CHAPTER 3

OUTLINE OF NATIONAL POWER CORPORATION

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3.1 History of NPC

National Power Corporation (NPC) was established in 1936 as a public corporation fully owned by the Philippine Government. NPC is in charge of the construction and operation of power generation, transmission and substation facilities, and wholesales electric power to Manila Electric Company (MERALCO), other power distribution companies and electric cooperatives, and also sells power directly to some large customers.

NPC was originally organized to develop hydroelectric power and electric power from other natural resources. NPC expanded the scope of operation in 1972, and purchased thermal power plants from MERALCO in 1978, and ever since, has been carrying out the operation of power generation, transmission and substation facilities.

Development of the scale of NPC's operation is as shown in the Table 3-1 and Figure 3-1.

Table 3-1 Development of the Scale of NPC's Operation

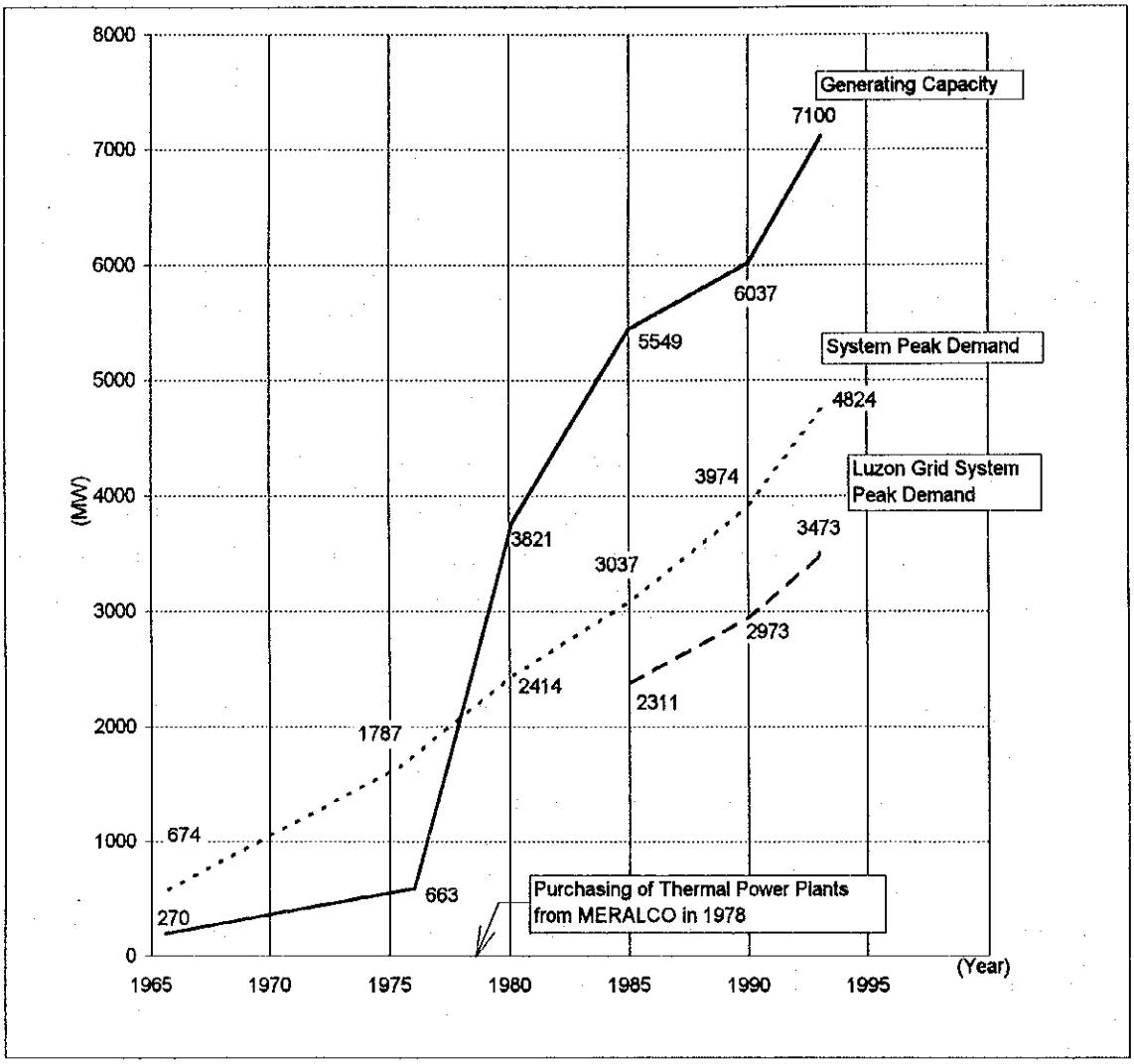
		1966	1976	1980	1985	1990	1993
Gross Energy Generation	GWh	1,425	3,140	15,086	18,757	24,799	23,654*1 2,808*2
Gross Energy Sales	GWh	1,310	2,966	14,033	17,140	22,915	24,805
System Peak Demand	MW	674	1,787	2,414	(2,311) 3,037	(2,973) 3,974	(3,473) 4,824
Generating Capacity	MW	270	663	3,821	5,549	6,037	7,100*1 874*2
Transmission Line, Circuit	Km	2,398	3,682	7,152	11,832	14,060	14,951
Substation Capacity	MVA	916	2,180	7,598	13,307	14,381	14,788

( ) : Luzon Grid Peak Demand

Note: *1 NPC

*2 Non-NPC

Figure 3-1 Generating Capacity and System Peak Demand



3.2 Organization of NPC

The government of President Ramos, which was set up in June 1992, established the Department of Energy (DOE) and repealed the Office of Energy Affairs (OEA) of the Office of the President in December 1992. Since then, NPC has been supervised by the DOE.

The Electric Power Crisis Act, RA7648 (passed through the both houses in April 1993) was purposed not only to support NPC to resolve effectively the brownout problems, but also to give the National Power Board the right to rationalize and activate the organization and the operation of NPC.

1) Reorganization

Following to the reorganization in November 1991, on the basis of the Electric Power Crisis Act, and under the administration of the new president, reorganizations and rationalizations are being done or being studied for NPC.
Figures 3-4, 3-5, and 3-6 show the old and the new organizations.

The present organization and functions have the following three points changed from the former.

- Three senior vice presidents were abolished from the Head Office organization

- As a result, the head of the groups of the Head Office and the vice presidents of the regional centers, has been assigned to report directly to the president. The vice president of MMRC is of course included in this category.

- Responsibilities for management and operation of all existing thermal power plants have been transferred to the vice presidents of the regional centers. For example, for the Luzon grid, procurement of all necessary machines and materials as well as ordering or contracting of overhaul works are now being carried out by MMRC, instead of the department concerned such as Material Management Department of the Head Office.

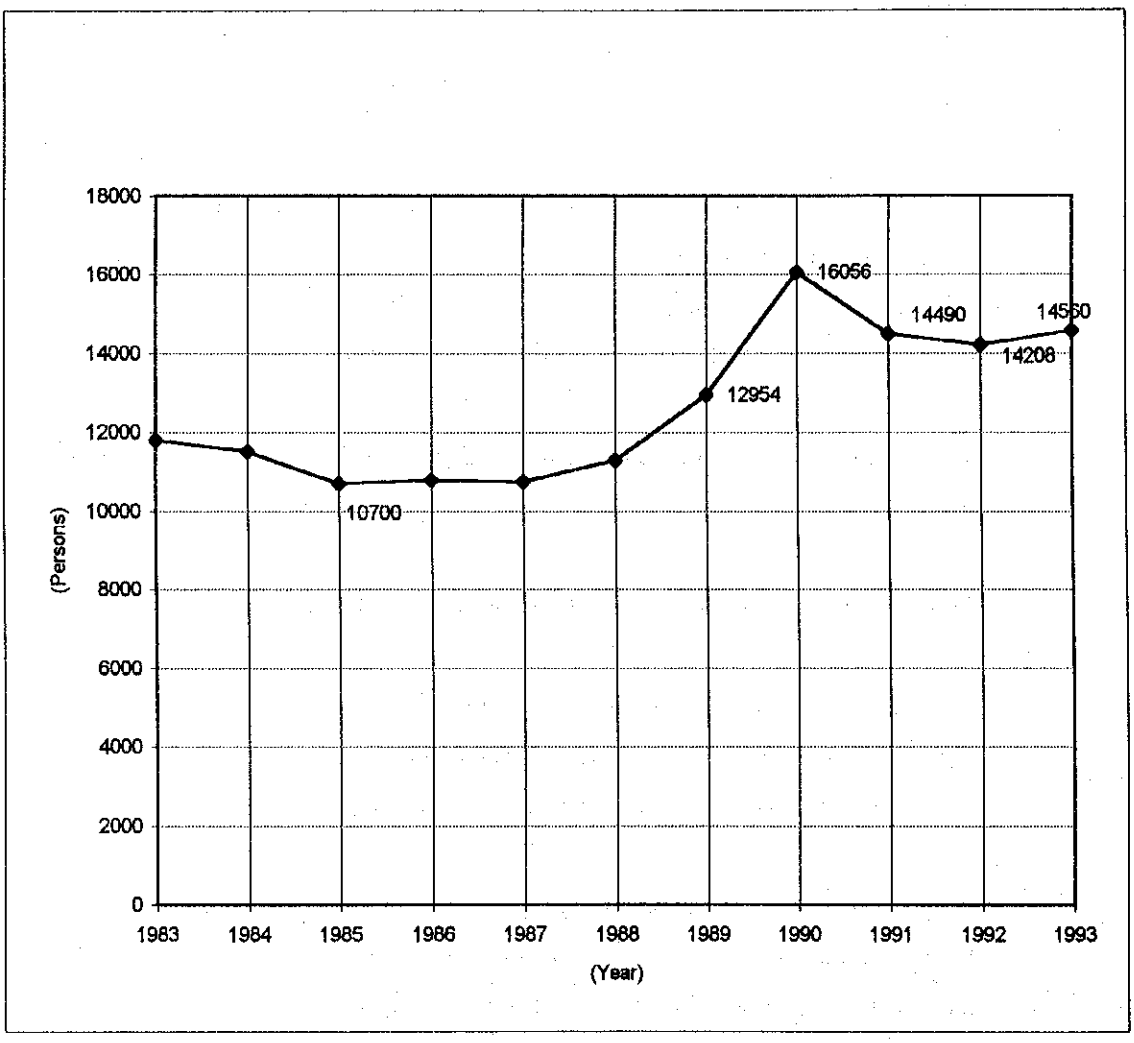
3.3 Changes of the Number of Employees

1) Total Number of Employees

As of 1993, the total number of NPC employees was 14,560.

Figure 3-2 shows changes of the number of NPC employees for 11 years from 1983.

Figure 3-2 Changes of Personnel (Including laborers in casual employment)



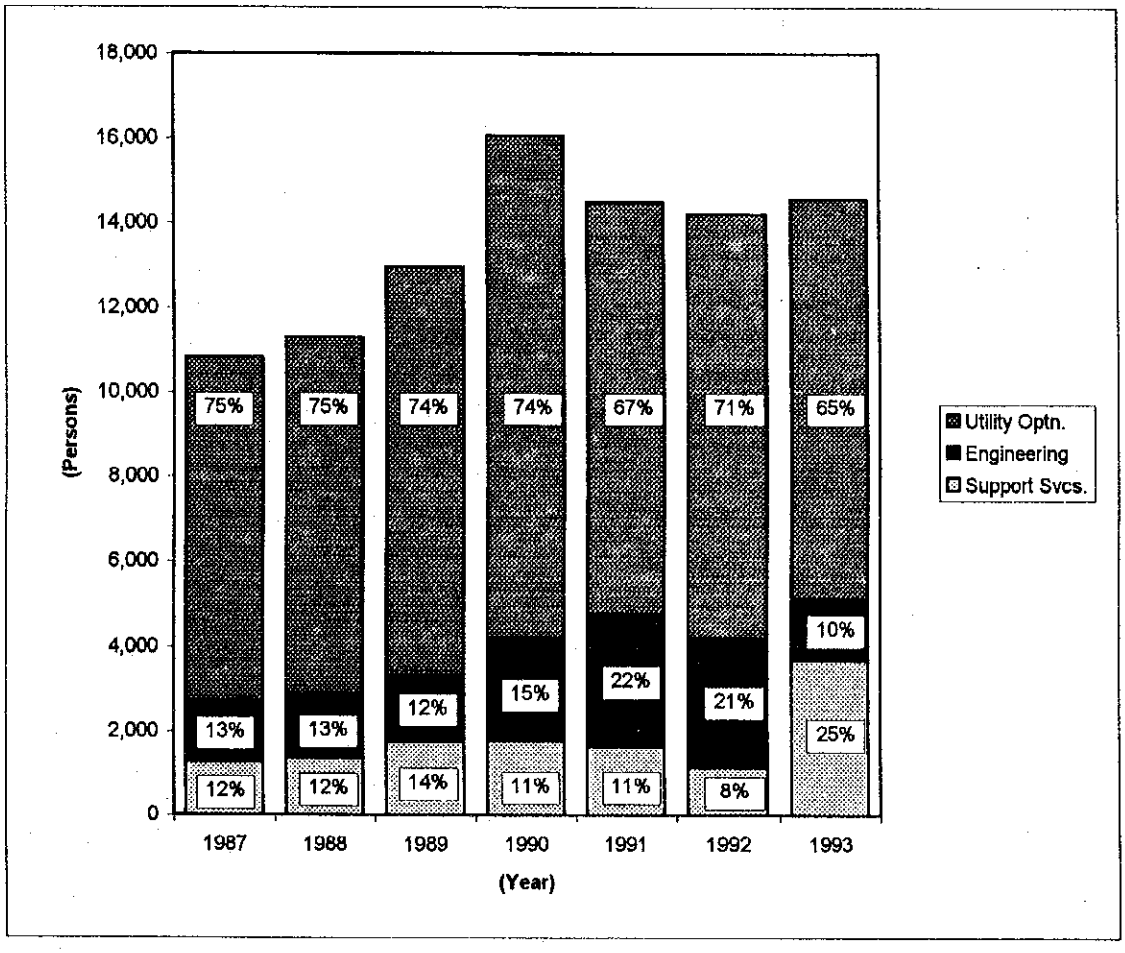
2) Personnel Allocation

The allocation of manpower in 1993 was 65% for utility operation, 10% for engineering, and 25% for supporting services, which indicates that a large portion of the manpower is allocated for the operation and maintenance works.

Table 3-2 Manpower Statistics

Year	1987	1988	1989	1990	1991	1992	1993
Utility Optn.	8,126	8,432	9,657	11,860	9,752	10,040	9,450
Engineering	1,423	1,494	1,541	2,402	3,095	3,023	1,418
Support Svcs.	1,270	1,368	1,756	1,794	1,643	1,145	3,692
Total	10,819	11,294	12,954	16,056	14,490	14,208	14,560

Figure 3-3 Manpower Statistics



3) Table 3-3 Manning by position Level as of 1993

Executive	19	1.6%
Managerial	467	3.86%
Supervisory	1,011	8.36%
Professional/Technical (High Level)	6,015	49.75%
Professional/Technical (Entry Level)	2,614	21.62%
Rank & File	1,965	16.25%
Total *	12,091	100%

*Regular employees only

4) Table 3-4 Regional Manning as of 1993

Head Office	5,366	36.8%
MMRC (Metro Manila Regional Center)	1,786	12.3%
NLRC (Northern Luzon Regional Center)	1,648	11.3%
SLRC (Southern Luzon Regional Center)	1,426	9.8%
VRC (Visayas Regional Center)	1,792	12.3%
MRC (Mindanao Regional Center)	2,542	17.5%
Total *	14,560	100%

*Regular and casual employees

Figure 3-4 Organization of National Power Corporation (As of May 16, 1994)

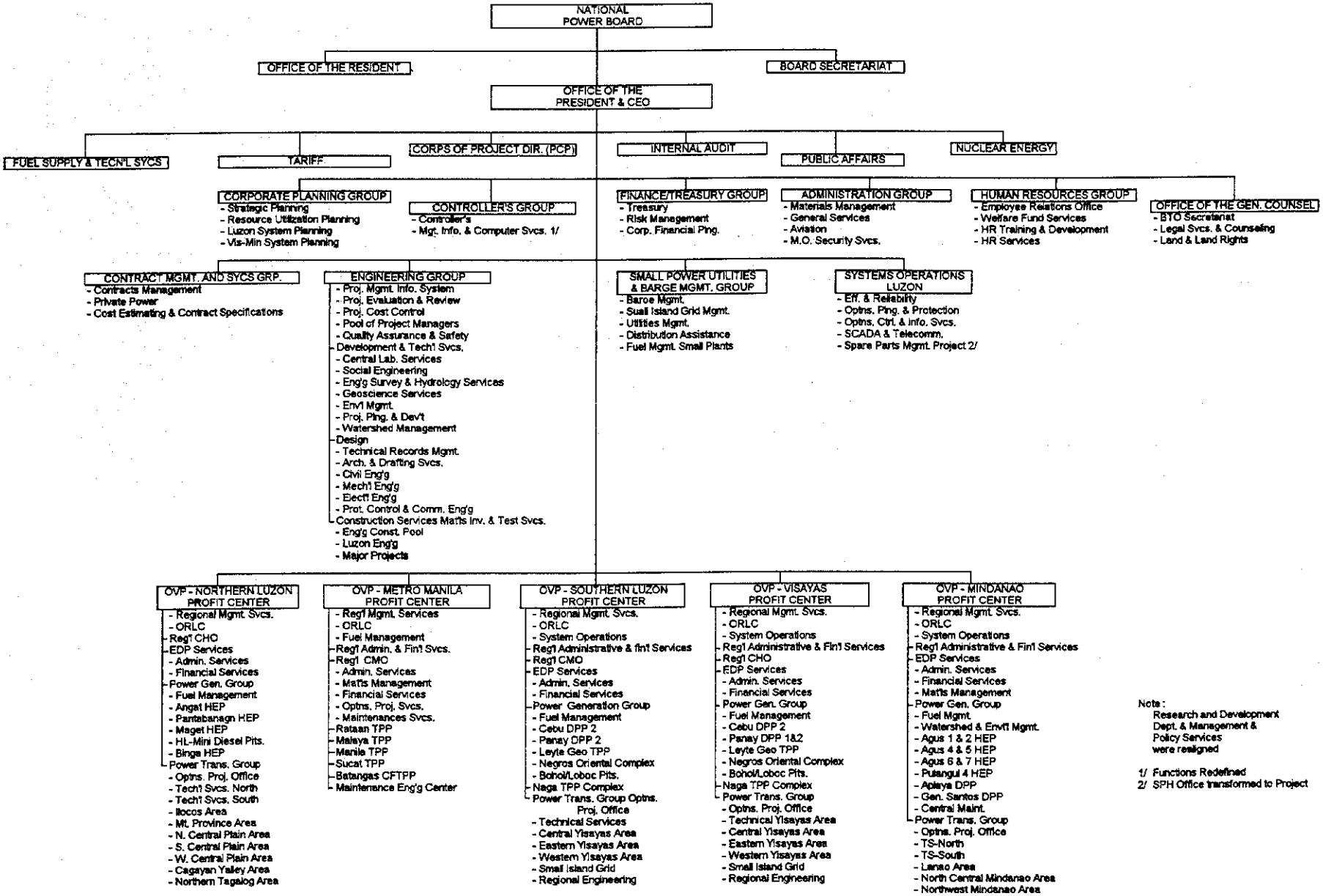


Figure 3-5 Organization of National Power Corporation (As of November 1991)

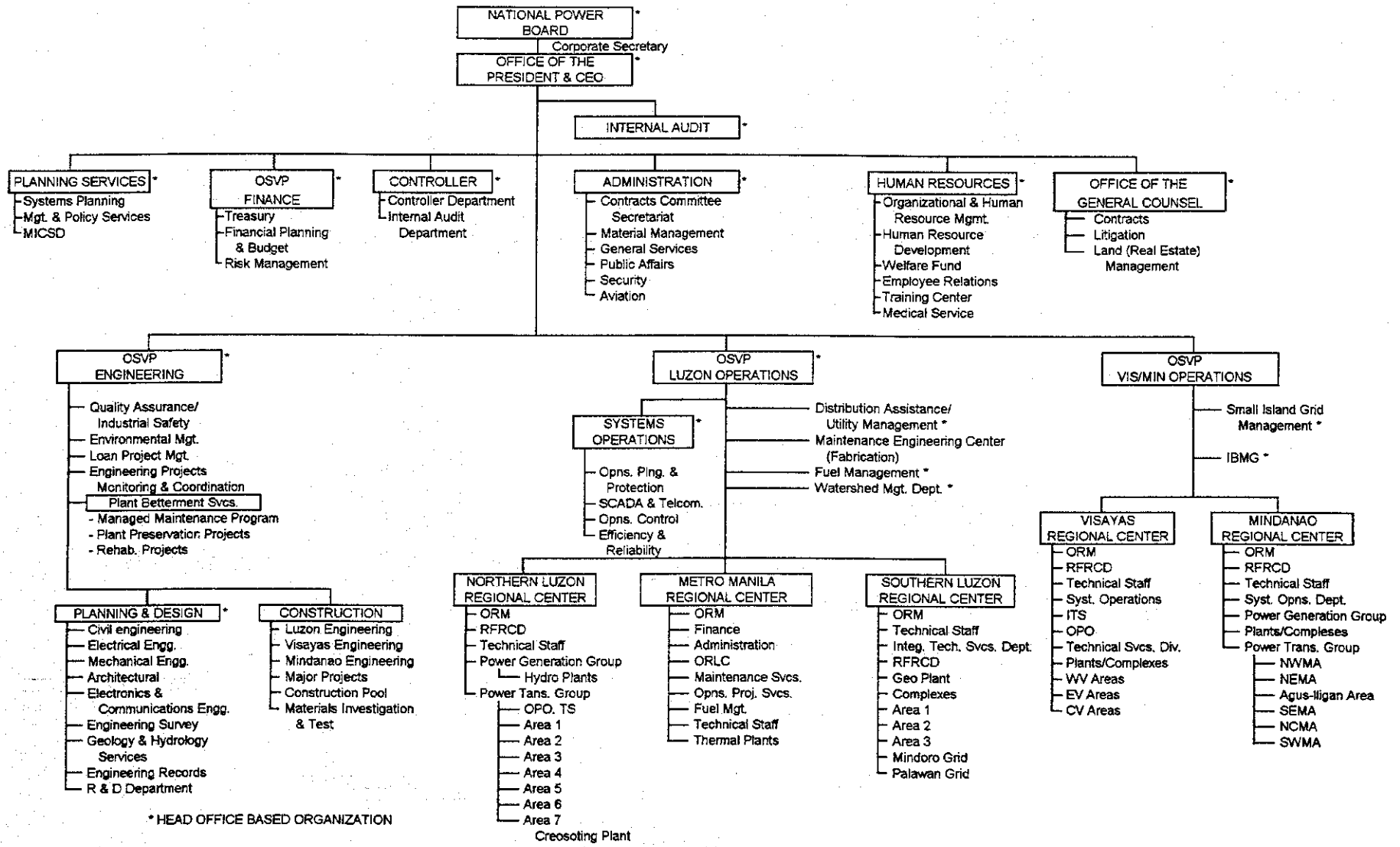
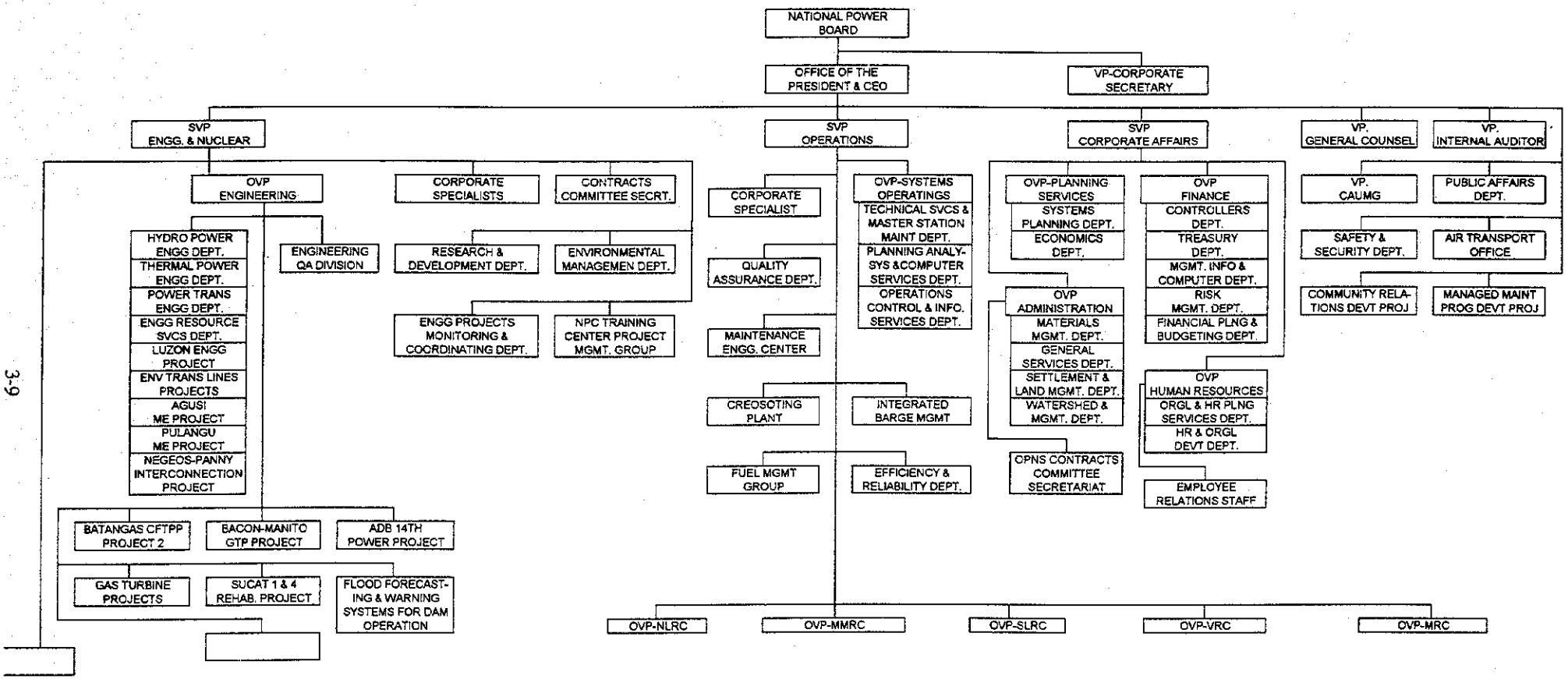


Figure 3-6 Organization of National Power Corporation (As of February 1991)



3.4 Financial Situation

Outline of financial performance in 1993 is shown in Table 3-5.

The energy sales were 24,805 GWh, an increase of 3.5% over the previous year.

The operating revenue amounted to 40,490 million pesos, a 7.6% growth from the 1992 figure. This increase was mainly a result of an about 3.5% increase in energy sales and of an increase by 0.06 P/kWh in the average power rate.

The operating expenses totaled 33,825 million pesos, an 11% growth from the 1992 expenses. This increase is attributable to the following:

1) A 136% increase in the purchased power
2) Higher depreciation costs largely brought about by the capitalized loan restatement and by new plants that went into operation.
3) Higher other operating expenses mainly due to increased operating and maintenance cost, plus increase in taxes.
4) Higher steam and coal cost. A much higher expense figure was off set by lower fuel cost.

Net operating income, after all, decreased by 5.8% to 6,665 million pesos, and from this net operating income NPC realized a net income of 1,365 million pesos, down by 66.9%, compared to the 1992 net income of 4,118 million pesos.

Table 3-5 Financial Performance in 1993

Items			Unit	1992	1993	Inc. (Dec) %
Energy Sales			GWh	23,958	24,805	3.5
Average Power Rate			P/kWh	1.57668	1.6385	3.9
Net Operating Revenue			P Million	37,644	40,490	7.6
Operating Expenses			P Million	30,567	33,825	10.7
	Generation		P Million	21,166	21,414	
	Transmission and Distribution		P Million	579	671	
	Administrative and General		P Million	878	937	
	Depreciation		P Million	6,258	8,501	
	Depletion		P Million	823	916	
	Provision		P Million	53	32	
	Other Operating Expenses		P Million	806	1,350	
Net Operating Income			P Million	7,078	6,665	(5.8)
Net Income			P Million	4,118	1,365	(66.9)
Rate Base			P Million	99,596	112,778	13.2
Return on Rate Base (Net O.I./Rate Base) x 100			%	7.11	5.91	(1.20)
Cost of Service			P/kWh	1.4746	1.5833	7.4
	Fuel Cost		P/kWh	0.5840	0.4807	
	Steam Cost		P/kWh	0.1404	0.1409	
	Coal Cost		P/kWh	0.0494	0.0512	
	Depreciation and Depletion		P/kWh	0.2966	0.3811	
	Manpower Related Expenses		P/kWh	0.0598	0.0632	
	Other Operating Expenses *1		P/kWh	0.1501	0.2517	
	Non-Other Operating Expenses *2		P/kWh	0.1943	0.2145	
Net Income (Average power rate - cost)			P/kWh	0.1022	0.0552	(46)
Assets	Total		P Million	203,154	245,375	20.9
	Utility Plant	Under Construction	P Million	21,478	27,559	28.3
		Operating (Net)	P Million	104,725	135,160	29.1
Proprietary Capital (equity)			P Million	67,760	72,191	6.5
Long Term Debt (Net current portion)			P Million	67,306	96,004	42.6
Capital Expenditures			P Million	15,242	29,431	93.1
Funding Sources	Foreign Loans		P Million	10,156	19,815	95.1
	Net Internal Cash Generation		P Million	1,643	2,209	34.4
	Equity Advance from the National		P Million	410	4,678	1041.0
	Others (Grant + others)		P Million	3,033	2,729	(10)

Notes: *1 includes purchased power cost

*2 includes interest expenses

3.5 Power Rates

On April 2, 1993, NPC increased power rates by 18 centavos per kWh as follows; 5.57 centavos per kWh adjustment in basic rate and 12.42 centavos per kWh through the Retroactive Component Adjustment (RCA). The RCA is a mechanism to recover unrealized revenue due to the non-implementation of the 17 centavos per kWh increase in 1991 and the supposed rate adjustment in 1992 to attain a 10% return-on-rate base.

Table 3-6 Average Power Rates

(Unit : P/kWh)

Year	Luzon	Visayas	Mindanao	Philippines	Annual Increase Rate (%)
1980	0.3641	0.4078	0.1644	0.3423	
1981	0.4480	0.4982	0.1800	0.4166	21.7
1982	0.4670	0.5444	0.1859	0.4299	3.2
1983	0.6152	0.7244	0.2966	0.5790	34.7
1984	0.9740	0.9980	0.3740	0.8754	51.2
1985	1.2082	1.0401	0.5205	1.0835	23.8
1986	1.0552	0.9063	0.5086	0.9548	-11.9
1987	0.9793	0.8671	0.5657	0.9038	-5.3
1988	1.0031	0.9252	0.6252	0.9354	3.5
1989	0.9877	1.0385	0.6669	0.9381	0.3
1990	1.2049	1.2424	0.7043	1.1263	20.1
1991	1.4728	1.5293	0.9028	1.3953	23.9
1992	1.6576	1.6922	0.9644	1.5768	13.0
1993	1.7194	1.7343	1.1596	1.6385	3.9

3.6 Privatization

The Aquino Administration set about a five-year temporary legislation to promote the privatization of 122 government owned firms out of 301. In 1991, the term of this legislation was extended for two years. At present, many items are still being examined at the Congress.

In NPC, several measures are being studied: dividing of the organization into Luzon, Visayas and Mindanao; optimal financial system; method of dividing; disposal of assets and others.

3.7 ROM Scheme

1) NPC is trying to transfer the operation and maintenance works to private sector. So called Rehabilitate-Operate-Maintain (ROM) were adopted in the Naga Thermal Power Plant Complex and the Binga Hydro Power Plant.

The Malaya Thermal Power Plant will also adopt the ROM and NPC invited candidates for bidding who passed pre-qualification by NPC. Bid closing date, i.e. opening date of proposals, was scheduled December 28, 1994.

2) ROM Contractual Agreement for Malaya TPP

The ROM contractual agreement is outlined for Malaya TPP as following Table 3-7:

Table 3-7 ROM Contractual Agreement

Item	Contractor	NPC
1. Equipment		
[1] 300 MW Malaya 1 350 MW Malaya 2 including Auxiliaries	Peaceful possession of all generating facilities involved in [1], except [2]	NPC retains ownership of the all generating facilities of Malaya TPP complex.
[2] 3 x 3- MW Gas Turbines Meralco Switchyard NPC Switchyard NPC Vehicles	(For Item 1. [2]) Out of Scope in ROM	(For Item 1. [2]) NPC takes care of these equipment [2]
2. Scope of Agreement	1) General Rehabilitation of the Item 1. [1] (Please refer; Minimum Rehabilitation Requirement)	
3. Duration of the Cooperation Period	1) Fifteen (15) years including: - first 4 years for Assessment & Rehabilitation for the Item 1. [1] 2) Commercial Operation starts - on 5th year or - After satisfactory completion of the rehabilitation works whichever comes first	

Item	Contractor	NPC
4. Rights & obligations	To be given peaceful possession of the Item 1. [1].	Retains ownership of the Malaya TPP complex, visitorial rights and use of the laboratory facilities
[1] Fuel	To convert NPC's fuel oil into quality electric power.	To supply all fuel requirements at its own cost
[2] Electric power generated	To supply electric power exclusively to NPC and guarantee volume of energy that it will deliver	To guarantee a minimum purchase of energy on take or pay basis
[3] General Rehabilitation	To do the works with the objective of bringing each the units to their designed condition and prolonging the economic life of the units by at least 15 years	-
[4] Operation	To guarantee capacity and efficiency of the units	-
[5] Employment	- To take at least 90% of its manpower requirements from the existing manpower of Malaya TPP. - The size of organization of the contractor shall follow the local industry standards in terms of Kilowatt per person	-

CHAPTER 4

RELIABILITY IMPROVEMENT PLAN OF HARDWARE

CHAPTER 4 RELIABILITY IMPROVEMENT PLAN OF HARDWARE

4.1 Outline of Malaya Thermal Power Plant

The Malaya TPP is located along the eastern shore of the Laguna Lake at Bario Malaya of Pililia, Rizal Province, roughly 70 km southeast of Metro Manila. The Malaya TPP has 740 MW capacity in total consisting of two (2) oil-fired thermal power units, Unit No.1 of 300 MW and Unit No.2 of 350 MW rated capacity, and three (3) gas turbine units with 30 MW rated capacity each. The two (2) oil-fired thermal units are the objective units for the study, and the outlines of the units are introduced in the following sub-sections.

4.1.1 Outline of Facilities

The technical specifications of the major facilities of the Malaya Units No.1 and No.2 are summarize as follows.

1) Malaya Unit No.1

a. Boiler

Type	Once-through Benson Boiler
Maximum Evaporation	1,033.7 tons/hr.
Steam Pressure (SH Out/RH Out)	194.8 kg/cm^{2}g / 38.3 kg/cm^{2}g
Steam Temperature (SH Out/RH Out)	541 °C / 541 °C
Fuel	Residual Oil Bunker C
Manufacturer	Babcock Hitachi K.K.

b. Turbine

Type	Tandem-compound, Single Reheat Extraction, Condensing
Rated Output	300,000 kW
Steam Pressure	189.8 kg/cm^2g
Steam Temperature (Main Steam/Hot Reheat)	538 °C/ 538 °C
Exhaust Vacuum	709.2 mmHg
Speed	3,600 rpm
Manufacturer	Siemens A.G.

c. Generator

Type	Totally Enclosed, Hydrogen Cooled
Rated Capacity	370,000 kVA (45 psigH_2)
Rated Voltage	21,000 V
Frequency	60 Hz
Power Factor	0.9
Manufacturer	Siemens A.G.

d. Main Transformer

Type	AFOC-3AMN/Y5CP, Oil Immersed, (FOA) Auto Transformer, Outdoor Type
Capacity	370,000 kVA
Primary Voltage	21 kV
Secondary Voltage (HV/LV)	230 kV/117.3 kV
Phase	3 phase
Connection	Delta-WYE/WYE
Neutral (HV side)	Solidly Grounded
Cooling System	Forced Oil, Forced Air Cooled (FOA)
Manufacturer	Hitachi Ltd.

2) Malaya Unit No.2

a. Boiler

Type	Single Drum, El Paso, Radiant, Indoor Type
Maximum Evaporation	1,305.4 tons/hr.
Steam Pressure (SH Out/RH Out)	173.8 kg/cm^{2}g / 32.7 kg/cm^{2}g
Steam Temperature (SH Out/RH Out)	541 °C/541 °C
Fuel	Residual Oil Bunker C
Manufacturer	Babcock Hitachi K.K.

b. Turbine

Type	Tandem-compound, Reheat, Four Flow, Extraction, Condensing, TC4F-26
Rated Output	350,000 kW
Steam Pressure	168.7 kg/cm^2g
Steam Temperature (Main Steam/RH Steam)	538 °C/538 °C
Exhaust Vacuum	699.1 mmHg
Speed	3,600 rpm
Manufacturer	Hitachi Ltd.

c. Generator

Type	Totally Enclosed, Hydrogen Cooled, Hitachi Type Form TFLQQ-KD
Rated Capacity	438,000 kVA
Rated Voltage	21,000 V
Frequency	60 Hz
Power Factor	0.9
Manufacturer	Hitachi Ltd.

d. Main Transformer

Type	AFOC-3MN/Y5CP, Oil Immersed (FOA), Auto Transformer, Outdoor Type
Capacity	442,000 kVA
Primary Voltage	21 kV
Secondary Voltage (HV/LV)	230 kV/117.3 kV
Phase	3 phase
Connection	Delta-WYE/WYE
Neutral	Solidly Grounded
Cooling System	Forced Oil, Forced Air Cooled (FOA)
Manufacturer	Hitachi Ltd.

4.1.2 Operational Data

Malaya Unit No.1 was initially synchronized on December 20, 1974 and commenced the commercial operation from August 15, 1975. As of August 25, 1994, the total operating hours reached 119,789.93 hours (69.4% of the total period hours) since the initial synchronization, and the total outage hours, 52,726.22 hours (30.6%). The total number of star-up and shutdown in the same period is 364 times. Refer to Tables 4-1 and 4-5.

Malaya Unit No.2 was initially synchronized on March 10, 1979 and commenced the commercial operation from April 21, 1979. As of August 25, 1994, the total operating hours reached 104,162.91 hours (76.9% of the total period of hours) since the initial synchronization, and the total outage hours, 31,362.82 hours (23.1%). The total number of start-up and shutdown in the same period is 206 times. Refer to Tables 4-2 and 4-5.

During the 1980's, the performance of both the units had declined. The derated unit capacities and insufficient reliability resulted in a low capacity factor and decrease of power generation. Both the units were rehabilitated in 1986 for Unit No.2 and in 1987 in Unit No.1, and the performance was recovered.

The operating data of both the units after the rehabilitation are summarized in the Tables 4-3 and 4-4. Both the units had been operated with good performance for around 4 ~ 5 years after the rehabilitation. But the performance has again been declining year by year at five (5) years after the rehabilitation due to insufficient maintenance. Figures 4-1, 4-2, 4-3, 4-4, and 4-5 show the recovered and declining operating conditions after the rehabilitation on total power generation, capacity factors, operating and outage hours and average load.

These operating data explain that the power plant performance can be recovered and maintained with a proper maintenance but the performance declines easily due to insufficient maintenance efforts, or the proper management of operation and maintenance is important and indispensable for maintaining performance and reliability of the power plant.

Table 4-1 Operating Hours Malaya Unit No.1

Year	Operating Hours	Outage Hours	Period Hours
1974	35.98	244.17	280.15
1975	2,454.01	6,305.99	8,760.00
1976	6,338.14	2,445.86	8,784.00
1977	7,499.04	1,260.96	8,760.00
1978	7,764.46	995.54	8,760.00
1979	7,713.12	1,046.88	8,760.00
1980	4,546.26	4,237.74	8,784.00
1981	7,696.58	1,063.42	8,760.00
1982	6,876.75	1,883.25	8,760.00
1983	5,383.24	3,376.76	8,760.00
1984	5,412.61	3,371.39	8,784.00
1985	5,227.35	3,532.65	8,760.00
1986	6,039.11	2,720.89	8,760.00
1987	2,332.80	6,427.20	8,760.00
1988	7,510.51	1,273.49	8,784.00
1989	6,249.25	2,510.75	8,760.00
1990	7,781.12	978.88	8,760.00
1991	6,492.57	2,267.43	8,760.00
1992	5,932.29	2,851.71	9,784.00
1993	6,709.63	2,050.37	8,760.00
'94/Jan. 1 ~ Aug. 25	3,795.11	1,880.89	5,676.00
Total	119,789.93 (69.4%)	52,726.22 (30.6%)	172,516.15

Table 4-2 Operating Hours Malaya Unit No.2

Year	Operating Hours	Outage Hours	Period Hours
1979	5,873.72	1,239.01	7,112.73
1980	6,158.81	2,625.19	8,784.00
1981	7,439.19	1,320.81	8,760.00
1982	6,505.49	2,254.51	8,760.00
1983	7,100.49	1,659.51	8,760.00
1984	7,991.54	792.46	8,784.00
1985	6,352.48	2,407.52	8,760.00
1986	5,464.71	3,295.29	8,760.00
1987	7,657.61	1,102.39	8,760.00
1988	7,368.85	1,415.15	8,784.00
1989	8,039.75	720.25	8,760.00
1990	7,483.95	1,276.05	8,760.00
1991	6,663.32	2,096.68	8,760.00
1992	8,073.63	710.37	8,784.00
1993	3,401.08	5,358.92	8,760.00
'94 Jan. 1 ~ Aug. 25	2,588.29	3,087.71	5,676.00
Total	104,162.91 (76.9%)	31,361.82 (23.1%)	135,524.73

Table 4-3 Malaya Unit No. 1 Operating Data after Rehabilitation (As of August 25, 1994)

		1987	1988	1989	1990	1991	1992	1993	1994
Rated Output	(MW)	300	300	300	300	300	300	300	300
Average Load	(MW)	245	251	250	268	243	209	177	84
Power Generation	(GWh)	538.00	1,884.00	1,567.67	2,106.03	1,581.82	1,245.69	1,159.04	329.94
Service Hours	(hr.)	2,194.42	7,495.65	6,265.34	7,863.42	6,521.29	5,949.17	6,553.64	3,939.46
Outage Hours	(hr.)	6,565.58	1,288.35	2,494.66	896.58	2,238.71	2,834.83	2,206.36	1,895.54
-Planned Outage	(hr.)	6,374.65	966.12	0.00	212.75	837.73	1,216.97	0.00	0.00
-Non-planned Outage	(hr.)	190.93	322.23	2,429.33	683.83	1,400.98	1,617.86	2,206.36	1,895.54
-Outside Accident	(hr.)	0.00	0.00	65.33	0.00	0.00	0.00	0.00	0.00
Capacity Factor	(%)	20.47	71.49	59.65	80.14	60.19	47.27	44.10	18.86
Heat Rate	(BTU/kWh)	10,458	10,256	10,431	10,883	10,934	11,494	11,575	16,787
Efficiency	(%)	32.63	33.27	32.71	31.35	31.21	29.69	29.48	20.33
No. of Start-up/Shutdown		13	15	22	19	15	19	16	9

Table 4-4 Malaya Unit No. 2 Operating Data after Rehabilitation (As of August 25, 1994)

		1987	1988	1989	1990	1991	1992	1993	1994
Rated Output	(MW)	350	350	350	350	350	350	350	350
Average Load	(MW)	254	286	280	292	287	222	131	271
Power Generation	(GWh)	2,028.00	2,121.00	2,209.31	2,197.69	1,897.06	1,828.97	440.50	701.48
Service Hours	(hr.)	7,972.60	7,409.58	7,883.75	7,533.16	6,604.13	8,229.64	3,360.98	2,588.30
Outage Hours	(hr.)	787.40	1,392.82	876.25	1,226.84	2,155.87	554.36	5,399.02	3,243.70
-Planned Outage	(hr.)	0.00	1,093.38	750.97	694.21	1,658.20	0.00	4,524.42	2,113.18
-Non-planned Outage	(hr.)	758.18	270.22	113.85	532.63	497.67	554.36	874.60	1,130.52
-Outside Accident	(hr.)	29.22	29.22	11.43	0.00	0.00	0.00	0.00	0.00
Capacity Factor	(%)	66.14	68.99	72.06	71.68	61.87	59.49	14.37	34.37
Heat Rate	(BTU/kWh)	9,982	9,778	9,909	10,021	9,945	10,554	11,321	11,032
Efficiency	(%)	34.18	34.90	34.43	34.05	34.31	32.33	30.14	30.93
No. of Start-up/Shutdown		11	12	7	10	7	8	9	7

Figure 4−1 Malaya Thermal Power Plant
Power Generation after Rehabilitation

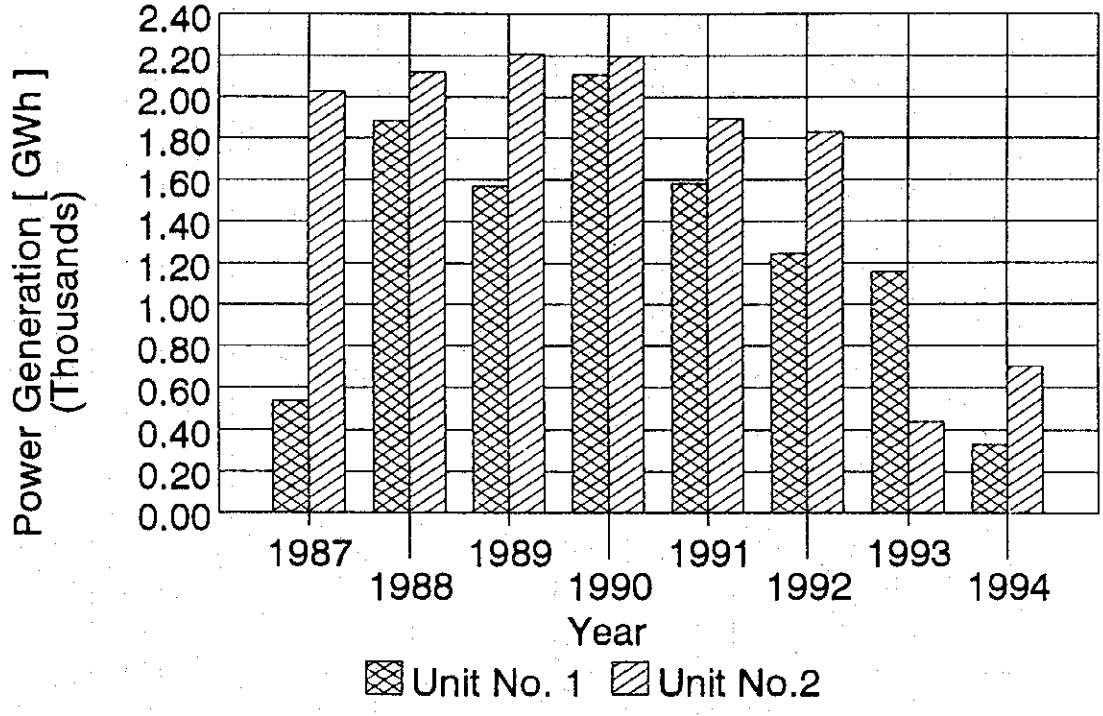


Figure 4−2 Malaya Thermal Power Plant
Capacity Factor after Rehabilitation

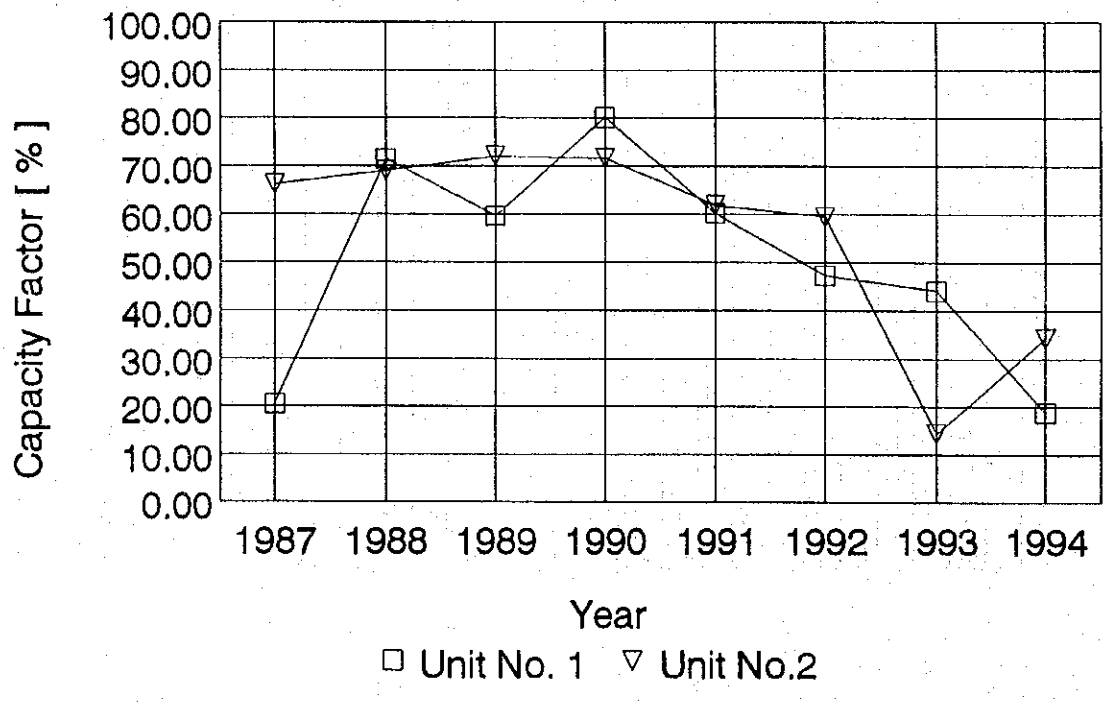


Figure 4-3 Malaya T.P.P Unit No.1
Operating Hours after Rehabilitation

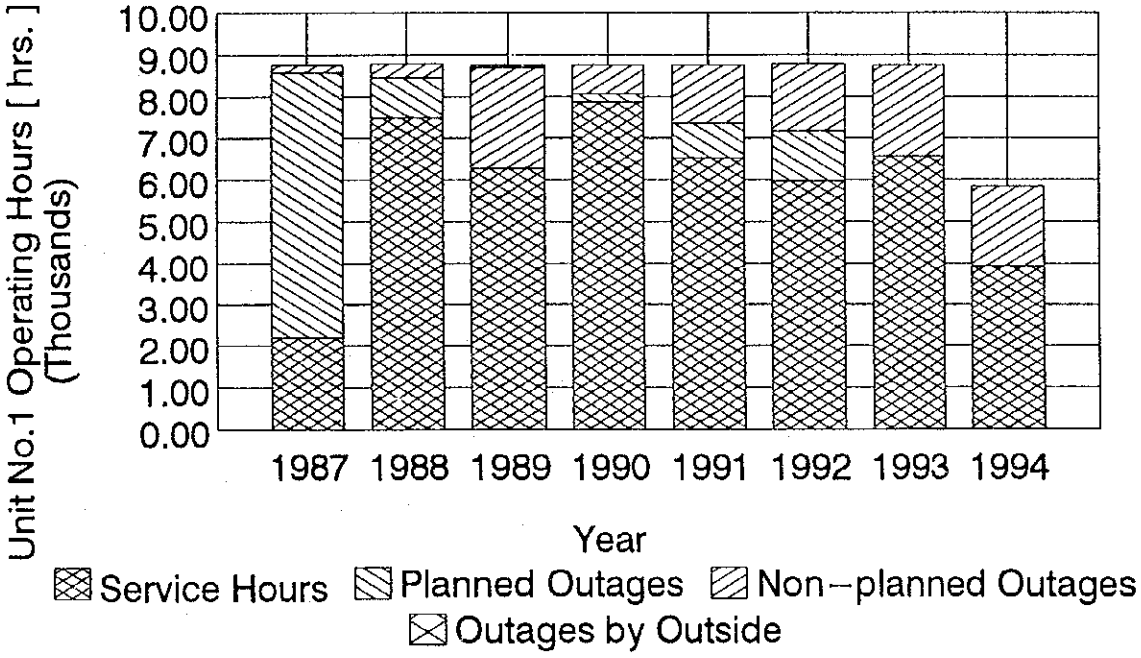


Figure 4-4 Malaya T.P.P Unit No.2
Operating Hours after Rehabilitation

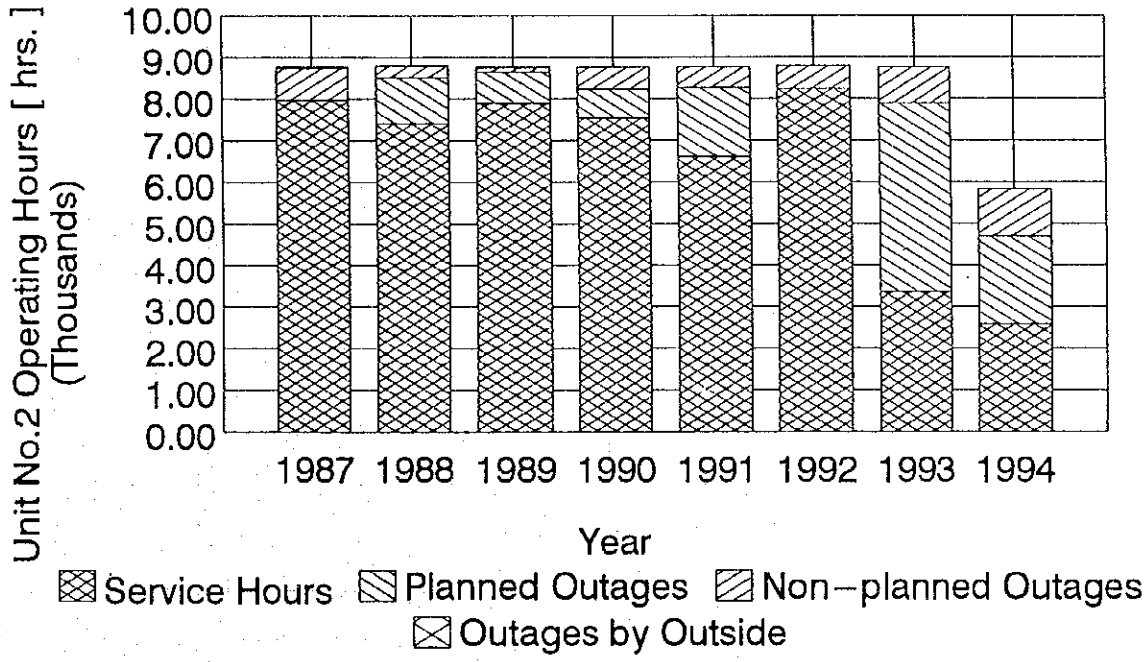


Figure 4−5 Malaya Thermal Power Plant
Average Load after Rehabilitation

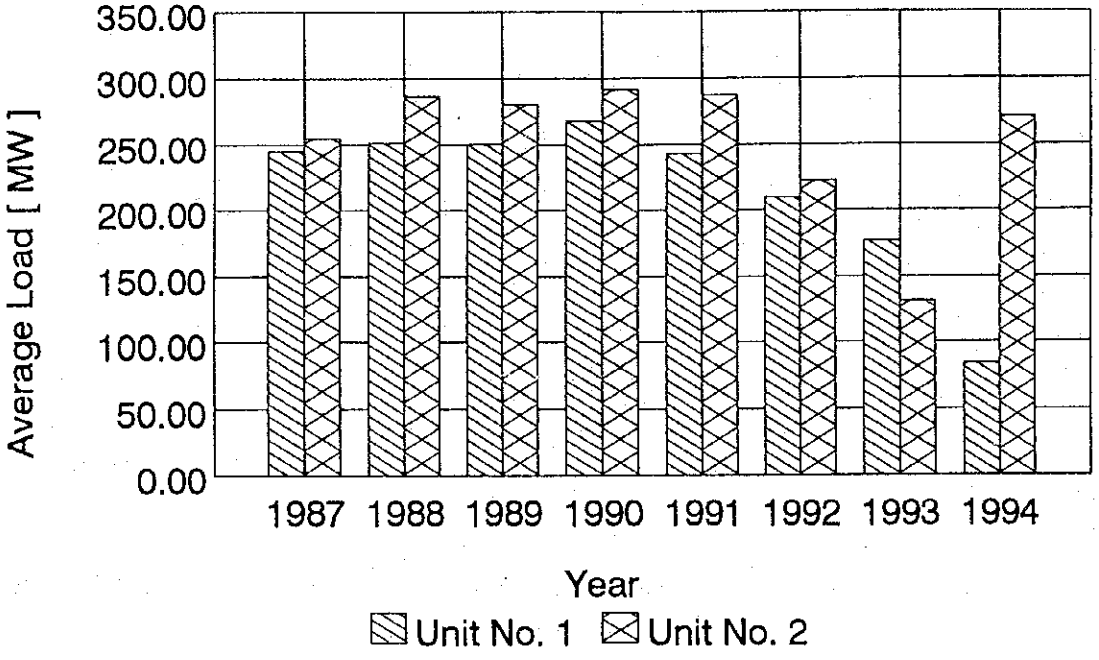


Table 4 − 5 Malaya Thermal Power Plant
No. of Start−up & Shutdown

	Unit No. 1		Unit No. 2	
	No. of Start−up	No. of Shtdown	No. of Start−up	No. of Shtdown
1974	1	1	− − −	− − −
1975	18	18	− − −	− − −
1976	20	19	− − −	− − −
1977	21	21	− − −	− − −
1978	37	37	− − −	− − −
1979	15	15	29	29
1980	21	22	17	17
1981	24	24	4	3
1982	30	30	20	21
1983	19	18	12	11
1984	14	15	10	11
1985	10	10	25	24
1986	13	13	19	19
1987	13	12	10	11
1988	15	15	10	10
1989	21	21	7	6
1990	20	20	15	16
1991	14	14	7	6
1992	16	17	7	8
1993	15	14	8	8
1994	7	8	7	6
Total	364	364	207	206

4.1.3 Maintenance Records

The Annual Overhauls of Malaya T.P.P. Units No. 1 & No. 2 have been implemented with a time schedule as shown in the Figure 4-6. The Annual Overhauls have been performed eleven (11) times in the twenty (20) year-operation since the commissioning in 1975 for the Unit No. 1, and seven (7) times in the sixteen (16) year-operation since the commissioning in 1979 for the Unit No. 2. In other words, the Annual Overhauls have been performed every two (2) years in average for both the units. The Annual Overhauls have not been carried out periodically. The overhaul intervals were often extent to two (2) to three (3) years.

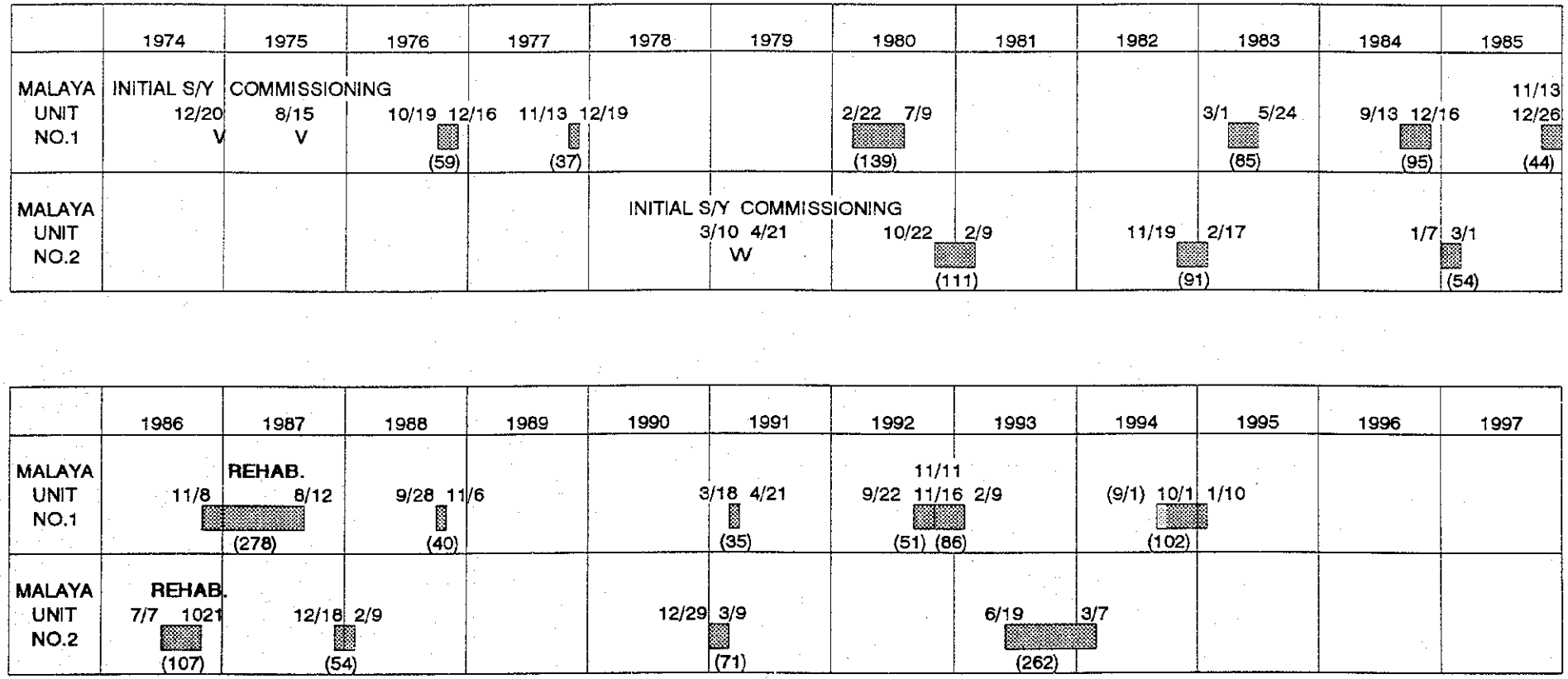
The Major Overhauls, in which whole turbines are completely disassembled for comprehensive overhaul, have been carried out two (2) times in 1980 and 1986 since the initial commissioning of 1975 for Unit No. 1, and those intervals are 4.5, 6 and more than 7 years respectively. For Unit No. 2 the Major Overhauls have been conducted in 1980, 1986 and 1993 in total three (3) times since the 1979 initial commissioning with intervals of 1.5, 5.5 and 6.7 years respectively.

The Preventive Maintenance has been frequently carried out between the Annual Overhauls. The Preventive Maintenance is scheduled for a short period repair of defective parts and malfunction of a system which are revealed during, unit operation to prevent a unit from forced outage. The Preventive Maintenance, however, trends actually toward symptomatic treatment for the revealed defects, instead of the preventive treatment what is called.

The Annual Overhaul must be carried out yearly to maintain performance and reliability of power plant facilities. In actual, the Annual Overhauls have not been carried out every year as mentioned above, and the performance and reliability can not be maintained due to the insufficient Annual Overhauls. These deterioration clearly appears in the operating records of the foregoing section as declined power generation, capacity factor, operating hours and efficiency.

The causes of the problems of insufficient overhaul works are studied in detail in the next chapter of the software division.

Figure 4-6 Malaya Thermal Power Plant Annual Overhaul Record



4.2 Present Conditions, Problems and Remedies

4.2.1 Mechanical Facilities

Present conditions, problems and remedies are summarized in Table 4-6 for Unit No. 1 mechanical facilities, in Table 4-7 for Unit No. 2 mechanical facilities and in Table 4-8 for common facilities.

Both of Malaya TPP Units No. 1 and No. 2 have been suffering from violent gas leakage. High sulfur content in the fuel of 3 to 4 % causes low temperature corrosion and gas leaks in various places of the boiler casings, air pre-heaters and gas ducts. Leaked gas fills not only the boiler room but the turbine room causing secondary corrosion on various equipments in the building. It also impedes operators and maintenance staffs in daily patrol and maintenance. Periodic repair to stop gas leakage is necessary. Detailed inspection/record and study of repair method/frequency are also essential.

High quality fuel oil with low sulfur content should be considered to reduce low temperature corrosion and to improve environment.

1) Malaya TPP Unit No. 1

Facilities of Unit No. 1 are considerably deteriorated because no major overhaul has been done since the rehabilitation in 1987. Their deterioration seems about the same as that before the rehabilitation in 1987.

Deterioration of furnace water wall tubers are considered to be severe, though damaged portions are replaced at the rehabilitation in 1987. Sample tube analysis, visual inspection and tube wall thickness measurement are needed. Replacement and chemical cleaning of all water wall tubes are recommended from experiences in rehabilitation projects of Malaya TPP and Sucat TPP.

One (1) sample tube was taken from the waterwall and examined in detail on appearance, dimension, cross section microstructure, hardness and interior scale in Japan. The examination revealed a large amount of interior scale of 70 mg/cm^2 with the primary component of Fe_3O_4. The scale quantity suggests the necessity of a boiler chemical cleaning. The detailed report examination of the sample tube is given in Appendix 4-4.

Conspicuous deterioration was not found except the interior scale mentioned above. Since the sample tube was taken from only one location for this examination, the sample tubes will have to be taken from several locations with systematic study and planning in order to ascertain the tube conditions and to judge the results of water management.

Averaged life time of the air pre-heater elements is only about 2 years.

Ash handling system which is now water slurry type is severely damaged by low temperature corrosion, and requires renovation with consideration for water pollution.

Inner lining of the smoke stack is damaged. complete replacement of the inner lining and rehabilitation of outer paintings are needed.

Major overhaul for HP and IP turbines should be urgently executed since it has not been done after the rehabilitation in 1987. Cracks on the heat grooves of IP turbine rotor requires detailed inspection. The IP turbine rotor may have to be replaced. Rotor blades of last two stages in LP turbine are cut due to crack problems. This crack problem has been exist since before the rehabilitation in 1987, and requires an essential countermeasure based on information from the original manufacturer.

Remaining life diagnosis for major equipments are necessary because Unit No. 1 has been operated over 100,000 hours. The general description on remaining life assessment is mentioned in Appendix 4-5.

2) Malaya TPP Unit No. 2

Unit No. 2 has not so many problems thanks to the major overhaul and extensive rehabilitation works executed from June 1993 to May 1994. Same countermeasures as Unit No. 1 are necessary to reduce low temperature corrosion in air pre-heaters, ash handling system and smoke stuck.

Remaining life diagnosis for major equipments are necessary because Unit No. 2 has been operated over 100,000 hours. The general description on remaining life assessment is mentioned in Appendix 4-5.

3) Common Facilities

The auxiliary boiler does not achieve rated performance, because accumulated ash on tubes near mud-drum causes corrosion and many tube leaks. Auxiliary boiler is indispensable for start-up of Unit No. 1 during shut-down of Unit No. 2.

Steel sheet piles are corroded and damaged, and need to be replaced.

Table 4-6 Present Conditions/Problems and Basic Countermeasures (1/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 1 Waterwall Tubes	- Frequent tube leak especially at burner zone - Sample tubes were taken for analysis.	- Tube thinning due to corrosion from outer surface - Boiler chemical cleaning has not been conducted for 7 years since the last rehabilitation.	- Total replacement of waterwall tubes - Study on adoption of fuel additive - Reduction of sulfur contents in fuel - Sample tube analysis - Chemical cleaning	O O O	 O 	
B - 2 Secondary SH	- Replacement history 1987 Rehab. 72 pnls. (all) replaced - 51 pnls. NPC supply - 21 pnls. BHK supply 1992 ~ 1993 Overhaul 35 pnls. replaced - MEC fabricated - BHPI fabricated 1994 Overhaul 37 pnls. replaced - 9 pnls. MEC fabricated - 28 pnls. BHPI fabricated	- Hard soot deposit at roof SH nose portion - Mis-aligned panel tubes - Tube leak - Study on unbalance of steam flow - Corrosion of support rugs	- Removal of deposit periodically - Monitoring of tube metal temperature - Installation of unitary design panels - Detailed inspection of existing panels including sample tube analysis - Study on improved design - Investigation of root cause of the problems - Study on adoption of fuel additive - Reduction of sulfur contents in fuel	 O O O 	O O 	

Table 4-6 Present Conditions/Problems and Basic Countermeasures (2/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 3 Boiler Casing and Gas Ducts	- Heavy gas leak - Damaged insulation	- Corrosive flue gas because of high sulfur contents in fuel. - Corrosion at expansion joints, sootblower box, furnace hopper, manholes, inspection holes, corners, etc. - Worn-out gaskets of manholes, inspection holes, sootblower port.	- Reduction of sulfur contents in fuel - Study on adoption of fuel additive - Thorough inspection and comprehensive repair - Daily patrol inspection and periodical planned repair - Study on up-graded material for expansion joints - NPC has a plan to install reverse insulation (inside insulation) for gas duct.	 O O 	 O O	
B - 4 Forced Draft Fan	- FDF 1B has damaged rotor and casing and derated capacity. - FDF 1A has deteriorated parts due to aging. - Overheating of bearing	- Rotor blades are cut and shorter than original length because blades contact with deformed casing. - Aged deterioration	- Replacement with new rotor assembly and casing (new assembly to be delivered from Sucat-4 spare or by I.O. No. 3127.) - Replacement of deteriorated (worn out) parts - Overhaul of bearing, check and adjustment of alignment, inspection of lubricating oil and cooling system	O 	 O O	 '94 Overhaul '94 Overhaul
B - 5 Gas Recirculation Fan	- Normal condition	- Regular maintenance	- Overhaul and replacement of deteriorated parts (spare parts available)		O	'94 Overhaul

Table 4-6 Present Conditions/Problems and Basic Countermeasures (3/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 6 Air Heater	- Deteriorated heating elements	- Severe corrosion of heating elements, seals, frame, rotor, etc. - Life of heating elements is around 2 years.	- Total replacement of cold end element (MEC fabrication) - Reduction of sulfur contents in fuel - Study on adoption of fuel additive - Total replacement of heating elements (cold, intermediate and hot ends) and seals - Inspection and repair of rotor - Comprehensive overhaul of accessories		O O O O	'94 Overhaul
B - 7 Main Fuel Oil Pump	- Normal condition	- Regular maintenance	- Overhaul and replacement of deteriorated parts (spare parts available)		O	'94 Overhaul
B - 8 Light Fuel Oil Pump	- All 3 sets of LFOPs were replaced with screw type pump from gear type pump.	- Regular maintenance	- Overhaul and replacement of deteriorated parts (spare parts available)		O	'94 Overhaul
B - 9 Fuel Oil Heater	- Normal condition	- Regular maintenance	- Cleaning and hydrostatic test No leakage was confirmed in '94 overhaul.		O	'94 Overhaul
B - 10 Burner	- Damaged diffuser	- Damaged diffuser	- Overhaul and replacement of damaged diffuser (spare parts available)		O	'94 Overhaul

Table 4-6 Present Conditions/Problems and Basic Countermeasures (4/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 11 Sootblower	- Deterioration of parts	- Oversize nozzles and valve orifice	- Re-building of nozzles and oversize orifice		O	'94 Overhaul
		- Corroded and clogged sealing device	- Fabrication of sealing boxes and cleaning of sealing line		O	'94 Overhaul
		- Worn-out of drive unit parts	- Replacement of worn-out parts		O	'94 Overhaul
		- Slag deposits are accumulated fast at sec. SH portion.	- Installation of additional sootblowers	O		
			- Study on adoption of fuel additive	O		
B - 12 Control Air Compressor	- Deteriorated control air piping system	- Leakage of control air	- Repair and revision of control air piping system		O	
	- 2 sets of new screw type compressors were installed in 1994.	- Atmosphere around compressors is poor due to dust and leaked gas.	- Construction of compressor house	O		
B - 13 Dust Collector	- Corroded dust collector cyclones, hopper casing	- Easy corrosion of dust collector components due to corrosive ash and flue gas with high sulfur contents	- Fabrication of deteriorated components by MEC and repair/replacement by MSD		O	'94 Overhaul
			- To study on adoption of fuel additive.	O		
			- To reduce sulfur contents in fuel.			
B - 14 Ash Handling System	- Severe corrosion of ash conveying piping	- Severe corrosion of piping due to corrosive ash and existing water wash conveying system	- Replacement of corroded piping and values		O	'94 Overhaul
			- Improvement of ash handling system including re-utilization of collected ash	O		

Table 4-6 Present Conditions/Problems and Basic Countermeasures (5/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 15 Smoke Stack	- Damaged inner lining	- Damaged inner lining	- Repair of inner lining and insulation - Complete rehabilitation of inner lining, insulation & painting		O O	Selective repair was carried out in '94 Overhaul.

Table 4-6 Present Conditions/Problems and Basic Countermeasures (6/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 1 HP Turbine	- The whole turbine can neither be barred manually nor be operated by turning device.	- When the unit tripped on July 7, 1994, the turbine was operated on turning until July 30, 1994. After repair of oil line leakage the turbine was able to be barred manually but could not be rotated by turning device on July 31, 1994. On August 24, 1994, catch finger of barring device was broken and repaired. After the repair the manual barring became very hard, and finally the turbine could not be rotated by manual barring.	- Overhaul and inspection of turbine internal, bearing, turning device, oil system	O	O	HP turbine was not disassembled in '94 Overhaul.
		- HP turbine have not been overhauled for 7 years since the last rehabilitation in 1987, and various parts deteriorated probably.	- Comprehensive overhaul should be carried out for detailed examination, reconditioning, repair and replacement of deteriorated parts.	O		
		- Worn-out thrust pads of thrust bearing # 2	- Replacement of thrust pads		O	
			- To study complete replacement of HP turbine rotor and inner casing with improved design	O		
		- Total operation time is more than 100,000 hours.	- Life expectancy analysis	O	O	

Table 4-6 Present Conditions/Problems and Basic Countermeasures (7/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 2 IP Turbine	- Un-reliable IP turbine rotor because of cracks on damping grooves and bent rotor with heavy balancing weight of 5 kg	- IP rotor has cracks on damping grooves. - IP rotor has heavy balancing weight (5 pcs., 3 kgs).	- Detailed inspection of cracks and study on repair possibility - "Run out check" should be conducted to verify straightness of rotor.		O	- IP turbine was not overhauled in 1994.
		- Complete overhaul of IP turbine has not been performed for 7 years since the last rehabilitation in 1987, and various parts deteriorated probably.	- Comprehensive overhaul should be carried out. - To study on complete replacement of IP rotor, inner casing and blade carrier with improved design.	O	O	- PR for new rotor will be prepared by NPC.
		- Total operating time already exceeds 100,000 hours.	- Life expectancy analysis	O		

Table 4-6 Present Conditions/Problems and Basic Countermeasures (8/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 3 LP Turbine	- LP-1 turbine rotor 8th stage blades are all cut.	- LP 1 & 2 turbine rotor blades were replaced with non-hardened blade during the rehabilitation in 1987. But blade failure recurred at the LP-1 8th stage blades in September 1991, and the blades were cut to 395 mm as a remedial measure.	- Replacement of LP-1 rotor 8th stage blades	O		
	- LP-1 turbine rotor 7th stage 2 blades were twisted/deformed. - LP-2 turbine rotor 9th stage 1 blade was deformed. - LP-2 turbine rotor 7th stage blades were eroded (2mm depth along blade length). - LP-1 stationary blades at last stage were partially chipped.	- 4 rotor blades of LP-1 7th stage, 2 defective blades and 2 opposite side blades, were cut by 230mm from tip in 1994. - 2 rotor blades of LP-2 9th stage, 1 defective blades and 1 opposite side blades, were cut by 250mm from tip in 1994.	- Examination of rotor blades - Study on recurrence of blade failure even non-hardened blade adoption. (to consult the original manufacture, Siemens.)	O	O	
		- LP-2 inner casing has radial cracks, 5 on lower casing and 6 on upper casing, and repaired by Metalock during rehabilitation in 1987.	- To inspect repaired cracks. If cracks develop again, replacement of casing will also be considered.	O	O	
		- Total operating time already exceeds 100,000 hours	- Life expectancy analysis	O		
T - 4 HP Stop Valve		- With leaks	- Reconditioning of parts - Life expectancy analysis	O	O O	'94 Overhaul

Table 4-6 Present Conditions/Problems and Basic Countermeasures (9/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 5 HP Control Valve		- With leaks	- Reconditioning of parts - Life expectancy analysis	 ○	○ ○	'94 Overhaul
T - 6 IP Stop Valve		- With leaks	- Reconditioning of parts - Life expectancy analysis	 ○	○ ○	'94 Overhaul
T - 7 IP Control Valve		- With leaks	- Reconditioning of parts - Life expectancy analysis	 ○	○ ○	'94 Overhaul
T - 8 Cross-over and Cross-under Pipe		- Deterioration	- Inspection of compensators		○	
T - 9 Turbine Oil System	- On normal operation	- Regular maintenance necessary	- Regular maintenance		○	
T - 10 Gland Steam Regulator	- Gland steam is regulated manually.	- Gland steam regulator can not be operated in automatic mode.	- Replacement of gland steam regulator and control system	○		Refer to IC-23 of Malaya Unit No.1

Table 4-6 Present Conditions/Problems and Basic Countermeasures (10/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 11 Main Condenser	- Condenser tube leak	- No. of plugged tube is 631 pcs. or 1.8% of total 34,000 tubes as of February 1993.	- Complete retubing (tubes available)	O		
			- To study on causes of frequent tube leak and selection of adequate tube material.	O	O	
	- Partial corrosion of tube sheets	-	- To conduct eddy current test periodically	O	O	
			- Plastocor Coating for partial corroded tube sheets were performed in '94 overhaul.		O	'94 Overhaul
	- Leak on make-up water piping to hotwell	- Pipe was attacked by Ammonex drain and corroded.	- Rehabilitation and installation of piping above ground		O	
T - 12 Aux. Condenser	- Tubes were replaced, and eroded tube sheet was coated with epoxy paint.	- Plugged tube is more than 6 % of total 2,800 tubes.	- Partial re-tubing and protective coating (Plastocor) on tube sheets were performed in '94 overhaul.		O	'94 Overhaul
			- To study on causes of frequent tube leak and selection of adequate tube material.	O	O	
			- To conduct eddy current test periodically.	O	O	
T - 13 LP-1 Feedwater Heater	- LP-1 Heater was replaced with new one (China make) in 1991.					

Table 4-6 Present Conditions/Problems and Basic Countermeasures (11/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 14 LP-2 Feedwater Heater	- LP-2 Heater was replaced with new one (China make) in 1991, but plugged tube is already 14.58%.	- Tube leak and plugged 30 tubes (14.58%) in October 1992	- Replacement of tube bundle or whole assembly - To study on cause of tube leak within a few years.	O		
T - 15 LP-3 Feedwater Heater	- LP-3 Heater was replaced with new one (Hitachi make) in 1987 rehabilitation, but the heater is isolated due to excessive leak.	- LP-3 Heater is isolated due to excessive leak. Total 334 tubes were plugged (34.54%) in 1991 overhaul.	- Replacement of tube bundle assembly with improved tube material (SUS tube) supplied by YUBA - To study on cause of frequent tube leak.		O	In '94 Overhaul, heater tube bundle was removed already, but new bundle was not yet delivered to site because L/C was not opened.
T - 16 HP-5 Feedwater Heater	- HP-5 A/B Heaters were replaced with new ones (Hitachi make), and recently tube leak started.	- Possible cause of tube leak is tube outside damage due to detached turbine seal strip piece in extraction steam. - Plugged tube in 1992 overhaul HP-5A : none HP-5B : 15 tubes	- Installation of strainer along extraction steam line to heaters		O	'94 Overhaul
T - 17 HP-6 Feedwater Heater	- Tube leak	- Tube leak due to same cause of HP-5 heaters probably	- To monitor effect of strainer for HP-5 heaters			

Table 4-6 Present Conditions/Problems and Basic Countermeasures (12/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 18 Deaerator	- Deformed condensate distributor of deaerator	- Deformed condensate distributor may increase pressure loss of condensate system.	- Replacement of distributor or modification of deaerator to spray type	O		
	- Detached heating coils in feedwater tank	- Heating coils were detached due to hammering during operation.	- Reinforcement of heating coil support and replacement of heating coils with improved design	O		
T - 19 BFP Turbine	- Derated capacity due to damaged rotor and stationary blades and limited unit output of 80 MW	- Damaged rotor and stationary blades at last 4 stages	- Reblading damaged rotor and stationary blades (rotor blades available on stock and stationary blades to be delivered in middle of October 1994)		O	'94 Overhaul
		- Damaged turning device	- Replacement of damaged parts of turning device		O	'94 Overhaul
			- Aux. condenser tubes should be investigated on damage due to broken piece of blades.		O	
T - 20 T-BFP	- Deteriorated parts		- Replacement with new assembly (overhaul, new complete assembly available)		O	'94 Overhaul
T - 21 T-BFP Booster Pump	- Normal condition	- To be overhauled.	- Regular overhaul and replacement of worn-out parts		O	'94 Overhaul
T - 22 M-BFP	- Insufficient capacity to attain 1/3 MCR feedwater flow	- Probably damage of pump inner components	- Complete overhaul and replacement of inner parts (spare parts available)		O	'94 Overhaul

Table 4-6 Present Conditions/Problems and Basic Countermeasures (13/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 23 M-BFP Lub. Oil Pump	- Driven gear is always detached from main oil pump shaft.	- Enlarged key was installed during a previous maintenance for emergency repair.	- Restoration of main components		O	'94 Overhaul
T - 24 BFP Minimum Flow Valves	- Manual operation of minimum flow valve of T-BFP during change over of M-BFP and T-BFP because of big disturbance of feedwater flow by quick open/close of minimum flow valves	- Unstable feedwater flow during change over of M-BFP and T-BFP - Reliability of BFP protection during change over	- Study on modification of BFP minimum flow system with minimal disturbance of feedwater flow and reliable pump protection during BFP change over	O		
T - 25 Condensate Pump	- Normal condition		- Regular maintenance (spare parts available)		O	'94 Overhaul
T - 26 Circulating Water Pump	- CWP 1A is under rated. - CWP 1B has defective planetary gear.	- CWP 1A is under rated due to deteriorated parts. - CWP 1B has defective planetary gear, and tripped on July 7, 1994, which resulted unit shutdown due to low vacuum. Various parts deteriorate.	- Complete overhaul - Complete overhaul and replacement of planetary gear - NPC plans replacement of CWP with direct drive type in future	 O	O O 	'94 Overhaul '94 Overhaul Procurement of new CWP under process
T - 27 Raw Water Pump	- RWP 1A has rough vibration.	- RWP 1A has rough vibration.	- Inspection/overhauling and repair (spare parts available)		O	'94 Overhaul

Table 4-6 Present Conditions/Problems and Basic Countermeasures (14/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
T - 28 House Service Cooling Water Pump	- Normal condition		- Regular maintenance (spare parts available)		
T - 29 House Service Heat Exchanger	- Standby shell & tube type heat exchangers 1A & 1B have plenty of tube leak. - Plate type HE is in normal condition.	- HE 1A & 1B have plenty of tube leak. -Plugged tubes as of 1992 October HE 1A : 198 pcs. (9.7%) HE 1B : 218 pcs. (10.7%) (Total No. of tubes: 2,040 pcs.) - Plate type HE can only be overhauled during long shutdown of unit because of unreliable standby HE 1A & 1B	- Installation of one additional plate type HE with 100 % capacity	O	Under procurement, bided & evaluated
T - 30 Main Steam Pipe	- Total operating period exceeds 100,000 hrs.	- To investigate aged deterioration.	- Examination of T-piece, elbows, nozzles, support lugs by PT, MT, UT, and replica for crack, fatigue and creep damage - Life expectancy analysis	O O	
T - 31 Hot Reheat Pipe	- Same as above	- Same as above	- Same as above	O	

Table 4-6 Present Conditions/Problems and Basic Countermeasures (15/15)

Malaya Unit No. 1 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 32 Cold Reheat Pipe	- Same as above	- Same as above - Mis-aligned CRH pipe due to water hammer	- Same as above - Improvement of draining system - Inspection and adjustment of piping supports and hangers - Check of piping alignment	O O O	 O	 '94 Overhaul

Table 4-7 Present Conditions/Problems and Basic Countermeasures (1/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 1 Water Wall Hopper Tube	- During 1993 overhaul, W/W hopper tubes were inspected. - Severe pitting corrosion on tube outer surface - Pitting of max. depth of 2.5 mm ~ 3 mm affects tube thickness less than tsr. of 5.9 mm. - None of hydrogen attack on tube internal surface	- W/W hoper tube thickness is less than tsr. of 5.9 mm due to severe pitting corrosion on outer surface, and reliability is low because of tube leak possibility.	- Replacement of W/W hopper tubes (straight tubes available at Malaya, to be fabricated at MEC.) - Sample tube analysis - Boiler chemical cleaning		O O O	
B - 2 Primary SH	- Damaged all vibration bars due to excessive radiant heat. - Weak primary SH tube	- Damaged all vibration bars due to excessive radiant heat. - Tube leak was experienced after start-up in 1994 March.	- Repair of all damaged vibration bars by welding with new bar pieces (SUS 304) - Replacement of identified weak primary SH tubes		O O	
B - 3 SH Attemperator	- Cracks on spray nozzles	- Cracks on spray nozzles due to thermal shock	- Replacement with new spray nozzles. New spray nozzles should be ordered.		O	
B - 4 Eco. FW Shut-off Valve (BO-6)	- Valve stem had broken and was repaired by welding.	- Broken valve stem was repaired by welding.	- Replacement of valve stem		O	

Table 4-7 Present Conditions/Problems and Basic Countermeasures (2/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 5 Boiler Casing	- Gas leak area was repaired during overhaul 1993 and 1994, but heavy gas leak was still observed at boiler rear casing.	- Fast corrosion of casing and recurrence of gas leak due to high sulfur contents in fuel	- Steady inspection of gas leak, grasp of leak area and tendency, preparation of detailed records with drawing, and plan of periodical preventive repair schedule - Study on adoption of fuel additive - Reduction of sulfur contents in fuel		O	
B - 6 GRF	- Inspected during 1993 overhaul	- Rotor has tendency to bend.	- Operating procedure was changed, rotor is put in turning during shutdown. - Replacement of rotating internal parts		O	PR was already prepared for bidding.
B - 7 Gas Duct	- All damaged portions of duct were repaired by patch work, and 75 % of expansion joints were replaced in 1993 overhaul.	- Gas leak due to low temperature corrosion	- Same as item B-5 Boiler Casing		O	
B - 8 Air Heater	- Corroded heating elements and seals - All hot end and intermediate heating elements of AH 2A and 2B were replaced with new baskets fabricated by MEC in 1993 overhaul	- Corrosion of heating elements and seals	- Same as M-1 item B-6			

Table 4-7 Present Conditions/Problems and Basic Countermeasures (3/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 9 Steam Coil Air Heater	- SCAH 2B was inspected, and 2 bundles were replaced with new spares because of steam leak during 1993 overhaul. - No work was done on SCAH 2A in 1993 overhaul.	- Deteriorating SCAH	- Replacement of both SCAH bundles	O		
B - 10 Sootblowers	- All sootblowers were overhauled in 1993 overhaul. All lance tubes were replaced.	- Regular maintenance	- Regular maintenance		O	
B - 11 Dust Collection	- Corroded D. C. cyclones, hopper casing	- Easy corrosion of D. C. components due to corrosive ash and flue gas	- Repair of D. C. casing and replacement of cyclones - To study on adoption of fuel additive - To reduce sulfur contents in fuel		O	
B - 12 Ash Handling System	- Repair during 1993 overhaul	- Corrosion of ash line due to corrosive ash and present water wash conveying systems	- Improvement of ash handling system including re-utilization of collected ash	O		
B - 13 Smoke Stack	- Damaged inner lining	- Aged deterioration and damaged inner lining	- Repair of inner lining - Complete rehabilitation of smoke stack including inner lining	O	O	

Table 4-7 Present Conditions/Problems and Basic Countermeasures (4/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
B - 14 Main Steam Pipe	- Total operating time exceeded 100,000 hours.	- Aged deterioration because of long operating hours - Fatigue - Creep	- Life expectancy analysis and examination by PT, MT, UT, Replica	O	O	
B - 15 Hot Reheat Pipe	- Same as above	- Same as above	- Same as above	O	O	
B - 16 Cold Reheat Pipe	- Same as above	- Same as above	- Same as above	O	O	
B - 17 Boiler Drum		- Severe leakage at root valves of level transmitters at left and right sides of dram	- Replacement of defective root valves during next unit shutdown (spare valve available)		O	To be replaced during scheduled shutdown in December 1994.

Table 4-7 Present Conditions/Problems and Basic Countermeasures (5/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 1 Condenser	- Partial re-tubing was performed in 1993 overhaul with only 789 tubes out of 1,002 plugged tubes of condenser 2B. No re-tubing was carried out for condenser 2A. No. of tube plugged: 2A - 663 tubes 2B - 277 tubes Total 940 tubes	- Condenser tube leak - Unstable lake water quality is one of reasons for frequent tube leak because selection of adequate tube material is difficult.	- NPC plans total re-tubing (CuNi 90 - 10). - To study on selection of adequate tube material - To conduct eddy current test periodically	O O	 O	
T - 2 LP - 2 Feedwater Heater	- LP-2 Heater was replaced with new one (China make) during 1993 overhaul.		- To study on cause of tube leak			
T - 3 LP - 3 Feedwater Heater	- LP-3 Heater was replaced with new one (China make) during 1993 overhaul.		- Same as above			

Table 4-7 Present Conditions/Problems and Basic Countermeasures (6/6)

Malaya Unit No. 2 Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
T - 4 Raw Water Pump	- RWP 2B is unreliable because of negative suction horizontal type. - RWP 2A was replaced with new turbine type pump (Fair Bank Morse, USA make) because casing crack had been temporary repaired during 1987 rehabilitation. - RWPs 2A & 2B were overhauled during 1993 overhaul.	- RWP 2A has high vibration (325 μm with un-coupled condition). Modification of discharge head is being studied by manufacturer.	- NPC plans replacement of RWP 2B with turbine pump in future.	O		
T - 5 Control Air Compressor	- One screw type control air compressor (Hitachi) was installed in 1987 rehabilitation. - Two additional screw type compressors were installed (Atlas Copco.).	- Two screw type compressors (Atlas Copco.) and three screw type compressors (2-Atlas Copco. & 1-Hitachi) are used as common air supply source for control & station air system of Malaya TPP units No. 1 & No. 2. - Control air piping installed underground has air leakage.	- To provide individual air system for units No. 1 & No. 2 and control & station air system respectively - Installation of above ground piping	O	O	

Table 4-8 Present Conditions/Problems and Basic Countermeasures

Malaya Common Facilities Mechanical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
CM - 1 Aux. Boiler	- Insufficient capability to attain 200 psig. steam pressure	- Many tube leak at mud drum connecting portion due to heavy corrosion of tube outer surface by accumulated acidic soot	- Total retubing of aux. boiler (PR prepared already)	O	
		- Unit No. 1 start-up is impossible without unit No. 2 operation, if aux. boiler can not operate for Unit No. 1	- Modification of construction of soot accumulated portion at mud drum with sealed type	O	
CM - 2 Intake Channel	- Corroded intake sheet pile	- Corroded intake sheet pile	- Installation of concrete pile in future	O	

4.2.2 Electrical Facilities

What can be stated in general regarding electrical facilities are that, except for the equipment, meters and relays located in the centralized control room and electrical equipment room for which air conditioning is provided, electrical facilities in both of boiler room and powerhouse are exposed to gases leaking from boilers and gas ducts. Accordingly, advanced contamination and deterioration can be found on many electrical facilities due to dust and SO_2 gases. Ii is necessary to urgently perform clean-up and detail inspection with all of the electrical equipment, in order to extract deteriorated points, to determine the points of replacement or repair, and to plan and implement necessary work.

As long-term countermeasures, it is essential to perform periodic cleaning and inspection, to repair gas leaking points of boilers and to take measures for preventing gas leakage from boilers.

The principal problems with the electrical facilities of Malaya Unit No. 1 and Unit No. 2 are described below, and general situations are shown in Table 4-9 (Unit No. 1) and in Table 4-10 (Unit No. 2).

1) Malaya Unit No. 1

a. Generator

The generator of Malaya unit No. 1 involves considerably large problems as stated below.

The problem of hot spot, that is, core end overheating on the stator in particular is large. Even if a temperature sensor was provided at the subject during rehabilitation of last time to permit monitoring of the extent of temperature rise. But due to shortage of the budget, complete measures were not taken, and there is a possibility where the limit temperature of the stator coil is exceeded due to failure and erroneous operation of the excitor. It is therefore desirable that stator modification work, which is identical to what was implemented with Sucat unit No. 4, is implemented as early as possible.

The exciter was originally of brushless type made by Siemens. But modification to static type was proposed when an excitor rotor bind wire failure accident occurred in 1987, and modification work was implemented in 1989. However, problems such as

sparking from the slip ring occurred during running after modification. As a result, the excitor is not used as static type but is used at the present time as returned to the state before the modification. The automatic voltage regulator (AVR) should also be replaced because it is deteriorated as exposed to furnace gases leaked from boilers for a long time.

Failure to the excitor occurred when a period of ten years elapsed since commissioning of Malaya Unit No. 1. As no problems occurred to the brushless type excitor of Sucat unit No. 4, which employs an excitor of the same type as Malaya Unit No. 1, and no problems occurred to the brushless type exciters of Sucat Unit No. 2 and 3, it can be hardly considered that there are problems in the design of the excitor, and it is considered that sufficient troubleshooting should be made instead of modification to static type.

Furthermore, damage was found at bearing No. 8 journal shaft of the generator rotor, and there is a fear that jack-up of the shaft becomes insufficient. Therefore, detail inspection and repair should be made during the overhaul of this time (September through November, 1994).

b. 4,160V Metal-Clad Switchgear and 480V Switchgear

Extension is required because spare switch units are not used any longer.

c. 4,160V and 480V Motors

The bearing temperature of FDF motors 1A and 1B (4,160V) is high, and troubleshooting and countermeasures are required. Furthermore, abnormal vibration was found with raw water pumps 1A, 1B (480V). They also require countermeasures.

2) Malaya Unit No. 2

The electrical facilities of Malaya Unit No. 2 do not involve critical problems. But the following can be raised as items requiring improvement.

a. 4,160V Switchgear and 480V Switchgear

There are no critical problems. But since spare units are already used for others, addition of a spare unit is required for each of 4,160V switchgear and 480 V switchgear.

In addition, 480V Motor Control Centers are deteriorated and draw-out type units are misaligned. Total replacement is recommendable.

The transformer for the power center (2,000kVA) is of insufficient cooling and overheat occurs at occasions. Therefore, addition of a fan to the existing transformer or replacement with a mold transformer (for fire prevention) will be examined.

b. 4,160V and 480V Motors

Damage was found on the stator core of the 4,160V CWP-2A motor. If replacement of the motor is required it should be examined upon detail investigation during overhaul.

The bearing temperature of 480V stator cooling water pump motors (3,600 rpm) 2A, 2B is high, and examination of countermeasures is required.

3) Common Facilities

a. 230kV Substation

The disconnecting switch is of manual operation on the field at the present time. But it is necessary to replace it with a motor-operated type for labor saving in the conduct of the substation and also improving the safety (particularly on rainy days).

b. Internal Illumination

The illumination in the power plant is dark because of shortage of facilities and insufficient maintenance, and there are many places where dark illumination is a problem from the standpoints of patrol inspection and safety. Review and consolidation of illumination facilities particularly at points requiring inspection during patrol and passages of the boiler room should be made urgently.

Table 4-9 Present Conditions/Problems and Basic Countermeasures (1/3)

Malaya Unit No. 1 Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
E - 1 Generator Rotor	Still in good condition	Bearing No. 8 journal with scratched which may affect jacking oil lift	Re-machining	O		To be implemented during the rehabilitation (To be consulted with Siemens)
E - 2 Generator Stator	Derated Capacity (300 → 290 MW) due to core end overheating	Can not attain full capacity	Maintain required cooling system	O		Recommend repair of core end to the manufacturer during the rehabilitation to attain full capacity of the unit.
E - 3 Exciter & AVR: Static EX	Stand-by due to damaged slip-ring	Poor designed. It was damaged during pre-commissioning.	Slip ring to be re-designed by competent manufacturer		O	Good coordination in the design, material etc. between Siemens and ABB seems to be essential, otherwise serious problems might be anticipated.

Table 4-9 Present Conditions/Problems and Basic Countermeasures (2/3)

Malaya Unit No. 1 Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
E - 3 Exciter & AVR: Existing EX	AVR-on manual mode of operation. Exciter is still in good condition.	Unavailability of spare parts. Rotating rectifier is locally repaired by ABB.	Close monitoring on manual operation of AVR.	O	O	Recommend replacement of existing AVR w/ new model by the manufacturer. (Siemens)
E - 4 4160 V SWGR and Transformer	Still in good condition	No spare cubicle w/ breaker	Additional installation be made for the future additional loads when existing get damaged.	O		To be implemented during the rehabilitation. (Spare cubicle is needed.)
E - 5 480 SWGR and Transformer P/C	Still in good condition	1. Can not implement inspection/overhaul because it has only one (1) person. 2. No spare breakers. 3. ISI transformer winding was locally repaired. 2,000 kVA 4,160 → 440/277	1. Split bar with tie breaker to be installed. 2. Provide spare breaker. 3. Replace the transformer with dry type (mold type).	O O O		Countermeasure be implemented during the rehabilitation. Additional cubicle to enable double bus system is recommendable.
E - 5 480 SWGR and Transformer MCC	Same as above Are all is good condition	Corrosive environment causing internal of MCC to be rusty including parts of the breaker and contactors.	Provide enclosure with adequate Ventilation	O		To be implemented during the rehabilitation period.

Table 4-9 Present Conditions/Problems and Basic Countermeasures (3/3)

Malaya Unit No. 1 Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
E - 6 Motors 4160 V	All are in good condition.	FDF 1A & 1B motor bearings temperature are above normal (overheating) due to no provision of lubrication recirculations	Additional forced oil recirculator of lubrication be installed.	O	Implement during rehabilitation.
E - 6 Motors 440 V	All are in good condition except RWP 1A & 1B and Hydroveyer pump motor No. 1A.	Always vibration occurs.	Replace with new motors.	O	Replace w/ new model during rehabilitation.
E - 7 Battery	Are all still in good condition.	Battery room not properly ventilated such that frequent addition of distilled water in made especially during summer when the temperature is high.	Renovate the room and provide w/ adequate room air condition.	O	Implement during rehabilitation. Repair the battery in 1995 for reliability.
E - 8 Main/house Transformer	Are all still in good condition.	The transformers are mineral oil filled which are flammable. And these transformers are installed just beside the building and are endangered falling objects.	Re-insulate the bushing terminals and wires which are near the bldg.	O	Implement during rehabilitation. To be studied.

Table 4-10 Present Conditions/Problems and Basic Countermeasures (1/2)

Malaya Unit No. 2 Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
E - 1 4160 V SWGR and Transformer	Good condition	No spare cubicle with breaker.	Install bus extension for future additional load.		O	Implement during rehabilitation.
E - 2 480 SWGR and Transformer P/C	Are all in good condition.	480 volt SWGR is locally manufactured. Circuit breaker sliding guides are misaligned. Ventilation of transformer vault is inadequate.	To check/fix alignment. Additional installation of cooling fans, or replacement with dry type transformer.		O O	Implement during rehabilitation. - do -
E - 2 480 SWGR and Transformer MCC	Same on above. Are all in good condition.	All MCC are locally fabricated. Circuit breakers/contactors sliding guides are not rigid/sturdy or min-aligned. Environment is corrosive and hot.	To check/fix alignment. MCC should be provided with enclosure with sufficient ventilation.		O	 - do -
E - 3 Motors 4160 V	Are all in good condition.	CWP 2A motor stator core with scratch caused during pump cutless bearings were damaged.	To be replaced.		O	With PR

Table 4-10 Present Conditions/Problems and Basic Countermeasures (2/2)

Malaya Unit No. 2 Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
E - 3 Motors 440 V	Are all in good condition, except stator cooling pump Motors 2A & 2B.	Bearings temperature are above normal due to high speed of motor (3,600 rpm).	To verify design of cooling for the bearings or a possible design of lower speed (rpm).	O	
E - 4 Battery	Still in good condition.	Inadequate room cooling such that frequent addition of distilled water is made especially during summer season when with higher temperature.	Additional installation of ventilation fans.	O	Implement as soon as possible. The battery should be replaced in 1994 for reliability.
E - 5 Main/house Transformer	Are all in good condition.	The transformers are mineral oil filled which are flammable. And then transformers are installed adjacent to the bldg. of which possible falling objects might affect and damaged the transformers.	Insulate the bushing terminal and portion of the lines to protect from falling objects which may cause short circuit.	O	Recommend to be implemented during the rehabilitation.

Table 4-11 Present Conditions/Problems and Basic Countermeasures

Common Electrical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
E - 1 230 kV Equipment	All still in good conditions	Disconnect switches are manually operated and can not do switching during rainy reason.	Modify with motor operated disconnect switches.	O	Implement during rehabilitation.
E - 2 Lighting System	1. Many fixtures at the boiler room are either with corroded sockets and fittings.	Existing fixture lamp socket are not available locally. Environment in corrosive and hot.	Replace with locally available sockets.	O	Implement during rehabilitation.
	2. Inadequate perimeter fence and street lighting fixture.	Not provided during the construction.	Additional installation.		- do -

4.2.3 Instrumentation and Controls

As general situations of the instrumentation and control facilities, corrosion and contamination due to gases leaking from boilers and gas ducts and found like electrical facilities. It is considered that cleaning, discovery of faulty points and repair to equipment are urgently required.

However, all of the troubles found in those days were corrected by the rehabilitation work conducted in 1986 - 1988 period and special repair was made to Unit No. 2 for the period of about eight months beginning in July 1993. Accordingly, the number of faulty points which became clear as a result of the investigation of this time was relatively small.

In a long-run, repair to gas leaking points of the boilers and gas ducts as well as permanent gas leakage preventing measures are required as described in the section of electrical facilities.

The principal problems with the instrumentation and control facilities of Malaya Unit No. 1 and Unit No. 2 are described below. In addition, general situations are shown in Table 4-12 (Unit No. 1) and Table 4-13 (Unit No. 2).

1) Unit No. 1

a. Steam Coil Air Heater Control

The air temperature does not rise to the specified level. Troubleshooting and countermeasures are required. NPC expressed the opinion that replacement of the steam coil is required. But it is considered better to carry out detail investigation to determine if the temperature control side involves no problem.

b. Corrosion to Control Air Pipeline

The control air was not dry enough and was of high humidity before the rehabilitation of 1987, and accordingly, the interior of the control air pipeline was corroded. Since the pipeline was almost unreplaced, rust is still contained in the control air, and it is necessary to replace the pipeline to eliminate the cause for this problem To determine which portions are to be replaced during the work of next time, pipe samples will be collected from a number of places to carry out investigation. Replacement of necessary portions will be made after this investigation.

c. FDF 1B Inlet Vane Control

High vibration is occurring with a unit load of 50% and up. It is necessary to perform troubleshooting during the overhaul of this time.

d. GRF Inlet/Outlet Damper Control Actuator

The actuator for inlet/outlet damper control has deteriorated and its operation is faulty. It is necessary to replace this actuator.

e. Reheater Spray Valve Seat Leak

Leakage from the reheater spray valve seat was found. It is recommended that the spray control valve is replaced with a valve of new type adopted for Sucat unit No. 4, as it is of less seat leakage.

f. Boiler Metal Temperature Measurement

Both of the thermocouple and recorder have deteriorated and require replacement. It is desirable that a recorder of hybrid type is adopted from the aspects of accurate temperature reading and alarm transmission.

g. Smokestack Monitoring TV

The smokestack monitoring TV has deteriorated and failed. It should be replaced.

h. Soot Blow Steam Pressure Control

The controller is out of order, and requires replacement.

i. Mini-Flow Valve Control for Turbine-Driven Boiler Feed Water Pump

At the time of switching from M-BFP to T-BFP at start of the unit, because of the fact that this mini-flow valve is of ON/OFF control, the rate of water feed to the boiler largely varies when the valve operates, and the unit output also varies accordingly. Therefore, stable running is disabled. It is used by manual control only at the present time due to this reason.

Re-examination of the control system is needed to permit automatic running. A new improvement plan will be considered using the modification plan adopted for Sucat unit No. 4 as a reference.

j. Drain Level Control of L. P. Heater No. 3

The control valve should be replaced, as its grand leak and seat leak are excessive.

k. Cold Reheat Drain Level Control

This control is not applied at the present time and manual control is made.
It is recommended that automatic control be newly provided.

l. HSCC Make-up Water Level Control

Since automatic water level control is out of order, troubleshooting will be made and necessary countermeasures will be taken. (It is considered that the positioner has failed.)

2) Unit No. 2

a. ABC System

The currently installed ABC is an old pneumatic type and it is hard to acquire its spare parts. Therefore, it will be replaced with a new INFI-90 system (made by Bailey) of digital type.

b. Control Air Pipeline

As the interior of the pipeline is corroded like Unit No. 1, the situations of the pipeline will be investigated and necessary portions will be replaced.

Table 4-12 Present Conditions/Problems and Basic Countermeasures (1/5)

Malaya Unit No. 1

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
IC - 1 SCAH Control	Operational in Auto Mode	Operational temp. cannot be attained. It might be of the bundle of coils that are isolated.		O	The real cause should be identified.
IC - 2 Fuel Oil Heater	Good condition	Fuel Oil temperature controller malfunction when F. O. heater heating steam pressure transmitter and controller air supply fail		O	Control air pipe line should be replaced.
IC - 3 Fuel Oil Control	Operational in Auto mode	Sometimes area meter (F.O.) stuck-up		O	After long shut-down
IC - 4 Control Air Back-up	Tie between M1 & M2 is not in service.	Pressure regulating valve operates inconsistently.	To be overhauled this coming over-hauling.	O	
IC - 5 Dust Collector By-pass Damper Control	Not operational in remote manual	Motor & damper stuck-up	Actuator - to be overhauled Motor - for checking at electrical shop. Damper - to be inspected/ overhauled by mechanical maintenance.	O O O	Mechanical problem
IC - 6 FDF Cooling and Sealing Air Damper	Operational but need of total overhauling	Manual operation most of the time	Motor - to be inspected/ overhauled by electrical maintenance. Actuator - to be inspected/ overhauled by instruments. Damper - to be inspected/ cleaned and overhauled by CMD.	O O O	

Table 4-12 Present Conditions/Problems and Basic Countermeasures (2/5)

Malaya Unit No.1

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
IC - 7 Control GRF Cooling and Sealing Air Damper Control	Operational but need of total overhauling	Manual operation	Sealing air cylinder to be overhauled.	O	
IC - 8 FDF Air Flow Control	Operational in auto mode. FDF 1B not operate normally with respect to its opening	Air flow control on automatic with high demand signal due to FDF 1B inlet vane problem. Combustion air leakage	Detail inspection needed.	O	High vibration at 50% load or higher
IC - 9 GRF Inlet/Outlet Damper Control	Operational in auto mode	Actuator sometimes malfunction	Recommended for replacement of actuator assembly. Awaiting delivery of new control drive.	O	
IC - 10 AH Gas Inlet Damper Control	A - side operational at remote manual B - side always open because motor control is defection.	Control interlock not functioning	To be overhauled & limit switch adjustment	O	
IC - 11 Automatic Boiler Control (A.B.C.)	Operational in auto mode but because CV 101 is not normally operated there are configuration that made in N - 90	- Due to unit de-rated & depressurized, MSP demand signal re-programmed to 2300 psi - MST demand signal re-programmed to 970 °F	To be put back to original program after overhauling	O	

Table 4-12 Present Conditions/Problems and Basic Countermeasures (3/5)

Malaya Unit No.1

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
IC - 12 Steam Temp. Control	Control can operate in auto mode SH Spray CV - OK RH Spray CV - by-pass	Defection valve shift	RH spray CV is to be replaced with new valve. Awaiting delivery sometime Oct '94.	O	
IC - 13 Boiler Metal Temp. Measurement	Recommended for replacement in 1994 overhauling. Many thermocouple are suspected defective.	Recorder obsolete (New one is already ordered.)	- Recorder to be replaced with hybrid type. Awaiting delivery sometime Nov '94 - Sensor - Defective ones to be replaced.	O	
IC - 14 Smoke Stack Monitoring TV.	CCTV camera not functioning	Defective camera	To be replaced with new one Awaiting delivery	O	Replacement (PR issued but not yet ordered.)
IC - 15 Soot Blow Steam Press Control	Regulator operate in auto mode	Operating pressure is not enough due to system design.	Regulator still to be overhauled.	O	Aux. steam pressure is low due to the steam supply from flush tank.
IC - 16 Flue Gas Oxygen Measurement	Inconsistent measurement	Sensor output different to portable analyzer reading	Sensor to be overhauled/cleaned & calibrated.	O	Cleaning/ calibration is needed.
IC - 17 Deaerator Level Control	Operate at remote manual	Slow response	Level controller & control valve to be calibrated.	O	Auto is only for condenser level control.

Table 4-12 Present Conditions/Problems and Basic Countermeasures (4/5)

Malaya Unit No.1

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
IC - 18 H.S.C.C. Make Up Water Level Control	Regulator unserviceable	Control valve positioner problem, beyond repair.	To be replaced with new one. For P.R. preparation	O		Positioner to be replaced.
IC - 19 Condenser Recorder	Temperature recorder - good Flow & vacuum - newly installed (OKYRA)	Limited spare parts			O	Make up flow sensor (transmitter are defective, PR are prepared and waiting for delivery.)
IC - 20 Local Gauge	Some local gauges defective & wrong indication		For calibration & replacement of defective gauges. Some gauges to be replaced		O	
IC - 21 Draft Gauge	Good condition	Other spare part is not available. Existing hose are brittle.	- Cleaning & calibration - Replacement of flexible hose		O	
IC - 22 Control Room Board Recorder	Good but obsolete	Low quality, obsolete, poor indication. No.1 Frequency recorder to be replaced. Boiler metal temp. recorder to be replaced. Equipment bearing temp. recorder, Steam temp. recorder are to be replaced in the on going O/H	Replacement with new one. Awaiting delivery of new recorder		O	All ordered. November 1994 to be delivered.

Table 4-12 Present Conditions/Problems and Basic Countermeasures (5/5)

Malaya Unit No.1

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
IC - 23 Turbine Steam Seal Control	Admission inoperable at remote leak-off valve operate at remote manual.	- No spare parts available	For study for replacement of valves.	O	To be replaced.
IC - 24 Turbine Valve Position Indicator	Erratic indication	Position indicator defective	To be replaced with new one. Awaiting delivery of newly purchased.	O	
IC - 25 Min. Flow Valve for BFP	Operated only in manual mode.	To be brought back to automatic operation. Leak at control valve	Modification of automatic control system. Control valve repacking	O	Detailed study on the modification to automatic operation should be made.
IC - 26 Hydrogen Purity Measurement	Measure inconsistently	Erratic/poor indication	To be replaced with new transmitter.	O	
IC - 27 Control Air Piping	Need re-piping	Clogging	Replacement of clogged pipe to be done this coming O.H.	O	50 ~ 70 meters length to be replaced. New air dyers are being installed.
IC - 28 Chemical Monitoring Instrument	Silica analyzer malfunctioning	No spare parts.	Chemical section preparation of part/unit	O	

Table 4-13 Present Conditions/Problems and Basic Countermeasures (1/2)

Malaya Unit No.2

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
IC - 1 Auxiliary Steam System	Operational in Auto mode Pneumatic Control System	Control Valve Leaking	Replace with new C.V.	O	
IC - 2 Fuel Oil Meter/Integrator	Integrator - Operational Main Fuel Oil Meter - Operational Return Flow Meter - Out of calibration	Reading High	For calibration at factory	O	
IC - 3 Light Oil Control	Operational in manual mode	Light oil control valve leaking through seat.	Repacking of C.V.	O	
IC - 4 FDF Air Flow Control	On automatic control	Sometimes air supply to inlet & outlet damper clogged-up & dirty (slow response)	Replace air supply filter & retubing (stainless steel)	O	
IC - 5 GRF Inlet/Outlet Damper Control	Always on manual operation	Output always going down & hunting (Inlet damper on auto mode)	Replacement of controller.	O	
IC - 6 Automatic Boiler Control (A.B.C.)	Pneumatic control system using Bailey type AD controllers. Still operable in auto mode	- Slower response and spare parts no longer available	Replacement with INFI-90 system micro processor base programmable control (but unit master only)	O	

Table 4-13 Present Conditions/Problems and Basic Countermeasures (2/2)

Malaya Unit No.2

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
IC - 7 Smoke Stack Monitoring TV.	Camera out of order (for Smoke Stack) Camera for furnace front & rear operational & in good condition	Camera is defective.	Make purchase requisition (P.R.) Replace two (2) new cameras & tubing house for cooling.		O	T.V. camera has been replaced.
IC - 8 H.S.C.C. Make Up Water Level Control	Operational in manual mode	Cannot operate in design level.	Replace level controller	O		
IC - 9 Draft Gauge	Now all in good condition	Sensing line (local) deteriorating	Replace all sensors (stainless steel)		O	Sensor: all stainless with copper tuning. (Bailey)
IC - 10 Boiler Drum Level Gauge	Hydrostep Level monitoring A-side: Leaking on 3rd port of sensor, isolated since 8/31/94. B-side: Leaking on isolating valve and flange. (water side)		Detailed inspection and replace defective packing and/or flange.	O		

4.2.4 Chemical Facilities

Present conditions, problems and countermeasures are summarized in Table 4-14 for Unit No. 1 chemical facilities and in Table 4-15 for Unit No. 2 chemical facilities.

1) Malaya Unit No. 1

Condensate polishing plant needs complete overhaul and restoration of automatic control. Use of a magnetic filter is recommended to improve feedwater quality. A magnetic filter was installed in Sucat TPP during the rehabilitation project, and provided incredible effect to remove iron during start-up.

Detailed overhaul is needed for demineralizer and pre-water treatment plant because no major overhaul has been done since installation during the rehabilitation project in 1987. Silica analyzer should be restored as soon as possible.

Raw water is supplied to the demineralizer from deep wells. Deep well water will decrease and degrade as the well is used longer. Although the demineralizer was designed for the lake water, sea water brought into Laguna Lake during draught season make it difficult to get raw water from the lake. Study and measures for stable water supply are required.

2) Malaya Unit No. 2

Sampling lack is aged and should be replaced for accuracy of water quality control.

Table 4-14 Present Conditions/Problems and Basic Countermeasures (1/2)

Malaya Unit No. 1 Chemical

Equipment	Present Condition	Problem	Basic Countermeasure	RH	OH	Remarks
CH -1 Condensate Polishing Plant			- Comprehensive overhaul should be carried out . - Recovery of automatic operation	O O		
CH - 2 Chemical Feed System	- Still in normal operating condition	- Regular maintenance and cleaning	- Regular maintenance		O	
CH -3 Sampling Rack	- Normal condition	- Regular maintenance and cleaning are necessary.	- Regular maintenance		O	
CH - 4 Magnetic Filter	- Magnetic filter is not provided in the existing system.	- Condensate polishing resin is contaminated by Fe especially during start-up.	- To study on installation of Magnetic Filter	O		
CH - 5 Pre-water Treatment Plant	- Pre-water Treatment Plant was installed during rehabilitation in 1986 and 1987. - Pre-water Treatment Plant is not used.	- Comprehensive overhaul has not been carried out since installation. - Not in service, intrusion of colloidal silica	- Comprehensive overhaul should be carried out and be put in service.	O		
CH - 6 Demineralizing Plant (Organo)	- Organo Demineralizing Plant was installed during rehabilitation project in 1986 and 1987.	- Comprehensive overhaul has not been conducted since installation, and various devices and parts have probably deteriorated. - Silica analyzer is not working	- Comprehensive overhaul should be carried out - Repair of Silica analyzer immediately	O O		

Table 4-14 Present Conditions/Problems and Basic Countermeasures (2/2)

Malaya Unit No. 1 Chemical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
CH - 7 Raw Water Supply for Demi. Plant	- Deepwells # 5, 6 & 7 supply raw water to Demi. plant - Lake water is not utilized as raw water due to high conductivity	- Deepwell water has high conductivity of 700 ~ 1000 μS, which is almost same conductivity of present lake water of 1,000 μS.	- To study on installation of stable raw water supply system, for example R. O., lake water flash evaporating system, etc.	O	
CH - 8 Chemical Laboratory	- Insufficient chemical apparatus	- Insufficient chemical apparatus	- Replenishment of chemical apparatus	O	

4.3 Rehabilitation and 5-Year Overhaul Plan

4.3.1 Outline of Project

1) Effects of Project

a. Recovery of Rated Output

The unit output will be recovered to 300 MW for Unit No. 1 and 350 MW for Unit No. 2.

b. Recovery of Plant Efficiency

The efficiency will be recovered to a 1988 value after the previous rehabilitation project.

c. Improvement of Reliability

The reliability will be improved, and the units can be operated with a higher capacity factor in 1988 after the previous rehabilitation project.

d. Service Life

Both the units will be operated until the originally scheduled retirement year, 2005 for Unit No. 1 and 2009 for Unit No. 2.

2) Scope of Works

In order to obtain the project effects mentioned above, the following major works should be carried out in addition to the comprehensive overhaul work of the power plant facilities.

Table 4-15 Present Conditions/Problems and Basic Countermeasures

Malaya Unit No. 2 Chemical

Equipment	Present Condition	Problem	Basic Countermeasure	RH OH	Remarks
CH - 1 Sampling Rack	- Existing sampling rack is deteriorated and obsolete.	- Deteriorated and obsolete sampling rack affects proper chemical monitoring and control.	- Total replacement with new complete set including chemical instrument.	O	
CH - 2 Chemical Feed System	- Still in normal position	- Regular maintenance	- Regular maintenance	O	

a. Malaya Unit No. 1

Plant Facilities	Major Work Items
Boiler	- Replacement of whole water wall tubes. - Boiler chemical cleaning - Examination of secondary superheater - Complete repair of boiler casing and gas duct - Replacement of heating elements of air pre-heater - Improvement of dust collector and ash handling system - Rehabilitation of smoke stack inner lining - Study on fuel additive injection - Installation of additional sootblower at secondary superheater section
Turbine	- Life expectancy analysis (HP-, IP- & LP-turbines, Major Valves, Main steam pipe, Reheat steam pipe) - Comprehensive overhaul of HP-turbine or replacement with higher efficiency HP turbine - Comprehensive overhaul of IP-turbine - Replacement of IP-turbine rotor - Comprehensive overhaul of LP-turbine and replacement of cut blades - Eddy current test of condenser tubes - Replacement of tube handle of LP feedwater heater or replacement of complete assembly - Replacement of condensate distributor of deaerator or replacement with spray type deaerator - Replacement of circulating water pump - Installation of additional plate type heat exchanger
Electrical Facilities	- Repair of generator stator core end - Installation of spare 4160V switchgear cubicle - Installation of spare 480 switchgear cubicle
Instrument & Control Facilities	- Replacement of boiler metal temperature recorder, etc. - Replacement of control valves and instruments - Improvement of minimum flow control of boiler feed pumps

a. Malaya Unit No. 1 (cont'd)

Plant Facilities	Major Work Items
Chemical Facilities	- Recovery of automatic operation of condensate polishing plant and comprehensive overhaul - Installation of magnetic filter - Establishment of steady raw water supply system to demineralizing plant - Replenishment of chemical apparatus for laboratory

b. Malaya Unit No. 2

Plant Facilities	Major Work Items
Boiler	- Replacement of boiler hopper tubes - Replacement of superheater spray nozzles - Replacement of feedwater stop valve at economizer inlet - Complete repair of boiler casing and gas duct - Replacement of GRF rotor - Replacement of heating elements of air pre-heater - Replacement of defective sections of steam coil air heater - Improvement of dust collector and ash handling system - Rehabilitation of smoke stack inner lining - Study on fuel additive injection - Life expectancy analysis of main steam pipe and reheat steam pipe
Turbine	- Comprehensive overhaul of HP-, IP- & LP-turbines and life expectancy analysis - Eddy current test of condenser tubes - Replacement of raw water pump for heat exchanger
Electrical Facilities	- Replacement of whole 480V motor control center and others
Instruments and Control Facilities	- Replacement of GRF damper controller - Replacement of automatic boiler control (ABC) and others
Chemical Facilities	- Replacement of whole sampling rack
Common Facilities	- Replacement of auxiliary boiler tubes and countermeasure for corrosion - Installation of concrete sheet pile at intake channel

Scope of works of the project is summarized in Table 4-16 for Malaya Unit No. 1 and Table 4-17 for Malaya Unit No. 2 and Table 4-18 for common facilities.

4.3.2 Implementation Plan

The reliability improvement plan for power generating facilities is targeted to be completed 5 years after the JICA survey. Reliability of the power plant can be improved and maintained by the generating facilities recovered to normal condition through the effective combination of rehabilitation, which includes large-scale improvement and replacement work, and regular annual overhauls before and after rehabilitation and by improvement of consolidated software including improvement of operation and maintenance methods. The project schedule is shown in Figure 4-7.

A major overhaul will be conducted in the first year after the JICA survey, and any deficiency will be identified. The main objective will be the main equipment including the boiler, turbine and generator, and auxiliary equipment. Regarding the main equipment, inspection and report by engineers from the original manufacturers should be significant. The Unit No. 1 has been operated for 20 years since commissioning, and the Unit No. 2 for 15 years. The total operation hours of each unit has already exceeded 100,000 hrs. Thus, it will be necessary to check for deterioration and diagnose the remaining service life (creep, fatigue) of the equipment sections exposed to high temperatures, pressure, or stress. If the diagnostic results of the remaining life should suggest replacement of the main equipment (turbine rotor, casing, turbine valve, main steam pipe, hot reheat pipe, etc.) during rehabilitation, early procurement should be arranged considering the delivery time and other factors. This first major overhaul will determine the contents of future annual overhauls, and rehabilitation work as well as those implementation schedule.

For the second overhaul, relatively short-term inspection and repair mainly for boilers will be conducted. Sections left uninspected during the first major overhaul and the degree of deterioration, etc. will be checked, and the results will be referred to implementing rehabilitation.

The third overhaul will be the rehabilitation. In accordance with the execution plan, the problem sections will be completely repaired or replaced, or the improvement work of the system will be carried out. From the points of view of quality, reliability and schedule of the work, it is recommended that the original manufacturers join the rehabilitation work.

One year after the completion of rehabilitation, a simplified annual overhaul will be conducted to check the sections repaired, replaced, or improved during rehabilitation. The sections, found defective yet which had not been completely rectified during rehabilitation, or those found defective after rehabilitation shall be provided with proper measures to eliminate any problems.

Two years after rehabilitation, a major overhaul will be conducted to perform an inspection for each section. The sections repaired or replaced during rehabilitation, including those given an inspection during the annual overhaul a year later will be checked. Depending on the inspection results, improvements in operating methods and the contents of the next overhaul will be studied. If the overhaul two years after rehabilitation does not fit within the time-frame of the 5-year overhaul plan, an overhaul one year after will be counted as the major overhaul and the above-mentioned detailed inspections will be performed.

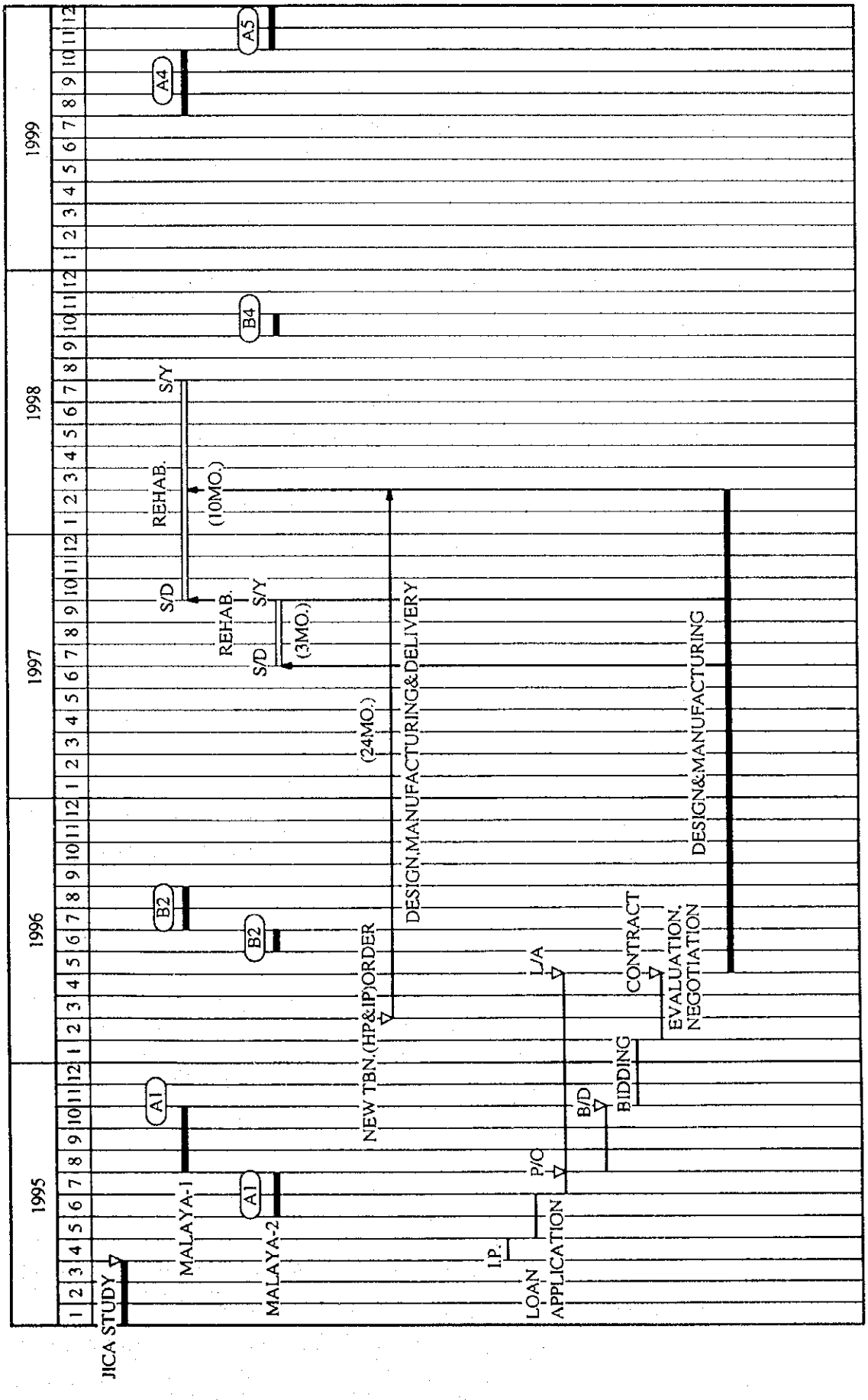
In tandem with the execution of the above-mentioned overhaul, funding, procurement/purchase procedures for equipment and materials needed for overhaul and rehabilitation, and work execution plans shall proceed.

After the completion of JICA survey, and implementation program shall be made and a loan application shall be submitted to the prospected financial agency. Immediately after a preliminary offer (P/O) is issued by the financial agency, the bidding documents shall be drawn up and preparations for the rehabilitation project and bidding shall be completed. The bidding documents shall be made based on the first overhaul results after the JICA survey.

The rehabilitation project contract will be signed in the first half of 1996. Considering the design and production periods, the rehabilitation work will be executed from sometime in the latter half of 1997 to the first half of 1998. During the overhaul following rehabilitation, the contractor's engineers who conducted the rehabilitation will carry out a fact finding inspection to ensure post-rehabilitation maintenance for the power generating facilities.

In addition, engineering services will be carried out with the assistance of a consultant in proceeding with the project .

Figure 4-7 Rehabilitation & 5-Year Overhaul Schedule



4.3.3 Project Procurement

The Project is implemented within 5 years after completion of the JICA study. The Project consists of two times of overhauls of pre-rehabilitation for determine the scope of works of rehabilitation, and overhauls of post-rehabilitation for follow-up of rehabilitation works.

The rehabilitation project is undertaken by contractor(s) with turn-key basis. The contractors are selected through bidding. The overhaul works of pre-rehabilitation and post-rehabilitation are conducted by NPC.

The cost for overhauls of pre-rehabilitation is prepared by NPC separately from Rehabilitation cost, and includes expenses for dispatch of fact finders from original manufacturers and for life expectancy analysis of major equipment. The cost for Rehabilitation and overhauls of post-rehabilitation is procured from the loan. The Japan EXIM Bank is tentatively assumed to be one of prospected fund sources for the Project in this report.

4.3.4 Project Cost and Disbursement Schedule

1) Cost Estimate

The Project cost is tentatively estimated in this report and does not include the cost for software improvement yet. The cost consists of Foreign Currency Portion and Local Currency Portion. The project cost will be expressed in US dollar at following exchange rate.

As of September 1994

US Dollar	Japanese Yen	Philippine Peso
1	100	26.3132

Source: InterBank

2) Price Escalation

The project schedule up to completion from this feasibility study is shown in sub-chapter 4.3.2 above. Since it is estimated to take 5 years from the month of cost estimate, the following price escalation is considered in the cost estimate up to the completion of the project.

	Annual Average Rate
Escalation rate for FC	3.0%
Escalation rate for LC	9.9% (As of Sep. 1994)

3) Project Cost

The total required fund for implementation of the Project is listed in Table 4-19 and the disbursement schedule is shown in Table 4-20. The estimate conditions are described below:

a. Tax and Duty

The taxes and duties on imported equipment will be exempted in the nature of the project as a national development project.

b. Consulting Fee

For preparation of tender documents, assistance in evaluation of tenders, supervision of rehabilitation works and commissioning, a consultant will be hired and the cost is included in the Project Cost.

c. Physical Contingency

The rehabilitation project like this often involves additional equipment supply and services which could not be expected in this FS or later stage at preparation of tender documents. To cope with such circumstances, a contingency of 10% to the total cost is appropriated.

Table 4-19 Project Cost

[Unit: Thousand US$]

Items	UNIT NO. 1			UNIT NO. 2			UNIT NOS. 1 & 2		
	F. C.	L. C.	TOTAL	F. C.	L. C.	TOTAL	F. C.	L. C.	TOTAL
1. Rehabilitation cost	96,134	5,161	101,295	36,817	1,977	38,794	132,951	7,138	140,098
2. Consultant fee	3,580	188	3,768	1,170	62	1,232	4,750	250	5,000
3. Total project cost	99,714	5,349	105,063	37,987	2,039	40,026	137,701	7,388	145,089

Table 4-20 Disbursement Schedule

[Unit: Thousand US$]

	1995	1996	1997	1998	1999	Total
Unit No. 1	1,815	15,746	55,316	30,373	1,814	105,063
Unit No. 2	1,586	5,862	30,464	1,057	1,067	40,026
Total	3,401	21,608	85,779	31,430	2,871	145,089

4) Fund Procurement

a. Procurement Method

The Japan EXIM Bank is assumed to be a prospected fund source for the Project in this report tentatively.

b. Loan Conditions

Source	Interest/Rate of Return	Repayment Period	Grace Period	Commit. Fee
Equity	8%			
Local Loan	NA (14% Inter Bank Rate as of July 1994)			
Exim Japan	5.8%	10 years	None	0.5%

Table 4-16 Rehabilitation Works of M-1 (1/7)

Malaya Unit No. 1 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
B - 1	Waterwall	1) Sample tube analysis 2) Total replacement of W/W 3) Boiler Chemical Cleaning	O O O			
B - 2	Sec. SH	1) Sample tube analysis 2) Tube metal temp. monitoring system	O O			
B - 3	Boiler Casing	Comprehensive repair & replacement of inner casing, insulation & outer casing	O			
B - 4	Gas Duct	Comprehensive repair & replacement of duct plates, expansion joints, dampers, insulation & outer casing	O			
B - 5	AH	1) Total replacement of heating elements (cold end, intermediate portion & hot end), seals, etc. 2) Inspection & repair of rotor 3) Comprehensive overhaul of accessories (drive unit, lub. oil system, sootblower, washing device, etc.)	O O O			
B - 6	Sootblower	Additional sootblowers at Sec. SH panel		O		
B - 7	Control Air System	1) Revision of control air piping 2) Installation of compressor house and relocation of compressors & accessories		O O		
B - 8	Ash Handling System	Improvement of ash handling system including ash reclaiming system		O		

Table 4-16 Rehabilitation Works of M-1 (2/7)

Malaya Unit No. 1 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
B - 9	Smoke Stack	Complete rehabilitation of inner lining, insulation & painting		O		
B - 10	Fuel Additive	Installation of fuel additive equipment		O		
T - 1	HP Turbine	1) Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis	O			
		2) Replacement of improved rotor & inner casing for higher efficiency & reliability or comprehensive overhaul	O			
T - 2	IP Turbine	1) Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis	O			
		2) Replacement of improved rotor & inner casing for higher efficiency & reliability or comprehensive overhaul	O			
T - 3	LP Turbine	Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis	O			
T - 4	HP Control & Stop Valve	1) Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis	O			
		2) Comprehensive overhaul	O			

Table 4-16 Rehabilitation Works of M-1 (3/7)

Malaya Unit No. 1 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
T - 5	IP Control & Stop Valve	1) Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis 2) Comprehensive overhaul	O O			
T - 6	Gland Steam Regulator	Replacement of gland steam regulator & control device	O			
T - 7	Main Condenser	Eddy current test of tubes	O			
T - 8	Aux. Condenser	Eddy current test of tubes	O			
T - 9	LP-2 FWH	Replacement of tube bundle or whole assembly	O			
T - 10	Deaerator	1) Replacement of condensate distributor or modification of deaerator to spray type 2) Improvement of heating coil & supports in feedwater tank	O O			
T - 11	BFP Turbine	1) Fact finding by original manufacturer & reporting recommendable remedies including life expectancy analysis 2) Comprehensive overhaul	O O			
T - 12	BFP Minimum Flow Valves	Modification of BFP minimum flow valve system with minimal feedwater disturbance during change over of BFP	O			

Table 4-16 Rehabilitation Works of M-1 (4/7)

Malaya Unit No. 1 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
T - 13	CWP	Replacement of CWP & motor with direct drive type	O			Bid has been awarded.
T - 14	House Service Heat Exchanger	Installation of 1 additional plate type heat exchanger with 100% capacity	O			PR process is in progress.
T - 15	Main Steam, Hot Reheat & Cold Reheat Pipes	1) Life expectancy analysis including examination on fatigue and creep damage and necessary remedy 2) Inspection, examination of supports, hangers and vibration eliminators and necessary remedy 3) Improvement of Cold Reheat pipe draining system to prevent water hammering	O O			
	Boiler & Auxiliary	Comprehensive overhaul	O			
	Turbine & Auxiliary	Comprehensive overhaul	O			

Table 4-16 Rehabilitation Works of M-1 (5/7)

Malaya Unit No. 1 Electrical

No.	Rehabilitation Item	Priority			Remarks
		1st	2nd	3rd	
E - 1	Generator rotor shaft at No. 8 bearing journal scratch	O			
E - 2	Generator stator core modification work to avoid overheating	O			
E - 3	AVR replacement	O			Brushless type exciter should be retained before the detail study of the applicability of newly installed static type exciter.
E - 4	Spare cubicle for 4,160V SWGR.		O		
E - 5	480V SWGR. spare breaker		O		One (1) set of spare shall be added.
E - 5 - (1)	Power Center transformer replacement with dry (molded) type		O		
E - 5 - (2)	480V SWGR. and MCC enclosure house		O		
E - 6	FDF 1A & 1B 4,160V motor bearing overheating repair	O			Forced recirculation of lube oil will be needed
E - 6 - (1)	RWP 1A & 1B 480V motor replacement	O			

Table 4-16 Rehabilitation Works of M-1 (6/7)

Malaya Unit No. 1 Electrical

No.	Rehabilitation Item	Priority			Remarks
		1st	2nd	3rd	
IC - 2	Fuel oil heater control valve control air line replacement	O			
IC - 8	Repair of FDF high vibration over 50% load in automatic operation	O			
IC - 12	RH spray control valve replacement	O			
IC - 15	Soot blower steam pressure control system modification	O			
IC - 18	HSCC make-up water level control valve replacement	O			
IC - 22	Control room board recorder replacement	O			10 sets
IC - 23	Turbine steam seal control replacement	O			
IC - 25	Mini. Flow Valve control for BFP	O			
IC - 26	Hydrogen purity measurement replacement	O			
IC - 27	Control air piping replacement	O			
IC - 28	Chemical monitoring instrument	O			

Table 4-16 Rehabilitation Works of M-1 (7/7)

Malaya Unit No. 1 Electrical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
CH - 1	Condensate Polishing Plant	1) Recovery of automatic operation 2) Comprehensive overhaul	O O			
CH - 2	Chemical Feed System	Comprehensive overhaul	O			
CH - 3	Sampling Rack	Comprehensive overhaul	O			
CH - 4	Magnetic Filter	Installation of Magnetic Filter	O			
CH - 5	Pre-water Treatment Plant	Comprehensive overhaul	O			
CH - 6	Demineralizing Plant (Organo)	1) Repair of Silica Analyzer 2) Comprehensive overhaul	O O			
CH - 7	Raw Water Supply to Demi. Plant	Installation of stable raw water supply system; R.O., lake water flash evaporating system or others		O		
CH - 9	Chemical Laboratory	Replenishment of chemical apparatus		O		

Table 4-17 Rehabilitation Works of M-2 (1/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
B - 1	Waterwall Hopper Tube	1) Sample tube analysis 2) Boiler Chemical Cleaning 3) Replacement of waterwall hopper tubes	O O O			
B - 2	Primary SH	1) Repair of damaged all vibration bars 2) Inspection & examination of primary SH tubes and replacement	O O			
B - 3	SH Attemperator	Replacement with new spray nozzle	O			
B - 4	Eco. FW Shut-off Valve	Replacement of valve stem	O			PR under preparation by NPC
B - 5	Boiler Casing	Comprehensive repair & replacement of inner casing, insulation & outer casing	O			
B - 6	Gas Duct	Comprehensive repair & replacement of duct plates, expansion joints, dampers, insulation & outer casing	O			
B - 7	GRF	Comprehensive overhaul and replacement of rotating internal parts	O			
B - 8	AH	1) Total replacement of heating elements (cold end, intermediate portion & hot end), seals, etc. 2) Inspection & repair of rotor 3) Comprehensive overhaul of accessories (drive unit, lub. oil system, sootblower, washing device, etc.)	O O O			

Table 4-17 Rehabilitation Works of M-2 (2/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item		Priority			Remarks
B - 9	Steam Coil Air Heater	Replacement of deteriorated bundles	O			
B - 10	Control Air System	Revision of control air piping		O		
B - 11	Ash Handling System	Improvement of ash handling system including ash reclaiming system		O		
B - 12	Smoke Stack	Complete rehabilitation of inner lining, insulation & painting		O		
B - 13	Fuel Additive	Installation of fuel additive equipment		O		
B - 14	Main Steam, Hot Reheat & Cold Reheat Pipes	1) Life expectancy analysis including examination on fatigue and creep damage and necessary remedy 2) Inspection, examination of supports, hangers and vibration eliminators and necessary remedy	O O			
T - 1	HP Turbine	Fact finding by original manufacture & reporting recommendable remedies including life expectancy analysis	O			
T - 2	IP Turbine	Fact finding by original manufacture & reporting recommendable remedies including life expectancy analysis	O			
T - 3	LP Turbine	Fact finding by original manufacture & reporting recommendable remedies including life expectancy analysis	O			

Table 4-17 Rehabilitation Works of M-2 (3/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item		Priority			Remarks
T - 4	Main Stop Valve & Control Valve	Fact finding by original manufacture & reporting recommendable remedies including life expectancy analysis	O			
T - 5	Reheat Stop Valve	Fact finding by original manufacture & reporting recommendable remedies including life expectancy analysis	O			
T - 6	Main Condenser	1) Replacement of all condenser tubes with improved material 2) Eddy current test of tubes	O O			
T - 7	Raw Water Pump	Replacement of RWP 2B with turbine pump	O			
	Boiler & Auxiliary	Comprehensive overhaul	O			
	Turbine & Auxiliary	Comprehensive overhaul	O			

Table 4-17 Rehabilitation Works of M-2 (4/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item	Priority			Remarks
		1st	2nd	3rd	
E - 1	Spare cubicle for 4,160V SWGR.		O		
E - 2	480V P/C transformer replacement with dry (molded) type.		O		
E - 3	480V MCC replacement	O			All MCC replacement

Table 4-17 Rehabilitation Works of M-2 (5/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item	Priority			Remarks
		1st	2nd	3rd	
E - 1	Modification of Disconnecting Switch to Motor operated.		O		
E - 2	Repair and Addition of Lighting System	O			

Table 4-17 Rehabilitation Works of M-2 (6/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item	Priority			Remarks
		1st	2nd	3rd	
IC - 1	Aux. steam control valve replacement	O			
IC - 5	GRF Inlet/Outlet Damper controller replacement	O			
IC - 6	ABC replacement with INFI-90 system	O			
IC - 8	HSCC make-up water level controller replacement	O			
IC - 10	Boiler drum level gauge repair	O			

Table 4-17 Rehabilitation Works of M-2 (7/7)

Malaya Unit No. 2 Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
CH - 1	Sampling Rack	Complete replacement	O			
CH - 2	Chemical Feed System	Comprehensive overhaul	O			

Table 4-18 Rehabilitation Works of Common Facilities

Malaya Common Facilities Mechanical

No.	Rehabilitation Item		Priority			Remarks
			1st	2nd	3rd	
CM - 1	Auxiliary Boiler	1) Total retubing of auxiliary boiler	O			
		2) Modification of construction of soot accumulated portion at mud drum	O			
		3) Reduction of sulfur contents in fuel or fuel conversion for auxiliary boiler	O			
CM - 2	Intake Channel	Installation of concrete pile at intake channel	O			