8．1．5　評価結果

1）発電量と発電原価

WithとWithoutの発電量及び平均発電原価の比較表を下記に示す。Withの場合の発電原価は夫々のリハビリ工事投資額を15%の割引率にて年平均化したものを考慮し，夫々の運転期間の平均値である。

	1号機		2号機	
	With	Without	With	Without
発電量　(GWh)	12，877	8，032	25，754	18，172
発電原価 (P/kWh)	1．3108	1．2249	1．0024	1．0383

注：Table 8-3 マラヤ発電所運転状況参照

発電量比較については，Withoutの場合利用率の低下が当然のごとく大きく影響し，Withの場合と比べて1号機で約60%，2号機で70%にまで落ち込んでいる。これらの不足分を他社からの購入に頼らざるをえないとすると，この観点からのWithの経済的な意義は大きい。

一方，Withの発電原価は多額のリハビリ工事のための投資によりWithoutより高くなるが，それでもなおNPCのルソン系統平均売電単価である1.8505ペソ/kWh以内であり，かつ，他社からの購入原価を下回っている。

2）ベースケース

内部収益率計算過程をTable 8-3に示す。（エクセル Ver．5.0による。）補充電源別のベースケース（Withケースの場合，利用率70%，燃料価格15US$／bbl.）の場合の1号機のみ，2号機のみ，及び1・2号機総合した，各ケースの経済的内部収益率を下表に示す。

	1号機のみ	2号機のみ	1・2号機総合
NPCルソン系統 －平　均	2．27%	26．65%	12．32%
－石油火力	1．34%	25．47%	11．35%
－石炭火力	3．74%	28．52%	13．86%
－地　熱	1．39%	25．53%	11．40%
－ガスタービン	25．46%	58．77%	37．40%
他社より購入 －平　均	21．57%	52．97%	33．06%
－石油火力	17．60%	47．23%	28．69%
－石炭火力	15．29%	43．97%	26．17%
－ガスタービン	32．65%	69．94%	45．59%

3）感度分析

Withケースの運転利用率及びプロジェクトコストに対するEIRRの感度を分析した。燃料費に対する感度については，燃料単価が高くなればなるほどEIRRの価は下がることが判明した。これは，Withケースの方がWithoutケースより発電量が多く，燃料消費量が大きいことに起因する。しかしながら，燃料価格及び効率の概念を補充電力発電原価に組み入れることがもし可能であれば，代替石油火力，ガスタービンに対する本プロジェクトのEIRRは上記と逆の傾向となることは容易に予測される。一方，石炭火力に対しては石炭の価格が石油より比較的安価なため，上記と同様な傾向となるであろう。

Withケースの利用率を70%から45%に変化した場合，更に総プロジェクトコストを1.4倍から0.85倍にした場合のEIRRの変化を求めた。結果はTable 8-4, Figures 8-1, 8-2に示す。

4）結　論

経済的利益の回収期間が１号機の場合７年とプロジェクトコストの額に対して比較的短期間であることが，総合的な本プロジェクトの経済評価を低いものにしている。２号機の場合は投資額も少なく，利益回収期間も長いためすべての代替案に対して15%のハードルレートを越え，２号機リハビリの経済的妥当性を示している。

フィリピンにおける本プロジェクト対象の単機容量同等の電源開発については，石炭火力の開発に集中しておりWithoutケースの場合，補充電力供給に石炭火力に依存することになると考えられ，この場合EIRRは13.86%となりNEDAの設定値15%をクリアーしないまでも，現行のフィリピンの割引率12%は十分越えており，NPCの立場としての経済性はあると判断される。

感度分析の結果からはWithケースの稼働率に対する感度が高いことが判明し，僅かな稼働率低下が，石炭火力に対してさえも，本プロジェクトの経済性を危うくし，この観点からも，プロジェクトが実施された場合，プラントの信頼性，有効性の維持が肝要である。同様に，石炭火力を第一の代替と考えた場合，プロジェクトコストは若干であるが増加することも可能である。補充電力を他社からの電力購入で賄う場合，すべての電源の場合において，NPCは経済的に本プロジェクトを実施した方がよいと結論付けられる。即ち補充電源として他社からの電力購入を増加させるより，NPCにてリハビリを実施し，マラヤ発電所を運転したほうが経済的であるということである。

Table 8-1 マラヤ発電所運転実績

Project Malaya Reliability Improvement Project
Subject MTTP Operating Conditions CY 1989 to 1993
File Name ope_con/Sheet1
Date 21/11/94
Rev. 18/01/95

Table 8-1 Malaya TPP Operating Record

No. 1 Unit Up to Aug. 1994

Code	Description	Unit	1989	1990	1991	1992	1993	*1994	Average up to 1993
A	Rated Output	MW	300	300	300	300	300	300	300
B	Average Load	MW	250	268	243	209	177	84	229
C	Total Power Production	GWh	1,567.67	2,106.00	1,581.00	1,245.00	1,159.04	329.94	1,531.74
D	Service Hours	Hr	6,265.34	7,863.42	6,521.29	5,949.17	6,553.54	3,960.46	6,630.55
E	Outage Hours	Hr	2,494.66	896.58	2,238.71	2,834.83	2,206.46	1,895.54	2,134.25
	a. Planned outage	Hr	0.00	212.75	837.73	1,216.97	0.00	0.00	453.49
	b. Forced outage (within)	Hr	2,429.33	683.83	1,400.98	1,617.86	2,206.46	1,895.54	1,667.69
	c. Forced outage (outside)	Hr	65.33	0.00	0.00	0.00	0.00	0.00	13.07
	d. Maint. outage	Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F	Aux. Power Ratio	%	3.00	3.00	3.19	3.62	3.26	n/a	3.21
G	Utilization factor	%	71.52	89.77	74.44	67.91	74.81	67.63	75.69
H	Capacity factor	%	59.65	80.14	60.16	47.37	44.10	18.78	58.29
I	Heat Rate	BTU/kWh	10,431	10,883	10,934	11,494	11,575	16,787	11,063.40
J	Frequency of Start/Shutdown		22	19	15	19	16	9	18.2
K	Fuel Consumption	Mil. lit	409.08	573.37	432.45	357.99	335.62	138.56	421.70
	a. Bunker-C	Lit/kWh	0.2609	0.2723	0.2735	0.2875	0.2896	0.4200	0.2768
	b. Light Oil	Lit/kWh	N/A	N/A	N/A	N/A	N/A	N/A	

No. 2 Unit

Code	Description	Unit	1989	1990	1991	1992	1993	1994	Average
A	Rated Output	MW	350	350	350	350	350	350	350
B	Average Load	MW	280	292	287	222	131	271	242
C	Total Power Production	GWh	2,209.31	2,197.69	1,897.06	1,828.97	440.50	701.48	1,714.71
D	Service Hours	Hr	7,883.75	7,533.16	6,604.13	8,229.64	3,360.98	2,612.30	6,722.33
E	Outage Hours	Hr	876.25	1,226.84	2,155.87	554.36	5,399.02	3,243.70	2,042.47
	a. Planned outage	Hr	750.97	694.21	1,658.20	0.00	4,524.42	2,113.18	1,525.56
	b. Forced outage (within)	Hr	113.85	532.63	497.67	554.36	874.60	1,130.52	514.62
	c. Forced outage (outside)	Hr	11.43	0.00	0.00	0.00	0.00	0.00	2.29
	d. Maint. outage	Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F	Aux. Power Ratio	%	2.50	2.50	2.70	3.45	7.63	n/a	3.76
G	Utilization factor	%	90.00	85.99	75.39	93.95	38.37	44.61	76.74
H	Capacity factor	%	72.06	71.68	61.87	59.65	14.37	34.23	55.93
I	Heat Rate	BTU/kWh	9,909	10,021	9,945	10,554	11,321	16,787	10,350.00
J	Frequency of Start/Shutdown		7	10	7	8	9	9	8.2
K	Fuel Consumption	Mil. lit	547.67	550.94	471.97	482.89	124.76	294.59	435.65
	a. Bunker-C	Lit/kWh	0.2479	0.2507	0.2488	0.264	0.2832	0.4200	0.25892
	b. Light Oil	Lit/kWh	N/A	N/A	N/A	N/A	N/A	N/A	

No. 1 & 2 Units

Code	Description	Unit	1989	1990	1991	1992	1993		Average
A	Rated Output	MW	650	650	650	650	650	650	650
B	Average Load	MW	530	560	530	431	308	355	472
C	Total Power Production	GWh	3,777	4,304	3,478	3,074	1,600	1,031	3,246
D	Service Hours	Hr	14,149.09	15,396.58	13,125.42	14,178.81	9,914.52	6,572.76	13,352.88
E	Outage Hours	Hr	3,370.91	2,123.42	4,394.58	3,389.19	7,605.48	5,139.24	4,176.72
	a. Planned outage	Hr	750.97	906.96	2,495.93	1,216.97	4,524.42	2,113.18	1,979.05
	b. Forced outage (within)	Hr	2,543.18	1,216.46	1,898.65	2,172.22	3,081.06	3,026.06	2,182.31
	c. Forced outage (outside)	Hr	76.76	0.00	0.00	0.00	0.00	0.00	15.35
	d. Maint. outage	Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F	Aux. Power Ratio	%	-	-	-	-	-	-	-
G	Utilization factor	%	80.76	87.88	74.92	80.71	56.59	56.12	76.17
H	Capacity factor	%	66.33	75.58	61.08	53.84	28.09	27.10	56.99
I	Heat Rate	BTU/kWh	-	-	-	-	-	-	-
J	Frequency of Start/Shutdown		29	29	22	27	25	18	26.4
K	Fuel Consumption	Mil. lit	956.75	1124.31	904.42	840.88	460.38	433.15	857.35
	a. Bunker-C	Lit/kWh	-	-	-	-	-	-	-
	b. Light Oil	Lit/kWh	-	-	-	-	-	-	-

Source: Malaya Thermal Power Plant

GENERATING COST

Total Operating Cost	Thou P.	2064.52	3895.26	4385.9	2974.34	1764.45	3,016.89
Capital Expenditure	Thou P.	53.58	2.96	6.34	4.03	2.34	13.85
Total Cost	Thou P.	2118.1	3898.22	4392.24	2978.37	1766.79	3,030.74
Generating Cost	Peso/kWh	0.54661	0.9051	1.26102	0.96759	1.1031	0.9567

Table 8-2 マラヤ発電所運転コスト

Project Malaya Reliability Improvement Project
Subject MTTP Operating Conditions CY 1989 to 1993
File Name ope_con Sheet2
Date 11/21/94
Rev. 1/18/95

Table 8-2 Malaya TPP Operating Cost

No. 1 & 2 Units

Description	1989	1990	1991	1992	1993	Average up to 1993	RATIO
OPERATING EXPENSES							
ADMINISTRATIVE & GENERAL EXPENSES	48,024	51,137	66,184	67,630	63,008	59,197	2.00%
MAN POWER RERATED	35,969	35,930	40,971	48,026	39,409	40,061	
O & M GENERAL PLANT EQT	-	1,479	1,529	1,546	1,687	1,248	
OTHERS	12,055	13,728	23,684	18,058	21,912	17,887	
OPERATION AND MAINTENANCE	35,592	31,944	108,382	45,440	63,175	56,907	1.90%
OPERATION	24,914	26,601	96,003	37,527	43,342	45,677	
MAINTENANCE	10,678	5,343	12,379	7,913	19,833	11,229	
TAX & INSURANCE	33,053	14,611	35,727	56,558	42,939	36,578	1.20%
TAXES & DUTIES	4,966	9,469	5,125	17,693	204	7,491	
INSURANCE	28,087	5,142	30,602	12,874	16,194	18,580	
FRANCHISE TAX	-	-	-	25,725	26,141	10,373	
REALITY TAX	-	-	-	266	400	133	
FUEL & ADDITIVES	1,735,094	3,328,836	3,647,726	2,088,050	806,996	2,321,341	76.60%
DEPRECIATION	212,761	468,550	527,878	716,660	788,326	542,835	17.90%
TOTAL OPERATING EXPENSES	2,064,524	3,895,078	4,385,897	2,974,338	1,764,446	3,016,857	99.50%
GENERAL PLANT EQUIPMENT	81	1,601	1,037	1,965	1,546	1,246	
CONSTRUCTION WORK IN PROGRESS	53,499	1,361	5,300	2,063	1,192	12,683	
TOTAL CAPITAL EXPENDITURE	53,580	2,962	6,337	4,028	2,738	13,929	0.50%
GRAND TOTAL	2,118,104	3,898,040	4,392,234	2,978,366	1,767,184	3,030,786	100.00%
POWER GENERATION (GWh)	3,777	4,304	3,478	3,074	1,600	3,246	
							GROWTH
GENERATING COST (P/kWh)	0.5608	0.9058	1.2629	0.9689	1.1047	0.9606	18.47%
ADMINISTRATIVE & GENERAL EXP.	0.0127	0.0119	0.019	0.022	0.0394	0.0210	32.72%
OPERATION & MAINTENANCE	0.0094	0.0074	0.0312	0.0148	0.0395	0.0205	43.18%
TAX & INSURANCE	0.0088	0.0034	0.0103	0.0184	0.0268	0.0135	32.10%
FUEL	0.4594	0.7735	1.0488	0.6793	0.5045	0.6931	2.37%
DEPRECIATION	0.0563	0.1089	0.1518	0.2331	0.4928	0.2086	72.00%
CAPITAL EXPENDITURE	0.0142	0.0007	0.0018	0.0013	0.0017	0.0039	-41.18%

Source: NPC/MMRC

Ope_con

Table 8-3 マラヤ発電所運転状況

Project	Malaya Reliability Improvement Project
Subject	Operation Data
File Name	Basic.xls/Ope_con
Date	11/15/94
Rev.	1/16/95

Table 8-3 Malaya TPP Operating Conditions

			With Project		Without Project	
ITEM		Unit	No. 1	No. 2	No. 1	No. 2
	No. of Unit	No.	1	1	1	1
	Date of Commissioning	Date	Aug-1975	Apr-1979	Aug-1975	Apr-1979
	Economic life	mm/yyyy	30	30	30	30
	Retirement year	mm/yyyy	Aug-2005	Apr-2009	Aug-2005	Apr-2009
	Years after 1994		11	15	11	15
OPERATING CONDITIONS						
	Unit Capacity	MW	300	350	300	350
	Dependable Capacity	MW	300	350	300	350
	Fuel Type		Bunker-C	Bunker-C	Bunker-C	Bunker-C
	Plant efficiency	%	33.27%	34.90%	29.69%	32.33%
	Station use	%	6%	6%	6%	6%
	Capacity factor	%	70%	70%	47.50%	60%
	Annual Generation	GWh	1839.6	2146.2	1248.3	1839.6
	Salable Energy	GWh	1729.22	2017.43	1173.4	1729.22
	Fuel Consumption	Mil. lit.	488.30	543.08	371.30	502.50
REHABILITATION PROJECT						
	Total Inv. Cost	M$	115.793	37.862	0	0
	Rehab. start		Mar-1998	Aug-1997	-	-
	Rehab. period	months	7	3	-	-
	Life/Life after rehab.	Years	7	12	7	12
WITH REHABILITATION						
	Efficiency decline	%/annum	-0.08%	-0.08%	-	-
WITHOUT REHABILITATION						
	Efficiency decline	%	-	-	-2.82%	-0.68%
	Capacity factor decline	%	-	-	-2.82%	-3.62%
UNIT COST						
	Administrative Cost	P/kW	91			
	O & M	P/kW	88			
	Depreciation	P/kW	835			
		Total	1014 Thousand Peso/kW			
	O & M Cost	P/kWh	0.0205	0.0205	0.0302	0.0239
	Administration Cost*	P/kWh	0.0210	0.0210	0.0309	0.0245
	Tax & Insurance	P/kWh	0.0135	0.0135	0.0199	0.0158
	Interest Cost*	P/kWh	0.2125	0.2125	0.3132	0.2479
	Subtotal	P/kWh	0.2675	0.2675	0.3942	0.3121
	Fuel Cost*	P/kWh	0.6864	0.658	0.8307	0.7262
	Levelized Rehab. Investment	P/kWh	0.3569	0.0895	0	0
	Unit generating cost	P/kWh	1.3108	1.0150	1.2249	1.0383

Note* : Average for respective operating years
The current average power rate at 1.8505 P/kWh

Project Malaya Reliability Improvement Project
Subject EIRR
File Name Basic.xls/eirr_2
Date 11/24/94
Rev. 1/18/95

Table 8-4 経済的内部収益率

No. 1 & No. 2 Combined EIRR =	12.32%	11.35%	13.86%	11.40%	37.40%	33.06%	28.69%	26.17%	45.59%
EIRR =	2.27%	1.34%	3.73%	1.39%	25.46%	21.57%	17.60%	15.29%	32.65%

No. 1 Unit

	Year	WITH REHABILITATION								WITHOUT REHABILITATION							Supply by Other Power Sources (P/KWh)									
		Project Cost	M-1 WITH Capability	Capacity Factor	Annual Energy	Efficiency	Fuel Consump.	Fuel Cost	With Total Cost	M-1 W/O Capability	Capacity Factor	Annual Energy	Efficiency	Fuel Consump.	Fuel Cost	Supplemental Energy	Luzon Grid Average	Oil Based	Coal	Geothermal	Gas Turbine	Non Oil Average	NPC Non Oil	Non Coal	NPC Non Coal	Non Gas T.	NPC Non Gas T.	
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	1.0797	1.051	1.1264	1.0525	2.088	1.878	1.6809	1.5742	2.5209		p/KWh
0	1994	0							0								0	0	0	0	0	0	0	0	0		
1	1995	1,815							1,815								-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815		
2	1996	15,746							15,746								-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746		
3	1997	55,315							55,315								-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315		
4	1998	30,373							30,373								-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373		
5	1999	1,814	300	70%	1,839.60	33.27%	488.30	48,216	50,030	300	47.50%	1,248.30	29.69%	371.30	36,663	591.30	11,188	10,535	12,250	10,569	34,119	29,343	24,861	22,434	43,964		
6	2000	0	300	70%	1,839.60	33.19%	489.48	48,332	48,332	300	46.16%	1,213.08	28.85%	371.33	36,666	626.52	14,351	13,660	15,477	13,696	38,648	33,588	28,839	26,267	49,080		
7	2001	0	300	70%	1,839.60	33.11%	490.66	48,449	48,449	300	44.86%	1,178.92	28.04%	371.30	36,663	660.68	15,650	14,921	16,837	14,959	41,272	35,935	30,927	28,216	52,272		
8	2002	0	300	70%	1,839.60	33.03%	491.85	48,566	48,566	300	43.59%	1,145.55	27.25%	371.25	36,658	694.05	16,914	16,148	18,160	16,188	43,830	38,224	32,962	30,114	55,385		
9	2003	0	300	70%	1,839.60	32.95%	493.04	48,684	48,684	300	42.36%	1,113.22	26.48%	371.26	36,659	726.38	18,139	17,338	19,444	17,379	46,309	40,442	34,935	31,955	58,403		
10	2004	0	300	70%	1,839.60	32.87%	494.24	48,802	48,802	300	41.17%	1,081.95	25.73%	371.35	36,668	757.65	19,329	18,493	20,690	18,536	48,711	42,592	36,848	33,739	61,326		
11	2005	0	300	70%	1,839.60	32.79%	495.45	48,922	48,922	300	40.01%	1,051.46	25.00%	371.42	36,675	788.14	20,482	19,612	21,898	19,658	51,047	44,681	38,706	35,472	64,169		
12	2006	0																									
13	2007	0																									
14	2008	0																									
15	2009	0																									
Total		105,063			12,877.20		3,443	339,971	445,034			8032.48		2599.21	256,652	4,844.72	12,804	7,458	21,507	7,736	200,687	161,556	124,829	104,948	281,350		

No. 2 Unit

EIRR =	26.65%	25.47%	28.52%	25.53%	58.77%	52.97%	47.23%	43.97%	69.94%																		
	Year	WITH REHABILITATION								WITHOUT REHABILITATION							Supply by Other Power Sources (P/KWh)									
		Project Cost	M-2 WITH Capability	Capacity Factor	Annual Energy	Efficiency	Fuel Consump.	Fuel Cost	With Total Cost	M-2 W/O Capability	Capacity Factor	Annual Energy	Efficiency	Fuel Consump.	Fuel Cost	Supplemental Energy	Luzon Grid Average	Oil Based	Coal	Geothermal	Gas Turbine	Non Oil Average	NPC Non Oil	Non Coal	NPC Non Coal	Non Gas T.	NPC Non Gas T.	
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	1.0797	1.051	1.1264	1.0525	2.088	1.878	1.6809	1.5742	2.5209		p/KWh
0	1994	0							0								0	0	0	0	0	0	0	0	0		
1	1995	1,586							1586								-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586		
2	1996	5,862							5862								-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862		
3	1997	30,464							30464								-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464		
4	1998	1,057	350	70%	2,146.20	34.90%	543.08	53,625	54,682	350	60.00%	1,839.60	32.33%	502.50	49,618	306.60	7,668	7,330	8,219	7,347	19,558	17,082	14,758	13,499	24,863		
5	1999	1,057	350	70%	2,146.20	34.82%	544.33	53,748	54,805	350	57.83%	1,773.07	32.11%	487.64	48,151	373.13	8,841	8,429	9,511	8,451	23,311	20,297	17,469	15,938	29,524		
6	2000	0	350	70%	2,146.20	34.74%	545.58	53,872	53,872	350	55.74%	1,708.99	31.89%	473.26	46,731	437.21	11,015	10,532	11,800	10,558	27,970	24,439	21,125	19,330	35,250		
7	2001	0	350	70%	2,146.20	34.66%	546.84	53,996	53,996	350	53.72%	1,647.06	31.67%	459.28	45,350	499.14	12,082	11,531	12,978	11,560	31,439	27,407	23,623	21,575	39,749		
8	2002	0	350	70%	2,146.20	34.58%	548.10	54,121	54,121	350	51.78%	1,587.57	31.45%	445.79	44,018	558.63	13,095	12,479	14,099	12,511	34,759	30,247	26,012	23,720	44,060		
9	2003	0	350	70%	2,146.20	34.50%	549.38	54,247	54,247	350	49.91%	1,530.24	31.24%	432.58	42,714	615.96	14,046	13,366	15,152	13,402	37,933	32,958	28,289	25,761	48,189		
10	2004	0	350	70%	2,146.20	34.42%	550.65	54,372	54,372	350	48.10%	1,474.75	31.03%	419.72	41,444	671.45	14,955	14,214	16,161	14,253	40,995	35,571	30,481	27,726	52,174		
11	2005	0	350	70%	2,146.20	34.34%	551.93	54,499	54,499	350	46.36%	1,421.40	30.82%	407.29	40,217	724.80	15,817	15,017	17,119	15,058	43,925	38,071	32,576	29,602	55,993		
12	2006	0	350	70%	2,146.20	34.26%	553.22	54,626	54,626	350	44.68%	1,369.89	30.61%	395.22	39,025	776.31	16,637	15,780	18,031	15,825	46,743	40,472	34,587	31,402	59,668		
13	2007	0	350	70%	2,146.20	34.18%	554.52	54,754	54,754	350	43.06%	1,320.22	30.40%	383.52	37,870	825.98	17,416	16,505	18,900	16,552	49,449	42,777	36,516	33,126	63,201		
14	2008	0	350	70%	2,146.20	34.10%	555.82	54,883	54,883	350	41.50%	1,272.39	30.19%	372.20	36,752	873.81	18,156	17,191	19,725	17,242	52,043	44,985	38,361	34,775	66,592		
15	2009	0	350	70%	2,146.20	34.02%	557.13	55,012	55,012	350	40.00%	1,226.40	29.93%	361.26	35,672	919.80	18,856	17,841	20,509	17,894	54,527	47,098	40,125	36,350	69,842		
Total		40,026			25,754.40		6,600.58	651,755	691,781			18,171.58		5140.26	507,562	7,583	130,672	122,303	144,292	122,741	424,740	363,492	306,010	274,892	550,993		

Table 8-5 利用率，プロジェクトコストに対するEIRR感度

Project	Malaya Reliability Improvement Project
Subject	Sensitivity
File Name	Basic.xls/sensitivity
Date	11/25/94
Rev.	1/16/95

Table 8 - 5 Sensitivity to Capacity Factor and Project Cost

To Capacity Factor

	EIRR of M-1/M-2					
Capacity Facotr	Luzon Grid Average	Oil Based	Coal	Geo-thermal	Gas Turbine	Non NPC Average
70%	12.32%	11.35%	13.86%	11.40%	37.40%	33.06%
68%	10.64%	9.74%	12.05%	9.79%	33.50%	29.57%
65%	8.90%	8.09%	10.18%	8.13%	29.49%	25.98%
63%	7.10%	6.37%	8.24%	6.41%	25.36%	22.28%
60%	5.23%	4.59%	6.23%	4.62%	21.09%	18.44%
58%	3.27%	2.72%	4.12%	2.75%	16.65%	14.44%
55%	1.20%	0.76%	1.89%	0.79%	11.99%	10.23%
53%	-0.98%	-1.31%	-0.47%	-1.29%	7.04%	5.75%
50%	-3.33%	-3.53%	-3.00%	-3.52%	1.69%	0.89%
48%	-5.87%	-5.93%	-5.77%	-5.93%	-4.26%	-4.52%
45%	-8.68%	-8.58%	-8.84%	-8.58%		

To Project Cost

	EIRR of M-1/M-2					
Project Cost	Luzon Grid Average	Oil Based	Coal	Geo-thermal	Gas Turbine	Non NPC Average
140%	5.86%	5.01%	7.20%	5.05%	27.31%	23.65%
135%	6.52%	5.65%	7.88%	5.70%	28.32%	24.59%
130%	7.21%	6.33%	8.59%	6.38%	29.38%	25.59%
125%	7.94%	7.05%	9.34%	7.09%	30.51%	26.64%
120%	8.71%	7.80%	10.13%	7.85%	31.71%	27.76%
115%	9.53%	8.61%	10.97%	8.65%	32.99%	28.96%
110%	10.40%	9.46%	11.87%	9.51%	34.36%	30.23%
105%	11.33%	10.37%	12.83%	10.42%	35.83%	31.59%
100%	12.32%	11.35%	13.86%	11.40%	37.40%	33.06%
95%	13.39%	12.40%	14.96%	12.45%	39.11%	34.65%
90%	14.55%	13.53%	16.15%	13.58%	40.96%	36.36%
85%	15.80%	14.75%	17.45%	14.81%	42.97%	38.24%

Figure 8-1 利用率に対するEIRR感度

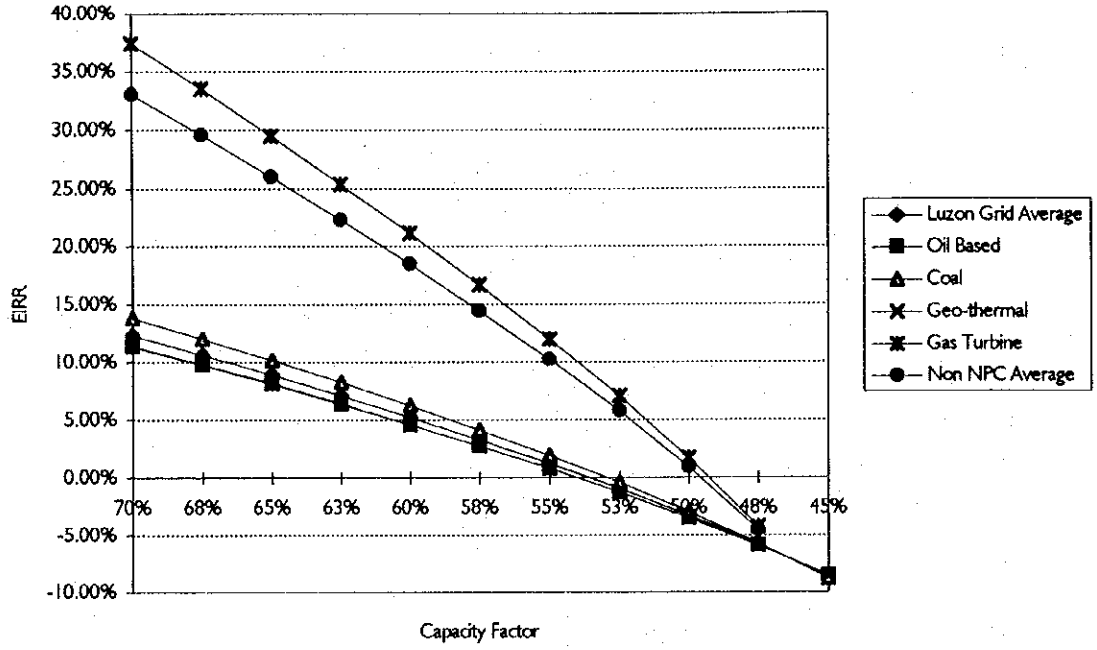
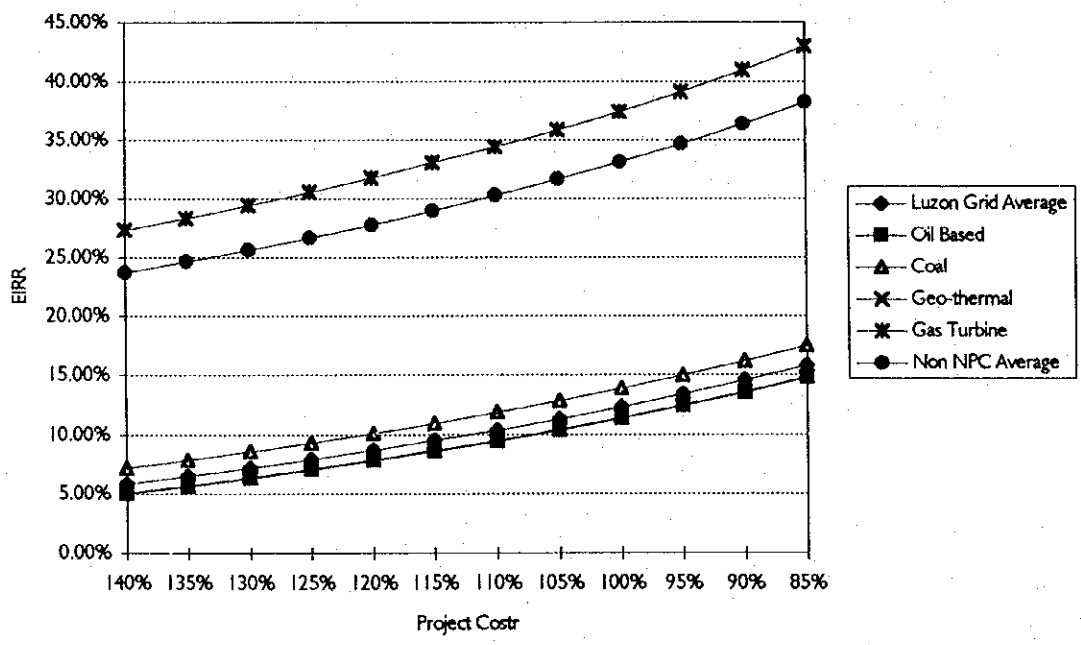


Figure 8-2 プロジェクトコストに対するEIRR感度



8．2　財務評価

8．2．1　評価方法

リハビリを実施した場合のマラヤ発電所の財務的健全性，即ち，NPCによる当該発電所の運転に対する財務的健全性を内部的収益率法により評価する。求められた財務的内部収益率（FIRR）は本プロジェクトの機会費用と比較するものとする。プロジェクトの財務的便益はWithとWithoutを比較した場合の電力量の差，従ってその売電収入の差となる。更に，プロジェクトを実行した場合の財務諸表；資金のながれ分析表，インカムステートメント，借款返済表を作成する。

8．2．2　評価想定条件

1）プロジェクト機会費用

先行しているNPCのリハビリプロジェクトと同様，NPCは日本輸出入銀行より融資を受けるものと仮定し，同行の金利5.8%をこのプロジェクトの機会費用とする。

2）プロジェクト期間

1995年に日本輸出入銀行との借款契約が成立次第コンサルティング役務の開始によりプロジェクトは始まり，コンサルタントによるリハビリ工事の仕様書作成，引き続きコントラクターの選定，その後1997年２号機，1998年１号機のリハビリ工事となる。1999年にはコンサルタントによるリハビリ後のサービスが行われる。１号機，２号機ともその後耐用年数30年を全うし2005年，１号機，2009年，２号機が退役するものとする。

3）便　　益

経済評価と同様な運転状況が想定され，Withoutと比べ，Withは出力の回復，効率の改善により収益が増加することになる。電力販売単価は1.5726ペソ/kWhとした。この値はルソン系統の1993年実勢平均値より減価償却分として0.2086ペソ/kWh，金利分として0.0693ペソ/kWhを差し引いたものである。これらは発電所の建設，第１回のリハビリ等現在まで投下された資本に帰属するものとした。

4）支　出

a．プロジェクトコスト

第4章で見積もられたプロジェクトコストが5年間のプロジェクト実施期間に支出されるものとし下表の支出計画を想定した。

単位：千US$

年	1 号 機	2 号 機	1・2号機合計
1995	1，815	1，586	3，401
1996	15，746	5，862	21，608
1997	55，315	30，464	85，779
1998	30，373	1，057	31，430
1999	1，814	1，057	2，871
合　計	106，063	40，026	145，089

b．燃料単価

財務評価にて用いた燃料単価は1994年7月現在の実績価格であり，高位発熱量，比重についてはJICA調査団が第1次調査時サンプルし，日本に持ち帰り分析した結果である。

タイプ	価　格	高 位 発 熱 量	比　重
バンカーC	15.00 US$/bbl.	10,240 kcal/kg	0.951

c．運転保守経費

リハビリをするしないにかかわらず運転保守経費を初め管理費，税，原建設費及び減価償却費は計上されるものであり，内部収益率計算にはこれらは考慮しなかった。

5）借款条件

借款条件は金利年5.8%，コミットメントフィー0.5%，返済猶予期間なしの10年間返済として返済計画表を作成した。コミットメントフィーについては借款未消化分について課せられるものとした。

6）感度分析

下記の項目について財務的内部収益率に対する感度を検討した。

a．Withケースの場合のプラント利用率

b．プロジェクトコスト

c．燃料費

d．売電単価

8．2．3　評価結果

1）　財務的内部収益率

本プロジェクトの内部収益率は１号機単独で16.06%，２号機単独にて46.67%，両ユニット合わせた場合，29.74%と全ての場合において機会費用の5.8%を越え，更にNPCのレートベース（世銀指定の資産に対する利益償還率）８%を越え本プロジェクトの財務的実行可能性が高いことを示す結果となった。今回の財務分析はWith/Withoutの収益の差を便益として計上したが，販売電力単価のうち減価償却費，利子相等分が差し引かれているので，純粋に原建設費，第１回のリハビリコストを考慮したWithケースのみの電力販売による収益率計算にても同様な結果が予測される。

技術的に計画された通りに機器設備の復旧が実現すれば本プロジェクトは財務的に十分実行可能と判断される。

2）財務性感度分析

a．対利用率

経済分析と同様，リハビリ後ある程度の利用率を維持することが本プロジェクトの財務性に対して最も重要なことである。このことは特に１号機についていえ，もし１号機の利用率が計画より10%下回ったとしたらFIRRは機会費用を下回る。ただし２号機については十分な余裕が見られる。

b．対プロジェクトコスト

同様に，１号機の計画はリハビリ後の操業が短く，多大な投資を必要とすることから，１号機に対する投資額に対しては注意が必要であり，１号機のリハビリを独立して行う場合，計画投資額より40%を越えてはならない。

c．対燃料費

WithとWithoutケース間の販売電力量の差を便益としてとらえる本評価方法では，燃料費の変化，特に燃料費が高騰した場合，通常とは逆にFIRRは下がる傾向となる。即ち，Withケースの場合発電量を増やせば増やすほど燃料消費が増加するからである。しかしながら，燃料単価が20US$/bbl．となってもFIRRは依然10%台をマークしている。

d．対売電単価

売電単価が上がれば，当然，売電収入も増加しFIRRも高くなる。現行の発電単価から前後25%についてFIRRに対する感度を検証したが，Figure 8-6に示すように全ての場合で十分フィージブルである結果となった。

3）財務諸表

本リハビリプロジェクトの１号機，２号機に対する投資（プロジェクトコスト）を対象に借款の返済計画表，インカムステートメント，資金の流れ分析表を作成した。それぞれTables 8-8, 8-9に示す。２号機が退役しプロジェクトが終了する2009年には本プロジェクトの借款金額を全て返済し約227百万ドルの純益となる。

firr - 1

Project Malaya Reliability Improvement Project
Subject FIRR
File Name firr.xls
Date 11/24/94
Rev. 1/18/95

Table 8-6 財務的内部収益率

M-1 & M-2 Combined FIRR = 29.74%

FIRR = 16.06%

No. 1 Unit

Year		WITH REHABILITATION								WITHOUT REHABILITATION						Benefit	Balance	Energy Sale	Cost
		Project Cost	M-1 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	With Total Cost	M-1 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	Energy With	of of Fuel Cost	Benefit	Balance
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	Thous $	Thous $	Thous $
0	1994								1,815										-1,815
1	1995	1,815							15,746										-15,746
2	1996	15,746							55,315										-55,315
3	1997	55,315							30,373										-30,373
4	1998	30,373							46,160							591.30	-10,625	35,765	23,326
5	1999	1,814	300	70%	1,839.60	33.27%	488.30	44,346	44,453	300	47.50%	1248.3	29.69%	371.30	33,721	626.52	-10,730	37,895	27,165
6	2000		300	70%	1,839.60	33.19%	489.48	44,453	44,561	300	46.16%	1213.08	28.85%	371.33	33,723	660.68	-10,840	39,961	29,121
7	2001		300	70%	1,839.60	33.11%	490.66	44,561	44,669	300	44.86%	1178.92	28.04%	371.30	33,721	694.05	-10,953	41,979	31,026
8	2002		300	70%	1,839.60	33.03%	491.85	44,669	44,777	300	43.59%	1145.55	27.25%	371.25	33,716	726.38	-11,060	43,935	32,875
9	2003		300	70%	1,839.60	32.95%	493.04	44,777	44,886	300	42.36%	1113.22	26.48%	371.26	33,717	757.65	-11,161	45,826	34,665
10	2004		300	70%	1,839.60	32.87%	494.24	44,886	44,996	300	41.17%	1081.95	25.73%	371.35	33,725	788.14	-11,265	47,670	36,405
11	2005		300	70%	1,839.60	32.79%	495.45	44,996		300	40.01%	1051.46	25.00%	371.42	33,731				
12	2006																		
13	2007																		
14	2008																		
15	2009																		
Total		105,063			12,877.20		3,443	312,688	417,751			8032.48		2599.21	236,054	4844.72	-76,634	293,031	111,334

FIRR = 46.67%

No. 2 Unit

Year		WITH REHABILITATION								WITHOUT REHABILITATION						Benefit	Balance	Energy Sale	Cost
		Project Cost	M-2 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	With Total Cost	M-2 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	Energy With	of of Fuel Cost	Benefit	Balance
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	Thous $	Thous $	Thous $
0	1994								1,586										-1586
1	1995	1,586							5,862										-5862
2	1996	5,862							30,464										-30,464
3	1997	30,464							50,378							306.6	-3,685	18,545	13,803
4	1998	1,057	350	70%	2,146.20	34.90%	543.08	49,321	50,492	350	60.00%	1,839.60	32.33%	502.50	45,636	373.13	-5,149	22,569	16,363
5	1999	1,057	350	70%	2,146.20	34.82%	544.33	49,435	49,548	350	57.83%	1,773.07	32.11%	487.64	44,286	437.21	-6,568	26,444	19,876
6	2000		350	70%	2,146.20	34.74%	545.58	49,548	49,663	350	55.74%	1,708.99	31.89%	473.26	42,980	499.14	-7,952	30,190	22,238
7	2001		350	70%	2,146.20	34.66%	546.84	49,663	49,777	350	53.72%	1,647.06	31.67%	459.28	41,711	558.63	-9,291	33,789	24,498
8	2002		350	70%	2,146.20	34.58%	548.10	49,777	49,893	350	51.78%	1,587.57	31.45%	445.79	40,486	615.96	-10,607	37,256	26,649
9	2003		350	70%	2,146.20	34.50%	549.38	49,893	50,009	350	49.91%	1,530.24	31.24%	432.58	39,286	671.45	-11,891	40,612	28,721
10	2004		350	70%	2,146.20	34.42%	550.65	50,009	50,125	350	48.10%	1,474.75	31.03%	419.72	38,118	724.80	-13,136	43,839	30,703
11	2005		350	70%	2,146.20	34.34%	551.93	50,125	50,242	350	46.36%	1,421.40	30.82%	407.29	36,989	776.31	-14,349	46,955	32,606
12	2006		350	70%	2,146.20	34.26%	553.22	50,242	50,360	350	44.68%	1,369.89	30.61%	395.22	35,893	825.98	-15,530	49,959	34,429
13	2007		350	70%	2,146.20	34.18%	554.52	50,360	50,478	350	43.06%	1,320.22	30.40%	383.52	34,830	873.81	-16,676	52,852	36,176
14	2008		350	70%	2,146.20	34.10%	555.82	50,478	50,597	350	41.50%	1,272.39	30.19%	372.20	33,802	919.80	-17,788	55,634	37,846
15	2009		350	70%	2,146.20	34.02%	557.13	50,597	639,474	350	40.00%	1,226.40	29.98%	361.26	32,809	7582.82	-132,622	458,644	285,996
Total		40,026			25,754.40		6,601	599,448				18,172		5140.26	466,826				

Project	Malaya Reliability Improvement Project
Subject	Sensitivity
File Name	firr.xls
Date	11/25/94
Rev.	1/18/95

Sensitivity to Capacity Factor

Capacity Factor	FIRR M-1	M-2	M-1/M-2
70%	16.06%	46.67%	29.74%
67.50%	13.56%	44.17%	27.24%
65.00%	11.06%	41.67%	24.74%
62.50%	8.56%	39.17%	22.24%
60.00%	6.06%	36.67%	19.74%
57.50%	3.56%	34.17%	17.24%
55.00%	1.06%	31.67%	14.74%
52.50%	-1.44%	29.17%	12.24%
50.00%	-3.94%	26.67%	9.74%
47.50%	-6.44%	24.17%	7.24%
45.00%	-8.94%	21.67%	4.74%

Investment to FIRR

Project Cost	M-1	M-2	M-1/M-2
140%	8.07%	36.50%	21.83%
135%	8.89%	37.50%	22.63%
130%	9.75%	38.55%	23.48%
125%	10.66%	39.68%	24.37%
120%	11.61%	40.88%	25.32%
115%	12.62%	42.17%	26.32%
110%	13.70%	43.55%	27.38%
105%	14.84%	45.05%	28.52%
100%	16.06%	46.67%	29.74%
95%	17.37%	48.45%	31.05%
90%	18.77%	50.38%	32.48%
85%	20.29%	52.52%	34.02%

Figure 8-3 利用率に対するFIRR感度

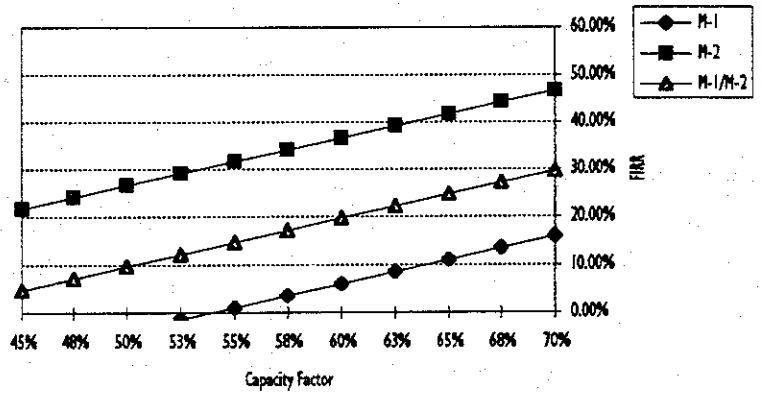
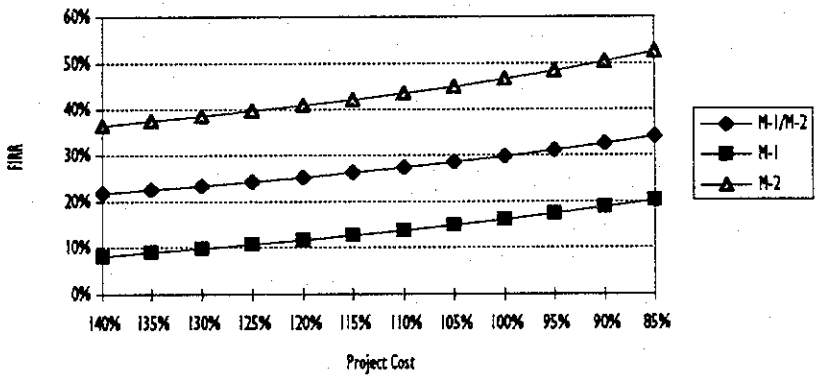


Figure 8-4 プロジェクトコストに対するFIRR感度



Sensitivity to Fuel Cost

Fuel Cost [$/bbl.]	FIRR M-1	M-2	M-1/M-2
20	12.37%	42.14%	26.01%
19	13.06%	42.99%	26.71%
18	13.73%	43.82%	27.40%
17	14.40%	44.63%	28.07%
16	15.06%	45.44%	28.73%
15	15.70%	46.23%	29.38%
14	16.34%	47.02%	30.02%
13	16.97%	47.79%	30.65%
12	17.59%	48.56%	31.27%
11	18.21%	49.32%	31.89%
10	18.81%	50.07%	32.49%

Sensitivity to Power Rate

Power Rate	FIRR M-1	M-2	M-1/M-2
125%	23.92%	57.44%	37.74%
120%	22.46%	55.36%	36.23%
115%	20.94%	53.25%	34.67%
110%	19.37%	51.10%	33.08%
105%	17.75%	48.91%	31.44%
100%	16.06%	46.67%	29.74%
95%	14.30%	44.39%	27.98%
90%	12.46%	42.04%	26.14%
85%	10.53%	39.62%	24.22%
80%	8.50%	37.11%	22.19%
75%	6.35%	34.50%	20.01%

Figure 8-5 燃料費に対するFIRR感度

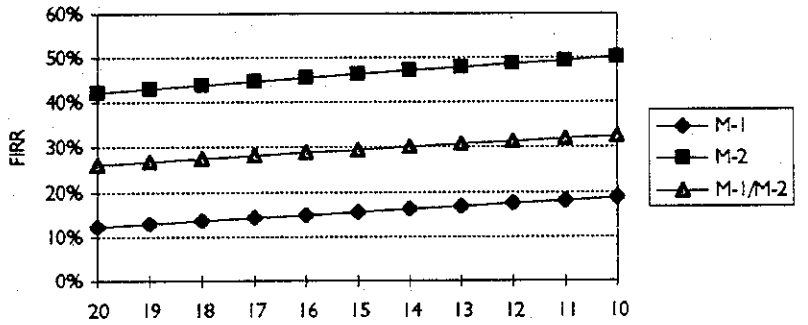


Figure 8-6 売電単価に対するFIRR感度

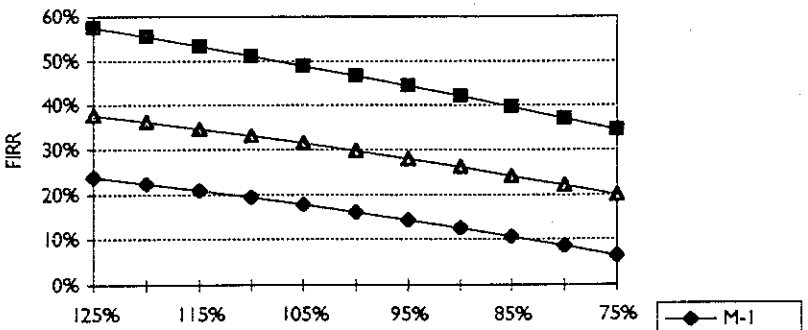


Table 8-7 返済計画表

		1995 loan				1996 loan				1997 loan				1998 loan				1999 loan			
Year		Loan	Principal	Interest	Repay-ment	Outstand-ing Balance	Principal	Interest	Repay-ment	Outstand-ing Balance	Principal	Interest	Repay-ment	Outstand-ing Balance	Principal	Interest	Repay-ment	Outstand-ing Balance	Principal	Interest	Repay-ment	Outstand-ing Balance
0	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1995	3,401	0	0	0	3,401	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1996	21,608	261	197	458	3,140	0	0	0	21,608	0	0	0	0	0	0	0	0	0	0	0	0
3	1997	85,779	276	182	458	2,865	1,655	1253	2,908	19,953	0	0	0	85,779	0	0	0	0	0	0	0	0
4	1998	31,430	292	166	458	2,573	1,751	1157	2,908	18,202	6,569	4975	11,544	79,210	0	0	0	31,430	0	0	0	0
5	1999	2,871	309	149	458	2,264	1,852	1056	2,908	16,350	6,950	4594	11,544	72,259	2,407	1823	4,230	29,023	0	0	0	2,871
6	2000	0	327	131	458	1,937	1,960	948	2,908	14,390	7,353	4191	11,544	64,906	2,547	1683	4,230	26,476	219	167	386	2,652
7	2001	0	346	112	458	1,592	2,073	835	2,908	12,317	7,779	3765	11,544	57,126	2,694	1536	4,230	23,782	232	154	386	2,419
8	2002	0	366	92	458	1,226	2,194	714	2,908	10,123	8,231	3313	11,544	48,895	2,851	1379	4,230	20,931	246	140	386	2,173
9	2003	0	387	71	458	839	2,321	587	2,908	7,801	8,708	2836	11,544	40,186	3,016	1214	4,230	17,915	260	126	386	1,912
10	2004	0	409	49	458	431	2,456	452	2,908	5,345	9,213	2331	11,544	30,973	3,191	1039	4,230	14,724	275	111	386	1,637
11	2005	0	431	25	456	0	2,598	310	2,908	2,747	9,748	1796	11,544	21,225	3,376	854	4,230	11,348	291	95	386	1,346
12	2006	0	0	0	0	0	2,747	159	2,906	0	10,313	1231	11,544	10,911	3,572	658	4,230	7,776	308	78	386	1,037
13	2007	0	0	0	0	0	0	0	0	0	10,911	633	11,544	0	3,779	451	4,230	3,997	326	60	386	711
14	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	3,997	232	4,229	0	345	41	386	365
15	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	365	21	386	0
Total		145,089	3,401	1,174	4,575		21,608	7,471	29,079		85,779	29,665	115,444		31,430	10,869	42,299		2,871	993	3,864	

		TOTAL				
Year		Principal	Interest	Repay-ment	Outstand-ing Balance	Commit-ment Fee
0	1994	0	0	0	0	725
1	1995	0	0	0	3,401	708
2	1996	261	197	458	24,748	600
3	1997	1,931	1,435	3,366	108,596	172
4	1998	8,612	6,298	14,910	131,414	14
5	1999	11,518	7,622	19,140	122,767	0
6	2000	12,407	7,120	19,527	110,360	0
7	2001	13,125	6,402	19,527	97,236	0
8	2002	13,889	5,638	19,527	83,347	0
9	2003	14,693	4,834	19,527	68,655	0
10	2004	15,545	3,982	19,527	53,110	0
11	2005	16,444	3,080	19,524	36,666	0
12	2006	16,941	2,126	19,067	19,725	0
13	2007	15,016	1,144	16,160	4,708	0
14	2008	4,343	273	4,616	365	0
15	2009	365	21	386	0	0
Total		145,089	50,172	195,261		2,219

LOAN TERM		
Interest	%	5.80%
Commitment fee	%	0.50%
Grace P.	Year	0
Repayment	Years	10

Table 8-8 インカムステートメント

	Year	Benefit Energy			With Revenue	OPERATING COST						With Total Cost	PROFIT	FINANCIAL COST		NET INCOME
						Add. Fuel Cost			Depreic. Cost					Commit. Fee	Interest	
		M-1	M2	Total		M-1	M-2	Total	M-1	M-2	Total					
		GWH	GWH	GWH	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $
0	1994	0	0	0	0	0	0	0			0	0	0	0	0	0
1	1995	0	0	0	0	0	0	0			0	0	0	725	0	-725
2	1996	0	0	0	0	0	0	0			0	0	0	708	197	-905
3	1997	0	0	0	0	0	0	0			0	0	0	600	1,435	-2,035
4	1998	0	306.60	306.60	18,545	3,685	3,685	7,370		3,336	3,336	10706	7839	172	6,298	1,369
5	1999	591.30	373.13	964.43	58,333	5,149	5,149	10,298	15,009	3,336	18,345	28643	29690	14	7,622	22,054
6	2000	626.52	437.21	1,063.73	64,339	6,568	6,568	13,136	15,009	3,336	18,345	31481	32858	0	7,120	25,738
7	2001	660.68	499.14	1,159.82	70,151	7,952	7,952	15,904	15,009	3,336	18,345	34249	35902	0	6,402	29,500
8	2002	694.05	558.63	1,252.68	75,768	9,291	9,291	18,582	15,009	3,336	18,345	36927	38841	0	5,638	33,203
9	2003	726.38	615.96	1,342.34	81,191	10,607	10,607	21,214	15,009	3,336	18,345	39559	41632	0	4,834	36,798
10	2004	757.65	671.45	1,429.10	86,439	11,891	11,891	23,782	15,009	3,336	18,345	42127	44312	0	3,982	40,330
11	2005	788.14	724.80	1,512.94	91,510	13,136	13,136	26,272	15,009	3,336	18,345	44617	46893	0	3,080	43,813
12	2006	0	776.31	776.31	46,955	14,349	14,349	28,698		3,336	3,336	32034	14921	0	2,126	12,795
13	2007	0	825.98	825.98	49,959	15,530	15,530	31,060		3,336	3,336	34396	15563	0	1,144	14,419
14	2008	0	873.81	873.81	52,852	16,676	16,676	33,352		3,336	3,336	36688	16164	0	273	15,891
15	2009	0	919.80	919.80	55,634	17,788	17,788	35,576		3,330	3,330	38906	16728	0	21	16,707
Total		4,844.72	7,582.82	12,428	751,676	132,622	132,622	265,244	105,063	40,026	145,089	410,333	341,343	2,219	50,172	288,952

Table 8-9 資金の流れ分析表

	Year	Loan	CASH INFLOW			CASH OUTFLOW			BALANCE	
			Net Income	Depreciation	Total	Rehab. Cost	Repay (Principal)	Total	Annual Balance	Accumu. Balance
		Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $	Thous $
0	1994	0	0	0	0	0	0	0	0	0
1	1995	3,401	-725	0	2,676	3,401	0	3,401	-725	-725
2	1996	21,608	-905	0	20,703	21,608	261	21,869	-1,166	-1,891
3	1997	85,779	-2,035	0	83,744	85,779	1,931	87,710	-3,966	-5,857
4	1998	31,430	1,369	3,336	36,135	31,430	8,612	40,042	-3,907	-9,764
5	1999	2,871	22,054	18,345	43,270	2,871	11,518	14,389	28,881	19,117
6	2000		25,738	18,345	44,083		12,407	12,407	31,676	50,793
7	2001		29,500	18,345	47,845		13,125	13,125	34,720	85,514
8	2002		33,203	18,345	51,548		13,889	13,889	37,659	123,173
9	2003		36,798	18,345	55,143		14,693	14,693	40,450	163,624
10	2004		40,330	18,345	58,675		15,545	15,545	43,130	206,754
11	2005		43,813	18,345	62,158		16,444	16,444	45,714	252,468
12	2006		12,795	3,336	16,131		16,941	16,941	-810	251,658
13	2007		14,419	3,336	17,755		15,016	15,016	2,739	254,396
14	2008		15,891	3,336	19,227		4,343	4,343	14,884	269,280
15	2009		16,707	3,330	20,037		365	365	19,672	288,952
Total		145,089	288,952	145,089	579,130	145,089	145,089	290,178	288,952	

APPENDICES

Appendix 4-1

NATIONAL POWER CORPORATION

MALAYA 1 ANNUAL OVERHAUL ACTIVITIES (REV. 3)

October 1, 1994 - January 10, 1995

As of [illegible]

Sheet 1 of 4

ACTIVITIES	RESP. MAINT.	DAYS	REMARKS
1.0 BOILER			
1.1 Cooling Down		3	1.1 FINISHED
1.2 Cleaning of Boiler Tubes/Washing	MSD	5	1.2 100% COMPLETE
1.3 Replacement of Sec SH tubes 37 panels	MEC/MSD	7 - 83 (90D)	1.3 70 % COMPLETE
1.4 Non-destructive Test of Boiler Tubes	MEC	20 - 65 (35D)	1.4
1.5 Sampling of W/W Tubes (2.0 M)	MSD	30 - 32	1.5
1.6 Repair of Casing Leak	MSD	20 - 50 (30D)	1.6 75% COMPLETE
1.7 Inspection/Repair of Burner/Air Register	MSD	30 - 60	1.7 55 % COMPLETE
1.8 Inspection/Overhaul of Sootblowers.	MM/EM	50 - 80 (30D)	1.8 10 % COMPLETE
1.9 Inspection/Repair of Boiler Valves	MM	7 - 42 (35D)	1.9
1.10 Replacement of Reheat Spray CV	IC/MM	25 - 35	1.10
1.11 Hydrostatic Test	OPN/ECS	90 - 92	1.11
2.0 BOILER AUXILIARIES			
2.1 AH Washing	EC/GS/OP	5 - 8	2.1 100% COMPLETE
2.2 Replacement of AH Elements & Repair of Rotor	MSD	0 - 50 (44D)	2.2 95 % COMPLETE
2.3 Replacement/Adjustment of Circumferential Seal	MSD	40 - 48	2.3
2.4 Cleaning of Gas Duct	GS	6 - 15	2.4 100% COMPLETE
2.5 Insp./Repair of Air & Gas Duct Dampers	MSD/GS	10 - 94 (90D)	2.5 60% COMPLETE

Appendix 4-1

NATIONAL POWER CORPORATION

MALAYA 1 ANNUAL OVERHAUL ACTIVITIES (REV. 3)

October 1, 1994 - January 10, 1994

As of _____

ACTIVITIES	RESP. MAINT.	DAYS	REMARKS
2.6 Repair of Gas Duct/ Dust Hopper	MSD	11–46	2.6 49% COMPLETE
2.7 Inspection of Smoke-stack Inner Liner	MEC/MSD	0–(60D)–70	2.7
2.8 Replacement of Dust Collector Conveying Line	MSD	20–(20D)–40	2.8
2.9 Re-blading of T-BFP (Stationary & Rotating)	MEC/MSD	5–(90D)–95	2.9 40% COMPLETE
2.10 Installation of T-BFP Turning Gear	MSD	65–70	2.10
2.11 Overhaul of T-BFP	MSD	6–(44D)–50	2.11 –
2.12 Overhaul of M-BFP	MM	30–(60D)–90	2.12 60% COMPLETE
2.13 Overhaul of FDF 1A & 1B	MM/EM	10–(25D)–35	2.13 95% COMPLETE
2.14 Replacement of FDF Discharge Dampers Assy.	MM/EM	6–21	2.14
2.15 Inspection/Overhaul of GRF	MM/EM	25–(15D)–40	2.15 5% COMPLETE
2.16 Replacement of GRF Control Drive	IC/MM	40–(10D)–50	2.16
2.17 Overhaul of MFOP 1A, 1B	MM	20–(20D)–40	2.17 100% COMPLETE
2.18 Cleaning/Hydro of FOH	GS/EC	6–(10D)–16	2.18
2.19 Cleaning/Hydro of SCAH	GS/EC	22–(15D)–37	2.19
2.20 Replacement of Drain Line (A.H. and S.B.)	MSD	60–(10D)–70	2.20 REPAIR OF AH BEARING 55%
2.21 Repair of Auxiliary Boiler	MEC/MSD	0–(90D)–100	2.21
2.22 Inspection of Flash Tank	MM	30–35	2.22
2.23 Overhaul of Relief Valve	MM	40–(20D)–60	2.23 20% COMPLETE

Appendix 4-1

NATIONAL POWER CORPORATION

MALAYA 1 ANNUAL OVERHAUL ACTIVITIES (REV. 3)

October 1, 1994 - January 10, 1995

As of _____

ACTIVITIES	RESP. MAINT.	DAYS	REMARKS
3.0 TURBINE/GENERATOR			
3.1 Cooling Down		3 8	3.1 Finished
3.2 Purging of Generator	EC	10 (15D) 25	3.2 100% complete
3.3 Disassembly of Exciter	EM		3.3 100% complete
3.4 Re-assembly of Exciter	MSD/EM/ Contr. IC/EM	30 (25D) 55	3.4
3.5 Simulation Test of Generator Control Devices		50 60	3.5
3.6 Charging of Generator	EC/EM	95 96	3.6
3.7 Re-blading of LP Turbine Blades 8th Stage	MSD/MEC	0 (80D) 90	3.7 80% complete
3.8 Collection of Turbine Blade Scale (LP)	MSD	30 (20D) 50	3.8 100% complete
3.9 Bearing Inspection	MSD	35 (50D) 85	3.9
3.10 Inspection/Overhauling of Turbine Valves	MSD	10 (30D) 40	3.10 25% complete
3.11 Inspection of Gland Steam Bellows	MSD	0 (15D) 25	3.11
3.12 Replacement of Drain Station Lines	MM	(10D) 25 35	3.12
3.13 Overhaul of Drain Station Valves	MM	15 (20D) 35	3.13 5% complete
3.14 Cleaning of TOT	OPTN	60 65	3.14
3.15 Turbine Oil Flushing	OPTN	(20D) 65 85	3.15
3.16 Turbine Oil Filtering (Vacuum-Dyne)	OPTN	65 85	3.16

NATIONAL POWER CORPORATION

MALAYA 1 ANNUAL OVERHAUL ACTIVITIES (REV. 3)

October 1, 1994 - January 10, 1995

As of _____

ACTIVITIES	RESP. MAINT.	DAYS	10	20	30	40	50	60	70	80	90	100	REMARKS
4.0 TURBINE AUXILIARIES													
4.1 Replacement of LPH 3	MSD/MEC							55 (45D) 90					4.1 95% COMPLETE
4.2 Hydrotest of LPHs and HPHs	EC/OPTN			15 (10D) 25									4.2
4.3 Installation of Strainers at Extraction Line to HPH 5	MSD							50 (20D) 70					4.3
4.4 Cleaning/Leak Test of Main Condenser	CS/ECS			10 (45D)			55						4.4 30% COMPLETE
4.5 Sampling of Main Condenser Tubes	MSD				30 35								4.5
4.6 Partial Re-tubing of Auxiliary Condenser	MSD				20 (15D) 35								4.6
4.7 Epoxy Cladding of Tube Sheet (MSC & Aux. Cdsr)	Contr.							45 (40D) 85					4.7
4.8 Inspection/Cleaning of H.E. (Tubular & Plate Type)	CS/MM/EC			10 (15D) 25									4.8 40 % COMPLETE
4.9 Overhaul of Turbine Gland Steam Seal	MM/IC				25 (10D) 35								4.9
4.10 Inspection/Repair of Auxiliary Valves	MM			0 (35D)		45							4.10 70 % COMPLETE
4.11 Overhaul of CWP 1A & 1B	MM			10 (60D)					70				4.11 70% COMPLETE
4.12 Overhaul of CP 1A & 1B	MM/EM		10						0				4.12 60% COMPLETE
4.13 Overhaul of MVP 1A & 1B	MM/EM		10		25								4.13 60% COMPLETE
4.14 Overhaul of HSCCP A,B,C	MM/EM				25	0							4.14
4.15 Inspection/Cleaning of CWP Suction Area	SCUBA/ OPTN							50 (25D) 75					4.15
4.16 Deferred Jobs	MM/EM/IC												4.16

Prepared by:

MC OBLEPIAS/TM VILLEGNA, JR.
P & S Section

Reviewed by:

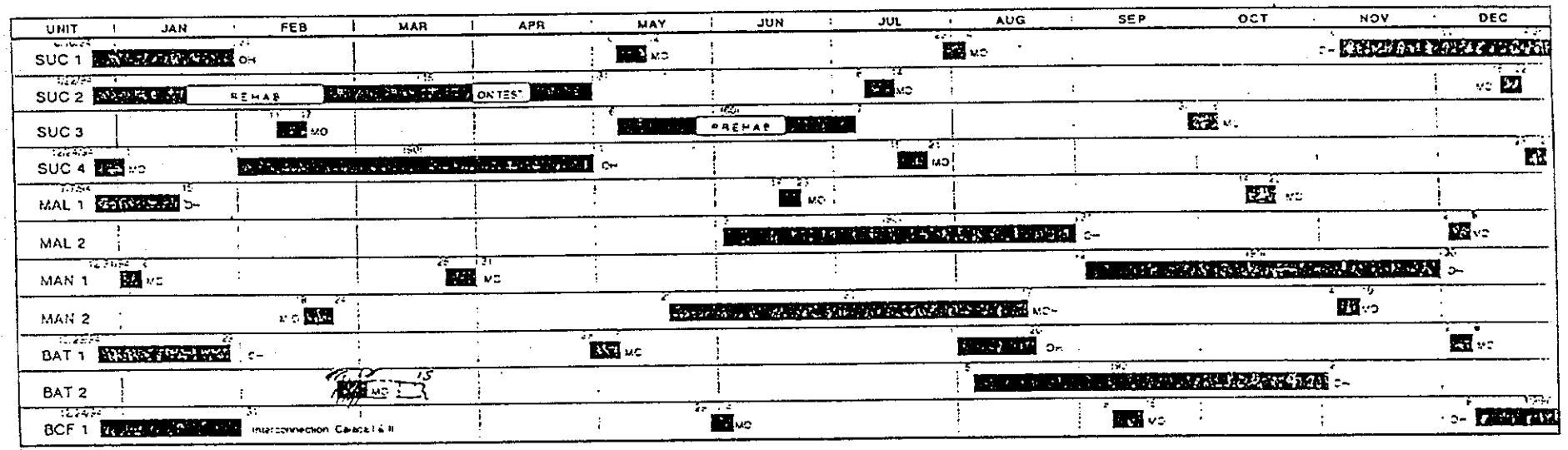
AS PALPAL-LATOC
Acting Maint. Manager

Approved by:

O.P. MENDOZA
Plant Manager

Appendix 4-2

MAINTENANCE SCHEDULE
MMRC PLANTS
TARGET
1995



Legend :

MO – Maintenance Outage
OH – Annual Overhauling
MOH – Major Overhauling

L. S. ACAPULCO
BCFTP Manager

C. C. CANDELARIA
Bataan TP Manager

V. C. DE GUZMAN
Manila TP, OIC

O. P. MENDOZA
Malaya TP Manager

V. P. ESTACIO
Sucat TP Manager

V. C. ALMAZAN
MSD Manager

Dec. 06, 1994

1994/12/08 Received at Malaya P/S

Appendix 4-3

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : UNIT #1

ACTIVITIES	EQUIPMENT/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
1.0 REPLACEMENT OF STAND-BY TUBE TYPE HEAT EXCHANGER W/ PLATE TYPE	ONE (1) SET PLATE TYPE HEAT EXCHANGER	1995 (4TH QTR)		FOR P.R.
2.0 INSTALLATION OF REVERSED INSULATION AT GAS DUCTS	FOR CONTRACT	1995 (4TH QTR)		FOR P.R.
3.0 OVERHAUL OF FDF/GRF	CONSUMABLE MATERIALS AND SPARE PARTS	1995 (4TH QTR)		FOR P.R.
4.0 INSTALLATION OF ON LINE VIBRATION MONITORING SYSTEM OF MAJOR EQPT.	FOR INQUIRY/CONTRACT	1995 (4TH QTR)		FOR P.R.
5.0 REPLACEMENT OF OBSOLETE RECORDERS AND GAUGES	RECORDERS AND GAUGES	1995 (4TH QTR)		FOR P.R.
6.0 INSTALLATION OF BOILER PROBE	MOTORIZED BOILER PROBE	1995		FOR P.R.
7.0 REHABILITATION OF AMMONEX REGENERATION SYSTEM	FOR CONTRACT	1995		FOR P.R.

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : UNIT #1

ACTIVITIES	EQUIPMENT/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
1.0 REPLACEMENT OF WEAK BOILER W/W TUBES (BURNER ZONE)	W/W PANELS	1996 (4TH QTR)		FOR P.R.
2.0 INSTALLATION OF RSB'S AT SEC SH TUBES	RSB ASSEMBLY (6 SETS)	1996 (4TH QTR)		FOR P.R.
3.0 REHABILITATION OF FWH DRIPS SYSTEM CV	FWH DRIPS CV PARTS	1996		FOR P.R.
4.0 PROCUREMENT OF SPARE MOTOR FOR GRF	SPARE MOTOR ASSEMBLY	1996		FOR P.R.
5.0 PROCUREMENT OF SPARE MOTOR FOR FDF	SPARE MOTOR ASSEMBLY	1996		FOR P.R.
6.0 REPLACEMENT OF NEW AVR	FOR CONTRACT	1996		FOR P.R.

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : UNIT #2

ACTIVITIES	EQUIPMENT/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
1.0 COMPLETE RETUBING OF MAIN CONDENSER	CONDENSER TUBES	1995 (3RD QTR)		WITH P.R.
2.0 REPLACEMENT OF WEAK FURNACE HOPPER TUBES	FURNACE HOPPER TUBE PANELS	1995 (3RD QTR)		FOR P.R.
3.0 REPAIR OF REVERSED INSULATION	FOR CONTRACT	1995 (3RD QTR)		FOR P.R.
4.0 REPLACEMENT OF DETERIORATED DC CYCLONE SEPARATOR	D.C. CYCLONE PIPES	1995 (3RD QTR)		FOR P.R.
5.0 REPLACEMENT OF OBSOLETE RECORDERS & PRESSURE GAUGES	RECORDERS AND PRESSURE GAUGES SET	1995 (3RD QTR)		WITH P.R. #2MAL93-00565, 2MAL93-00728
6.0 REPLACEMENT OF DRUM LEVEL LOCAL INDICATION	DRUM LEVEL INDICATOR ASSEMBLY	1995 (3RD QTR)		FOR P.R.
7.0 REPLACEMENT OF GRF CONTROL DRIVE	CONTROL DRIVE ASSEMBLY	1995 (3RD QTR)		FOR P.R.
8.0 INSTALLATION OF ON LINE VIBRATION MONITORING SYSTEM ON MAJOR EQPT.	FOR CONTRACT	1995 (3RD QTR)		FOR P.R.
9.0 INSTALLATION OF BOILER THERMO PROBE	MOTORIZED THERMO PROBE	1995 (3RD QTR)		FOR P.R.
10.0 REPLACEMENT OF CWP 2A MOTOR	MOTOR ASSEMBLY	1995 (3RD QTR)		WITH P.R.

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : UNIT #2

ACTIVITIES	EQUIPMENT/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
11.0 REPLACEMENT OF OBSOLETE SAMPLING RACK	FOR CONTRACT - NEW DESIGN SAMPLING RACK	1995 (3RD QTR)		WITH P.R. BUT NO SUPPLIER QUOTED FOR RE-P.R.

Appendix 4-3

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : UNIT #2

ACTIVITIES	EQUIPMENT/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
1:0 REPLACEMENT OF RWP	TURBINE TYPE PUMP ASSEMBLY	1996 (2ND QTR)		FOR P.R.
2.0 OVERHAUL OF FDF/GRF	CONSUMABLE PARTS & MATERIALS	1996 (2ND QTR)		FOR P.R.
3.0 REPLACEMENT OF THE EXISTING PNEUMATIC TYPE TO AUTOMATIC BOILER CONTROL AND AUXILIARIES TO BAILEY INF 1-90 SYSTEM (MICROPROCESSOR BASE PROGRAMMABLE CONTROL)	FOR CONTRACT	1996 (2ND QTR)		FOR P.R.
4.0 PROCUREMENT OF GRF SPARE MOTOR	SPARE MOTOR ASSEMBLY	1996 (2ND QTR)		FOR P.R.
5.0 PROCUREMENT OF FDF SPARE MOTOR	SPARE MOTOR ASSEMBLY	1996 (2ND QTR)		FOR P.R.

FIVE-YEAR PLANT MAINTENANCE PROGRAM

Regional Center : MMRC
Plant : MALAYA THERMAL PLANT
Unit : COMMON FACILITIES

ACTIVITIES	EQUIPMENTS/PARTS/ COMPONENTS AND MATERIALS	DATE NEEDED	ESTIMATED COST	REMARKS STATUS
1.0 INSTALLATION OF FUEL OIL METERING TO FUEL OIL STORAGE TANKS	F.O. METERS	1994 (3RD QTR)		WITH P.R. UNDER PROCESS
2.0 REPLACEMENT OF EXISTING FLAMMABLE MINERAL OIL AT EMERGNCY TRANSFORMER	FOR CONTRACT	1995 (4TH QTR)		FOR P.R.
3.0 REPLACEMENT OF AGING HOIST WIRE ROPE OF CWP OVERHEAD CRANE	SPARE WIRE ROPE	1995 (4TH QTR)		FOR P.R.
4.0 REHABILITATION OF IN-TAKE CHANNEL SHEET FILES	FOR CONTRACT	1995		FOR P.R.
5.0 DREDGING OF SETTLING BASIN	FOR CONTRACT	1995		FOR P.R.
6.0 REPLACEMENT OF STORAGE BATTERY - 60 CELLS SET	60 CELLS BATTERY SET	1996 (2ND QTR)		FOR P.R.

BOILER SAMPLE TUBE TEST REPORT

NATIONAL POWER CORPORATION
MALAYA THERMAL POWER PLANT
UNIT NO. 1 BOILER WATERWALL

JANUARY 1995

WEST JAPAN ENGINEERING CONSULTANTS, INC.
KYUDEN INDUSTRIES CO. INC.

1. Introduction

This is a report on the results of the evaluation of the deterioration of the waterwall tubes of Malaya Unit No. 1.

2. Sample Tube

Waterwall tube: 900 mm (300 mm for deterioration tests, 600 mm for dissolution tests)

3. Test Items and Methods

(1) Appearance

Upon receipt, the sample tube was visually inspected, and checked for any deformations in the tube shape and any scale discoloration. The appearances were photographed for recording purposes.

(2) Dimension

Outer diameter and wall thickness of sample tube were measured to check for any decrease in the wall thickness or for any deformation.

(3) Cross section microstructure

The microstructure in the circumferential section was examined on the furnace side and furnace-wall side, and was checked for any structural change due to overheating, etc. Photographs were taken for recording purposes.

(4) Hardness measurement

The hardness at the center of tube wall thickness in the circumferential section was measured at 8 points.

(5) Thickness of interior surface scale

Thickness of the interior surface scale was measured on the furnace side and furnace-wall side

in the circumferential section using an optical microscope, and photographs were taken for recording purposes.

(6) Amount of interior surface scale buildup

Scale built up on the interior surface on the furnace side and furnace-wall side was removed by acid cleaning and the amount of scale was found by measuring the weight difference before and after scale removal.

(7) Composition analysis of interior surface scale

Composition of the interior surface scale was analyzed by chemical analysis and X-ray diffraction.

(8) Dissolution test of interior surface scale

Dissolution test with hydrochloric acid (circulation method) was conducted. Schematic diagram of the scale dissolution test equipment is provided in Fig. 9. Acid solution (hydrochloric acid) at 60°C was circulated through the 300 mm long sample tube, and the concentration of the eluted Fe ion was measured hourly until saturation was reached.

4. Test Results

(1) Appearance

Fig. 2 and Fig. 3 show the appearance.
The T. P. No. 1 and No. 2 had, on their furnace side surface, roughly 0.2 mm of dark-gray hard scale with approx. 0.2 mm adhesion of whitish gray ash on top of the scale. Their furnace-wall side surfaces had roughly 0.1 mm of dark-gray hard scale with a 0.2 ~ 0.5 mm adhesion of reddish brown powdery scale on the top.

(2) Dimensional check

Fig. 4 and Table 1 show the dimensional check results.
The outer diameter was 37.2 mm in all the four directions measured. The wall thickness was 5.0 ~ 5.3 mm and neither conspicuous unevenness in the thickness nor swelling was noted.

(3) Cross-section microstructure

The cross-section microstructure on the furnace side and furnace-wall side are shown in Fig. 5 and Fig. 6 respectively.

Both the furnace and furnace-wall sides had ferrite-perlite structure with no indication of structural changes caused by overheating, etc. However, a decarburized layer was noted roughly 0.10 mm deep from the interior surface on the furnace side and roughly 0.07 mm from the furnace-wall side interior surface.

(4) Hardness test

The hardness test results are shown in Table 2. The hardness level was within the range of Hv 133 ~ 141, with Hv 133 ~ 136 on the furnace side and Hv 137 ~ 141 on the furnace-wall side. The values on the furnace side were slightly lower.

(5) Thickness of interior surface scale

Fig. 7 shows the thickness measurement results of the interior surface scale.

The thickest part of the scale was 0.11 mm on the furnace side and 0.05 mm on the furnace-wall side, with the mean thickness 0.095 mm on the furnace side and 0.038 mm on the furnace-wall side. The scale was thicker on the furnace side than on the furnace-wall side.

(6) Measurement of the degree of interior surface scale

Table 3 shows the measurement results of the amount of interior surface scale.

The scale buildup was 70 mg/cm^2 on the furnace side and 49 mg/cm^2 on the furnace-wall side. A larger amount of scale was noted on the furnace side than on the furnace-wall side.

(7) Composition analysis of interior surface scale

Table 4 shows the results of chemical analysis for the interior surface scale composition, and Fig. 8 shows the results of component identification by X-ray diffraction.

The chemical composition of the interior surface scale was Fe 66.3%, Cu 0.02%, Ni 0.02%, Al 1.38%, Zn 0.14%, Ca 0.08%, Mg 0.02%, Si 0.15%, and insoluble matter in acid 2.17%, of which Fe was the principal component. The X-ray diffraction identified Fe_3O_4.

(8) Interior surface scale dissolution tests

1) Study of concentration for test solution

The amount of the interior surface scale measured this time was 70 mg/cm^2 on the furnace side. If it is assumed to be mostly composed of Fe_3O_4 , the Fe will be:

Fe = 70 (mg/cm^2) x (1/1.38) = 50.7 (mg/cm^2).

If the chemical cleaning solution ratio for the test is 2.5 mℓ/cm^2, the eluted Fe is considered to be:

50.7 (mg/cm^2) x 1000 x [1/2.5(mℓ/cm^2)] = 20,280 (mg/ℓ).

Since an Fe elution of 5,740 mg/ℓ is possible with the 1% acid solution of conventionally used hydrochloric acid of single component solution, solution specification of hydrochloric acid concentration of

$$20,280\,(mg/\ell) \div 5,740\left(\frac{mg/\ell}{\%}\right) = 3.5\,(\%)$$

would be applicable. By taking an allowance for residual acid concentration into account so as to secure 2.0 ~ 2.5% post-test concentration, it was decided to change the solution specification for [Test No.2] after the scale behavior checking with a test using 5% hydrochloric acid concentration [Test No. 1].

2) Scale dissolution test results

Table 5 shows the test conditions and results, Fig. 10 shows the change in the eluted Fe ion concentration with the passage of time, and Photo 1 shows the interior surface status of the specimen after the respective tests.

a. Test No. 1

The test was carried out by using a solution of 5.0% concentration of hydrochloric acid. After one hour from the start of the test, the eluted Fe ion concentration was 14,025 ppm. Thereafter the value gradually rose, and reached saturation point at 15,675 ppm in three hours from the start. Then the internal surface of the tube was checked to confirm that the scale had been completely removed.

b. Test No. 2

Since the scale was confirmed to have been completely removed with use of the solution of 5.0% hydrochloric acid concentration specification, another test was conducted with the solution for which the hydrochloric acid concentration was changed to 3.5%.

In an hour after starting the test, the eluted Fe ion concentration was 11,550 ppm. Thereafter the value gradually rose, and reached the saturation point at 14,850 ppm in three hours from the start. Then the internal surface of the tube was checked to confirm that the scale had been completely removed.

5. Summary

(1) No discoloration or deformation was observed on the furnace side or the furnace-wall side.

(2) In the dimensional check, no uneven thickness or swelling was found.

(3) The structures were ferrite perlite with no indication of structural change caused by overheating, etc. A decarburized layer roughly 0.1 mm deep was noted on the interior surfaces of the tubes.

(4) The hardness level was within the range of Hv 133 ~ 141, and the values on the furnace side were slightly lower.

(5) The mean thickness of interior surface scale was 0.095 mm on the furnace side and 0.038 mm on the furnace-wall side. The amount of interior surface scale was 70 mg/cm^2 on the furnace side and 49 mg/cm^2 on the furnace-wall side. In both measurements, higher values were indicated on the furnace side where the tube wall temperature is high.

(6) The results of the composition analysis for the interior surface scale showed that Fe was the primary component, and other components (metallic components such as Cu, Ni, Al, and Zn, and hardness components in boiler water such as Ca, Mg, and Si) were of mere trace quantity.

(7) In the result of the interior surface scale could be completely removed with a solution of 5% and 3.5% hydrochloric acid concentration.

A summary of the results is that the sample tube showed no discoloration due to overheating or reduced tube wall thickness due to corrosion, and their structures were ferrite perlite with no indication of structural changes due to overheating, etc.

On the interior surface of the tubes, a decarburized layer, assumed to have occurred during manufacturing, was noted. The hardness value was slightly lower on the furnace side, which seems to indicate a tendency towards softening.

In the composition of the interior surface scale caused by overheating or corrosion of the tube material, the amount of impure elements was minimal and the Fe_3O_4 was dominant. Although conspicuous deterioration was not found with the tube sample this time, we recommend that a sample tube test be implemented systematically to ascertain the status of the tube materials changing with the passage of time and to use the results for water quality management.

Furthermore, since the scale amount is anticipated to increase, we recommend that dissolution tests be conducted again when the boilers are chemically cleaned.

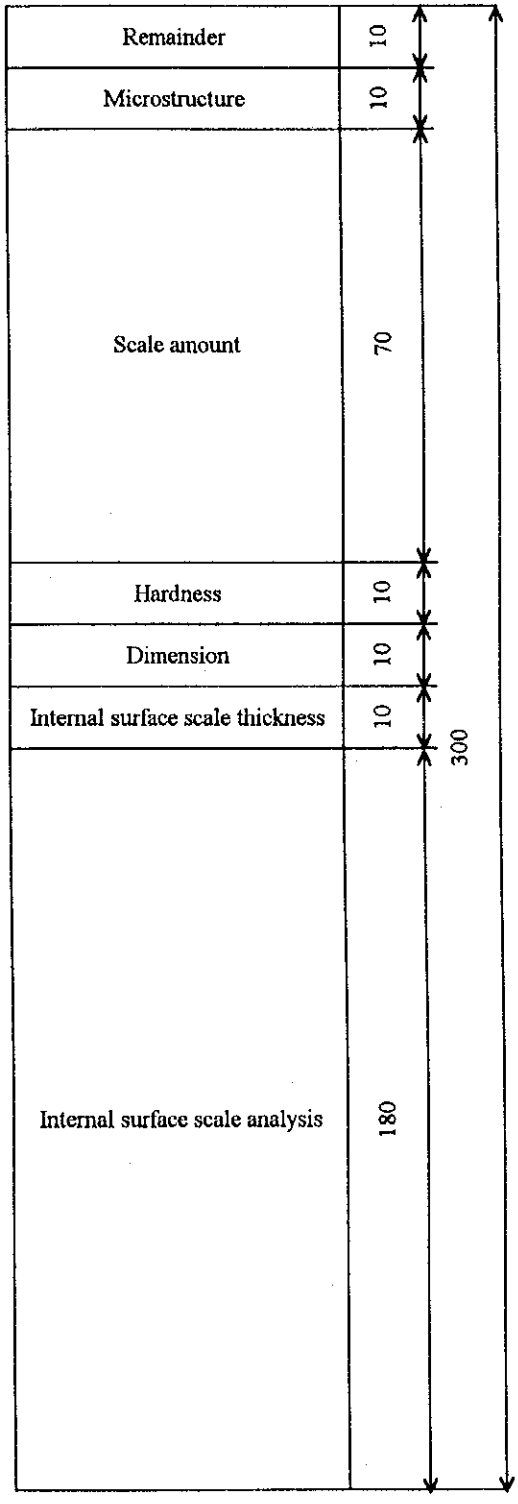
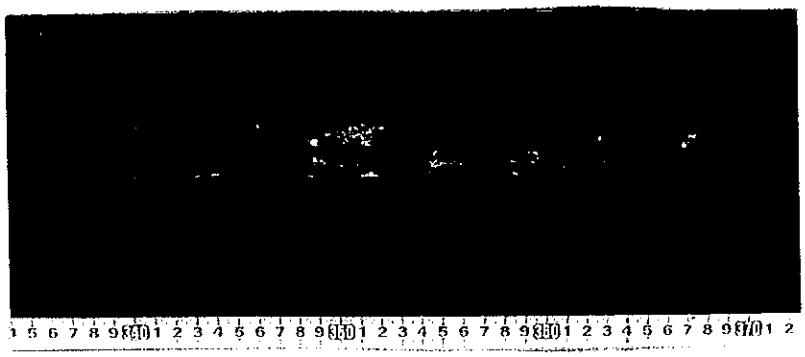


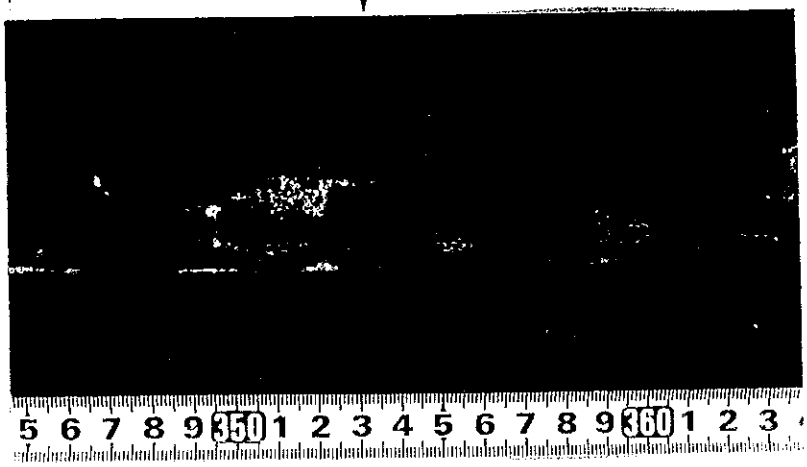
Fig. 1 Specimen Allocation in the Sample Tube

Overall view



Furnace side

Enlarged



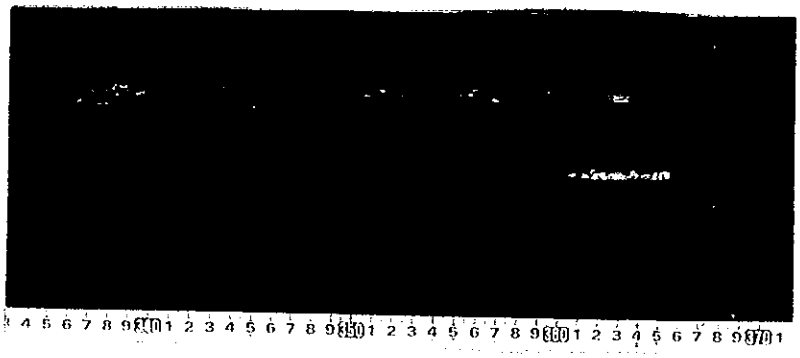
Overall view

Furnace-wall side

Enlarged

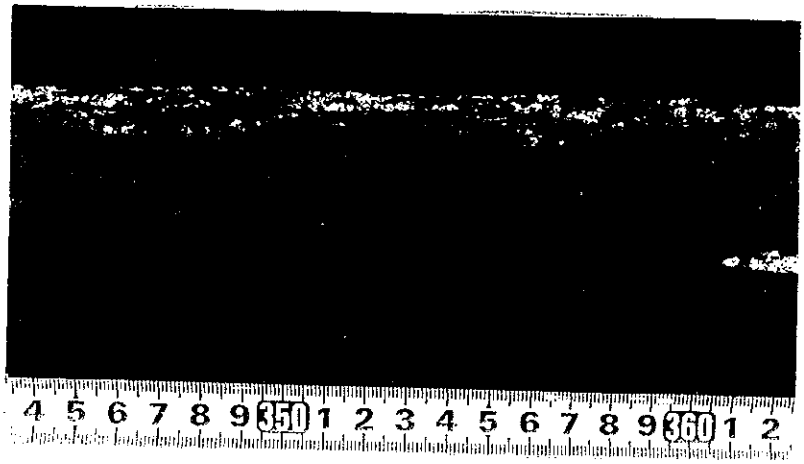
Fig. 2 T. P. No. 1 Appearances

Overall view

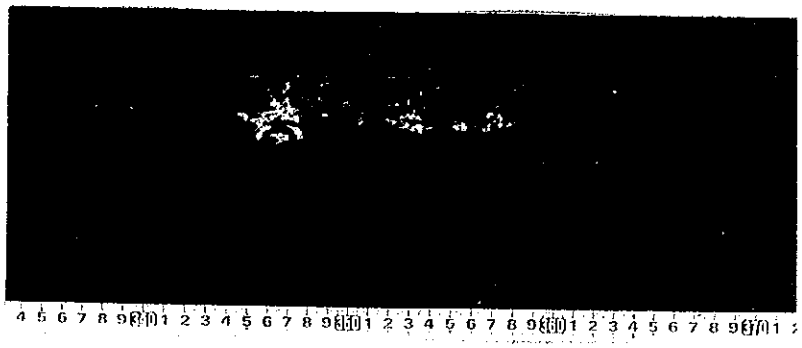


Furnace side

Enlarged



Overall view



Furnace-wall side

Enlarged

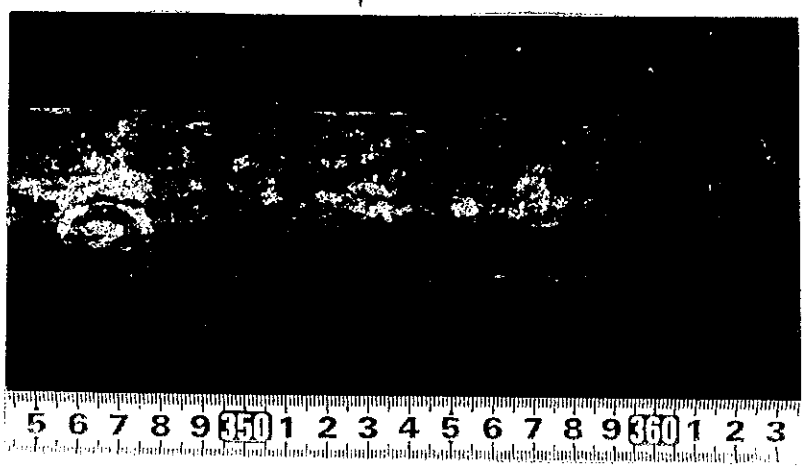
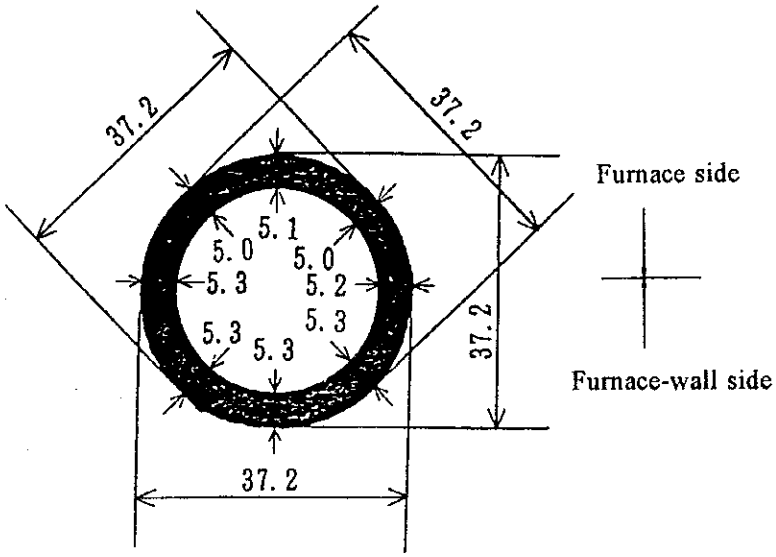
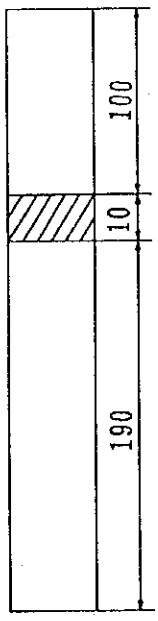


Fig. 3 T. P. No. 2 Appearances



No variation of thickness, swelling, etc. was found.

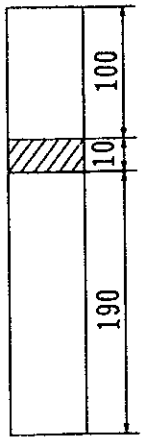


Sampled location of specimen (▨)

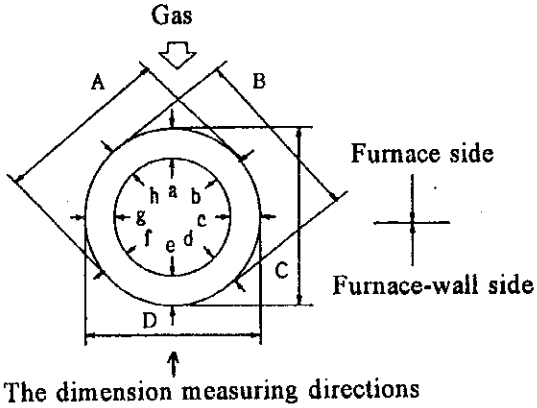
Fig. 4 T. P. No. 1 Dimensional Check Results (mm)

Table 1 T. P. No. 1 Dimensional Check Results (mm)

Check Items	Measuring Directions	Measured Values
Outer Diameter	A	37.2
	B	37.2
	C	37.2
	D	37.2
Wall Thickness	a	5.1
	b	5.0
	c	5.2
	d	5.3
	e	5.3
	f	5.3
	g	5.3
	h	5.0



Sampled location of specimen (marked by ▨)



The dimension measuring directions

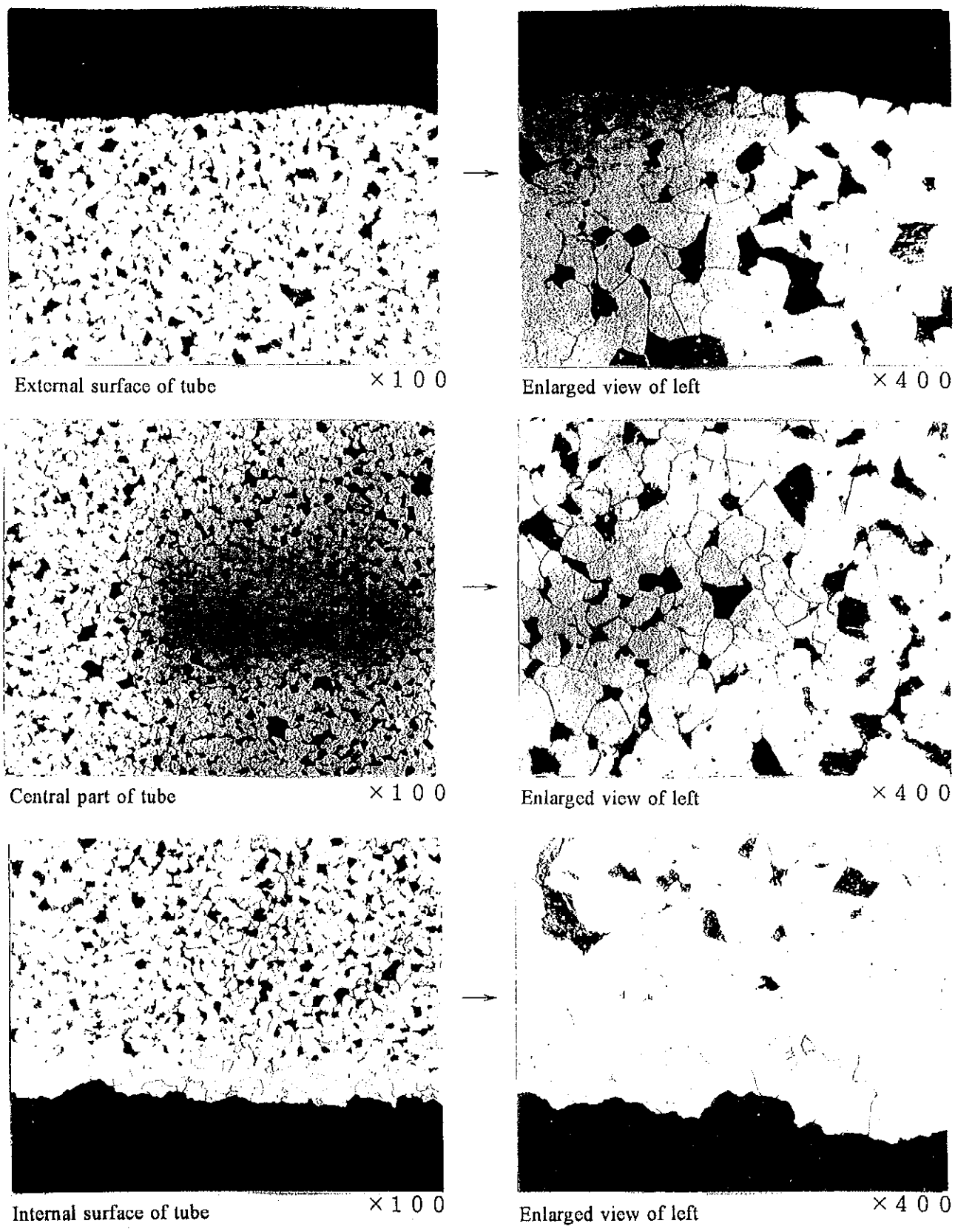


Fig. 5 Cross-section Microstructure on Furnace Side

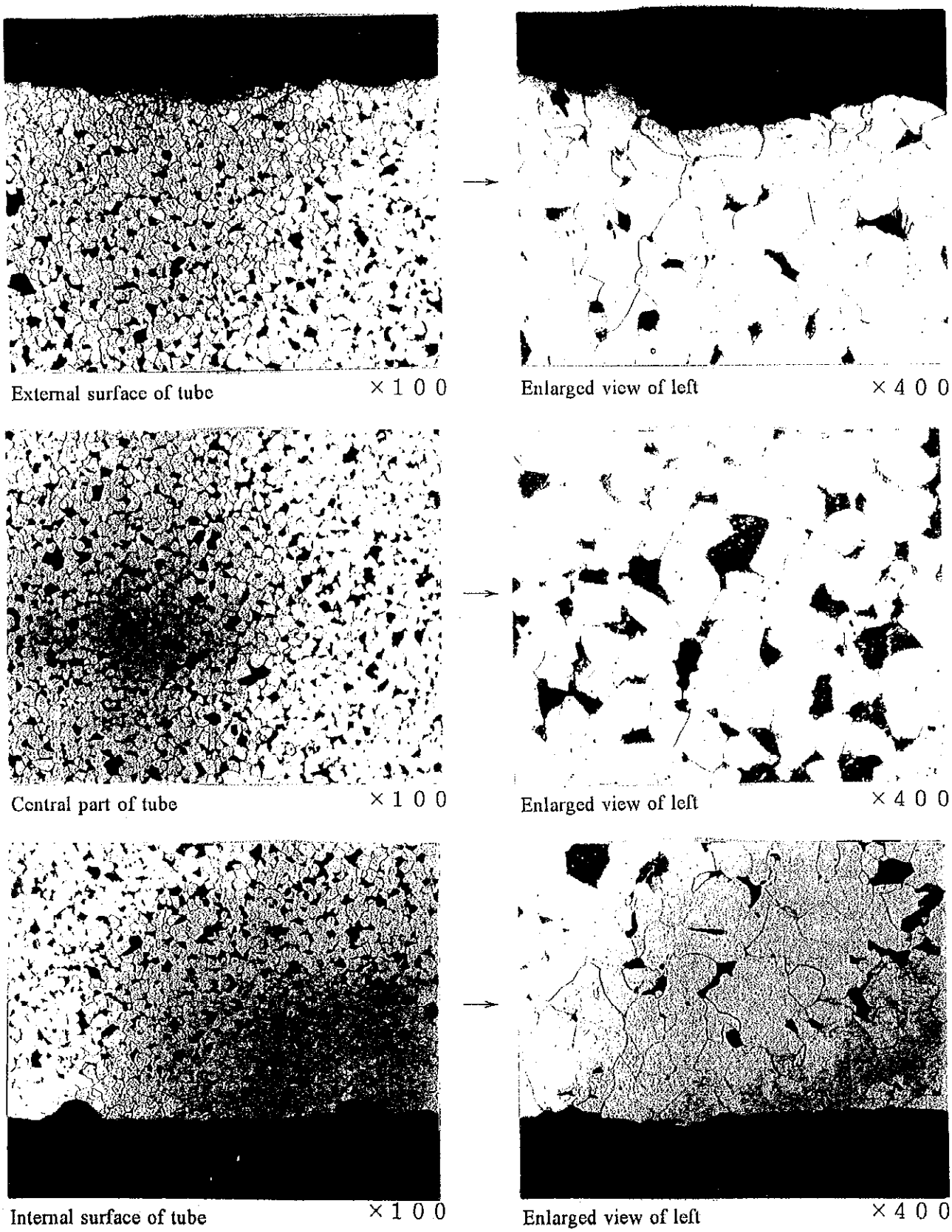
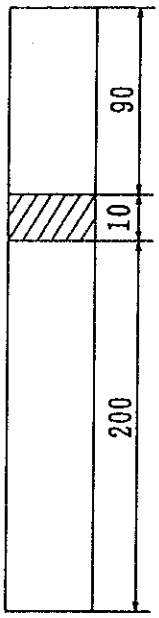


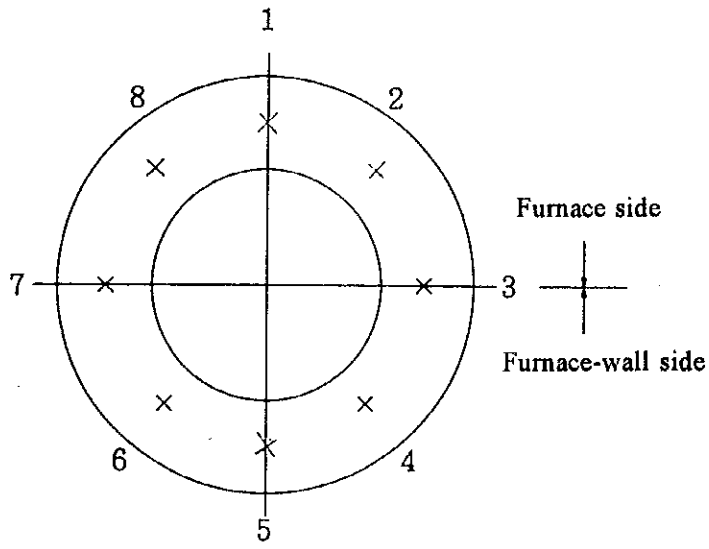
Fig. 6 Cross-section Microstructure on Furnace-wall Side

Table 2 Hardness Test Results (Hv)

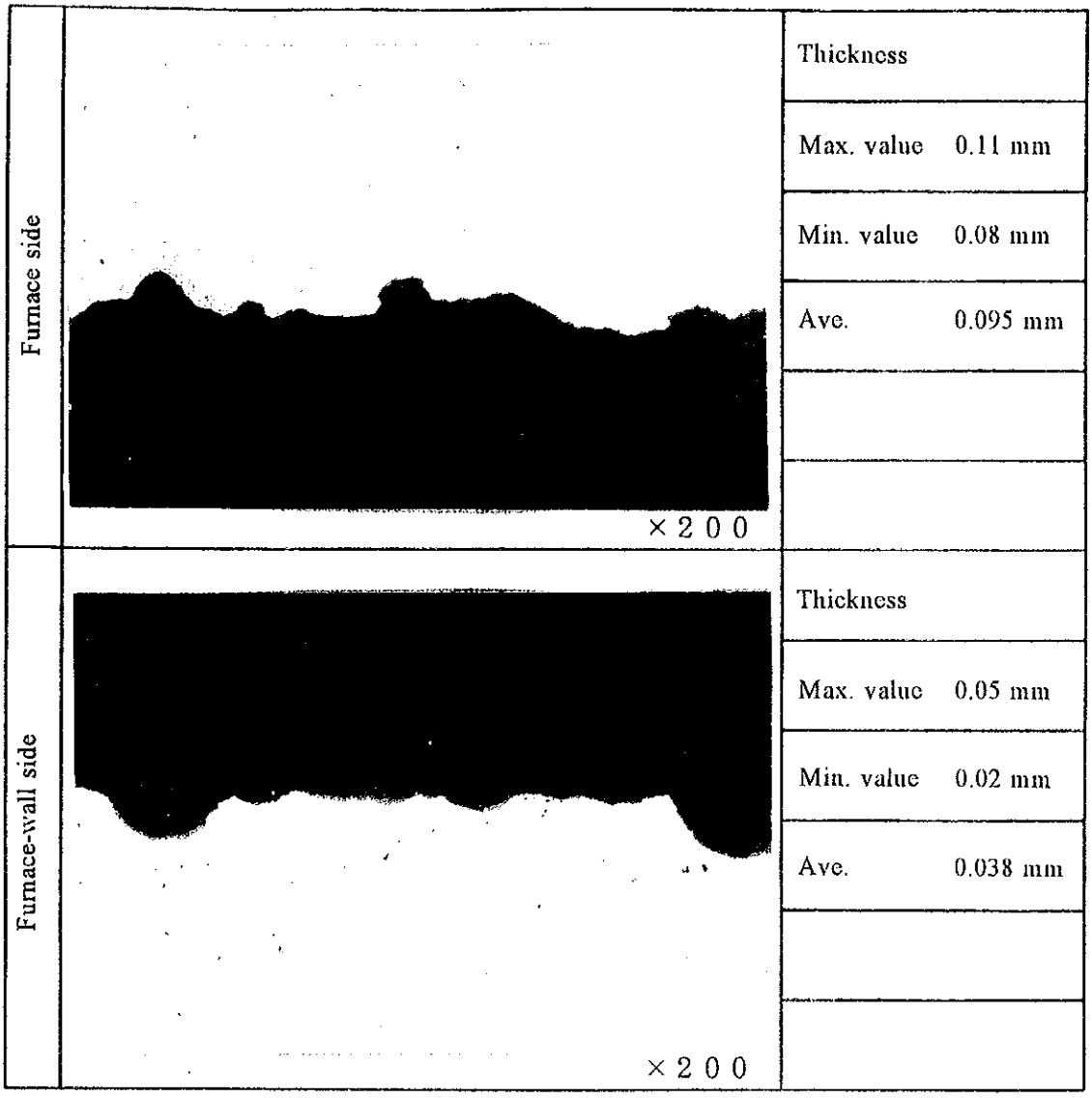
Measuring points	1	2	3	4	5	6	7	8
Measured value	133	134	135	141	138	137	134	136

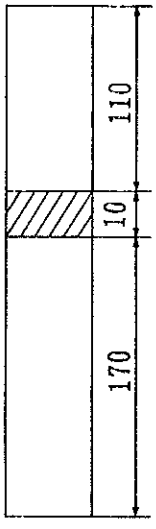


Sampled location of specimen

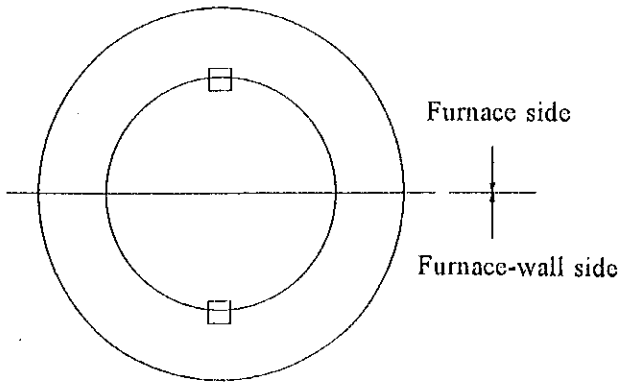


Measuring points x (center of the wall thickness)





Sampled location of specimen

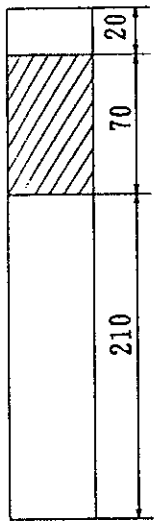


Measuring points

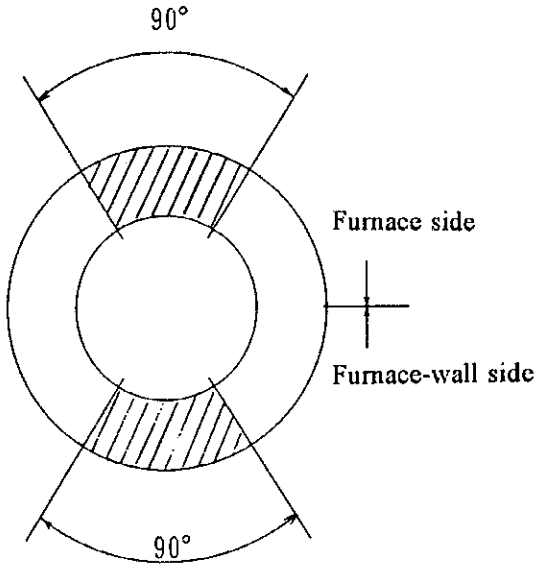
Fig. 7 Thickness Measurement Results of Interior Surface Scale (mm)

Table 3 Interior Surface Scale Measurement (mg/cm^2)

Furnace side	Furnace-wall side
70	49



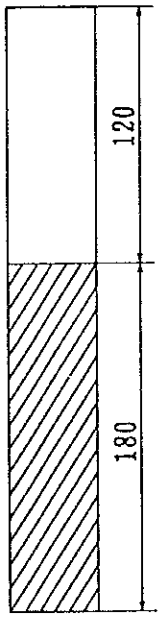
Sampled location of specimen



Measuring points

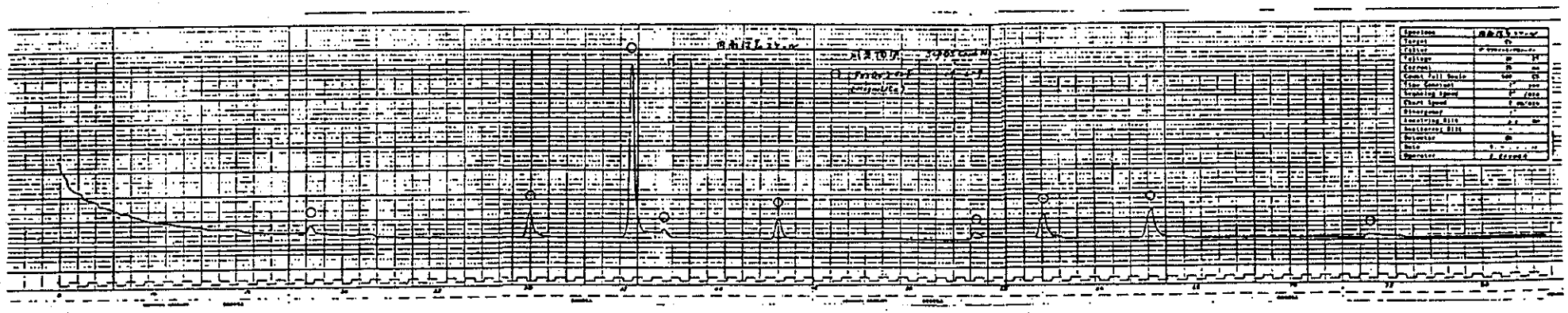
Table 4 Chemical Analysis Result of Scale Composition (%)

Scale composition	Fe	Cu	Ni	Al	Zn	Ca	Mg	Si	Unsolvable elements
%	66.3	0.02	0.02	1.38	0.14	0.08	0.02	0.15	2.17



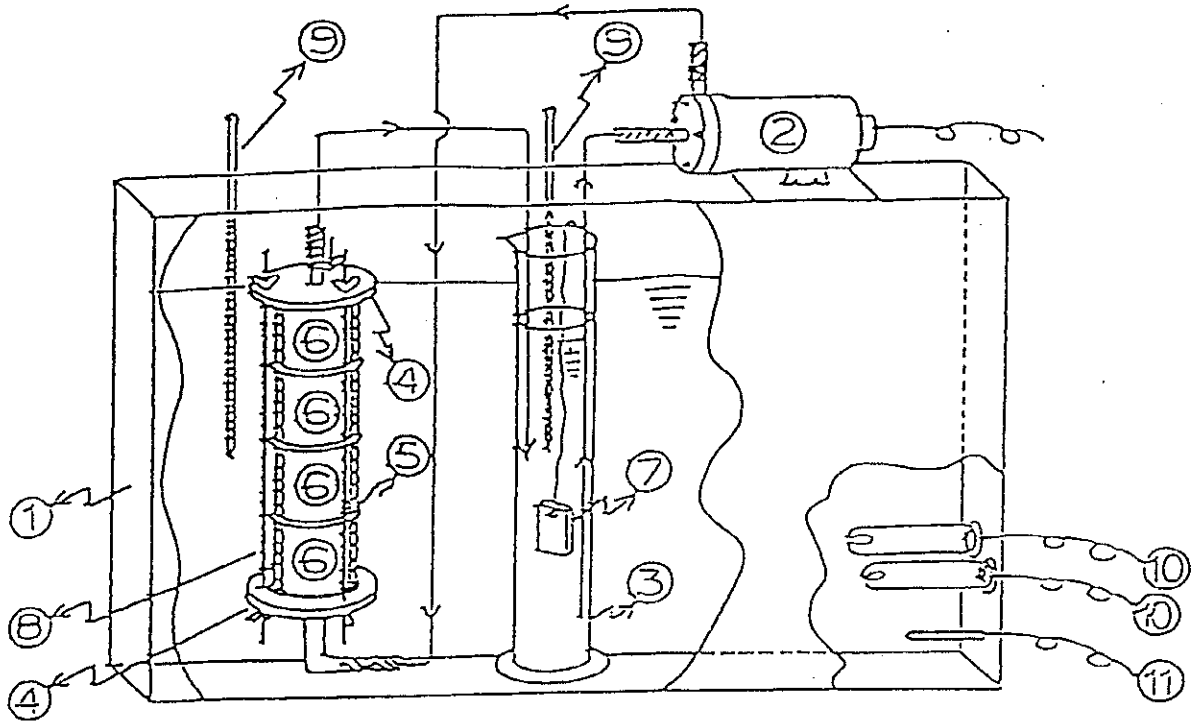
Sampled location of specimen

Identified substance Fe_3O_4



Specimen	Scale on interior surface
Target	Cu
Filter	Graphite monochromator
Voltage	30 KV
Current	20 mA
Count Full Scale	500 CS
Time Constant	2° sec
Scanning Speed	2° /min
Chart Speed	2 cm/min
Divergency	1°
Receiving Slit	0.3 mm
Scattering Slit	-
Detector	GM
Date	H. 7. 1. 11
Operator	O. SAKODA

Fig. 8 Component Identification of Internal Surface Scale by X-ray Diffraction



(1)	Constant-temperature bath	(6)	Specimen
(2)	Circulating pump	(7)	Test piece
(3)	Circulation tank	(8)	Connecting rod
(4)	Flange	(9)	Thermometer
(5)	Gasket	(10)	Heater
		(11)	Thermostat

Fig. 9 Outline of Dissolution Test Equipment

Table 5 Scale Dissolution Test Conditions and Results

Test No. / Specifications	1	2
Test conditions		
Hydrochloric acid (%)	5.0	3.5
Ibit 2S (%) 0.3	0.3	
Swellin S (%)	0.2	0.2
Processing temperature (°C)	60	60
Test solution ratio (mℓ/cm^2)	2.5	2.5
Circulating speed inside tube (m/s)	0.3 ~ 0.4	0.3 ~ 0.4
Fe ion elution (mg/ℓ)		
After 1 hour	14,025	11,550
After 2 hours	15,125	14,300
After 3 hours	15,675	14,850
After 4 hours	15,675	14,850
Residual acid content (%)	1.6	0.2
Sludge amount (mg/cm^2)	0.56	1.56
Scale removal status	complete removal	complete removal

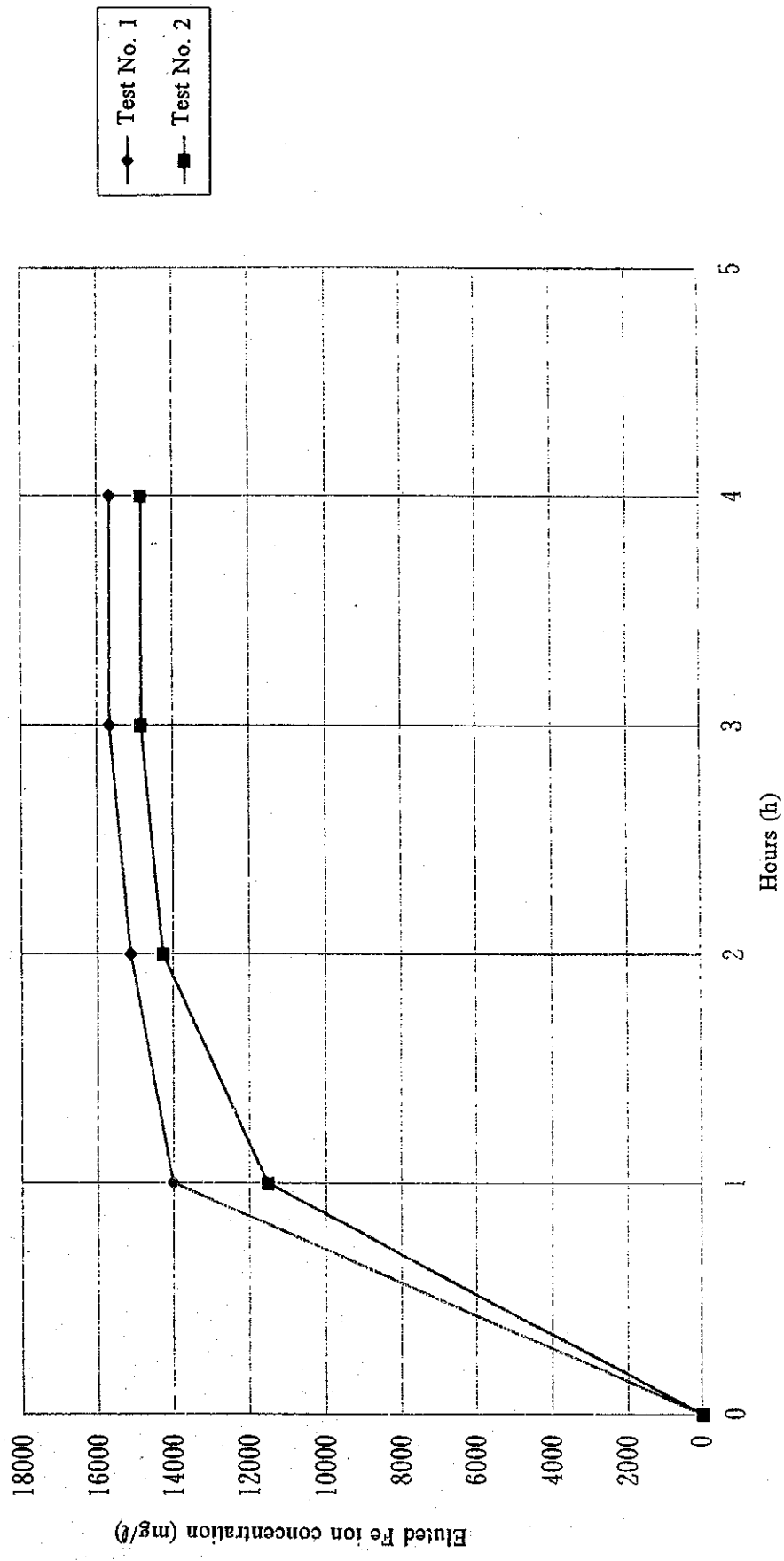
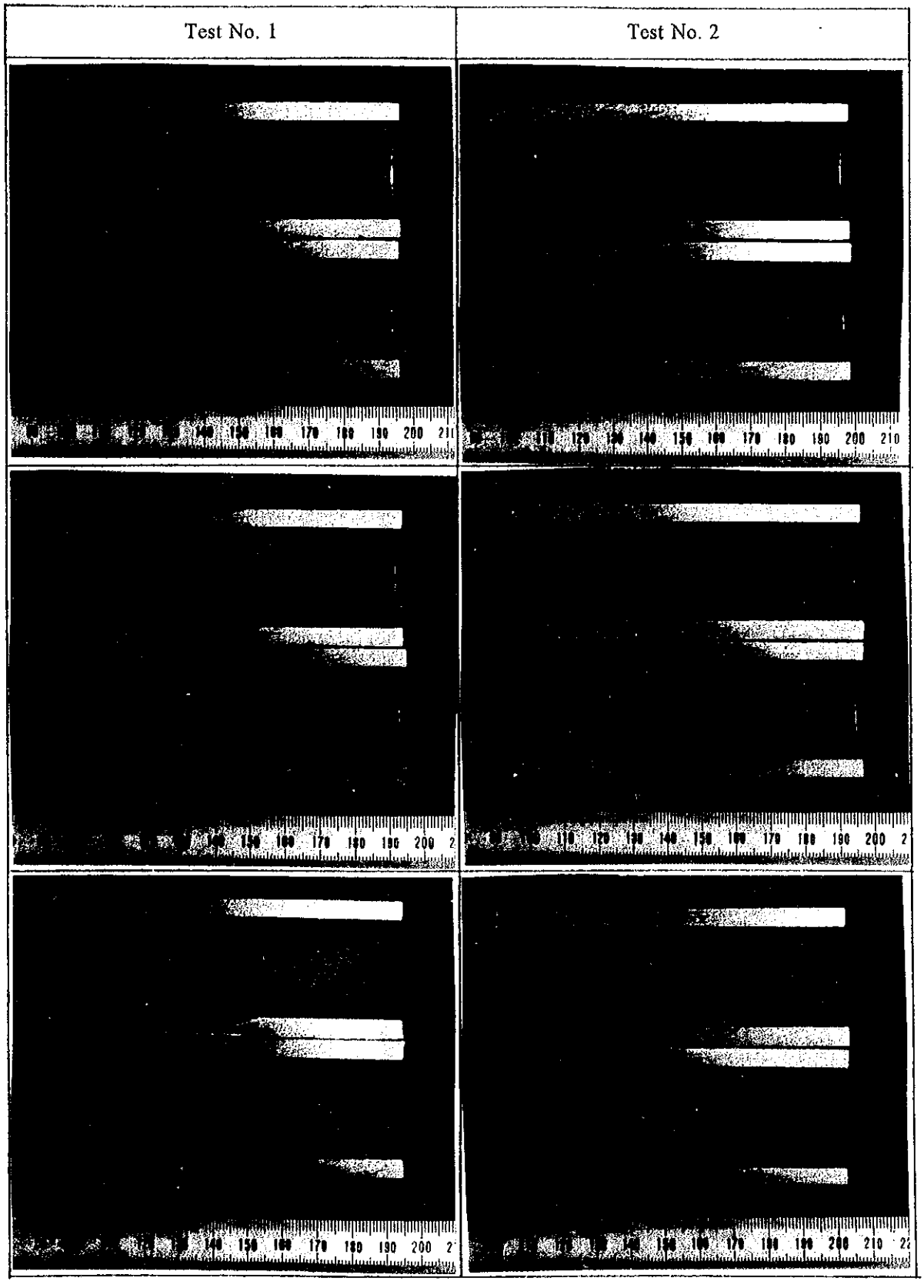
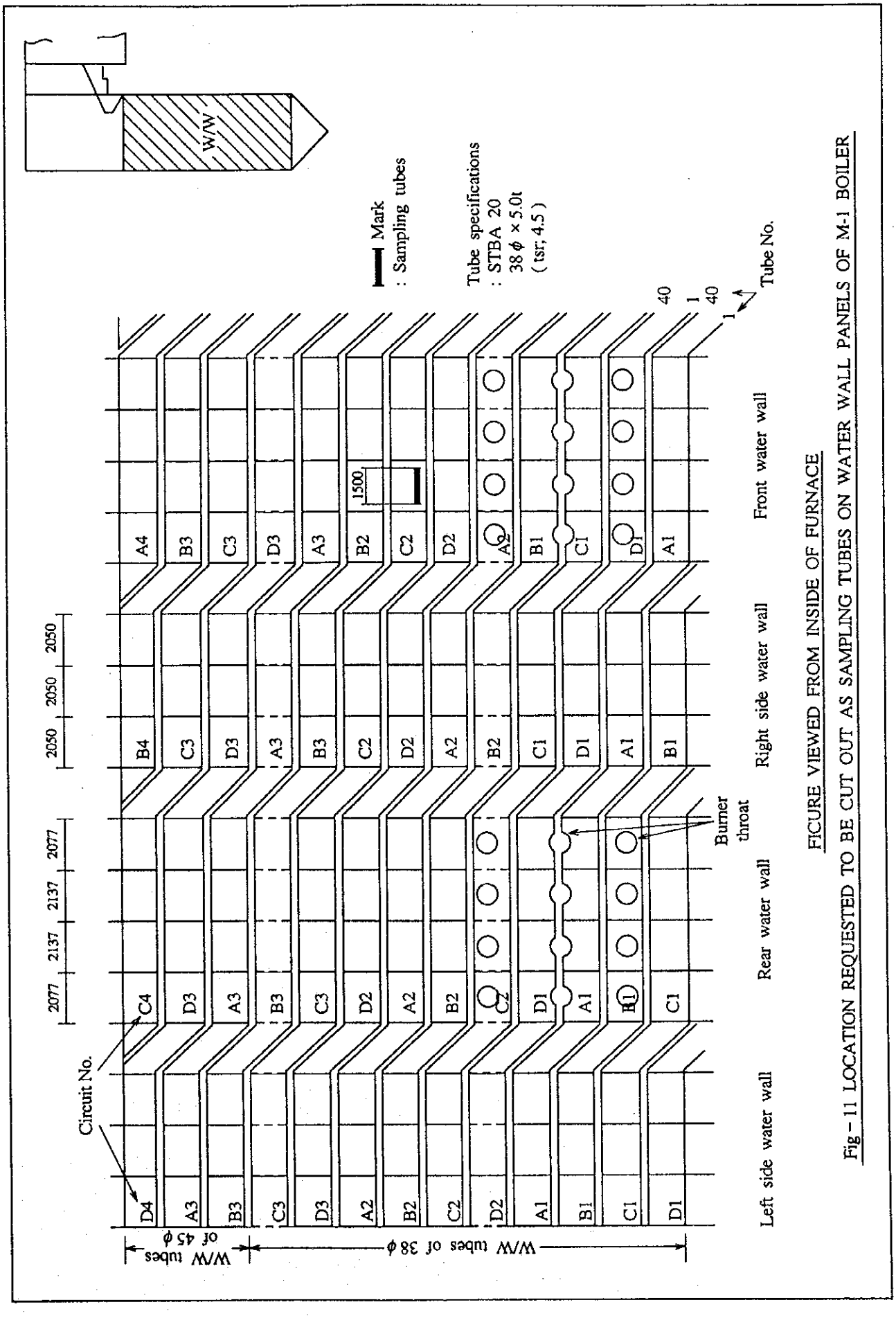


Fig. 10 Eluted Fe Ion Concentration with the Passage of Time

Photo 1 Status of Internal Surface of Tubes after Dissolution Test





FICURE VIEWED FROM INSIDE OF FURNACE

Fig - 11 LOCATION REQUESTED TO BE CUT OUT AS SAMPLING TUBES ON WATER WALL PANELS OF M-1 BOILER

TECHNOLOGY FOR ASSESSMENT OF REMAINING LIFE

I. GENERAL DESCRIPTION

1. Objective

The objective of remaining life assessment will be considered as follows;

(1) To assure the reliable operation of power plant

(2) To establish/enrich "preventive maintenance" system

(3) To determine critical equipment/components which shall be taken necessary measures at the coming major periodic overhaul or rehabilitation.

(4) To prepare the suitable examination method of those components

(5) To assess actual conditions of equipment/components

(6) To find out ideas or methods of elongation of power plant's life span.

2. Assessment of Remaining Life

(1) Timing for Remaining Life Assessment (R. L. A.)

(a) Standard timing for R. L. A. in japan is;

- Total operation hour reaches 100,000 hours or
- Total number of start reaches 2,500

(b) Applicable Timing for R. L. A.

It is recommendable for those power plants operating for a long time without any R. L. A. to implement inspection in the earliest chance, because the results of these inspections will be essential to draw up the prescriptions for preventive maintenance necessary for safe and reliable operation after rehabilitation.
The timing applicable for such power plants mentioned above will be only in the time of plant overhaul.

(2) Facilities/components to be inspected for R. L. A.

In general, all major facilities of the plant should be inspected in view of detecting aged deterioration, if not implemented any R. L. A. up to the date. However, from technical and economic view points, it is practical and recommendable way to limit to critical equipment such as boiler, turbine, generator, etc.
The critical parts of major equipment are considered as follows;

Boiler	:	Pressure parts such as drum, SH/RH tubes, water wall tubes and headers
Turbine	:	HP/IP casing and rotor, LP rotor and its long blades, Major Valves (MSV, CV, RSV, ICV)
Major Pipes	:	Main steam pipe, Reheat steam pipe

Generator : Stator/rotor coil and rotor shaft

(3) Facilities/components to be inspected by non-destructive inspection

There are some facilities/components that should be inspected by non-destructive inspection to assure the reliable operation before R. L. A. This inspection will give their present conditions of deterioration and be needed for R. l. A.

3. Critical Equipment/components to be Examined

In this article, the critical equipment/components and their examination method are shown as follows: (in Table 3)

Table 3-1 Major Equipment and Components (For reference)

	Unit A		Unit B	
Equipment	Components	Parts	Components	Parts
Boiler	Furnace	Wall tubes	Same as Unit No. 1	
	High Temp. Superheater and Reheater (Upper part)	Outlet header tube nozzles		
		Tubes		
		Dissimilar weld joint of tubes		
	Type	Drum type	Type	Drum type
Turbine	HP/IP rotor	Center bore Heat groove Blade groove	HP/IP rotor	Outer surface
		Moving Blade Governing stage HP. 1st & 2nd IP. 1st & 2nd		Moving Blade HP. IP.
	LP rotor	Center bore Blade groove L-0, L-1	HP/IP Inner casing and Outer casing	Inner surface
	Type	WH type	Type	Simense Type
Equipment	Components	Parts	Components	Parts
Generator	Stator	Coil (*1)(*2)	Stator	Coil (*2)
	Rotor	NA	Rotor	NA
	Manufacturer	Mitsubishi Electric Co.	Manufacturer	Fuji Electric Co.

(*1) No special examination is carried out, but remaining life will be assessed by the operation hours and number of start/stops.

(*2) Coil insulation precise examination
This is considered as ageing deterioration examination and not included here in this remaining life assessment. However, WEST JEC recommends to do this examination, if the stator coils are not rewound in the rehabilitation.

NA = Not applied

MALAYA THERMAL POWER PLANT

LIST OF MMP PROCEDURES

TABLE OF CONTENTS

*: Under preparation

MALAYA THERMAL POWER PLANT
MECHANICAL MAINTENANCE PROCEDURES
(MYTP/MMP)

PROCEDURE NO.	TITLE	
MMP - 01	VALVE PACKING REPLACEMENT	
- 02	COUPLING ALIGNMENT OF ROTATING EQUIPMENT	
- 03	TANK AND VESSEL ENTRY, INSPECTION, REPAIR AND CLOSURE	
- 04	LIMITORQUE OPERATOR, REMOVAL OVERHAUL AND INSTALLATION	
- 05	LUBRICATION, INSPECTION OF MECHANICAL EQUIPMENT	*
- 06	MAINTENANCE OF RELIEF VALVE	
- 07	GENERAL WELDING PROCEDURE (PIPING)	*
- 08	GENERAL WELDING PROCEDURE STRUCTURAL	
- 09	MYTP #1 BOILER FEEDWATER PUMPS	*
- 10	DISASSEMBLY AND REASSEMBLY OF MYTP #2 CIRCULATING WATER PUMPS	
- 11	MYTP #1 VERTICAL CIRCULATING WATER PUMPS	
- 12	MAINTENANCE OF MYTP #2 CONDENSATE PUMPS TYPE TSM-VB6	
- 13	MYTP #1 M-BFP, TYPE HDG55N	*
- 14	MAINTENANCE OF MOTOR DRIVEN CENTRIFUGAL FIRE SERVICE BOOSTER PUMP	*
- 15	MAINTENANCE OF MOTOR DRIVEN CENTRIFUGAL FIRE SERVICE BOOSTER PUMP	*
- 16	INSPECTION & CLEANING OF FUEL OIL STRAINER	*

* Under preparation

MALAYA THERMAL POWER PLANT
ELECTRICAL MAINTENANCE PROCEDURES
(MYTP/MMP)

PROCEDURE NO.	TITLE	
EMP- 01	GENERAL INSULATION RESISTANCE	
- 02	LUBRICATION OF ELECTRICAL MOTOR BEARINGS	
- 03	MOTOR OPERATED VALVES MAINTENANCE/TESTING	
- 04	ROUTINE MAINTENANCE AND OVERHAUL OF DC MOTORS	
- 05	DC HI-SPOT TESTING	
- 06	AC HI-SPOT TESTING	
- 07	PREVENTIVE MAINTENANCE AND INSPECTION OF AC MOTORS	
- 08	BATTERY PERFORMANCE TEST	
- 09	INSPECTION AND MAINTENANCE OF BATTERY	
- 10	MYTP #2 480 V SWITCHGEAR	
- 11	AMMETER & VOLTMETER CALIBRATION	
- 12	INSPECTION AND MAINTENANCE OF TYPE FA2-N GAS CIRCUIT BREAKER	
- 13	TRANSFORMER TURNS RATIO TEST	*
- 14	INSPECTION AND MAINTENANCE OF TRANSFORMER	
- 15	INSPECTION AND MAINTENANCE OF GENERATOR	*
- 18	CONTACT RESISTANCE TESTING	
- 20	INSPECTION AND MAINTENANCE OF 480 VOLTS MCC	

* Under preparation

MALAYA THERMAL POWER PLANT
INSTRUMENT AND CONTROL PROCEDURE (ICF)
(MYTP/MMP)

PROCEDURE NO.	TITLE
ICP - 01	GENERIC CALIBRATION OF INDICATORS
- 02	GENERIC CALIBRATION OF INSTRUMENTATION SWITCHES
- 03	CALIBRATION FOR LOCAL TEMPERATURE INDICATORS
- 04	GENERIC CALIBRATION OF RECORDERS
- 05	CALIBRATION OF PRESSURE INDICATORS OR PRESSURE GAUGES
- 06	CALIBRATION OF PRESSURE SWITCHES
- 07	GENERIC CALIBRATION OF CONTROL VALVE AND POSITIONER
- 08	CALIBRATION OF PNEUMATICALLY ACTUATED VALVE

MALAYA THERMAL POWER PLANT
RESULT TESTING PROCEDURES
(MYTP/MMP)

PROCEDURE NO.	TITLE	
RTP - 01	BOILER PERFORMANCE TEST	
- 02	BOILER EFFICIENCY TEST (HEAT LOSS METHOD)	
- 03	BOILER CIRCUIT DROP TEST	*
- 04	BOILER SYSTEM LEAK TEST	*
- 05	BOILER HYDROSTATIC TESTING a Once-Through b Drum-Type	*
- 06	BOILER TUBES ACID TESTING	*
- 07	BOILER STORAGE AND PRESERVATION	*
- 08	BOILER SAFETY VALVE SETTING (JACK METHOD)	*
- 09	HEAT RAT PERFORMANCE TESTING	
- 10	AIR PREHEATER "LJUNGSTROM" PERFORMANCE	
- 11	STEAM COIL AIR HEATER LEAK TEST	*
- 12	TURBINE STAGE EFFICIENCY TESTING	
- 13	FEEDWATER HEATER PERFORMANCE (LOW/HIGH PRESS)	*
- 14	FEEDWATER HEATER LEAK TEST AND TUBES PLUGGING	*
- 15	HOUSE SERVICE CLOSED CYCLE PERFORMANCE	
- 16	TURBINE PROTECTIVE DEVICE TEST a. Siemens Turbine b. Hitachi Turbine	*
- 17	MAIN CONDENSER PERFORMANCE	
- 21	IN-PLACE DYNAMIC BALANCING	

* Under preparation

MALAYA THERMAL POWER PLANT
CHEMICAL ANALYSIS PROCEDURES
(MYTP/MMP)

PROCEDURE NO.	TITLE	
CAP - 01	DETERMINATION OF PHOSPHATE, TITRATION METHODS	
- 02	DETERMINATION OF PHOSPHATE, CALORIMETRIC METHODS	
- 03	DETERMINATION OF COPPER, ZINCON METHOD	
- 04	DETERMINATION OF IRON BY SPECTROPHOTOMETRIC METHOD	
- 05	PREVAILING CONDITION OF THE PLANT TO BE SHUTDOWN	*
- 06	CHEMICAL MANAGEMENT IN NORMAL OPERATION OF BOILER	*
- 07	DEPOSITS - SLAG ANALYSIS	
- 08	ADDITIONAL GUIDELINES FOR NPC POWER PLANT INITIAL START-UP/PRESERVATION	*
- 09	DEMINERALIZE PLANT (REGENERATION PROCEDURE, NEUTRALIZATION)	*
- 10	DETERMINATION OF CHLORIDE, NEPHELOMETRY METHOD (TOTAL RESIDUAL Cl, COLOMETRIC METHOD)	
- 11	HYDRAZINE TEST (IODOMETRIC METHOD)	
- 12	HYDRAZINE, CALORIMETRIC DETERMINATION WITH PARADIMETHYL AMINO BENZALDEHYDE	
- 13	SILICA, SPECTROPHOTOMETRIC DETERMINATION (LOW RANGE/HIGH RANGE COLLOIDAL SILICA PROCEDURE)	
- 14	DISSOLVED OXYGEN DETERMINATION BY INDIGO CARMINE METHOD	
- 15	DISSOLVED OXYGEN DETERMINATION USING CHEMIT KITS	
- 16	DETERMINATION OF SPECIFIC GRAVITY, HYDROMETER METHOD	
- 17	MEASUREMENT OF PH	
- 18	DETERMINATION OF FREE MINERAL ACIDITY	
- 19	MEASUREMENT OF ALKALINITY, PHENOLPHTHALEIN AND TOTAL ALKALINITY	*
- 20	DETERMINATION OF TOTAL SOLID, TOTAL DISSOLVED SOLIDS & TOTAL SUSPENDED SOLIDS (HIGH RANGE)	
- 21	DETERMINATION OF TOTAL HARDNESS (MAGNESIUM AND CALCIUM) BY VOLUMETITRATION	
- 22	STANDARDIZATION OF HYDROCHLORIC SULFURIC ACID, SPECIAL IN	

* Under preparation

MALAYA THERMAL POWER PLANT
CHEMICAL ANALYSIS PROCEDURES
(MYTP/MMP)

PROCEDURE NO.	TITLE	
CAP - 23	STANDARDIZATION OF SODIUM THIOSULFATE 0.1N	
- 24	STANDARDIZATION OF SODIUM HYDROXIDE 0.02 TO 1.ON	
- 25	STANDARDIZATION OF SODIUM POTASSIUM PERMANGANATE 0.1N	
- 26	STANDARDIZATION OF IODINE 0.1N	
- 27	STANDARDIZATION OF IODINE. 0.1N	
- 28	STANDARDIZATION OF HYDROCHLORIC/SULFURIC ACID. 0.02 TO 1.0N	
- 29	DETERMINATION OF CATION CONDUCTIVITY	
- 30	SAL T-SPLITTING (STRONG BASE) ANION RESIN CAPACITY DETERMINATION	
- 31	RESINS, DETERMINATION OF TOTAL CATION EXCHANGER CAPACITY	
- 32	WATER RETENTION OF CAPACITY RESINS	
- 33	ION-EXCHANGE RESINS SCREEN ANALYSIS	
- 34	DETERMINATION OF AVAILABLE CHLORIDE IN SODIUM HYPOCHLORITE SHIPMENTS	
- 35	ANALYSIS OF SODIUM HYDROXIDE (DETERMINATION OF PURITY, TOTAL ALKALINITY AS NaOH)	
- 36	ANALYSIS OF HYDROCHLORIC ACID (DETERMINATION OF PURITY, ACIDITY AS HCl)	
- 37	CORROSION RATE AND DEPOSIT DENSITY TEST	*
- 38	FUEL OIL TANK SAMPLING FOR ANALYSIS (DIESEL FUEL)	*
- 39	SPECIFIC GRAVITY DETERMINATION IN DIESEL FUEL OIL	*
- 40	DETERMINATION OF SPECIFIC GRAVITY	*
- 41	CARBON RESIDUE DETERMINATION IN FUEL OIL	*

* Under preparation

MALAYA THERMAL POWER PLANT
TECHNICAL DOCUMENT CONTROL PROCEDURE
(MYTP/MPP)

PROCEDURE NO.	TITLE
TDC - 1	RECEIVING OF EXTERNAL AND INTERNAL INCOMING DOCUMENTS
- 2	PROCESSING AND DISPATCH OF INTERNALLY INTENDED AND OUTGOING DOCUMENTS
- 3	MYTP RECORDS RETENTION/DISPOSAL
- 4	CLASSIFYING/INDEXING OF DOCUMENTS
- 5	FILLING, SUPPLEMENTING, CORRECTING AND UPDATING OF DOCUMENTS
- 6	CONTROL OF GENERATED DOCUMENTS
- 7	HANDLING OF CONFIDENTIAL AND RESTRICTED DOCUMENTS

Scheduled Maintenance Control List for Boiler and the Relevant Equipment

Scheduled Maintenance Routine List will be drawn up based on this List

Thermal Power Plant, Maintenance Sec. (Mechanical)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
			D	Inspection on the Body of Boiler		2		I						II						I						II					10	11	12	1	2	3
			D	Inspection on the Ancillary Valves, Piping, Valves		1											I						II												
			D	Inspection on Soot Blower Facilities		1																I						II								
			D	Inspection on Burners and the Surroundings		2		II						I						II						I										
			D	Cleaning Heavy Oil Burner Tips		4	I, II						I, II						I, II						I, II											
O			D	Inspection on Tanks of Heavy/Crude Oil and Light Oil, and the Surroundigns		2									©												©									
			A	Cleaning of High, Low Pressure Heavy/Crude Oil Pump and Strainer Pan		Unit 1: 1 Unit 2: 2															I, II	II														
			D	Inspection of Ancillary Piping, Valves of Fuel Oil Pump		2		I, II												I, II																
O			D	Inspection on Receiving Equipment of Heavy/Crude Oil		2				©												©														
			D	Inspection on Forced Draft Fan		1			I						II																					
			D	Inspection on Exhaust Gas Mixing Fan		1															I						II									
			D	Inspection on Gas Recirculating Fan		1									©																					
			D	Inspection on Ash Treatment Equipment		4			I, II						I, II						I, II						I, II									
			D	Inspection on Hammering Devices of EP		1					II																			I						
			D	Inspection on Driving Device of EP Damper		1												I					II													
O			D	Inspection on Ammonia Injection Equipment		2				©																			©								
			D	Inspection/Repair on Packing Equipment of Heavy Oil Ash		4					©						©						©						©								
			D	Inspection on and around Air Heater		1								II												I										
			D	Inspection on Driving Device of Air Heater Damper		1						I						II																		
			D	Inspection on Drain Pump of Steam Air Heater		1									II														I							
O			D	Adjustment and Repair of In-Hourse Compressors		1							©																							
O			D	Adjustment and Repair of Soot Blow Compressors		4		©						©						©						©										
			D	Inspection on Drain Disposal Equipment of Soot Blow Compressors		1																								©						
O			D	Inspection on Compressor for Control		1									©																					
			D	Inspection on Steam Converter		1											I													II						
O			D	Oil Treatment for Small Sized Oil Separation Reservoir		2	©											©																		
O			D	Oil Treatment for Large Sized Oil Separation Reservoir		4					©						©						©						©								
O			D	Cleaning of Pump Yard for Oil Delivery		4						©						©						©						©						
			D	Inspection/Maintenance of Explosion-Proof Tools		1						©																								
			D	Main Pipe Inspection		1						I						II																		
			D	Inspection/Repair of Gas Reheating Equipment		1					II																									
			D	Inspection on Cooling, Absorption Equipment for Exhaust Gas Desulfurizer		1				II																										
			D	Inspection on Oxidation Equipment for Desulfurizer		1										II																				
			D	Inspection on Gypsum Separation Equipment		1											II																				
			D	Inspection on Transportation Facilities of Gypsum for Desulfurizer		1																II														
			D	Inspection on Raw Material Transportation, Storage Equipment for Desulfurizer		1																II														
			D	Inspection on Adjusting Equipment of Raw Material for Desulfurizer		1																							II							
			D	Inspection on Desulfurizer Pit and Drainage Equipment		1																								II						
			D	Inspection on Water and the relevant Facilities for Desulfurizer		1																								II						

Note 1 : The mark of O will be executed during economy shutdown, too.

Note 2 : Work Division

A : All work will be attended by the personnel of Electric Power Co.
B : The personnel of Electric Power Co. will be present at the beginning, intermediate and end of the work.
C : The personnel of Electric Power Co. will be present at the beginning and end of the work.
D : Without attendance of Electric Power Co.

I . . . . . No. 1 Unit
II . . . . . No. 2 Unit
I, II . . . . No. 1 Unit and No. 2 Unit
© . . . . . Common Units for No. 1 and No. 2

Scheduled Maintenance Control List for Turbine and the Relevant Equipment

Scheduled Maintenance Routine List will be drawn up based on this List.

Thermal Power Plant, Maintenance Sec. (Mechanical)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
																														10	11	12	1	2	3
O			D	Inspection/Repair of Turbine Body		2	II	I											II	I																
			D	Inspection/Repair of Oiling System		4	II	I					II	I					II	I					II	I										
			D	Inspection/Repair of Main Valves		2	II	I											II	I																
			D	Inspection/Repair of Condenser Body and Auxiliary Valves		2		I, II												I, II																
			D	Inspection/Repair of Circulating Water Pump and its Surroundings		2			I, II												I, II															
			D	Inspection/Repair of Condensate Pump		2			I												I															
			D	Inspection/Repair of Condensate Pump, Condensate Booster Pump		2			II												II															
			D	Inspection/Repair of Ejector, Gland Condenser		1										I																				
			D	Inspection/Repair of Vacuum Pump, Gland Condenser		1										II																				
			D	Inspection/Repair of Feed Water Pump (M.T)		4					I, II						I, II						I, II						I, II						
			D	Inspection/Repair of Feed Water Heater and Deaerator		2											I, II												I, II						
			D	Inspection/Repair of Low Pressure Drain Pump and Drain Tank		2											I, II												I, II						
			D	Inspection/Repair of Demineralized Water Pump, Condensate Transfer Pump		1			I, II																											
			D	Inspection/Repair of Condensate Demineralizer		2									II												II									
O			D	Inspection/Repair of Make-up Water Treatment Equipment		4				I						I						I						I								
			D	Inspection/Repair of Chemicals Feed Pump and Solution Tank		2				I, II												I, II														
			D	Inspection/Repair of Sampling Rack		1				I, II																										
			D	Inspection/Repair of Cooling Water Pump for Bearing		2								I, II													I, II									
			D	Inspection/Repair of Cooling Water Cooler for Seawater Booster Pump		2								I, II													I, II									
			D	Inspection/Repair of Main Piping System		1							II															I								
O			D	Inspection/Repair of Seawater Strainer		No. 1 Unit: 2 No. 2 Unit: 1					I, II						I																				
O			D	Cleaning of Seawater Strainer		1								I																						
			D	Inspection/Repair of Dust Collector		2					II	I											I	II												
O			D	Inspection/Repair of Seawater Electrolysis Equipment		2											I							I												
O			D	Cleaning of Dust Receiver		4						I						I						I						I						
O			D	Inspection/Repair of Iron Ion Dosing Equipment		3						I						I						I												
			D	Inspection/Repair of Deforming Equipment		2					II												II													
O			A	Inspection/Repair of Emergency Diesel Generator		2		I, II													I, II															
			D	Inspection/Repair of Diesel Fire Extinguishing Pump		1									I																					
O			D	Inspection/Repair of Overhead Crane		1															I															
O			D	Inspection/Repair of Motor Driven Hoist		1									I, II																					
			D	Inspection/Repair of Drainage Pump in Turbine Room		2		II			I										II			I												
O			D	Cleaning of Lubrication Stand & its Surroundings and Making up Oil		4	I						I							I						I									
O			D	Inspection/Repair of Waste Water Treatment Equipment		4				I						I							I						I						
O			D	Inspection/Repair of Air Conditioner		2									I														I						
O			D	Inspection/Repair of Vacuum Cleaner		1																								I						
			D	Inspection of Explosion - Proof Tools		1																														
			D	Putting Warehouse of Maintenance in Order		1																		II												
			D	Supplement of Oil Catcher		1												II																		
			D	Checking of Fixtures/Equipment		1												II																		

Note 1 : The mark of O will be executed during economy shutdown, too.

Note 2 : Work Division

A : All work will be attended by the personnel of Electric Power Co.

B : The personnel of Electric Power Co. will be present at the beginning, intermediate and end of the work.

C : The personnel of Electric Power Co. will be present at the beginning and end of the work.

D : Without attendance of Electric Power Co.

I . . . . . No. 1 Unit

II . . . . . No. 2 Unit

I, II . . . . No. 1 Unit and No. 2 Unit

Scheduled Maintenance Control List for Electric and the Relevant Equipment (1/2)

Scheduled Maintenance Routine List will be drawn up based on this List.

Thermal Power Plant, Maintenance Sec. (Electrical)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
																														10	11	12	1	2	3
			A	Brushes of Generator (Implemented in the fifth week, too)	8		I, II			I, II			I, II			I, II			I, II			I, II			I, II										
O			D	Cooling Equipment of Generator Stator (Implemented in the fifth week, too)	4			I, II						I, II						I, II						I, II										
O			D	Casing of Generator	1								I, II																							
			A	Measurement of Generator Shaft Voltage	2								I, II																							
			D	Cleaning of Generator Filter	2									I, II													I, II										
O			D	Exciter Panel, Rectifier Panel	2			I, II												I, II																
O			D	Hydrogen Sealing Oil (Implemented in the fifth week, too)	4						I, II						I, II						I, II						I, II						
O			D	Oil Change of Vacuum Pump for Sealing Oil	1									I	II																					
			D	Replacement of Hydrogen Bottle (Implemented in the fifth week, too)	8			I, II			I, II			I, II			I, II			I, II			I, II			I, II			I, II							
O			D	Transformer	2											I, II													I, II							
O			D	Substation Facilities	2		I												I																	
O			A	Insulator Washing, Contamination Meter (Implemented in the fifth week, too)	4						I						I						I						I							
O			D	Diesel Generator	2				I, II												I, II															
			D	EP Facilities (Implemented in the fifth week, too)	2			I	II											I	II															
O			D	Panelboard Switchgear	2									I, II															I, II							
O			D	High Voltage Moter	1					I, II																											
O			D	Low Voltage Moter	1				I, II																												
O			A	Insulation Measurement and Space Heater Current Measurement of Main Equipment	2								I												I											
O			A	Insulation Measurement and Space Heater Current Measurement of Main Equipment (Including Exhaust Gas Desulfurization)	2								II												II											
O			D	Direct Current Power Source Unit		1																I, II														
			D	Equal Charging of Battery		once/ 6 months																I, II										O					
																														O					
O			A	Measurement of Leakage Current of L. A.		once/ 3 months																			I							O			O		
																															O			O		
O			A	Detector Operation of L. A.		once/ 6 months	I																								O					
																														O					
O			D	OF, CV Cable		1										I																				
O			A	Insulation Measurement of Lighting		once/ 3 months													I, II													O			O		
																															O			O		
O			A	Measurement of Grounding Resistance		once/ 6 months													I													O					
																															O					
O			D	Measurement of Illuminance		1															I															
O			D	Overhead Crane		1															I															
O			D	Inspection of BFPT Hoist		1										I, II																				
O			A	Make-Up Water Treatment		1					I																									
O			D	Drainage Pump Inspection for House Service (Underwater Pump)		once/ 3 months			I																							O			O		
																															O			O		
O			D	Waste Water Treatment System		2				I												I														
O			D	Control Panel for Airplane Warning Light		1					II																										
O			A	Pump Station at Sasagawa River		once/ 3 months	I																									O			O		
																															O			O		
O			D	Bagging Equipment		2					I												I													
O			D	Room for High Pressure Gas Bottle		1								I																						

Note 1 : The mark of O will be executed during economy shutdown, too.

Note 2 : Work Division

A : All work will be attended by the personnel of Electric Power Co.
B : The personnel of Electric Power Co. will be present at the beginning, intermediate and end of the work.
C : The personnel of Electric Power Co. will be present at the beginning and end of the work.
D : Without attendance of Electric Power Co.

I . . . . . No. 1 Unit
II . . . . . No. 2 Unit
I, II . . . . No. 1 Unit and No. 2 Unit

Scheduled Maintenance Control List for Electric and the Relevant Equipment (2/2)

Scheduled Maintenance Routine List will be drawn up based on this List.

Thermal Power Plant, Maintenance Sec. (Electrical)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
																														10	11	12	1	2	3
O			D	Air Conditioner		2									I											I									
O			D	Receiving Equipment of Heavy Crude Oil		1										I																				
O			D	Seawater Electrolytic Equipment		2												I												I						
O			D	Condensate Demineralizer		1															II															
O			D	Facilities installed in Service Building		1																				I									
O			D	Electric Anticorrosion Equipment		1																						I, II								
O			D	Low Voltage Moter for Exhaust Gas Desulfurizer No. 1 & No. 2		1						II																								
O			D	Low Voltage Moter of Common Use for Exhaust Gas Desulfurizer (No. 1)		1												II																		
O			D	Low Voltage Motor of Common Use for Exhaust Gas Desulfurizer (No. 2)		1																	II													
O			D	High Voltage Motor for Exhaust Gas Desulfurizer		1																								II						
O			D	Panelboard Switchgear for Exhaust Gas Desulfurizer		1																							II							
O			D	Air Conditioner for Exhaust Gas Desulfrizer, etc.		1																							II							

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Note 2 : Work Division

A : All work will be attended by the personnel of Electric Power Co.

B : The personnel of Electric Power Co. will be present at the beginning, intermediate and end of the work.

C : The personnel of Electric Power Co. will be present at the beginning and end of the work.

D : Without attendance of Electric Power Co.

I . . . . . No. 1 Unit

II . . . . . No. 2 Unit

I, II . . . . No. 1 Unit and No. 2 Unit

Scheduled Maintenance Control List for Control and the Relevant Equipment (1/2)

Scheduled Maintenance Routine List will be drawn up based on this List

Thermal Power Plant, Maintenance Sec. (Control)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
																														10	11	12	1	2	3
			D	Hydrogen Cooling Equipment for Generator Stator		1														I, II																
O			D	Event Recorder		1																						I								
			A	ABC Control System		1		I																												
			A	APC Control System		1		II																												
			A	Air Dehumidifier System		1				I, II																										
			D	Cleaning Filter of Air Dehumidifier System		once/ 3 months				I, II																						O			O	
																															O			O	
			D	Control Equipment of No. 1 Burner (Disassembled Cleaning is only implemented for equipment with lots of trouble frequency of torch nozzle tips.)		2							I												I											
			D	Control Equipment of No. 2 Burner (Disassemble, Cleaning of Torch, Flame Detector and Igniter)		4	E,C *sg						D,C *sg						B,C *sg						A,C *sg											
			A	Purge of Draft Detecting Pipe		1																				I, II										
			A	Opening & Cleaning of Detection Seat of Detecting Pipe		once/ 3 months																				I, II					O			O		
																														O			O		
			D	Local Control Equipment (Boiler)		1			I, II																											
			D	Local Control Equipment (Turbine)		1																				I, II										
			D	NO_x Control Equipment (Including Blowing of Detection Pipe on the First Week)		2				I												I														
			D	Dust Collector Control Equipment (Rotary Screen)		1														I, II																
O			D	Receiving Equipment for Fuel Oil Tank		1	I																													
O			D	Test of Oil Leakage Detector for Fuel Oil Tank		1	I																													
O			D	Nitrojection Equipment		1					I, II																									
O			D	Detection Equipment for Ammonia Gas		1					I																									
O			D	Make-up Water Treatment, Drainage Neutralization Equipment		1																I														
O			D	Drainage Treatment Equipment		1																						I								
			D	Chemical Feeder		1																							I, II							
			D	PH Meter, Conductivity Meter (Relevant to Central Rack)		1																		I, II												
			D	Replacement of After Cation Resin for Conductivity Meter of Chemical Dosing (Replacement every two months)		once/ 2 months																							I, II							
			D	Analyzer of Dissolved Oxygen, Hydrazine		1		I, II																												
			D	Silica Meter		1															I															
O			D	Boiler for House Service		1																I														
			D	Condensate Demineralizer		1																II														
			D	Seawater Electrolytic Equipment		1																I														
			D	Iron Ion Dosing Equipment		1																	I													
			D	SO_2, NO_X, O_2 Analysis of Exhaust Gas (Implemented in the fifth week, too)		4			I, II						I, II						I, II						I, II									
			D	Inspection of Pretreatment Probe for SO_2, NO_x, O_2 Analyzer of Exhaust Gas		once/ 3 months									I, II																						
																														O			O		
																														O			O		
			D	CO Analyzer		2									I, II														I, II							
			D	Inspection on Probe of CO Meter		once/ 3 months									I, II																		O			O	
																															O			O	
			D	Analyzer of Eco. O_2		Unit No. 1: 2 Unit No. 2: 1									I														I, II								
O			D	Detector for Combustible Gas (No. 2 includes DS)		1										I, II																					
O			-	Analyzer of Sulfur Contents		1										I, II																					
O			D	TV System of Flue Gas Monitoring for House Service		1																	II														

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Note 2 : Work Division

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C : The personnel of Electric Power Co. will be present at the beginning and end of the work.
D : Without attendance of Electric Power Co.

I ..... No. 1 Unit
II ..... No. 2 Unit
I, II .... No. 1 Unit and No. 2 Unit

* Stage

Scheduled Maintenance Control List for Control and the Relevant Equipment (2/2)

Scheduled Maintenance Routine List will be drawn up based on this List

Thermal Power Plant, Maintenance Sec. (Control)

Division (Note 1)	Work Criteria No.	Check Sheet No.	Work Division (Note 2)	Inspection Items	Number of Equipment	Frequency (Time/ Month)	First Week						Second Week						Third Week						Fourth Week						Execution Month					
							M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	M.	Tu.	W.	Th.	F.	Sa.	4	5	6	7	8	9
																														10	11	12	1	2	3
			D	Monitoring Instrument for Turbine		1																	I, II												
			D	Vibration Monitoring Equipment for Auxiliary Facilities		1				I, II																									
			D	Clock System		1										I																			
			D	No. 1 Satellite Control Panel (Turbine)		once/ 4 months												I														O				O
			D	No. 1 Satellite Control Panel (Boiler)		Ditto												I															O				
			D	No. 2 Satellite Control Panel (Turbine)		Ditto												II													O				O	
			D	No. 2 Satellite Control Panel (Boiler)		Ditto												II															O				
			D	Recorder for BTG Panel		1																						I, II					O			
			D	Recorder for BA Panel		1																							I, II							
O			D	Computer, BSC Equipment		1											II																			
O			D	Small Sized Oil Separation and Reserving Tank		1											I																			
O			D	Insulation Measurement for Electrical Final Control Element (Shutdown Time of Mar. Jun. Sep. Dec.)		once/ 3 months								I, II																			O			O
																																O				O
			D	Checking of Fixture/Equipment, Stock (Prepared in advance)		once/ 2months						I																				O		O		O
O			D	Checking of Explosion-Proof Tool		once/ 6 months																										O				
			D	Level Instrument with Purge Set for Exhaust Gas Desulfurizer		1					II																									
			D	Recorder for Exhaust Gas Desulfurizer		1						II																								
			D	PH Meter for Exhaust Gas Desulfurizer (Absorber, Oxidation Equipment)		1								II																						
			D	SO_2 Analyzer for Exhaust Gas Desulfurizer		1															II															

Note 1 : The mark of O will be executed during economy shutdown, too.

Note 2 : Work Division

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C : The personnel of Electric Power Co. will be present at the beginning and end of the work.
D : Without attendance of Electric Power Co.

I . . . . . No. 1 Unit
II . . . . . No. 2 Unit
I, II . . . . No. 1 Unit and No. 2 Unit

Monthly Routine List of Scheduled Maintenance for Mechanical Equipment of Units 1,2 (for Boiler)

Thermal Power Plant
Maintenance Sec.

Week	Unit / Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1st.Week	Unit 1	1.Oil Treatment for Small Sized Oil Separation Reservoir ⊗Ⓒ 2.Cleaning Heavy Oil Burner Tips	1.Adjustment and Repair of Soot Blow Compressors ⊗Ⓒ 2.Inspection of Ancillary Piping,Valves of Fuel Oil Pump 3.Inspection on the Body of Boiler	1.Inspection on Ash Treatment Equipment 2.Inspection on Forced Draft Fan	1.Inspection on Receiving Equipment of Heavy·Crude Oil (※)Ⓒ 2.Inspection on Ammonia Injection Equipment(※)Ⓒ	1.Oil Treatment for Large Sized Oil Separation Reservoir(※)Ⓒ 2.Inspection and Repair on Packing Equipment of Heavy Oil Ash(※)Ⓒ	1.Cleaning of Pump Yard for Oil Delivery(※)Ⓒ 2.Main Pipe Inspection 3.Inspection on Driving Device of Air Heater Damper
	Unit 2	1.Cleaning Heavy Oil Burner Tips	1.Inspection of Ancillary Piping,Valve of Fuel Oil Pump 2.Inspection on Burners and the Surroundings	1.Inspection on Ash Treatment Equipment	1.Inspection on Cooling Absorption Equipment for Exhaust Gas Desulfurizer	1.Inspection and Repair of Gas Reheating Equipment	1.Inspection on Hammering Devices of EP 2.Inspection and Maintenance of Explosion-Proof Tools
2nd.Week	Unit 1	1.Adjustment and Repair of House Service Compressors 2.Cleaning Heavy Oil Burner Tips	1.Adjustment and Repain of Soot Blow Compressors ⊗Ⓒ 2.Inspection on Burners and the Surroundings	1.Inspection on Tanks of Heavy·Crude Oil and Light Oil,and the Surroundings ⊗Ⓒ 2.Inspection on Ash Treatment Equipment 3.Inspection on Gas Recirculating Fan (※)Ⓒ	1.Inspection on Compressor for Control (※)Ⓒ	1.Oil Treatment for Large Sized Oil Separation Reservoir(※)Ⓒ 2.Inspection on the Ancillary Valves, Piping,Valves 3.Inspection and Repair on Packing Equipment of Heavy Oil Ash(※)Ⓒ	1.Cleaning of Pump Yard for Oil Delivery (※)Ⓒ 2.Inspection on Steam Converter 3.Inspection on Driving Device of EP Damper
	Unit 2	1.Cleaning Heavy Oil Burner Tips	1.Inspection on and around Air Heater 2.Inspection on the Body of Boiler	1.Inspection on Ash Treatment Equipment 2.Inspection on Forced Draft Fan	1.Inspection on Drain Pump of Steam Air Heater 2.Inspection on Oxidation Equipment for Desulfurizer	1.Inspection on Gypsum Separation Equipment	1.Main Pipe Inspection 2.Inspection on Driving Device of Air Heater Damper
3rd.Week	Unit 1	1.Oil Treatment for Small Sized Oil Separation Reservoir ⊗Ⓒ 2.Cleaning Heavy Oil Burner Tips	1.Adjustment and Repair of Soot Blow Compressors⊗Ⓒ 2.Inspection of Ancillary Piping,Valves of Fuel Oil Pump 3.Inspection on the Body of Boiler	1.Inspection on Ash Treatment Equipment ②Cleaning of High,Low Pressure Heavy·Crude Oil Pump and Strainer Pan 3.Inspection on Exhaust Gas Mixing Fan	1.Inspection on Receiving Equipment of Heavy·Crude Oil(※)Ⓒ 2.Inspection on Soot Blower Facilities	1.Oil Treatment for Large Sized Oil Separation Reservoir(※)Ⓒ 2.Inspection and Repair on Packing Equipment of Heavy Oil Ash(※)Ⓒ	1.Cleaning of Pump Yard for Oil Delivery (※)Ⓒ
	Unit 2	1.Cleaning Heavy Oil Burner Tips	1.Inspection of Ancillary Piping,Valves of Fuel Oil Pump 2.Inspection on Burners and the Surroundings	1.Inspection on Ash Treatment Equipment ②Cleaning of High,Low Pressure Heavy /Crude Oil Pump and Strainer Pan	①Cleaning of High,Low Pressure Heavy /Crude Oil Pump and Strainer Pan 2.Inspection on Transportation Facilities of Gypsum for Desulfurizer	1.Inspection on the Ancillary Valves, Piping,Valves 2.Inspection on Raw Material Transportation, Storage Equipment for Desulfurizer	1.Inspection on Driving Device of EP Damper
4th.Week	Unit 1	1.Cleaning Heavy Oil Burner Tips	1.Adjustment and Repair of Soot Blow Compressors⊗Ⓒ 2.Inspection on and around Air Heater 3.Inspection on Burners and the Surroundings	1. Inspection on Tanks of Heavy·Crude Oil and Light Oil,and the Surroundings ⊗Ⓒ 2.Inspection on Ash Treatment Equipment	1.Inspection on Ammonia Injection Equipment(※)Ⓒ 2.Inspection on Drain Pump of Steam Air Heater	1.Oil Treatment for Large Sized Oil Separation Reservoir(※)Ⓒ 2.Inspection and Repair on Packing Equipment of Heavy Oil Ash(※)Ⓒ	1.Cleaning of Pump Yard for Oil Delivery (※)Ⓒ 2.Inspection on Hammering Devices of EP
	Unit 2	1.Cleaning Heavy Oil Burner Tips	1.Inspection on the Body of Boiler	1.Inspection on Ash Treatment Equipment 2.Inspection on Exhaust Gas Mixing Fan	1.Inspection on Soot Blower Facilities 2.Inspection on Adjusting Equipment of Raw Material for Desulfulizer	1.Inspection on Desulfulizer Pit and Drainage Equipment	1.Inspection on Steam Converter 2.Inspection on Water and the relevant Facilities for Desulfulizer 3.Inspection on Drain Disposal Equipment of Soot Blow Compressors(※)Ⓒ
5th.Week	Unit 1						
	Unit 2						

Remarks

1.Scheduled Maintenance Work will be implemented in accordance with the attached sheet of maintenance work criteria.
2.Contact with both operation sec. and the person in charge will be kept without fail before and after the work.
3.As a rule,the scheduled maintenance work will be executed after completion of the requested maintenance work.
4.The marked of the underlined part will be also performed during economy shutdown.
5.The marked of ① or ② will be executed in the presence of the personnel of Electric Power Co.
6.Vibration measurement on auxiliary equipment will be executed on 5th week,implemented after the date of 29th.
7.The marked of Ⓒ indicates the work for common facilities regarding unit 1 and unit 2.

Overhaul Inspection manual at the Time of Periodical Examination

Time and Contents of Periodical Inspection for Boiler Facilities (Inspection implemented by Installer)

Notes (*): The inspection means detailed inspection selected checking portion at the approaching time of rapture strength, which is 100,000 hours determined as design criteria of strength of thermal power plant facilities.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
1. Boiler (1) Steam Drum [To include Flush-Tank for Starting Bypass]	a. On the condition steam-water separation equipment will be removed numbers required, visual inspection inside drum and liquid Penetrant test (hereinafter, referred to PT test) on welding lines inside Drum is to be implemented.	a. If inside welding portion of nozzle stub is not machined smoothly, visual inspection of the inside nozzle stub and PT test shall be performed on the condition steam-water separation equipment will be removed numbers required. b. In case that round-off work is not executed at the edge of welding portion attaching drum internals, visual inspection and PT test for the part shall be implemented.	———	a. To implement periodical inspection based on standard period, A Inspection.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "B" inspection of periodical inspection based on standard period, the following are to be added. · When inside welding portion of nozzle stub has been machined smoothly, inspection will be executed on the condition of attaching steam-water separation equipment and welding portions to be inspected is to be performed PT test. b. To "C" inspection of periodical inspection based on standard period, the following are to be added. · When inside welding portion has not been machined smoothly, visual inspection of the inside nozzle stub and PT test are to be implemented on the condition of removing required numbers of steam-water separation equipment	o Water Quality Surveillance o Observance of Temperature Rising Ratio of Boiler Water o Confirmation of Steam Leakage	o Special Precise Inspection executed at the time of Periodical Inspection based on Standard Period is recommendable to be implemented according to the interval described below; · first time after 80,000 hours' operation · second time and later every 8 years or after 60,000 ~ 80,000 hours' operation o As to special precise inspection (*) a. Selecting typical spots out of nozzle stub outside welding and longitudinal, circumferential joints of outside welding, magnetic particle testing (hereinafter, referred to MT) is to be implemented. b. Required numbers of drum internals attached by welding are to be removed and MT is to be implemented welding portion of inside nozzle stub.
(2) Water Drum	(Same as Steam Drum, however, steam-water separation equipment is to be superseded with inside equipment)						

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(3) Header (A) Furnace Economizer	a. To inspect Header and Header Lifting Ring from the outside b. Selecting typical spots, PT test on Header, welding portion of nozzle stub and support metals are to be implemented. [But, after about six years since commercial operation started] c. Including other Headers, selecting more than two typical ones and inside inspections are to be implemented.	a. Same as mentioned A Inspection b. For the welding portions of Furnace outlet Header and nozzle stub which have not been taken measures of both flexible countermeasures and round-off processing at the end of welding portion, typical points are to be selected and PT test shall be implemented. ———	——— ——— ———	a. To implement periodical inspection based on standard period, A Inspection. Besides, Examination implemented more than six years later from the start of commercial operation is also implemented at the initial periodical inspection.	Excluding the following the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. To inspect Header and Header Lifting Ring from the outside.	· Water Quality Surveillance · Confirmation of Steam Leakage	o In case of inspecting Header and Header Lifting Ring form the outside, header with heat insulating material is not needed to remove the insulating material. o As to special precise inspection o Selecting typical spots out of outside welding of longitudinal, circumferential joints of Header and MT is to be implemented.
(B) Superheater Reheater	Same as described above	a. To inspect Header and Header Lifting Ring from the outside b. Welding portion of nozzle stub which has not been taken measures of both flexible countermeasures and round-off processing at the end of welding portion, typical portions are to be selected and PT test shall be implemented.	——— ———	Same as described above	Same as described above	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	Same as described above

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(4) Tube (A) Evaporation Tube	[In Case of Oil-Fired, Gas-Fired Boiler] a. Visual Inspection is to be executed after setting scaffolds up to the burner level inside furnace. b. PT test is to implemented on the typical spots of welding metal attached with tube	[In Case of Oil-Fired, Gas- Fired boiler] a. Tubes inside furnace are to be inspected from the outside, however, scaffolds will not be required to set up.		a. To implement Periodical inspection based on Standard Period, A inspection	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · To inspect tubes inside furnace from the outside. No need required setting up scaffolds.	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	o It is recommendable to take out sample tubes and check them every two years, to inspect and confirm the inside condition
	[In Case of Coal-Fired Boiler] a. Visual Inspection is to be executed after setting scaffolds up to the burner level inside furnace. b. PT test is to implemented on the typical spots of welding metal attached with tube c. Thickness measurement is to be implemented on the typical spots of tubes affected by steam cut	[In Case of Coal-Fired Boiler] a. Tubes inside furnace are to be inspected from the outside, however, scaffolds will not be required to set up. c. In case that measures for erosion have not been applied, thickness test of typical spots of tubes affected by steam cut shall be implemented.	a. Same as described in the relevant to "B" Inspection item.	a. To implement Periodical inspection based on Standard Period, A inspection	To be same as periodical inspection based on standard period.	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	o It is recommendable to take out sample tubes and check them every two years, to inspect and confirm the inside condition.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(B) Tube of Superheater Reheater, Economizer	[In Case of Oil-Fired Boiler] a. Visual Inspection is to be implemented on Superheater, Reheater and Economizer Tubes b. Thickness measurements will be implemented on the typical spots of Superheater and Reheater Tubes c. PT test is to be executed as to typical spots of dissimilar metal joints without using Inconel series welding rods. d. PT test is to be executed as to typical spots of metal welding attached with tube.	[In Case of Oil-Fired Boiler] a. Same as described in the relevant to "A" Inspection item. ——— ——— ———	——— ——— ——— ———	a. To implement periodical inspection based on Standard Period, A inspection.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · To implement visual inspection of superheater tubes, reheater tubes and economizer tubes.	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	
	[In Case of Gas-Fired Boiler] a. Visual Inspection is to be implemented on Superheater, Reheater and Economizer Tubes b. PT test is to be executed as to typical spots of dissimilar metal joints without using Inconel series welding rods c. PT test is to be executed as to typical spots of metal welding attached with tube	[In Case of Gas-Fired Boiler] a. Same as described in the relevant to "A" Inspection item. ——— ———	——— ——— ———	a. To implement periodical inspection based on standard period, A inspection.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · To implement visual inspection of superheater tubes, reheater tubes and economizer tubes.	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(B) Tubes of Superheater, Reheater, Economizer	[In Case of Coal-Fired boiler] a. Visual inspection is to be implemented on Superheater Tubes, Reheater and Economizer Tubes b. Thickness measurements will be implemented on the typical spots of Superheater, Reheater and Economizer Tubes. c. PT test is to be executed as to typical spots of dissimilar metal joints without using Inconel series welding rods. d. PT test is to be executed as to typical spots of metal welding attached with tube.	[In Case of Coal-Fired boiler] a. Same as described in the relevant to "A" Inspection item. b. In case of without countermeasures for errosion, visual and feeling with hand inspections will be executed on superheater tubes, reheater tubes and economizer tubes. c. In case of without countermeasures for errosion, thickness measurements will be implemented on the typical spots of Superheater Tubes, Reheater and Economizer Tubes. ———	——— b. Same as described in the relevant to "B" Inspection item. c. Same as described in the relevant to "B" Inspection item. ———	a. To implement periodical inspection based on standard period, A inspection	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · To implement visual inspection of superheater tubes, reheater tubes and economizer tubes.	· Water Quality Surveillance · Confirmation of Steam Leakage · Surveillance of Metal Temperature	
(5) Valves (A) Safety Valve	Such safety valves as of steam drum, superheater, reheater and electrical relief valve are checked as follows; a. To disassemble, to check b. After assembling, to implement working test	a. To implement working test	a. To implement working test	a. To implement periodical inspection based on standard period, A inspection	To be same as periodical inspection based on standard period.	· Confirmation of Steam Leakage · Confirmation by visual inspection from outside	· Working test can be done by using hydraulic jack.
(B) Main Valves [With excessive wear on valve body, valve seat]	a. To disassemble and to check	a. To disassemble and to check	a. To disassemble and to check	a. To implement periodical inspection based on standard period, A inspection	To be same as periodical inspection based on standard period	· Confirmation of Steam Leakage · Confirmation by visual inspection from outside	

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(6) Boiler Circulation Pump	a. Existence of abnormality on pumps is to be performed by means of pressure, electric current, etc.	a. Same as described in the relevant to "A" Inspection item	———	a. To disassemble more than one unit, and to check b. For the pumps without disassembling, test which can be confirmed of existence of abnormality is to be executed by means of pressure, electric current, etc.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · Test, which can be confirmed of existence of abnormality, is to be executed by means of pressure, electric current, etc.	· Confirmation of Leakage · Confirmation Vibration, Noise · Confirmation by means of visual inspection from the outside	○ It is recommendable to disassemble and to inspect every four years.
(7) Boiler Auxiliary Facilities (A) Water Feed Pump and its Driving Steam Turbine	a. For Water Feed Pump, the test being capable of confirming of abnormality on pumps will be implemented by means of pressure, flow rate, bearing temperature, etc. and for the driving steam turbine, test, which is able to confirm abnormality of steam turbine such as revolution per minute, bearing temperature, will be implemented.	a. Same as described in the relevant to "A" Inspection item	———	a. More than two units are to be disassembled and inspected. As for water feed pump not being disassembled, the test, which is able to confirm abnormality of pump by means of pressure, flow rate, bearing temperature, etc., will be implemented and for the driving steam turbine not being disassembled, the test which is able to confirm abnormality of the steam turbine such as revolution per minute, bearing temperature,etc. will be executed.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following are to be added. For water feed pump, the test being capable of confirming existence of abnormality of pump by means of pressure, flow rate, bearing temperature, etc. will be executed, and for the driving steam turbine, the test, which is able to confirm abnormality of steam turbine such as revolution per minute, bearing temperature, will be implemented.	· Confirmation of Leakage · Confirmation of Vibration, Noise	○ It is recommendable to disassemble and to inspect every four years.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(B) Fan [Forced Draft Fan, induced Draft Fan, Gas recirculating Draft Fan, Gas Mixing Draft Fan]	a. Tests being capable of confirming existence of abnormality of fans will be implemented by means of wind pressure, bearing temperature, etc.	a. Same as described in the relevant to "A" Inspection item.	———	a. Opening manhole fully, inside inspection is to be implemented. b. As for lubrication oil equipment, bearing portions, disassembled inspection will be implemented.	Excluding the following, the case is same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · Tests being capable of confirming existence of abnormality of the fan will be implemented by means of wind pressure, bearing temperature, etc.	· Confirmation of Vibration, Noise	It is recommendable to disassemble and to inspect every two years.
(C) Air Heater	a. Tests being capable of confirming existence of abnormality of air heater will be implemented by means of air temperature of the inlet and outlet, differential pressure, etc.	a. Same as described in the relevant to "A" Inspection item.	———	a. Rotary Regenerative Air Heater will be inspected, opening manhole fully, on rotor body, heating surface and driving device. b. Steam Air Heater will be inspected the inside after opening manhole fully.	Excluding the following, the case is same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · Tests being capable of confirming existence of abnormality of air heater will be implemented by means of air temperature of the inlet and outlet, differential pressure, etc.	· Confirmation of Vibration, Noise	It is recommendable to disassemble and to inspect heating surface every two years.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(D) Combustion Equipment a. Burner	a. To disassemble and to check	———	———	a. To implement periodical inspection based on standard period, A inspection.	To be same as periodical inspection based on standard period.	· Confirmation by visual inspection from outside	o Burner Refractory, Diffuser, etc. shall be maintained sufficiently in order to be in use for about three years.
b. Oil Pump [Heavy, Crude Oil Pump Light Oil Pump]	[In Case of Oil-Fired Boiler] a. Tests being capable of confirming existence of abnormality of pumps will be implemented by means of pressure, electric current, etc.	[In Case of Oil-Fired Boiler] a. Same as described in the relevant to "A" Inspection item.	———	a. More than two units will be disassembled and inspected. b. As for pumps not to be disassembled, tests being capable of confirming existence of abnormality of pumps will be implemented by means of pressure, electric current, etc.	Excluding the following, the case is to be same as periodical inspection base on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · Tests being capable of confirming existence of abnormality of pumps will be implemented by means of pressure, electric current, etc.	· Confirmation of Vibration, Noise	o It is recommendable to disassemble and to inspect every four years.
c. Coal Pulverizer	[In Case of Coal-Fired Boiler] a. Tests being capable of confirming existence of abnormality of coal pulverizer will be performed by means of electric current, etc.	[In Case of Coal-Fired Boiler] a. Same as described in the relevant to "A" Inspection item.	———	a. More than one unit will be disassembled and inspected. b. As for coal pulverizer not to be disassembled, tests being capable of confirming existence of abnormality will be implemented by means of electric current, etc.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "C" inspection of periodical inspection based on standard period, the following is to be added. · Tests being capable of confirming existence of abnormality of coal pulverizer will be implemented by means of electric current, etc.	· Confirmation by visual inspection from outside.	o It is recommendable to disassemble and to inspect every four years.

Time and Contents of Periodical Inspection for Turbine Facilities (Inspection implemented by Installer)

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
2. Steam Turbine (1) Casing	a. Removing Upper Casings and in the condition Diaphragm and Labyrinth packing are attached, inspection will be implemented. As the occasion demands, the following are to be performed. · PT test · Strain Measurement (on the surface of horizontal joint)	a. Removing Upper Casings of High and Intermediate Pressure, and in the condition Diaphragm and Labyrinth packing are attached, inspection will be implemented.	a. Visual Inspection will be implemented during operation.	a. To implement periodical inspection based on standard period, A Inspection. b. As the occasion demands, selecting high stress level portions (For instance, nozzle coupling portion) and the following is to be implemented. · MT test	Excluding the following, the case is same as periodical inspection based on standard period. a. To "A" inspection of periodical inspection based on standard period, the following is to be added. · As the occasion demands, selecting high stress level portions, the following is to be implemented. (For instance; nozzle coupling portion, etc.) b. To "B" inspection of periodical inspection based on standard period, the following is to be added. · Removing Upper Casing in the condition Diaphragm and Labyrinth packing are attached inspection will be implemented.	· Surveillance of Elongation · Surveillance of Elongation Difference · Surveillance of Temperature Difference between inside surface and outside surface. · Surveillance of Extraction Temperature · Confirmation of Allophone (Strange Noise) · Surveillance of Degree of Vacuum Surveillance of Exhaust Temperature · Measurement of Air Extraction Quantity	a. It is recommendable that the barrel-type steam turbine is fully opened and inspected once every four years to six years. b. For every 4 ~ 8 years, including Lower Casing, Diaphragm and Labyrinth Packing will be removed and it is recommendable to implement inspection. c. (*) Special precise inspection executed at the time of periodical inspection based on standard period is to be implemented according to the interval described below; · Initial: after 80,000 hours passed · After second time: It is determined to implement after every eight years or 60,000 ~ 80,000 hours.
(2) Turbine Shaft, Disc, Moving Blade	a. Rotating turbine shaft smoothly without its removal and the following inspections will be implemented. (a) turbine shaft (b) disc (c) vanes and the attached portions (d) shroud, lacing wire (e) setting condition of balance weight b. As the occasion demands, the following is to be implemented. · PT test	a. Rotating turbine shaft smoothly without its removal and inspection will be implemented.	a. Investigating the condition of shaft vibration change, and to confirm no existence of abnormality.	a. To implement periodical inspection based on standard period, A Inspection. b. Selecting typical spots of moving vanes and PT test will be implemented.	Excluding the following, the case is same as periodical inspection based on standard period. a. To "B" inspection of periodical inspection based on standard period, the following are to be added. o Without removing turbine shaft, turning it smoothly and the following inspection will be implemented. · turbine shaft, disc · vanes and the attached portions · shroud, lacing wire · setting condition of balance weight	· Fatigue Life Span Management · Surveillance of Shaft Vibration	a. It is recommendable to remove turbine shafts every 4 ~ 8 years and to inspect them. b. Special precise inspection executed at the time of periodical inspection based on standard period it to be implemented according to the interval described below; · Initial: after 80,000 hours passed · After second time: It is determined to implement after every eight years or 60,000 ~ 80,000 hours.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(3) Diaphragm, Nozzle Stationary Blade	a. To inspect Nozzle at the first stage of high pressure, intermediate pressure, respectively. b. Diaphragm will be inspected in the condition being attached to casing. c. As the occasion demands, the following will be implemented. · PT test · Clearance Measurement · Measurement of Throat	a. To inspect upper side of nozzle at the first stage of high pressure, intermediate pressure, respectively. b. As the occasion demands, the following will be implemented. · PT test · Measurement of Throat	a. Under the confines of the following measures being not implemented at all, inspection is to be performed. · Surface Hardening Treatment · Simultaneous opening · closing method of multi-valves. (combined governing, 2, 3 admission) · Scale blow equipment · Adoption of improved material to secondary superheater tubes and reheater tubes of boiler (SUS347 or shot peening) · Consideration of operation control (Variable pressure operation, DSS) b. As the occasion demands, the following inspections will be executed. · PT test · Measurement of Throat	a. To implement periodical inspection based on standard period, A Inspection	Excluding the following, the case is same as periodical inspection based on standard period. a. To "B" inspection of periodical inspection based on standard period, the following is to be added. · The inspection will be implemented in the condition keeping diaphragm attached to casing.	· Surveillance of Shaft Vibration · Surveillance of Steam Pressure after First Stage · Management of Internal Efficiency of Turbine · Surveillance of Temperature Change after First Stage	a. It is recommendable to inspect after removing diaphragm every 4 ~ 8 years.
(4) Bearing	a. Visual inspection will be implemented on bearing portion	———	———	a. To implement periodical inspection based on standard period, A Inspection	Excluding the following, the case is same as periodical inspection based on standard period. a. To implement periodical inspection based on standard period, A Inspection. b. To "B" inspection of periodical inspection based on standard period, the following is to be added. · Visual inspection will be executed on bearing portions.	· Surveillance of Metal or Temperature of Supply · Discharge Oil · Surveillance of Shaft Vibration · Control of Shaft Voltage · Confirmation of Discharge Oil Quantity, Oil Color.	a. Whenever necessary, in accordance with the period of turbine shaft removal, the inspection will be implemented.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(5) Main Valves [Main Stop Valve Steam Governing Valve Reheat Stop Valve Intercept Valve]	a. Disassembling each valve, strainer, valve body, valve seat, etc. will be inspected. b. As the occasion demands, the following will be implemented. · PT test · Clearance Measurement · Bending Measurement	a. Subsidiary Valve of Main Stop Valve will be inspected. b. As the occasion demands PT test will be implemented.	a. Under the confines of the following measures being not implemented for subsidiary valve of main stop valve at all, inspection is to be performed. · Anti-Corrosion Type Valve · Adoption of improved material to superheater · reheater tubes (SUS347, shot peening treatment tubes) · Scale blow equipment · Consideration of operation control (variable pressure operation, DSS) b. As the occasion demands, PT test will be executed.	a. To implement periodical inspection based on standard period, A Inspection	Excluding the following, the case is same as periodical inspection based on standard period. a. To implement periodical inspection based on standard period, A Inspection. b. To "B" inspection of periodical inspection based on standard period, the following are to be added. · Disassembling each valve, strainer, valve body, valve seat, etc. will be inspected. · As the occasion demands, the following will be implemented · PT test	· Confirmation of Vibration, Noise · Confirmation of Steam Leakage · Confirmation of Loosened Bolts, etc. · Working Test	a. Inspection performed by disassembling for each valve is recommendable to be implemented every 4 ~ 6 years.
(6) Speed Governing Device [Emergency Stop Device, etc.]	a. Visual inspection will be implemented on link mechanism of governor, emergency governor, trip mechanism, etc. b. Working test of auxiliary oil pump for emergency stop device, etc. will be implemented.	a. Same as described in the relevant to "A" Inspection item. b. Same as described in the relevant to "A" Inspection item.	a. Same as described in the relevant to "A" Inspection item. b. Same as described in the relevant to "A" Inspection item.	a. To implement periodical inspection based on standard period, "A" Inspection.	Contents are to be same as periodical inspection based on standard period.	· Greasing · Confirmation of Loosened Bolts and Whirl-Stop of Pins · Confirmation of Oil Leakage · Working Test	It is recommendable to implement the following inspections every 4 ~ 8 years a. Inspection of wear and rust condition of lever, link mechanism. b. Inspection of contamination of foreign material, wear condition of servo-valve, solenoid valve and their wear condition. c. Inspection of wear condition of hydraulic operation equipment.

Essential Equipment	1. Periodical Inspections based on Standard Periods			2. Initial Periodical Inspection	3. Periodical Inspection after Long-Term Operation	Measures taken in Daily Maintenance	Remarks
	A Inspection	B Inspection	C Inspection				
(7) Condenser	a. Opening water box, inspection will be implemented inside and small tubes. b. As the occasion demands, the following will be implemented. · Leakage Test of Small Tubes (Filling Water) · Vortex Flaw Detective Test of Small Tubes.	———	———	a. To implement periodical inspection based on standard period, "A" Inspection.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To "B" inspection of periodical inspection based on standard period, the following is to be added. · Opening water box, the inside and small tubes are to be inspected.	· Surveillance of Leakage · Surveillance of Electric Anticorrosion Device · Operation and Control of Prevention Device of Contamination of Foreign Material. · Operation and control of Cleaning Device. · Implementation of Back Washing.	
(8) Auxiliary Equipment of Steam Turbine (A) Feed Water Heater	a. Opening water chamber, the inside and small tubes will be inspected. b. As the occasion demands, leakage inspection of water supply side will be implemented.	———	———	a. To implement periodical inspection based on standard period, "A" Inspection.	Excluding the following, the case is to be same as periodical inspection based on standard period. a. To implement periodical inspection based on standard period, "A" Inspection. b. To "B" Inspection of periodical inspection based on standard period, the following is to be added. · Opening water chamber, the inside and small tubes will be inspected.	· Surveillance of Opening of Drain Valve · Surveillance of Water Level of Drain · Surveillance of Temperature Difference of Feed Water · Confirmation of Allophone (Strange Noise) · Surveillance of pressure Difference of Feed Water · Confirmation of Feed Water Leakage	

Notes; (*) The inspection means detailed inspection selected checking portion at the approaching time of rapture strength, which is 100,000 hours determined as design criteria of strength of thermal power plant facilities.

WEEKLY PREVENTIVE MAINTENANCE SCHEDULE
For the Period: 05/27/94 to 06/02/94

UNIT : MYT2 WORK CENTER : OP PAGE : 1

REVIEWED BY: PEDROCILLO/TM VILLENA,JR. -PLS APPROVED BY: JT ABELA - Opn. Manager

DATE : 05.26.94 DATE :

PMRC No. / PMRC Seq. No.	PLANT EQUIPMENT	MON	TUE	WED	THU	FRI	SAT	SUN	PM ACTIVITY DESCRIPTION	SL	CL
MYT2-94-3374	FO23APMP02	01WK							LUBRICATE BEARINGS	010	000
OP-FO-1726-0009N	MAIN FUEL OIL PUMP 2 B										
MYT2-94-3474	BA20SFAN01		01WK						LUBRICATE BEARINGS	010	000
OP-BA-013F-0009N	FLAME DETECTOR COOLI NG FAN A										
MYT2-94-3434	DR201PMP01		01WK						LUBRICATE BEARINGS	010	000
OP-DR-0031-0009N	BOILER SUMP PUMP 2A										
MYT2-94-3459	DR201PMP02		01WK						LUBRICATE BEARINGS	010	000
OP-DR-0041-0009N	BOILER SUMP PUMP 2B										
MYT2-94-3464	DR202PMP01		01WK						LUBRICATE BEARINGS	010	000
OP-DR-0071-0009N	TURBINE SUMP PUMP 2A										
MYT2-94-3469	DR202PMP02		01WK						LUBRICATE BEARINGS	010	000
OP-DR-0081-0009N	TURBINE SUMP PUMP 2B										
MYT2-94-3556	BA203FAN02			01WK					LUBRICATE BEARINGS	010	000
OP-BA-013F-0009N	FLAME DETECTOR COOLI NG FAN 2B										
MYT2-94-3561	CY213FAN01			01WK					LUBRICATE BEARINGS	010	000
OP-CY-0455-0009N	GLAND STEAM EXHAUSTE R FAN 2A										
MYT2-94-3566	CY213FAN02			01WK					LUBRICATE BEARINGS	010	000
OP-CY-0476-0009N	GLAND STEAM EXHAUSTE R FAN 2B										
MYT2-94-3546	GC202PMP01			01WK					LUBRICATE BEARINGS	010	000
OP-GC-0151-0009N	STATOR COOLING PUMP A										
MYT2-94-3551	GC202PMP02			01WK					LUBRICATE BEARINGS	010	000
OP-GC-0171-0009N	STATOR COOLING PUMP B										
MYT2-94-3676	VA201FAN01			01MO					LUBRICATE BEARINGS	010	000
OP-2VA0018-0009N	BOILER ROOF VENTILAT OR 2A										
MYT2-94-3677	VA201FAN02			01MO					LUBRICATE BEARINGS	010	000
OP-2VA0028-0009N	BOILER ROOF VENTILAT OR 2B										
MYT2-94-3678	VA201FAN03			01MO					LUBRICATE BEARINGS	010	000
OP-2VA0038-0009N	BOILER ROOF VENTILAT OR 2C										
MYT2-94-3679	VA201FAN04			01MO					LUBRICATE BEARINGS	010	000
OP-2VA0048-0009N	BOILER ROOF VENTILAT OR 2D										
MYT2-94-3680	VA201FAN05			01MO					LUBRICATE BEARINGS	010	000
OP-2VA0058-0009N	BOILER ROOF VENTILAT OR 2E										

WEEKLY PREVENTIVE MAINTENANCE SCHEDULE
For the Period: 06/27/94 to 07/03/94

PLANT : MYT1 | WORK CENTER : IC | PAGE : 1

REVIEWED BY: JV PAZ IGI/TM VILLONA,JR. - P&S | APPROVED BY: AS PALPAL-LATOC - Maint. Manager
DATE : 6.24.94 | DATE :

PMNO No. / PMRC Seq. No.	PLANT EQUIPMENT	MON	TUE	WED	THU	FRI	SAT	SUN	PM ACTIVITY DESCRIPTION	SL	LL
MYT1-94-5515	1AR-8209	02WK							RECORDER INKING AND	ESD	000
IC-MC-115A-0041N	F. G. FLOW & MFBP DI								CLEANING		
	SCH. PRESS. RECORDER										
MYT1-94-5511	1FR-8211	02WK							RECORDER INKING AND	ESD	000
IC-MC-107A-0041N	FEED WATER FLOW RECO								CLEANING		
	RDER										
MYT1-94-5503	1TR-8100	02WK							RECORDER INKING AND	ESD	000
IC-MC-091A-0039N	GEN STATOR, HYDROGEN								CLEANING		
	& EXCITER TEMP REC.										
MYT1-94-5507	1TR-8119	02WK							RECORDER INKING AND	ESD	000
IC-MC-099A-0039N	EQUIPMENT BEARING TE								CLEANING		
	MPERATURE RECORDER										
MYT1-94-5601	1AR-8101		02WK						RECORDER INKING AND	EIS	000
IC-MC-001B-0017N	FAULT RECORDER (LS2)								CLEANING		
MYT1-94-5573	1AR-8210		02WK						RECORDER INKING AND	ESD	000
IC-MC-116A-0036N	SH & RH FLOW, BFP DI								CLEANING		
	SCH. PRESS. RECORDER										
MYT1-94-5565	1TR-8109		02WK						RECORDER INKING AND	ESD	000
IC-MC-092A-0037N	GENERATOR CORE TEMPE								CLEANING		
	RATURE RECORDER										
MYT1-94-5569	1TR-8201		02WK						RECORDER INKING AND	ESD	000
IC-MC-100A-0036N	BOILER AIR & GAS TEN								CLEANING		
	PERATURE RECORDER										
MYT1-94-4494	1AR-8117			02WK					RECORDER INKING AND	ESD	000
IC-MC-109A-0036N	STRESS EVALUATOR REC								CLEANING		
	ORDER										
MYT1-94-4499	1AR-8212			02WK					RECORDER INKING AND	ESD	000
IC-MC-117A-0036N	BOILER FAULT RECORDE								CLEANING		
	R										
MYT1-94-4484	1TR-8109			02WK					RECORDER INKING AND	ESD	000
IC-MC-093A-0036N	STEAM TEMPERATURE RE								CLEANING		
	CORDER										
MYT1-94-4489	1TR-8202			02WK					RECORDER INKING AND	ESD	000
IC-MC-101A-0036N	BOILER STEAM & WATER								CLEANING		
	TEMPERATURE RECORD.										
MYT1-94-4692	1AR-8121				02WK				RECORDER INKING AND	ESD	000
IC-MC-110A-0036N	FAULT RECORDER (LS-1								CLEANING		
	)										
MYT1-94-4697	1AR-8205				02WK				RECORDER INKING AND	ESD	000
IC-MC-111A-0034N	FD & AIR FLOW, FD HD								CLEANING		
	R & FLUE GAS PRESS.										
MYT1-94-4702	1GR-8103				02WK				RECORDER INKING AND	ESD	000
IC-MC-113A-0036N	GENERATOR FREQUENCY								CLEANING		
	RECORDER										
MYT1-94-4682	1TR-8111				02WK				RECORDER INKING AND	ESD	000
IC-MC-094A-0036N	TURBINE BEARING TEMP								CLEANING		
	ERATURE RECORDER										

WEEKLY PREVENTIVE MAINTENANCE SCHEDULE

For the Period: 08/22/94 to 08/28/94

PLANT : MYTI | WORK CENTER : EE | PAGE : 1

REVIEWED BY: JV RAZ III/TM VILLONA,JR. - P & S | APPROVED BY: AS PALPAL-LATOC - Maint.Manager

DATE : 8.19.94 | DATE :

PMNO No. / PMRC Seq. No.	PLANT EQUIPMENT	MON	TUE	WED	THU	FRI	SAT	SUN	PM ACTIVITY DESCRIPTION	SL	LL
MYTI-94-6171	DC1038AT	02WK							INSPECT, CLEAN AND T	EIS	000
EE-DC-0018-0038N	60-CELL STATION BATT								EST		
	ERY (125V)										
MYTI-94-6193	DC1038AT02		02WK						INSPECT, CLEAN AND T	EIS	000
EE-DC-0028-0038N	M1 48V STATION BATTE								EST		
	RY										
MYTI-94-6215	DC1038AT03			02WK					INSPECT, CLEAN AND T	EIS	000
EE-IDC-068-0036N	48V TELEMETERING BAT								EST		
	TERIES										
MYTI-94-6217	DC1038AT04			02WK					INSPECT, CLEAN AND T	EIS	000
EE-IDC-073-0036N	48V PABX COMMUNICATI								EST		
	ON BATTERIES										
MYTI-94-6240	DC1038AT05				02WK				INSPECT, CLEAN AND T	EIS	000
EE-IDC-098-0036N	FIRE PUMP DIESEL ENG								EST		
	INE BATTERY										
MYTI-94-6255	SY1628AT					02WK			INSPECT, CLEAN AND T	EIS	000
EE-1SY-978-0036N	230KV SUBSTATION BAT								EST		
	TERIES										
MYTI-94-6294	DC1038AT05							02WK	INSPECT, CLEAN AND T	EIS	000
EE-IDC-088-0036N	EMERGENCY DIESEL GEN								EST		
	ERATOR BATTERY.										

Received by:

Date: 8/22/94

PREVENTIVE MAINTENANCE SCHEDULE
For the Month of June , 1994

PLANT MGT: [illegible] APP CENTER: EC Page : 1

REVIEWED BY: JV PAZ III/TM VILLONA,JR. - P&S APPROVED BY: AS PALPAL-LATOC - Maint. Manager
DATE : 5.26.94 DATE :

PMRQ No. / PMRC Seq. No.	PLANT EQUIPMENT	MAINTENANCE ACTIVITY DESCRIPTION	SCHEDULE DATE	PRIO	CRAFT SKILL LIMIT	CRAFT SKILL REQUIRED
MYT2-94-3875	AB204FAN	VIBRATION AND TEMP.M	06/01/94	01M2	EIS	
EC-2AB-730C-0005N	GAS RECIRCULATION FAN	ONITORING				
MYT2-94-3872	FW205PMP01	MONITOR VIBRATION &	06/01/94	01M2	EIS	
EC-FW-053L-0005N	MOTOR-DRIVEN BOILER FEEDWATER PUMP#1	TEMPERATURE				
MYT2-94-3873	FW205PMP02	MONITOR VIBRATION &	06/01/94	01M2	EIS	
EC-FW-054L-0005N	MOTOR-DRIVEN BOILER FEEDWATER PUMP#2	TEMPERATURE				
MYT2-94-3874	TS209PMP	MONITOR VIBRATION &	06/01/94	01M2	EIS	
EC-2TS-259-0005N	TURBINE DRIVEN BOILER FEED PUMP	TEMPERATURE				
MYT2-94-3980	AB201FAN01	VIBRATION AND TEMP.M	06/02/94	01M2	EIS	
EC-AB-023L-0005N	FORCE DRAFT FAN 2A	ONITORING				
MYT2-94-3981	AB201FAN02	VIBRATION AND TEMP.M	06/02/94	01M2	EIS	
EC-AB-023L-0005N	FORCED DRAFT FAN 2B	ONITORING				
MYT2-94-4069	HS204PMP01	MONITOR VIBRATION &	06/03/94	01M2	EIS	
EC-HS-047J-0005N	HOUSE SERVICE CLOSE CYCLE PUMP-2A	TEMPERATURE				
MYT2-94-4070	HS204PMP02	MONITOR VIBRATION &	06/03/94	01M2	EIS	
EC-HS-048J-0005N	HOUSE SERVICE CLOSE CYCLE PUMP 2B	TEMPERATURE				
MYT2-94-4071	HS204PMP03	MONITOR VIBRATION &	06/03/94	01M2	EIS	
EC-HS-049J-0005N	HOUSE SERVICE CLOSE CYCLE PUMP 2C	TEMPERATURE				
MYT2-94-4132	CY203PMP01	MONITOR VIBRATION &	06/04/94	01M2	EIS	
EC-CY-029L-0005N	CONDENSATE PUMP 2A	TEMPERATURE				
MYT2-94-4133	CY203PMP02	MONITOR VIBRATION &	06/04/94	01M2	EIS	
EC-CY-030L-0005N	CONDENSATE PUMP 2B	TEMPERATURE				
MYT2-94-4213	CW202PMP01	MONITOR VIBRATION &	06/05/94	01M2	EIS	
EC-CW-042K-0005N	CIRCULATING WATER PUMP NO. 2A	TEMPERATURE				
MYT2-94-4214	CW202PMP02	MONITOR VIBRATION &	06/05/94	01M2	EIS	
EC-CW-043K-0005N	CIRCULATING WATER PUMP NO. 2B	TEMPERATURE				
MYT2-94-4268	CW203PMP01	MONITOR VIBRATION &	06/06/94	01M2	EIS	
EC-CW-046F-0005N	SCREEN WASH PUMP NO.1	TEMPERATURE				
MYT2-94-4269	CW203PMP02	MONITOR VIBRATION &	06/06/94	01M2	EIS	
EC-CW-047F-0005N	SCREEN WASH PUMP NO.2	TEMPERATURE				
MYT2-94-4312	FO234PMP01	MONITOR VIBRATION &	06/07/94	01M2	EIS	
EC-FO-171L-0005N	MAIN FUEL OIL PUMP 2A	TEMPERATURE				
MYT2-94-4313	FO234PMP02	MONITOR VIBRATION &	06/07/94	01M2	EIS	
EC-FO-172L-0005N	MAIN FUEL OIL PUMP 2B	TEMPERATURE				
MYT2-94-4326	BA203FAN03	VIBRATION AND TEMP.M	06/09/94	01M2		
EC-2B4020A-0001N	FLAME DETECTOR COOLING FAN C	ONITORING				
MYT2-94-4327	BA203FAN04	VIBRATION AND TEMP.M	06/09/94	01M2		
EC-2B4021A-0001N	FLAME DETECTOR COOLING FAN D	ONITORING				
MYT2-94-4328	CY215FAN01	VIBRATION AND TEMP.M	06/10/94	01M2	EIS	
EC-CY-044L-0005N	BLAND STEAM EXHAUSTER FAN 2A	ONITORING				
MYT2-94-4329	CY215FAN02	VIBRATION AND TEMP.M	06/10/94	01M2	EIS	
EC-CY-047E-0005N	BLAND STEAM EXHAUSTER FAN 2B	ONITORING				
MYT2-94-4750	GC202PMP01	MONITOR VIBRATION &	06/11/94	01M2	EIS	
EC-GC-014K-0005N	STATOR COOLING PUMP A	TEMPERATURE				
MYT2-94-4751	GC202PMP02	MONITOR VIBRATION &	06/11/94	01M2	EIS	
EC-GC-013L-0005N	STATOR COOLING PUMP B	TEMPERATURE				

NATIONAL POWER CORPORATION

PREVENTIVE MAINTENANCE WORK ORDER

PMWO No. MYT2-94-S-53

DATE ISSUED: 07/20/94

PLANT ID	SYSTEM	SPIN	LOCATION	LEAD WORK CENTER: IC
MYT2	MC	ETR-8174	K2 - -	

EQUIPMENT DESCRIPTION: AH 2B AIR INLET GAS OUTLET TEMP.RECORDER RECORDER

INITIATING DOCUMENT: IC-MC-0278-0011N

PLANNED ACTIVITY SEQUENCE	CRAFT	M-HRS
RECORDER INKING AND CLEANING 1. Visually inspect recorders. 2. Clean internals and externals. Purge with dry low pressure instrument air if necessary. 3. Refill recorder ink. 4. calibrate recorder if required. 5. Random checking of input signal. 6. Report adverse findings to supervisor for proper disposition.	1IC2	0.50
	TOTAL	0.50

NOTE: Observe 'Plant Housekeeping and Cleanliness Control'

PART/MAT/TOOLS/EQPT	NSN OR P/N	U/M	QTY
RAGS			
INK			

REQUIREMENTS

PRIORITY 3 | FREQUENCY 02WK

DUEDATE 07/23/94 | EQPT. REQMT. CODE EIS

CLEARANCE? [ ] YES [ ] NO NO.

FOR EXECUTION: _____ SHIFT SUPT. _____ DATE

OPERATIONS TEST REQUIRED? [ ]YES [ ]NO [ ]N/A

_____ WITNESS _____ DATE

TAG REMOVED? [ ]YES [ ]NO [ ]N/A

_____ PRINT NAME & SIGN _____ DATE

STATUS CODE: [DG] [CA] [DF] [RS]

ACTUAL COMPLETION DATE:

RESCHEDULED DATE:

WORK SUMMARY/REMARKS:

DG - CLOGGED RECORDER INK LINE

SKILL CODE	MPWR	M-HRS	PART/MATERIAL	NSN or PN	QTY	COST

LABOR COST: EQUIPMENT COST: PART/MATERIAL COST:

COMPLETED BY: _____ FOREMAN/LEADER DATE: 8/1/94

REVIEWED/APPROVED BY: _____ Work Center SUPT. DATE: 8-1-94

ACCEPTED BY: _____ SHIFT SUPT. DATE: 8/2

CLOSED OUT BY: _____ P&S SECTION CHIEF DATE: _____

Appendix 5-7

NATIONAL POWER CORPORATION

PREVENTIVE MAINTENANCE WORK ORDER

PLANT	SYSTEM	SPIN	LOCATION	LEAD WORK CENTER
MPT2	AG	AC221FAN01		

EQUIPMENT DESCRIPTION (FDF-2A BS-1)
FORCE DRAFT FAN 2A
FAN

INITIATING DOCUMENT
Work order no. EC-AG-022L-0005N

PLANNED ACTIVITY SEQUENCE

VIBRATION AND TEMP MONITORING

VIBRATION MONITORING
1. Take radial and axial filter out reading at all bearing points.
2. For failed bearing take radial and axial filter in readings.
3. Record test results on applicable data sheets.

TEMPERATURE MONITORING
1. Measure ambient temperature of the area.
2. Measure bearing temperature.
3. Record readings on applicable data sheets.
4. Allow establization time of 2 to 3 minutes for newly operated equipment.

NOTE: Observe Plant Housekeeping and Cleanliness Control.

CRAFT	M-HRS
IECA	0.5
IECS	0.5
IECX	0.5
TOTAL	1.5

PART/MAT/TOOLS/EQPT	NSN OR P/N	U/M	QTY
IRD 308 OR EQVL		SET	1.00
THERMOMETER		PC.	1.00
DATA SHEETS		PCS	2.00
EAR MUFFS		PC.	1.00
CLIP BOARD		PC.	1.00
BALLPEN			

REQUIREMENTS

PRIORITY	FREQUENCY
3	01F
DUEDATE ✓ 06/02/94	EQPT. REQMT. CODE EIS

CLEARANCE? [ ] YES [ ] NO

FOR EXECUTION:

SHIFT SUPT. DATE

OPERATIONS TEST REQUIRED? [ ] YES [ ] NO [ ] N/A

WITNESS DATE

TAG REMOVED? [ ] YES [ ] NO [ ] N/A

PRINT NAME & SIGN DATE

STATUS CODE: [ ] [CA] [DE] [RS]

ACTUAL COMPLETION DATE: 6/30

RESCHEDULED DATE:

WORK SUMMARY/REMARKS:

VIBRATION
Highest @ Point # 4 (Hor)
Fan outboard bearing
Sharp mode 76 microns
5.2 mm/sec
Severity - SLIGHTLY ROUGH

TEMPERATURE
Highest @ Pt. # 3
Fan outboard - 58°C
Ambient - 36°C

Load - 320 MW
Speed - 1480 RPM
Amperage - 340 Amps
Blade opening - 76%

SKILL CODE	MRWR	M-HRS	PART/MATERIAL	NSN or PN	QTY	COST
ECA	1	0.1	IRD 650			
ECS	2	0.2				

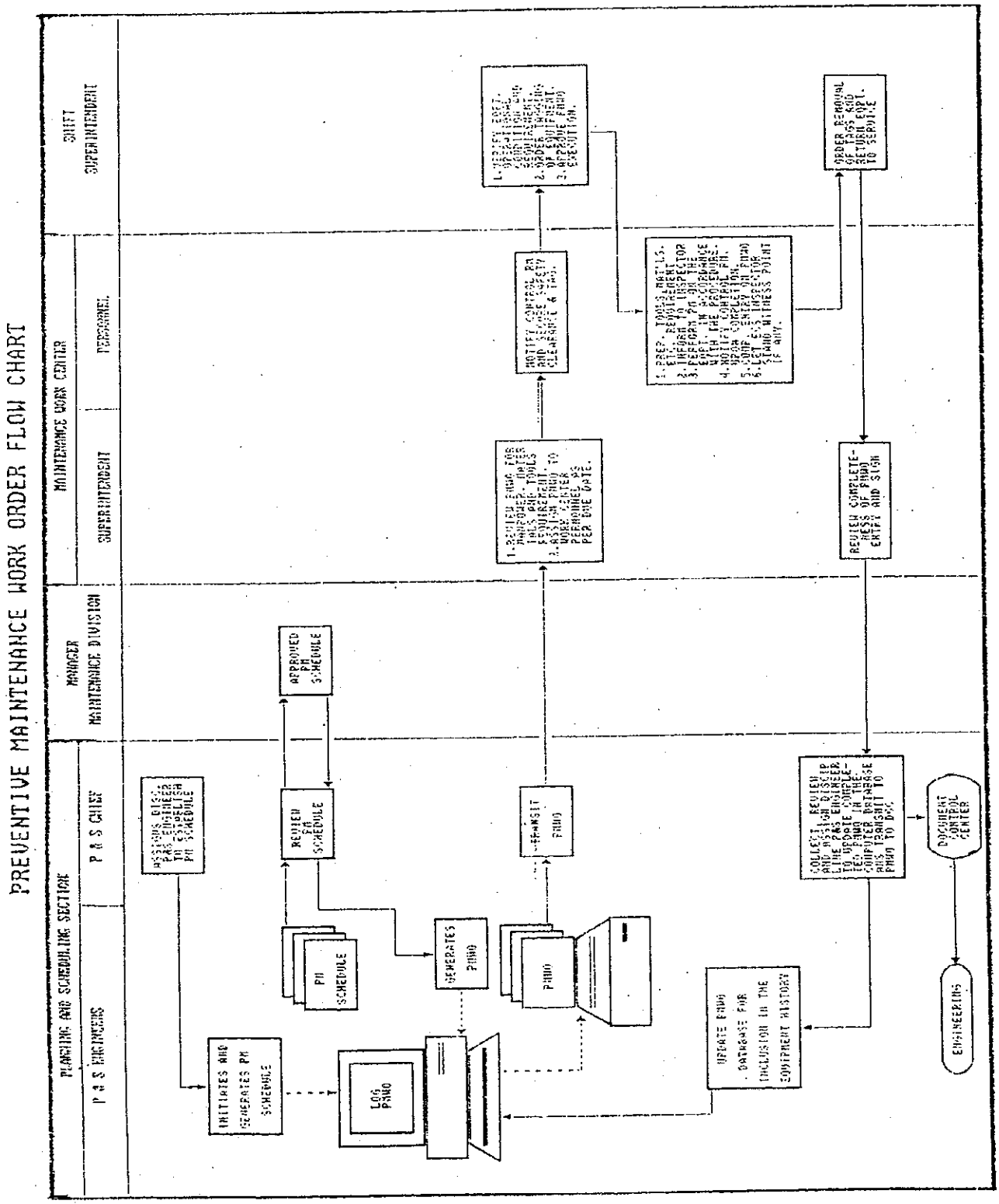
LABOR COST: EQUIPMENT COST: PART/MATERIAL COST:

COMPLETED BY: R.O. GARCIA
FOREMAN/SUPVR DATE: 6/30/94

REVIEWED/APPROVED BY: W.M. [illegible]
Work Cent. SUPT. DATE: 7/5/94

ACCEPTED BY: [illegible] 7/5
SHIFT SUPT. DATE:

CLOSED-OUT BY: [illegible]
C&S SECTION CHIEF DATE: 7.6.94


PREVENTIVE MAINTENANCE WORK ORDER FLOW CHART
PLANNING AND SCHEDULING SECTION
P & S ENGINEERS
P & S CHIEF
MANAGER
MAINTENANCE DIVISION
MAINTENANCE WORK CENTER
SUPERINTENDENT
PERSONNEL
SHIFT
SUPERINTENDENT
ASSIGNS DISC. P&S ENGINEER TO ESTABLISH PM SCHEDULE
INITIATES AND GENERATES PM SCHEDULE
LOG PMWO
PM SCHEDULE
REVIEW PM SCHEDULE
APPROVED PM SCHEDULE
GENERATES PMWO
PMWO
--SHOWSIT PMWO
1. REVIEW PMWO FOR MANPOWER, PARTS TOOLS AND EQUIPMENT. 2. ASSIGN PMWO TO WORK CENTER PERSONNEL AS PER DUE DATE.
NOTIFY CONTROL RM AND SECURE SAFETY CLEARANCE & TAG.
1. PREP. TOOLS, MATLS, ETC. REQUIREMENT 2. INFORM INSPECTOR 3. PERFORM PM IN ACCORDANCE WITH THE PROCEDURE. 4. NOTIFY INSPECTOR WHEN PM IS COMPLETED. 5. GET CLEARANCE FROM CONTROL CENTER TO REMOVE TAG. 6. GET ENGINEERING REP. TO BE WITNESS POINT IF ANY.
REVIEW COMPLETENESS OF PMWO ENTRY AND SIGN
ORDER REMOVAL OF TAGS AND RETURN EQPT. TO SERVICE
COLLECT, REVIEW AND ASSIGN DISCIP LINE P&S ENGINEER TO UPDATE COMPLETED PMWO IN THE COMPUTER, DETERMINE AND TRANSMIT TO DCC
UPDATE PMWO DATABASE FOR INCLUSION IN THE EQUIPMENT HISTORY
DOCUMENT CONTROL CENTER
ENGINEERING