Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (2)

NORTHERN LUZON REGIONAL CENTER

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
AREA 3													
San Manuel 230	2,729	6.8	81SM4 82SM4/8 83SM4/8	5	ACB	230	1,200	5,000	(12.5)	3	NISSIN Elect.	1968	
San Manuel 69	602	5.0	52SM4, 54SM4	2	ACB	69	1,200	2,500	(20)	5	NISSIN Elect.	1968	
			53SM4	1	OCB	69	1,200	2,500	(20)	5	TAKAOKA	1975	
Cabanatuan 230	2,055	5.2	81CA4, 82CA4 83CA4	3	ACB	230	1,200	5,000	(12.5)	3	NISSIN Elect.	1970	
			84CA4	1	ACB	230	1,200	10,000	(25)	3	NISSIN Elect.	1975	
Cabanatuan 69	808	6.8	52CA4, 53CA4	2	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1970	
			54CA4	1	OCB	69	1,200	(2,400)	19	5	INOUE Elect.	1983	
Labrador 230	2,027	5.2	82LR4/124/8 83LR4/124/8	6	GCB	230	2,000	(13,000)	31.5	3	NISSIN Elect.	1987	
Labrador 69	412	3.4	52LR4, 55LR4 57LR4	3	OCB	69	1,200	(2,400)	19	5	INOUE Elect.	1987	
			58LR4	1	OCB	69	1,200	(2,400)	19	5	INOUE Elect.	1988	
AREA 4													
Tuguegarao 230	626	1.6	81GT124	1	GCB	230	1,200	10,000	(25)	3	MITSUBISHI	1979	
Tuguegarao 69	233	1.9	51GT4, 53GT4 54GT4, 55GT4 56GT4	5	OCB	69	600	(1,500)	12.5	5	INOUE Elect.	1980	
Santiago 230	2,164	5.4	81ST4/124/8	3	GCB	230	2,000	8,000	(20)	3	B.B.C.	1982	
			82ST4/124/8	3	GCB	230	2,000	10,000	(25)	3	FUJI Elect.	1980	
			83ST4/124/8	3	GCB	230	2,000	10,000	(25)	3	FUJI Elect.	1979	

Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (3)

NORTHERN LUZON REGIONAL CENTER

(3/7)

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
Santiago 69	306	2.6	51ST4. 54ST4 55ST4	3	OCB	69	600	(1.500)	12.5	5	TAKAOKA	1979	
			53ST4. 57ST4	2	OCB	69	600	(1.500)	12.5	5	TAKAOKA	1980	
			58ST4	1	OCB	69	600	(1.500)	12.5	5	INOUE Elect.	1979	
Bayombong 230	2.260	5.7	81BO4/124/8	3	GCB	230	1.200	10.000	(25)	3	MITSUBISHI	1980	
Bayombong 69	307	2.6	51BO4. 52BO2 53BO4. 54BO4	4	OCB	69	600	2.500	(20)	5	INOUE Elect.	1979	
			55BO4	1	OCB	69	1.200	2.500	(20)	5	INOUE Elect.	1983	
AREA 5													
Hermosa 230	8.497	21.3	81HM4/124/8 83HM8 86HM4/8 87HM4/124/8 88HM4/124/8	12	OCB	230	2.000	15.000	(37.5)	3	GOULD	1979	
			82HM4/124/8	3	GCB	230	2.000	10.000	(25)	3	NISSIN Elect.	1978	
			86HM124	1	GCB	230	2.000	10.000	(25)	3	NISSIN Elect.	1983	
Hermosa 69	433	3.6	52HM4. 53HM4 54HM4	3	OCB	69	1.200	2.500	(20)	5	NISSIN Elect.	1978	
Olongapo 230	4.743	11.9	81OL4. 82OL4 83OL4. 84OL4	4	ACB	230	1.200	5.000	(12.5)	3	NISSIN Elect.	1970	
			85OL4	1	GCB	230	1.200	(13.000)	(31.5)	3	FUJI Elect.	1980	
Olongapo 69	643	5.4	51OL4. 52OL4 53OL4	3	OCB	69	1.200	2.500	(20)	5	NISSIN Elect.	1970	
			54OL4. 55OL4	2	OCB	69	1.200	1.500	(12.5)	5	NISSIN Elect.	1972	

Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (4)

NORTHERN LUZON REGIONAL CENTER (4/7)

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
Botolan 230	4,642	11.7	82BL4/124/8	3	GCB	230	1,200	(13,000)	31.5	3	FUJI Elect.	1982	
			83BL8/124	2	GCB	230	2,000	(16,000)	40	3	NISSIN Elect.	1983	
Botolan 69	450	3.8	52BL4, 53BL4 54BL4, 55BL4	4	GCB	69	1,200	2,500	(20)	3	FUJI Elect.	1980	
AREA 6													
Concepcion 230	2,759	6.9	82CN4/124/8 83CN4	4	GCB	230	2,000	10,000	(25)	3	NISSIN Elect.	1978	
			83CN8	1	GCB	230	1,200	(13,000)	31.5	3	NISSIN Elect.	1983	
Concepcion 69	396	3.3	51CN4, 53CN4 54CN4, 55CN4	4	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1978	
Mexico 230	8,355	21.0	81MX4/124/8 82MX8/124 83MX4/124/8 84MX4/124/8	11	OCB	230	1,200	5,000	(12.5)	3	MITSUBISHI	1965/67	
			82MX4	1	OCB	230	1,200	5,000	(12.5)	3	FEDERAL PACI.	1958	
			85MX8	1	OCB	230	1,200	5,000	(12.5)	3	GOULD	1979	
Mexico 69	1,088	9.1	52MX4/124/8 53MX4	4	OCB	69	1,600	1,500	(12.5)	5	MITSUBISHI	1965	
			51MX8	1	OCB	69	1,200	2,500	(20)	5	OERLIKON	1958	
			51MX4, 54MX4 54MX8, 55MX4	4	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1968	
			51MX124 53MX124 54MX124	3	OCB	69	1,200	2,500	(20)	5	INOUE Elect.	1972	
			53MX8	1	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1978	
			56MX4	1	OCB	69	1,200	2,500	(20)	5	INOUE Elect.	1989	

Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (5)

NORTHERN LUZON REGIONAL CENTER

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
AREA 7													
San Jose 230	10,866	27.2	82SJ4/124/8 83SJ4/124/8	6	GCB	230	3,000	15,000	(37.5)	3	NISSIN Elect.	1978	
			84SJ4/124	2	GCB	230	2,000	10,000	(25)	3	NISSIN Elect.	1978	
			84SJ8 85SJ4/124/8	4	OCB	230	2,000	15,000	(37.5)	3	GOULD	1979	
San Jose 115	2,824	14.2	61SJ4/124/8 62SJ4/124 63SJ4/124/8 64SJ4/124/8 65SJ4/124/8	14	GCB	115	2,000	10,000	(50)	3	NISSIN Elect.	1978	
Dolores 230	8,950	22.5	81DL4/124/8 82DL4/124/8 83DL4/124/8 84DL4/124	11	GCB	230	3,000	15,000	(37.5)	3	FUJI Elect.	1982	
Dolores 115	7,378	37.0	63XM8/124 64XM8/124	4	OCB	115	2,000	7,500	(37.5)	3	G.E.	1972	
			62XM8	1	OCB	115	2,000	7,500	(37.5)	3	Allis-Chalm.	1977	
			62XM124	1	GCB	115	2,000	(8,000)	(40)	3	FUJI Elect.	1982	

Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (6)

SOUTHERN LUZON REGIONAL CENTER

(6/7)

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
AREA 1													
Batangas 230	3,448	8.7	81BS4/124 82BS4/124	4	GCB	230	1,200	5,000	(12.5)	3	FUJI Elect.	1978	
Batangas 69	718	6.0	51BS4, 52BS4 53BS4, 54BS4	4	ACB	69	2,000	3,500	(30)	5	B.B.C.	1976	
			56BS4, 57BS4	2	OCB	69	1,200	2,500	(20)	5	INOUE Elect.	1978	
AREA 2													
Binan 230	10,554	26.5	81BN8/124 82BN4/124	4	GCB	230	1,200	5,000	(12.5)	3	FUJI Elect.	1978	
			83BN4/124/8 84BN4/124/8 85BN4/124/8 86BN4/124/8	12	GCB	230	2,000	(13,000)	31.5	3	NISSIN Elect.	1983	
Binan 115	3,969	19.9	61BN4/124/8 62BN4/124/8	6	OCB	115	1,200	5,000	(25)	3	INOUE Elect.	1978	
			63BN4, 64BN4	2	GCB	115	2,000	(8,000)	40	3	FUJI Elect.	1982	
Gumaca 230	2,783	7.0	81GM4/124/8	3	GCB	230	2,500	(12,500)	31.5	3	MERLIN. G	1975	
			82GM8/124	2	GCB	230	2,000	10,000	(25)	3	NISSIN Elect.	1978	
Gumaca 69	317	2.7	51GM4, 52GM4 53GM4, 55GM4	4	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1975	
			54GM4	1	OCB	69	600	(1,500)	12.5	5	INOUE Elect.	1987	
			56GM4	1	OCB	69	600	(1,500)	12.5	5	INOUE Elect.	1981	
AREA 3													
Labo 230	2,604	6.5	81LB4/124/8	3	GCB	230	2,500	(12,500)	31.5	3	MERLIN G.	1977	
			82LB8/124	2	GCB	230	2,500	(12,500)	31.5	3	FUJI Elect.	1983	

Table 6-4-4 230kV SUBSTATION FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (7)

SOUTHERN LUZON REGIONAL CENTER

(7/7)

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
Labo 69	489	4.1	52LB4, 53LB4 55LB4	3	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1975	
			54LB4	1	OCB	69	600	(1,500)	12.5	5	INOUE Elect.	1983	
Naga 230	3,585	9.0	81NG4	1	GCB	230	2,500	(12,500)	31.5	3	MERLIN G.	1975	
			81NG124 82NG4/124/8	4	GCB	230	2,000	10,000	(25)	3	NISSIN Elect.	1978	
			81NG8	1	GCB	230	2,000	(12,500)	31.5	3	FUJI Elect.	1987	
			83NG4/124/8 84NG4/124/8 87NG8	7	GCB	230	3,000	(16,000)	40	3	FUJI Elect.	1987	
Naga 69	521	4.4	51NG4, 52NG4 53NG4, 54NG4 55NG4	5	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1975	
			57NG4	1	OCB	69	600	(1,500)	12.5	5	AICHI	1979	
Daraga 230	2,451	6.2	82DG4/8	2	GCB	230	1,200	(12,500)	31.5	3	FUJI Elect.	1980	
			82DG124	1	GCB	230	2,000	10,000	(25)	3	NISSIN Elect.	1978	
Daraga 69	667	5.6	52DG4	1	OCB	69	1,200	2,500	(20)	5	NISSIN Elect.	1975	
			53DG4	1	OCB	69	1,200	2,500	(20)	5	INOUE Elect.	1977	
			54DG4, 55DG4	2	GCB	69	1,200	(2,300)	19	3	W.H	1981	
			56DG4	1	OCB	69	600	(1,800)	15	5	INOUE Elect.	1981	

Table 6-4-5 HYDRO POWER PLANT TRANSFORMER TECHNICAL DATA(1)

NORTHERN LUZON REGIONAL CENTER (1/2)

Name of Power Plants	Bank Nos.	Capacity (MVA)	Rated Voltage (kV)	Connec-tions	Manufac-turer	Mfg. Date	Remarks
Magat	T1	112.5	13.8/238	D-Y	RADE KONCAR	1982	
	T2	112.5	13.8/238	D-Y	RADE KONCAR	1982	
	T3	112.5	13.8/238	D-Y	RADE KONCAR	1982	
	T4	112.5	13.8/238	D-Y	RADE KONCAR	1982	
Ambuklao	T1	32	13.2/220	D-Y	G.E	1956	
	T2	32	13.2/220	D-Y	G.E	1956	
	T3	(20)	13.0/69	D-Y	W.H	1956	Distri. Tr.
	T4	(20)	13.0/69	D-Y	W.H	1956	Distri. Tr.
Binga	T1	64	13.2/220	D-Y	ASEA	1956	
	T2	64	13.2/220	D-Y	ASEA	1956	
	T3	(30)	13.2/69	D-Y	OSAKA	1958	Distri. Tr.
Pantabangan	T1	64	13.2/230	D-Y	MITSUBISHI	1976	
	T2	64	13.2/230	D-Y	MITSUBISHI	1976	
Masiway		15	13.8/69	D-Y	MEIDENSHA	1981	
Angat	T1	122.2	13.2/115	D-Y	MITSUBISHI	1965	
	T2	122.2	13.2/115	D-Y	MITSUBISHI	1965	
	T3	22	4/115	D-Y	MITSUBISHI	1965	
	T4	12.5	13.8/115	D-Y	TRAFO UNION	1986	
	T5	(25)	34.5/115	D-Y	MITSUBISHI	1990	Distri. Tr.

Table 6-4-5 HYDRO POWER PLANT TRANSFORMER TECHNICAL DATA(2)

SOUTHERN LUZON REGIONAL CENTER (2/2)

Name of Power Plants	Bank Nos.	Capacity (MVA)	Rated Voltage (kV)	Connec-tions	Manufac-turer	Mfg. Date	Remarks
Kalyaan	T1	170	13.8/230	D-Y	INDUSTRIE	1981	
	T2	170	13.8/230	D-Y	INDUSTRIE	1981	
Caliraya	T1	22	13.2/115	D-Y	MITSUBISHI	1966	
	T2	22	13.2/115	D-Y	MITSUBISHI	1966	
	T3	50	115/69	D-Y	OSAKA	1980	
Botocan	T1	3x6.6=20	13.8/115	D-Y	PENNSYLVANIA	1927	
	T2	33.3	13.8/115	D-Y	ELIN.	1927	

Table 6-4-6 HYDRO POWER PLANT FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (1)

NORTHERN LUZON REGIONAL CENTER

(1/2)

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	Remarks
Magat 230	2,198	5.5	81MG4/124 82MG4/124/8	5	GCB	230	2,000	(8,000)	20	3	B.B.C.	1982	
Ambuklao 230	2,775	7.0	81AA8 82AA4/124/8 83AA4/124/8	7	GCB	230	1,200	10,000	(25)	3	MITSUBISHI	1979	
Binga 230	2,903	7.3	81BB4/124/8 82BB4/124/8 83BB4/8	8	OCB	230	1,200	5,000	(12.5)	3	W.H.	1958	
			80BB4, 84BB4 83BB124	3	GCB	230	1,200	15,000	(37.7)	3	FUJI Elect.	1980	
Binga 69	261	2.2	50BB4	1	OCB	69	1,200	1,500	(12.5)	8	MITSUBISHI	1967	
Pantabangan 230	1,986	5.0	82PT4, 84PT4	2	GCB	230	1,200	10,000	(25)	3	NISSIN Elect.	1976	
			81PT4, 83PT4	2	GCB	230	1,200	(15,000)	37.5	3	NISSIN Elect.	1983	
Nasiway 69	175	1.5	51MY4	1	OCB	69	200	1,500	(12.5)	5	NISSIN Elect.	1979	
Angat 115	2,344	11.8	61AG4/124/8 62AG4/124/8 63AG4/124/8 65AG4	10	ABB	115	1,200	3,500	(17.6)	5	NISSIN Elect.	1964	
			64AG4	1	GCB	115	1,600	3,500	(17.6)	5	Siemens	1984	

Table 6-4-6 HYDRO POWER PLANT FAULT LEVELS AND TECHNICAL DATA OF CIRCUIT BREAKERS (2)

SOUTHERN LUZON REGIONAL CENTER

Substation Bus	Fault Level in 1995 (MVA/kA)		Breaker Nos.	Units	Type	Rated Voltage (kV)	Rated Current (A)	Rated Int. Capacity (MVA/kA)		Int. Time (Cy's)	Manufacturer	Mfg. Date	
Kalayaan 230	11,551	30.0	81KN4/124/8 82KN4/8 83KN4/124/8 84KN4/124/8 85KN4/8 86KN4/124/8	16	GCB	245	2,000	(17,000)	40	-	MAGRINI G.	1980	
			87KN4/124/8	3	GCB	230	3,000	(17,000)	40	3	FUJI Elect.	1982	
Caliraya 115	741	3.7	63CL4	1	OCB	115	800	1,500	(7.5)	-	PACIFIC E.	1948	
Caliraya 69	257	2.2	51CL4 52CL4	2	OCB	69	1,200	2,500	(20)	5	INOUE Elect.	1983	
Botocan 115	510	2.6	61D4 62D4 64D4	3	OCB	115	1,200	3,500	(17.6)	-	MITSUBISHI	1965	

Table 6-4-7 TRANSMISSION LINE FAULT RECORDS IN 1990 (1)

(230kV)

Transmission Lines	No. of Circuit	Circuit Length (km) A	Frequency B	Duration (hours) C	B/A×100	C/B
Ambuklao-Bayombong	1	62.34	3	123.00	4.8	41.0
Ambuklao-Binga	2	17.62	3	312.80	17.0	104.3
Ambuklao-Santiago	1	105.01	20	159.60	19.0	8.0
Balintawak-Mexico	1	55.03	1	1.10	1.8	1.1
Balintawak-San Jose	1	30.18	2	0.40	6.6	0.2
Batangas-Makban	2	70.24	1	100.80	1.4	100.8
Bauang-La Trinidad	2	71.76	2	97.70	2.8	48.9
Bauang-San Esteban	1	95.17	1	49.10	1.0	49.1
Bayombong-Santiago	1	42.68	5	86.50	11.7	17.3
Binan-Calaca	2	122.94	5	2.00	4.1	0.4
Binan-Makban	2	65.48	6	39.40	9.2	6.6
Binga-La trinidad	2	23.92	5	331.40	20.9	66.3
Binga-San Manuel	2	68.60	17	316.50	24.8	18.6
BTPP-Hermosa	1	37.19	3	34.60	8.1	11.5
BTPP-PNPP	1	40.03	2	11.40	5.0	5.7
Cabanatuan-Mexico	1	67.31	2	1.40	3.0	0.7
Cabanatuan-Pantabangan	1	52.47	8	38.40	15.2	4.8
Concepcion-Mexico	1	37.42	3	6.70	8.0	2.2
Concepcion-San Manuel	1	79.66	11	307.70	13.8	28.2
Dolores-Malaya	2	78.00	2	0.20	2.6	0.1
Dolores-San Jose	2	76.68	2	0.20	2.6	0.1
Gumaca-Kalayaan	2	188.22	15	79.40	8.0	5.3
Gumaca-Labo	2	177.92	3	760.50	1.7	253.5
Hermosa-Mexico	2	75.30	6	4.60	8.0	0.8
Hermosa-PNPP	1	27.19	2	1.70	7.4	0.9
Hermosa-San Jose	2	149.96	3	40.90	2.0	13.6
Kalayaan-Makban	2	83.80	9	17.60	10.7	2.0
Kalayaan-Malaya	2	57.74	3	1.60	5.2	0.5
Labo-Naga	2	198.18	7	134.50	3.5	19.2
Magat-Santiago	2	30.74	6	219.10	19.5	36.5
Mexico-San Jose	1	54.04	2	20.70	3.7	10.4
Naga-Tiwi	2	118.60	4	269.50	3.4	67.4
Pantabngan-San Manuel	1	66.22	4	13.10	6.0	3.3
Santiago-Tuguegarao	1	116.29	3	0.40	2.6	0.1
Others		396.36	—	—		
TOTAL		3,040.29	171	3,584.50	5.6	21.0

Table 6-4-7 TRANSMISSION LINE FAULT RECORDS IN 1990 (2)

(115kV)

Transmission Lines	No. of Circuit	Circuit Length (km) A	Frequency B	Duration (hours) C	B/A×100	C/B
1. STEEL TOWER						
Angat-San Jose	2	34.78	3	0.5	8.6	0.2
Balintawak-San Jose	2	59.64	1	3.3	1.7	3.3
Binan-Sucat	2	30.98	4	6.5	12.9	1.6
Binan-Dasmarinas	2	28.92	—	—		
Sub-Total		154.32	8	10.3	5.2	1.3
2. WOODEN POLE						
Angat-San Jose	1	16.00	12	153.1	75.0	12.8
Laoag-San Esteban	1	120.87	24	150.7	19.9	6.3
Dasmarinas-Tagaytay	1	24.80	1	0.3	4.0	0.3
Dasmarinas-Ternate	1	26.15	2	5.2	7.6	2.6
Novaliches-San Jose	1	13.50	3	2.7	22.2	0.9
Sub-Total		201.32	42	312.0	20.9	7.4
3. 115kV TOTAL		355.64	50	322.3	14.1	6.4

Table 6-4-7 TRANSMISSION LINE FAULT RECORDS IN 1990 (3)

(69kV)

Regional Centers	Area Offices	Circuit Length (km) A	Frequency B	Duration (hours) C	B/A×100	C/B
NLRC	Area 1	182.57	49	38.00	26.8	0.78
	Area 2	354.94	224	1,334.74	63.1	5.96
	Area 3	397.29	145	849.18	36.5	5.86
	Area 4	443.54	396	7,401.39	89.3	18.69
	Area 5	272.10	158	266.86	58.1	1.69
	Area 6	269.65	94	374.61	34.9	3.99
	Area 7	65.00	12	114.80	18.5	9.57
SLRC	Area 1	—	NA	NA	—	—
	Area 2	261.38	157	417.08	60.1	2.66
	Area 3	467.94	352	350.16	75.2	0.99
Total		2,714.41	1,587	11,146.82	58.5	7.02

Table 6-4-7 SUBSTATION / SWITCHYARD FAULT RECORDS IN 1990 (4)

(230kV & 115kV)

Equipment		Frequency	Duration (hours)	
Ambuklao	52MVA	2	68.10	
Bayombong	40MVA	2	21.30	
Binan	300MVA (T3)	3	19.90	
Binan	300MVA (T4)	4	7.90	
Binga	30MVA	1	53.20	
Botolan	50MVA	1	44.70	
Cabanatuan	50MVA	1	0.90	
Concepcion	50MVA	3	0.70	
Hermosa	50MVA	1	0.40	
Kalayaan	230kV Bus	1	0.40	
Mexico	100MVA (T1)	1	0.60	
Mexico	100MVA (T2)	1	0.60	
Mexico	50MVA	1	0.60	
PNPP	50MVA	1	0.50	
San Jose	300MVA	1	0.80	
Santiago	40MVA	2	3.20	

Table 6-4-7 TRANSMISSION LINE FAULT RECORDS IN 1990 (5)

(69kV)

Transmission Line	Frequency B	Outage Duration (Hours)	Causes	Damaged Facilities							Circuit Length (km) A	B/A×100
				Wood Pole	Cross Arm	X Brace	Insulator	Conductor				
Tuguegarao-Camalaniugan	58	4.96	Transient									
	11	89.39	Row Obstruction									
	12	248.34	Grass Fire	11	3							
	13	215.32	Broken	6	7							
	6	693.71	Typhoon	279	5	11						
	3	28.80	Flashover				16					
	103	1,280.52		296	15	11	16				78.25	131.6
Camalaniugan-Sta Ana	23	1.61	Transient									
	7	65.45	Row Obstruction									
	3	67.80	Grass Fire	3								
	3	55.97	Broken	2	1							
	8	2,586.84	Typhoon	310	11	17						
	2	32.06	Flashover				10					
	46	2,809.73		315	12	17	10				53.29	86.3
Magapit-Lucban	38	3.23	Transient									
	23	192.07	Row Obstruction									
	11	204.80	Grass Fire	9	4							
	12	188.54	Broken	7	5							
	6	1,003.36	Typhoon	136	8							
	4	31.76	Flashover				21					
	94	1,623.76		152	17		21				44.72	210.2

Table 6-4-7 TRANSMISSION LINE FAULT RECORDS IN 1990 (6)
(69kV)

Transmission Line	Frequency B	Outage Duration (Hours)	Causes	Damaged Facilities							Circuit Length (km) A	B/A×100
				Wood Pole	Cross Arm	X Brace	Insulator	Conductor				
Tuguegarao-Solana-Piat	17	1.02	Transient									
	5	28.43	Row Obstruction									
	3	37.78	Grass Fire	3								
	3	20.94	Broken	2	1							
	4	296.71	Typhoon	45								
	9	718.58	River Flood					9				
	3	19.35	Flashover				15					
	44	1,122.81		50	1		15	9			37.51	117.3
Solana-Tabuk	37	2.52	Transient									
	6	26.76	Row Obstruction									
	8	100.29	Grass Fire	8	2							
	3	37.59	Broken	3								
	5	234.74	Typhoon	54	2							
	1	8.75	Flashover				5					
	60	410.65		65	4		5				46.14	130.0
Cagayan Total	173	13.34	Transient									
	52	402.10	Row Obstruction									
	37	659.01	Grass Fire	34	9							
	34	518.36	Broken	20	14							
	29	4,815.36	Typhoon	824	26	28						
	9	718.58	River Flood					9				
	13	120.72	Flashover				67					
	347	7,247.47		878	49	28	67	9			259.91	133.5

Table 6-4-8 TRANSMISSION LINE DEVELOPMENT PROGRAM (1)

Voltage (kV)	Comm Year	Section	Structure	Length (km)	Conductor (MCM)	Financing Source	Description
500	1992	San Jose-Kalayaan	ST-DC	80.0	4-795	OECF	EHVS Stage II
	1993	Naga-Kalayaan	ST-DC	245.0	4-795	None	Rehabilitation
	2000	San Jose-Munoz	ST-DC	120.0	4-795	〃	EHVN Stage I
		Coal B-Munoz	ST-DC	120.0	4-795	〃	Coal B Asso.
	2002	Coal D cut-in to Naga-Kalayaan	ST-DC	15.0	4-795	〃	Coal D Asso.
	2003	Mexico cut-in to Munoz-San Jose	ST-DC	48.0	4-795	〃	Coal E Asso.
	2004	Coal F-Coal D	ST-DC	15.0	4-795	〃	Coal F Asso.
		Coal F-Binan	ST-DC	88.0	4-795	〃	
		Circuit Length Total		1,462.0			
D C ±350	1997	Tongonan-Naga Overhead	ST-DC	406.0		None	Tongonan Geo Asso.
		〃 Submarine Cable	ST-DC	23.0		〃	
		Circuit Length Total		858.0			
230	1992	Manito-Daraga	ST-DC	32.0	1-795	IBRD	Bacman I Asso.
	1993	Botong-Bacman I	ST-DC	6.0	1-795	〃	Bacman II Asso.
		Cauayan cut-in to Botong-Bacman I	ST-DC	3.0	1-795	〃	
		Limay-Hermosa	ST-DC	38.0	2-795	Bid with Financing	Combined Cycle Asso.
		Mexico-Asia Pacific	ST-DC/1	8.5	1-795	None	
	1994	Sucat-Araneta-Balintawak	SP-SC	34.0	2-795	KFW	
		Calaca-Dasmarinas	ST-DC	57.0	2-795	OECF	Calaca II Asso.
		Dasmarinas-Zapote	ST-DC	10.0	2-795	None	
		〃	SP-DC	11.0	2-795	〃	
		Balintawak-San Jose	ST-DC	21.0	4-795	IBRD	

Table 6-4-8 TRANSMISSION LINE DEVELOPMENT PROGRAM (2)

Voltage (kV)	Comm Year	Section	Structure	Length (km)	Conductor (MCM)	Financing Source	Description
230	1995	Del Gallego-Labo	ST-DC	20.0	1-795	None	Del Gallego GEO Asso.
		Masinloc-Botolan	ST-DC	38.0	2-795	〃	Masinloc Coal Asso.
		Botolan-Hermosa	ST-DC	91.0	2-795	〃	
		Hermosa-Mexico	ST-DC	41.0	2-795	〃	
		Mexico-san Jose	ST-DC	46.0	2-795	〃	
		Pagbilao-Kalayaan	ST-DC	60.0	4-795	〃	Hopewel BOT Asso.
		Kalayaan-Binan	ST-DC	73.0	4-795	〃	
	1996	Bulusan-Bacman I	ST-SC	53.0	1-795	〃	Bulusan GEO Asso.
	1997	Binan-Dasmarinas	ST-DC	15.0	4-795	〃	Hopewell II BOT Asso.
	1999	Sual-Labrador	ST-DC	11.0	2-795	〃	Coal A Asso.
		Labrador-Botolan	ST-SC	74.0	1-795	〃	
		Botolan-Olongapo	ST-SC	77.0	1-795	〃	
	2000	Casecnan-Munoz	ST-DC	27.0	1-795	〃	Casecnan Asso.
	2001	San Manuel-Munoz	ST-DC/1	60.0	1-795	〃	Uprating of EHVN Asso.
		Circuit Length Total		1,506.5			
138	1993	P.Princesa-Narra	WP-SC	95.0	1-336.4	IBRD	Palawan Island
		Narra-Brooke's PT	WP-SC	102.0	1-336.4	〃	
		Circuit Length Total		197.0			
115	1993	San Esteban-Bantay-Laoag	WP-SC	121.0	1-795	IBRD	
	1994	Dasmarinas-Rosario	ST-DC	15.0	1-795	None	
		Circuit Length Total		151.0			

Table 6-4-8 TRANSMISSION LINE DEVELOPMENT PROGRAM (3)

Voltage (kV)	Comm Year	Section	Structure	Length (km)	Conductor (MCM)	Financing Source	Description
	1992	Bantay-S.Domingo	WP-SC	20.0	1-336.4	ADB	
		Cabaruguis-Casiguran	WP-SC	50.0	1-336.4	〃	
		Tabuk-Lubuagan	WP-SC	45.0	1-336.4	〃	
		Gamu Tap-San Maria	WP-SC	25.0	1-336.4	〃	
		Concepcion-Tarlac Ind. Center	WP-SC	20.0	1-336.4	None	
		La Union-Poro	WP-SC	4.0	1-336.4	〃	
		Cauayan-Ind. Center	WP-SC	1.0	1-336.4	〃	
		Legaspi Tap-Ind. Center	WP-SC	4.0	1-336.4	〃	
		Sta Ana(Tap)-Cagayan Ind. Center	WP-SC	8.0	1-336.4	〃	
		Mamburao-Calapan	WP-SC	86.0	1-336.4	IBRD	
		Calapan-Bansud	WP-SC	64.0	1-336.4	〃	Mindoro Island
69	1993	Bansud-San Jose	WP-SC	107.0	1-336.4	〃	
		P.Princesa-Taytay	WP-SC	170.0	1-336.4	〃	Palawan Island
		Virac-Viga	WP-SC	30.0	1-336.4	〃	Catanduanes Island
		Virac-San Sndres	WP-SC	22.0	1-336.4	〃	
		Masbate-Cataingan	WP-SC	54.0	1-336.4	〃	
		Masbate-Sn Juan	WP-SC	34.0	1-336.4	〃	Masbate Island
		Masbate-Aroroy	WP-SC	28.0	1-336.4	〃	
		Marcopper-BOAC	WP-SC	23.0	1-336.4	〃	Marinduque Island
		Marcopper-Torrijos	WP-SC	34.0	1-336.4	〃	
		Mabalacat-Angeres	WP-SC	10.0	1-336.4	〃	
		Mabalacat-Dau	WP-SC	8.0	1-336.4	〃	
		Maibarara-Makban A	WP-SC	11.0	1-336.4	〃	Maibarara GEO Asso.
		Maibarara-Calamba	WP-SC	5.0	1-336.4	〃	

Table 6-4-8 TRANSMISSION LINE DEVELOPMENT PROGRAM (4)

Voltage (kV)	Comm Year	Section	Structure	Length (km)	Conductor (MCM)	Financing Source	Description
69	1993	Bulalo 2-Makban A	WP-SC	4.5	1-336.4	None	Makban Binary GEO Asso.
		Bulalo67-Makban A	WP-SC	1.5	1-336.4	〃	
	1994	Cabanatuan-Sn Isidro	WP-SC	16.0	1-336.4	〃	
		Cabanatuan-Talavera	WP-SC	16.0	1-336.4	〃	
		Balayan-Calatacan	WP-SC	22.0	1-336.4	〃	
		Tuguegarao-Cabagan	WP-SC	25.0	1-336.4	〃	
		Santiago-Cauayan (Second Circuit)	WP-SC	73.0	1-336.4	〃	
	2000	Luzon-Marinduque	WP-SC	36.0	1-336.4	〃	
		Sub Cable		24.0	4-195SQMM	〃	
		Luzon-Masbate	WP-SC	27.0	1-336.4	〃	
		Sub Cable		42.0	4-195SQMM	〃	Island Interconnection
		Luzon-Catanduanes	WP-SC	81.0	1-336.4	〃	
		Sub Cable		12.0	4-195SQMM	〃	
		Luzon-Mindoro	WP-SC	23.0	1-336.4	〃	
		Sub Cable		18.0	4-300SQMM	〃	
		Masiway-Munoz	WP-SC	16.0	1-336.4	〃	Casecnan Asso.
	Circuit Length Total			1,300.0			

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (1)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Breaker					Financing Source	Description
			kV	MVA	500kV	230kV	115kV	69kV	MV		
500	1997	Naga	500/230	3 - 600	8					None	Uprating of EHVS
		Kalayaan	500/230	600	8					〃	
		San Jose	500/230	3 - 600	8					〃	
	2001	Sual	500/230	2 - 600	4	4				〃	Coal C Asso.
		Munoz			4					〃	
		Munoz	500/230	2 - 600	6					〃	Uprating of EHVN
		San Jose	500/230	2 - 600	6					〃	
	2002	Coal D			3					〃	Coal D Asso.
		Kalayaan	500/230	600	2	2				〃	
	2003	Mexico	500/230	600	8	2				〃	Coal E Asso.
	2004	Coal F			2					〃	Coal F Asso.
		Binan	500/230	2 - 600	6	4				〃	
	2005	Binan	500/230	600	2	2				〃	Coal G Asso.
		Total		10,800	67	14					
D C ±350	1997	Tongonan								None	Converter Station
		Naga								〃	

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (2)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Breaker					Financing Source	Description
			kV	MVA	500kV	230kV	115kV	69kV	MV		
230	1992	Mexico				(12)				ADB	Luzon Trans Rehab.
		San Manuel				8				〃	
		Solano				2				〃	
		Daraga				5				IBRD	Bac-Man I Asso.
	1993	Hermosa				4				Bid With Financing	Combined Cycle Asso.
	1994	Balintawak				2				KFW	Sucat-Araneta-Balintwake Proj.
		Araneta	230/115	3 - 300						〃	
		Sucat	230/115	3 - 300		9	9			〃	
		Dasmarinas				6				OECF	Calaca II Asso.
		Zapote	230/115	(2 - 230)		6	4			None	Tr from Binan
		Balintawak				3				IBRD	Balintawak-San Jose T/L
		San Jose				4				〃	
		Olongapo	230/ 69	50→100		1		3		〃	
		Dasmarinas	230/115	2 - 100		6				〃	Dasmarinas S/S Uprating
		Binan				3				〃	
		Mabalacat	230/ 69	100		5		5		〃	
		San Manuel	230/ 69	50		2		3		〃	
		Concepcion	230/ 69	50		2		3		〃	
		San Esteban	230/115	100		2	2			〃	
		Binan	230/115	100→300		6	6			〃	
		Bauang	230/ 69	50		2		3		〃	
		Dolores	230/115	300		2	3				
		Naga	230/69/138	50		2		3			

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (3)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Breaker					Financing Source	Description
			kV	MVA	500kV	230kV	115kV	60kV	MV		
230	1994	Batangas	230/69/138	100		2		3		IBRD	
		Mexico								None	230kV 4-50MVA Capacitors
		Cruz-Na-Daan	230/ 69	100		2		3		〃	
		Daraga	230/ 69	50		2		3		〃	
		Santiago	230/ 69	50		2		3		〃	
	1995	Del Gallego				6				〃	Del Gallegeo Geo Asso.
		Botolan				8				〃	Masinloc Coal Asso.
		Hermosa				6				〃	
		Mexico				8				〃	
		San Jose				4				〃	
		Kalayaan				6				〃	Hopewell I BOT Asso.
		Binan				4				〃	
	1996	Bacman I				2				〃	Bulusan GEO Asso.
		Dasmarinas	230/115	300		2	2			〃	
	1997	Binan				2				〃	Hopewell II BOT Asso.
		Dasmarinas				4				〃	
		Mabalacat	230/ 69	100		2		3		〃	
		San Manuel	230/ 69	50		2		3		〃	
	1998	La Trinidad	230/ 69	100		2		3		〃	
		Concepcion	230/ 69	50→100		2		3		〃	
		Hermosa	230/ 69	50		2		3		〃	
	1999	Mexico	230/ 69	100		2		3		〃	

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (4)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Bbreaker					Financing Source	Description
			kV	MVA	500KV	230kV	115kV	69kV	MV		
230	1999	Batangas	230/ 69	50→100		2		3		None	
		Cabanatuan	230/ 69	50		2		3		〃	
		Labrador				5				〃	Coal A Asso.
		Botolan				3				〃	
		Olongapo				2				〃	
	2000	Batangas	230/ 69	50		2		1		〃	
		Munoz				3				〃	EHVN Stage I
		San Jose	230/115	300		3	1			〃	
		Munoz	230/ 69	50		11		5		〃	Casecnan Asso.
		Munoz				3				〃	Coal B Asso.
	2001	Bataan	230/ 69	50		2		3		〃	
	2002	Olongapo	230/ 69	50→100		2		3		〃	
		Makban	230/ 69	50		2		3		〃	
		Tuguegarao	230/ 69	50		2		3		〃	
	2003	Botolan	230/ 69	50		2		3		〃	
		Labrador	230/ 69	50		2		3		〃	
	2004	Mexico	230/ 69	100→300		2		3		〃	
		Total		5,000		204	27	83			

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (5)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Bbreaker					Financing Source	Description
			kV	MVA	500KV	230kV	115kV	69kV	MV		
115	1993	San Esteban					1			IBRD	Ilocos T/L Proj.
		Laoag					1			〃	
		Bantay	115/ 69	20			4	2		〃	
	1994	San Jose	115/34.5	50					2	〃	Balintawak-San Jose T/L
		Rosario	115/34.5	50			3		4	None	
		Dasmarinas					3			〃	
		Laoag	115/ 69	20			1	3		〃	
	1998	San Jose	115/34.5	50			2		2	〃	
	1999	San Esteban	115/ 69	20			1	3		〃	
	2003	Dasmarinas	115/34.5	50			2		3	〃	
		Total		260			18	7	11		

Table 6-4-9 SUBSTATION DEVELOPMENT PROGRAM (6)

Voltage (kV)	Comm Year	Substation	Transformer		Circuit Bbreaker					Financing Source	Description
			kV	MVA	500KV	230kV	115kV	69kV	MV		
69	1993	Calapan	69/13.8	10				3	1	IBRD	Mindoro Island
		San Jose	69/13.8	10				1	1	〃	
		Mamburao	69/13.8	5				1	1	〃	
		Bansud	69/13.8	10				3	1	〃	
		P.Princesa	69/13.8	20				1	1	〃	Palawan Island
		Narra	69/13.8	5				1	1	〃	
		Brooke's PT.	69/13.8	5				1	1	〃	
		Roxas	69/13.8	5				1	1	〃	
		Taytay	69/13.8	5				1	1	〃	
		Virac	69/13.8	5				3	1	〃	Catanduanes Island
		Masbate	69/13.8	5				3	1	〃	Masbate Island
		Marcopper	69/13.8	5				3	1	〃	Marinduque Island
		Makban A						1		〃	Maibarara GEO Asso.
		Calamba						1		〃	
		Makban A						2		None	Makban Binary GEO Asso.
	1994	Cruz-Na-Daan								〃	69kV 5MVAR Switched Cap.
	Total			90				26	12		

Table 6-4-10 TOWERIZATION PLAN OF TRANSMISSION LINE

Regional Center	Area Office	Transmission Line	River Crossing	Main Road Crossing	Others	Remarks
NLRC	Area 3	San Manuel - Bayambang	1			Agno River
		San Manuel - Binga			1	230kV
	Area 4	Santiago - Cauayan	1			#258-259
		Cauayan - Ilagan	1			#612-613
		Tap Gamu - Roxas	1			#237-238
		Tuguegarao - Solano - Tabuk	1			#84-85
	Area 5	Botolan - Castillejos	2			#394-395, #398-399
	Area 6	Mexico - Bataan	3	1		Pasig-Potrero River Gumain River, Valdez River
		Mexico - Angeles	1	1		Abacan River
		Mexico - Apalit	1	1		Pampanga River
		Mexico - CND	1			Pampanga River
		Mexico - CIGI		1		
SLRC	AREA 3	Naga - Pili	4	1		#12-13, #17-18, #30-31, #33-34 #1-2
		Pili - Iriga	1	1		#50-51, #47-48
		Naga - Tinambac	1	1		#154-155, #156-157
		Naga - Capucnasan - Libmanan	1	2		Minalabac River #83-84-85
Total			20	9	1	

Table 6-4-11 REPLACEMENT PLAN OF 230kV SUBSTATION CIRCUIT BREAKERS (1)

Name of Substation		System Voltage (kV)	Number of Existing Circut Breakers				Number of Breakers to be Replaced by GCB			
			GCB	OCB	ACB	Total	GCB	OCB	ACB	Total
(NLRC)										
AREA-1	Bauang	230	7	-	3	10	-	-	3	3
		115	-	-	1	1	-	-	-	-
		69	-	5	-	5	-	-	-	-
	San Esteban	230	5	-	-	5	-	-	-	-
		115	1	-	2	3	-	-	2	2
		69	-	-	3	3	-	-	-	-
AREA-2	La Trinidad	230	9	-	-	9	-	-	-	-
		69	-	8	-	8	-	2	-	2
AREA-3	San Manuel	230	-	-	(5)	5	-	-	-	-
		69	-	1	2	3	-	1	2	3
	Cabanatuan	230	-	-	(2)+2	4	-	-	2	2
		69	-	3	-	3	-	-	-	-
	Labrador	230	6	-	-	6	-	-	-	-
		69	-	4	-	4	-	-	-	-
AREA-4	Tuguegarao	230	1	-	-	1	-	-	-	-
		69	-	5	-	5	-	-	-	-
	Santiago	230	9	-	-	9	-	-	-	-
		69	-	6	-	6	-	-	-	-
	Bayombong	230	3	-	-	3	-	-	-	-
		69	-	5	-	5	-	-	-	-
AREA-5	Hermosa	230	4	12	-	16	-	12	-	12
		69	-	3	-	3	-	-	-	-
	Olongapo	230	1	-	4	5	-	-	4	4
		69	-	5	-	5	-	5	-	5
	Botolan	230	5	-	-	5	-	-	-	-
		69	4	-	-	4	-	-	-	-
AREA-6	Concepcion	230	5	-	-	5	-	-	-	-
		69	-	4	-	4	-	-	-	-
	Mexico	230	-	(13)	-	13	-	-	-	-
		69	-	14	-	14	-	9	-	9

[Note] 1. ( ) Shows Number of Breakers Under Replacement by GCB

2. * Shows Insufficient Breaking Capacity

Table 6-4-11 REPLACEMENT PLAN OF 230kV SUBSTATION CIRCUIT BREAKERS (2)

Name of Substation		System Voltage (kV)	Number of Existing Circut Breakers				Number of Breakers to be Replaced by GCB			
			GCB	OCB	ACB	Total	GCB	OCB	ACB	Total
AREA-7	San Jose	230	8	4	-	12	*2	4	-	6
		115	14	-	-	14	-	-	-	-
	Dolores	230	11	-	-	11	-	-	-	-
		115	1	5	-	6	-	*5	-	5
NLRC Total		230	74	29	16	119	2	16	9	27
		115	16	5	3	24	-	5	2	7
		69	4	63	5	72	-	17	2	19
		Total	94	97	24	215	2	38	13	53
(SLRC)										
AREA-1	Batangas	230	4	-	-	4	-	-	-	-
		69	-	2	4	6	-	-	-	-
AREA-2	Binan	230	16	-	-	16	*4	-	-	4
		115	2	6	-	8	-	-	-	-
	Gumaca	230	5	-	-	5	3	-	-	3
		69	-	6	-	6	-	1	-	1
AREA-3	Labo	230	5	-	-	5	-	-	-	-
		69	-	4	-	4	-	-	-	-
	Naga	230	13	-		13	1	-	-	1
		69	-	6	-	6	-	-	-	-
	Daraga	230	3	-	-	3	-	-	-	-
		69	2	3	-	5	-	-	-	-
SLRC Total		230	46	-	-	46	8	-	-	8
		115	2	6	-	8	-	-	-	-
		69	2	21	4	27	-	1	-	1
		Total	50	27	4	81	8	1	-	9
TOTAL		230	120	29	16	165	10	16	9	35
		115	18	11	3	32	-	5	2	7
		69	6	84	9	99	-	18	2	20
		Total	144	124	28	296	10	39	13	62

[Note] 1. ( ) Shows Number of Breakers Under Replacement by GCB

2. * Shows Insufficient Breaking Capacity

Table 6-4-12 REPLACEMENT PLAN OF HYDRO POWER CIRCUIT BREAKERS

Name of HEP	System Voltage (kV)	Number of Existing Circut Breakers				Number of Breakers to be Replaced by GCB			
		GCB	OCB	ACB	Total	GCB	OCB	ACB	Total
(NLRC)									
Magat	230	5	-	-	5	-	-	-	-
Ambuklao	230	7	-	-	7	-	-	-	-
Binga	230	3	8	-	11	-	8	-	8
"	69	-	1	-	1	-	-	-	-
Pantabangan	230	4	-	-	4	-	-	-	-
Masiway	69	-	1	-	1	-	-	-	-
Angat	115	1	-	10	11	-	-	10	10
NLRC Total	230	19	8	-	27	-	8	-	8
	115	1	-	10	11	-	-	10	10
	69	-	2	-	2	-	-	-	-
	Total	20	10	10	40	-	8	10	18
(SLRC)									
Kalayaan	230	19	-	-	19	-	-	-	-
Caliraya	115	-	1	-	1	-	1	-	1
"	69	-	2	-	2	-	-	-	-
Botocan	115	-	3	-	3	-	-	-	-
Barit		-	-	-	-	-	-	-	-
Cawayan		-	-	-	-	-	-	-	-
SLRC Total	230	19	-	-	19	-	-	-	-
	115	-	4	-	4	-	1	-	1
	69	-	2	-	2	-	-	-	-
	Total	19	6	-	25	-	1	-	1
TOTAL	230	38	8	-	46	-	8	-	8
	115	1	4	10	15	-	1	10	11
	69	-	4	-	4	-	-	-	-
	Total	39	16	10	65	-	9	10	19

CHAPTER 7

OPERATION/MAINTENANCE IMPROVEMENT PLAN

CHAPTER 7 OPERATION/MAINTENANCE IMPROVEMENT PLAN

7.1 General

7.1.1 Present Status and Problems

1. Significance of Operation/maintenance Improvement Plan

In this study, Operation/Maintenance Improvement was taken up as the main theme. This is based on the following reasons and recognition.

(1) After the implementation of the Rehabilitation/Renovation and maintenance works, the effect would not last long if the operation and maintenance management is inadequate and the effect of the investment would not be satisfactorily achieved. In other words, it is necessary to improve the efficiency of maintenance.

(2) The sections in charge of operation and maintenance carry out the most important works supporting the reliability and efficiency of electric power supply, even though their works are not conspicuous. The work efforts of these sections should be esteemed, and their challenge to improvement of their works should be encouraged and assisted.

In view of the above, the Task Force and the parties concerned were requested to participate in this study with zeal, and tackle the study of the improvement plans earnestly.

This study was carried out with full cooperation of NAPOCOR, and the results were made clues for the proposal of the improvement plans. The continued effort of the Task Force and the parties concerned will make the improvements more meaningful.

2. Present Status and Problems

The present status of the electric power facilities in the Luzon Grid is symbolized by the following two phenomena.

- Low reliability of power supply
  - Frequent brownouts and forced outages

- Low quality of power supply
  - Low voltage and unstable frequency

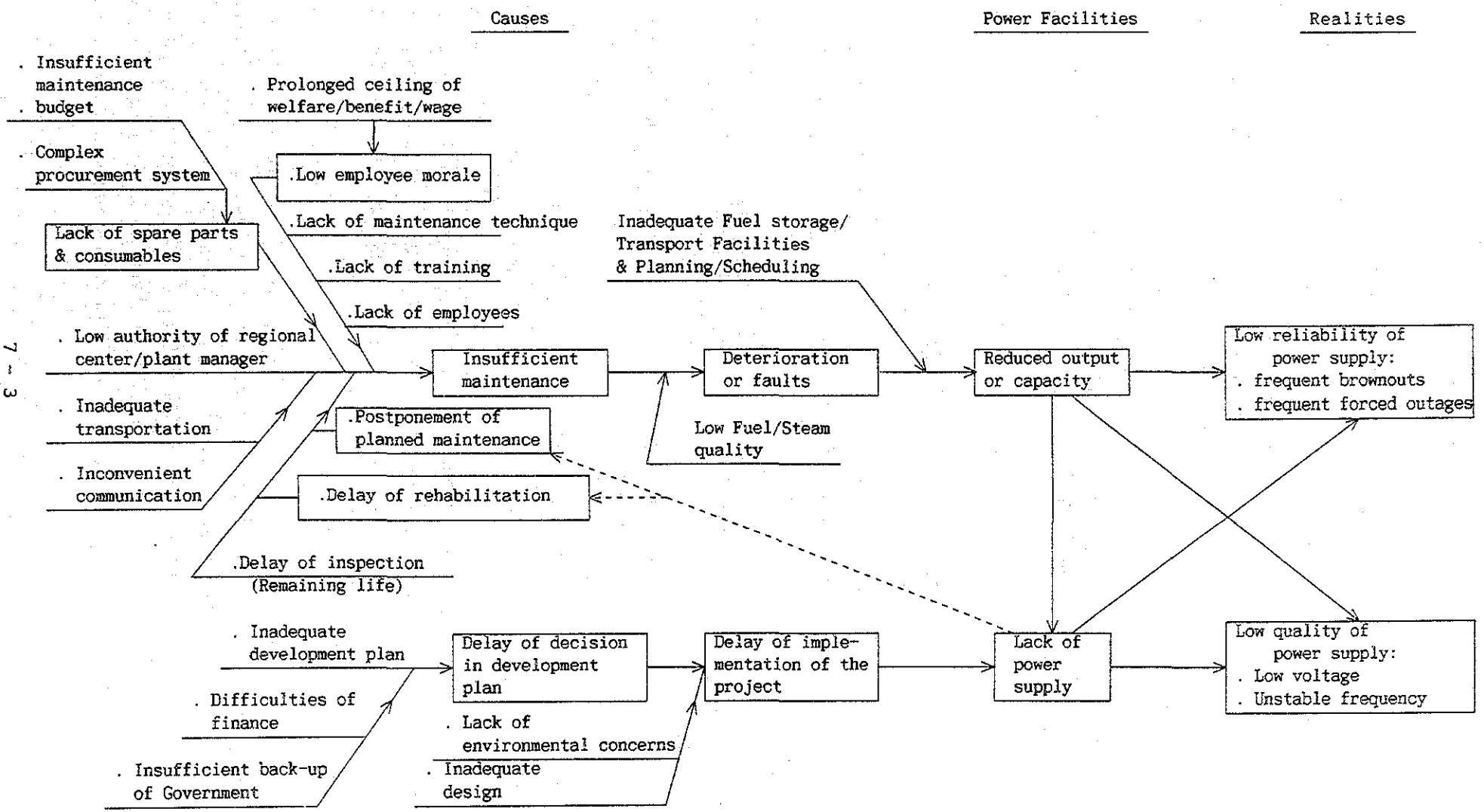
Fig. 7-1-1 is the compilation of the "live voices" the Study Team came by at places visited.

It is clear that the supply capability is lacking. As of 1990, the total installed generating capacity in the Luzon Grid is 4,321 MW and the maximum demand is 2,973 MW (equivalent to 69% of the installed capacity), and it appears that there is about 31% of the reserve capacity.

Actually the supply power shortage is due to two causes; the one is the delay in the development of new power sources and the other is the fact that the above-mentioned reserve capacity is not working effectively. These two causes are at present in the relationship of the hen and the egg. Extensive rehabilitation of the existing facilities is necessary to revive the reserve capacity, and the rehabilitation entails unit shutdowns which in turn requires addition of new power sources to cover the supply shortage.

As clearly seen in Fig. 7-1-1, there are many problems related with the operation and maintenance management (software) in the background of the present status of the existing power facilities (hardware). These problems are tackled first in the following.

Fig. 7-1-1 Analysis chart of Causes



(1) Problems and Approach to the Remedy

a. Sorting of problems

The causes, or problems, appearing in Fig. 7-1-1 are analyzed in more detail and arranged in Tables 7-1-1 through 7-1-3. Even if confined to the problems related to operation and maintenance, the problems are widely varied and involve many elements interrelated with one another.

b. Clues for approach

The clues for the approach to the problems are as follows.

- Data and information collected.
- 1990 Annual Audit Report by the Quality Assurance Department (QA) of NAPOCOR Head Office.
- Operation and Maintenance Management Survey Report of 1987 by ADB.

c. Management and administration system

One of the problems advised to the Study Team at many power plants and other offices was the "delay in the procurement of goods". NAPOCOR also considers this to be a serious problem, as clearly seen by the Annual Audit Report.

To cope with these problems, it is necessary to study the management and administration system. In the "Implementing Arrangement" agreed upon between JICA Preparatory Study Team and NAPOCOR, it is stated that "The study shall also cover the improvement of efficiency of maintenance through improvement of the NAPOCOR's management and

administration systems...".

d. Study items for improvement planning

(a) Based on the clues, important problems were picked up from among the sorted problems, and their present conditions and improvement plans were studied. Surveys and studies were made briefly on all the study items entered in the Inception Report.

(b) The problems related with NAPOCOR as a whole are treated in this Section 7.1 General, and those related with the regional centers, power plants, etc. are treated in Section 7.2 and the sections that follow.

(c) The following were taken up as the problems related to NAPOCOR as a whole.

- Organization of NAPOCOR Head Office
- Equipment and materials procurement system
- Personnel plan
- Education and training plan
- Morale of employees

(2) Organization of NAPOCOR Head Office

a. Present Status

NAPOCOR carried out the review of the organization of the corporation as a whole in the period from August through November 1991, which coincided with the survey period of the Study Team.

In August 1991, reshuffle of the top management, including the President, was made. And under the new management, the organization of the Head Office was altered.

As compared with the former organization, the new organization is more functional and well defined.

(Refer to Table 7-1-4 and Table 7-1-5)

Major alterations related to the operation and maintenance are as described in the following.

Engineering Department

(a) Plant Betterment Services Department was proposed. In the Interim Report, JICA recommended the establishment of a department to have the overall control of the maintenance of the hydro power, transmission, and substation facilities. This new Department is different in its functions from the JICA recommendation. The former project team which was independent and in charge of the Managed Maintenance Program (MMP) was transferred to the Engineering Department, and together with the teams in charge of the nuclear power plant and the rehabilitation works which belonged to the Engineering Department, forms this new department.

(b) The Quality Assurance Departments which were formerly a part of the Operation Department and the Engineering Department respectively, were combined in the Engineering Department, and these two departments and the formerly independent Safety & Security Department were made into one new department.

(c) The Hydro Power, Thermal Power and Transmission Departments which were formerly separate departments were reorganized into the Development /Design Department and the Construction Department. The former is divided into functional engineering groups of the mechanical, electrical, civil, architectural, etc. And the latter is divided into regional project groups and the group in charge of the investigation and testing of materials. This new organization seems to have in the background an aim to utilize the limited number of (or lacking) engineers as much as possible, namely to use the engineers more flexibly within the department.

Operation Department

(a) Formerly there was one senior vice president, but two senior vice presidents were newly instituted, one in charge of Luzon and the other in charge of Visayas and Mindanao, and the operation department was divided into two independent systems.

The operation department in charge of Luzon, has been relieved of the duties covering Visayas and Mindanao.

(b) There was a reorganization within the System Operation Department, and the formerly independent Efficiency & Reliability Department has been absorbed by the System Operation Department.

Others

The Planning Services, Finance, Controllers, Administration and Human Resources Departments which were under the Senior Vice President of Corporate Affairs were made independent departments directly under the President.

b. Problems

(a) Reinforcement of Planning Services Department

The duty and responsibility of the Planning Services Department is primarily to formulate the corporation-wide basic plans (excluding the personnel affairs).

The plan prepared by the department is made the corporation-wide management policy and basic plan after the approval by the Board. In other words, the policy and plan must be practical and feasible, and consequently, the formulation of the plan involves coordination and adjustments with many related departments.

Speaking from the view point of the operation and maintenance improvement planning, the plans of improvement, repair and or abolishment of the existing power plants and transmission and substation facilities must be studied in relation with the power sources development plans and the generating plans.
To carry out these important duties, it is necessary that the staff of the Planning Services Department is reinforced.

(b) Establishment of operation and maintenance management control department.

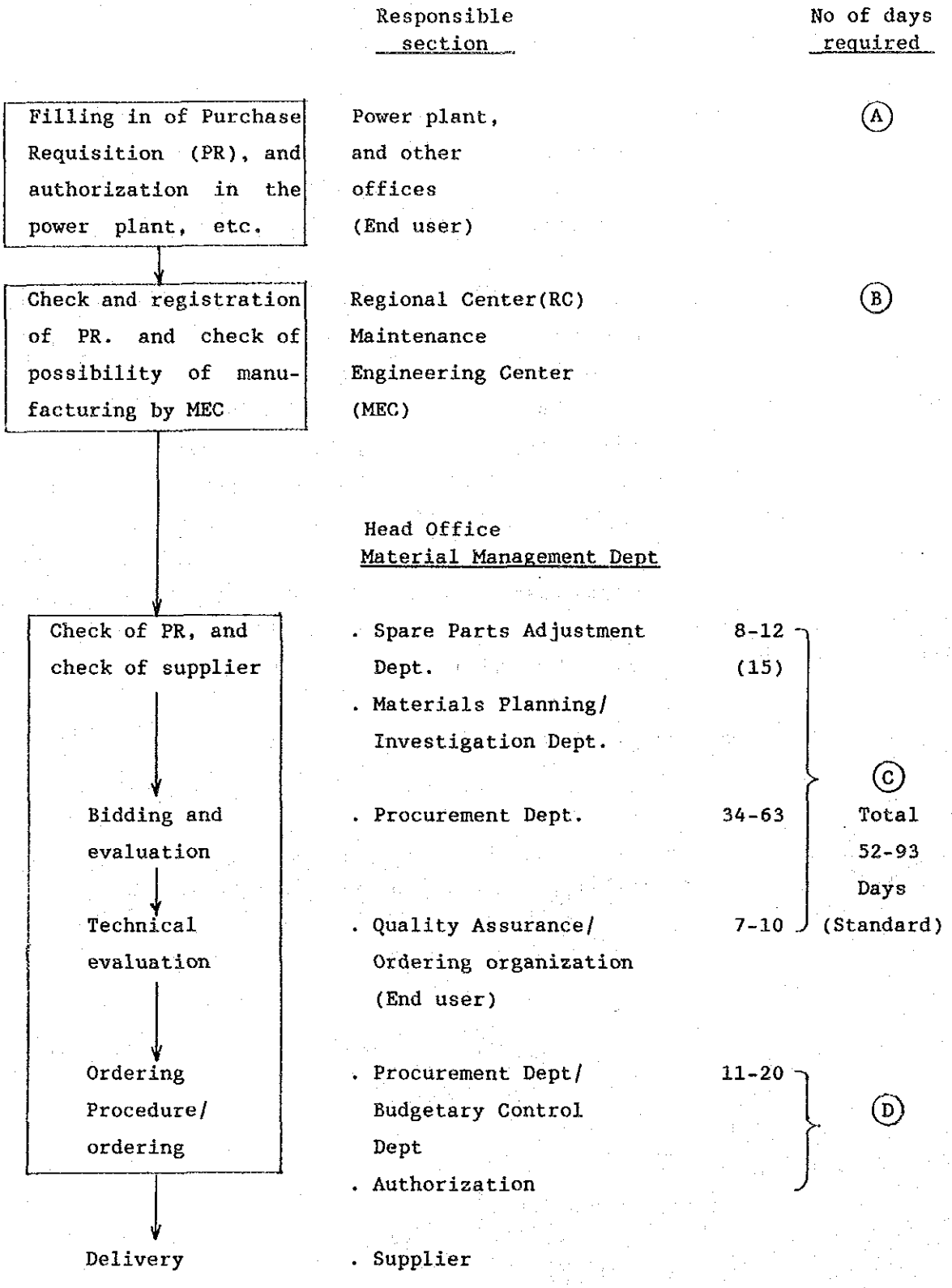
It was JICA's opinion on the system before the reorganization, that there was no integrated department in the NAPOCOR Head Office to control the operation and maintenance management.

In the new organization, the Utility Management Department is newly made. Improvements on the various problems described in Section 7.2 and the following sections should be made in accordance with the policy and plan on the corporation-wide level and the so-called "headquarters" to control the implementation should be established in the Head Office. In this sense, it is desirable that a department similar to the Utility Management Department be established for the management of operation and maintenance.

(3) Equipment and Materials procurement system

a. Present status

The process of procurement is presented schematically in the following. (Refer to Tables 7-1-6 and 7-1-7).


Responsible section
No of days required
Filling in of Purchase Requisition (PR), and authorization in the power plant, etc.
Power plant, and other offices (End user)
A
Check and registration of PR. and check of possibility of manufacturing by MEC
Regional Center(RC) Maintenance Engineering Center (MEC)
B
Head Office
Material Management Dept
Check of PR, and check of supplier
. Spare Parts Adjustment Dept.
8-12
(15)
. Materials Planning/ Investigation Dept.
Bidding and evaluation
. Procurement Dept.
34-63
C
Total 52-93 Days (Standard)
Technical evaluation
. Quality Assurance/ Ordering organization (End user)
7-10
Ordering Procedure/ ordering
. Procurement Dept/ Budgetary Control Dept
. Authorization
11-20
D
Delivery
. Supplier

b. Problems

(a) According to the voices from sites and the opinion of the QA, the problems seem to lie in the following.

. The system of procurement of the equipment and materials is complicated.

- It takes too long in the procurement procedure, and as a result,the delivery of goods is delayed.

. Shortage of maintenance budget

- Because of short budget, the procurement of necessary equipment and materials is difficult.

. Shortage of spare parts and consumables

- Necessary spare parts cannot be obtained timely.
- Equipment and materials (mainly imported goods) desired by the site cannot be procured.

It seemed that these problems are all dependent on the policy and the system of procurement of the Head Office. Therefore, the Study Team made the investigation and exchange of opinions at the departments concerned in the Head Office.

(b) Results of investigation

The results of investigation are summarized in the following.

i) Problems with the origin of purchase requisition

. The delivery period entered in the purchase requisition sometimes dose not meet the necessary time (Ⓐ+Ⓑ+Ⓒ+Ⓓ).

. The procurement specifications are sometimes incomplete and it takes time in the adjustment between the Procurement Department and the origin of P.R.

. The authority of the power plant manager and such local managers in the procurement is very limited.

ii) Problems with regional centers

. The regional centers are too busy in processing of many P.R.'s submitted from the power plants and others. The staffs are relatively short in number and it takes time in the processing.

. The regional centers and/or end user's engineering section should be able to check the problems with manufacturer's design.

iii) Problems with departments concerned in the Head Office.

. There are many offices concerned with the procurement in the Head Office, and it takes time in processing through them.

. As the equipment and materials that can be purchased by the power plants, etc. for them selves are so limited that the procurement is made mostly in Manila, and it takes time in processing many P.R.'s submitted from all the organizations in NAPOCOR.

iv) Problems related to the policy and authorization of procurement

. In the procurement of equipment and materials and the works necessary for rehabilitation/ maintenance of the existing facilities, even the important procurement looks like being processed on the "cheaper the best" principle, and large losses are incurred in some cases.

. As the approval of procurement of the equipment and materials and the works are subjected to the top management, it takes time in the procurement.

The Study Team could not pursue these problems in sufficient detail, and cannot propose concrete improvement plans. Therefore, the Team would submit the plans as reference opinions.

(4) Personnel program

a. Present status

The change of the number of personnel in the past 10 years and the formation by the department are shown in the figures below. It is noted that the number of personnel increased conspicuously in two years, 1989-1990, mostly in the Operation and Maintenance Departments.

On the other hand, resignation of medium-level operators and maintenance crew members from NAPOCOR (actually, moving to other companies) is increasing.
This is due to the ceiling limit on the salary of NAPOCOR employees by the Salary Standardization Law, Republic Act

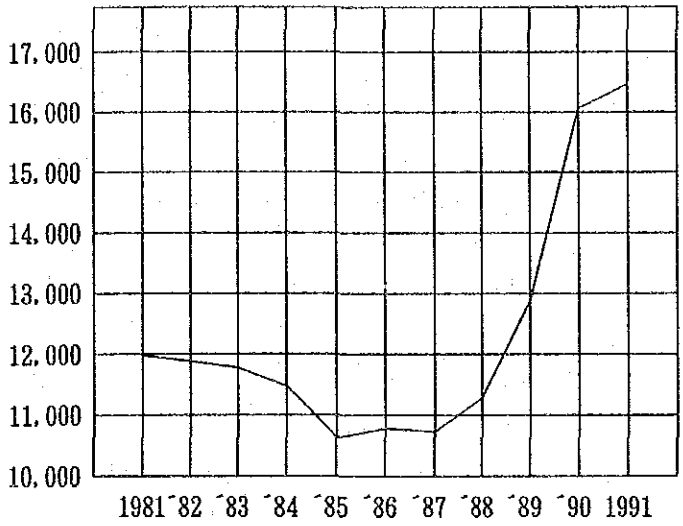
No 6758 of August 1989, and the fact that the demand for experienced operators and maintenance personnel is high as a result of the participation of private enterprises in the electric utilities by BOT. And this tendency would last into the future.

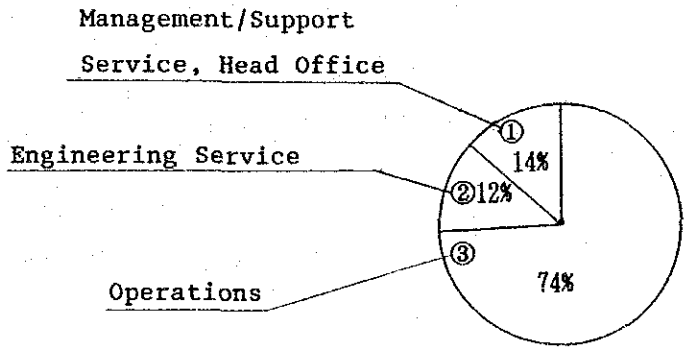
b. Problems

The above situation means that less experienced operators and maintenance personnel would increase and experts would decrease, which is an important problem that cannot be neglected. In the future, as the electric power sources development progresses, the necessary number of operators and maintenance personnel will increase further, and it is necessary to secure these personnel systematically through employment of new employees and other means, and at the same time the prevention of resignation of personnel of the existing power plants and other institutions should be considered seriously.

Changes of Personnel

(incl. laborers in casual employment)





Number of Regular Employees as of June 30, 1991

①	Management/Support Service.....	1,404 (14%)
②	Engineering Service.....	1,186 (12%)
③	Operations.....	7,389 (74%)
	Total	9,979 (100%)

(5) Education and training program

a. Problems

In the situation described in the foregoing Personnel program, the education and training of the operation and maintenance staff is one of the important problems for the future. Especially, the education and training of the new employees and unskilled personnel to foster medium-level staff is extremely important.

b. Measures to be taken

- To increase the knowledge, ability and experience of the medium-level personnel and also increase the number of medium-level operators and maintenance personnel.

- To reinforce the education and training of new employees.

It is advisable to review the present education and training program with the above two points in view.

(6) Morale of Personnel

a. Problems

Employees look dissatisfied at their salaries which have been frozen nearly 10 years pursuant to the Salary Standardization Law. Under this Law, they are faced with the grim reality that even though they are promoted in position, their salaries would remain unraised. It may not be helped under these conditions that the willingness of the employees to work looks very low.

b. Countermeasure

It is impossible to evade the Law by the power of NAPOCOR itself, and therefore, it would be the only way for NAPOCOR to seek measures to raise the morale of the employees by some method which are in the hand of NAPOCOR.

Table 7-1-1 Causes of Frequent Supply Failures

1. Shortage of Power Supply Sources

(1) Insufficient power sources development

a. Deficiency in formulation of development program
b. Delay in decision on development program
c. Delay of construction works
d. Shortage of fund

(2) Decreased capability of existing generating facilities

a. Deficient facilities
(Not always NAPOCOR's responsibilities)
(a) Deficiency in design
(b) Defects in equipment and materials
(c) Defective construction works

b. Delay of planned maintenance works
(a) Suspension of maintenance works to cover supply power shortage
(b) Shortage of maintenance materials
. Shortage of fund
. Deficient inventory control (storage/handling) of spare parts
. Delay in delivery of maintenance materials
- Deficiency in spare parts procurement plan
- Long procurement time
Complex procurement system
Small authority given to power plants
Deficient procurement specifications
. Purchase of defective, used/goods
- Deficient acceptance system
- Deficient or misleading specifications
- Preference of lowest priced goods

c. Deficient Maintenance works

(a) Deficient maintenance management system
- . Deficiency in organization
- . Deficiency in preparation of materials
- . Omission of periodical inspections
- . Insufficient data control and insufficient utilization of results of diagnosis
- . Insufficient inspection patrols

(b) Inadequate countermeasures and remedies
- . Insufficient investigation of causes of troubles
- . Delay in countermeasures and remedies

(c) Deficiency in working
- . Repair works not executed
- . Inadequate method of works
- . Poor quality of works
- . Use of inadequate materials

d. Lack of experienced operator and/or supervisor be able to react with abnormalities during emergency.

2. Weak Transmission System

(Causes are the same as with the Shortage of Power Supply Sources, above.)

3. Frequent Troubles

(Causes are the same as with the Shortage of Power Supply Sources, above.)

(1) Defective facilities
(2) Deficiency in maintenance
(3) Deficiency in operation (poor fuel, and rough/unsafe operation of units with bypassed protection devices)

Table 7-1-2 Causes of Excessive Voltage and Frequency Fluctuations

1. Excessive Voltage Drop

   (1) Deficiency of capacity of transmission system
   (2) Shortage of phase modifying capacity
   (3) Poor operation

2. Excessive Frequency Fluctuation

   (1) Shortage of regulating capability
   (2) Poor Operation

Table 7-1-3 Causes Common to Various Problems

1. Shortage of Office Work Capability

   (1) Shortage of personnel
   (2) Low morale

2. Deficiency in Technology (Lack of training)

   (1) Shortage of able personnel
   (2) Deficiency in education

3. Poor Operation

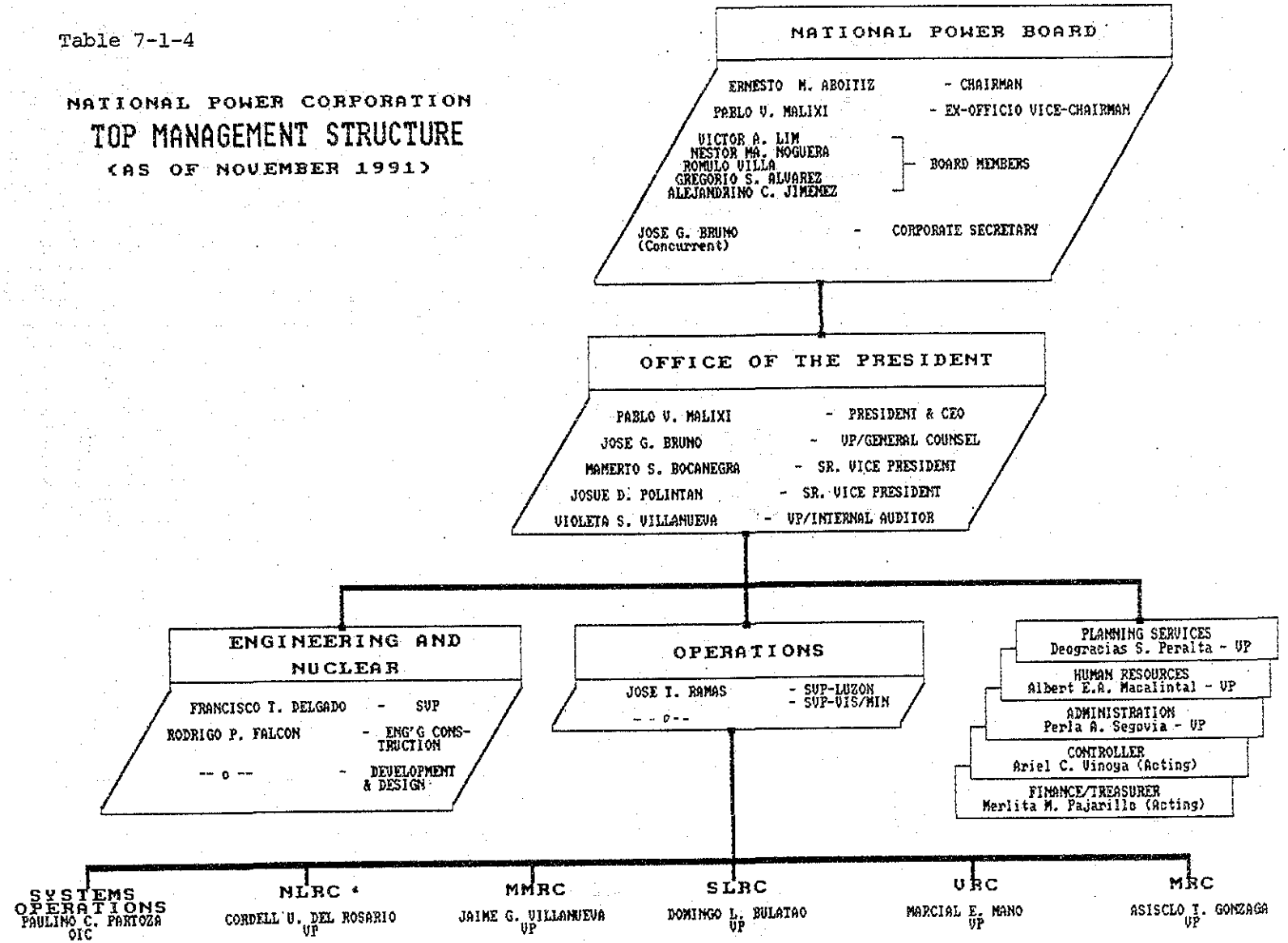
   (1) Deficiency in data and manuals
   (2) Poor coordination among departments concerned
   (3) Lack of rotation of personnel
   (4) Poor system operation

Table 7-1-4

NATIONAL POWER CORPORATION

TOP MANAGEMENT STRUCTURE

(AS OF NOVEMBER 1991)



(SOURCE: ORGANIZATIONAL & MANPOWER PLANNING DIVISION/OHRPSD)

TOPMS/BAT-ALVIN

Table 7-1-5 REORGANIZED NPC SET-UP

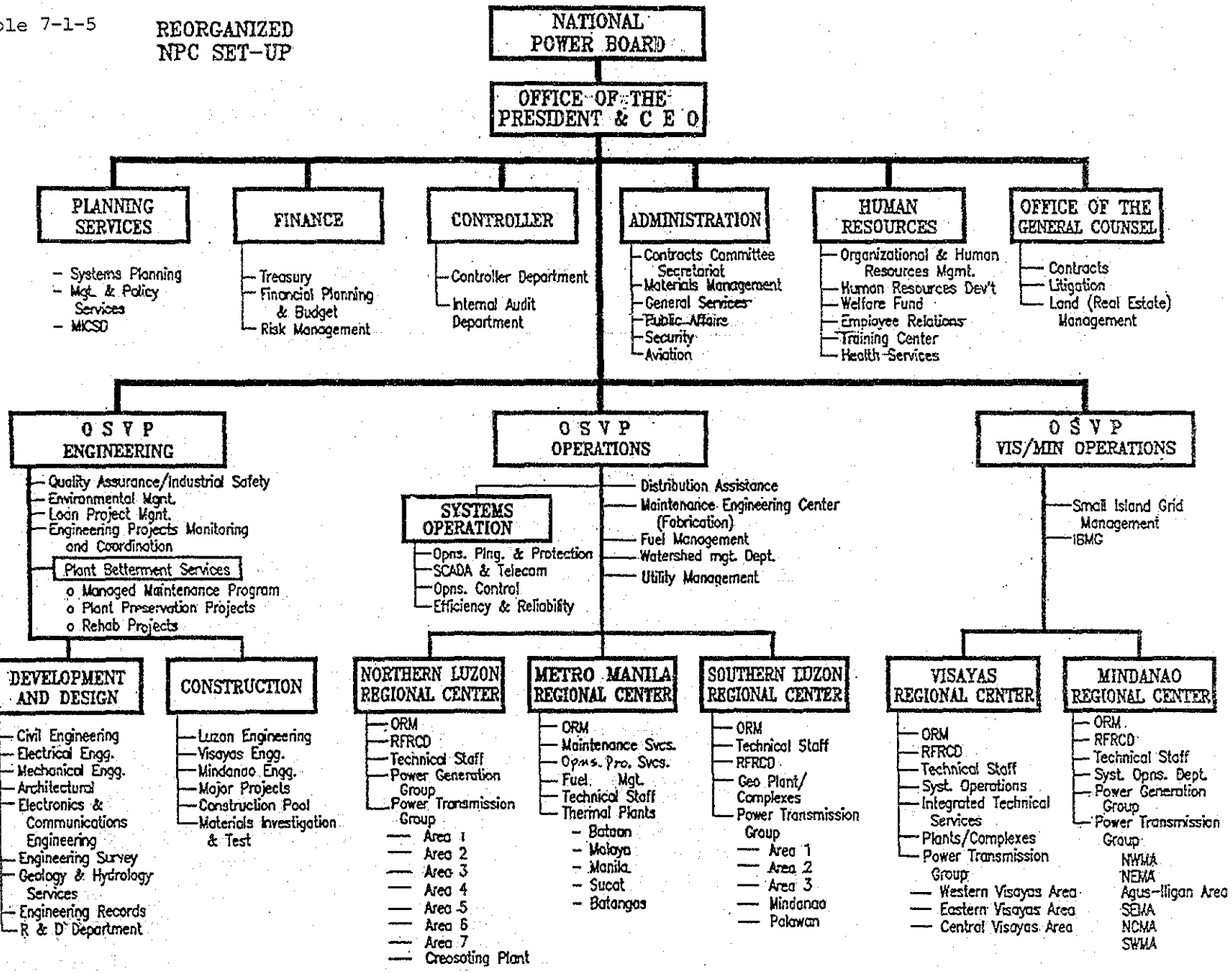


Table 7-1-6

ORGANIZATION FOR PROCUREMENT

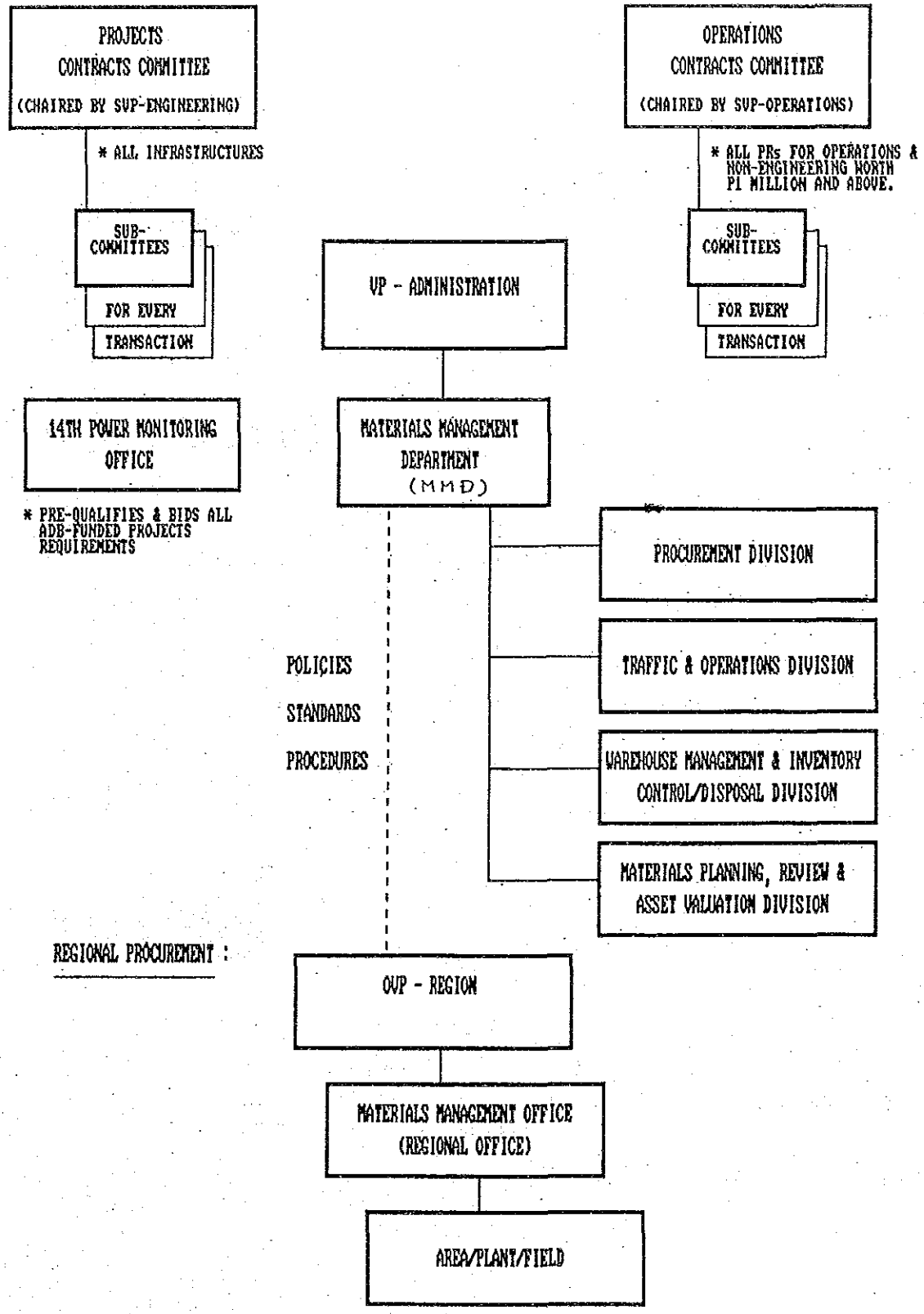
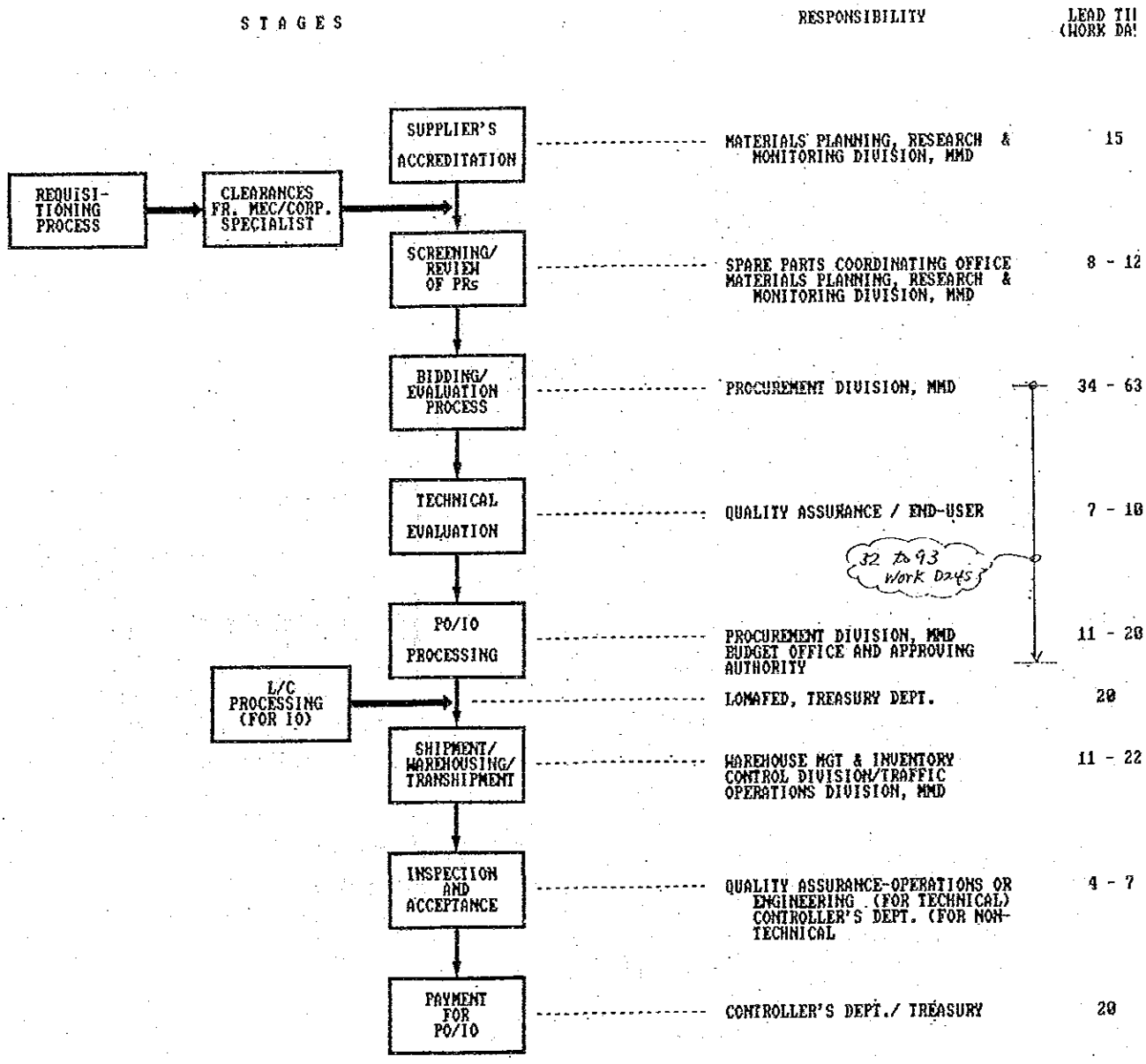


Table 7-1-7

OVERVIEW OF THE PROCUREMENT PROCESS



SUMMARY OF LEAD TIME :

1. Receipt of PR by Proc. Div. to Placement of Order : 32 to 93 W.D. (2.4 to 4.2 mos.)
2. Receipt of PR to Payment :
   a. PO - 87 to 142 W.D. (4 to 6.4 mos.)
   b. IO - 107 to 162 W.D. (4.8 to 7.3 mos.)

7.1.2. Proposals on Organization and System of Head Office

In the following are given the JICA's opinions from the view point of the maintenance management (operation and maintenance control).

1. Organization of Head Office

(1) Reinforcement of Planning Department

a. The NAPOCOR-wide management policy and basic plan(excluding personnel affairs) should be compiled by the Planning Department. Various departments will prepare their implementation plans (draft) on their responsibility, on the basis of the management policy and the basic plan.

b. The authority and the staff of the Planning Department should be reinforced adequately for discharging the above responsibility. In connection with the improvement of maintenance management, which is the objective of the present study, the following items should be included to the job of the Planning Department.

(a) Coordination of power development plan with the future major rehabilitation and operation plan for the existing facilities (including their retirement plan)
- Power sources and transmission and substation facilities.

(b) Economic evaluation of power generation plan by existing power facilities for the medium-term and long-term in consideration of rehabilitation

(c) Formulation of appropriate foreign fund requirement to support the major rehabilitation plans

A foregoing major rehabilitation and operation plans are closely related with the future expansion program for the power system facilities, and it is advisable that these (a), (b) and (c) be handled by the Planning Department.

(2) Establishment of Maintenance Department

a. A department to make the overall control of the maintenance of power plant facilities, which are in the charge of the regional centers, should be established in the Operations Group. It would be necessary to make the adjustment in the relationship with the Utility Management Department.

b. With regard to the procurement items to be approved by the Head Office, this Department can make preliminary adjustment in place of the end users, with the Materials Management Department (MMD) prior to the issuance of the Purchase Requisition (PR). Further this Department can check the progress of processing of PR's submitted to MMD.

2. Equipment and Materials Procurement System

(1) Systematic Preparation for Procurement of Important Equipment and Materials (Especially imported items)

a. Power plants and such end users should make the following preparations prior to the issuance of PR's on the basis of the approved maintenance program.

- Reconfirmation of delivery period.
- Setting of delivery period and timing of issuance of PR's.
- Preparation of procurement specifications, attached drawings, reference drawings, and data. In this stage, inquiry and discussions will be made with the manufactures, if necessary.
- Preparation of explanatory statement of the reasons, if procurement from the original manufactures is necessary.

In this stage, the opinions of the regional center and MEC will be consulted. Preliminary consultation is essential for prevention of delay in the processing of the procurement documents after the PR's are issued.

b. The issuance of PR's should be made promptly, not later than the set date.

(2) Enlargement of Authority of End Users on Procurement

a. The Study Team learned that the procurement procedures in regional center and end users are all handled in the Head Office under the new organization, for the reason that the offices of the suppliers are all located in Manila. If it is more practical for the enhancement of the processing of the procurement, there is no reason to object to the system.

b. However, the authority on the procurement of the managers of power plants and regional centers should be reconsidered into the direction of enlargement, for the following reasons.

(a) To enable the managers to carry out the periodical and routine maintenance works on their responsibilities.

(b) To expedite the procurement procedures (including request for works and emergency case)

(3) Expediting of Procurement Procedure

a. In connection with the foregoing Item (2), the following processes should be simplified positively for increased efficiency.

(a) Processing of procurement procedure (especially in the Head Office) for the procurement made on the responsibility of the power plant managers.

(b) Processing of procurement procedure (especially in the Head Office) for the procurement made on the responsibility of the managers of regional centers.

b. With the procurement items which must be approved by the Head Office, the processing of PR's, when received by MMD, should be expedited by the work of the Maintenance Department in the Head Office, the establishment of which is recommended in the foregoing.

3. Personnel Plan

(1) Formulation of Short-term/Long-term Personnel Plans

Especially with the Operation and Maintenance Departments, the unbalance between the personnel requirements under the new organization and the present number of personnel should be checked. And also, the age structure and experiences of the personnel in the field will be reviewed to check any unbalance that may exist. Based on these check data, the short-term and the long-term personnel plans should be formulated.

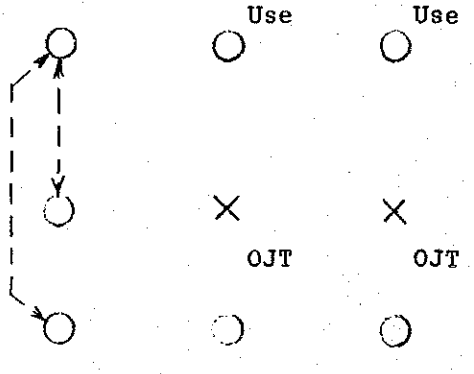
(2) Systematic Movement of Personnel

With the age structure and experiences of the operation and maintenance personnel at the work places taken as the reference, adequate changes of personnel among the work places to raise the capability of the work places.

4. Education and Training

(1) Especially in the operation and maintenance departments, the education and training system for the medium-level personnel and the new employees and less experienced personnel should be established. The method for the above should be formed based on the present conditions as reviewed in the following check list.

Item	Department in Charge: Head Office	RC	Power Plants, etc
a. Preparation of master plan *inside NAPOCOR/outside NAPOCOR/* training overseas		Direction	Direction
b. Annual implementation plan based on the above		Control	Collection, Preparation
c. Budgeting		Notice	Notice
d. Preparation of curricula and materials		Cooperation	Cooperation
e. Implementation of education/training			
f. Monitoring/control of records of training of personnel		Report	Report
g. Preparation of education and training facilities (NAPOCOR-wide: Training Center/Simulator)		Use	Use
h. Assignment of lecturers and leaders		× OJT	× OJT
i. Preparation of reference books and apparatuses			



(2) Early implementation of the training center and introduction of operation simulator

(3) Reinforcement of Human Resources Staff

5. Enhancement of Morale

The following are considered for the enhancement of the morale of the personnel.

(1) To continue to appeal to the authorities concerned for the improvement of the salary and the fringe benefit.

(2) To give opportunities of education and training, within the country and overseas, to the personnel (especially technical personnel) impartially.

(3) To give the opportunities of promotion to the personnel impartially based on the years of service, experience and other conditions.

(4) To implement the group proposal system to encourage the job units to submit practicable proposals of cost saving, improvement of work efficiency, etc.

(5) To improve the environment and conditions of the work places.

(6) To enforce the safety measures necessary for the works of personnel.

(7) To adopt other measures to incite the personnel to action.

7.2 Thermal Power Plants

7.2.1 Present Status and Problems of Operation and Maintenance

1. Operation and Maintenance Organization

The operation and maintenance organization for the thermal power plants has been reorganized in parallel with the reorganization of the Metro Manila Regional Center (MMRC). One of the targets of the reorganization was to increase the efficiency of the operation and maintenance as well as to include of the items pointed out by the Audit Report regarding the thermal power plants prepared by the Quality Assurance Division of the Head Office.

For the realization of the targets, the Organization was reformed functionally and simplified. Now the problems for the future are:

1) Early establishment of the procedure for effective operation of the works to take full advantage of the new organization

2) Securing of the personnel and their effective assignment

(1) Metro Manila Regional Center (MMRC)

At present, five thermal power plants are in operation in Luzon Island, and the operation and maintenance of these power plants, including Batangas Power Plant located in the Southern Luzon Regional Center (SLRC) area, are under the jurisdiction of MMRC. The organization of MMRC is shown in Tables 7-2-1 -- 7-2-5.

a. Major change

(a) The former Central Maintenance/Technical Service Division (CM/TS) was reorganized into the Operation Project Services and the Maintenance Services.

- Operation Project Services (Refer to Table 7-2-3)

  This organization is in charge of the design, engineering study of major operation projects/modifications and control of operation of the thermal power plants, and is composed of five divisions; the Mechanical Design and Tech. Division, the Electrical Design and Tech. Division, the Chemical Engineering Services Division, the Computer Services Division, and the Regional Efficiency Control and Data Management Division.

- Maintenance Services (Refer to Table 7-2-4)

  This organization is in charge of the inspection, repair and maintenance of the thermal power plants, and is composed of three divisions; the Mechanical Division, the Electrical Division, and the Support Services Division.

  The Mechanical Division is divided into three sections; the Boiler Section, the Turbine Section, and the Auxiliary Section, and the Electrical Division is divided into four sections; the Generation Section, the Substation Section, the Relay Section, and the Test/Meter Section.

b. Merits of the reorganization

  (a) MMRC has come to have the Operation Project Services, the organization to effect the overall control of the engineering problems.

  (b) The Maintenance Services has unified the Central Maintenance Division and the Technical Services Division into a concise and more efficient organization.

(c) All the procurement activities have been transferred to the Head Office and the procurement system has been rationalized.

c. Problems

(a) Problems with the former organization and the reorganization

The Study Team stated in the Interim Report that it seemed necessary to establish an integrated department in NAPOCOR Head Office which handles the maintenance management, because in the observation of the Study Team there seemed to be no such organization in NAPOCOR, not only in the hydro power and transmission and substation department but also in the thermal and geothermal power department.

This is a big difference from the organization of the Japanese power companies. In the opinion of the Study Team, the Head Office should have the general headquarters to carry out the management of maintenance systematically and efficiently, and the lack of such headquarters was a problem.

The present reorganization gives the impression to the Team that the opinion of the Team has been half realized, because the general headquarters was established in MMRC, not in the Head Office.

(b) Future problems

- It is desired that the operating procedures under the new organization be established quickly.

- It is necessary to secure the necessary personnel and to assign them strategically.

For example, in the procurement of the equipment and materials for maintenance and repair, the following activities should be carried out by MMRC, even after all the procurement business has been transferred to the Head Office.

[Planning and Decision of Maintenance Costs and Improvement Work Costs]

i) To collect the plans (including the annual plan and the long-range plan) of the power plants and compile them into an overall plan.

ii) To submit the overall plan (including the budget)to the departments concerned in the Head Office for approval.

iii) To notify the power plants of the approved plan (budget).

This is merely an example. Such overall control (including the planning, execution and results control) is considered to be the duty of MMRC in charge of the overall management of the thermal power plants.

It is necessary also to make it clear which sections or groups will be in charge of these activities.

(2) Thermal Power Plants

The organizations of individual thermal power plants have also been reformed. The new organizations are shown in Table 7-2-6 through 7-2-10(1),(2).

a. Major Changes

(a) The six sections in the old organization have been reorganized as follows and each division is headed by the manager who is in full charge of the division.

Old Organization	New Organization
. Operation (1 section.)	. Operation (1 div.)
. Chemical (1 section.)	
. Plant Eng. and Control (1 section.)	. Eff. Control (1 group) (newly organized)
. Mech./Elect. Maint. (2 sections)	. Maintenance (1 div.) (Including planning & scheduling group (newly organized))
. MMP (Adhoc)	
. Support Services (1 section.)	. Support Services (1 section.)
Total 6 sections	2 divisions + 1 section + 1 group

(b) The Efficiency Control Group has been established under the plant manager.

(c) The Planning and Scheduling Group has been established within the Maintenance Division.

(d) Managed Maintenance Program (MMP)

The Managed Maintenance Program Teams have been established in MMRC and individual thermal power plants as a special project for the period of July 1990 through December 1992. The MMP team is in a position of a staff of the maintenance manager, and the role of the team is to complete the data base, by the program developed by NAPOCOR, for unified

management of the recording of information and data, preparation of statistics, documents, ledgers and slips, control of the movements of equipment and materials (including spare parts) in and out of the store, etc.

Once the system is materialized in every power plant, this Program is expected to contribute greatly to modernized management of the thermal power plants.

b. Features of the Reform

(a) The organization has been reformed functionally and simplified.

The newly established Efficiency Control Group will promote the efficient operation of the power plant, as symbolized by its name. The control-related works have been transferred from the old Plant Engineering and Control Section to the Maintenance Division in the new organization, and the engineering works has been separated and absorbed in the Efficiency Control Group.
THe former Chemical Section has been combined under the Operations Department, and the chemical operation personnel are assigned in the shift work. Thus the chemical control has been reinforced.

(b) New organization defines the line of command and directions and the division of responsibility.

The Operation Manager and the Maintenance Manager take the responsibility over the respective operations in place of the Plant Manager. This constitute the transfer of authority, and the Operation and Maintenance Managers control and manage the sections and groups under them,

respectively, and coordinate and adjust the relations with other divisions and groups.

This means that the manager responsible for the maintenance has come nearer to the actual work level, and the chief of each section no longer has to bring up every matter with the plant manager. As a result, the efficiency of works will be increased and more precise control will become possible.

(c) In the new organization is observed the intention to strengthen the staff of the maintenance department to carry out the maintenance works by the power plant's own staff.

c. Problems and Effects of Reorganization

(a) Problems with the old organization

- It was necessary to reinforce the engineering activities in the power plant and the regional center.

- The group to handle the environmental problems was not clear.

- Each section of the maintenance department was positioned directly under the plant manager, which made the unified control of the maintenance works difficult.

- It was necessary to assign a staff to coordinate the maintenance sections in the formulation of the maintenance program and work schedule, budget and working plans.

(b) Present reorganization and problems

The present reorganization is esteemed as the solution of the foregoing problems. However, the part to handle the environmental problems is not clear yet.

(c) Future problem

- To establish the work management procedure under the new organization.

- To secure necessary personnel and assign them strategically.

(3) Maintenance Engineering Center(MEC)

a. The Maintenance Engineering Center (MEC) was founded in 1988, and is playing an important role in the maintenance system of NAPOCOR. The organization of the MEC is shown on Table 7-2-11. The office and factory were built adjacent to Sucat Power Plant and the equipment and facilities are being expanded. With the expanded faculties and staff, the MEC has come to undertake inspection and repair of larger parts, improvement and domestic production of some kind of parts. The MEC is now carrying out reblading of the turbine, and balancing, fabrication and assembling of tube panels, fabrication and assembling of AH elements, repair of water turbines and water gates, and re-babbitting of large size bearings.

Now MEC is installing the equipment for non-destructive tests and eddy current tests and other materials inspection equipment, and plans to equip with chemical cleaning facilities in the near future. In addition, MEC is receiving technical cooperation from and subcontracted by Babcock-Hitachi Philippines Inc. (BHPI) in the manufacture and fabrication of boiler tubes, pressure vessels, etc.

(4) Organization for Periodical Overhaul

a. Former Organization

The organization for the periodical overhaul of thermal power plants consisted of the Quality Assurance (QA) group of the Head Office, CM/TS Division of MMRC, the sections in charge of maintenance of the power plant, manufacturers, and several sub-contractors under an overhauling coordinator. The coordinator was selected from among the shift supervisors of the operation section of the power plant. Because of the complexity of the organization, there seems to have been problems in the work management, overhaul schedule control and whereabouts of the responsibilities.

b. Organization after the reorganization

As stated before, the Maintenance Services of MMRC and the Maintenance Divisions of thermal power plants were reorganized, while there has been no fundamental change in the periodical overhaul in the sense that the overhaul is carried out by these two groups at the plant and with the cooperation of the other related parties. However, it is expected that some new effect, for example smoother progress of the overhaul schedule, more precise execution of the overhauling works, etc., will be realized as a result of the reorganization.

c. Future Problems

Under the new organization, too, the Plant Manager will be the highest responsible person in charge of the overhaul, and the Manager of Maintenance Division will assume the actual responsibility in place of the Plant Manager.

At any rate, it would be necessary to review the organization for the periodical overhaul. Shifting from the present direct working system into the contract working system would be worth considering.

- For example, a subsidiary company specializing in the maintenance work will be founded and the maintenance works will be contracted out to this company. This company will be staffed mainly by maintenance engineers and technicians of NAPOCOR (now working in the Maintenance Service Department of MMRC and maintenance sections of power plants), joined by specialists and technicians from the outside as direct employees or subcontractors. Or, the Maintenance Engineering Center may join this company as its engineering department.

- In view of the prospect of creation of thermal power plants under such new systems as BOT, the need for the works of this new maintenance company would not be limited to the works in NAPOCOR. And of course, the construction works of new power plants and rehabilitation works would also be the field of activities of this company.

Table 7-2-1

METRO MANILA REGIONAL CENTER

TABLE OF ORGANIZATION

SUMMARY:

OVP	- 4
TECHNICAL STAFF	- 8
RFRCD	- 19
MAINT. SVCS.	-197
OPERATIONS PROJECT SVCS.	- 41
FUEL MGMT.	- 74
OFFICE OF THE RES. MGR.	- 4
FINANCE	- 36
ADMINISTRATION	- 36
ORLC	- 3
BATAAN TPP	-268
MALAYA TPP	-287
MANILA TPP	-221
SUCAT TPP	-404
BATANGAS CFTPP	-340
TOTAL	1942

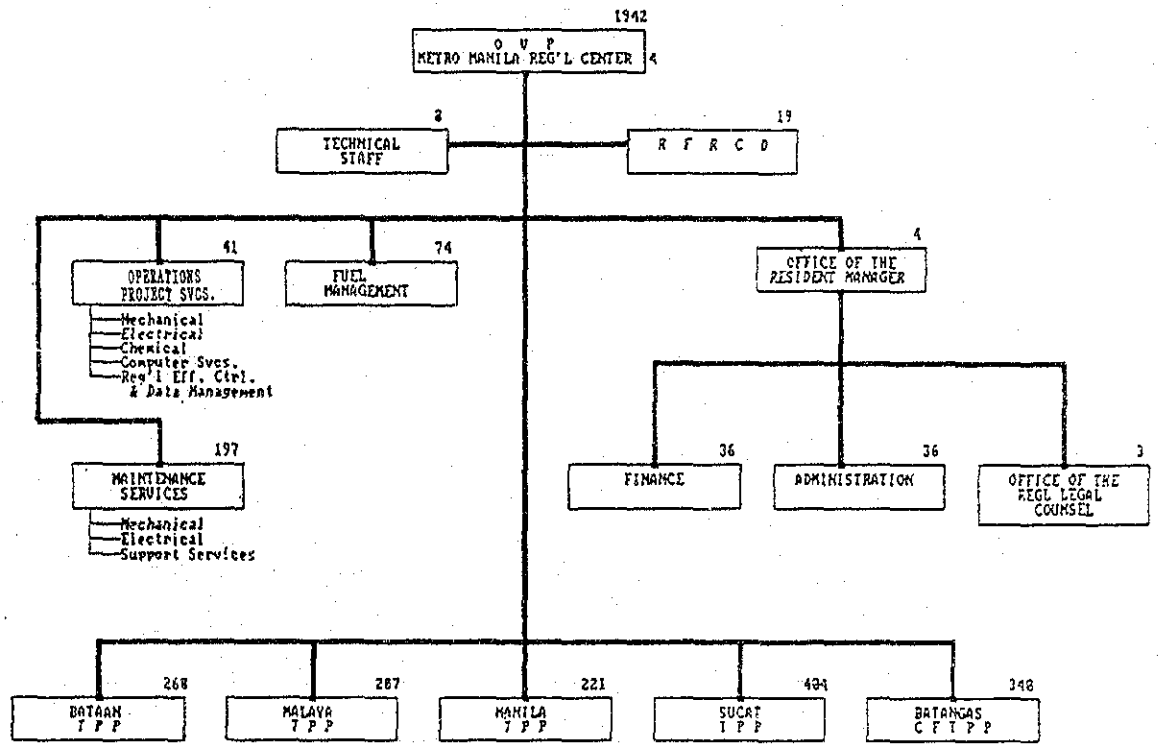


Table 7-2-2

OFFICE OF THE VICE-PRESIDENT

TABLE OF ORGANIZATION

SUMMARY:

OVP	- 4
Tech. Staff	- 8
RFRCD	- 19
Total	31

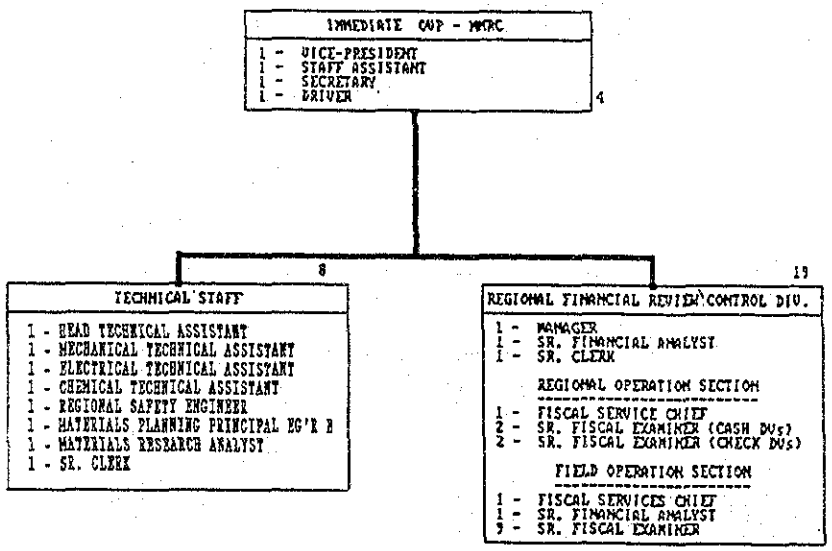
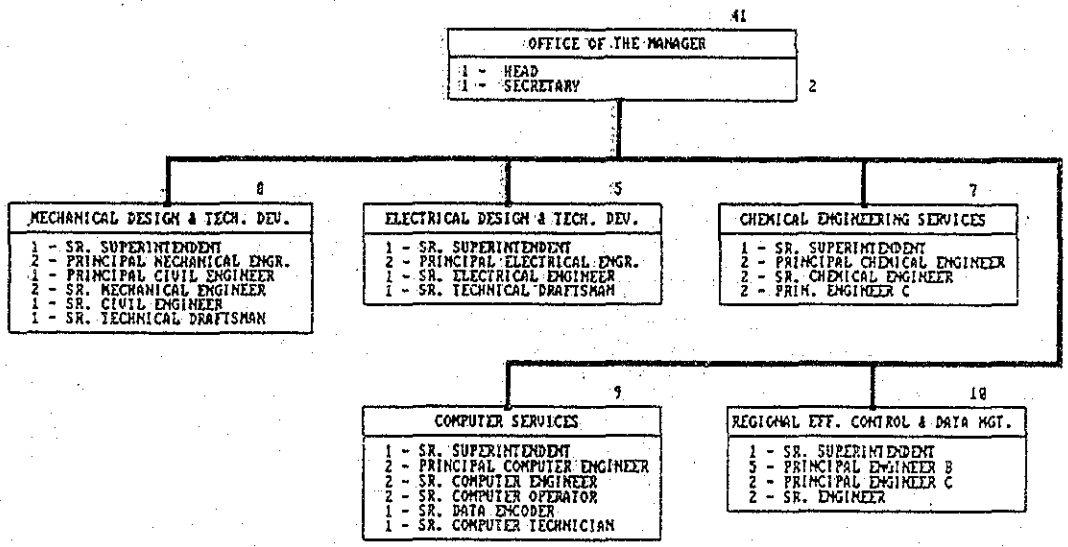


Table 7-2-3 OPERATIONS PROJECT SERVICES

TABLE OF ORGANIZATION

SUMMARY:

OM	- 2
MD & T DIV.	- 8
ED & T DIV.	- 5
CD & T DIV.	- 7
CS	- 9
REC & DM	- 10
Total.....	41



SUMMARY:

OM	- 2
MECHANICAL DIV	- 130
ELECTRICAL DIV	- 51
SUPPORT SVCS.	- 14
Total.....	197

Table 7-2-4

MAINTENANCE SERVICES

TABLE OF ORGANIZATION

197

OFFICE OF THE MANAGER — 2

1 - HEAD
1 - SECRETARY

MECHANICAL DIVISION — 130

1 - MANAGER
1 - SR. CLERK

BOILER SECTION

1 - BOILER SUPERINTENDENT
2 - BOILER SUPERVISOR

BOILER PROPER

1 - BOILER MAINT. FOREMAN
7 - MECHANIC 1/C
3 - MECHANIC 2/C
1 - MECHANIC 3/C
7 - WELDER 1/C

BOILER ACCESSORIES

2 - BOILER MAINTENANCE FOREMAN
7 - MECHANIC 1/C
3 - MECHANIC 2/C
8 - WELDER 1/C
1 - WELDER 2/C

TURBINE SECTION

1 - TURBINE SUPERINTENDENT
2 - TURBINE SUPERVISOR

TURBINE PROPER

1 - TURBINE MAINT. FOREMAN
7 - MECHANIC 1/C
4 - MECHANIC 2/C

TURBINE ACCESS./GAS TURBINE

2 - TURBINE MAINT. FOREMAN
9 - MECHANIC 1/C
5 - MECHANIC 2/C
1 - WELDER 1/C

AUXILIARY SECTION

1 - AUXILIARY SUPT.
3 - AUXILIARY SUPERVISOR

ROTATING MACHINES

2 - AUX. MAINTENANCE FOREMAN
8 - MECHANIC 1/C
5 - MECHANIC 2/C
1 - MECHANIC 3/C

STATIONARY EQUIPMENT

1 - AUX. MAINTENANCE FOREMAN
8 - MECHANIC 1/C
5 - MECHANIC 2/C
1 - WELDER 1/C

AIR HEATER/FO PIPELINE

1 - BOILER MAINTENANCE FOREMAN
2 - MECHANIC 1/C
2 - MECHANIC 2/C
2 - WELDER 1/C
1 - WELDER 2/C

SCUBA DIVING TEAM

10 - SCUBA DIVER

ELECTRICAL DIVISION — 51

1 - MANAGER
1 - SR. CLERK

GENERATION SECTION

1 - SUPERINTENDENT
1 - PRINCIPAL ENGINEER
2 - FOREMAN
4 - ELECTRICIAN 1/C
2 - MECHANIC 1/C
2 - ELECTRICIAN 2/C
1 - MECHANIC 2/C

SUBSTATION SECTION

1 - SUPERINTENDENT
2 - PRINCIPAL ENGINEER
2 - FOREMAN
4 - ELECTRICIAN 1/C
2 - MECHANIC 1/C
2 - MACHINIST 1/C

RELAY SECTION

1 - SUPERINTENDENT
2 - PRINCIPAL ENGINEER
2 - SR. ENGINEER
6 - SR. TECHNICIAN

TEST/METER SECTION

1 - SUPERINTENDENT
2 - PRINCIPAL ENGINEER
3 - SR. ENGINEER
6 - SR. TECHNICIAN

SUPPORT SERVICES — 14

1 - CHIEF, SUPPORT SERVICES

ADMINISTRATION

1 - SR. HR ANALYST
1 - DATA CONTROLLER/ENCODER
1 - SR. DRAFTSMAN
4 - DRIVER/MECHANIC
1 - HEAVY EQUIPMENT MECHANIC
1 - DRIVER/MESSENGER

FINANCE

1 - FINANCIAL ANALYST A

PROPERTY

1 - SR. PROPERTY OFFICER
1 - PROPERTY ASSISTANT
1 - DATA CONTROLLER/ENCODER

SUMMARY

OFFICE OF THE MANAGER	- 2
FUEL CONTROL	- 12
FUEL OPTNS. & CUSTODIANSHIP	- 60
TOTAL	74

Table 7-2-5

FUEL MANAGEMENT

TABLE OF ORGANIZATION

74

OFFICE OF THE MANAGER	SG
1 - DEPT. MANAGER B	25
1 - ADM. SVCS. ASST.A	12

2

12

FUEL CONTROL	SG
1 - DIS. MANAGER A	24
1 - SECRETARY A	9
RECORDING & BILLING SVCS	
1 - PROP./SUPPLY MGT. SVCS. CHIEF	21
2 - SR. ECONOMIST A	18
1 - DATA ENCODER-CONTROLLER	10
1 - CLERK-PROCESSOR B	6
PLNG., COORD. & MONIT. SVCS.	
1 - PROP./SUPPLY MGT. SVCS. CHIEF	21
2 - SR. ECONOMIST A	18
1 - DATA ENCODER-CONTROLLER	10
1 - CLERK-PROCESSOR B	6

FUEL

60

FUEL OPERATIONS & CUSTODIANSHIP	SG
1 - DIV. MANAGER A	24
1 - SECRETARY A	9
GROUP 1 OPERATIONS	
1 - PRIN. ENGINEER B	21
1 - PRIN. ENGINEER C	20
1 - CLERK-PROCESSOR B	6
BATANGAS DEPOT	
1 - PLANT EQPT. OPERATOR B (CUSTODIAN)	14
4 - PLANT EQPT. OPERATOR C	12
4 - PLANT EQPT. OPTR. D	11
SUBIC	
1 - PLANT EQPT. OPERATOR B (CUSTODIAN)	14
4 - PLANT EQPT. OPERATOR C	12
4 - PLANT EQPT. OPTR. D	11
MALAYA	
1 - PLANT EQPT. OPERATOR B (CUSTODIAN)	14
4 - PLANT EQPT. OPERATOR C	12
4 - PLANT EQPT. OPTR. D	11
MANILA	
1 - PLANT EQPT. OPERATOR B (CUSTODIAN)	14
5 - PLANT EQPT. OPERATOR C	12
GROUP 2 OPERATIONS	
1 - PRIN. ENGINEER B	21
1 - PRIN. ENGINEER C	20
1 - CLERK-PROCESSOR B	6
CALACA	
1 - PRINCIPAL ENGINEER B	21
4 - PRINCIPAL ENGINEER C	20
4 - PLANT EQPT. OPERATOR C	12
BATAAN	
1 - PRINCIPAL ENGR. C	20
1 - PRINCIPAL CHEMIST	20
3 - PLANT EQPT. OPERATOR C	12
BOPEKELL	
1 - PLANT EQPT. OPERATOR B (CUSTODIAN)	14
4 - PLANT EQPT. OPERATOR C	12

Table 7-2-6

BATAAN THERMAL POWER PLANT

TABLE OF ORGANIZATION

SUMMARY:

OM	- 2
EFF CTLR.	- 7
SUPPORT SVCS.	- 21
OPRNS	-144
MAINT	- 94
Total	268

268

OFFICE OF THE PLANT MANAGER

1 - PLANT MANAGER
1 - SECRETARY — 2

7

EFFICIENCY CONTROL GROUP

1 - PRIN.EFF.CONTROL ENGR. A
2 - PRIN.EFF.CONTROL ENGR. B
2 - SR. EFF. CONTROL TECH'N
1 - RECORDS OFFICER
1 - DATA CTLR./ENCODER

21

SUPPORT SERVICES SECTION

1 - CHIEF, SUPPORT SERVICES

ADMINISTRATION
1 - SR. HR ANALYST
1 - HR ANALYST
1 - PROCUREMENT OFFICER
1 - GH CARETAKER
1 - PLANT NURSE
1 - DRIVER/MESSENGER
2 - DRIVER/MECHANIC
1 - CIVIL SECURITY OFFICER
1 - SUPVG. SECURITY GUARD
1 - SENIOR CLERK

FINANCE
1 - SR. FINANCIAL ANALYST
1 - FINANCIAL ANALYST
1 - SR. BOOKKEEPER
1 - SR. CASHIER

PROPERTY
1 - SUPVG. PROPERTY OFFICER
1 - PROPERTY OFFICER
1 - PROPERTY CLERK
1 - RECEIVING/ISSUING CLERK
1 - HELPER

144

OPERATIONS

1 - OPERATION MANAGER
1 - DATA CTLR./ENCODER

94

MAINTENANCE

1 - MAINTENANCE MANAGER
1 - DATA CTLR./ENCODER

6

PLANNING & SCHEDULING GROUP

1 - PRIN. ENGINEER A
3 - PRIN. ENGINEER B
1 - SPAREPARTS ENGR.
1 - DATA CTLR./ENCODER

15

CHEMICAL OPERATIONS*

1 - CHEMICAL SUPT.
6 - PRIN. CHEM. ENGINEER B
2 - SR. CHEMICAL ENGINEER
6 - SR. CHEMICAL TECHNICIAN

22

GAS TURBINE

5 - OPERATIONS PRIN. ENGR. B
5 - SR. CONTROL OPERATOR A
10 - EQUIPMENT OPERATOR C
2 - ELECTRICIAN I / C

* Chemical operation personnel assigned in shift work shall report to the Shift Superintendent.

185

SHIFT OPERATIONS

5 - OPERATION SUPT.
10 - OPERATION PRIN. ENGR. B

BOILER
10 - SR. BOILER CTRL. OPTR. B
10 - SR. BOILER OPERATOR
10 - BOILER AUX. OPERATOR
10 - BOILER AUX. OPERATOR (PH)

TURBINE
10 - SR. TURBINE CTRL. OPTR. B
10 - SR. TURBINE OPERATOR
10 - SR. TURBINE AUX. OPTR.
5 - TURBINE AUX OPERATOR (SH)

ELECTRICAL
5 - SR. ELECT'L CTRL. OPTR. B
5 - SR. ELECT'L OPERATOR
5 - SR. OPERATIONS ELECT'M

86

MECHANICAL SECTION
1 - PRINCIPAL ENGINEER A
2 - PLT. MECH. MAINT. FOREMAN
2 - SUPVG. MACHINIST
8 - SR. PLANT MECHANIC

METAL WORKS SECTION
1 - PRINCIPAL ENGINEER A
2 - BOILERMAKER FOREMAN
4 - BOILERMAKER 1/C
4 - BOILERMAKER 2/C
2 - PIPEFITTER FOREMAN
8 - PIPEFITTER 1/C
6 - WELDER 1/C

ELECTRICAL SECTION
1 - PRINCIPAL ENGINEER A
1 - ELECT'L MAINT. SUPV'R
3 - ELECTRICAL FOREMAN
8 - SR. PLT. ELECTRICIAN
4 - PLT. ELECTRICIAN A
1 - PLT. ELECTRICIAN B

INST. & CONTROL SECTION
1 - PRIN. ENGINEER A
1 - PRIN. I & C ENGR. B
2 - SUPVG. I & C ENGR. A
7 - SUPVG. INSTRUMENT TECH'N.
2 - SR. INSTRUMENT TECH'N.

GENERAL SERVICE SECTION
1 - PRINCIPAL ENGINEER B
2 - SR. PLANT PAINTER
2 - INSULATION MAN
1 - HEAVY EQUIPMENT OPERATOR
2 - PLUMBER
2 - CARPENTER/MASON
5 - PLANT HELPER A

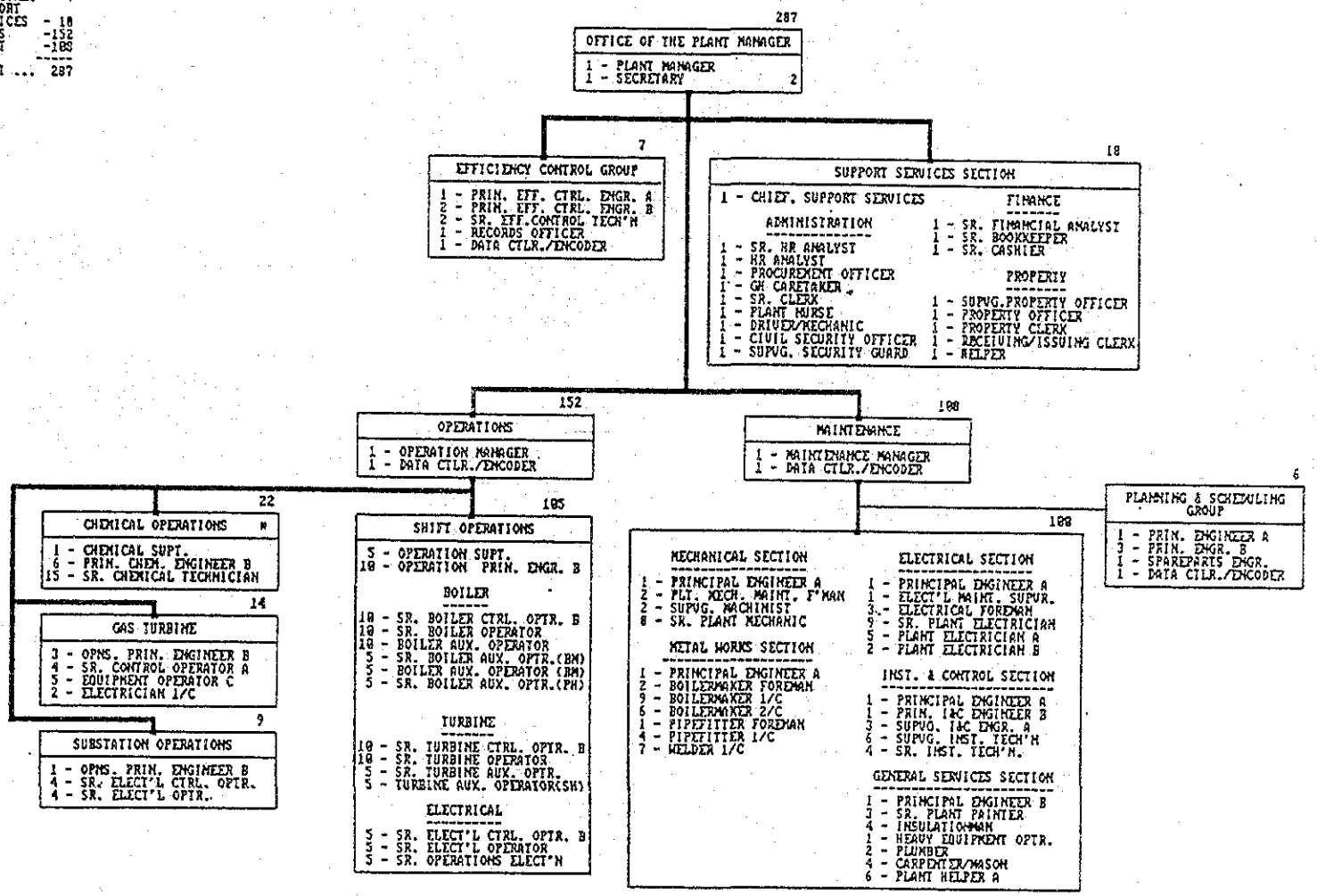
Table 7-2-7

MALAYA THERMAL-POWER PLANT

TABLE OF ORGANIZATION

SUMMARY:

OM	- 2
EFF CTRL.	- 7
SUPPORT SERVICES	- 18
OPNS	-152
MAINT	-108
Total ...	287



Chemical Operations personnel assigned in shift work shall report to the Shift Superintendent.

Table 7-2-8

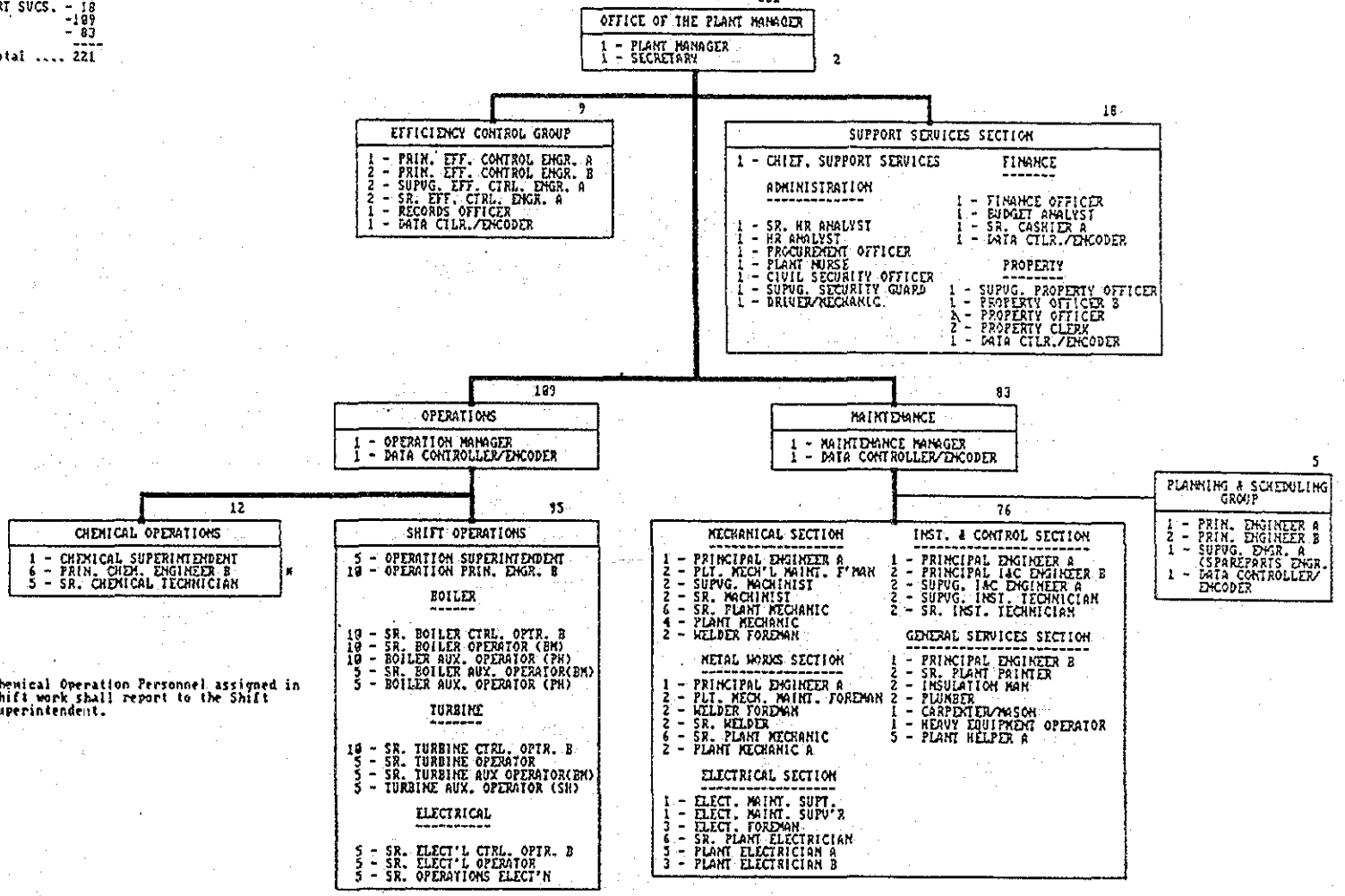
MANILA THERMAL POWER PLANT

TABLE OF ORGANIZATION

221

SUMMARY:

OM	- 2
EFF CONTROL	- 9
SUPPORT SVCS.	- 18
OPRNS	-109
MAINT	- 83
Total	221



* Chemical Operation Personnel assigned in shift work shall report to the Shift Superintendent.

Table 7-2-9

SUCAT THERMAL PLANT

TABLE OF ORGANIZATION

404

SUMMARY:

OM	- 2
EFFICIENCY CONTROL	- 11
SUPPORT SVCS.	- 28
OPERATIONS	-243
MAINTENANCE	-120
TOTAL	404

OFFICE OF THE MANAGER — 2

- 1 - PLANT COMPLEX MANAGER (M)
- 1 - SECRETARY

EFFICIENCY CONTROL GROUP — 11

- 1 - PRIN. EFF. CTRL. ENGR. A
- 4 - PRIN. EFF. CTRL. ENGR. B
- 4 - SR. EFF. CTRL. TECH'N
- 1 - RECORDS OFFICER
- 1 - DATA CONTROLLER/ENCODER

SUPPORT SERVICES — 28

- 1 - CHIEF, SUPPORT SERVICES

ADMINISTRATION	FINANCE	PROPERTY
1 - SR. HR ANALYST	1 - SR. FINANCIAL ANALYST	1 - SUPVG. PROPERTY OFFCR.
2 - HR ANALYST	1 - FINANCIAL ANALYST	2 - PROPERTY OFFICER
1 - SENIOR CLERK	2 - SR. BOOKKEEPER	3 - PROPERTY CLERK
1 - PROCUREMENT OFFICER	1 - SR. CASHIER	2 - RECEIVING/ISSUING CLERK
1 - PLANT NURSE		1 - TOOLKEEPER
1 - CIVIL SECURITY OFFICER		
3 - SUPVG.SECURITY GUARD		
1 - DRIVER/MESSENGER		
2 - DRIVER/MECHANIC		

OPERATIONS — 243

- 1 - OPERATION MANAGER
- 1 - DATA CTLR./ENCODER

MAINTENANCE — 120

- 1 - MAINTENANCE MGR.
- 1 - DATA CTLR./ENCODER 2

PLANNING & SCHEDULING GROUP — 9

- 1 - PRIN. ENGINEER A
- 6 - PRIN. ENGINEER B
- 1 - SPAREPARTS ENGR.
- 1 - DATA CTLR./ENCODER

PLANT 1-SHIFT OPERATIONS — 108

- 5 - OPERATION SUPT.
- 10 - OPTNS. PRIM. ENGR. B

BOILER

- 10 - SR. BOILER CTRL. OPTR B
- 10 - SR. BOILER OPERATOR
- 10 - BOILER AUX. OPERATOR
- 5 - SR. BOILER AUX. OPTR.
- 5 - BOILER AUX. OPTR. (BM)

TURBINE

- 10 - SR. TURBINE CTL. OPTR B
- 10 - SR. TURBINE OPERATOR
- 5 - SR. TURBINE AUX. OPTR
- 5 - TURBINE AUX. OPTR. (SH)

ELECTRICAL

- 5 - SR.ELECT'L.CTRL. OPTR B
- 5 - SR.ELECT'L. OPERATOR
- 5 - SR.OPTNS. ELECTRICIAN

PLANT 2-SHIFT OPERATIONS — 105

- 5 - OPERATIONS SUPT.
- 10 - OPERATIONS PRIM. ENGR B

BOILER

- 10 - SR. BOILER CTRL. OPTR B
- 10 - SR. BOILER OPERATOR
- 10 - BOILER AUX. OPERATOR
- 5 - SR. BOILER AUX. OPTR
- 5 - BOILER AUX. OPTR. (BM)
- 10 - SR. BOILER AUX OPTR(PH)

TURBINE

- 10 - SR. TURBINE CTRL.OPTR.B
- 10 - SR. TURBINE OPERATOR
- 5 - SR. TURBINE AUX. OPTR

ELECTRICAL

- 5 - SR. ELECT'L CTRL OPTR B
- 5 - SR. ELECT'L OPERATOR
- 5 - SR. OPTNS. ELECTRICIAN

PLANT 1 - CHEM'L. OPERATIONS — 19

- 1 - CHEMICAL SUPERINTENDENT
- 6 - PRIN. CHEM. ENGINEER B
- 12 - SR. CHEM. TECHNICIAN

PLANT 2 - CHEM'L. OPERATIONS — 17

- 1 - CHEMICAL SUPERINTENDENT
- 6 - PRIN. CHEM. ENGINEER B
- 10 - SR. CHEM. TECHNICIAN

MAINTENANCE — 109

MECHANICAL SECTION

- 1 - PRINCIPAL ENGINEER A
- 3 - PLT. MECH. MAINT. F'MAN
- 2 - SUPVG. MACHINIST
- 1 - SR. MACHINIST
- 7 - SR. PLT. MECHANIC
- 3 - PLANT MECHANIC

METAL WORKS SECTION

- 1 - PRINCIPAL ENGINEER A
- 3 - BOILERMAKER FOREMAN
- 5 - BOILERMAKER 1/C
- 2 - BOILERMAKER 2/C
- 3 - PIPEFITTER FOREMAN
- 5 - PIPEFITTER 1/C
- 2 - PIPEFITTER 2/C
- 8 - WELDER 1I/C
- 2 - WELDER 2/C

I & C SECTION

- 1 - PRINCIPAL ENGINEER A
- 2 - PRINCIPAL I&C ENGINEER B
- 4 - SUPVG. I&C ENGINEER A
- 8 - SUPVG. INST. TECH'N
- 3 - SR. INST. TECH'N

ELECTRICAL SECTION

- 1 - PRINCIPAL ENGINEER A
- 1 - ELECT'L MAINT. SUPVR.
- 4 - PLT. ELECT. MAINT. F'MAN
- 14 - SR. PLT. ELECTRICIAN
- 8 - PLT. ELECTRICIAN A
- 2 - PLT. ELECTRICIAN B

GENERAL SERVICES

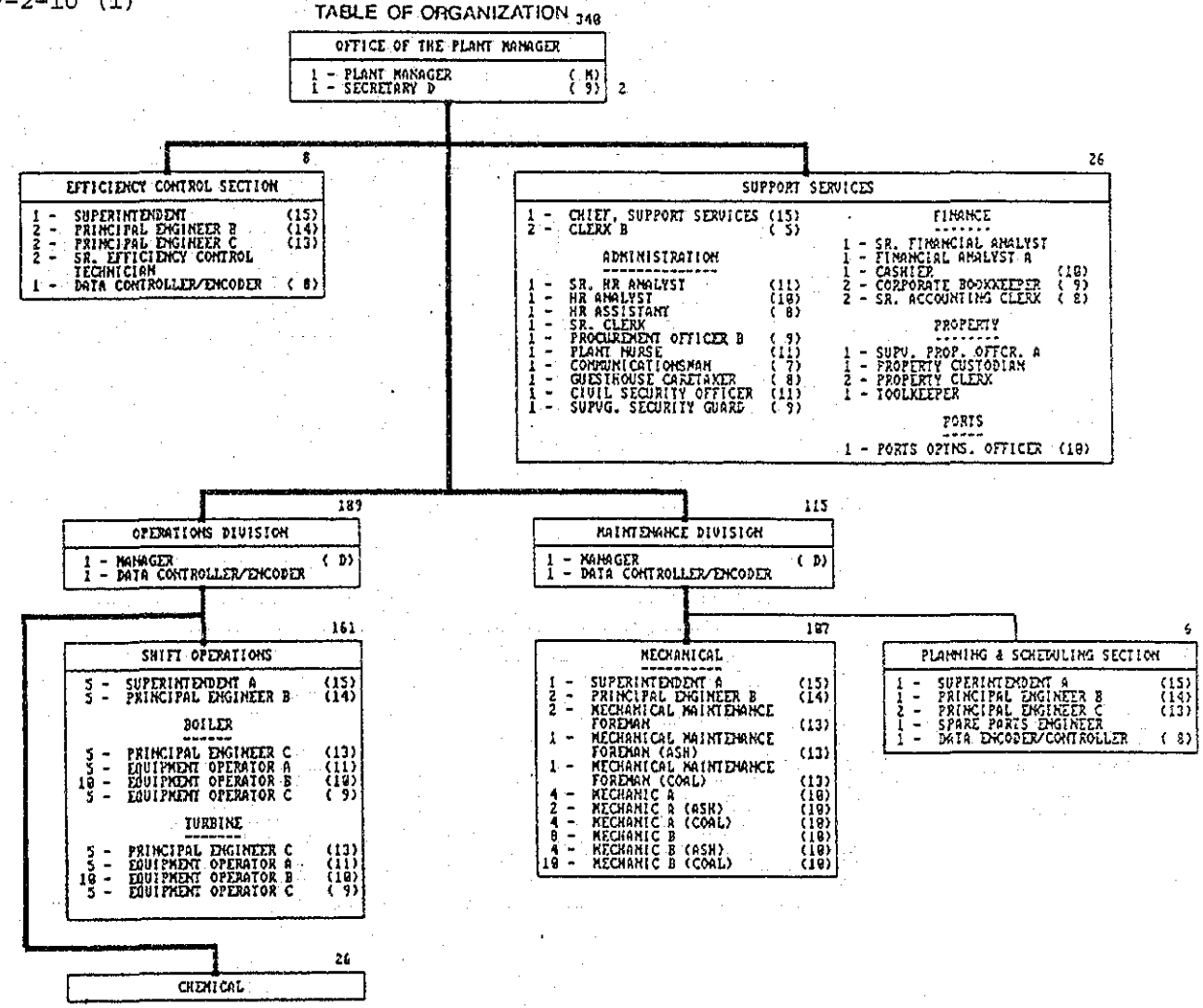
- 1 - PRINCIPAL ENGINEER A
- 2 - FOREMAN
- 4 - INSULATIONMAN
- 1 - HEAVY EQUIPMENT OPERATOR
- 2 - SR. PLANT PAINTER
- 1 - PLUMBER
- 2 - CARPENTER/MASON

Table 7-2-10 (1) BATANGAS COAL-FIRED THERMAL POWER PLANT

TABLE OF ORGANIZATION

SUMMARY:

Office of the Plant Manager	- 2
Efficiency Control	- 8
Support	- 26
Operations Division	-189
Maintenance Division	-115
T o t a l.....	340



SUMMARY:

Table 7-2-10 (2)

BATANGAS COAL-FIRED THERMAL POWER PLANT

TABLE OF ORGANIZATION

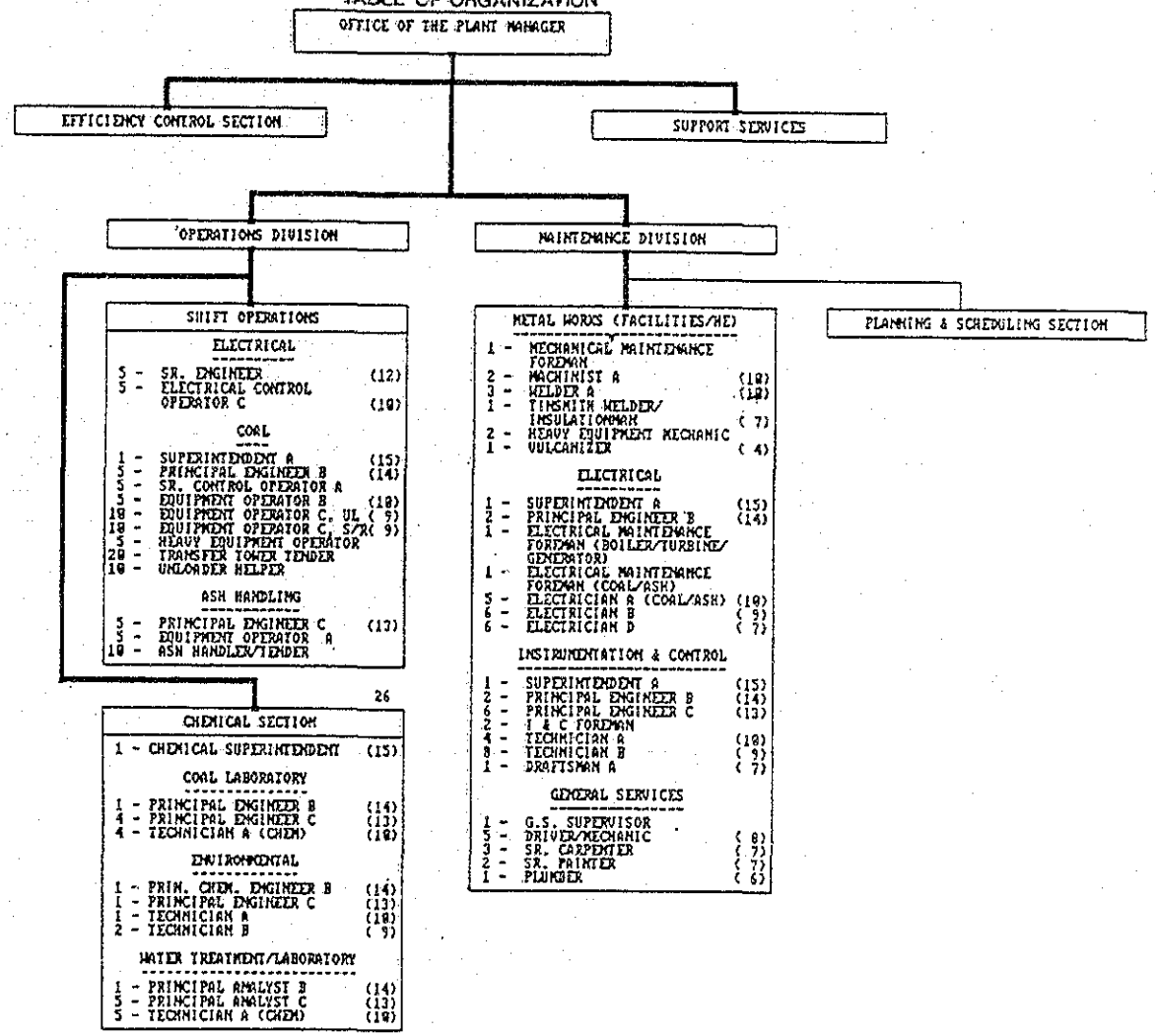


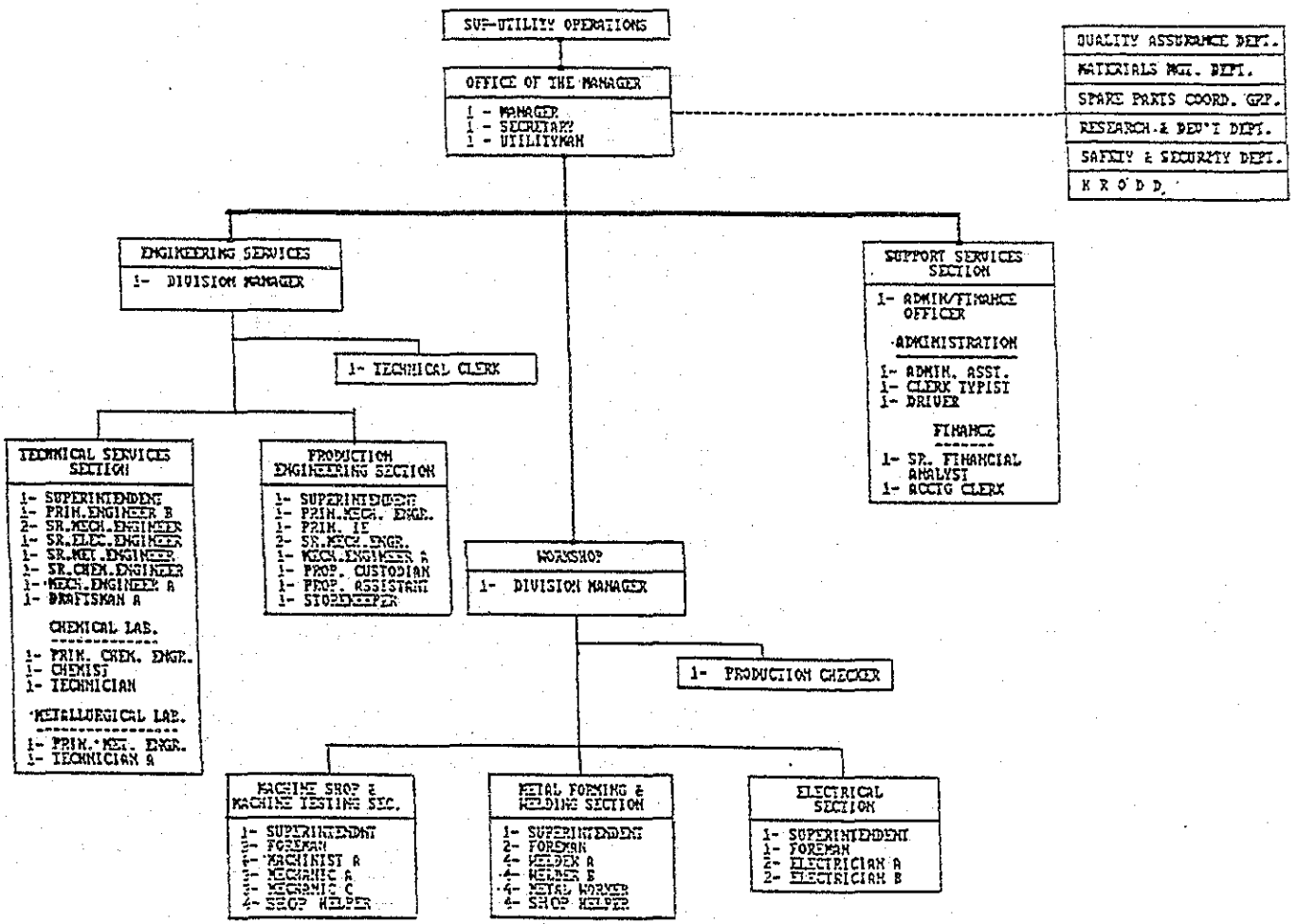
Table 7-2-11 MAINTENANCE ENGINEERING CENTER

1985–1990 TRANSITIONAL

TABLE OF ORGANIZATION

SUMMARY

OFFICE OF THE MGR.	- 3
SUPPORT SVCS.	- 8
ENG'G SVCS.	- 32
WORKSHOP	- 45
TOTAL	88



NOTE ALL POSITION TITLES & JOB LEVELS ARE SUBJECT TO FINAL EVALUATION BY THE JOB EVALUATION COMMITTEE

2. Operation and Maintenance Works

(1) Operation

a. Patrol inspection

The most important matter in daily operation is for the operators to be fully versed in the operating manual, and grasp and monitor the operating conditions of the equipment. For this, the patrol inspection must be carried out strictly, but actually, they are not made sufficiently. The examination of the causes of the loose patrol and inspection is a fundamental problem.

b. Check list

Improvement of the check lists for patrol inspection, development of the methods to enable the operators to detect abnormal indications of the supervisory instruments and judge the abnormal conditions of the equipment, and such practical measures should be studied and materialized. In short, it is necessary to make the operators have interest in, aspiration for, and responsibility in the operating job as their own profession.

c. Routine test

It was observed further that because routine patrol inspections as well as the routine tests were not carried out satisfactorily, the abnormal conditions were often found late.

d. Maintenance request slip

Even when abnormality of operating equipment, leakage of water, steam, and oil, etc. are discovered, the request slip for the repair is not issued timely. As a result, a

small abnormality becomes a cause of larger damages and accidents requiring larger maintenance expenses.

e. Chemical activity

The same is found with the routine chemical activities. The analysis of data and diagnosis of the chemical conditions should be made timely, and appropriate countermeasures should be taken.

(2) Maintenance

The most prominent cause of the decline of power plant output is incomplete maintenance. The major problems in the performance of the maintenance works are listed below:

a. Daily maintenance

Routine inspections are not strictly carried out, and witness by the maintenance personnel of the routine tests carried out by the operators is not clearly specified. Review of the daily maintenance manual is necessary.

b. Disposition of maintenance request slips

The processing speed of the maintenance request slips issued by the operation section differs by the power plants. At some power plants, it takes a long time from the issuance of the slip to the actual repair by the maintenance section. Speedier processing is necessary. Lack of parts or spare parts, or delay in the delivery of ones makes it difficult to repair the defective equipment timely. The measures to remedy this situation are necessary.

c. Periodical equipment diagnosis

The operating conditions of the equipment are diagnosed by the examination of the data of vibration, pressure, temperature, noise, flow, etc. measured periodically.

The following activities of the periodical equipment diagnosis are not carried out strictly;

(a) Periodical measurement
(b) Management of the measured data
(c) Diagnosis by the managed data
(d) Reporting of the diagnosis results
(e) Decision of countermeasures for diagnosis results reported.

The improvement of the above situation should be made through the review of the organization and the education.

d. Periodical overhaul

The periodical overhaul is the most important of the maintenance works for the continuous and reliable operation of the power plant. The following must be paid attention to in performing the overhaul:

(a) Boiler is to be overhauled once every year as a rule.

(b) Turbine is to be overhauled once every two years for simple inspection and once every 4 years for detailed inspection as a rule.

(c) Parts, equipment and materials necessary for the periodical overhaul must be confirmed in the inventory and, if necessary, purchase arrangement must be made.

(d) Imported parts, equipment and materials should be procured to detailed specifications, and their timely delivery must be secured.

(e) Transporting, lifting, and moving equipment and vehicles (e.g., overhead traveling crane, winch, large truck, folk lift, etc.) must be inspected and maintained for ready use, and the necessary number must be secured.

(f) Special equipment, materials, and tools for disassembling and assembling (e.g., wire rope, special tools for the turbine, etc.) must be prepared and inspected regularly for ready use, and the necessary number must be secured.

(g) Special packings, oils and fats, and chemicals must be secured.

(h) Necessary consumables must be prepared.

(i) An organization for inspection must be set up for reliable performance of the tests, and test equipment must be prepared.

(j) The necessary volume of demineralized water must be secured.

(k) Necessary safety measures must be taken.

(l) Necessary environmental protective measures must be taken.

(m) Suitable working environment must be established (cleaning and arrangement in order).

Since preparation of these items are not satisfactory, unnecessary time lags occur, and decision of the measures for unexpected event is delayed. These often cause the delay of the overhaul work schedule.

Further, the overhaul itself is sometimes forced to be postponed for a year or more to supply the power in place of the other power plant which happens to be shut down, and the deterioration of the equipment advances due to overwork without proper maintenance. This is a critical problem. These seem to be crucial faults in NAPOCOR's power demand and supply program and operation. Fundamental countermeasures are required.

3. Training and Education

(1) The Head Office prepares the training and education program for the operation and maintenance staff of thermal power plants, but the confirmation of the effect of the training and education is not made.

At the thermal power plants, new employees are assigned to the jobs immediately after a simple orientation is given, and on-the-job training is made in the actual work. The operators seem to be making group studies in each shift.

(2) Thus, it is observed that the basic education for the operators and maintenance crew and also the education/training in the basic technique for their coping with the faults and trouble shooting are not sufficient.

It is necessary to make the training courses to enable the operators to make proper judgment of the causes and to take adequate measures in case of the troubles, and to enable the maintenance crew to clarify the causes, to remedy and repair, and to take preventive measures against recurrence of the troubles.

(3) Safety Control and Education

There is a section in charge of safety in the Head Office, where the basic safety manual and education materials are prepared, but actually no practical results have been achieved for lack of the budget, staff and education aids.

4. Procurement and Management of Equipment and Materials

(1) Procurement of Equipment and Materials

a. Delay of delivery to power plants

The most important problem in the maintenance of the power plants is the procurement of equipment and materials. The following factors revealed in the present study are considered to be the responsibility of the power plants.

- As the issuance of the purchase requisition slips is delayed and the time for the necessary procurement procedure is too short for the delivery to be made timely.

- Because of defective procurement specifications, extra time is required in the procurement procedure.

b. Future problems

The above problems are not of the nature that can be remedied by the recent reorganization, and seem to be caused by the following.

(a) Slipshod procurement plan

- The delivery period for the goods to be procured was not examined beforehand,

. Although the delivery period was known, the request for procurement was made too late, etc.

These problems would be prevented if the yearly and monthly maintenance programs are made in advance and the progress of the program is checked from time to time. The larger the volume of works, the better planned execution is needed.

(b) The sections in charge of engineering and maintenance are not strong enough.

Generally, the persons in charge in the power plant should know best the articles to be procured. And the reasons for occurrence of these problems are considered to be as follows.

. Available specifications for the goods to be procured are not satisfactory.

. The persons in charge do not take the time and labor of requesting the detailed specifications from the manufacturers.

. The standard specifications lacks the reference drawings.

If these are the problems, the remedy should be worked out at this opportunity of reorganization. It should be started with the clarification of which section of which department is in charge of these activities.

(2) Procurement of Fuel

a. Major reform

The management of fuel (including receiving and transport of fuel) is an important work in the thermal power plant. By the recent reorganization, the Fuel Management Department was created in MMRC. The new organization is shown in Table 7-2-5.

b. Features of the reform

(a) Fuel Management Department takes the charge of and controls the heavy oil, light oil, and coal used in the thermal power plants, from the procurement to the receiving and transportation.

(b) The personnel engaged in the receiving and storing of the fuel belong to this Fuel Management Department.

- The personnel in charge of fuel belonged to the power plants, but used to receive the directives from MMRC. This incoherent condition was rectified by the reorganization, but the actual activities including the liaison between MMRC and the power plants remain unchanged.

c. Future problems

The deterioration of the domestic coal (Run of mine) quality and the foreign matters mixed in the coal at Batangas Power Plant make the obstacles in the operation and the cause of environmental pollution. The increase of the tonnage of the coalers should also be considered.

(3) Management of Equipment and Materials

a. Inventory control

The Planning and Scheduling Group of the power plant is in charge of the inventory control. Even though the computer is used for the inventory control, the inventory should be reconfirmed from time to time and the responsibility of inventory must be clearly defined.

b. The plan of procurement of spare parts is controlled by the Materials Management Department of the Head Office.

It would be necessary to review and readjust the kinds and quantity of the spare parts in stock based on the record of past use, and it would be necessary also to readjust the stock of common spare parts with the other power plants.

In some cases, large and expensive spare parts are kept in store more than 10 years and are deteriorating.

c. Responsibility of inspection and acceptance

Who has the responsibility for the inspection and acceptance of the delivered goods does not seem to be clearly stipulated, and consequently there are many cases where accepted goods are neglected as unusable, because they are not conforming to the specifications, but defective, in short of accessories, etc.

d. Method of storing

There are many cases where the spare parts, equipment and materials in store, especially the special materials, precision instruments, chemicals, etc. become unusable because of poor method of storing. Sometimes used/defective or rejected parts are stored together with

unused/ready spares.

e, Procurement

The authorization of procurement is classified into the following.

Power Plant	Less than 20,000 pesos (Less than ¥100,000.-)
MMRC	20,000 to 1 million pesos (¥100,000.- to ¥5 million)
Head Office	More than 1 million pesos (More than ¥5 million) including all foreign purchase

As the authority delegated to the power plant is so small that most of the procurement request slips are submitted to MMRC for disposition. By the recent reorganization, all the procurement activities of MMRC was absorbed by the Head Office and simplified.

Even though the practical disposition of the procurement is carried out in the Head Office, the authorization of decision making had better be reviewed and readjusted.

5. Performance and Efficiency Management

In the routine management of the performance of the equipment, the characteristic values should be measured periodically and recorded for diagnosis of the conditions of the equipment and decision of countermeasures to be taken.

The plant efficiency should be checked by major daily data, and if abnormal conditions are discovered, further detailed check should be made and necessary countermeasures should be taken.

Especially before and after the periodical overhaul, and periodically once a year, the performance test of the plant should be carried out to grasp the conditions of the plant correctly. At present, neither the routine management of the plant performance nor accurate efficiency management is considered to be sufficiently made.

Even if system demand does not permit performing regular tests of the units, the plant should carry out the performance test at the load the unit has been operated in order to check the performance by means of plotting the data on the characteristic curves.

7.2.2 Recommendations of Maintenance Management and Operation and Maintenance Improvement Program

With a view to solving the problems in the operation and maintenance discussed in Sub-clause 7.2.1 and to effect improvement, the Survey Team recommends basically the following program for each item.

1. Organization for Operation and Maintenance Management

(1) MMRC

a. The operating procedures for the Operations Project Services and the Maintenance Services under the new organization should be established quickly.

It is recommended especially that the scope of works for MMRC and that for the power plant be discussed between MMRC and the power plant and defined.

b. The necessary personnel should be secured and assigned strategically.

(2) Power Plants

a. Efficiency Control Group

This group should work positively, as the organ to promote the improvement of the operation and maintenance of the power plant, and for this the following are recommended.

(a) To prepare the technical manual with definite job descriptions of the group.

. By this, each member of the group would know his duty precisely.

. The routine activities, the timing of their

execution, the type of documents to be prepared and where to submit them will be described in detail.

. The liaison and consultations with the Head Office and the Operations Project Services of MMRC will be clearly described.

(b) Periodical liaison and consultation should be made not only between the Operations and Maintenance Divisions but also with the Support Services in the power plant. This group will act as the coordinator on such occasions.

(c) It may be advisable to assign the handling of environmental problems to this group.

b. Maintenance Division

The maintenance manual covering the works of the newly formed planning and scheduling group should be prepared. The contents of this manual will follow generally the content of Item (a) for the Efficiency Control Group.

c. Necessary personnel should be secured and assigned strategically.

2. Performance of Operation and Maintenance

(1) Improvement of Daily Operation Management

a. To carry out the daily, weekly and monthly patrol inspections strictly.

b. To carry out the daily, weekly and monthly routine tests strictly.

c. To communicate on and report the abnormalities of the plant speedily when discovered.

d. To take early and appropriate countermeasures.

e. To issue the maintenance request slips timely.

(2) Improvement of Daily Maintenance Management

a. To put the marking of the limit values and allowable ranges on the supervisory instruments and meters.

b. To mark the recorder papers and check sheets with the limit values.

c. To attach name plates or put the names on all the equipment, piping and valves.

d. To take the measurements of the equipment data periodically.

e. To make the statistical management of the data and diagnosis.

f. To dispose of the maintenance request slips quickly.

Thus some method should be devised to motivate the individual operators and maintenance crew members to take interest in the problems close to them and encourage them to work positively.

(3) Improvement of Periodical Overhaul Management

The periodical overhaul is important for the proper maintenance of the power plant equipment and for the improvement of the plant efficiency, and should be planned carefully and carried out completely. The current overhaul management system where the organization for the overhaul is formed for individual overhauls should be improved so that the

following may be achieved satisfactorily.

a. Review of responsibility in overhaul organization

The plant manager is the supreme manager (project manager) responsible for the periodical overhaul, but the system in which the maintenance manager takes the responsibility as the actual manager in place of the plant manager should be studied.

b. Close coordination between MMRC and QA and defining of the responsibility should be made.

c. Sufficient preparation for the overhaul

- Inspection and repair of the overhauling equipment and materials.

- Securing of equipment and materials.

d. Prompt and right judgment on the results of inspections and tests.

e. Joint confirmation by the responsible supervisor and the representative of the maintenance executing party at appropriate times.

f. Preparation of working environment.

- Safety countermeasures

- Measures for safe keeping of the equipment and materials.

g. Effective utilization of MEC and close cooperation with BHPI and other contractors.

h. Establishment of inspection organizations and improvement of reliability of inspection.

i. Improvement of the equipment and materials procurement system.

(4) Operation and Maintenance Manuals

There are some differences by the power plants, but most power plant use the manuals submitted from the manufacturers at the time of commissioning as they were. These manuals should be revised with the later changes of equipment and system and the later experiences incorporated.

(5) Enhancement of MMP Functions

Establishment of the MMP is very effective. Further, the following functions should be added:

a. Performance management function to diagnose the plant/equipment performance.

b. Supervisory function to detect abnormal values and abnormal tendencies.

And in case of abnormal conditions, the MMP should detect the cause promptly and take the initiative for the countermeasures. The Survey Team recommends more effective utilization of the MMP.

3. Training and Education

(1) The training and education should be given not only to operating and maintenance technical staff but to the administrative staff with well-defined educational curricula and schedules.

(2) Further, the education and training program should be utilized for reeducation to raise the levels of the employees already in service.
Especially, the basic education and training for new employees and the education and training for the middle-level employees should be strengthened. Also, the job rotation system should be introduced to have the operators get versed in all the positions.

(3) It is desired that the training center planned in the compound of Bataan Nuclear Power Plant be used effectively for fundamental education and basic technical training of the operation and maintenance staff with certification program. Especially the installation of Simulator for training operators of thermal power plants should be expedited.

(4) It is necessary to formulate an education program to introduce the management officers including the top management to the newly developed technology and quality control concepts.

(5) It would make an effective means of training to hold meetings for analysis and discussions of accidents and troubles in the power plant and make the field training in the countermeasure against troubles.

(6) Personnel rotations within and between power plants, from the operation section to the maintenance section for example, is also recommended for further consideration.

4. Procurement and Management of Equipment and Materials

(1) Improvement of Procurement System for Spare Parts, Parts and Consumables

a. The purchase authority of the power plant manager should be increased so that the period of delivery may be minimized.

b. Preparation of standard purchase specifications must also be taken up as the study item.

c. The registered supplier system should be adopted for the procurement of the equipment and materials, and the supplier qualification criteria should be prepared.

d. For the procurement of special equipment and parts and for the emergency procurement, the nominated or preferred ordering should be permitted more flexibly if a strong economic justification/evaluation is presented.

(2) Improvement of Acceptance System

The section in charge of the inspection and acceptance of the delivered equipment and materials and the responsibility of acceptance should be defined clearly in the framework of the procurement system. One method may be the utilization of resident Q.A. effectively.

(3) Improvement of Inventory Management

a. The computer data of inventory should be verified periodically with the actual stock.

b. The method of storing of the spare parts common to the power plants should be studied or installation of central/regional warehouse.

c. The method of storing of the special materials, precision equipments, chemicals, etc. will be improved.

For the improvement of the above, the manual stipulating the practical actions should be prepared and used in the actual acceptance work.

(4) Improvement of As-received Coal Quality

Foreign matters are often found mixed in the domestic coal