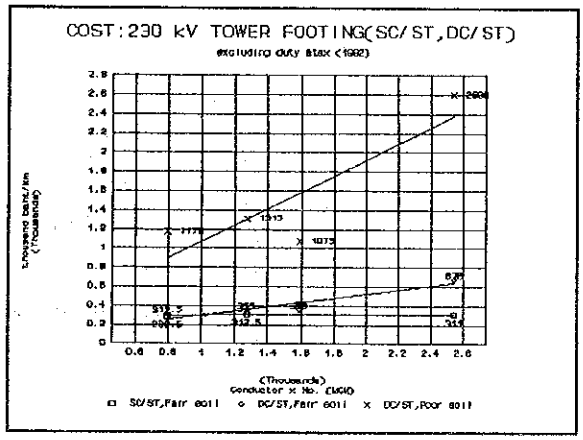
- 230 kV line(General)	100 thousand baht/km
- 500 kV line(General)	155 thousand baht/km

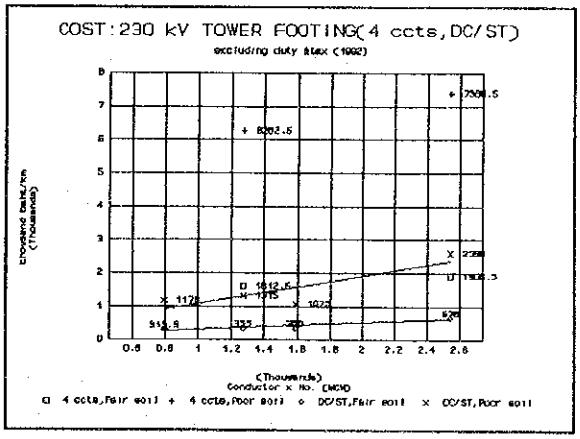
d) Tower Footing

The cost of tower footing includes supply and installation of tower foot, which is indicated in the figures below.

The rate of import duty is 35 % of imported material.





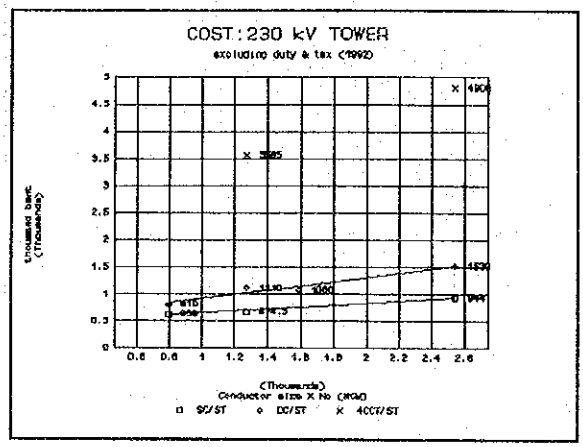


e) Equipment

- Tower Bodies

The cost of tower bodies includes supply and installation of tower bodies, which is indicated in the figure below as a parameter of maximum number of circuits stringing.

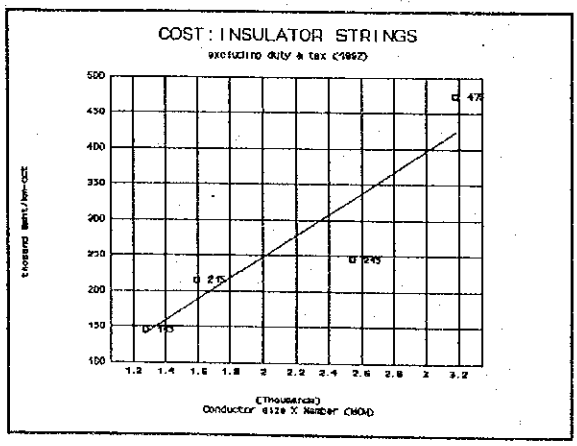
The import duty is not necessary (domesticall produced).



- Insulator String

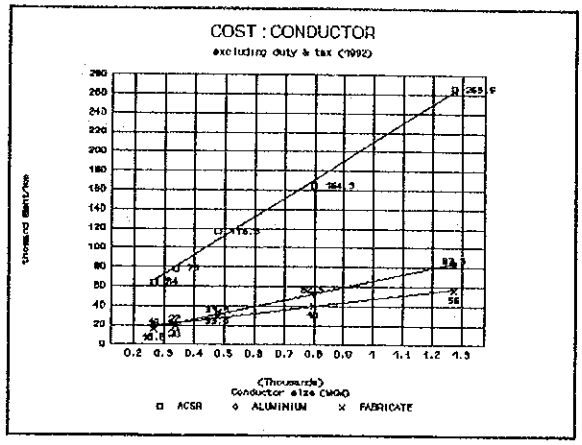
The cost of insulator string is supply cost of insulator strings.

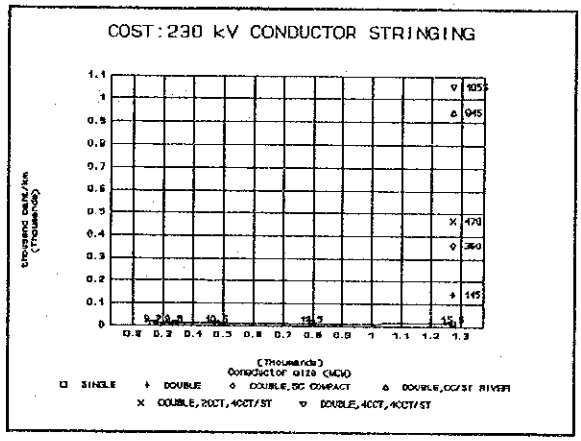
The rate of import duty is 35%.



- Conductor

The supply cost of conductor and stringing cost are separately indicated in the figures below.





- Overhead Groung Wire

The following prices are indicated, according to EGAT price catalog.

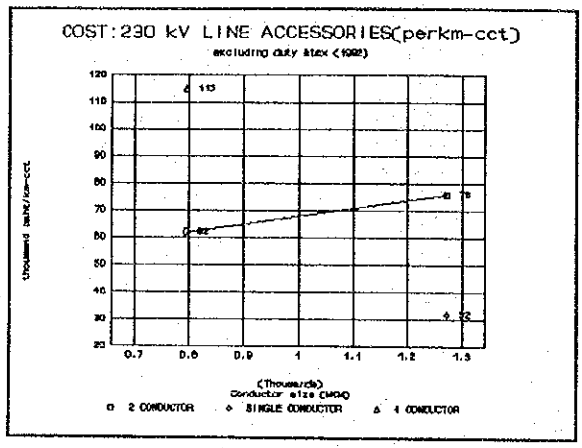
- with 6 cores OPGW with accessories	400 thousand baht/km
- with 10 cores OPGW with accessories	500 thousand baht/km
- 3/8 inch galvanized steel overhead ground wire	20 thousand baht/km
- Stringing (for 4cct compact line)	66.5 thousand baht/km
- Stringing (230 kV)	10 thousand baht/km
- stringing (500 kV)	30 thousand baht/km

The rate of import duty is 35% of imported material (3/4 of the price for 6 core type, 4/5 of the price for 10 core type and 100% for galvanized steel)

- Line Accessories

The cost of line accessories is supply cost as indicated in the figure below.

The rate of imported duty is 35%.



- Grounding Material
  The following prices are indicated, according to EGAT price catalog.

- 230 kV line	27.5	thousand baht/km
- 500 kV line	39	thousand baht/km

The rate of import duty is 35 % of imported mterial.

8.2 Construction Scheduling

In accordance with optimal power system plan of each planned year (1997, 2001, 2006 and 2011) described in Chapter 5, the construction schedule is planned as indicated in the attached bar charts.

In planning, in addition to the result of power system analysis (i.e., the time when the short circuit current or power flow exceeds the existing equipment ratings), the following items are taken into consideration to determine the critical path for construction scheduling.

(1) To make a small roop of 500 kV system via SAI NOI, RANGSIT, NORTH BANGKOK and BANGKOK NOI by 2006 without reduce or cutting power supply to the central consumers area during construction, the loop is to be reconstructed and completed in four time-related divisions, the first of which is the portion between Rangsit and Chaeng Watthana.

This first portion (between Rangsit and Chaeng Watthana) is estimated to be overloaded with the existing lines and to be reinforced (replaced by 500/230 kV 4 lines and operated at 230 kV tentatively) by 1997, and in addition, power transmission to central consumers area will be secured by this route during the construction period of the other part of the loop, in the case this portion is reconstructed prior to start reconstruction of the other part of the loop.

Followed by this, replacement of line between North Bangkok and Bangkok Noi (by 500 kV double lines), which portion has less capability of power transmission than the other part in the loop as it is a single line, and replacement of lines between Sai Noi and Bangkok Noi (by 500 kV double lines) are to be performed and completed by 2000.

Replacement of lines between North Bangkok and Chaeng Watthana by 500/230 kV 4 lines together with construction of 230 kV new substation <A> at junction point of lines among Rangsit, North Bangkok and Lat Phrao will be completed by 2002, and Sai Noi-Bangkok Noi line start operation at 500 kV by 2002.

The remaining part of the loop between Sai Noi and Rangsit site is to be completed by 2004 replacing the existing line by 500 kV double lines, and the small 500 kV loop start 500 kV operation by 2005.

(2) To increase the transmission capability to central consumers area through On Nuch, <C> substation is to be constructed by 2008 and number of lines will be tapped to <C> substation.

The construction of <C> substation will be followed by :

- Tap to <C> of existing 230 kV lines (Nong Chok-Bang Pakong, On Nuch-Bang Pakong -2008)

- 230 kV double overhead lines replaced by 230 kV 4 lines (underground cable crossing airport area and overhead line in the other area) between <C> and On Nuch (2008)

- New 230 kV 4 lines between <C> and Nong Chok (2009)

- New 500 kV double lines between <C> and Nong Chok (2011)

(3) The other lines are to be reinforced depending on the capability of power transmission corresponding the growth of power demand in each consumers area.

Table 8 - 1 CONSTRUCTION AND EXPANSION SCHDULE OF THE TRANSMISSION LINES IN THE GREATER BANGKOK AREA

No	Transmission Lines				Scale in 1992			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Scale in 2011		
	From	To	Length (km)	Construction length(km)	Voltage (kV)	No. of Circuits	Conductor n x MCM																				Voltage (kV)	No. of Circuits	Conductor n x MCM
29	WANG NOI	NONG CHOK	64	64					****	******																			
28	SAI NOI	WANG NOI	56	56					****	******																	500	2	4 x 795
	BANG PLI	BANG PAKONG	44.1		230	2	2 x 1272																				500	2	4 x 795
26	BANG PLI	D (BANG BOR)	17.5	1.0											***														
26	D (BANG BOR)	BANG PAKONG	27.5	1.0											***												230	2	2 x 1272
22	ON NUCH	BANG PLI	10.5	10.5	230	2	1 x 1272													******							230	2	2 x 1272
15	ON NUCH	BANG KAPI	10	10	230	2	2 x 1272													******							230	2	2 x 1272
	ON NUCH	BANG KAPI	10		230	2	2 x 1272																				230	4	2 x 1272
16	B (PATANAKARN)	BANG KAPI	5	5.0																							230	2	2 x 1272
	LAT PHRAO	BANG KAPI	10.4		230	2	2 x 1272																		******		230	2	2 x 1272
	LAT PHRAO	RATCHADA PHISEK	4.5	0.5					****																				
	RATCHADA PHISEK	BANG KAPI	6.5	0.5					****																		230	2	2 x 1272
	SOUTH BANGKOK	BANG PLI	15.9		230	2	2 x 1272																				230	2	2 x 1272
27	SOUTH BANGKOK	E (TEPARAK)	11.5	2.0							******																		
27	E (TEPARAK)	BANG PLI	5.5	2.0							******																230	2	2 x 1272
	NONG CHOK	BANG PAKONG 2	42.3		230	2	2 x 1272																				230	2	2 x 1272
23	NONG CHOK	Site C	19	19																			******	***					
24	Site C	BANG PAKONG 2	24	2.0																				***			230	4	2 x 1272
	ON NUCH	BANG PAKONG 2	56		230	2	2 x 1272																				230	2	2 x 1272
	ON NUCH	C	22	22																									
19,21			Overhead 12	Overhead 12																	***	******					230	4	2 x 1272
20			Cable 10	Cable 10																	***	******				******	230	4	cable
25	Site C	BANG PAKONG 2	36	2.0	230	2	2 x 1272																	***			230	2	2 x 1272
	NONG CHOK	KHLONG MAI	34.3		230	2	2 x 1272																						
18	NONG CHOK	C	19	19																				***	******		500	2	4 x 1272
	C	KHLONG MAI	15.5	2.0																				***			230	2	2 x 1272
	KHLONG MAI	BANG PAKONG	8		230	2	2 x 1272																				230	2	2 x 1272
2	SAI NOI	BANGKOK NOI	29.6	29.6	230	2	2 x 1272							*******	***												500	2	4 x 1272
	BANGKOK NOI	NORTH BANGKOK	18.4		230	1	1 x 1272																						
1	BANGKOK NOI	Site F (TALINGCHAN)	9.2	9.2											***														
4	Site F (TALINGCHAN)	NORTH BANGKOK	9.2	9.2											***												500	2	4 x 1272
4	F (TALINGCHAN)	NORTH BANGKOK	9.2	9.2																					***		500	2	4 x 1272
	SAI NOI	RANGSIT	24.5		230	2	2 x 1272																				230	2	2 x 1272
3	SAI NOI	Site RANGSIT	24.5	24.5															******								500	2	4 x 1272
	RANGSIT	NORTH BANGKOK	19.4		230	1 / 2	1 x 1272																						
	RANGSIT	LAT PHRAO	17.7		230	1 / 2	1 x 1272																						
	RANGSIT	CHAENG WATTANA	10	1.0	230	2	1 x 1272		***																				
3	Site RANGSIT	Site CHAENG WATTANA	10	10							******																500	2	4 x 1272
13	RANGSIT	CHAENG WATTANA	10	10																									
			Overhead 5	Overhead 5							******																230	2	4 x 1272
			Cable 5	Cable 5							******																230	2	cable
	CHAENG WATTANA	NORTH BANGKOK	11.4	1.0	230	1 / 2	1 x 1272		***																				
	CHAENG WATTANA	LAT PHRAO	9.7	1.0	230	1 / 2	1 x 1272		***																				
	NORTH BANGKOK	LAT PHRAO	7		230	1 / 2	1 x 1272																						
5	Site CHAENG WATTANA	Site A	7.1	7.1												*******	***												
5	CHAENG WATTANA	A	7.1	7.1												*******	***										500	2	4 x 1272
6	Site A	NORTH BANGKOK	4.4	4.4												*******	***										230	2	2 x 1272
6	A	NORTH BANGKOK	4.4	4.4												*******	***										500	2	4 x 1272
7	A	LAT PHRAO	2.7	2.7												*******	***										230	2	4 x 1272
14	NONG CHOK	ON - NUCH	16.8	16.8	230	2	2 x 1272						******														230	4	2 x 1272
17	BAN PONG2	SAI NOI	53.6	53.6	230	2	1 x 1272							***	******												500	2	4 x 1272
12	WANG NOI	RANGSIT	50	50					*****	******																	230	2	2 x 1272
12	WANG NOI	RANGSIT(orRANGSIT 2)	50	50													***	******									230	2	2 x 1272
	RANGSIT	RANGSIT 2	4.0	4.0														***									230	2	2 x 1272
	BANGKOK NOI	SAM PHRAN 1	12		230	1	2 x 1272																						
8	BANGKOK NOI	Junction near BANGKOK NOI	0.3	0.3	230	1	2 x 1272										***	******									230	2	4 x 1272
9	Junction near BANGKOK NOI	SAM PHRAN 1	11.7	11.7	230	2	2 x 1272										***	******									230	4	4 x 1272
10	Junction near BANGKOK NOI	SOUTH THONBURI	8.1	8.1	230	1	2 x 1272													******							230	2	4 x 1272
11	BANGKOK NOI	SOUTH THONBURI	8.1	8.1	230	2	2 x 1272													******							230	1	4 x 1272
30	A	G (SANAMPAO)	9	9										*** 5ccts ***										** 1cct **			230	6	Cable
32	SOUTH TONBURI	I (THANONTOK)	10	10						*** 3ccts ***														** 1cct **			230	4	Cable
33	BANGKOK NOI	J (THONBURI)	11	11																*** 2ccts ***					** 1cct **		230	3	Cable
31	BANG KAPI	H (KLONG TOEY)	8	8						*** 3ccts ***				*** 2ccts ***										** 1cct **			230	6	Cable

Note : (1) **** shows a period of construction work.

(2) ▒▒▒▒ shows recomended reinforcement, though outside the Greater Bangkok Area.

CHAPTER 9

ENVIRONMENTAL IMPACT STUDY

CHAPTER 9 ENVIRONMENTAL IMPACT STUDY

9.1 General

The ultimate plan for horizon year transmission system covers introduction of 500 kV system into Bangkok Noi and North Bangkok substations, with replacement of existing 230 kV loop lines, Sai Noi - Bangkok Noi - North Bangkok - Rangsit - Sai Noi with 500 kV transmission lines. Since it is extremely difficult or rather impossible to obtain a new line-route, therefore existing 230 kV right of way of 40 m. will be rather restricted for the 500 kV line construction.

The objective of the study includes environmental problem, protective measure and compensation cost to build 500 kV transmission line on the existing 230 kV line right of way around the Bangkok Metropolitan Area.

9.2 Recent EGAT Experience with Re-built 230 kV Multiple Circuit on Single Right of Way

9.2.1 Transmission Lines

The principal problem and its solution are briefly summarized as follows:

(1) Design Stage

a) Due consideration has to be made prior to the bids as the condition that either the construction can be carried out with the existing line shut-off during off- peak period (e.g. during 8-16 hours daily) only, or that line section can be taken out of service for 2-3 months for the purpose of erection of tower and/or stringing of conductor.

b) Locate the new tower on the spot closed to former site so that middle span reinforced tower can be set up in the middle of the span.

c) Problem of conflict with new infrastructure, e.g. the crossing of new expressway, or the new elevated railroad etc. can be easily solved during the design stage.

(2) Construction Stage

a) During construction period, two options are available, i.e. the temporary detour line or the planned permanent additional line - to be built on the edge of the Right of Way, for instance.

b) Transportation of major equipment or supplies - e.g. long concrete piles - can pose as one of major problem to deal with very narrow Right of Way.

9.2.2 Substation

(1) In general, the existing substation occupy rather small area. It is therefore necessary to modify the substation layout, either by replacing the equipment with higher capacity rating, or

(2) Re-build the substation with Gas Insulated Switchgear (GIS) equipment, which occupy small space than the conventional type.

Attention is drawn here concerning the construction of the new 500 kV lines and substations as part of the Bulk Power Supply in the Greater Bangkok Area will pose similar and/or rather more difficult problems to the above-mentioned project.

9.3 Environmental Problem : Superimpose 500 kV Line on Existing 230 kV Line Right of Way

Mae-Moh-Tha Tako-Nong chok 500 kV line was built in most of the rural area, i.e. running through the forest, rice field etc. In another word, it occupies the area of rural environment. The proposed lines of the Bulk Power Supply Project, Sai Noi-Bangkok Noi-North Bangkok-Rangsit-Sai Noi loop line would be built on the existing 230 kV Right of Way, which lie within the sub-urban as well as the urban one. This loop line will go through very-densely populated community, commercial center and all kinds of social infrastructure. In another words, it will occupy the area in sub-urban and urban environment.

9.3.1 Environment Countermeasure

There are various methods to countermeasure the environmental impact, some of them are elaborated here.

(1) Adoption of Safety Clearance Standard

Up to the present, EGAT may adopt a certain clearance standard for the 500 kV line in the rural area. It might be benificial to adopt the Japanese standard for Electrical Safety, as the other alternative for EGAT. It is however used for this study of Environmental compensation. The text of Japanese Government (MITI) Regulation is abstracted in Chapter 9.4 for reference for EGAT.

(2) Reduction of Span Length for Narrower Right of Way

The nominal span length of 420 m. is used for the Tha Tako-Nong Chok line No.2 with 60 m. Right of Way width (but with 795 MCM conductor size). In order to accommodate the 500 kV line with 40 m. Right of Way, it is necessary to reduce the span length such that the outer conductor at the middle of the span, would not swing beyond the Right of Way edge. The result of a computer study indicates that the maximum span length would be about 330 m, with the maximum swing being within 38 meter width of the corridor - leaving one meter safety clearance on both sides to the edge of the Right of Way.

(3) Transformer Noise Abatement.

With the new 500 kV substation, built on the existing ones, like Bangkok Noi and North Bangkok, whose locations are very close to the densely populated residential area. The question of noise pollution should be carefully reviewed. It is recommended that low-noise transformer should be installed in those two new 500 kV substation to reduce the noise pollution down to that restricted by international standard.

9.3.2 Cost of Environmental Protection Measures and Compensations

Evaluation of the cost to compensate for Environmental Protection would generally based on the Marginal Cost of the transmission line; built on the restricted right of way in the urban/suburban area, over the similar line built on the unrestricted corridor in the rural area. In another words, the compensation cost is evaluated as the difference in costs of the 500 kV line-built on the 40 m. Right of Way around Bangkok area and that of the 500 kV line -built on the 60 m. Right of Way such as the THA TAKO-NONG CHOK line (but with the same conductor size, e.g. 4 x 1272 MCM).

Marginal Cost on Different Ruling Span

At first, computer studies to determine the maximum ruling span that limit the conductor swing at the middle of the span to be within the safety zone of the Right of Way, have to be carried out. Then two set values of the ruling span would yield the number of towers to be used in each line. The different number of tower would lead to the evaluation in Marginal Cost to build that two transmission line on two different width of the Right of Way.

Consider, all other components of the line are the same, i.e.

a) Approximately the same length of conductors,
b) Conductor stringing cost being regarded equal, and
c) also other remaining works, as well.

Therefore, the cost to erect the different number of tower (i.e. land area for tower footing, tower bodies, foundation, insulator string and all other tower fixtures) would determines the cost differences between the two alternatives. It is therefore the so called "marginal cost" which has been defined as the compensation cost for environmental protection measure as well.

The text and illustrative example are as follows.

(1) Marginal Cost Study

Item	Description	T/L in rural area	T/L in sub-urban /urban area	Marginal Cost
1.	Right of Way	Un-restricted	Restricted	-
2.	Ruling span	x meter	y meter	x > y
3.	Estimated number of tower	$\frac{1}{x}$ (line length)	$\frac{1}{y}$ (line length)	$(\frac{1}{y} - \frac{1}{x})$ (line - length)
4.	Overall cost of different number of tower (i.e.each tower cost includes tower bodies, foundation included land cost - as well as insulator and other fixtures)	A	B	B - A
5.	Conductor, overhead groundwire and accessories (since it is the same length of line)	C	practically "same"	- nil -
6.	Others	D	- ditto -	- nil -
7.	Conclusion:Marginal cost of the 2 transmission line is	-	-	$\frac{B - A}{}$

(2) Marginal Cost of 500 kV Transmission Line in the Greater Bangkok Area

Excerpt : The re-built of 500 kV transmission line in the Greater Bangkok Area has to be on the existing right of way (of 40 meter width). Question to evaluate the over increasing value of land use for the whole Right of Way is irrelevant for "Marginal Cost" study. Only land cost of the increased number of the new tower over the hypothetical line (in the rural area) will be evaluated.

a) Since the ruling span on 40 m. Right of Way = 330 m.

Total length of 500 kV = 146.600 km.

Approximate number of tower = $\frac{146.600}{0.330}$

= 444.24 ≈ 445 towers

And the ruling span on 60 m. Right of Way = 400 m.

Approximate number of tower = $\frac{146.600}{0.400}$

= 366.50 ≈ 367 towers

The increased no. of towers = 445-367

= 78 towers

b) Cost of each tower

a)	Tower body	=	4,500,000	Baht
b)	Tower foundation	=	1,500,000	Baht
c)	Cost of land used for foundation	=	4,000,000	Baht
d)	V-string assembly and insulator cost	=	100,000	Baht
	Total cost for each tower location	=	10,100,000	Baht
	Total different number of tower	=	78	towers
	Therefore different cost of the two lines	=	10,100,000 x 78	Baht
		=	787,800,000.-	Baht
		=	Marginal Cost	

As quoted above, cost of environmental protection measures and compensation equals to the marginal cost of the proposed line over the hypothetical rural line. In this case the compensation cost for the environmental protection is estimated to be approximately 787.800 million Baht.

9.3.3 Finalized Compensation Cost for Environmental Measure

During the detailed design stage of the works, design engineer generally would try to locate the tower position, free from environmental impact. Even so there may be several finalized tower locations that require higher than normal tower to avoid electrical impact for such environment. The increased cost of the tower (body and foundation) can then be evaluated as one item of finalized environmental compensation cost.

9.4 Japanese Standard for Electrical Safety

Required height and clearance allowable for human safety in accordance with Japanese Standard are cited follows:

(1) Minimum Required Height of energized part of transmission line from the ground level on account of allowable electrostatic induction to human

a) Criteria Value

- 30 V/cm (27 V/cm=10 % allowance) at 1 m above ground level
  - Resident area - code 112

- 50 V/cm at 1 m above ground level
  - Other area

b) Standard Required Height

Nominal System Voltage (kV)	Conductor			Min. Required Height (m)	
	Site (mm^2)	Type	Number	Resident Area	Non-resident Area
187	240	ACSR (TACSR)	1	7.0	5.0
220	410	ACSR (TACSR)	1	8.5	6.0
220	610	ACSR (TACSR)	2	10.5	7.5
275	410	ACSR (TACSR)	2	12.5	8.5
275	410	ACSR (TACSR)	4	14.0	10.0
275	810	ACSR (TACSR)	4	14.0	10.0
500	810	ACSR (TACSR)	4	23.0	16.0

(2) Required Height of energized part of transmission line from the ground level on account of insulation coordination

Nominal System Voltage (kV)	Required Height (m)	
	Resident Area	Non -resident Area
187	6.36	5.36
220	6.72	5.72
275	7.44	6.44
500	10.08	9.08

(3) Clearance of Energized Part to Building

a) Criteria Value

At least 3 m to horizontal direction-Code 133

(4) Clearance of Energized Part to Tree

a) Height of tree grown in 10 years is to be considered.
- Code 144

b) The table below indicates the average height of tree after 15 years growth by region in Japan and growth rate per year.

The value of 6 m seems to be sufficient for 10 years growth in Japan.

Cedar Tree		Cypress Tree		Pine Tree	
Height	m/year	Height	m/year	Height	m/year
8.3	0.55	5.4	0.36	7.3	0.49
Akita Province		Kiso Province		Iwata Province	
7.4	0.49	6.1	0.41	8.5	0.57
Echigo/Aizu Province		Amagi Province		Nagano/Niigata Province	
6.2	0.41	7.3	0.49	8.7	0.58
Kumamoto Province		Shikoku/Setouchi Province		Chugoku/Setouchi Province	

(5) Telecommunication Line

Potential not more than 5,500 V at 5m in height from ground level

(6) Minimum Height and Clearance (Summary)

Minimum Height of Conductor

		Nominal System Voltage (kV)				Note
		187	220	275	500	
From the ground level	Resident Area	6.36	6.72	7.44	10.08	Code 116 Code 112
		Electric field strength not more than 30 V/m at 1m above ground level				
	Non-resident Area	5.36	5.72	6.44	9.08	Code 116
From snow surface		Not dangerous for passengers				Code 116
From water surface		Not dangerous for navigation				Code 116

Clearance of Conductor to various Objects

	Nominal System Voltage (kV)				Note
	187	220	275	500	
Structure	5.40	5.85	6.60	10.05	Code 133
Road	ditto	ditto	ditto	ditto	134
Railway	3.56	3.92	4.64	7.28	135
Cable of small current	ditto	ditto	ditto	ditto	136
EHV	ditto	ditto	ditto	ditto	137
Other structure	ditto	ditto	ditto	ditto	138
Tree	ditto	ditto	ditto	ditto	141

9.5 Static Induction under Extra-High Voltage Overhead Transmission Line

The study of the static induction under transmission lines has been started as a part of the research program for clarification of technical problems introduction by the 500 kV transmission lines.

When a man carrying an umbrella passes beneath a 500 kV transmission line, a part of his body, such as his cheek may touch the metallic part of the umbrella stem to sense the static induction, or a man touching metallic part of a car, building, fence, etc. may sense the static induction. Concerning these circumstances, the following subjects were studied.

* Effect on human body and the strength of the sensing.

* The relation between the strength of electric field under the transmission line and the strength of the sensing.

* Measurement method and prediction method of electric field strength.

* Target of reduction and measures for reduction.

9.5.1 Effect on Human Body

When a object in which the electrostatic induction is induced touches a human a body, a transient discharge occurs instantaneously, and intermittent pulse current flows through the human body.

The "Induction Sensing Survey Medical" conducted a research on such phenomena. In this research, minute discharge energy was artificially applied to men holding umbrellas, and experiments were repeated by changing the discharge duration. The result of this research indicated that, since the duration of the discharge caused by the contact to the umbrellas was very short, the mental and physical stimuli produced by the discharge were within the biological fluctuations that usually occur in human bodies in normal life, and they are transient in nature.

Another research on the effect of instantaneous discharges on human bodies was performed by Grusile, et al. of U.S., which indicated that the dangerous threshold, as expressed by the discharge energy, is from 10 to 50 Ws. The discharge energy produced by the contact of a human bodies to umbrella is far lower, which can be roughly calculated as several mWs, and which is applied only intermittently.

9.5.2 Extent of Sensing

(1) When the transmission line structures are conventionally designed, the electric current that passes the human body during the sensing of static induction is so small as compared to the safety limit of electrification that there is no risk to the human body.

However, since it is not desirable to produce the feeling of discomfort of anxiety on the public due to the stimuli produced

by the contact, it is necessary to study and identify the magnitude of the static induction which should be selected in establishing the target of reduction of induction.

It would be easier for such a study to divide the objects on which static induction is induced to those having almost similar structure and size, such as umbrellas and cars, and those which structure and size can not be defines, such as metallic roofs and fences.

The electrostatic induction is a phenomenon produced when an insulated conductors are present in the electric field beneath transmission lines, and such conductors have electric potential with respect to the earth. When a human body touches such a conductor, the man senses a stimulus, and a discharge current flows through the human body at such an instance. The same phenomena is observed when an insulated human body touches a grounded conductor. The amount of electricity that passes through the human body under such a circumstance is much lower than the safety limit set against electrification, and this phenomenon does not adversely affect the human body.

However, as people sense stimuli at such instance, with the feeling of anxiety, it would be required to provide mitigation measures for such high voltage transmission line as the 500 kV line.

It is easier to deal with problem by dividing the induced objects into:

a) Objects having almost similar structures and size, such as umbrellas and cars, although they are not held by specific groups of people.

b) Objects which can be specified and which are relatively small in number, but their structure and size are indefinite, such as metallic roofs and fences.

The result of the study conducted under this classification indicates the following facts.

(2) The reports provided by the "Induction Sensing Survey Medical Group" and the "500 kV Verification Test Research Committee" are available as the reports on the extent of sensing of the transient discharge which is produced at the instant of contact of human bodies to umbrellas.

Voltage Induced in Umbrella	Feeling When Cheek Touches
1 - 2 kV (5 - 10 V/cm)	Scarcely sensed.
3 - 4 kV (15 - 20 V/cm)	May be sensed, but scarcely bothering.
5 - 6 kV (25 - 30 V/cm)	Minutes stimulus may be sensed at the moment of contact
8 kV or more (40 V/cm or more)	Fairly clear stimulus is sensed

Note: Figures in parentheses indicate the corresponding electric field strength.

Source: Report of Induction Sensing Survey Medical Group

Bank	Extent of Sensing (Sensing at the instant of contact of check to the umbrella stem while walking beneath the charged part holding an umbrella.	Electric Field Intensity at Ground Surface (V/cm)
1	Scarcely sensed.	Approx. 30 or less
2	Sensed a little.	Approx. 30 to 60
3	Sensed.	Approx. 60 or more

Source: Report of 500 kV Verification Test Research Committee

By comparing these two reports, it is seen that almost the same results are reports for phenomena with electric field intensity of 30 V/cm or less, although the expressions in the report differs somewhat. However, the Induction Sensing Medical Group reports "fairly clear stimulus is sensed" with field intensity of 40 V/cm or more, while the 500 kV Verification Test Research Committee reports" sensed a little" at approximately 30 to 60 V/cm, and "sensed" at approximately 60 V/cm or more.

This difference seems to have come from the fact that, while the former group conducted the experience under a condition in which the subject can be more sensitive than under normal circumstance, by making the subject stand still beneath a transmission line and touch the umbrella slowly, the latter committee conducted the experiment under a more realistic condition, in which the subject simulated the situation of a man innocently walking under a transmission line and accidentally touching the umbrella.

9.5.3 Measurement and Prediction Methods

There are methods of field measurement that depend on the measurement items and measurement subjects, as illustrated.

Measurement Item		Measurement Method	Measurement Object
Induced Voltage on Induced Object		Static Voltmeter Method	Applicable to all induced objects.
		Vacuum Tube Voltmeter Method	
		Neon Tube Voltmeter Method	
Induced Current in Human Body	(Steady State)	Ammeter Method	Applicable to all induced objects.
	(Transient)	Oscillograph Method	
Electric Field Intensity		Electric Field Intensity Meter Method	Not applicable to fixed objects.

9.5.4 Reduction Method

There are reduction methods as illustrated.

Reduction Method	Outline
Increased ground clearance of transmission line.	This method is suitable if they are contemplated before the start of transmission line construction.
Adoption of reversed phase conductor sequence for transmission line.	Applicable to transmission line having vertical conductor arrangement for each of two circuits.
Installation of shielding facilities.	The static induction can be reduced without modifying the transmission line.
Grounding the induced objects. (500 Ω or less)	Applicable to fixed objects and when works are done near the transmission line. The facilities must be added to the induced objects.

CHAPTER 10

ECONOMIC EVALUATION

CHAPTER 10 ECONOMIC EVALUATION

10.1 Outline

In the economic evaluation of this bulk power supply project, the economic internal rate of return (EIRR) by which the total benefit [B] and the total cost [C] become equal has been calculated, and at the same time the surplus benefit (B-C) and the benefit to cost ratio (B/C) have also been calculated as the bases of overall judgment.

The following benefits and costs are considered:

Benefit: 1) The incremental electric energy which is made available to the customers by this Project.

2) The reduction in the electric energy lost by power supply failures which is expected to be brought about by this Project.

3) The reduction of operating/maintenance costs which is expected to be brought about by this Project.

Cost : 1) Total project investment

2) Operation and maintenance costs of completed facilities.

10.2 Basic Assumptions/Conditions

The calculations in the economic evaluation were performed based on the following assumptions and conditions.

(1) The Electricity Tariff Rate

The average selling price of EGAT based on the current tariff structure was used in the study. This average selling price is the tariff rate at transmission level and based on the investment and expense of EGAT on generation and transmission system. The transmission costs have been considered to include only EGAT investment and expenses. (Transmission or sub-transmission costs by MEA and PEA are assumed to be part of distribution.)

(2) Total Project Investment

It has been agreed in principle that any transmission or sub-transmission line that should be constructed along the public right-of-way will be implemented by MEA or PEA. Therefore, some part of the works recommended in the Project will be implemented by MEA. Corresponding to the current tariff structure which based on the investment of each power utility, the investment costs on the MEA's portions were taken out and not included in the study.

The total project investment (only EGAT's investment) was calculated as the construction cost of the Project excluding the

interests during construction, import duties, VAT (Value Added Tax) and escalation. The total construction cost has been added up on the 1992 price base.

(3) Foreign Currency Exchange Rate

It was assumed that 1 US$ = 25 Bahts

(4) Operation and Maintenance Cost

In line with the economic analysis standard of EGAT, the annual operation and maintenance cost was assumed to be 1.0% of the construction cost (without Import duty and VAT) for transmission and distribution lines and 2.0% of the same for substation equipment respectively.

(5) Period of Calculation

The amortization period of the related facilities is set forth by the economic analysis standard of EGAT as follows:

Transmission and Distribution lines:	40 years
Substation equipment :	25 years

The amortization period for this Project was calculated by averaging the above figures using weighing factors for transmission and substation facilities which are proportional to the relative weight of each sector in the total investment. The calculated amortization period was 32 years.

Considering that the facilities to be constructed under this Project will be completed one by one from 1994 to 2011, the period of calculation for the economic evaluation was set from the middle point of the construction period (from 1994 to 2011), that is, 2002, until 32 years later, that is 2034.

(6) Discount Rate

The discount rate was selected at 10% per annum based on the discussion with EGAT.

(7) Generation Cost

In line with the economic analysis standard of EGAT and taking transmission loss into account, the energy cost was assumed to be 0.6998 Baht/kWh and the capacity cost was assumed to be 4,409.16 Baht/kW (per annum).

Calculation of figure are as follows:

- Energy Cost

  0.6480 B/kWh x 1.08 = 0.6998 B/kWh

- Capacity Cost

  38,184.9 x B/kW x 0.10497172 = 4,008.33 B/kW p.a.

  (0.10497172 : Capital recovery factor for 32 years, 10% p.a.)

  4,008.33 x 1.1 = 4,409.16 B/kW p.a.

10.3 Economic Evaluation

10.3.1 Cost

(1) Construction Cost

The total construction cost used in this analysis was calculated by deducting import tax and VAT (Value Added Tax) from the construction cost added up in Chapter 8.

Escalation is not considered.

The yearly construction cost for Economic Evaluation is presented in Table 10-1.

(2) Operation & Maintenance Cost

The annual values of operation & maintenance costs of this Project, as calculated by the assumption in Paragraph 10.2 (4), are presented in Table 10-2.

10.3.2 Benefit

(1) Value of Incremental Electric Energy made available to Customers by this Project

The portion of the energy demand exceeding the limit which can be met by the currently existing facilities will not be met after 1998, if the new facilities under this Project do not start service in 1998. Possible demand increase after 2012 will be met by a new Project following this Project. Therefore, the sum of the energy consumption in MEA area (as estimated by the demand projection and after 2012 the amount will be flat) that exceeds the amount of 1997 in MEA area (as estimated by the demand projection) for the period starting from 1998, when a part of facilities under this project is completed and commenced operation to 2034, when the calculation period ends, can be regarded as the incremental electric energy that is made available to the customers by this Project.

The benefit of this project was calculated by multiplying this incremental energy supply with unit price of electricity tariff, which will be referred later, and deducting generation costs.

This incremental energy supply of each year is given in Table 10-3.

(2) Other Benefits
(Value of electric energy made available by this Project through reduction in supply failures and Reduction of Distribution System Operation/Maintenance Costs)

The energy being lost by supply failures can be reduced when the transmission and distribution system reliability improvement plan, proposed by the JICA Study Team is implemented.

The operation/maintenance costs will be reduced by the rationalization and other factors brought by this Project.

However, as the magnitude of benefits brought about by these factors is very small as compared with the incremental energy supply discussed in the previous section, these benefits are not counted is this economic evaluation.

(3) Electric Energy Benefit

It is appropriate to use the EGAT's average selling price of electricity after deducting generation costs as the reference of benefit in evaluating this Project, because the tariff of an electric company is calculated on cost basis as an utility company and can be regarded to reflect the "willingness to pay" (WTP) of the customers.

EGAT's average selling price is shown in Table 10-4. The figures up to year 2001 is in line with EGAT's current Tariff plan and from year 2002 to 2011 (when construction of the Project is completed) annual 1% increase is assumed in constant 1992 price term. After year 2012 no increase is assumed in the same term. (In conversion from actual tariff rate to 1992 constant price figure, 5% annual escalation is assumed.) The benefit gained by this Project, as obtained by multiplying the incremental energy gained with the unit electricity price and deducting generation costs of EGAT, is presented in Table 10-5.

10.3.3 Results of Economic Evaluation

The flow of benefit and cost of this Project is shown in Table 10-6 and calculation of EIRR is shown in Table 10-7.

The economic internal rate of return (EIRR), the excess benefit (B-C) and the benefit to cost ratio (B/C) as obtained by these benefit and cost are as below.

EIRR: 17.54% (Table 10-7)
B-C : 668,715 Thousand US$ (Table 10-6, discount rate 10% p.a.)
B/C : 2.18 (Table 10-6, discount rate 10% p.a.)

In judging the economic soundness of this Project, the JICA Study Team rates that all of EIRR, B-C and B/C values are good, and this Project is economically feasible.

Table 10-1 Construction Cost for Economic Analysis

(1,000 US$)

Year	Total Construction Cost for Transmission Line	Value Added Tax	Import Duty	Construction Cost (Transmission Line) for Analysis	Total Construction Cost for Substation Equipment	Value Added Tax	Import Duty	Construction Cost (Substation) for Analysis	Total Construction Cost for Analysis
	A	B	C	D=A-(B+C)	E	F	G	H=E-(F+G)	D+H
1994	300	16	10	274					274
1995	161,280	6,692	3,950	150,638					150,638
1996									0
1997	81,410	650	298	80,462	206,995	11,358	14,337	181,300	261,762
1998	14,850	764	322	13,764					13,764
1999									0
2000	45,370	2,347	1,318	41,705					41,705
2001					193,909	10,660	12,506	170,743	170,743
2002	23,000	1,215	490	21,295					21,295
2003	15,080	791	445	13,844					13,844
2004	25,930	1,307	927	23,696					23,696
2005	12,510	4,718	298	7,494					7,494
2006					171,788	9,435	9,748	152,605	152,605
2007	175,180	555	250	174,375					174,375
2008									0
2009	18,190	8,701	405	9,084					9,084
2010	13,750	700	474	12,576					12,576
2011					112,518	6,184	7,314	99,020	99,020
2012 - 2034				0				0	0
Total	586,850	28,456	9,187	549,207	685,210	37,637	43,905	603,668	1,152,875

Table 10-2 Operation and Maintenance Cost

(1,000 US$)

Year	Construction Cost (Transmission Line) without VAT and Import Duty	Operation and Maintenance Cost for Transmission Line	Construction Cost (Substation) without VAT and Import Duty	Operation and Maintenance Cost for Substation Equipment	Total Operation and Maintenance Cost
1994	274		0		
1995	150,638		0		
1996	0		0		
1997	80,462		181,300		
1998	13,764	2,314	0	3,626	5,940
1999	0	2,314	0	3,626	5,940
2000	41,705	2,314	0	3,626	5,940
2001	0	2,314	170,743	3,626	5,940
2002	21,295	2,868	0	7,041	9,909
2003	13,844	2,868	0	7,041	9,909
2004	23,696	2,868	0	7,041	9,909
2005	7,494	2,868	0	7,041	9,909
2006	0	2,868	152,605	7,041	9,909
2007	174,375	3,532	0	10,093	13,625
2008	0	3,532	0	10,093	13,625
2009	9,084	3,532	0	10,093	13,625
2010	12,576	3,532	0	10,093	13,625
2011	0	3,532	99,020	10,093	13,625
2012 – 2034		5,492		12,073	17,565
Total	549,207	167,573	603,668	377,860	545,434

Table 10-3 Incremental Electric Energy in MEA area, which will become available by this Project

(GWh)

Year	Received Energy by MEA (Forecast)	Received Energy by MEA (1997 Forecast)	Incremental Energy received by MEA
1998	40,214	37,292	2,922
1999	43,345	37,292	6,053
2000	46,560	37,292	9,268
2001	50,003	37,292	12,711
2002	53,041	37,292	15,749
2003	56,261	37,292	18,969
2004	59,484	37,292	22,192
2005	62,713	37,292	25,421
2006	66,051	37,292	28,759
2007	69,304	37,292	32,012
2008	72,396	37,292	35,104
2009	75,345	37,292	38,053
2010	78,161	37,292	40,869
2011	80,825	37,292	43,533
2012 - 2034	80,825	37,292	43,533
Total			1,332,874

Table 10-4 EGAT's Average Selling Price of Energy

No	YEAR	Average Selling Price (Baht/kWh)	Constant 1992 Price (Baht/kWh)
0	1992	1.2168	1.2168
1	1993	1.2353	1.1765
2	1994	1.2513	1.1350
3	1995	1.5631	1.3503
4	1996	1.6807	1.3827
5	1997	1.8298	1.4337
6	1998	1.9419	1.4491
7	1999	2.1001	1.4925
8	2000	2.1976	1.4874
9	2001	2.3875	1.5390
10	2002	2.5319	1.5544
11	2003	2.6851	1.5699
12	2004	2.8476	1.5856
13	2005	3.0199	1.6015
14	2006	3.2026	1.6175
15	2007	3.3963	1.6337
16	2008	3.6018	1.6500
17	2009	3.8197	1.6665
18	2010	4.0508	1.6832
19	2011	4.2959	1.7000
20	2012	4.5106	1.7000
21	2013	4.7361	1.7000
22	2014	4.9729	1.7000
23	2015	5.2216	1.7000
24	2016	5.4827	1.7000
25	2017	5.7568	1.7000
26	2018	6.0446	1.7000
27	2019	6.3469	1.7000
28	2020	6.6642	1.7000
29	2021	6.9974	1.7000
30	2022	7.3473	1.7000
31	2023	7.7147	1.7000
32	2024	8.1004	1.7000
33	2025	8.5054	1.7000
34	2026	8.9307	1.7000
35	2027	9.3772	1.7000
36	2028	9.8461	1.7000
37	2029	10.3384	1.7000
38	2030	10.8553	1.7000
39	2031	11.3981	1.7000
40	2032	11.9680	1.7000
41	2033	12.5664	1.7000
42	2034	13.1947	1.7000

Table 10-5 Benefit of the Project

Year	Incremental Energy	Energy Price of EGAT	Energy Cost of EGAT	Incremental Capacity	Capacity Cost of EGAT	Benefit	
	A	B	C	D	E	(AxB) - ((AxC) + (DxE))	
	GWh	Baht/kWh	Baht/kWh	MW	Baht/kW p.a.	Mil. Baht	1,000 US$
1998	2,922	1.4491	0.6998	491	4,409.16	24.56	982
1999	6,053	1.4925	0.6998	1,017	4,409.16	314.10	12,564
2000	9,268	1.4874	0.6998	1,556	4,409.16	438.82	17,553
2001	12,711	1.5390	0.6998	2,134	4,409.16	1,257.92	50,317
2002	15,749	1.5544	0.6998	2,644	4,409.16	1,801.28	72,051
2003	18,969	1.5699	0.6998	3,185	4,409.16	2,461.75	98,470
2004	22,192	1.5856	0.6998	3,726	4,409.16	3,229.14	129,166
2005	25,421	1.6015	0.6998	4,268	4,409.16	4,103.82	164,153
2006	28,759	1.6175	0.6998	4,828	4,409.16	5,104.71	204,188
2007	32,012	1.6337	0.6998	5,374	4,409.16	6,201.18	248,047
2008	35,104	1.6500	0.6998	5,893	4,409.16	7,372.64	294,906
2009	38,053	1.6665	0.6998	6,388	4,409.16	8,620.12	344,805
2010	40,869	1.6832	0.6998	6,861	4,409.16	9,939.33	397,573
2011	43,533	1.7000	0.6998	7,309	4,409.16	11,315.16	452,606
2012 - 2034	43,533	1.7000	0.6998	7,309	4,409.16	11,315.16	452,606
Total	1,332,874					322,433	12,897,325

Table 10-6 Benefit Flow and Cost Flow of the Project

(1,000 US$)

Discount Rate		Year	Cost				Benefit		NPV
			Costruction	O&M	Total	PV	Total	PV	
10.00	1	1994	274		274	226			-226
% pa	2	1995	150,638		150,638	113,177			-113,177
	3	1996	0		0	0			0
	4	1997	261,762		261,762	162,534			-162,534
	5	1998	13,764	5,940	19,704	11,122	982	554	-10,568
	6	1999	0	5,940	5,940	3,048	12,564	6,447	3,399
	7	2000	41,705	5,940	47,645	22,227	17,553	8,189	-14,038
	8	2001	170,743	5,940	176,683	74,931	50,317	21,339	-53,592
	9	2002	21,295	9,909	31,204	12,030	72,051	27,779	15,748
	10	2003	13,844	9,909	23,753	8,325	98,470	34,513	26,188
	11	2004	23,696	9,909	33,605	10,708	129,166	41,156	30,449
	12	2005	7,494	9,909	17,403	5,041	164,153	47,549	42,508
	13	2006	152,605	9,909	162,514	42,795	204,188	53,769	10,974
	14	2007	174,375	13,625	188,000	45,006	248,047	59,380	14,375
	15	2008	0	13,625	13,625	2,965	294,906	64,180	61,215
	16	2009	9,084	13,625	22,709	4,493	344,805	68,218	63,725
	17	2010	12,576	13,625	26,201	4,712	397,573	71,507	66,795
	18	2011	99,020	13,625	112,645	18,418	452,606	74,005	55,586
	19	2012		17,565	17,565	2,611	452,606	67,277	64,666
	20	2013		17,565	17,565	2,374	452,606	61,161	58,787
	21	2014		17,565	17,565	2,158	452,606	55,601	53,443
	22	2015		17,565	17,565	1,962	452,606	50,546	48,585
	23	2016		17,565	17,565	1,783	452,606	45,951	44,168
	24	2017		17,565	17,565	1,621	452,606	41,774	40,153
	25	2018		17,565	17,565	1,474	452,606	37,976	36,502
	26	2019		17,565	17,565	1,340	452,606	34,524	33,184
	27	2020		17,565	17,565	1,218	452,606	31,385	30,167
	28	2021		17,565	17,565	1,107	452,606	28,532	27,425
	29	2022		17,565	17,565	1,007	452,606	25,938	24,932
	30	2023		17,565	17,565	915	452,606	23,580	22,665
	31	2024		17,565	17,565	832	452,606	21,437	20,605
	32	2025		17,565	17,565	756	452,606	19,488	18,731
	33	2026		17,565	17,565	688	452,606	17,716	17,029
	34	2027		17,565	17,565	625	452,606	16,106	15,481
	35	2028		17,565	17,565	568	452,606	14,641	14,073
	36	2029		17,565	17,565	517	452,606	13,310	12,794
	37	2030		17,565	17,565	470	452,606	12,100	11,631
	38	2031		17,565	17,565	427	452,606	11,000	10,573
	39	2032		17,565	17,565	388	452,606	10,000	9,612
	40	2033		17,565	17,565	353	452,606	9,091	8,738
	41	2034		17,565	17,565	321	452,606	8,265	7,944
	Total		1,152,875	545,425	1,698,300	567,272	12,897,319	1,235,986	668,715

B-C	668,715
B/C	2.1788264

Table 10-7 Calculation of EIRR

(1,000 US$)

Discount Rate		Year	Cost				Benefit		NPV
			Costruction	O&M	Total	PV	Total	PV	
17.53573	1	1994	274		274	198			-198
% pa	2	1995	150,638		150,638	92,774			-92,774
	3	1996	0		0	0			0
	4	1997	261,762		261,762	116,696			-116,696
	5	1998	13,764	5,940	19,704	7,474	982	372	-7,101
	6	1999	0	5,940	5,940	1,917	12,564	4,055	2,138
	7	2000	41,705	5,940	47,645	13,082	17,553	4,819	-8,262
	8	2001	170,743	5,940	176,683	41,273	50,317	11,754	-29,519
	9	2002	21,295	9,909	31,204	6,202	72,051	14,320	8,118
	10	2003	13,844	9,909	23,753	4,017	98,470	16,651	12,634
	11	2004	23,696	9,909	33,605	4,835	129,166	18,583	13,748
	12	2005	7,494	9,909	17,403	2,130	164,153	20,093	17,963
	13	2006	152,605	9,909	162,514	16,924	204,188	21,264	4,340
	14	2007	174,375	13,625	188,000	16,657	248,047	21,978	5,320
	15	2008	0	13,625	13,625	1,027	294,906	22,231	21,204
	16	2009	9,084	13,625	22,709	1,456	344,805	22,115	20,658
	17	2010	12,576	13,625	26,201	1,430	397,573	21,695	20,265
	18	2011	99,020	13,625	112,645	5,230	452,606	21,013	15,783
	19	2012		17,565	17,565	694	452,606	17,878	17,184
	20	2013		17,565	17,565	590	452,606	15,211	14,620
	21	2014		17,565	17,565	502	452,606	12,941	12,439
	22	2015		17,565	17,565	427	452,606	11,011	10,583
	23	2016		17,565	17,565	364	452,606	9,368	9,004
	24	2017		17,565	17,565	309	452,606	7,970	7,661
	25	2018		17,565	17,565	263	452,606	6,781	6,518
	26	2019		17,565	17,565	224	452,606	5,769	5,546
	27	2020		17,565	17,565	190	452,606	4,909	4,718
	28	2021		17,565	17,565	162	452,606	4,176	4,014
	29	2022		17,565	17,565	138	452,606	3,553	3,415
	30	2023		17,565	17,565	117	452,606	3,023	2,906
	31	2024		17,565	17,565	100	452,606	2,572	2,472
	32	2025		17,565	17,565	85	452,606	2,188	2,103
	33	2026		17,565	17,565	72	452,606	1,862	1,790
	34	2027		17,565	17,565	61	452,606	1,584	1,523
	35	2028		17,565	17,565	52	452,606	1,348	1,295
	36	2029		17,565	17,565	45	452,606	1,147	1,102
	37	2030		17,565	17,565	38	452,606	976	938
	38	2031		17,565	17,565	32	452,606	830	798
	39	2032		17,565	17,565	27	452,606	706	679
	40	2033		17,565	17,565	23	452,606	601	578
	41	2034		17,565	17,565	20	452,606	511	491
	Total		1,152,875	545,425	1,698,300	337,859	12,897,319	337,859	0

B-C	0
B/C	1.0000000

CHAPTER 11

FINANCIAL ANALYSIS

CHAPTER 11 FINANCIAL ANALYSIS

11.1 Outline

The following values shall be calculated based on the value of incremental electric energy (sales revenue) and the total cost of this Project in terms of domestic price in the Kingdom of Thailand.

<1> Financial internal rate of return (FIRR)

<2> Development of disbursement schedule table

<3> Production of profit and loss statement

<4> Cash flow

<5> Calculation of Debt Service Ratio

11.2 Analytical Methodology

(1) Calculation of Financial Internal Rate of Return (FIRR)

The financial internal rate of return, by which the yearly sums of costs and revenues are equal (the financial internal rate of return), has been calculated, and this value has been compared with the opportunity cost of capital. The cost applicable to this evaluation will include the total investment (construction cost with import duty) without consideration of the financing conditions, such as interest, interest during construction, repayment of principal, repayment period, etc., and the operation and maintenance cost.

In this evaluation, the profitability of the investment for the project will be judged regardless of financial conditions.

(2) Calculation of Debt Service Ratio

Debt Service Ratio is the ratio of the corporate internal financing, which is business profit plus depreciation, to the reimbursement plus interest of borrowed money.

To calculated this value, the following three works were required.

1) Development of reimbursement plan

2) Development of profit and loss statement

3) Cash flow analysis

The costs that are applicable to this evaluation consist of the operation and maintenance cost and depreciation cost. The depreciation cost will be calculated based on the total construction cost including import duties, interest during construction and escalation.

11.3 Basic Conditions

This financial analysis has been conducted by the following basic conditions.

11.3.1 Financial Internal Rate of Return (FIRR)

(1) Electricity Sales Revenue

The benefit value of this Project calculated in the Economic Evaluation is used.

(2) Construction Cost

Same as in Economic Evaluation, only EGAT's portion of the construction cost was considered and the construction cost including import duties, which was excluded in the Economic Evaluation, is used.

However, VAT, interest and interest during construction are excluded.

VAT is excluded since VAT will be refunded to EGAT as a governmental body.

(3) Operation & Maintenance Cost

The cost calculated in Economic Evaluation is used.

(4) Escalation

Not considered.

11.3.2 Debt Service Ratio

(1) Electricity Sales Revenue

Same as in the calculation of FIRR, but escalation is considered.

(2) Construction Cost

The construction cost including import duties, interest during construction and escalation.

(3) Operation & Maintenance Cost

Same as FIRR, but escalation is considered.

(4) Escalation

Escalation of 5% per annum is considered.

(5) Capital Procurement Condition

(a) Foreign Currency

An interest rate of 8% per annum. The principal and interest to be uniformly reimbursed for 20 years.

Amount borrowed from year 1994 to 1997 will be reimbursed from year 1998.

In the same manner, amount borrowed, from 1998 to 2001, amount borrowed from 2002 to 2006 and amount borrowed from 2007 to 2011 will be reimbursed from 2002, 2007 and 2012 respectively.

(b) Local Currency

An interest rate of 10% per annum on 50% of the construction cost to be provided by local currency.

The principal and interest to be uniformly reimbursed for 10 years in the same manner as Foreign Currency amount.

(6) Depreciation

As mentioned in Economic Evaluation, the economic life of facilities is assumed to be 32 years. The depreciation has been calculated on the straight line method with no residual value.

11.4 Financial Internal Rate of Return (FIRR)

(1) Construction Cost

The construction cost for calculation of FIRR is shown in Table 11-1.

(2) FIRR

The flows of expenditures and revenues of this Project based on the construction cost above-mentioned and other assumptions is as presented in Table 11-2, and the FIRR is estimated 17.10%.

Based on this estimation, it can be concluded that this project is financially sound.

11.5 Debt Service Ratio

(1) Reimbursement Plan

The reimbursement plan based on the conditions of capital procurement shown in Paragraph 11.3.2 (5) is presented in Table 11-5 to 11-9.

It has been assumed that the interest during construction and escalation are included in the construction cost (Shown in Table 11-3 and 11-4) which is the basis of calculation of the borrowed money, and these accounts are recovered as a part of depreciation.

(2) Profit and Loss Statement and Cash Flow

The profit and loss statement and the cash flow are presented in Table 11-10 and 11-11 respectively.

(3) Debt Service Ratio

The calculated debt service ratio is presented in Table 11-12.

The debt service ratio up to year 2020 is 6.85, which shows this Project is sound also in the aspect of profitability.

Table 11-1 Construction Cost for Financial Analysis

(1,000 US$)

Year	Total Construction Cost for Transmission Line	Value Added Tax	Construction Cost (Transmission Line) for Analysis	Total Construction Cost for Substation Equipment	Value Added Tax	Construction Cost (Substation) for Analysis	Total Construction Cost for Analysis
	A	B	C=A-B	D	E	F=D-E	C+F
1994	300	16	284				284
1995	161,280	6,692	154,588				154,588
1996							0
1997	81,410	650	80,760	206,995	11,358	195,637	276,397
1998	14,850	764	14,086				14,086
1999							0
2000	45,370	2,347	43,023				43,023
2001				193,909	10,660	183,249	183,249
2002	23,000	1,215	21,785				21,785
2003	15,080	791	14,289				14,289
2004	25,930	1,307	24,623				24,623
2005	12,510	4,718	7,792				7,792
2006				171,788	9,435	162,353	162,353
2007	175,180	555	174,625				174,625
2008							0
2009	18,190	8,701	9,489				9,489
2010	13,750	700	13,050				13,050
2011				112,518	6,184	106,334	106,334
2012 - 2034			0			0	0
Total	586,850	28,456	558,394	685,210	37,637	647,573	1,205,967

Table 11-2 Calculation of FIRR

(1,000 US$)

Discount Rate		Year	Cost				Revenue		NPV
			Costruction	O&M	Total	PV	Total	PV	
17.10040	1	1994	284		284	207			-207
% pa	2	1995	154,588		154,588	96,272			-96,272
	3	1996	0		0	0			0
	4	1997	276,397		276,397	125,528			-125,528
	5	1998	14,086	5,940	20,026	7,767	982	381	-7,386
	6	1999	0	5,940	5,940	1,967	12,564	4,161	2,194
	7	2000	43,023	5,940	48,963	13,848	17,553	4,965	-8,884
	8	2001	183,249	5,940	189,189	45,695	50,317	12,153	-33,542
	9	2002	21,785	9,909	31,694	6,537	72,051	14,861	8,324
	10	2003	14,289	9,909	24,198	4,262	98,470	17,345	13,082
	11	2004	24,623	9,909	34,532	5,194	129,166	19,429	14,235
	12	2005	7,792	9,909	17,701	2,274	164,153	21,086	18,812
	13	2006	162,353	9,909	172,262	18,896	204,188	22,398	3,502
	14	2007	174,625	13,625	188,250	17,634	248,047	23,236	5,601
	15	2008	0	13,625	13,625	1,090	294,906	23,591	22,501
	16	2009	9,489	13,625	23,114	1,579	344,805	23,555	21,976
	17	2010	13,050	13,625	26,675	1,556	397,573	23,193	21,637
	18	2011	106,334	13,625	119,959	5,976	452,606	22,548	16,572
	19	2012		17,565	17,565	747	452,606	19,255	18,508
	20	2013		17,565	17,565	638	452,606	16,444	15,805
	21	2014		17,565	17,565	545	452,606	14,042	13,497
	22	2015		17,565	17,565	465	452,606	11,992	11,526
	23	2016		17,565	17,565	397	452,606	10,240	9,843
	24	2017		17,565	17,565	339	452,606	8,745	8,406
	25	2018		17,565	17,565	290	452,606	7,468	7,178
	26	2019		17,565	17,565	247	452,606	6,377	6,130
	27	2020		17,565	17,565	211	452,606	5,446	5,235
	28	2021		17,565	17,565	180	452,606	4,651	4,470
	29	2022		17,565	17,565	154	452,606	3,972	3,817
	30	2023		17,565	17,565	132	452,606	3,392	3,260
	31	2024		17,565	17,565	112	452,606	2,896	2,784
	32	2025		17,565	17,565	96	452,606	2,473	2,377
	33	2026		17,565	17,565	82	452,606	2,112	2,030
	34	2027		17,565	17,565	70	452,606	1,804	1,734
	35	2028		17,565	17,565	60	452,606	1,540	1,481
	36	2029		17,565	17,565	51	452,606	1,315	1,264
	37	2030		17,565	17,565	44	452,606	1,123	1,080
	38	2031		17,565	17,565	37	452,606	959	922
	39	2032		17,565	17,565	32	452,606	819	787
	40	2033		17,565	17,565	27	452,606	700	672
	41	2034		17,565	17,565	23	452,606	597	574
	Total		1,205,967	545,425	1,751,392	361,266	12,897,319	361,266	0

B-C	0
B/C	1.0000000

Table 11-3 Construction Cost divided into Foreign and Local Currency Portion

(1,000 US$)

	Construction Cost for Transmission Line				Construction Cost for Substation Equipment				Total Const. Cost
Year	Total (a)+(b)	Foreign (a)	Local (b)	(Local) (VAT) (c)	Total (d)+(e)	Foreign (d)	Local (e)	(Local) (VAT) (f)	(a)+(b)+(d)+(e)
1994	300	20	280	16	0				300
1995	161,280	11,280	150,000	6,692	0				161,280
1996	0	0	0	0	0				0
1997	81,410	24,160	57,250	650	206,996	138,528	68,468	11,358	288,406
	242,990				206,996				449,986
1998	14,850	920	13,930	764	0				14,850
1999	0	0	0	0	0				0
2000	45,370	3,770	41,600	2,347	0				45,370
2001	0	0	0	0	193,906	136,943	56,963	10,660	193,906
	60,220				193,906				254,126
2002	23,000	1,400	21,600	1,215	0				23,000
2003	15,080	1,270	13,810	791	0				15,080
2004	25,930	2,650	23,280	1,307	0				25,930
2005	12,510	850	11,660	4,718	0				12,510
2006	0	0	0	0	171,786	124,385	47,401	9,435	171,786
	76,520				171,786				248,306
2007	175,180	59,700	115,480	555	0				175,180
2008	0	0	0	0	0				0
2009	18,190	1,160	17,030	8,701	0				18,190
2010	13,750	1,350	12,400	700	0				13,750
2011	0	0	0	0	112,519	77,580	34,939	6,184	112,519
	207,120				112,519				319,639
Total	586,850	108,530	478,320	28,456	685,207	477,436	207,771	37,637	1,272,057

Table 11-4 Calculation of Interest during Construction

(1,000 US$)

	Construction cost without VAT before escalation			Construction cost without VAT after escalation			Interest during Construction			Total		
Year	Foreign (a)+(d)	Local (b)-(c)+(e)-(f)	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Grand total
1994	20	264	284	22	291	313	1	7	8	23	298	321
1995	11,280	143,308	154,588	13,058	165,897	178,955	524	4,162	4,686	13,582	170,059	183,641
1996	0	0	0	0	0	0	1,046	8,309	9,356	1,046	8,309	9,356
1997	162,688	113,710	276,398	207,636	145,126	352,762	9,352	11,938	21,289	216,988	157,064	374,051
			431,270			532,030			35,339			567,369
1998	920	13,166	14,086	1,233	17,644	18,877	49	441	490	1,282	18,085	19,367
1999	0	0	0	0	0	0	99	882	981	99	882	981
2000	3,770	39,253	43,023	5,570	57,995	63,565	321	2,332	2,653	5,891	60,327	66,218
2001	136,943	46,303	183,246	212,444	71,831	284,275	9,042	5,578	14,620	221,486	77,409	298,894
			240,355			366,716			18,744			385,460
2002	1,400	20,385	21,785	2,280	33,205	35,485	91	830	921	2,372	34,035	36,407
2003	1,270	13,019	14,289	2,172	22,267	24,439	269	2,217	2,486	2,441	24,484	26,925
2004	2,650	21,973	24,623	4,759	39,460	44,219	547	3,760	4,307	5,305	43,220	48,526
2005	850	6,942	7,792	1,603	13,090	14,693	801	5,074	5,875	2,404	18,164	20,568
2006	124,385	37,966	162,351	246,274	75,170	321,444	10,716	7,280	17,996	256,990	82,450	339,440
			230,840			440,281			31,586			471,866
2007	59,700	114,925	174,625	124,112	238,921	363,033	4,964	5,973	10,938	129,076	244,894	373,970
2008	0	0	0	0	0	0	9,929	11,946	21,875	9,929	11,946	21,875
2009	1,160	8,329	9,489	2,659	19,090	21,749	10,035	12,423	22,459	12,694	31,514	44,208
2010	1,350	11,700	13,050	3,249	28,157	31,406	10,272	13,604	23,876	13,521	41,762	55,282
2011	77,589	28,755	106,335	196,041	72,662	268,703	18,243	16,125	34,368	214,284	88,787	303,071
			303,499			684,891			113,515			798,407
Total	585,966	619,998	1,205,964	1,023,111	1,000,807	2,023,918	86,302	112,882	199,185	1,109,413	1,113,689	2,223,103

Table 11-5 Financing for Construction

(1,000 US$)

	Construction cost after escalation		Interest during Construction		Financing for Construction		
Year	Foreign	Local	Foreign	Local	Foreign	Local	Total
1994	22	291	1	7	23	153	176
1995	13,058	165,897	524	4,162	13,582	87,110	100,693
1996	0	0	1,046	8,309	1,046	8,309	9,356
1997	207,636	145,126	9,352	11,938	216,988	84,501	301,488
					231,639	180,073	411,712
1998	1,233	17,644	49	441	1,282	9,263	10,545
1999	0	0	99	882	99	882	981
2000	5,570	57,995	321	2,332	5,891	31,330	37,221
2001	212,444	71,831	9,042	5,578	221,486	41,493	262,979
					228,758	82,968	311,727
2002	2,280	33,205	91	830	2,371	17,433	19,804
2003	2,172	22,267	269	2,217	2,441	13,350	15,792
2004	4,759	39,460	547	3,760	5,306	23,490	28,796
2005	1,603	13,090	801	5,074	2,404	11,619	14,023
2006	246,274	75,170	10,716	7,280	256,990	44,865	301,855
					269,512	110,757	380,269
2007	124,112	238,921	4,964	5,973	129,076	125,434	254,510
2008	0	0	9,929	11,946	9,929	11,946	21,875
2009	2,659	19,090	10,035	12,423	12,694	21,968	34,663
2010	3,249	28,157	10,272	13,604	13,521	27,683	41,204
2011	196,041	72,662	18,243	16,125	214,284	52,456	266,740
					379,505	239,487	618,991
Total	1,023,111	1,000,807	86,302	112,882	1,109,413	613,285	1,722,698

Table 11-6 Repayment Schedule of Debt (loan supplied 1994-1997)

(1,000 US$)

		Financing for Construction			Repayment of foreign Currency				Repayment of local Currency			
No.	Year	Foreign	Local	Total	Interest	Principal	Total	Balance	Interest	Principal	Total	Balance
	1994	23	153	176								
	1995	13,582	87,110	100,693								
	1996	1,046	8,309	9,356								
	1997	216,988	84,501	301,488				231,639				180,073
1	1998				18,531	5,062	23,593	226,577	18,007	11,299	29,306	168,774
2	1999				18,126	5,467	23,593	221,110	16,877	12,429	29,306	156,346
3	2000				17,689	5,904	23,593	215,206	15,635	13,671	29,306	142,674
4	2001				17,217	6,376	23,593	208,830	14,267	15,039	29,306	127,635
5	2002				16,706	6,887	23,593	201,943	12,764	16,543	29,306	111,093
6	2003				16,155	7,437	23,593	194,506	11,109	18,197	29,306	92,896
7	2004				15,560	8,032	23,593	186,473	9,290	20,016	29,306	72,880
8	2005				14,918	8,675	23,593	177,798	7,288	22,018	29,306	50,862
9	2006				14,224	9,369	23,593	168,429	5,086	24,220	29,306	26,642
10	2007				13,474	10,119	23,593	158,311	2,664	26,642	29,306	0
11	2008				12,665	10,928	23,593	147,382				
12	2009				11,791	11,802	23,593	135,580				
13	2010				10,846	12,747	23,593	122,834				
14	2011				9,827	13,766	23,593	109,067				
15	2012				8,725	14,868	23,593	94,200				
16	2013				7,536	16,057	23,593	78,143				
17	2014				6,251	17,342	23,593	60,801				
18	2015				4,864	18,729	23,593	42,072				
19	2016				3,366	20,227	23,593	21,845				
20	2017				1,748	21,845	23,593	0				
	Total	231,639	180,073	411,713	240,220	231,639	471,859		112,988	180,073	293,061	

Table 11-7 Repayment Schedule of Debt (loan supplid 1998-2001)

(1,000 US$)

			Financing for Construction		Repayment of foreign Currency				Repayment of local Currency			
No.	Year	Foreign	Local	Total	Interest	Principal	Total	Balance	Interest	Principal	Total	Balance
	1994											
	1995											
	1996											
	1997											
	1998	1,282	9,263	10,545								
	1999	99	882	981								
	2000	5,891	31,330	37,221								
	2001	221,486	41,493	262,979				228,758				82,968
1	2002				18,301	4,999	23,300	223,759	8,297	5,206	13,503	77,762
2	2003				17,901	5,399	23,300	218,360	7,776	5,726	13,503	72,036
3	2004				17,469	5,831	23,300	212,530	7,204	6,299	13,503	65,737
4	2005				17,002	6,297	23,300	206,233	6,574	6,929	13,503	58,808
5	2006				16,499	6,801	23,300	199,432	5,881	7,622	13,503	51,186
6	2007				15,955	7,345	23,300	192,087	5,119	8,384	13,503	42,802
7	2008				15,367	7,933	23,300	184,154	4,280	9,222	13,503	33,579
8	2009				14,732	8,567	23,300	175,587	3,358	10,145	13,503	23,434
9	2010				14,047	9,253	23,300	166,334	2,343	11,159	13,503	12,275
10	2011				13,307	9,993	23,300	156,342	1,228	12,275	13,503	0
11	2012				12,507	10,792	23,300	145,549				
12	2013				11,644	11,656	23,300	133,894				
13	2014				10,712	12,588	23,300	121,306				
14	2015				9,704	13,595	23,300	107,711				
15	2016				8,617	14,683	23,300	93,028				
16	2017				7,442	15,857	23,300	77,171				
17	2018				6,174	17,126	23,300	60,045				
18	2019				4,804	18,496	23,300	41,549				
19	2020				3,324	19,976	23,300	21,574				
20	2021				1,726	21,574	23,300	0				
	Total	228,758	82,968	311,726	237,232	228,758	465,990		52,059	82,968	135,027	

Table 11-8 Repayment Schedule of Debt (loan supplied 2002-2006)

(1,000 US$)

		Financing for Construction			Repayment of foreign Currency				Repayment of local Currency			
No.	Year	Foreign	Local	Total	Interest	Principal	Total	Balance	Interest	Principal	Total	Balance
	1994											
	1995											
	1996											
	1997											
	1998											
	1999											
	2000											
	2001											
	2002	2,371	17,433	19,804								
	2003	2,441	13,350	15,792								
	2004	5,306	23,490	28,796								
	2005	2,404	11,619	14,023								
	2006	256,990	44,865	301,855				269,512				110,757
1	2007				21,561	5,889	27,450	263,623	11,076	6,949	18,025	103,808
2	2008				21,090	6,361	27,450	257,262	10,381	7,644	18,025	96,163
3	2009				20,581	6,869	27,450	250,393	9,616	8,409	18,025	87,754
4	2010				20,031	7,419	27,450	242,974	8,775	9,250	18,025	78,504
5	2011				19,438	8,013	27,450	234,961	7,850	10,175	18,025	68,330
6	2012				18,797	8,654	27,450	226,308	6,833	11,192	18,025	57,137
7	2013				18,105	9,346	27,450	216,962	5,714	12,311	18,025	44,826
8	2014				17,357	10,093	27,450	206,868	4,483	13,543	18,025	31,283
9	2015				16,549	10,901	27,450	195,967	3,128	14,897	18,025	16,387
10	2016				15,677	11,773	27,450	184,194	1,639	16,387	18,025	0
11	2017				14,736	12,715	27,450	171,480				
12	2018				13,718	13,732	27,450	157,747				
13	2019				12,620	14,831	27,450	142,917				
14	2020				11,433	16,017	27,450	126,900				
15	2021				10,152	17,298	27,450	109,601				
16	2022				8,768	18,682	27,450	90,919				
17	2023				7,274	20,177	27,450	70,742				
18	2024				5,659	21,791	27,450	48,951				
19	2025				3,916	23,534	27,450	25,417				
20	2026				2,033	25,417	27,450	0				
	Total	269,512	110,757	380,270	279,496	269,512	549,008		69,495	110,757	180,252	

Table 11-9 Repayment Schedule of Debt (loan supplied 2007-2011)

(1,000 US$)

		Financing for Construction			Repayment of foreign Currency				Repayment of local Currency			
No.	Year	Foreign	Local	Total	Interest	Principal	Total	Balance	Interest	Principal	Total	Balance
	1994											
	1995											
	1996											
	1997											
	1998											
	1999											
	2000											
	2001											
	2002											
	2003											
	2004											
	2005											
	2006											
	2007	129,076	125,434	254,510								
	2008	9,929	11,946	21,875								
	2009	12,694	21,968	34,663								
	2010	13,521	27,683	41,204								
	2011	214,284	52,456	266,740				379,505				239,487
1	2012				30,360	8,293	38,653	371,212	23,949	15,027	38,975	224,460
2	2013				29,697	8,956	38,653	362,256	22,446	16,529	38,975	207,931
3	2014				28,980	9,673	38,653	352,583	20,793	18,182	38,975	189,749
4	2015				28,207	10,447	38,653	342,136	18,975	20,001	38,975	169,748
5	2016				27,371	11,283	38,653	330,853	16,975	22,001	38,975	147,747
6	2017				26,468	12,185	38,653	318,668	14,775	24,201	38,975	123,547
7	2018				25,493	13,160	38,653	305,508	12,355	26,621	38,975	96,926
8	2019				24,441	14,213	38,653	291,295	9,693	29,283	38,975	67,643
9	2020				23,304	15,350	38,653	275,945	6,764	32,211	38,975	35,432
10	2021				22,076	16,578	38,653	259,368	3,543	35,432	38,975	0
11	2022				20,749	17,904	38,653	241,464				
12	2023				19,317	19,336	38,653	222,127				
13	2024				17,770	20,883	38,653	201,244				
14	2025				16,100	22,554	38,653	178,690				
15	2026				14,295	24,358	38,653	154,332				
16	2027				12,347	26,307	38,653	128,025				
17	2028				10,242	28,411	38,653	99,614				
18	2029				7,969	30,684	38,653	68,929				
19	2030				5,514	33,139	38,653	35,790				
20	2031				2,863	35,790	38,653	0				
	Total	379,504	239,487	618,992	393,563	379,505	773,068		150,267	239,487	389,754	

Table 11-10 Statement of Profit and Loss

(1,000 US$)

Year	Revenue	Business Expenses			Business Profit	Financial Cost			Net Profit
		OM cost	Depreci-ation	Total		Interest Dur.Const.	Interest	Total	
1994						8		8	-8
1995						4,686		4,686	-4,686
1996						9,356		9,356	-9,356
1997						21,289		21,289	-21,289
1998	1,316	7,960	17,730	25,690	-24,374	490	36,538	37,028	-61,402
1999	17,679	8,358	17,730	26,088	-8,409	981	35,003	35,984	-44,393
2000	25,934	8,776	17,730	26,506	-572	2,653	33,324	35,977	-36,549
2001	78,058	9,215	17,730	26,945	51,113	14,620	31,484	46,104	5,009
2002	117,363	16,141	29,776	45,917	71,447	921	56,068	56,989	14,458
2003	168,417	16,948	29,776	46,724	121,693	2,486	52,941	55,427	66,266
2004	231,964	17,795	29,776	47,571	184,392	4,307	49,523	53,830	130,562
2005	309,535	18,685	29,776	48,461	261,074	5,875	45,782	51,657	209,417
2006	404,278	19,619	29,776	49,395	354,883	17,996	41,690	59,686	295,197
2007	515,672	28,325	44,522	72,847	442,825	10,938	69,849	80,787	362,038
2008	643,743	29,742	44,522	74,264	569,479	21,875	63,783	85,658	483,821
2009	790,299	31,229	44,522	75,751	714,549	22,459	60,078	82,537	632,012
2010	956,807	32,790	44,522	77,312	879,495	23,876	56,042	79,918	799,577
2011	1,143,713	34,430	44,522	78,952	1,064,761	34,368	51,650	86,018	978,743
2012	1,200,898	46,605	69,472	116,077	1,084,821		101,171	101,171	983,650
2013	1,260,943	48,935	69,472	118,407	1,142,536		95,142	95,142	1,047,394
2014	1,323,991	51,382	69,472	120,854	1,203,136		88,576	88,576	1,114,560
2015	1,390,190	53,951	69,472	123,423	1,266,767		81,427	81,427	1,185,340
2016	1,459,700	56,649	69,472	126,121	1,333,579		73,645	73,645	1,259,934
2017	1,532,685	59,481	69,472	128,953	1,403,731		65,169	65,169	1,338,562
2018	1,609,319	62,455	69,472	131,927	1,477,391		57,740	57,740	1,419,651
2019	1,689,785	65,578	69,472	135,050	1,554,735		51,558	51,558	1,503,177
2020	1,774,274	68,857	69,472	138,329	1,635,945		44,825	44,825	1,591,120
Total	18,646,562	793,908	1,067,658	1,861,566	16,784,996	199,184	1,343,008	1,542,192	15,242,804

Table 11-11 Cash Flow

(1,000 US$)

Year	Cash Inflow				Cash Outflow			Balance	
	Financing	Net Profit	Depreci-ation	Total	Investment	Repayment of princi.	Total	Year	Accumulated
1994	176	-8		168	176		176	-8	-8
1995	100,693	-4,686		96,007	100,693		100,693	-4,686	-4,694
1996	9,356	-9,356		0	9,356		9,356	-9,356	-14,050
1997	301,488	-21,289		280,199	301,488		301,488	-21,289	-35,339
1998	10,545	-61,402	17,730	-33,127	10,545	16,361	26,906	-60,033	-95,372
1999	981	-44,393	17,730	-25,682	981	17,896	18,877	-44,559	-139,932
2000	37,221	-36,549	17,730	18,402	37,221	19,575	56,796	-38,394	-178,326
2001	262,979	5,009	17,730	285,718	262,979	21,415	284,394	1,324	-177,002
2002	19,804	14,458	29,776	64,038	19,804	33,635	53,439	10,599	-166,403
2003	15,792	66,266	29,776	111,834	15,792	36,759	52,551	59,283	-107,119
2004	28,796	130,562	29,776	189,134	28,796	40,178	68,974	120,160	13,041
2005	14,023	209,417	29,776	253,216	14,023	43,919	57,942	195,274	208,315
2006	301,855	295,197	29,776	626,828	301,855	48,012	349,867	276,961	485,276
2007	254,510	362,038	44,522	661,070	254,510	65,328	319,838	341,232	826,508
2008	21,875	483,821	44,522	550,218	21,875	42,088	63,963	486,255	1,312,763
2009	34,663	632,012	44,522	711,197	34,663	45,792	80,455	630,742	1,943,504
2010	41,204	799,577	44,522	885,303	41,204	49,828	91,032	794,271	2,737,775
2011	266,740	978,743	44,522	1,290,005	266,740	54,222	320,962	969,043	3,706,818
2012		983,650	69,472	1,053,122		68,826	68,826	984,296	4,691,115
2013		1,047,394	69,472	1,116,866		74,855	74,855	1,042,011	5,733,125
2014		1,114,560	69,472	1,184,032		81,421	81,421	1,102,611	6,835,737
2015		1,185,340	69,472	1,254,812		88,570	88,570	1,166,242	8,001,979
2016		1,259,934	69,472	1,329,406		96,354	96,354	1,233,052	9,235,030
2017		1,338,562	69,472	1,408,034		86,803	86,803	1,321,231	10,556,262
2018		1,419,651	69,472	1,489,123		70,639	70,639	1,418,484	11,974,746
2019		1,503,177	69,472	1,572,649		76,823	76,823	1,495,826	13,470,572
2020		1,591,120	69,472	1,660,592		83,554	83,554	1,577,038	15,047,609
Total	1,722,701	15,242,804	1,067,658	18,033,163	1,722,701	1,262,853	2,985,554	15,047,609	

Table 11-12 Calculation of Debt Service Ratio

(1,000 US$)

Year	Internal Fund Procured				Repayment of Debt				Debt Service Ratio
	Business Profit	Depreci-ation	Total	Accumlated	Interest	Principal	Total	Accumlated	
1994				(A)				(B)	(A)/(B)
1995									
1996									
1997									
1998	-24,374	17,730	-6,644	-6,644	36,538	16,361	52,899	52,899	-0.13
1999	-8,409	17,730	9,321	2,676	35,003	17,896	52,899	105,798	0.03
2000	-572	17,730	17,158	19,834	33,324	19,575	52,899	158,697	0.12
2001	51,113	17,730	68,843	88,677	31,484	21,415	52,899	211,596	0.42
2002	71,447	29,776	101,223	189,900	56,068	33,635	89,703	301,299	0.63
2003	121,693	29,776	151,469	341,370	52,941	36,759	89,700	390,999	0.87
2004	184,392	29,776	214,168	555,538	49,523	40,178	89,701	480,700	1.16
2005	261,074	29,776	290,850	846,388	45,782	43,919	89,701	570,401	1.48
2006	354,883	29,776	384,659	1,231,047	41,690	48,012	89,702	660,103	1.86
2007	442,825	44,522	487,347	1,718,394	69,849	65,328	135,177	795,280	2.16
2008	569,479	44,522	614,001	2,332,395	63,783	42,088	105,871	901,151	2.59
2009	714,549	44,522	759,071	3,091,465	60,078	45,792	105,870	1,007,021	3.07
2010	879,495	44,522	924,017	4,015,482	56,042	49,828	105,870	1,112,891	3.61
2011	1,064,761	44,522	1,109,283	5,124,765	51,650	54,222	105,872	1,218,763	4.20
2012	1,084,821	69,472	1,154,293	6,279,059	101,171	68,826	169,997	1,388,760	4.52
2013	1,142,536	69,472	1,212,008	7,491,066	95,142	74,855	169,997	1,558,757	4.81
2014	1,203,136	69,472	1,272,608	8,763,675	88,576	81,421	169,997	1,728,754	5.07
2015	1,266,767	69,472	1,336,239	10,099,914	81,427	88,570	169,997	1,898,751	5.32
2016	1,333,579	69,472	1,403,051	11,502,964	73,645	96,354	169,999	2,068,750	5.56
2017	1,403,731	69,472	1,473,203	12,976,168	65,169	86,803	151,972	2,220,722	5.84
2018	1,477,391	69,472	1,546,863	14,523,031	57,740	70,639	128,379	2,349,101	6.18
2019	1,554,735	69,472	1,624,207	16,147,238	51,558	76,823	128,381	2,477,482	6.52
2020	1,635,945	69,472	1,705,417	17,852,654	44,825	83,554	128,379	2,605,861	6.85
Total	16,784,996	1,067,658	17,852,654		1,343,008	1,262,853	2,605,861		

CHAPTER 12

FUTURE STUDIES

CHAPTER 12 FUTURE STUDIES

It is necessary to continue the following studies for implementing the project in accordance with the feasibility study on Bulk Power Supply Project for the Greater Bangkok Area:

(1) Study on the land acquisition for the transmission lines and substations to be installed in accordance with the feasibility study.

(2) Economic comparison study on the design of substation and transmission line taking environmental aspects into consideration.

(3) Review on the feasibility study in case that circumstances be changed.

(4) Study for obtaining governmental authorization of the actual implementation of the Project, such as environmental assessment of the Project.

(5) Study on the detailed design of the Project, including studies such as optimization of the transmission line design whether the overhead transmission line should be employed or underground cable.

(6) Study on the detailed implementation schedule.

(7) Study on the arrangement of the budget.

(8) Study on the procurement arrangement of the services and materials.

CHAPTER 13

TECHNOLOGY TRANSFER

CHAPTER 13 TECHNOLOGY TRANSFER

(1) OJT During Implementation of Activities in Thailand

On each occasion of activities of the team in Thailand, the team made a presentation on the progress of the study.

At least 30 engineers as well as managing directors from EGAT and MEA joined the half day presentation each time, where many technical matters were discussed.

The presentations were made in such a manner that the personnel in direct charge of the topics explained using over head projector and other visual materials such as route or location maps, and technical discussion was followed chaired by an executive of EGAT.

The topics at each presentation were;

-1st time (Inception Report)

- -The features and problems of the Project
- -Study items required to solve the problem
- -Approach and methodology of the study in each field
- -Data required for the study
- -Computer tools and application software to be used
- -Scheduling of the study
- -Design concept of transmission line and substation

-2nd time (Progress Report)

- -Idea of power system reinforcement by introducing 500 kV lines in the Greater bangkok Area under the restriction of right of way
- -Idea of replacing existing 230 kV lines by multiple line towers and conductors with larger current carrying capacity under the restriction of right of way
- -Idea of renovation of existing substation and new site for substation
- -Line sections overloaded and bus of which short circuit current exceeds 50 kA according to the results of power system analysis
- -Idea of optimal system configulation

-3rd time (Interim Report)

- -Revision of optimal power system configulation
- -Line sections composed of underground cable
- -Indoor substation
- -Cost estimation
- -Construction scheduling

-4th time (Draft Final Report)

-Marginal cost for environmental countermeasure
-Economic analysis
-Financial analysis
-Overall recommendation and suggestions for further study required
-Asessment by EGAT and MEA

(2) Training of Counterpart in Japan

During the study period, two (2) counterparts were invited for trainning in Japan.

Much importance was placed on to deepen the understanding of current technology for transmission system and it's transfer to the counterparts.

a) The major subjects in class room training concerning transmission line and substation expansion planning were;

i) Power System Analysis and Planning

- Power flow calculation
- Short circuit capacity calculation
- Power system stability calculation
- Optimal power system planning

ii) Transmission Line and Substation Designs

- Design of urban type substations
- Transmission line tower structural calculation
- Insulation coordination and power line design

b) The major subjects during on-site training were;

- Honsyu-Shikoku 500 kV Interconnection Project

  -Construction details of 500 kV oil filled cable interconnection lines layed under the bridge

  -Technical features of 500 kV oil filled cable

  -Studies required for planning 500 kV oil filled cable

- Tadami Trunk Line Reinforcement Project

  -Construction details of 500 kV transmission towers and lines

  -Technical features of 500 kV overhead transmission line

  -Studies required for planning 500 kV overhead transmission line