6.2 Present Environmental Conditions around Malaya Thermal Power Plant

6.2.1 Land Use and Demography

1) Existing Land Uses around the Malaya TPP

The delineated 15 sq. km. radius from the Malaya TPP study area encompasses 14 municipalities in the provinces of Rizal and Laguna. These include the whole municipalities of Pililia and Jala-jala in Rizal and portions of Binangonan, Cardona, Tanay, Morong and Baras also located in Rizal. The whole municipality of Mabitac in Laguna is also covered within the study area including portions of the following Laguna municipalities: Famy, Siniloan, Pangil, Pakil, Lumban and Sta. Cruz.

The following is a brief description of the existing land uses around the Malaya TPP based on the 15 km. radius study area with reference from the power station.

There are seven (7) major land uses within the delineated 15 km. radius area from the Malaya TPP, namely; built-up area, riceland, orchard, forest, scrub, grassland and swamp/marshes.

Built-up areas are those developed for residential, commercial, institutional and other urban uses. Total estimated area is 17.62 sq. km. or 5.04% of the total area. The "poblacions" and centers of various barangays within the covered municipalities make up the built-up areas.

Two major agricultural uses found in the area include riceland and mixed orchard. Ricelands cover about 94.26 sq. km. the biggest among seven identified land uses. Most ricelands are located in low-lying areas. However, patches of ricelands are also found in upland areas. Unlike those in the lowland, upland areas devoted to rice production are rained or unirrigated.

Mixed orchard covers about 21.98 sq. km. Crops grown are mostly coconuts and other fruit-bearing trees. Most orchards are located in the rolling areas of Pililia in Rizal Province and in the municipalities of Mabitac, Famy, Siniloan and Pangil in the province of Laguna.

Three distinct land uses can be identified within the rolling and mountainous portions of the study area. Forest areas which covers 101.28 sq. km. is the largest, followed by the scrub with 66.24 sq. km. and grassland covering 34.60 sq. km. Forest areas are found mainly in Jala-jala, Pililia and Cardona in Talim Island.

Scrubs include areas where vegetative cover include small trees and dense shrubs. These are found adjacent or close to the forest areas in Talim Island, Jala-jala, Pililia and Tanay, whereas, patches of grasslands are found in Jala-jala and Pililia.

Swamps/marshes are located along the coasts of Santa Cruz, Lumban, Mabitac, Siniloan and Pangil in the province of Laguna and Baras in Rizal. Estimated area covered by this use is 13.42 sq. km.

2) Population

Based on the 1990 Population Census, the estimated total population within the 15 km radius study area is (223,223) 60.27% of which are in the province of Rizal.

Of the total population of Rizal (980,194) and Laguna (1,370,232) 13.72% and 6.47% respectively, reside within the identified municipalities covered within the 15 km radius study area. The municipalities of Tanay, Pililia and Binangonan in Rizal have the most population residing within the said area. The municipalities of Lumban and Pakil in the province of Laguna have the lowest population due to the fact that only a very small portion of these municipalities are covered within the 15 km radius from the Malaya TPP.

The total number of households is estimated at 35,066. Considering the total household population of 222,969, household size is about 6.36. This is slightly higher than the estimated household sizes in the provinces of Rizal and Laguna which are 5.158 and 5.08, respectively, based on the 1990 National Census figures for household population and number of households in both provinces.

With an estimated area of 349.4 sq. km, the population density is approximately 638.88 person per sq. km.

3) Water Utilization of Laguna Lake around the Malaya TPP

Laguna Lake is a multi-purpose resource. The Malaya TPP uses the lake water for cooling purposes. The PPC's lube oil refinery, which is located adjacent to the Malaya TPP, uses lake water also for cooling and process water. The aquaculture (fishpens and fishcages) use of Laguna Lake is also apparent in the area around the Malaya TPP.

Lake water is also used to irrigate rice farms in the area apart from the barging of fuel oil across the lake to the Malaya TPP. Treated wastes generated from Malaya TPP and the adjacent PPC including domestic wastes generated from nearby residential areas use the lake as a final disposal sink.

According to LLDA Limnologist, Ms. Adelina Santos-Borja, during a recent JICA Study Team visit to the LLDA, historical and recent pH measurements at the lake have remained nearly neutral, i.e., at pH7 and that the Dissolved Oxygen (DO) results, over the years since monitoring started in the early seventies have remained fairly constant at 7-8 mg/L. Fluctuating monitoring measurements of BOD over the years have also been observed by LLDA. At present, thirty (30) river and lake sampling stations are monitored by LLDA.

4) Pollution Sources around the Malaya TPP.

Apart from the Malaya TPP, the adjacent PPC is a source of potential air pollutants like sulfur dioxide (SO_2), nitrogen oxides, particulate matter, carbon monoxide (CO), hydrocarbons and oily wastes. Relative to the Laguna Lake land resource near these two plants, no major source of potential pollution is apparent. Present vehicular emissions are considered not significant due to the very few vehicles plying in the area. No other major air polluting industrial establishments exist in the vicinity of the Malaya TPP.

5) Investigation of any Precious fauna and flora around the Malaya TPP.

The 1988 Environmental Impact Statement Report of the proposed 30 MW x 3 Gas Turbine Power Plant project prepared by NPC gave details of the existing fauna and flora species found in the study area. The NPC 1988 study noted that there were no rare or endangered fauna and flora species encountered during the survey. It is expected that this same condition exists at present in the area around the Malaya TPP.

6.2.2 Air Pollution

1) Outline of Surrounding Area

The Malaya TPP is located along the eastern shore of Laguna Lake, Barrio Malaya, Pililla, Rizal, 70 km southeast of Manila. Topographically, the region west of the Power Plant is Laguna Lake, while land lies mainly to the east. A chain of mountains to the east runs from north to south, of which the highest is Mt. Sembrano (743 m). Of the land area, the flatlands are limited to a narrow strip of roughly 1 ~ 4 km width along Laguna Lake, dotted with rice fields and houses. Behind the Power Plant, the foothills of the aforementioned mountains extend almost to the shore of Laguna Lake. No accurate data concerning wind direction around the Power Plant is available because there are no meteorological stations in the area. However, according to the Power Plant staff, wind direction is generally northeast-southwest, from the mountains to the lake or vice-versa. During the site survey (roughly one month), we visually observed the flue gas and confirmed these to be the main wind directions.

An air pollution source other than the Malaya TPP is the PPC lubrication oil refinery (fuel oil consumption 276 T/D, sulfur content in fuel 3.5%) adjacent to the south side of the Power Plant. Vehicle traffic is insignificant in terms of pollution.

2) Air Pollutants Emitted from the Power Plant

a. Emission Data

The data of stack gas emission during full-load operation of both Malaya Unit No. 1 of 300 MW and Malaya Unit No. 2 of 350 MW are shown in Table 6-6.

Table 6-6 Data of Stack Gas Emission

Item (unit)	M-1	M-2	Gas Turbine
Plant Capacity (MW)	300	350	30 x 3
Fuel	Bunker C Residual		Light oil
Fuel consumption (t/h)	71.27	80.80	roughly 10
Sulfur content in fuel (%)	3.8	3.8	0.68
Flue gas flow average Dry (m^3N/h) Wet (m^3N/h)	934×10^3 $1,046 \times 10^3$	$1,059 \times 10^3$ $1,186 \times 10^3$	- -
Flue gas temperature average (°C)	155	149	-
SO_2 concentration *1 (Dry base ppm)	2,030	2,030	-
SO_2 emission (m^3 N/h)	1,896	2,151	48
NO_x concentration (ppm)	na	na	-
Fly ash : soot (mg/m^3 N)	363 *2	300 *3	-
Stack height (m)	90	90	-
Stack inside diameter (m)	4.57	4.57	-
Stack outlet emission speed (m/s)	17.7	20.1	-

Note: *1 Calculated value

*2 Average of two measurements

*3 Average over five measurements

b. Emission

a) SO_2 Emission

The sulfur dioxide concentration is 2,030 ppm as shown in the table above. Concerning the SO_2 emission from thermal power plants, the Philippine government originally set a very strict standard of 250 mg/m^3 N (87.5 ppm), when the emission control regulation was first stipulated in 1987. This standard was eased in the revision of April 23, 1993 to allow thermal power plants except the one in Metro Manila to use fuel of 3.8% or lower sulfur content (valid term: July 1, 1993 to January 1, 1996), under the condition that the power plants assume the responsibility of studies with plume dispersion simulation and measurement of ambient SO_2.

b) NO_2 Emission

No data has been obtained concerning the concentration of nitrogen dioxide emission. The emission standard for NO_2 in the Philippine is 1500 mg/m^3 N (730

ppm), which is higher than in other countries (250 ~ 520 mg/m^3 N). The nitrogen content in consumed heavy oil at the Malaya Power Plant is 0.24% (generally, the nitrogen content in heavy oil is 0.1 ~ 0.5%). The NO_x in stack gas needs to be measured to confirm whether or not it is below the emission standard value.

c) Particulate Matter Emission

The average concentration of soot and dust emission is 363 mg/m^3 N for Malaya Unit No. 1 and 300 mg/m^3 N for Malaya Unit No. 2, both of which satisfy the emission standards for existing power plants of 500 mg/m^{3}N.

c. Ambient Concentration

The ambient concentration of SO_2, NO_2 and suspended particulate matter in the vicinity of the Power Plant was measured at the two sampling stations.

The measurement results were ND for ambient SO_2 and NO_2 concentrations at the two sampling stations. The ambient concentration of SPM (suspended particulate matter) was 47 ~ 88 μg/scm, which is far below the ambient standard of 250 μg/scm.

d. Atmospheric Diffusion Forecast Simulation of SO_2

a) Outline

For sulfur-dioxide (SO_2) emission from the Malaya TPP (Unit No. 1 and No. 2), atmospheric diffusion forecast simulation was carried out to predict short-term (one-hour) and long-term (yearly mean) concentration values. Values used for the forecast calculation were taken from the emission data during full-load operation of both Unit No. 1 (300MW) and Unit No. 2 (350MW) given in Table 6-7.

Table 6-7 Emission Data

Unit No.		M - 1	M - 2
Plant capacity	(MW)	300	350
Fuel consumption	(t/h)	71.27	80.80
Sulfur content in fuel	(%)	3.8	3.8
Flue gas flow average, Dry	(m^3N/h)	934 x 10^3	1,059 x 10^3
Flue gas flow average, Wet	(m^3N/h)	1,046 x 10^3	1,186 x 10^3
SO_2 concentration, Dry base	(ppm)	2,030	2,030
SO_2 emission	(m^3N/h)	1,896	2,151
Stack height	(m)	90	90
Stack inside diameter	(m)	4.57	4.57
Stack outlet emission speed	(m)	17.7	20.1
Stack height	(m)	90	90
Stack effective emission height	(m)	299	307

b) Forecast of Diffusion of Short-Term (1 hr.) Values

Two modes indicated below were used for forecast of diffusion of short-term (1 hr.) values.

- Plume model (level ground)
- ERT model

ERT Model (PSDM)

This model is what takes into account changes in the axis of the smoke flow that accompanies ups/downs of the air stream caused by the topography, and it is as indicated below.

c) Forecast of Diffusion of Annual Average Concentration

Diffusion Formulae

The following diffusion formulae (Plume long-term average formula and Puff formula) were used for forecast of diffusion of annual average concentration.

- Windy State: Wind velocity 0.5 m/s or higher

"Plume long-term average formula" is used as the diffusion calculation formula.

d) Conditions for Calculation of Diffusion

Calculation of Diffusion of Short-term (1 hr.) Values

- Wind Direction : SW is used

- Wind Velocity

Surface wind at 2.5 m/s: Upper wind of the height of the smokestack was corrected by exponent 0.25 (P).

$$Uz = Us\ (Z/Zs)^{P}$$

Calculation of Diffusion of Long-term (Annual Average) Values

- Particulars of Discharge

It was assumed as particulars of discharge that Malaya Units No. 1 and No. 2 are operated for one year under the conditions of Table 6-12.

- Meteorological Conditions

Since no field observation values are available, observation data acquired in Japan was used as the annual meteorological conditions with the wind direction and wind velocity of the field used.

For acquisition of the observation data mentioned above, a coastal area of similar topographic conditions was selected, and a point, where the frequency of occurrence is similar regarding the wind direction, and the wind direction of the field is satisfied by changing the angle, was selected. The field's wind direction condition is NE:SW = 7:5 and the average wind velocity is 2.5 m/s.

Regarding the wind velocity, the surface wind was corrected so that the average wind velocity (annual average 1.5 m/s) is matched with average

Regarding the wind velocity, the surface wind was corrected so that the average wind velocity (annual average 1.5 m/s) is matched with average wind velocity of 2.5 m/s of the field, and the upper wind was estimated by exponent rule 0.25.

e) Results of Calculation

The results of calculation are as shown in Table 6-8 and Table 6-9. Figures 6-1, 6-2, and 6-3 show SO_2 concentration contours.

Table 6-8 Results of Calculation of 1-Hour Values

Calculation Model	Wind Direction	Wind Velocity (m/s)	Upper Wind Velocity (m/s)	Max. Ground Concentration (ppm)	Max. Ground Concentration Appearing Distance (m)
Plume Model	SW	2.5	4.3	0.091	NE 17,800
ERT Model	SW	2.5	4.3	0.501	NE 5,100

Table 6-9 Results of Calculation of Annual Average Valve

Calculation Model	Max. Ground Concentration (ppm)	Max. Ground Concentration Appearing Distance (m)
Plume Puff Model	0.026	NNE 1,100

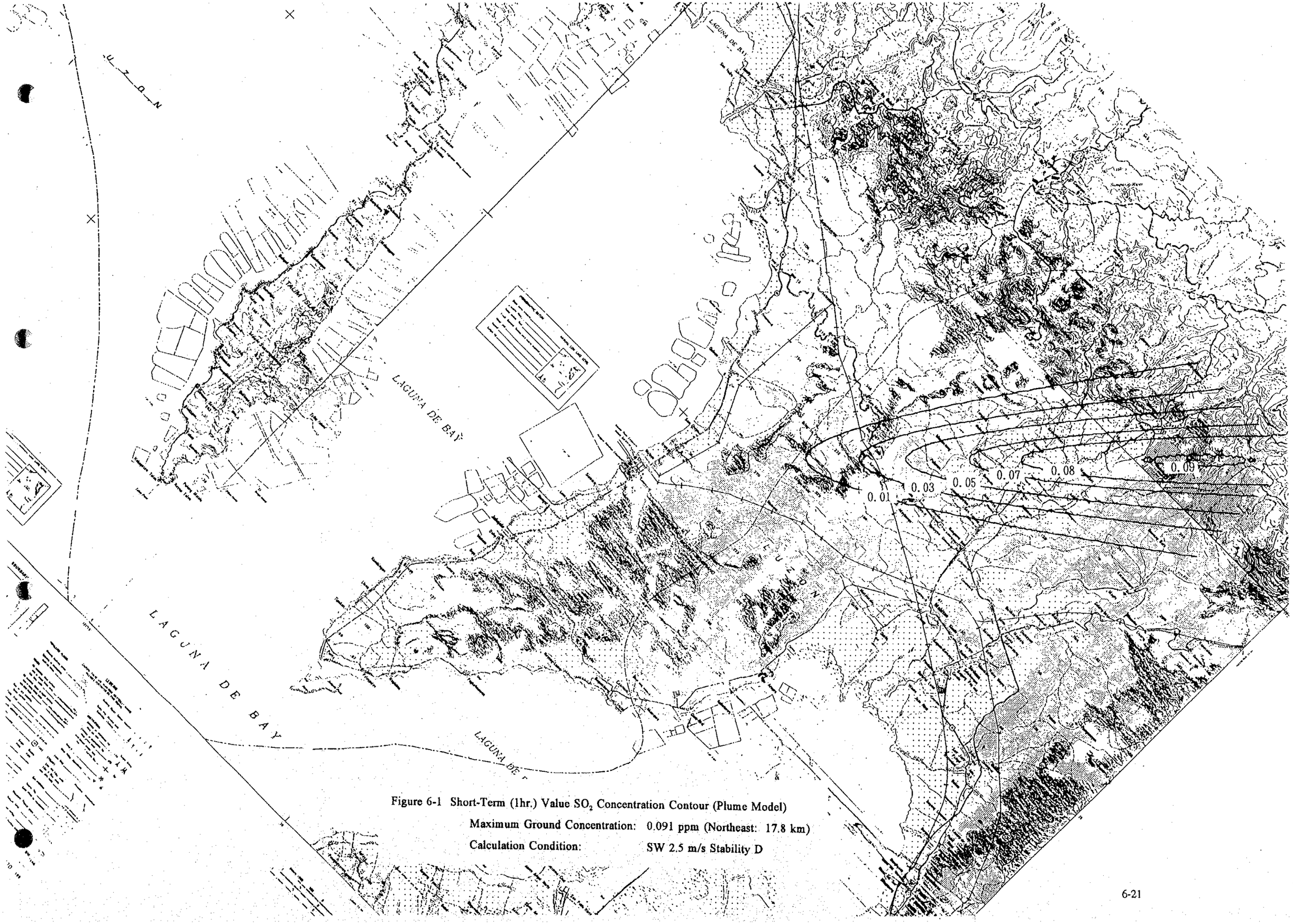


Figure 6-1 Short-Term (1hr.) Value SO_2 Concentration Contour (Plume Model)

Maximum Ground Concentration: 0.091 ppm (Northeast: 17.8 km)

Calculation Condition: SW 2.5 m/s Stability D

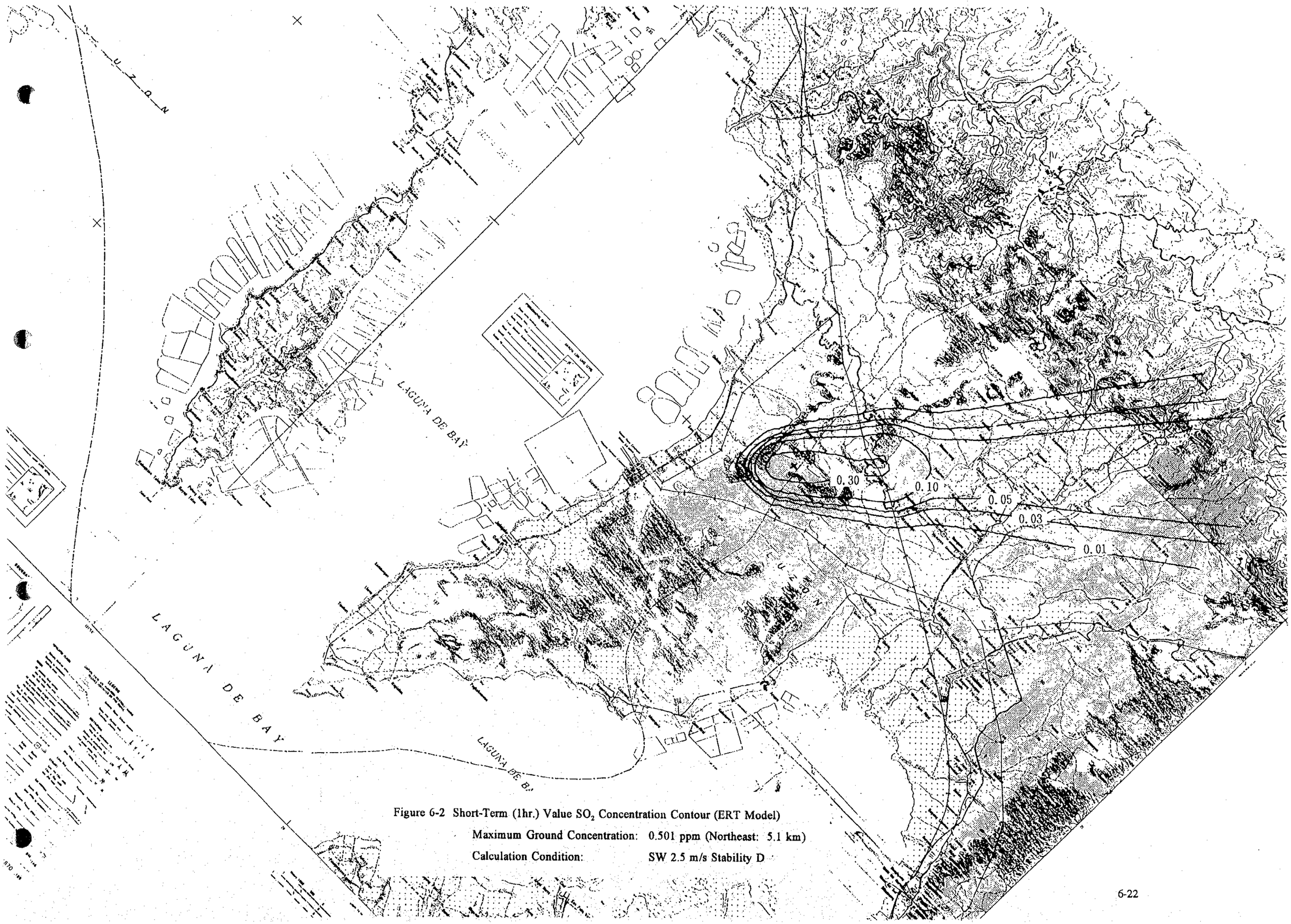


Figure 6-2 Short-Term (1hr.) Value SO_2 Concentration Contour (ERT Model)

Maximum Ground Concentration: 0.501 ppm (Northeast: 5.1 km)

Calculation Condition: SW 2.5 m/s Stability D

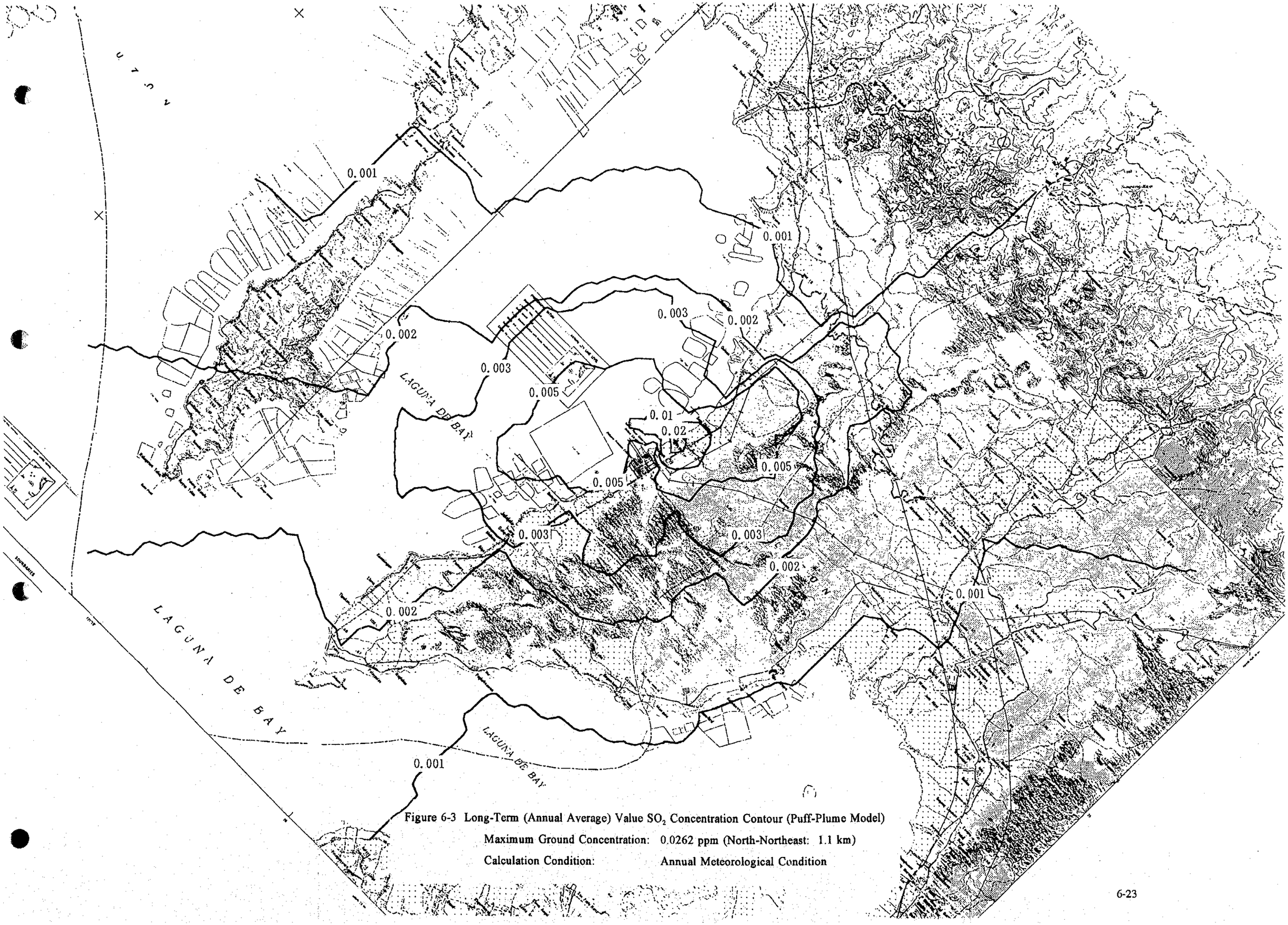


Figure 6-3 Long-Term (Annual Average) Value SO_2 Concentration Contour (Puff-Plume Model)

Maximum Ground Concentration: 0.0262 ppm (North-Northeast: 1.1 km)

Calculation Condition: Annual Meteorological Condition

6.2.3 Water Contamination

1) Present State of Water for Power Generation and Waste Water

At the Malaya TPP, water for power generation is supplied from 7 deep wells, and no water is taken form rivers. The condenser cooling water, 14.4 m^3/s for Malaya Unit No. 1 and 20.1 m^3/s for Unit No. 2 respectively, is taken from Laguna Lake, and returned to Laguna Lake through the discharge channel with the temperature increasing by 5°C ($\Delta t=5^{\circ}C$: temperature difference between the condenser inlet and outlet).

The volume of effluent power generation water is roughly 840 m^3/D. After neutralized by caustic soda (NaOH), the waste water is introduced to settling basin and then drained to the cooling water discharge channel. Also, the results of quality examination of waste water samples conducted in Japan are shown in Table 6-10.

Table 6-10 Waste Water Quality Data

Item	Unit	Analytical Data	Effluent Standards	Suitable O Unsuitable X
pH	-	2.5	6.0 ~ 9.0	X
COD (Chemical Oxygen Demand)	mg/ℓ	72.7	150	O
SS (Suspended Solids)	mg/ℓ	823	90	X
TSM	mg/ℓ	4,210	-	-
Conductivity	μs/cm	3,660	-	-
V_2O_5 (Vanadium Pentaoxide)	mg/ℓ	20.0	-	-
T-Hg (Total Mercury)	mg/ℓ	<0.0005	0.005	O
Pb (Lead)	mg/ℓ	2.16	0.5	X
Cr^{6+} (Chromium Hexavalent)	mg/ℓ	1.23	0.2	X
As (Arsenic)	mg/ℓ	0.022	0.5	O
Cd (Cadmium)	mg/ℓ	0.001	0.1	O
Turbidity	degree Kaoline	910	-	-

Waste water from the Power Plant contains suspended solids of unburnt carbon ash. Its pH value is 2.5, which is lower than the bottom limit of pH 6.0 of the waste water effluent standards, even after neutralization with caustic soda. Analytical data of items SS, Pb and Cr^{6+} also do not meet the effluent standards.

Waste oil from the Power Plant is separated from water and removed by the API oil-water separator and the water is then discharged to the discharge channel.

2) Present Conditions of Laguna Lake

a. General Features of Laguna Lake

Laguna Lake is the largest inland body of water in Southeast Asia with a surface area of 900 km^2, a shoreline of 220 km, a total volume of 3.2 billion m^3, and an average depth of 2.8 m.

b. Water Uses

Laguna Lake is a multi-purpose resource. At present, it is used extensively for aquaculture by means of fishpens and fishcages, and produced more than two thirds of the freshwater fish demand for Metro Manila and the surrounding provinces at the height of its production during the late seventies. Likewise, more than 15,000 small-scale fishermen engaged in open fishing depend on the lake for their livelihood.

Lake water is also used for irrigation. At present, there are about 30,000 ha of irrigated land. More than 12,000 ha receive water by pumped irrigation, and this is expected to increase by another 13,000 ha upon completion of the Cavite Friar Lands Project.

Some industries also depend on the lake for cooling water and power generation, and for transporting fuel, raw materials and finished products. Inhabitants of the lakeshore towns and Talim Island rely mostly on boats and bancas for transportation. Plans are also under way to utilize the lake for the domestic water supply of Metropolitan Manila from the early part of 1994. All of these uses are water-quality dependent, but unfortunately, the lake also serves as a dumping site for wastes generated by industrial, community, and agricultural activities within the watershed.

c. Water Quality of Laguna Lake

The LLDA (Laguna Lake Development Authority) has been conducting twice-monthly water quality surveys since the 1970's by dividing Laguna Lake into four parts; I - West Bay, II - East Bay, III - South Bay and IV - Central Bay.

The water quality data on Laguna Lake is listed in Table 6-11.

The results of quality analysis conducted in Japan of the Laguna Lake water samples brought back from the Power Plant is shown in Table 6-12.

Table 6-11 Water Quality Data on Laguna Lake

Parameters (Annual Average)	Stations				Class C Standard (1979 NPCC Rules and Regulations)
	West Bay	Central Bay	East Bay	South Bay	
Ammonia, (μg/ℓ)	47.5	36.5	37.2	25.9	
Nitrate, (μg/ℓ)	150	198	151	145	
Inorganic Phosphate, (μg/ℓ)	88.4	104	90.7	91	
Dissolved Oxygen (DO), (mg/ℓ)	7.4	7.5	7.6	7.3	5
pH	8	8	8	8.2	6.5 - 8.5
Temperature (°C)	29	29.1	29.2	29.6	
Turbidity (mg/ℓ SiO_2)	42	38	38	33	
Total Dissolved Solids (mg/ℓ)	389	384	295	323	1,000
MPN Coliform (thousand/mℓ)	1.29	2.75	1.29	4.72	5.00
Net Primary Production (cc/m^2/day)	0.66	0.69	0.6	0.67	

Source: Water Quality Data on the Laguna Lake and the Tributaries, Vol.5, LLDA, 1988

The major sources of contamination in Laguna Lake include the following:

- Aquaculture

  About fifteen thousand fishermen and 1,300 fishpen operations
- Industry

  There are 1,075 industrial establishments in the basin (1990)
- Domestic waste and solid waste

  There are now close to 9 million people living in the basin. About 60% of all households discharge their liquid or solid wastes.
- Agricultural activities

  Among the industries surveyed in 1989, those involved in livestock production rank at the top.
- Uncontrolled developments in the watershed

  About 54,000 ha of land in the region were deforested from 1966 to 1977. Most of them have been transformed into unproductive open grasslands which now comprise more than 16% of the total area.

Table 6-12 Measuring Data of Laguna Lake Water

Item	Unit	Laguna Lake Water (at the Malaya TPP)	Class C Standard
pH	-	7.2	6.5 ~ 8.5
Conductivity	μs/cm	1,060	
Ca^{2+}	mg/ℓ	12.3	
Mg^{2+}	mg/ℓ	20.6	
T-Fe	mg/ℓ	2.42	
HCO_3^-	mg/ℓ	57.4	
CO_2	mg/ℓ	<1	
SO_4^{2-}	mg/ℓ	30.2	350
Cl^-	mg/ℓ	261	
T-N	mg/ℓ	1.49	
T-P	mg/ℓ	0.254	
COD	mg/ℓ	6.8	
SS	mg/ℓ	46	
DO	mg/ℓ	7.2	5.0
Pb	mg/ℓ	<0.005	0.05
Cr^{6+}	mg/ℓ	<0.04	0.01
Cd	mg/ℓ	<0.001	
As	mg/ℓ	0.001	0.05
TSM (Total Suspended Matter)	mg/ℓ	666	
T-Hg	mg/ℓ	<0.0005	0.002
CN	mg/ℓ	<0.1	0.05
T-SiO_2	mg/ℓ	18.7	
Colloidal - SiO_2	mg/ℓ	0.3	
n-Hexane extracts	mg/ℓ	<0.5	2

For reference, the water quality data of the Lake Biwako (number of sampling points: 47) are provided in Table 6-13.

The COD (Chemical Oxygen Demand) value of the Laguna Lake water is 6.8mg/ℓ and much higher than the COD of the Lake Biwako of 2.7mg/ℓ. The SS (Suspended Solids) of the Laguna Lake (46mg/ℓ) is also extremely higher than that of the Lake Biwako (3.9mg/ℓ). Those data explain the heavy contamination of the Laguna Lake water.

Table 6-13 Data of Lake Biwako Water Quality (47 Sampling Points in Total)

Item	Unit	Water Quality Range (min. ~ max.)	Average
pH	-	7.0 ~ 9.4	-
DO	mg/ℓ	7.7 ~ 13	9.9
COD	mg/ℓ	1.6 ~ 5.0	2.7
SS	mg/ℓ	<1 ~ 25	3.9
MPN Coliform	MPN/100 ml	0.0 ~ 13,000	319

6.2.4 Noise

1) Conditions around Malaya TPP

Along the northern Malaya TPP property line, just beyond the cooling water discharge channel, lies a large residential area extending for roughly 500 m. The eastern property line is the Power Plant's No.1 fuel oil site across a provincial road. There is no adjacent residential area in the east. The western property line faces Laguna Lake, and the southern property line abuts on the site of the PPC.

This means that the residential area along the northern property line of the Power Plant is the only neighboring area which could have a problem with the Power Plant noise. The major sources of noise which might affect the northside residents are the gas turbines (30 MW x 3), Unit No. 1 boiler and Unit No. 2 boiler.

We measured the noise at the northern property line of the Power Plant during this site survey. The results are shown in Table 6-14.

Table 6-14 Noise Level Measured along the Northern Property Line and in the Gas Turbine Area

Measuring Point	Noise Level (dB)	Main Source of Noise
1	62	Gas turbine
2	55	
3	55	
4	57 (62)	( )during paging
5	57	
6	59	
7	65	Oil heater steam
8	90	Steam trace leakage
9	66	Malaya Unit No. 2 boiler
10	56	
Gas Turbine Area	90 ~ 95	

Measuring Time & Date: 14:00 ~ 14:55 p.m., Sept. 07, 1994

Malaya Unit No. 1 : Not operating

Malaya Unit No. 2 : In operating

Gas Turbines : In operating

(30 MW x 3)

In the environmental quality standards for noise in the Philippines, the Malaya TPP falls into Class D in Area Category - a section which is reserved as a heavy industrial area. The environmental quality standards for noise in Class D are shown in Table 6-15.

Table 6-15 Environmental Quality Standards for Noise in Class D

	Daytime	Mornings & Evenings	Night
Class D	75dB	70 dB	65 dB

The noise level surveyed at the site was 55 ~ 66 dB, which, in general, is within the Class D daytime value of the environmental quality standards (75 dB).

6.2.5 Unburnt Carbon Ash Treatment

1) Present Unburnt Carbon Ash Treatment

At the Malaya TPP, roughly 20 T/D unburnt carbon ash is emitted while both Unit No.1 and Unit No. 2 are in full-load operation. To control particulate emission, each boiler of

the Malaya TPP is equipped with two mechanical type (multicyclone) dust collectors. A series of nozzles are installed at the dust collector hoppers to periodically wash down the collected ash with water. Waste water from the ash transport system is neutralized and discharged into Laguna Lake via a settling basin.

2) Contents of Unburnt Carbon Ash and the Quality of Waste Water from Unburnt Carbon Ash Treatment

During the site survey, unburnt carbon ash was sampled from the dust collector hopper for the Malaya Unit No. 2 boiler. The analysis results are given in Table 6-16.

The waste water is neutralized by caustic soda, thereafter the components of turbidity are removed in the settling basin.

Table 6-16 Analytical Result of Unburnt Carbon Ash

Item	Unit	Unburnt Carbon Ash (M-2)
pH (1g Ash/100mℓ Water)	-	2.78
C	%	74.21
H	%	<0.3
N	%	0.83
S	%	5.74
V	%	0.47
SO_3	%	2.78
Calorific value	kcal/kg	5,700
Pb	mg/ℓ	2.74
Cr (VI)	mg/ℓ	0.57
Cd	mg/ℓ	<0.001
As	mg/ℓ	0.207
T-Hg	mg/ℓ	<0.0005
CN	mg/ℓ	<0.1

Noted from the above result are an extremely high calorific value of 5,700 Kcal/kg, and a low pH of 2.78. The latter indicates that waste water needs more effective neutralization before discharge by using expensive caustic soda.

6.3 Environmental Impact Assessment and Problems

6.3.1 Air Pollution

1) Emission

During full operation of Units No.1 and No.2 of the Malaya TPP, there are large emissions of sulfur dioxide (SO_2); 2,030 ppm in concentration and 4,047 m^3N/h in amount. Presently, to alleviate emission control regulations, existing facilities in areas other than Metro Manila are permitted a sulfur content in fuel of up to 3.8%, as long as the ambient concentration in the surrounding area stays within the standard value.

As NO_x (nitrogen oxide) in stack gas has not been measured, the NO_x concentration is not known. However, the maximum emission standard for NO_2 (nitrogen dioxide) is 1500 mg/scm (730 ppm), and it is most unlikely that the NO_x concentration will exceed this value.

The average measured values of particulate matter are 363 mg/scm (max. 393 mg/scm) for Malaya Unit No. 1 and 300 mg/scm (max. 369 mg/scm) for Unit No. 2, both of which are well within the emission standard value of 500 mg/scm.

An SO_2 emission source other than the thermal power generating facilities is the gas turbines within the Power Plant premises. Their SO_2 emission is 48 m^3N/h, constituting roughly 1% of total SO_2 emission from the Power Plant. SO_2 emission from the PPC (Philippine Petroleum Company), adjacent to the Power Plant, is 282 m^3N/h, equivalent to approx. 7% of the Power Plant's SO_2 emission.

Motor vehicles are not considered to be a significant source of pollutants in the area of the Power Plant, as traffic is quite light.

2) Atmospheric Conditions around the Power Plant

As the Malaya TPP has no meteorological facilities, assumption is unavoidable. According to the Power Plant staff, the main winds are south-westerly, blowing from Laguna Lake to the mountains, followed by north-easterly winds.

In the leeward areas, southeast and northeast, there are hardly residential areas, or agricultural products which could be affected by air pollution.

From the results of ambient concentration measurements at the north and south sides of the Power Plant, both of which have residential areas, the measured values for SO_2 and NO_2 indicated ND (not detectable) and SPM (suspended particulate matter) was 47 ~ 88 μg/scm. These values are far below the ambient standard of 250 μg/scm.

3) Simulation of Atmospheric Diffusion Forecast

Atmospheric diffusion forecast of sulfur dioxide (SO_2) was calculated. For the short-term (one-hour value) forecast, the leeward diffusion pattern (northeast of the power plant) of the land side's main wind direction was simulated.

With the plume model (for flat terrain), the maximum landing concentration, 0.091 ppm, appears 17.8 km northeast from the plant. With the ERT* (Environmental Research Technology Inc.) model (for cases with a high mountain or other high obstacle in the plume axial direction), the maximum landing concentration, 0.501 ppm, appears 5.1 km northeast of the power plant.

*Note: The ERT model is also called the PSDM (the Point Source Diffusion Model).

Since there are mountains northeast of the Malaya TPP, the ERT model is closer to the actual topographical condition than the plume model. That is, since the flue gas, after ascending and diffusing, alights on the mountainside, a high concentration appears a rather short distance from the source. This almost corresponds to the visual observation of flue gas.

In the National Ambient Air Quality Standards for Source, Specific Air Pollutants from "Industrial Sources/Operation," the standard for sulfur dioxide (SO_2) is 0.13 ppm. While the 0.091 ppm with the plume model is below the standard, the 0.501 ppm with the ERT model largely surpasses it. However, this would not cause any environmental problem because the maximum landing concentration site is in the mountain forest where there are no people or livestock. Furthermore, even though more than 15 years have passed since the Malaya TPP was constructed, the forest shows no sign of damage from the flue gas.

With the long-term (yearly mean value) forecast, the maximum landing concentration 0.0262 ppm appears 1.1 km northeast of the plant. Whereas, in the National Ambient Air Quality Guideline for Criteria Pollutants, the long-term (one-year value) criterion for sulfur dioxide (SO_2) concentration is 0.03 ppm.

Although the value at the maximum landing concentration point is forecasted below the criterion (0.03 ppm), it must be taken into account that, with no meteorological data representing this area available, the forecast simulation was conducted this time by inputting some similar meteorological data from Japan.

From the comprehensive results of short-term and long-term atmospheric diffusion forecast simulations, there is no apprehension of air pollution by SO_2 emission from the power plant under the current circumstances. However, if a new thermal power generating unit is to be added in the future, the meteorology of this area should be observed for one year, and an atmospheric diffusion forecast should be conducted by inputting the obtained meteorological data.

6.3.2 Water Contamination

The main waste waters discharged from the Power Plant are cooling water, waste water from power generation (regenerated waste water of demineralization plant, equipment cleaning water, personal waste water, etc.), unburnt carbon ash treatment waste water, and API oil separator waste water.

The total quantity of cooling water for Malaya Units No. 1 and No. 2 is 34.5 m^3/s. Although this is a big figure, the only change in the water is the 5°C temperature rise and that there is no problem with the water quality. Waste water from power generation and that from unburnt carbon ash treatment both enter the settling basin (30 m x 80 m x depth unknown due to sediment deposit which has almost filled the basin), then flow out to Laguna Lake from one discharge port.

As indicated in the subsection 6.2.3 Table 6-10, items pH, SS, Pb and Cr^{6+} do not meet the effluent standards. Efforts should be made to conform to the effluent standards.

Waste oil from the Power Plant is separated from water and removed by the API oil-water separator (46 m x 11 m), and the water is then discharged into Laguna Lake.

No oil detectors are installed at the separator outlet. In order to cope with oil outflow trouble or heavy rain, oil detector(s) should be installed or the patrol system should be strengthened. Oil outflow into Laguna Lake should be prevented.

Laguna Lake, into which waste water is discharged, seems to be highly contaminated. There are numerous sources of this contamination, and the discharge of contaminants from one power plant is considered minor among the total quantity of contaminants. Yet, from a wider perspective, prevention of water contamination in Laguna Lake is an important issue, so it is imperative that the national regulations be conformed to by every party in any field causing water contamination.

6.3.3 Noise

Noise from the Malaya TPP can be an environmental issue because the north property line (roughly 500 m) adjoins a residential area with only a cinder-block wall in between. At other boundaries, which have no adjoining residential areas, it is regarded that there are no noise pollution problems.

The noise level at the northern property line was 55 ~ 66 dB (measured during a Malaya Unit No. 1 shutdown). These values are below the 75 dB environmental quality standard (Class D Daytime). Environmental noise during the daytime does not seem to be such a problem.

A comprehensive assessment is impossible as no night-time data or data taken during unit start-ups is available. There is plenty of measurement data for noise levels inside the Power Plant. However, the noise level inside the Power Plant is an issue that concerns safety and health of plant employees, which should be dealt with separately from the environmental impact imposed on residents in the neighborhood.

6.3.4 Treatment of Unburnt Carbon Ash

Unburnt carbon ash is treated by the wet method at the Malaya TPP. Thus, if the waste water treatment is not functioning properly, a water contamination problem will be raised.

At the Malaya TPP, the generation of unburnt carbon ash is roughly 20 T/D at 650 MW full operation. A heavy oil-fired thermal power plant (375 MW and 500 MW, 875 MW in total) in Japan generates roughly 8.4 T/D of unburnt carbon ash. Conversion of this value to Malaya's 650 MW makes roughly 6.2 T/D, which is approx. 1/3 of the unburnt carbon ash

amount of the Malaya TPP. Also, at the cited plant in Japan, unburnt carbon ash is treated by the dry method (unburnt carbon ash incinerator), eliminating any problems in waste water treatment.

A possible cause for the large amount of unburnt carbon ash may be the inferior fuel quality of Bunker C residual oil.

The following are measures to resolve the unburnt carbon ash problem:

1) Decrease of unburnt carbon ash generation by improvement in boiler combustion
2) Improvement in unburnt carbon ash treatment method
3) Upgrading of fuel oil (lower viscosity, lower sulfur contents, etc.)

The improvement proposal for item 2) will be explained in the following section.

6.4 Recommendations on Environmental Improvement Plan

6.4.1 Air Pollution

1) Procurement of Fuel Oil Sulfur Meter (roughly 4 million yen)

The fuel oil sulfur meter (Fluorescent X-ray analytical instrument for sulfur) can measure the sulfur content in heavy fuel oil in 3 to 5 minutes, and thereby:

a. the sulfur content in fuel on which restrictions are imposed by national regulation can be controlled; and

b. the sulfur dioxide (SO_2) concentration in flue gas can be calculated by using the measured value. (Calculated value is almost identical to actually measured value.) The calculation formula is:

$$SO_2\ ppm = \frac{0.7S}{Vd + (m-1)\,A_0} \times 10^6$$

$$m = \frac{21}{21-(O_2)}$$

S : sulfur content in fuel oil (wt %)

Vd : amount of combustion gas per 1 kg of heavy oil
$m^3N = 10.0\ m^3N/1$ kg fuel

(O_2) : oxygen (vol. %) in air preheater outlet

A_0 : theoretical amount of air per 1 kg of heavy oil
$m^3N = 10.6\ m^3N/1$ kg fuel

m : air ratio

We recommend that one sulfur meter be purchased by the NPC, and used to measure sulfur content in fuel oil for the Malaya, Manila and Sucat power plants.

2) Measurement of NOx in Stack Gas

The SO_2 emission and particulate concentration in the stack gas have been measured annually by MMRC, but NOx measurement has not been conducted. Now that a standard value for NOx has been stipulated by national regulation, it should certainly be included among the annual measurement items. NOx concentration cannot be easily predicted as

it is the total of fuel NOx and thermal NOx values.

3) Procurement of Wind Vane Anemometer with a 10-m Pole and Continuous Recorder

In the EIA (Environmental Impact Assessment) for existing sources and new sources, the Philippine government requires an atmospheric diffusion forecast calculation. However, due to the unavailability of meteorological data (wind direction and velocity data, in particular) for the area, an accurate forecast calculation cannot be obtained. It is necessary for the NPC to purchase one or two sets of wind vane anemometers and consecutively take meteorological data for one year for each existing thermal power plant as well as for the planned sites for new thermal power stations.

6.4.2 Water Contamination

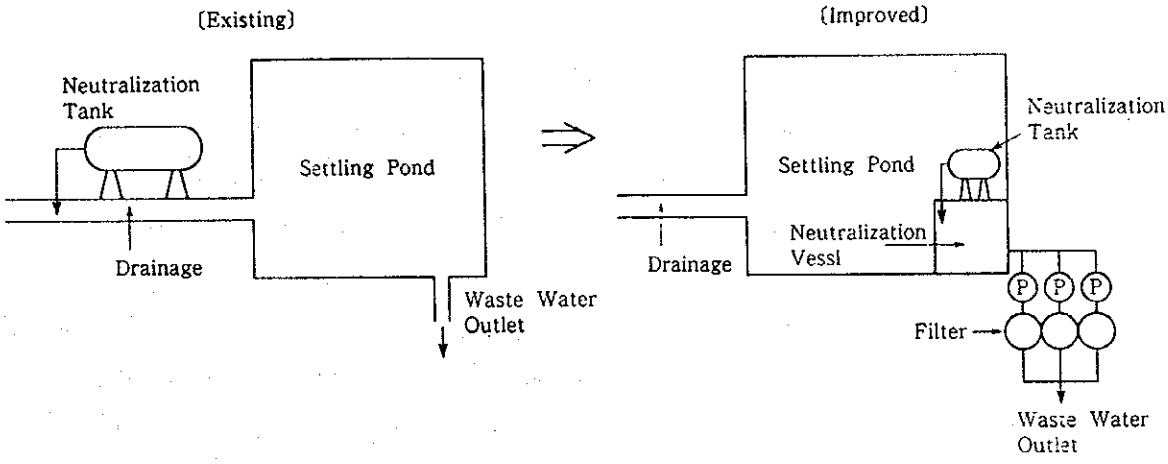
1) Relocation of the Waste Water Neutralization Tank, and Installation of Neutralization Vessel

Presently, at the Malaya TPP, the waste water from unburnt carbon ash treatment is neutralized while draining by adding caustic soda (NaOH) before reaching the settling pond. This method cannot ensure satisfactory neutralization, as is evident with the value, pH 5.29, measured at the outlet during the survey, which is lower than the effluent standard 6.0. This should be rectified by relocating the neutralization tank to a position immediately before the outlet as illustrated in Figure 6-4, so that the waste water will be completely neutralized at this point.

2) Installation of Waste Water Clarifier.

Highly-concentrated unburnt carbon ash is in the waste water discharged into Laguna Lake. A waste water clarifier should be installed to prevent contamination. To cut costs, use of the existing Permutit demineralization plant (with filters replacing the ion-exchange resin) as the clarifying system should be considered.

Figure 6-4 An Example of a Recommended Waste Water Treatment Process



3) Prevention of Oil Spill from the API Oil-Water Separator

Oil spill can cause severe contamination of Laguna Lake. Oil detectors should be installed or patrol frequency should be increased as measures to prevent spillage due to accident or flood.

6.4.3 Noise

Noise should be measured at the northern boundary and in the surrounding area (Residential area within 500 m of the property line) with the following conditions.

Measuring Conditions:

1) Night-time during normal operation of Malaya Units No. 1 and No. 2 (at the northern boundary)
2) During start-up (at the northern boundary and in the surrounding area)

6.4.4 Unburnt Carbon Ash

As described in 6.3.4, a large amount of unburnt carbon ash is generated due to poor fuel quality. Viscosity of the fuel oil used at Malaya TPP is much higher than that usually used in Japan (Malaya TPP: 483.6 cSt (50°C), Japan: 81 to 138 cSt (50°C)).

To reduce unburnt carbon ash, it is important to keep combustion condition good through fine combustion control, for example:

- Fuel oil temperature should be high enough to keep low viscosity.
- Pressure and temperature of atomizing steam should be kept properly.
- Maintenance and management of burner tips should be done securely.
- Defected diffuse cones should be repaired or replaced during an overhaul.

High quality fuel oil with low viscosity may improve combustion in the boiler, and reduce unburnt carbon ash. It's low sulfur consistency may reduce concentration of SO_2 in flue gas as well.

Some additive into fuel oil will be another method to improve combustion and reduce unburnt carbon ash. The cost of fuel additive should be considered in this case.

6.5 Improvement Proposals for Safety and Antidisaster Management

6.5.1 Necessity of Safety and Antidisaster Management

We believe that the measures for environmental management and safety & antidisaster management should be drawn up separately. The former is to study influences of actions which may cause some unfavorable effects to the surrounding environment of power plants and to formulate countermeasures if deemed necessary. Such serious or unfavorable actions would include continuous contaminant emission to the atmosphere and effluent of the same to lakes or the sea. While, the latter, safety & antidisaster management, is to prevent reprehensible incidents or situations, such as accidents resulting in injury or death, fires, explosions, or oil leakage, which must never be allowed to occur. In the event of some unforeseen accident or situation, utmost efforts should be made to minimize the damage. The unfortunate oil leak accident that recently occurred at the Malaya TPP should be considered as basically a Safety & Antidisaster Management problem which transformed into an environmental problem affecting the environment surrounding the power plant.

In the event of a major accident, e.g. fire, explosion or oil leakage, and others which may lead to injury and/or loss of life, suspended power supply, repair costs, compensation for environmental problems, it is a loss of precious human life as well as a tremendous financial waste. Therefore, we feel strongly that accident prevention through safety & antidisaster management is as important as the power generating operations themselves, and should be treated with equal concern and emphasis.

NPC has a corporate-wide, Safety and Antidisaster committee with counterparts in the regional and plant levels. At this opportunity, we suggest to reaffirm items shown in 6.5.2, and make safety & antidisaster management understood and implemented by all personnel.

6.5.2 Concrete Improvement Proposals

We suggest following items to be done for safety & antidisaster management.

1) Establishment of Safety & Antidisaster Management Committee Headquarters (either at the NPC Head Office or MMRC)

   a. The Committee Headquarters will have a chairman to be selected from among the NPC management and some exclusively designated members (or those who concurrently hold another post).

b. Main duties

a) Committee Headquarters will gather reports of the safety & antidisaster management status at each power plant, and submit them to upper management. It will also inform power plants of conditions at other power stations and relay instructions from upper management.

b) Committee Headquarters will witness safety & antidisaster drills carried out at power plants, and visit and observe the safety & antidisaster management of each power plant.

c) A safety & antidisaster seminar will be held jointly for members of the Safety & Antidisaster Management Committee from each power plant.

d) Committee Headquarters will investigate and analyze domestic and foreign disasters or accidents and provide each power plant with the information and request them to study the possible occurrence of a similar disaster or accident at their facility.

e) Committee Headquarters will study the procurement and installation request of safety & antidisaster facility or equipment (e.g. oil fence, oil leak detector, fire extinguish equipment, and fire alarm) respectively submitted by each power plant.

f) Committee Headquarters will study the support system at the time of accident occurrence.

g) Others

2) Establishment of Thermal Power Plant Safety & Antidisaster Committee (at each thermal power plant)

a. The Committee will consist of the power plant manager as chairman, all superintendents, and 1 or 2 personnel selected from each section.

b. Main duties

a) The Committee will study the safety & antidisaster patrol routes, sections to be checked[1)], patrol frequency[2)], patrol team[3)], check sheet form, etc. These will be implemented upon approval of the Safety & Antidisaster Management Committee Headquarters.

1) The Committee will select probable sections where accidents causing injury or death, fire, explosion, oil leaks, or other hazardous chemical leaks may occur.

The committee will also select sections to be checked during unit operation and periodic overhaul work respectively (including supervision of hazardous or dangerous work).

2) Patrol frequency will be increased after typhoons or earthquakes.

3) It is recommended that the patrol team include the power plant manager and superintendents.

b) The Committee will plan safety & antidisaster drills (e.g. oil leak and fire) (1 ~ 2 times annually)

c) The Committee members will attend the seminar offered by the Safety & Antidisaster Management Committee Headquarters and make presentations concerning their own plant's safety and antidisaster status.

d) Based on the information and material provided by the Safety & Antidisaster Management Committee Headquarters, the Committee will study and submit a report on the possible occurrence of similar accidents, disasters or potentially dangerous situations at their own power plant.

e) The Committee will study the necessity of procuring and installing antidisaster facility/equipment, and send requests to Committee Headquarters if deemed necessary.

f) In the even of an accident, the Committee will immediately notify Committee Headquarters and request support, etc.

g) Others

CHAPTER 7

MALAYA THERMAL POWER PLANT RELIABILITY IMPROVEMENT PLAN

CHAPTER 7. MALAYA THERMAL POWER PLANT RELIABILITY IMPROVEMENT PLAN

Based on the aforementioned survey results on hardware and software, improvement plans for both aspects will be formulated in this chapter.

7.1 General

1) Reliability Improvement Plan for Power Generating Facilities (Hardware) - Basic Concept

As a result of this Study, we have formulated an improvement plan which includes periodic overhauls in addition to rehabilitation.

a. Time-frame for Improvement Plan and Rehabilitation

For this Study, the period of the improvement plan shall be 5 years on condition that the periodic overhaul for Units No. 1 and No. 2 is annually executed. Considering the time required for equipment/material delivery and commissioning, rehabilitation work shall commence in the third year and be completed by the end of fourth year. Refer to Figure 4-7, Rehabilitation & 5-Year Overhaul.

b. Rehabilitation Items and Periodic Overhaul Items

The NPC's periodic overhaul items shall be excluded from the rehabilitation work items. New items not included in the rehabilitation items shall be carried out during the periodic overhauls within the planned period even if they are not included among the NPC's periodic overhaul items. (The periodic overhaul work: repair cost, the rehabilitation work: facilities cost.)

2) Basic Concept of Improvement Plan for the Software

The software is solely responsible for improvement and maintenance of hardware reliability of the power plant facilities. From the recommendations regarding the improvement plan for the software in Chapter 5, the improvement plan shall be formulated by selecting priority items that are necessary in achieving the project goal of "No Forced Outages and No Accident".

a. Time-frame and Time of Commencement

The time-frame for improvement is 5 years, the same as for hardware. Although it varies depending on items, preparations should be finished in 1 or 2 years, to be commenced in the 2nd or 3rd year, and be completed by the end of 5th year. Refer to Figure 7-5, Improvement Plan Overall Schedule.

b. Priority Items

a) The following 5 items are priority items:

I. Formulation of complete periodic overhaul plan
II. Implementation of complete periodic overhaul
III. Safe and reliable operation
IV. Hiring, education and training of personnel
V. Improvement of morale

b) Contents of Individual priority Items

Regarding software and human factors, the Study led us to find many issues which need to be solved behind each problem.

- Figure 7-1 provides easy understanding of the current problems of the power plant and their direct causes, and the situation surrounding the problems.
- Table 7-1 is a summary of issues behind the problems on software and human factors, and their measures by priority items.

Figure 7-1 Current Condition of Power Plant and Cause of Problems

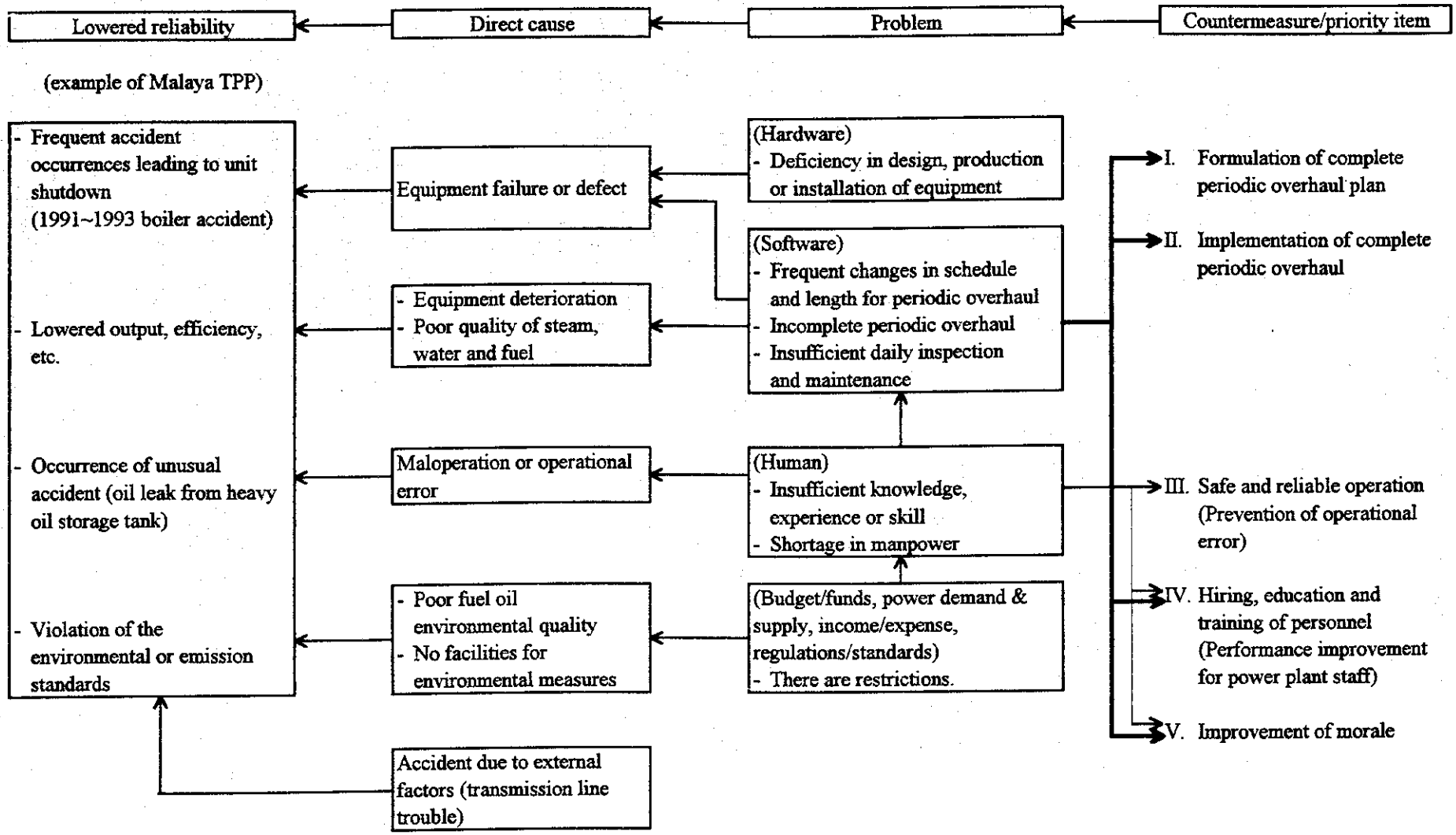


Table 7-1 Software Improvement Plan (Priority Items)

I. Formulation of Complete Periodic Overhaul Plan

(Issues)	(Measures)
1) No standards for periodic inspection items and their intervals	1) Repletion of contents for periodic overhaul plan a. Formulation/establishment of periodic inspection items and intervals b. In relation to the above, study required periodic overhaul length and interval for each power plant unit.
2) Section in charge of periodic overhaul and its range of responsibility should be clarified. Strengthening of its capability should be necessary, including formulation of the standards mentioned in 1).	2) Strengthening of function to formulate periodic overhaul plan - Further study of power plant organization, division of work, education, training
3) Acquisition of know-how to formulate a complete periodic overhaul plan.	

II. Implementation of Complete Periodic Overhaul

(Issues)	(Measures)
1) Periodic overhaul time and length are frequently changed, which almost becomes a normal practice.	1) Company policy should be established that the scheduled time and length of periodic overhaul should not be changed without a specific reason.
2) There are no legal regulations regarding the periodic inspection items and their intervals.	2) Legalization of requirements regarding the periodic overhaul, such as periodic inspection items and their intervals.
3) Insufficient capacity for work implementation	3) System improvement for periodic overhaul work implementation
4) Preparation of equipment disassembly/ inspection manuals, and check sheets.	4) Should be prepared by MSD.
5) Delay in delivery of spare parts and other parts for periodic overhaul	5, 6 & 7) - Responsibility system for the periodic overhaul work should be clarified. - Expediting (following-up) of ordered items - Work schedule control - Implementation of inspections and test, and preparation of records and reports
6) Work schedule is often extended. Improvement in care of work.	

Table 7-1 Software Improvement Plan (Priority Items)

II. Implementation of Complete Periodic Overhaul (cont'd)	
7) Certain implementation of inspections & tests during overhaul and at the time of completion of work, and preparation of records and reports (to be reflected in the periodic overhaul plan or safe and proper operation)	
8) Improvement of daily inspection and maintenance	8) Preparation of maintenance manuals.
III. Safe and Reliable Operation	
(Issues)	(Measures)
1) Preparation of operation manuals is necessary. These manuals should be used as text for training.	1) Preparation of operation manuals The operation manuals under preparation at OMP of NPC Head Office can be used as models.
2) Sound implementation of operator routine work	2) Implementation of the same
3) Review of organization of operation shift	3) Implementation of the same
IV. Hiring, Education and Training of Personnel	
(Issues)	(Measures)
1) The fill-the-vacancy or occasional hiring system is problematic.	1) Improvement of hiring system Periodic hiring based on a long-term staff plan is imperative.
2) Collective education of new employees is not conducted.	2) & 3) New employee education, position education, and job rotation are necessary.
3) Operators stay in the same position for a long time. Promotion opportunities are limited.	
4) OJT only for operator training	4) Training of operators with simulator
V. Improvement of Morale	
(Issues)	(Measures)
1) There are hardly any job rotations within MMRC or power plant, or between them.	1) Systematic implementation of job rotation
2) Evaluation of education/training results and a qualification system for promotion need to be studied.	2) Implementation of the same
3) Proposal and reward system needs to be studied.	3) Implementation of the same

7.2 Reliability Improvement Plan for Power Plant Facilities (Hardware)

- Rehabilitation period shall be the 5 years after completion of the JICA Study.
- Rehabilitation shall be effectively combined with Annual Overhaul before and after rehabilitation.
- Rehabilitation work shall be completed by the end of the fourth year of the above said rehabilitation period.

1) Implementation Plan

a. First Year

- A Major Overhaul will be carried out for both the Units No. 1 and No. 2
- Remaining service life of boilers, turbines, and generators will be diagnosed.

Based on the results of the above work, implementation plans for overhauls and rehabilitation work for the 2nd and subsequent years will be drawn up.

b. Second Year

- An annual overhaul will be carried out for both the Units No. 1 and No. 2. Work periods will be relatively short.
- Sections left uninspected during the Major Overhaul in the first year will be inspected to determine the degree of deterioration. The results will be reflected in the plans for rehabilitation.

c. Third Year

- Rehabilitation and overhaul will be executed.
- For rehabilitation work items, refer to Chapter 4, Clause 4.3.

d. Fourth Year

- One year after completion of rehabilitation, a simplified annual overhaul will be conducted to check the sections repaired, replaced or improved during the rehabilitation. Items left uncorrected during the 3rd overhaul (Rehabilitation), if any, will be properly rectified.

- All defective sections will be completely rectified by the rehabilitation and four periodic overhauls.

e. Fifth Year

- In the second year after completion of rehabilitation, a Major Overhaul will be carried out.
- In accordance with the inspection results, standards for future overhauls and deterioration surveys will be formulated.
- If this 5th Major Overhaul does not fit within the planned time-frame of 5 years, the 4th annual overhaul will be conducted as this Major Overhaul.

2) General Work Schedule

Overall work schedule is given in Figure 4-7.

3) Implementation Method

a. Rehabilitation

- Rehabilitation of major equipment will be subcontracted to individual contractors including the original manufacturers. Their responsibilities will be made clear by a 'turnkey' contract.
- Supervision over the entire job will be conducted with assistance of a consultant.

b. Overhauls

- Overhauls will be executed by the NPC.

- Planning and supervision of the remaining life and deterioration surveys will be conducted with assistance of a consultant. Actual surveys and work will be contracted.

c. Costs

- Funds for rehabilitation and post-rehabilitation overhauls (construction costs) will be procured through a loan.

4) Scope of Implementation

a. Rehabilitation

a) Scope of Work

The scope of work is described in detail in the clause 4.3.1 item 2) in Chapter 4.

b) Costs of Work

Unit:Thousand US $

	No. 1 Unit	No. 2 Unit	Total
Project costs	101,295	38,794	140,089
Consultant fee	3,768	1,232	5,000
Total	105,063	40,026	145,089

c) Projected Disbursement Schedule

Unit:Thousand US $

	No. 1 Unit	No. 2 Unit	Total
1995	1,815	1,586	3,401
1996	15,746	5,862	21,608
1997	55,316	30,464	85,779
1998	30,373	1,057	31,430
1999	1,814	1,057	2,870
Total	105,063	40,026	145,089

7.3 Improvement Plan for Operations and Maintenance Management (Software)

7.3.1 Formulation of Complete Periodic Overhaul Plan (Priority Item I)

1) Approach to Improvement Plan

In order to make a complete periodic overhaul plan, exact and accurate conditions of hardware (defective parts and sections) must be grasped, first of all. Figures 7-2 explain the periodic overhaul plan and the detailed work-flow up to the finalization of periodic overhaul budget in the case of Japan.

The Study results of this time show that standards for periodic overhauls of the thermal power plant hardware have not yet been established. Therefore, along with the preparation of a list of defective sections of hardware (Figure 7-2, Item No.①), the completion of the following three standards is necessary.

- Periodic Overhaul Standards (Figure 7-2, Item No.②)
- Deterioration Examination Standards (Figure 7-2, Item No. ③)
- Routine Maintenance Standards (Figure 7-2, Item No.④)

In this improvement plan, the following three items, including the first among the three standards, are chosen as the most important items. The numbers given for the items correspond to those in "Measure" column of Table 7-1.

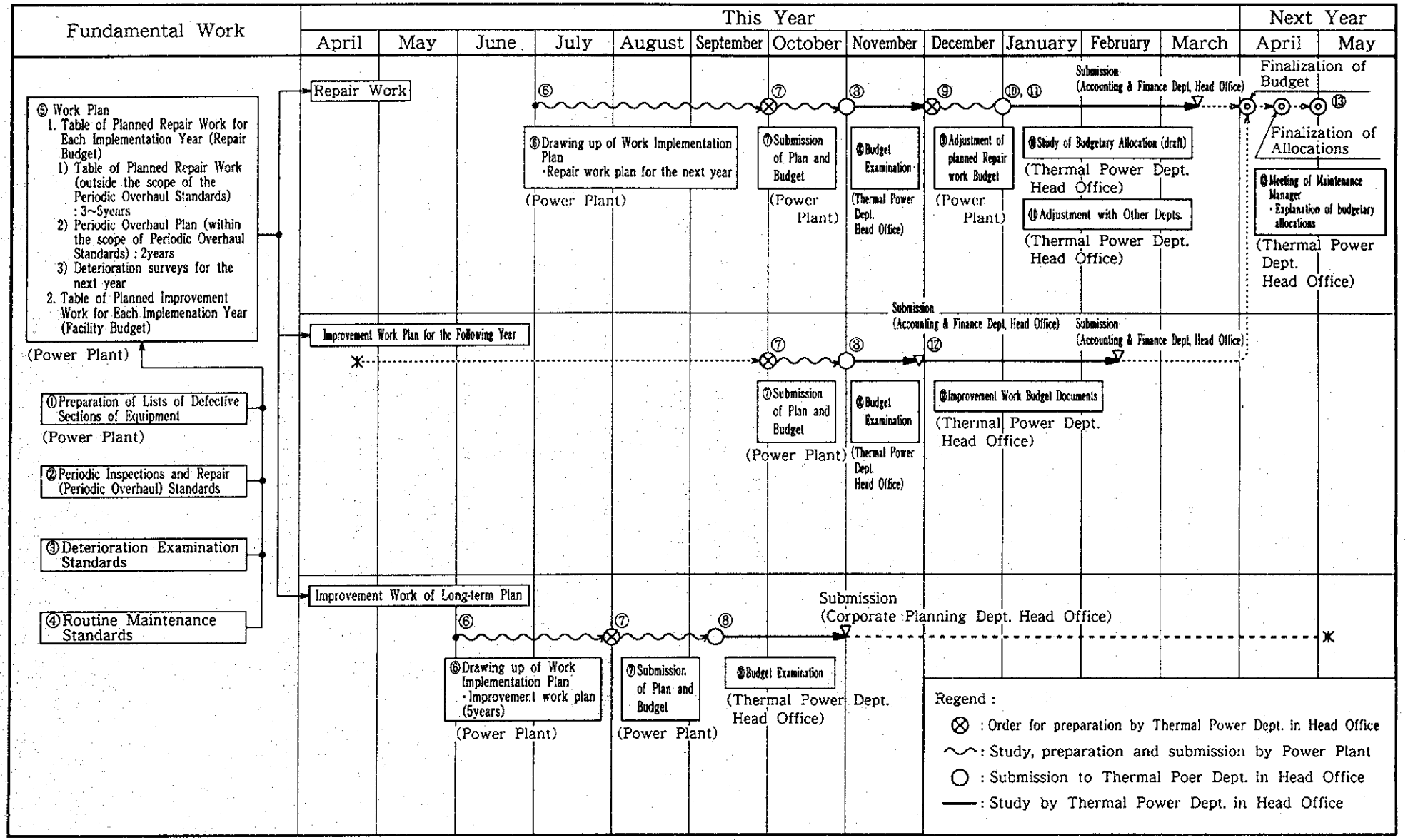
I, 1) a. Preparation and establishment of periodic overhaul standards

I, 1) b. Review of standard duration and interval of periodic overhauls for each power plant unit

I, 2) Reinforcement of formulating function of periodic overhaul plan

The approach to these is given in the following clauses.

Figure 7-2 Periodic Overhaul Plan (Work-flow up to the Finalization of Periodic Overhaul Budget)



2) Preparation and Establishment of Periodic Overhaul Standards (Priority Item I-1)-a.)

a. Purpose

- To set standards for the kinds and intervals of periodic inspections; and
- To set inspection and repair work items to be repeatedly carried out at every periodic overhaul, and to set execution intervals for them.

b. Effects

- Periodic overhauls correspond to the periodic health check of humans. Vital sections will be regularly and successively inspected, and the collected data will be stored and accumulated. This will enable a grasp of current conditions and tendencies and encourage appropriate, economical, and timely repair.
- Establishment of Periodic Overhaul Standards will make it possible to computerize estimates of periodic overhaul costs and preparation of budgets, allowing for rationalization of job operation.

c. Contents of Work and Sections in Charge (Draft)

- Preparation and Establishment of "Guidelines for Preparing Periodic Overhaul Standards"

Sections in charge	ERD and QA in the Head Office
Person(s) in charge	Designated manager(s) of ERD or QA
Responsibilities	- Drawing up of the guideline draft - Appointment of staff for the task - Supervision and control of the task operation - Coordination with the power plants and MMRC/MSD - Authorization of guideline draft - Notification, distribution and explanation of the guideline, after authorization, to the respective sections and departments concerned.

- Preparation and Establishment of Periodic Overhaul Standards for Each Power Plant

Section in charge	Power Plant	MSD	MMRC
Person(s) in charge	Manager of Maintenance & Repair Dept.	Manager designated by VP	Manager designated by VP
Responsibilities	- Preparation of standards for equipment to be inspected under the power plant's responsibility - All items related to the above	- Preparation of standards for equipment to be inspected under MSD's responsibility - All items related to the above	- Monitoring and steering of preparation - To obtain cooperation of ERD and QA of the Head Office, as occasion demands

Note: 1. Power plants and MSD will prepare the Periodic overhaul Standards (Draft) respectively in accordance with the aforementioned guidelines.

2. Each power plant will put together what has been prepared, including those made by the MSD, into their Periodic Overhaul Standards (Draft).

3. The MMRC will examine each power plant's Periodic Overhaul Standards (Draft) and authorize them.

d. Periodic Overhaul Standards (Draft)

a) Categories and intervals of periodic overhauls

In order to help preparation of Periodic Overhaul Standards, a suggestion on the categories and intervals of periodic overhauls is provided in Table 7-2 for reference.

When this table is applied to the Units No. 1 and No. 2 of the Malaya TPP as of the end of 1993, both the units fall under the category of Special Precise Inspection on Long-term Running Unit (S-inspection) because the total operating hours after the initial commissioning exceed 100,000 hours, as mentioned below.

	Total Operating Hours (Hr.)	Total No. of Start-up
No. 1 Unit	116,089.01	359
No. 2 Unit	101,510.93	213

Table 7-2 A Draft of Standards for Periodic Overhaul Categories (for Reference)

Periodic Overhaul Categories	Levels of Inspection*1
Periodic Inspection for Standard Use Period*2	A-inspection
	B-inspection
	C-inspection
Periodic Inspection for Prolonged Use Period *3	A or B, plus S-inspection

Notes: *1 Levels of inspection

A-inspection; Level of inspection which allows 4 years continuous operation for turbine and 2 years for boiler before coming overhaul.

B-inspection; Level of inspection which allows 3 years continuous operation for turbine and 1.5 years for boiler before coming overhaul.

C-inspection; Level of inspection which allows 2 years continuous operation for turbine and 1 year operation for boiler before coming overhaul.

S-inspection; Inspection to be added which is included in "Periodical inspection after long-term operation" shown in Appendix 5-4 of the main report.

*2 The period from the 2nd year after initial operation up to 100,000 hours (total operation hours after commissioning) or up to 2500 times (total number of start-ups after commissioning) is categorized as normal stage, and standard-type periodic inspections (A or B or C) will be conducted.

However, during the initial periodic inspection, detailed inspections shall be conducted in addition to the standard-type periodic inspections so that initial stage troubles and problems particular to the facility will be identified.

*3 The period exceeding that of the 'Periodic Inspection for Standard Use Period' is categorized as the prolonged use period and, in addition to the standard-type periodic inspections (A or B), detailed inspections (S-inspection) will be conducted so that the state of deterioration will be grasped and data necessary for taking measures for future operations will be collected.

b) Combination of Periodic Inspection Categories

Diverse patterns are conceivable for the order and combination of periodic inspections. Those in charge of facility management must consider the execution schedule of periodic inspections in accordance with the operating conditions of facilities such as turbines and boilers, and plan the order and combination properly.

The order of the periodic inspections shall be based on the following rule:

- As a principle, A-and B-inspections shall be conducted alternately.
- The first periodic inspection shall be A-inspection.
- The inspection immediately after an extended interval of periodic inspections shall not be C-inspection.
- Consecutive implementation of C-inspections shall not be allowed.
- The periodic inspection either before or after C-inspection shall be A-inspection.

Examples of the combination concept based on the above-stated rule are provided in Table 7-3 and 7-4.

Table 7-3 Periodic Inspection for Standard Use Period (Example)

Year		0	1	2	3	4	5	6	7	8	9
Basic	Boiler	A	B	A	B	A	B	A	B	A	B
	Turbine	A		B		A		B		A	
Application example 1	Boiler	A	···B		···A	···B		···A	···B		···A
	Turbine	A			···B			···A			···B
Application example 2	Boiler	A	C	B	C	A	C	B	C	A	
	Turbine	A		C		B			C	A	
Application example 3	Boiler	A	C	A	C	A	C	A	C	A	
	Turbine	A		C		A		C		A	

Note: In this table, the starting point is the year when A-inspection is conducted for both boiler and steam turbine.

Table 7-4 Periodic Inspection for Prolonged Use Period (Example)

The basic combination is the same as for the standard use period. Special inspections (S-inspection) under the Deterioration Examination Standards shall be conducted in addition to A- or B-inspections.

	Year	0	1	2	3	4	5	6	7	8	9
Basic	Boiler	A	B	A	B	A	B	A	B	A	B
	Turbine	A		B		A		B		A	
Application example 1	Boiler	A	B		A	B		A	B		A
	Turbine	A	B		A	B		A	B		A

Note: In this table, the starting point is the year when A-inspection is implemented for both boiler and steam turbine.

c) Periodic Inspection Work Items

- Periodic inspections are divided into three major types of A, B, and C. Standards for the work items for each of these three inspection types and those for S-inspection shall be prepared.
- A draft of the standards shall be prepared for both boiler facilities and turbine facilities.
- For ease and convenience in preparation of a draft of standards, utilize the standards which have been actually used.

3) Days Required for Standardized Periodic Overhaul for Each Unit (Priority Item I-1-b)

a. Purpose

- Along with the establishment of standards for periodic overhauls, the appropriate number of days required for such standardized periodic overhauls shall be determined.

- The days needed for a standardized periodic overhaul shall be determined in accordance with unit capacity, type of main equipment (boilers, turbines) and fuel variety, and also with the periodic inspection category and the combination of inspection types.

b. Effects

- Once the basic schedules of standardized periodic overhauls (Days of SPO) have been established, the power plant and the MSD will be able to make long-term periodic overhaul plans more easily. Further, the MMRC will be able to collectively grasp the overhaul plans of the power plants, and will be able to manage the comprehensive program.
- Establishment of the SPO duration requires, as a basis, the standardization of SPO processes. This will enable the man-hours to be established for each work item of the standardized periodic overhaul, which will pave the way for a standardized and computerized budget.

c. Sections in Charge and Responsibilities (Draft)

Sections in charge	Power Plant	MSD	MMRC
Person(s) in charge	Manager designated by plant manager	Manager designated by VP	Manager designated by VP
Responsibilities	- All items relevant to this task - In consultation with the MSD, each power plant shall formulate their own standardized periodic overhaul processes and determine the number of days required. - Rendering cooperation to the MMRC by joining MMRC-hosted conferences and other activities.		- See below

Responsibilities of the MMRC

- To present a policy on this project to the concerned sections in the Head Office and the respective power plants for internal confirmation.
- To set the launching date and completion target date of the task for each power plant, and to notify them of the schedule.
- To monitor the progress of each power plant, and give necessary advice.

- To study the drafts submitted by the respective power plants and prepare the standards (draft) as a whole.
- To adjust and coordinate the standards (draft) within the MMRC as well as with the concerned sections in the Head Office.
- To authorize the adjusted and coordinated draft in-house and put the standards into practice under the name of the VP.

d. Determining the Days Required for Standardized Periodic Overhauls

- Based on the standards for periodic overhauls (standardized periodic overhaul work items and periodic inspection categories), days required for standardized periodic overhauls, i.e. standard number of days and processes, shall be studied.
- The points to which attention must be paid are:

a) When records of processes or number of days needed for past periodic overhauls are referred to, work other than standardized periodic overhauls, such as special repair work or improvement work, should be excluded. In addition, extensions of work schedules due to delay in delivery of purchased parts should not be taken into consideration.

b) The periodic overhaul plan of the MSD and power plant maintenance repair group who take charge of the work, as well as work executing capability and efficiency, should be taken into consideration. The reason is that these are vitally important factors which may determine the issue of the number of days needed.

- Table 7-5 gives an example of s standardized number of days for periodic overhauls in Japan. This can be used as a reference for the NPC study.

Table 7-5 Days Needed for Standardized Periodic Overhauls in Japan (for Reference)

Thermal Power Plant		Periodic Inspection Categories		
Output (MW)	Fuel	a-A	a-B	b-B
500	Heavy Oil	53	45	36
375	Heavy Oil	50	42	32
250	Heavy Oil	48	37	27
700	Coal	70	70	55

Note: Periodic Inspection Categories

a; Boiler - A-inspection A; Turbine - A-inspection

b; Boiler - B-inspection B; Turbine - B-inspection

Refer to Table 7-2 for definition of A- and B-inspections.

Days are working days, not including holidays.

e. Days Needed for Standardized Periodic Overhauls (Draft)

a) MMRC Annual Periodic Overhaul Schedule

The NPC has prepared the periodic overhaul schedule for 1995 (dated December 6, 1994). (Refer to Figure 5-8) According to this schedule:

- 90 days are required for standardized periodic overhauls for existing thermal power plants, regardless of the capacity of the power plant unit.
- Between periodic overhauls, maintenance outages of 6 days are scheduled twice.
- Total yearly outage per unit comes to 102 days, leaving availability at 72%.
- The 90 days decided upon for periodic overhaul is assumed to have been arrived at through past experience as the longest commonly applicable period.

b) Days Needed for Standardized Periodic Overhaul (Suggestion)

The standardized periodic inspection items are considered to be about the same as those in Japan. As a suggestion for the (targeted) days for standardized periodic overhaul to be applicable when the periodic overhaul plan in the MSD and power plants as well as the improvement of the execution capabilities proposed in this report have been implemented, we propose the following Table 7-6.

Table 7-6 Days Needed for Standardized Periodic Overhauls (suggested targets)

Thermal Power Plant		Periodic Inspection Categories		
Output (MW)	Fuel	a-A	a-B	b-B
350	Heavy Oil	55	41	36
300	Heavy Oil	50 (85)	37	35
200	Heavy Oil	45 (85)	32	30
300	Coal	60	50	40

Note: The Figures in parentheses are for Siemens turbine.

a-A; Boiler A inspection Turbine A inspection

a-B; Boiler A inspection Turbine B inspection

b-B; Boiler B inspection Turbine B inspection

Table 7-7 Breakdown of Required Number of Days of Disassembled Inspection

	GE, WH type Turbine (375 MW)	Siemens Turbine
Cooling down	5	5
Disassembling	10	30
Inspections	7	7
Assembling	15	30
Oil flushing until start-up	13	13
Total	50	85

4) Reinforcement of Formulating Function of Periodic Overhaul Plan (Priority Items, I-2)

a. Purpose

- To clarify the section in charge of periodic overhaul and the scope of responsibility at Power Plant and MSD.
- To review organization and allocation of personnel which are deemed to be necessary in connection with the above mentioned item, and to set the improvement.

b. Effects

- To promote formulation of perfect periodic overhaul plan

c. Section in Charge of Review of Work and Items in Charge (Draft)

Sections in Charge	Power Plant	MSD	MMRC
Person(s) in Charge	Manager designated by Plant Manager	Manager designated by VP	Manager designated by VP
Responsibilities	1. Review of Statement of Function - From a viewpoint of implementation of perfect periodic overhauls, on the periodic overhaul plan (Contents of Work, Work Schedule, Budget, etc., Everything), to review the scope of work in charge of each section and to adjust it. - Based on the results of the work mentioned above, to draw up a draft of revision for the existing statement of function. 2. To study on the necessary organization and allocation of personnel in connection with the revision mentioned above. 3. Regarding works aforementioned, to participate in the meeting sponsored by MMRC. 4. To cooperate with MMRC on putting works together		Items described below:

Items handled by MMRC:

- To show the policy of the work to relevant sections in Head Office, MSD and each power plant and to confirm it in NPC
- To set the starting date and scheduled completion date of works at each power plant, to indicate them to MSD and each power plant
- To monitor progress conditions of the works above mentioned and to give necessary advice.
- To study on the proposals submitted by each power plant and to draw up a corporate-wide revised draft plan.
- To adjust the plan with relevant sections of MMRC and those of Head Office
- To authorize the draft plan and to make public and implement under the name of VP.

d. Review of Statement of Function

Power Plant:

P & S (Planning & Scheduling), which is one section of maintenance groups, must take responsibility for essential role on implementation of perfect periodic overhaul plan. The role is to be clarified in the statement of function.

a) Present Function of P & S

Present Functions	Points of Review
1. Planning & scheduling of predictive, preventive maintenance, minor and major overhaul.	1. The present function is sound, however, the following are to be considered. (1) Drawing up individual work plan and schedule is not P & S's duty, but the responsibility of the sections concerned. P & S is rather to act as coordinator of maintenance groups of Power Plant and each section of MSD and to monitor the progress of their work, from the stand point of overall Power Plant. (2) Section Chief of P & S is able to make a request necessary for execution of the duty to maintenance groups of Power Plant and MSD's each section. Each section shall follow the request.
2. Adjustment of the plans and schedules with other sections in power plant	2. To conduct adjustment among power plants and MSD as well as among other sections in a power plant
3. Monitoring and follow-up after procedures for placing order of spare parts, materials	3. P & S should not be responsible for follow-up of requisitioned materials and parts. It is the responsibility of the requisitioning sections to follow up these requisitions. P & S should, however, monitor the status of these requisitioned items.

b) Division of Functions among P & S and Each Maintenance Section

- From the stand point of implementing perfect periodic overhaul plan, each group is to clarify the respective duty in detail referring to Table 7-8 "Division of Duties in Connection with Periodic Overhauls".
- Based on the results mentioned above, to draw up drafts of Statement of Function and Statement of Duties.

e. Study on Organization and Allocation of Personnel

In connection with the review of assignment of duties aforementioned, organization and allocation of necessary personnel will also be studied.

Table 7-8 Division of Duties in Connection with Periodic Overhauls

Duties	P & S	Each Section of Maintenance Groups
1. Planning - Work item, scope and contents - Schedule - Budget - Purchase plan of parts and materials - Engineering	- To request drawing up the plan, informing the planning policy to each section of power plant and MSD. - To adjust and arrange the items drawn up by each section - To arrange and coordinate the plan as for power plant including items prepared by MSD. - Prepare Bar charts, PERT-CPM for overall works - Addresses concerned groups of changes to plans and schedules	Each section is to implement the respective items in charge. - Mechanical Maintenance - Electrical maintenance - Instrument & Control Maintenance - Chemical
2. Requisitioning - Drawing up purchase specifications - Drawing up a written estimate - Drawing up documents of application for approval by relevant sections and departments - Drawing up and submission of Purchase Requisition - Spare parts, materials, equipment, etc. - Items relevant to maintenance work	- To monitor status of inventory of spare parts and materials needed for preventive maintenance and periodic OH. - To initiate necessary PRs including preparation	Each section is to implement the respective items in charge. - Mechanical Maintenance - Electrical maintenance - Instrument & Control Maintenance - Chemical
3. Implementation		
- Preparation for maintenance work	NA	- Each section of power plant and MSD is to implement the respective items in charge.
- Receiving procured parts and components - Testing - Certificate of acceptance	NA	- Receiving should be joint responsibility of end user and QC.

Duties	P & S	Each Section & Maintenance Groups
- Overall implementation plan	Coordination among all groups is to be responsibility of P & S including tagging out and isolation of system to be worked out by concerned maintenance sections	
- Implementation of maintenance work		
- Management of work schedule	P & S is to be responsible for monitoring overall progress of the work and revision/updating of Bar chart, PERT-CPM as necessary.	Each section is to conduct schedule control of the work in charge. The progress condition is to be submitted to P & S.
- Performance test planning, implementation and preparation of reports	Efficiency & Control has the responsibility and other sections groups will cooperate with the items.	Same as the Left
4. Management of reports and documents		
- Preparation of reports	- NA	- Presentation of reports is to be implemented by each section of power plant and MSD.
- Collection and arrangement of records such as measurements, tests during periodic overhaul	- To arrange and collate all reports drawn up by each section.	- The records are submitted to P & S.

7.3.2 Complete Implementation of Periodic Overhaul (Priority Item II)

1) Approach to Improvement Plan

The measures deemed necessary for complete implementation of periodic overhauls are given in Table 7-1. The following three items will be particularly essential:

1 To make mandatory, implementation of periodic overhauls in conformity with periodic overhaul standards

2 To review MSD's insufficient logistic for work implementation and to formulate an improvement plan

3 To review and improve the existing organized implementation system and clearly define the lines of responsibility for periodic overhauls

Approach concerning these items will be outlined below:

2) To make mandatory, implementation of periodic overhaul in conformity with periodic overhaul standards

a. Purpose

- Company guidelines which stipulate mandatory implementation of periodic inspections will be formulated and enacted.
- Legal measures, if possible, supporting said guidelines will be studied and made into a proposal to submit to superior officers or upper management

b. Effect

- Ensured complete implementation of periodic inspection for facilities by the facility owners will contribute to the improvement of power plant reliability, thereby stabilizing electric power supply.
- Now that the balance between supply and demand of power has finally been improved by development of a new power source and brown-outs have been almost eliminated, it is high time to implement complete periodic overhauls. If this opportunity is missed, the effects cannot be completely predicted nor should they be underestimated.

c. Sections in Charge of Work and Responsibilities (Suggestion)

Sections in charge	Head Office ERD/QA	MMRC
Person in charge	Manager designated by VP in charge of ERD/QA	Manager designated by VP
Responsibilities	- Preparation of company regulations (draft) stipulating mandatory implementation of periodic inspections - Study of legal measures supporting said company guidelines and preparation of the proposal	- To extend cooperation to the Head Office sections in charge of carrying out the work

d. Contents of the Company Regulations Stipulating Mandatory Implementation of Periodic Inspections (for reference)

a) Power plant facilities and their scope or sections to be subjected to the periodic inspections shall be specified.

b) Standards for implementation period and interval of periodic inspections

c) Persons in charge of inspections (e.g. to be selected from MMRC or ERD)

e. Study of Legal Measures Concerning Periodic Inspections, and Preparation of the Proposal

a) Research and review of the examples implemented in other countries

b) Preparation of proposal and submission to superior officers

3) Review of the MSD's Insufficient Capability for Work Implementation, and Proposal of Improvement Plan

a. Purpose

- Preparation of improvement proposal on MSD's capability for work implementation

b. Effect

- To contribute to complete implementation of periodic overhaul

c. Sections in Charge of Work and Responsibilities (suggestion)

Sections in charge	Head Office, Personnel Dept. Human Resources	MMRC/MSD/Power Plant
Person in charge	Manager designated by VP	Manager designated by VP
Responsibilities	1. Review of the recommendations and improvement plans given in this report concerning power plant/MSD staff size and education/training	1. Same as 1. left. In addition, collection and sorting of review results and submission to the Head Office (Personnel Dept.)
	2. Completion of NPC's Improvement plan concerning MSD staff size and their education & training by taking the results of the MMRC's review, and submission to superior officers	2. Review of recommendations and improvement plans given in this report concerning facilities and equipment necessary for MSD's capability improvement. Completion of review results and submission to superior officers

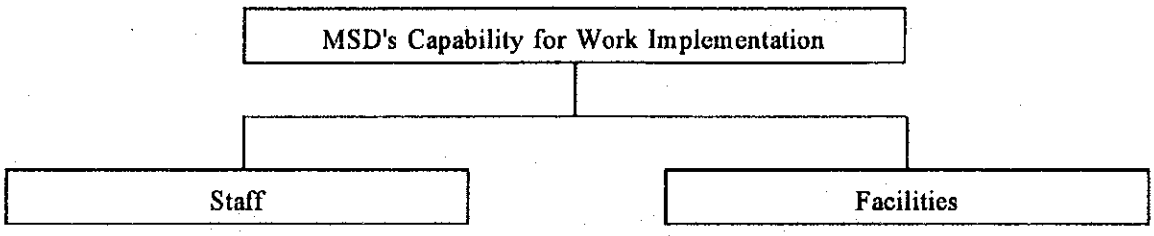
Note: For review of the improvement plans provided hereinafter, task forces will be organized and led by a manager designated by the VP. Each task force shall prepare respective work schedule and establish the general work schedule in the joint meeting.

d. Improvement Plan of MSD's Capability for Work Implementation

a) Improvement fields and issues to be examined

Improvement of capability requires a number of issues to be considered as listed below. The task forces will address these issues and prepare the improvement plans.

Figure 7-3 Improvement of MSD's Capability for Work Implementation



- Review of necessary number of staff and sufficiency
- Implementation of education and training
- Nurturing or training subcontractors
- Improvement of work procedure manuals

- Sufficiency of equipment and tools for work
- Preparation of transporting and carrying vehicles
- Preparation of site office and accommodations
- Preparation of facilities for skill education and training

b) Re-examination of Required Number of Staff, and Sufficiency

- Annual Periodic Overhaul schedule, 1995

  Figure 5-8 is the annual maintenance schedule for 1995 gathered by the MMRC for thermal power plants.

  - The schedule is so prepared that two or more power plants will not concurrently undergo a major overhaul. This matches the general estimation on the current capability of MSD that they cannot effectively implement more than one major and one minor overhaul at the same time.
  - The schedule also suggests that they make it a policy to conduct the periodic overhaul once every year for each unit. However, it has periodic overhauls for many power plant units in January, when there deems to be practical problems.

- Necessary number of MSD staff

  Based on the aforementioned annual maintenance schedule, we estimated the necessary number of overhaul staff throughout the year from a broad perspective. The result is provided in Figure 5-8. In this figure, periodic overhauls for gas turbines are included.

  This Figure 5-8 indicates that the hatching section requiring more than the total 189 MSD engineers requires staff supplement.

- Total number of required supplement of staff for MSD (estimate)

Peak period	roughly 200 skilled workers and craftsmen	[3 units (350 MW, 250 MW & 100 MW) and gas turbines]
Intermediate period	roughly 100 skilled workers and craftsmen	[2 units (including a 350 MW unit) and gas turbines]
Off-peak period	roughly 20 skilled workers and craftsmen	[2 units (100 MW & 150 MW) and gas turbines]

Conventionally, such personnel shortages were supplemented by temporary employment from outside in addition to assistance from maintenance & repair staff and operators of power plant.

(Policy for re-examination)

- Out of the schedule over a year, the peak period is rather short (roughly one month). Therefore, the targeted number of supplemental staff members shall be 100 (maximum), and for the first stage half will be necessary (roughly 50). Proceeding on to the second stage will be done only after reviewing the results of the first stage.
- The remaining shortage of staff for the peak and intermediate periods will be supplemented with temporary employment from outside.

- In-house MSD staff supplementation method

It is practical to replenish the staff shortage with personnel from power plants within the NPC. A suggestion of the procedure for this is provided below:

1 Re-examine the required number of operators per shift for each power plant.

2 As a result of 1 above, several operators may be transferred to maintenance & repair group.

3 After the increase in maintenance & repair group engineers, an equivalent number will be allocated to MSD.

4 For those transferred from operations to maintenance & repair group, education and training will be implemented systematically.

5 Those maintenance engineers allocated to MSD will, during the periodic overhaul at the power plant to which they currently belong, be engaged in the periodic overhaul there, and will be assigned to other power plants for the periodic overhaul as required.

- Details Concerning 1 and 2 above

1 Re-examination of the Required Number of Operators Per Shift at Power Plant

The current full strength of shift operators/shift is as follows:

Power plant	Malaya No. 1 & No. 2 Units	
Shift operators total number/number per shift	105 / 20	
Operations Superintendent A Operations Principal Engineer B	1 2 (1 + 1)	3
Boiler Auxiliary	6 (3 + 3) 2	8
Turbine Auxiliary	4 (2 + 2) 2	6
Electrical control	3	3

The number in brackets indicate the number of operators per unit. Those for chemical service are excluded.

The full strength for shift operations shall be reviewed so that it will correspond to the present conditions at Malaya Power Plant.

	Present	After review	Surplus
Boiler operators	3 + 3 = 6	(2 + 2) + 1 = 5	1
Turbine operators	2 + 2 = 4	(1 + 1) + 1 = 3	1
Chemical operators	3	2	1

Similar number of reduction in average may be expected for power plants other than Malaya TPP after review. This will allow for total reduction per power plant of: 3 operators x 5 shifts = 15 operators. Necessary measures shall be studied in efforts toward this goal.

2 Transfer to Maintenance & Repair Group

Each power plant shall study the transfer of these 15 operators to another group including maintenance & repair group.
The number of operators to be transferred to maintenance & repair group is assumed to be 10, not including the operator for chemical.

3 Selection of Engineers to be Allocated to MSD

From among the engineers in the MSD (excluding those operators to be transferred from shift operations), those to be assigned to MSD shall be selected. Targeted number is 10 (5 in the first stage and 5 in the second stage).

4 Implementation of Education/Training

- Scheduled training will be given to those personnel transferred from operations group to maintenance group by each job group.
- The human resources group at Head Office will also let them participate the education and training program to cooperate the above mentioned education and training.

5 The maintenance personnel of MSD stationed at a particular power plant will join the overhaul work of his plant during the overhaul period, however, he will work for the overhaul of other plant while his plant is under operation.

Reinforcement of MSD personnel by the above scheme will be completed within 5 years.

4) Fostering of Subcontractors

a. Purpose

Subcontractors shall be fostered for efficient and economic supplement of the capability of MSD.

b. Effect

- Since the NPC supervisor can control the overhaul work through the supervisors of the subcontractors, he can avail himself of ease of schedule and quality control of the various works simultaneously conducted.
- Specifying the work by the contract specifications, the scope of the responsibility of the contractor can be easily clarified to enable less MSD personnel should the contract include the procurement of the equipment and materials for the work and required labor.

c. Fostering Plan of Subcontractors

a) A section in charge of fostering of subcontractors will be created within MSD.

b) That section of MSD will prepare the fostering plan through the coordination with relevant departments and sections of MMRC.
   - Short listing of Candidate Subcontractors
     Subcontractors (in plural number) and their respective area of the work will be decided on the basis of their experience on the overhaul and inspection works of power plant equipment or similar.
   - The selected subcontractors will be constantly given some particular portion of the overhaul works to let them obtain skills and know-how of the overhaul work for the fostering purposes.

c) Their capability shall gradually be strengthened and scope of works expanded of subcontractors.

7.3.3 Safe and Reliable Operation (Priority Item III)

1) Complete Preparation of Operation Manuals

As referred to in Chapter 5, the operation manuals currently used in the power plants are insufficient. More comprehensive operation manuals should be prepared, in which the contents can be thoroughly understood by all operators.
These manuals should be prepared by effectively utilizing the OMP (Operations Management Program) organization and under the cooperation of power plant personnel.

2) Daily Patrol and Inspections, and Routine Work

a. Daily Patrol and Inspection by Operators

At the Malaya TPP, in view of its superannuated facilities with insufficient monitoring instruments and alarm devices, hourly patrol and inspections are indispensable for early detection of abnormalities. However, selective patrol with rationalized patrol items is possible.

For safe and proper patrol and inspections, the patrol passages and lighting equipment must be improved and gas or steam leaking sections must be repaired. Efforts should be made to avoid leaving troubled sections un-repaired for an extended period.

b. Stand-by Equipment Change-over Test and Other Routine Operations

No problem seems to exist in the current intervals of spare equipment switching tests for auxiliary equipment and turbine routine tests.

To prevent operational errors and to record the results of the operational performance during switching, a routine operation check-sheet needs to be prepared. In addition, for comprehensive management of routine work, a monthly routine table should be prepared to ensure accurate implementation of prescribed routine operations.

c. Review of Operational Rotation System

a) Operation Staff and Rotation Staff Structure

Although the Malaya TPP has a central control system, the power generating facilities are old and, therefore, not designed for automation and labor-saving. An effective means for improvement of the power plant reliability would be to reduce the number of operators through automation of the facilities, and reinforce the maintenance and repair system by sending the freed staff to maintenance and repair, thereby securing them for periodic overhauls.

b) Shift Categories and Shuttle Bus Service

Since traffic congestion in Metro Manila has become aggravated and a reduced commuting time cannot be expected, it is imperative to lessen the commuting drag by increasing bus operations and improving road conditions. As a fundamental measure, we also recommend that company houses and dormitories be constructed in the vicinity of the Malaya TPP.

One (1) additional bus, three (3) buses in total, is also recommended for more efficient commuting of the plant personnel.

7.3.4 Hiring, Education and Training of Personnel (Priority Item IV)

1) Hiring System

a. Review of Staff Complement

Whether the current complement is appropriate or not shall be reviewed in detail for each section and department in the power plant organization and MMRC.

b. Formulation of Long-term Hiring Plan

A long-term hiring plan shall be formulated by forecasting future vacancies and increasing staff (vacancies from retirement on or before retirement age, and increases based on the power development plan).

c. Hiring System

The current practice of hiring whenever there is an opening shall be replaced by a hiring system in which all necessary personnel will be recruited from graduating classes at a predetermined time every year based on the above-mentioned long-term hiring plan.

As one (1) of the measures to materialize this regular hiring, the study on the conversion of the positions prepared for Cadetship Program into those for regular employee will be conducted by NPC.

2) Education and Training

Education and training should be implemented separately for new employees and employees with some experience.

a. Education of New Employees

a) Collective education of new employees

In tandem with annual periodic hiring, collective education for newly employed power plant personnel and MMRC engineers shall be implemented in the NPC Training Center.

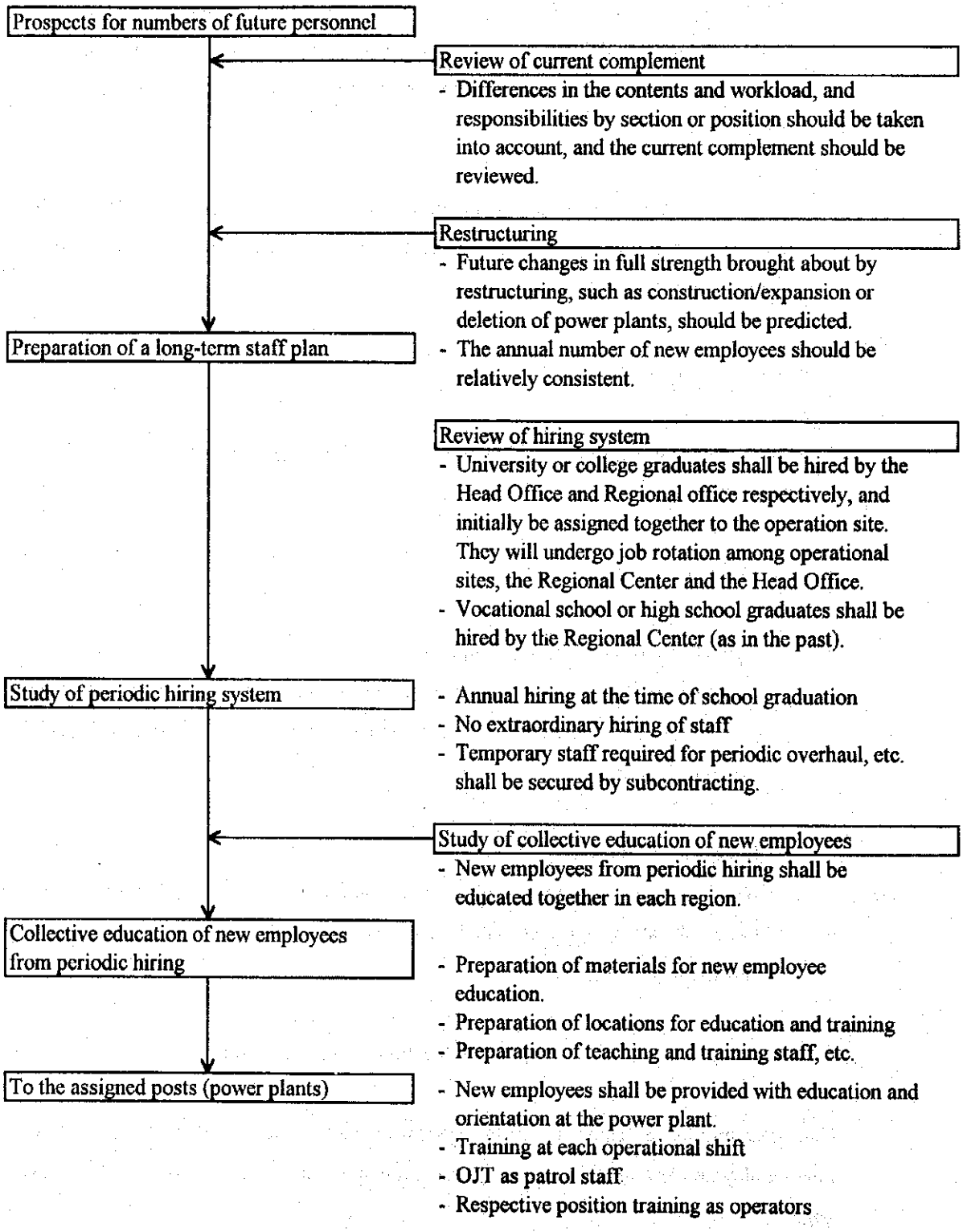
b) Education at the power plants

After the above-explained collective education at the Training Center, all new technical staff will be sent to their respective power plants to undergo orientation, and training.

3) Implementing Procedure of Hiring and Education of New Employee

The procedure to implement the hiring system as well as the education and training of new employees explained in 1) and 2) above are summarized in the flow chart on next page.

Figure 7-4 Employment of a Periodic Hiring System and Implementation of New Employees' Collective Education



4) Education of Experienced Personnel

a. Special Skill Education

Education and training for special skills required in each section of the power plant shall be provided for an adequate length of time at the training center, at the manufacturers' or at varieties of research institutions, etc.

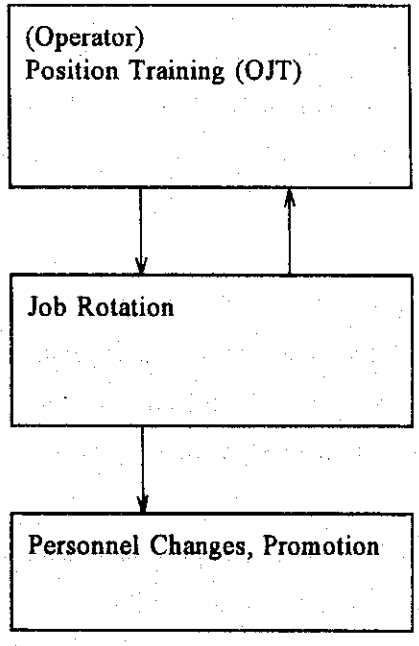
b. Position Training of Operators

Regardless of transfers to fill vacancies opened through retirement of an operator, position training shall be planned and implemented systematically as a part of the plan. The implementation plan shall be particularly designed to educate younger operators.

c. Operator Training with a Simulator

- Training shall be conducted by using the simulator to be constructed with the No. 2 Unit of the Batangas Power Plant (expected to start operation by the third quarter of 1995)

d. Personnel Transfer, Job Rotation and Position Training



- Training for 2 positions or more
- To be regularly conducted regardless of vacancy
- Freshmen are out of complement in the shift during this training.

- Experience further on the acquired position
- 2 positions are targeted to be acquired for 2 years.

- Study on the scheduled personnel changes
- Study on the scheduled promotion system

e. Overseas Training of Middle-ranking Operators and Maintenance Engineers

5) Employment of Operations and Maintenance Consultants

Schedule	Duration and number of consultants	
	1st phase	2nd phase
Before rehabilitation	2 years, 2 people	-
After rehabilitation	-	2 years, 2 people

- Instructors Combination of consultants and expert engineers (manufacturers, etc.)

- Consultants will join the NPC's managers in charge in providing effective instructions concerning all matters necessary for complete implementation of periodic overhauls

7.3.5 Improvement of Morale (Priority Item V)

1) Measures

One of the issues raised by the NPC during our survey was the lowered morale of the employees. The Human Resources Dept. of the NPC has also been well aware of this issue and has been making a variety of efforts. For further improvement, following measures are recommended.

a. The current personnel management system shall incorporate a qualification system to identify those who have passed both the academic and practical skill tests as competent and qualified for promotion. (Qualification system is currently under study in the NPC, aiming towards early implementation.)

b. Periodic education and training for morale improvement shall be implemented to be attended by all employees of the power plant in shifts.

c. To prevent employee burnout, there shall be rotation of personnel between different sections within the power plant, or, where possible, between different power plants and/or the MMRC.

d. Quality control circles and/or other similar groups of employees to make voluntary proposals shall be organized at each work place to, in combination with a reward system, encourage and motivate all members to exercise their originality and ingenuity in the work place.

2) "No Forced Outage & No Accident" Campaign

As with all other businesses and industries, the key to success is "human resources."

In Chapters 4, 5 and 6, improvement proposals are explained regarding hardware and software. However, actual implementation needs involvement of all staffs from the power plant executives to ordinary employees. Therefore, the management should appraise the operational efforts, and initiate a campaign to encourage and support involvement in improvement.

As a target of this campaign, we recommend the "No forced outage and No accident."

When the JICA visited the Philippines for the first site survey, they proposed "No forced outages" to the NPC's task force as a target in the reliability improvement plan. This means that no unit trip attributable to the power plant should occur before the next annual overhaul.

The results of the campaign shall be evaluated for reduced forced outages and accidents, etc. and achievements will be the subject of commendation. The method of commendation will be discussed later in this paper within the framework of the incentive system.

7.4 Implementation Method

Reliability improvement plan for the Malaya TPP, as explained previously, has to be executed in parallel with rehabilitation of power plant facilities and improvement of operations and maintenance procedures. The following have been formulated in coordination with this principle:

1) Classification of Implementation Plan

For actual implementation, the above-stated priority items shall be categorized into the following 3 programs.

Program-I	:	Power plant facility rehabilitation project
Program-II	:	a. Improvement of periodic overhaul plan methods and system
		b. Reinforcement of periodic overhaul implementation methods and system
		c. Measures for safe and reliable operation
Program-III	:	a. Hiring, education and training of personnel
		b. Improvement of morale

2) Project Implementation

a. Implementation Methods

a) Program-I

Like other conventional rehabilitation projects for the power plant facilities, this program shall be executed by mainly contracted work to contractors.

b) Program-II

Task forces will be organized with the operations and maintenance staff members from NPC Head Office, MMRC, power plants, MSD and MEC. The program shall be carried out in cooperation with OMP and MMP groups.

This program needs versatile study in detail not only for the improvement of hardware but also for the solution of software issues.

Therefore, along with the review of the software for the other two important items, 'Complete Periodic Overhaul Plan' and 'Safe and Reliable Operation,' one study project shall be formed and an immediate Feasibility Study (F/S) shall be conducted.

However, there are items in Program-II, which need to be implemented at once and can also be implemented as soon as the NPC system has been ready, such as those related to 'Safe and Reliable Operation.' They include:

- Preparation of operations manuals and procedures
- Review of daily patrol and inspections, and routine work
- Review of operational shift system

We recommend that these be categorized under Program-II/Phase-I, and to be carried out in parallel with the aforementioned F/S led by the NPC task forces and supported by consultants.

c) Program-III

Task forces shall be organized, involving power plant staff, led mainly by NPC Head Office Human Resources and MMRC Human Resources Section. Then the concrete improvement plan shall be studied and executed by referring to the advice given in this study report.

b. Implementation Schedule

The implementation schedule for these three types of programs are as shown in Malaya TPP Reliability Improvement Plan, Implementation Schedule.

3) Disbursement Schedule

Cost has been calculated for only the rehabilitation project of power plant facilities (hardware).

Table 7-9 Disbursement Schedule

[Unit: Thousand US$]

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

Figure 7-5 Improvement Plan Overall Schedule

	1st year 1995	2nd year 1996	3rd year 1997	4th year 1998	5th year 1999
1. Program-I					
Rehabilitation (Hardware) Unit No. 1	Major Overhaul	Annual Overhaul		Major Overhaul REHABILITATION	Major Overhaul
Unit No. 2	Major Overhaul	Annual Overhaul	Major Overhaul REHABILITATION	Annual Overhaul	Major Overhaul
2. Program-II					
1) Feasibility Study on Program-II					
2) Implementation of Program-II	Phase-I		Phase-II		
a. Improvement of Planning system of Overhaul	Taskforce	Detailed Study	Implementation		
b. Reinforcement of Implementation System of Overhaul					
a) Regulations of Overhaul, etc.	Taskforce	Detailed Study	Implementation		
b) Reinforcement of MSD					
• Personnel&System	Taskforce	Detailed Study Peparation	Addition of Personnel & training		
• Provement of tools, machines, vehicles, etc. for overhaul		Peparation	Procurement		
• Construction of Facilities.		Peparation	Construction		
·Site offices at P/S.					
·Material Centre					
·Training Centre, etc.					
c) Preparation of various Manuals	Preparation		Implementation		
c. Countermeasures for Safe and Reliable operation	Taskforce	Detailed Study	Implementation		
3. Program-III					
1) Improvement of Hiring, Education and Training System	Taskforce	Detailed study	Implementation		
2) Improvement of Morale	Taskforce	Detailed study	Implementation		