5.2 Recommendations on Improvement Plan

5.2.1 Operation Management

1) Operation Manuals

a. Preparation of Complete Operation Manuals

NPC's standard Start-up/Shutdown Procedure Manual describes only the outlines in flowchart form. For operation of each equipment, instruction manuals from manufacturers are just gathered and used. Since the system and facilities of a thermal power plant are very complicated, such basic operation manuals are insufficient for the operators, who are required to have high technical knowledge.

The distribution of these operation manuals is limited to the Sr. Control Operators and superior staff. The operation manuals should be distributed or lent to all operators. Furthermore, the start-up and shutdown schedule, and the major operational instructions are given by the Operations Superintendents based on their experience and past records. Standard operation criteria have not been established yet.

For unification of operation methods and efficient operation, a comprehensive set of operation criteria like a Data Book should be prepared, so that even inexperienced operators can plan an operation schedule with ease.

For reference, "Required Start-up/Shutdown Time" and "Unit Start-up/Shutdown Curve" are given in Appendix 5-13 and 5-14 respectively.

b. Start of OMP Project

Recently, the Operations Management Program (OMP) Project has started and the operating procedure manuals have already been completed at the Bataan TPP and Mak-Ban Geothermal TPP. At the Malaya TPP as well, the OMP Project should be launched for preparation of the operating procedure manual as soon as possible.

2) Daily Patrol and Inspections, and Routine Work

a. Daily Patrol and Inspections by Operators

At power plants in Japan, data loggers, monitoring instruments and alarm devices enable a reduced number of operators, so field patrol and inspections are carried out about 2 times per shift. To ensure the proper covering patrol a large area, patrol routes are predetermined and patrol check sheets are used. Also, a cross-check system between the operator and maintenance staff is implemented.

At the Malaya TPP, for hourly patrol and inspections, an hourly shift patrol checklist is distributed to the Sr. Control Operators in charge of monitoring and operation in the central control room, and to the Plant Equipment Operators conducting operation, patrol and inspections at the site.

At the Malaya TPP, facilities are deteriorated and monitoring instruments and alarm devices are not sufficient, hourly patrol and inspections are essential for the early detection of trouble or abnormality. However, priority patrol for the selected patrol items is possible.

For the 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 not to leave troubled sections unrepaired for an extended period.

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

The present test intervals for turbine routine test and change-over test of stand-by auxiliary equipment would incur no problem.

Since no check sheets are provided for routine operations, operator has to carry out the routine operations based on his experience and past records. For prevention of operational errors and for record of change-over test, check sheets for routine operation with procedure and precautions should be provided.

In addition, for comprehensive management of routine work, a monthly routine list should be provided to ensure implementation of prescribed routine operations. "Monthly Routine List" and "Routine Operation Check Sheet" are shown in Appendix 5-15 and 5-16 respectively.

3) Operation Shift System

a. Operation Staff and Shift Operators

The Malaya TPP adopts a central control system, however, data logger is not equipped, and automation and labor-saving for power generating facilities have not been realized. In addition, control rooms for the gas turbine power plant and 230 kV substation are located separately with full-time operators. Eventually, a quite large number of operators is required.

The present staffing of shift operators would be no problem. However, it seems possible to reduce the number of staff by 3 persons (one person each from boiler, turbine and chemical) during normal operation, provided that the number of operators is increased at start-up and shutdown operations.

Additionally, since there are surplus staff, position training is recommended to implement early promotion of operator and to improve operators' skill.

b. Circumstances of Duty Operation and Commuters' Bus Service

Most of the Malaya TPP employees live in the Metro Manila area and commute a long distance by shuttle bus. Furthermore, a midnight bus service is impossible because of safety conditions. Under these circumstances, the current shift schedule and bus schedule cannot be altered. Since traffic congestion in Metro Manila has become aggravated, a reduced commuting time cannot be expected. Therefore, it is necessary to lessen the commuting load by increasing bus operations and improving road conditions. As a fundamental measure, we also recommend that company housing quarters and dormitories be constructed in the vicinity of the Malaya TPP.

5.2.2 Maintenance Management

1) Maintenance Work Procedures

Both Administrative Procedures and Technical Procedures have unconditionally smaller numbers of items, compared with those in Japan. Further improvement should be required.

2) Daily Maintenance

Simplified work can be achieved if the Preventive Maintenance Work Order (PMWO), used by the maintenance group of the power plant, is arranged in the form of a monthly routine list. Refer to Appendix 5-3.
PMWO items are insufficient and need to be improved.

3) Periodic Overhaul and Preventive Maintenance Plan

a. Observance of Periodic Overhaul Interval

Improved reliability cannot be expected if the periodic overhaul is constantly postponed due to the power supply situation, as has been the usual practice. It is important to establish set standards and to observe the periodic overhaul interval.

b. Periodic Overhaul Schedule and Manpower

Regarding the commencement of this periodic overhaul for the Malaya Unit No. 1, as the overhaul inspection for a power plant in the MMRC jurisdiction coincided, MSD manpower fell short and the MSD's arrival was delayed. Shutdown is meaningless if the periodic overhaul cannot be started even after the unit has been shutdown.
According to the 1995 Periodic Overhaul Plan, 2 units or more are to be overhauled concurrently most of the time throughout the year, and 2 months out of the year have 4 units or more undergoing concurrent overhauls. This schedule is too tight.
Efforts to disperse MSD manpower can be fully understood. It is quite possible, though, that a slight deviation to this plan could aggravate the already demanding schedule. Once determined, the starting time for each power plant should be observed barring an exceptional reason. A complete periodic overhaul can be expected only

with carefully planned preparation. Irregular adherence to the starting schedule may lead to insufficient preparation. As Figure 5-22 indicates, MSD's manpower shortage is obvious, therefore, reinforcement of MSD manpower shall be studied in the future.

For reference purpose, typical man power requirement curves of the major overhaul of thermal power plants is Japan, rated 375 MW and 156 MW each, are shown in Appendix 5-17 of this report.

c. Filing of Periodic Overhaul Records

Records of periodic overhauls, general repairs, improvement work, etc. shall be filed in chronological order as Equipment Maintenance Records. This will enable us to assume the progressive degree of deterioration, whereby future repairs can be predicted.

d. Formulation of a Long-term Inspection Schedule

A long-term inspection schedule shall be formulated for the important equipment. This will eliminate the chance of an inspection being overlooked. Examples from the power plants in Japan are given in Appendix 5-12.

e. Implementation of Remaining Life Diagnosis

In Japan, the guideline of the Ministry of International Trade and Industry prescribes that a remaining life diagnosis be implemented for units with long hours of operation. For the Malaya TPP, the remaining life of the units needs to be diagnosed, as the total operation hours have exceeded 100,000. Discussions with equipment manufacturers are recommended regarding the items including monitoring points and diagnostic methods.

4) Periodic Overhaul Procedures and Implementation System

In Japan, the main purpose for an equipment overhaul inspection is to inspect the inside of the equipment in detail to prevent accidents. Regarding such important equipment as turbines and boilers, some inspection intervals and procedures are set down by law, and the inspections, etc. are carried out by the Ministry of International Trade and Industry. To conform to this model, the following are recommended for the NPC.

a) Formation of Periodic Inspection Standards, etc.

Figure 5-23 illustrates the concept for thermal power plant maintenance. As explained in 5.1.2, 3) Periodic Overhaul and Preventive Maintenance Plan, the NPC does not have standards for periodic inspection items (indicated as (1) in the figure). To make preventive maintenance a fundamental policy, and to maintain reliability of the power generating facilities, it is imperative to formulate standards covering periodic inspection items and inspection procedures.

We recommend that overhaul inspection procedures for major equipment such as boilers, turbines and generators, for which the MSD is taking responsibility, be of improved contents and be included in the MMP (Managed Maintenance Program) of the power plant.

b) Creating witness standards for major equipment overhaul inspections

- Who witness the inspection? (Manager, Superintendent, Principal Engineer)
- Who approves the inspection results?

c) Shortages of required equipment and tools for work should be remedied, and management methods for them should be established.

d) Lodging facilities, transportation, etc. should be sufficiently prepared for those assisting in the periodic overhaul including MSD.

5) Subcontracting Methods for Periodic Overhaul and Preventive Maintenance Work

With regard to part repairs for major equipment such as turbines, boilers and generators, expansion of the subcontracting range, e.g. subcontracting to original manufacturers or hiring of instructors, is worth review from the aspect of a comprehensive guarantee.

In Japan, a wide range of jobs, including pressure-part welding, are subcontracted to original manufacturers.

6) Management of Drawings and Data

As for drawings, a management system shall be established by setting drawing management standards for classification, modification, storing methods, etc. Ledgers shall be created based on these classification standards to facilitate search.

The data shall be sorted and disposed of according to the respective stored years so that the data volume can be reduced.

Figure 5-22 Number of Required Workers Based on the Overhaul Plan in 1995

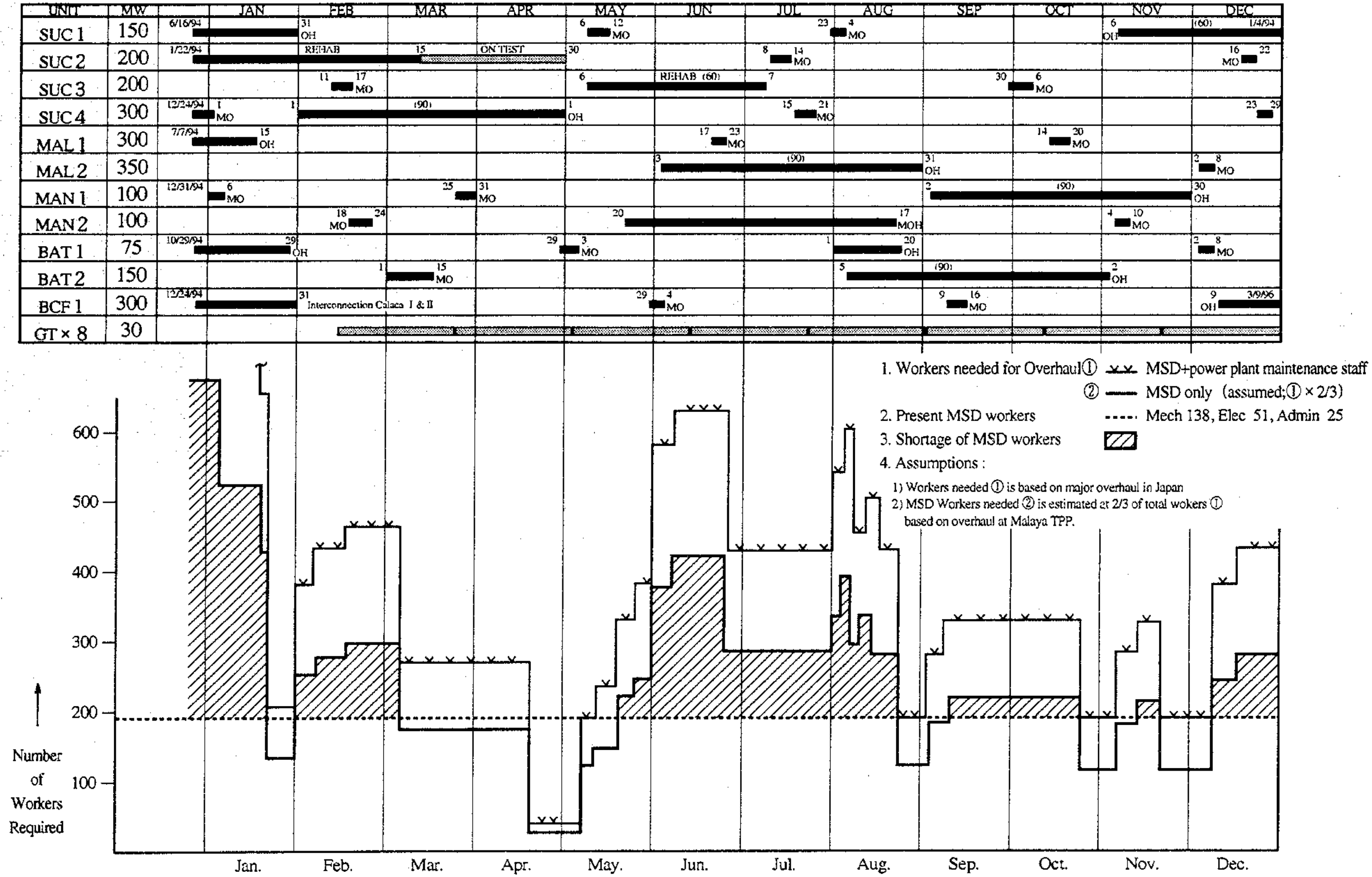
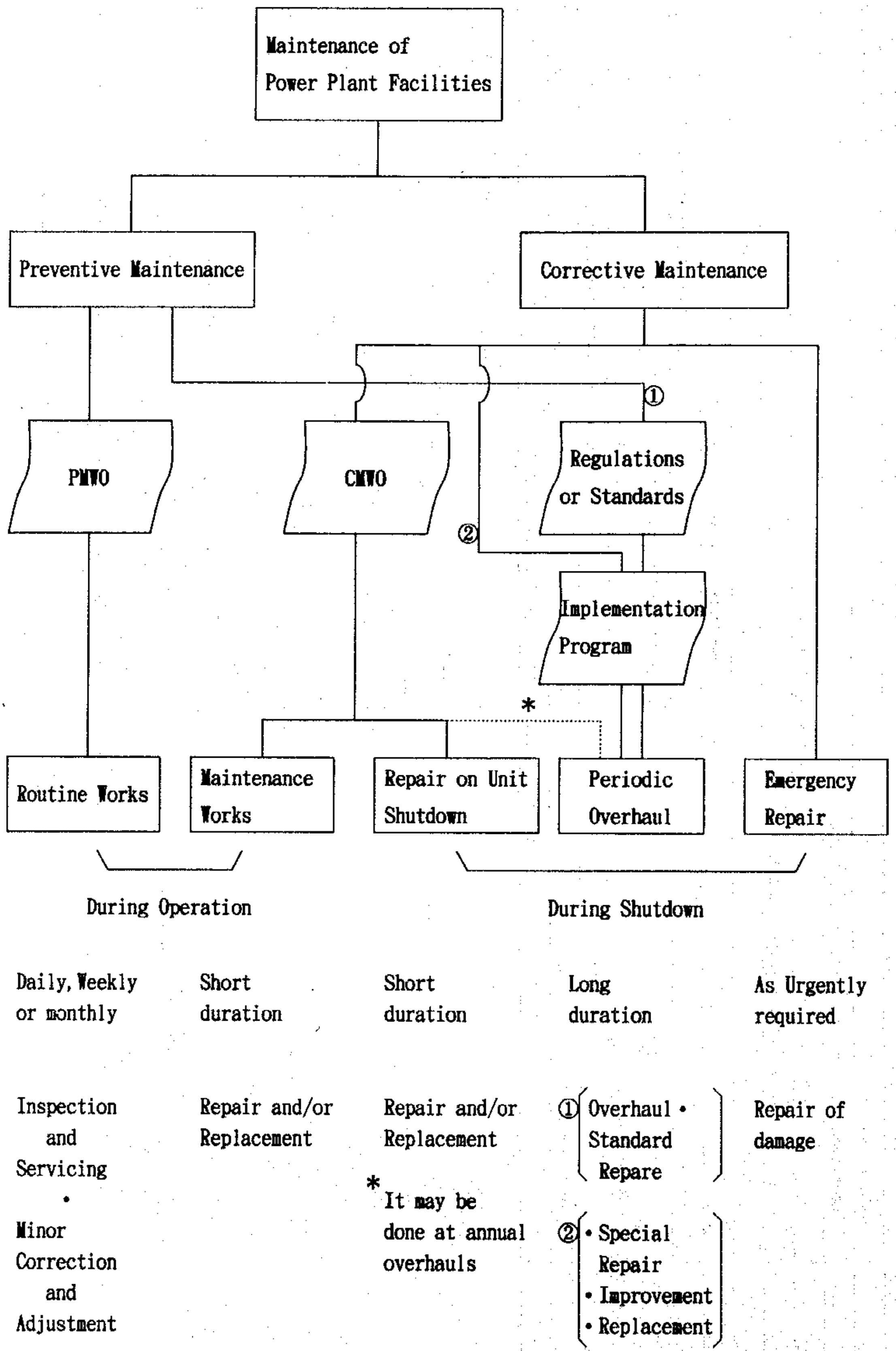


Figure 5-23 Concept of Thermal Power Plant Maintenance



5.2.3 Chemical Management

1) Water Quality during Operation

a. High silica content in the feed water of Malaya Unit No. 2.

Possible cause might be colloidal silica. Resumption of the coagulator is recommended.

b. No data of copper contents
Analysis of copper is recommended.

c. High dissolved oxygen content

Although the current value is within the standard, a zero value would be desirable. Air leakage points around the condenser should be found out.

2) Analysis Frequency

Plant system water is frequently analyzed every 4 hours probably due to condenser tube leak. To reduce the frequency, the following countermeasures are necessary:

a. To reduce condenser tube leak by thorough investigation and study, and

b. To improve reliability of chemical instruments by training of maintenance staff and steady replenishment of spare parts

3) Deep Well (Raw Water)

Conductivity is high and water quantity is unstable. Demineralization of deep well water or Laguna Lake water by Reverse Osmosis method or by evaporation method should be studied. It will reduce the cost of chemicals needed for regeneration of resins.

4) Demineralizer

a. SiO_2 meter must be repaired and put into operation as soon as possible.

b. Outflow of colloidal silica should be watched.

5) Chemical Injection

A confirmation test should be performed to examine whether the sodium oxychloride (NaClO) injection into the condenser cooling water is effective at the current concentration and frequency. One testing method could be to change the injection concentration and frequency for a certain period and check the effects of chemical injection by inspection of condenser water box conditions.

6) Countermeasures for Condenser Leaks

a. During periodic overhauls, remove the leaking tube to investigate the cause of the leak, and study countermeasures.

b. Refer to literatures from other countries where water similar to Laguna Lake water has been used for condenser cooling water.

c. Increase the water pressure at the rotary screen. After the pressure has been increased, conduct a test to confirm the effects of foreign matter removal. Removed foreign matters should be prevented from flowing into the condenser.

7) Record and save data concerning equipment preservation during shutdown.

8) Record and save water quality data for each step during start-up.

9) Inspections during Periodic Overhaul

a. Inspections of condenser hotwell, water box, deaerator, flash tank (M-1), drum (M-2) and turbine blade should be ensured.

b. Inspection results should be recorded and saved.

c. If any defective sections are found, investigate the cause and take appropriate measures.

10) Chemical Cleaning of the Boilers

Entrusting the work to a company which has experienced specialists is recommended.

11) Chemical Instruments and Sampling Rack

a. Improvement of the reliability of chemical instruments

We recommend training some personnel to take charge of instrument maintenance for all power plants. (It might be worthwhile to consider dispatching them to Japan for this training.)

b. At the time of instrument procurement, sufficient quantities of parts, consumable, accessories, etc. should be delivered to allow for a quick response to any failures.

c. At the time of instrument procurement, a manual with detailed troubleshooting instructions should be requested.

d. Complete replacement is considered necessary for chemical instruments and sampling rack of Malaya Unit No. 2.

12) M-2 Boiler Continuous Blow

M-2 boiler blow of approximately 14 tons/h is carried out almost continuously. The necessity and reasons for such a large amount of the blow down water must be investigated. Probable cause is boiler water contamination due to condenser tube leak and/or colloidal silica in the make-up water.

5.2.4 Organizations of Power Plant and Relevant Management Office

1) Organization of Malaya TPP

a Operations Division

The Efficiency Control Group acts as staff of plant manager at present. Accordingly, a certain length of time is required for acquisition of records of boiler performance test, boiler leak test, AH performance test, fuel consumption, vibration test, etc. It is anticipated that actions of performance management and operations management will become quick when the Efficiency Control Group belongs to the Operations Division.

The operation manager has duties of management such as revision of operation manual, study of operations method , preparation of training plans and materials and preparation of operation shift schedule. The operations superintendents and principal engineers of daytime duties are expected to assist the operation manager in those management duties. The technical subjects must be studied for improvement of the efficiency and reliability of the plant through cooperation with engineers of other divisions.

b Maintenance Division

The thermal power plant maintenance at NPC are performed by MSD and the Maintenance Division of the power plant. MSD is in charge of overhaul and repair of major equipment, and the Maintenance Division of the power plant is in charge of daily maintenance and overhaul of auxiliary equipment.

The maintenance works of NPC are mainly performed by its own staff. Majority of maintenance ability such as maintenance staff, maintenance tools, machine tools, etc. are centralized to MSD. Accordingly, the overhaul works depend on MSD conditions of overhaul schedule and available manpower. There are some cases where the maintenance works cannot be performed as scheduled, and delay occurs sometimes.

It is considered that the present organization of the Maintenance Division of the power plant is of no problem. But it is necessary to study the organization and capacity of MSD.

2) Relevant Management Offices for Power Plant Operation and Maintenance

a. The Responsibility at the Time of Overhaul

The responsibility of NPC at the time of periodic overhaul is divided as described below.

- MSD is responsible for planning and implementation of overhaul of major equipment (including recording and preparation of report).
- The maintenance group of the power plant is responsible for planning and implementation of overhaul of minor equipment.
- The power plant is responsible for scheduling of the entire periodic overhaul.
- MMRC has the authorities for placement of orders for goods and works necessary for periodic overhaul. (However, the power plant has the authorities for up to 100,000 pesos.)
- ERD of NPC head office is responsible for quality assurance.

Accordingly, even though the plant manager has overall responsibility for periodic overhaul, there may be cases where the location of responsibility becomes unclear. On the other hand, the vice president of MMRC is fully responsible for power plants, however, even if quality assurance is in the hands of NPC head office.

In the case of an electric power company in Japan, basically the power plant is fully responsible for its periodic overhaul. Even if head office has some of authority for placing orders for goods, the power plant has responsibility without doubt. The maintenance staff of the power plant, therefore, is fully responsible for planning of periodic overhaul, placement of orders for goods, management of schedule and works, and up to the result of trial operation.

b. Capability of MSD

In Japan, those equivalent to MSD are subcontractors which specialize in power plant construction and maintenance well versed in the necessary technical skills.

(Example of Japan) A power plant construction and maintenance firm in Japan
Total 1,760 employees (excluding subcontractors), including
250 employees at Head Office

MSD has roughly 210 employees, including 138 for mechanical work, 51 for electrical work, and others in support services. As the Malaya Unit No. 1 periodic overhaul was concurrent with another power plant's overhaul, MSD's manpower fell short, delaying the dispatch of personnel.

The staff structure for the recent periodic overhaul has been analyzed as shown in Table 5-28. Their use of many temporary employees, most of whom are helpers, indicates an insufficiency in MSD's permanent staff, particularly of skilled engineers.

From this , we would like to put forth the following proposals to the NPC.

c. Proposals for MSD and MEC

a) Reinforcement of MSD Manpower

The current MSD manpower has the capability to perform just one major overhaul and one minor overhaul at a time. As explained in the Periodic Overhaul and Preventive Maintenance Plan, the shortage of manpower at MSD is obvious. With the conventional practice of filling the shortage through subcontractors or temporary workers, lowered engineering quality is unavoidable. The following shall be studied in the future:

- Reinforcement of MSD manpower
  For work where expertise is required, such as in disassembly of a turbine main unit, MSD should be reinforces so that the necessary number of groups can be secured by using only full-time MSD staff.

- Fostering of subcontractors
  Subcontractors equipped with reliable expertise in particular areas shall be nurtured.

- Support of maintenance personnel from other power plants
  Maintenance personnel from other power plants are alternately dispatched to support periodic overhauls. Any shortage after that is filled by temporary employees.

b) Improvement of MSD Technical Skill

- Preparation of disassembly inspection procedures
  During a periodic overhaul, the MSD is in charge of major equipment such as turbine main units and generators. The disassembly inspection procedures are of a summarized version, or there are no procedures, in which case the staff's experience is depended on.

  For all major equipment, in addition to the disassembly procedures provided by the equipment manufacturers, detailed procedures including quality management and safety management should be prepared.

- Maintenance and improvement of technical skill
  OJT (on-the-job training) shall be the main job training. However, nurturing of skilled workers should be targeted by, for example, conducting specified collective training set for respective special fields during non-peak periods.

- Preparations of equipment, tools and vehicles
  Equipment, tools and vehicles needed by MSD shall be completely prepared and their thorough management shall be targeted.

c) Privatization of MSD

In general, the privatization of public corporation include the following merits.

- Thorough pursuit for profits, wastefulness caused by mannerism will be eliminated.
- Labor saving is promoted as a firm's effort in order to win the competition with other firms.
- Development consciousness will be more pronounce in the private than public corporation..
- Education and training of successors is promoted for continuation of the firm.

While these may be required for public corporations, the necessity may be greater for non-governmental corporations.
MSD does not have enough manpower to execute periodic overhauls for the power plants. Privatization is also an effective measure to increase manpower and improve technical skill.

It is necessary to accumulate technical capabilities by improving the personnel system, compensation, etc., enhancing work volition and loyalty to the firm.

As a private firm, MSD may be able to get some job at construction of new power plants by BOT and BOO, and the improvement work for existing power plants shifted to ROM.

The business activities of a new private firm can be extended from Luzon Island to the whole Philippines in the future for construction and maintenance of thermal and geothermal power plants.

Diversified operation will be possible contracting of construction and maintenance of other plants than power plants in the future by utilizing accumulated technical capabilities. It has merits as follows;

- to level the workload throughout a year (to keep the workload when no job at power plants)
- to develop and accumulate wider technical capability.

If the technical capability become internationally competitive, overseas work might be subcontracted.

On the other hand, viewed from the power plant side, once corporation MSD become a private contractor, the instruction and direction system will be simplified and the responsibility will be clarified.

d. Privatization of MEC

As described in "b. Privatization of MSD" above, merits of privatization will be attained successfully by the effort of firm through pursuit of profit and competition with other similar firms.

In the case of a manufacturing shop, the management will be stable when diversification of business is attempted so that idle of equipment and manpower are eliminated and ideal operation factor of facilities is attained. Because of these reasons, privatization of MEC has some merits.

There is no leading manufacturer of boiler nor turbine in the Philippines, however, the existence of substitute for such manufacturers is valuable.

For upgrading of technical level, enlargement of scale of the firm is expected. By doing so, not only the production capacity but also capability of acquisition of technical know-how and technology development can be strengthened.

By privatization, business activities in Luzon Island will be extended to nationwide, and future of the firm will be promising.

It is requested to enhance the technical capabilities by introducing technologies in cooperation with overseas leading manufacturers.

It is also requested, in the future, to level the operation factor of equipment and manpower by diversification of business activities through manufacturing and repair of products other than those related to power plants, utilizing accumulated technologies.

3) System of Responsibility and Authorities

Increase of Authority of Plant Manager for Procurement

Increase of authorized purchase amount of the plant manager should be studied to enable him to implement routine daily maintenance works or alike at his own responsibility.

Purchasing related to the above, including work order placement and in the case of emergency, should be quickened.

5.2.5 Equipment and Material Procurement and Management

1) Equipment and Material Procurement

a. Major Problems

The following are problems which have been indicated concerning purchase of equipment, parts and materials:

a) Long time purchasing procedures

b) Some parts for major equipment procured from a manufacturer other than the original manufacturer caused major problems later.

c) Because prices are often a major determining factor in evaluation of the bid proposals, some purchased items are not of the required specifications or are inferior.

d) Unsatisfactory items sometimes have been delivered due to incomplete or inappropriate specifications attached to the P.R. (Purchase Requisite).

b. Countermeasures

The NPC has made considerable efforts to rectify the above problems, yet some remain unsolved. Including efforts already initiated by the NPC, measures for future improvement are provided below:

a) Expansion of MMRC's authorized purchase amount

Formerly, for all purchases of 2 million peso or more, the Regional Center had to submit the application to the Material Management Dept. in the Head Office for their scrutiny and approval. Now that this has been amended so that the Regional Center will submit the application for approval directly to the Office of the President any amount in excess of authority of the vice-president of MMRC, and now that the Regional Center's authorized amount of purchase has been expanded to 5 million peso for sealed bidding and 10 million peso for public bidding, the required processing time for purchases is expected to be greatly reduced.

b) Speed-up of purchasing procedure

In view of the nature of public corporations, though, a reasonable amount of time may be required in the NPC for the internal approval procedure. Hence, it will be necessary to establish a system which, under given conditions, minimizes the processing time for purchase of parts and materials, and ensures punctual delivery. As the specific measures, we recommend the following:

- The parts and material purchasing plan included in the periodic overhaul plan currently being prepared by the Planning & Scheduling Section of the Power Plant should be made as accurate as possible, and the P. R. should be issued early enough to allow sufficient lead time for delivery. In order to facilitate this, the annual periodic overhaul must be completely and precisely executed, and the major work items to be executed in the overhauls during the next and 3 or so years should be clarified along with the necessary parts and materials.

- The Planning & Scheduling Section of the Power Plant must draw up the above-mentioned periodic overhaul plans and purchase plans in cooperation with the Maintenance Group of the power plant and MSD (Maintenance Services Dept.). In addition, the department must follow up on the progress of the purchase, and after an order has been placed, control the delivery through close communication and coordination with the Material Management Division of the MMRC.

c) Procurement from the original manufacturer

In order to avoid the problem of ordering parts for major equipment from manufacturers other than the original manufacturer, regulations designed to this effect are stipulated in Circular No. 88-34. It will be necessary to prevent any such problems through effective application of these regulations.

d) Improving P.R. and technical specification

The following countermeasures are recommended to prevent the problems of purchasing parts and materials not conforming to the specifications:

- In conjunction with the preparation of the Purchase Requisites and the attached technical specifications to be made in accordance with the purchase plans of parts necessary for overhauls, the Power Plant organization should be reviewed so that these important documents will be prepared by engineers who are thoroughly versed in the actual overhaul work at site as well as in the engineering design work, or thoroughly examined by similarly qualified engineers.

- In order to ensure the availability of such qualified engineers, OJT should be conducted, and job rotation with the Engineering Dept. of the NPC Head Office and MMRC should be implemented.

2) Equipment and Material Management

a. Major Problems

The following are the major problems we found with material management:

- All parts for overhaul recommended by major equipment manufacturer have been purchased and stored.
- Inventory seems excessive.
- Some large parts have been left outdoors and exposed to the elements.

b. Countermeasures

Below are the recommended countermeasures to the above problems:

- In order to avoid purchase of unnecessary parts and materials, review the items and quantities in the parts list recommended by the manufacturer. If any items are deemed to be unnecessary or excessive, or can be replaced with a ready-made or existing item, they can be deleted or decreased.
- In conjunction with the above, comprehensive rationalization of the inventory items and quantities should be studied.
- For purchase of large parts and materials, such as super heater panels and condenser tubes, delivery time should be adjusted to come immediately before the time the parts are needed. Outdoor storage should be avoided if at all possible.

5.2.6 Hiring, Education and Training of Personnel

1) Hiring of Personnel

a. Recruitment Guideline

It is recommended to adopt a new guideline of recruitment which allows periodic employment of once, or twice if difficult, a year in lieu of the current policy for employment on vacancy basis.

The current complements of all power plants under MMRC are to be reviewed. The number of personnel of the individual groups and sections are to be examined considering the following points.

- Difference in the power plant type: Coal-fired, heavy oil-fired, etc.
- Difference in the range and level of automation and remote control at the power plant
- Adjustment of complements to meet work load of power plant and other departments

After the number of personnel is reviewed, recruitment of personnel will be made with sufficiency ratio 100% to the new each complement. Those who were periodically employed will be educated and trained during the apprenticeship period, and they will not be counted as a part of the complement in this period.

b. Long-term Manpower Outlook

On the basis of the long-term manpower outlook, recruitment plan and education and training plans will be developed.

c. Casual Workers

Employment of casuals for periodic overhaul will be discontinued, and instead of that, subcontractors will be used for a part of the periodic overhaul work as permanent measures.

d. Method for Hiring

Currently there are few personnel rotation among power plants, and relevant offices such as Engineering Department of Head Office, MMRC, etc.

As a result, the number of personnel having actual experience of operation and maintenance at power plants is extremely few at the Engineering Department, etc. at the Head Office. On the other hand, there are few personnel who have experience in the engineering and design work for thermal power plants in MMRC and existing power plants accordingly. In other words, NPC organizations have weak points respectively.

As solution to this, we would make recommendation on the mutual rotation of personnel among relevant departments and on the revision of the recruitment system.

It is also recommendable that employment of college graduates for the thermal power groups jointly be made at Head Office for both MMRC and Head Office, subject to the following conditions;

- Consent of relevant vice presidents of MMRC and Head Office is needed for selection of new employee.
- All new employee of thermal power group will be divided and assigned for training to the power plants for a certain period of time.

2) Education and Training

a. Freshman Training (collective training)

Freshman training will be conducted in conjunction with the new recruitment system previously recommended.

A committee will be established for development of this guideline.

- Since NPC extends nation-wide, individual implementation, on Regional Center basis, of this new training system for newly hired personnel is recommendable for the case of actual conduct.

- The Head Office seems better to be combined with MMRC due to the geographical relation.

A plan for implementation of freshman collective training by each unit stated above will be developed. Whole company wide coordination and authorization are required.

Privatization of NPC is a current issue subject to the detailed deliberation.

b. Freshman Training at Power Plant

"Freshman collective training" will also be conducted once a year at each power plant at the time of recruitment. Decision on this policy solely depends on the Vice President of MMRC.

If the collective training on the Regional Center basis stated hereinbefore will be conducted, the training at the power plant can be the one for the purpose of orientation only.

In this case for example, the training will only include admonitory lectures by plant manager, briefing by principal engineers of each section on the operation system of the power plant, working regulations, outline of the power plant facility, functions and services of each section, flow of clerical services, etc. and observation tour of the power plant.

c. Position Training of Operators

Position training has to be regularly conducted according to the operators training program irrespective of the shifting of the personnel. It is therefore, to be built in the regular training system of NPC and is not to be designed as mere provisional training of the operator for filling the vacancy due to retirement or shifting.

The training implementation program will be developed for the purpose of training particularly young operators. A sample draft outline for such a program is given below.

a) Purpose

- Fast bring-up of freshmen to the capable level
- Learning multiple position

b) Trainee

Operators of second year to fourth year after entry to the company. All operators will be the trainee as a rule.

c) Positions to be Learned

- The target is to learn three positions, i.e., boiler, turbine and electrical control positions.
- Positions on both Units No. 1 and No. 2 should be learned.
- The already acquired positions are excluded.

d) Period

Two years or less as the target.

e) Implementation Plan

The superintendent will develop, in deliberation with the principal engineers, a training implementation program for the trainees selected among their subordinates (shift operators.) It is necessary to determine the basic concept of the implementation of the training program as the common policy prior to the start of the implementation to avoid inconsistency among the trainee groups.

f) Evaluation

Evaluation of training results will be made in coordination with the training program being developed by the Human Resources Department of NPC Head Office.

d. Installation of Simulator for Operation Training

A simulator will be installed at Batangas TPP as a part of the construction project of Unit No. 2. The simulator at Batangas TPP is recommended to be equipped with a training center and lodging facilities for collective training, if there is not any plan to equip a simulator with the existing NPC training center.

e. Job Rotation

Job rotation of operators will be implemented regardless of shifting for fill-up of vacancy. It will help morale enhancement of the young people. Job rotation will become feasible when the position training mentioned earlier is regularly conducted.

CHAPTER 6

SURVEY ON ENVIRONMENTAL ASPECTS

CHAPTER 6. SURVEY ON ENVIRONMENTAL ASPECTS

6.1 Environmental Policy of the Philippines

6.1.1 Administrative Organization of Environmental Protection

The Department of Environment and Natural Resources (DENR), the Laguna Lake Development Authority (LLDA) and the National Power Corporation (NPC) have the major roles in the environmental protection mandate as far as the operation of the Malaya Thermal Power Plant (Malaya TPP) is concerned. The following discussion gives a brief description of the various functions of these environmental offices.

1) The Department of Environment and Natural Resources (DENR)

The DENR is the lead governmental authority which administers and implements the various laws and regulations related to environment and the management of natural resources. A number of agencies and bureaus are attached to the DENR. Figure 6-1 shows the DENR organizational chart.

The Regional Office (one for each of the twelve administrative regions in the Philippines plus the National Capital Region of Metro Manila and the Cordillera Area Region, the mountainous indigenous tribal area of north central Luzon), the Environmental Management Bureau (EMB) and the Pollution Adjudication Board are the DENR offices which have key roles in the environmental function of the DENR.

a. The Environmental Management Bureau (EMB)

The main functions of the EMB which has its offices in Metro Manila is to give advice to the DENR Secretary on matters relating to environmental management, conservation and pollution control. EMB is also the reviewing agency of the DENR for submitted Environmental Impact Assessment/Statement studies from project proponents of Environmentally Critical Projects or for projects proposed to be located in Environmentally Critical Areas as defined by the DENR. (Note: Electrical power development projects of more than 10 MW are considered by the DENR as environmentally critical.) Establishment, formulation and/or revision of environmental quality standards and criteria are also major functions of the EMB. Figure 6-2 shows the organizational chart of EMB.

b. DENR Regional Office

Each Regional Office is headed by a Regional Executive Director (RED) assisted by five (5) Regional Technical Directors (RTD) for each of the five sectors: Environment and Protected Areas, Mines and Geosciences, Land Research. The DENR Regional Office organization is shown in Figure 6-3. The Malaya TPP which is located in the Municipality of Pililia, Province of Rizal is within the jurisdiction of the DENR-Region IV which holds an office in Manila.

The Environment and Protected Areas Sector (EMPAS) is mandated to enforce the air quality and water quality standards required by the DENR. The Environmental Quality Division under EMPAS is directly involved in environmental compliance and pollution control monitoring. Figure 6-4 shows the organizational chart of EMPAS.

c. The Pollution Adjudication Board (PAB)

In 1987, the PAB was created under the Office of the DENR Secretary. The PAB is composed of the DENR Secretary as Chairman, two DENR Undersecretaries as may be designated by the DENR Secretary, the EMB Director, and three others to be designated by the DENR Secretary as members.

PAB's main function is to adjudicate the pollution cases as provided for by law. The EMB serves as the Secretariat of the PAB. The powers and functions of the PAB may be delegated to the DENR Regional Office in accordance with the rules and regulations that may be promulgated by the PAB.

2) The Laguna Lake and Development Authority (LLDA)

To achieve an optimum use of Laguna Lake (considered the largest lake in Southeast Asia having a surface area of 900 km^2) and related land resources, the LLDA was created in 1968. Over the years LLDA's mandate was broadened. LLDA's functions also include powers pertaining the management of air quality, noise, etc. since 1982 with E. O. 927. Recently, however, LLDA's focus is on lake water quality management with the other concerns monitored by the DENR-Region IV Office.

The water quality monitoring and surveillance function of the LLDA necessitated the creation in 1979 of an Environmental Protection Division (EPD) in the Authority. The functional chart of the EPD is presented in Figure 6-5. The LLDA is a quasi-judicial authority and is mandated by law to perform its function as a basin-wide authority. However, LLDA does not have control over all projects and activities affecting the lake and its region due to overlapping areas of jurisdiction with other government agencies.

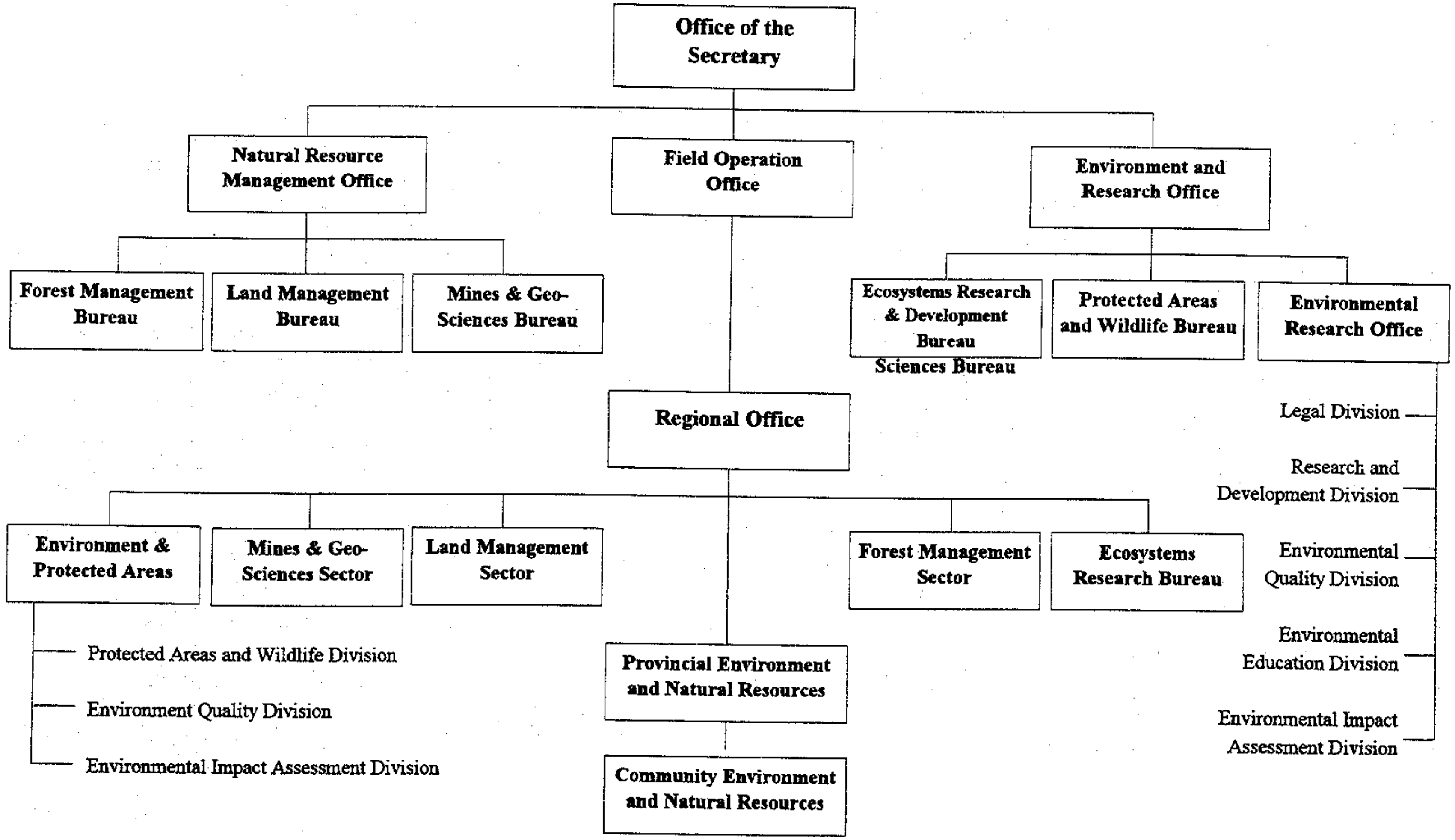
3) The National Power Corporation (NPC)

As operator of most of the electrical power plants in the country, NPC's policy is to ensure that its power plants operate in an environmentally sound manner. The Environmental Management Department (EMD) of NPC provides information and advice to NPC's top management on environment-related matters affecting their power plants and projects. The department also provides environmental technical support to the Operations group down to the plant level.

The EMD Manager at present reports to the Manager of the Development and Technical Services Group who reports to the Engineering Vice President.

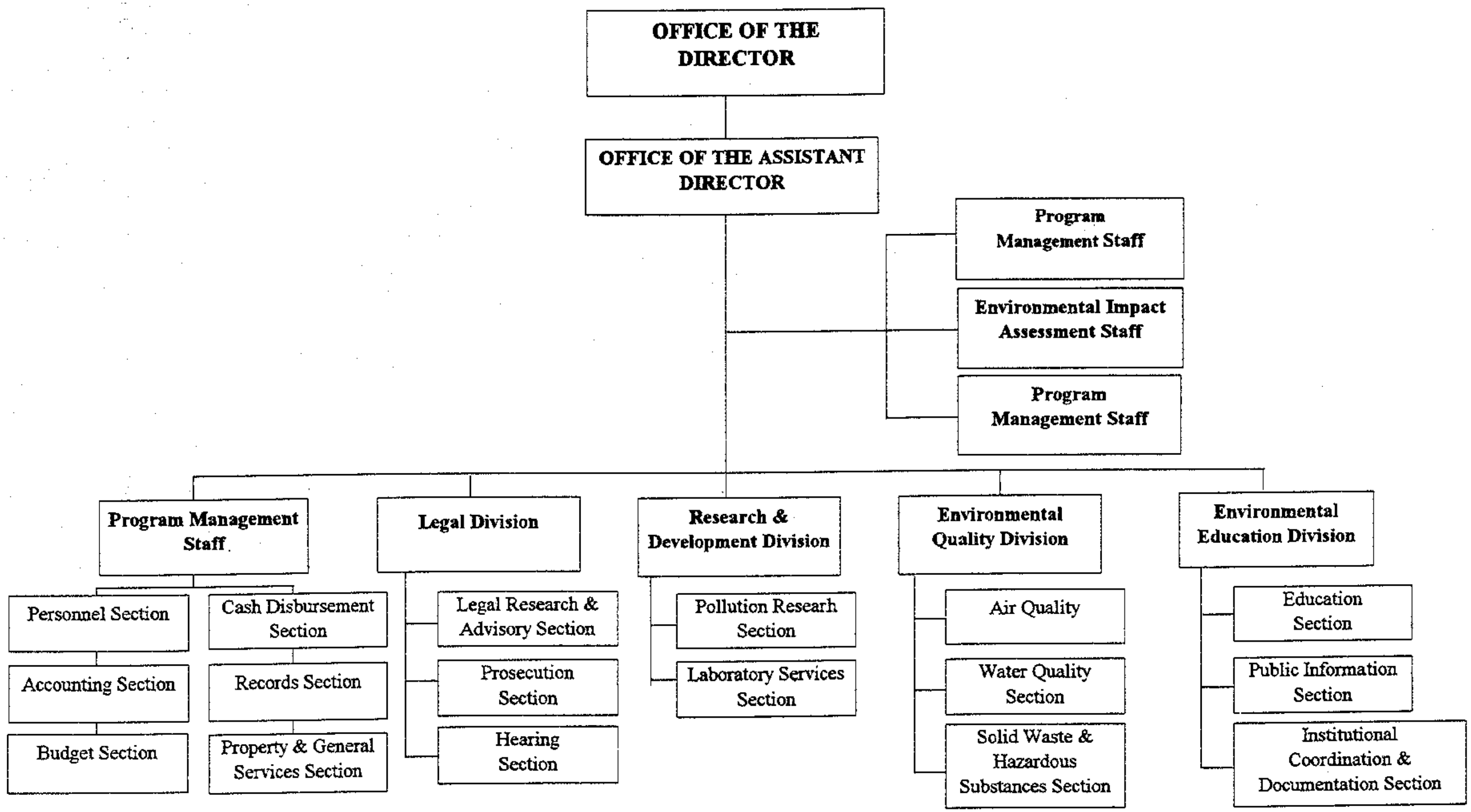
Figure 6-6 shows the organizational chart of the EMD which at present is staffed with seventy-nine (79) people. The Environmental Impact Assessment Division (EIAD) is responsible for the preparation of EIA reports and studies and applications for Authority to Construct and Permit to Operate pollution control systems with the DENR. The Environmental Monitoring Services Division (EMSD) is responsible for the monitoring of project implementation of Environmental Compliance Certificate requirements/ conditions for DENR-approved major power development projects. Monitoring and sampling at operating power plants which used to be a key function of EMSD has been devolved to the plant facility level beginning last year. At the plant level, DENR has also directed the designation of Pollution Control Officers (PCO) to handle the various environmental/pollution control functions. At the Malaya TPP, the Chemical Superintendent acts concurrently as the Pollution Control Officer.

Figure 6-1 Organization of DENR



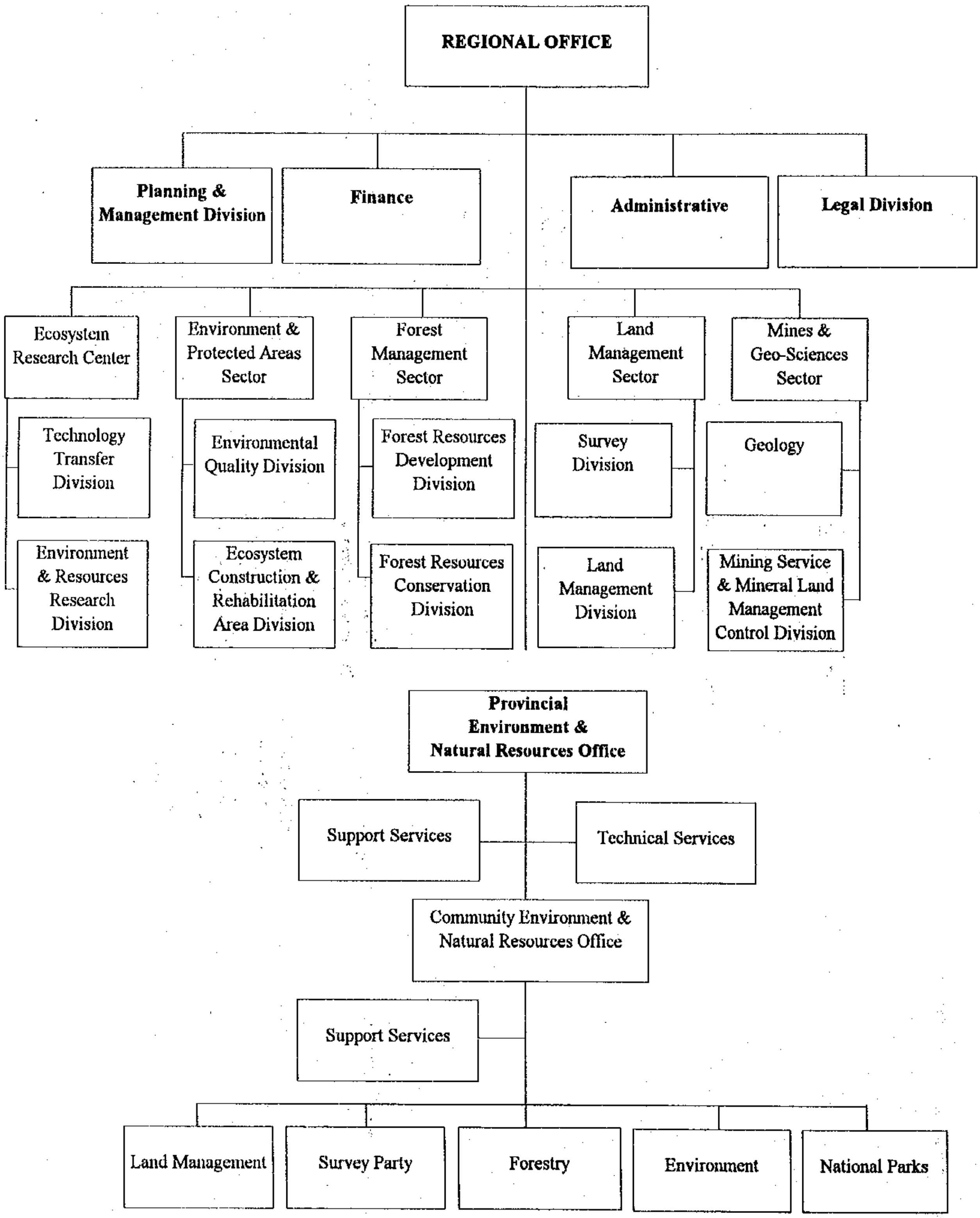
Source: DENR, 1994

Figure 6-2 Organization of EMB



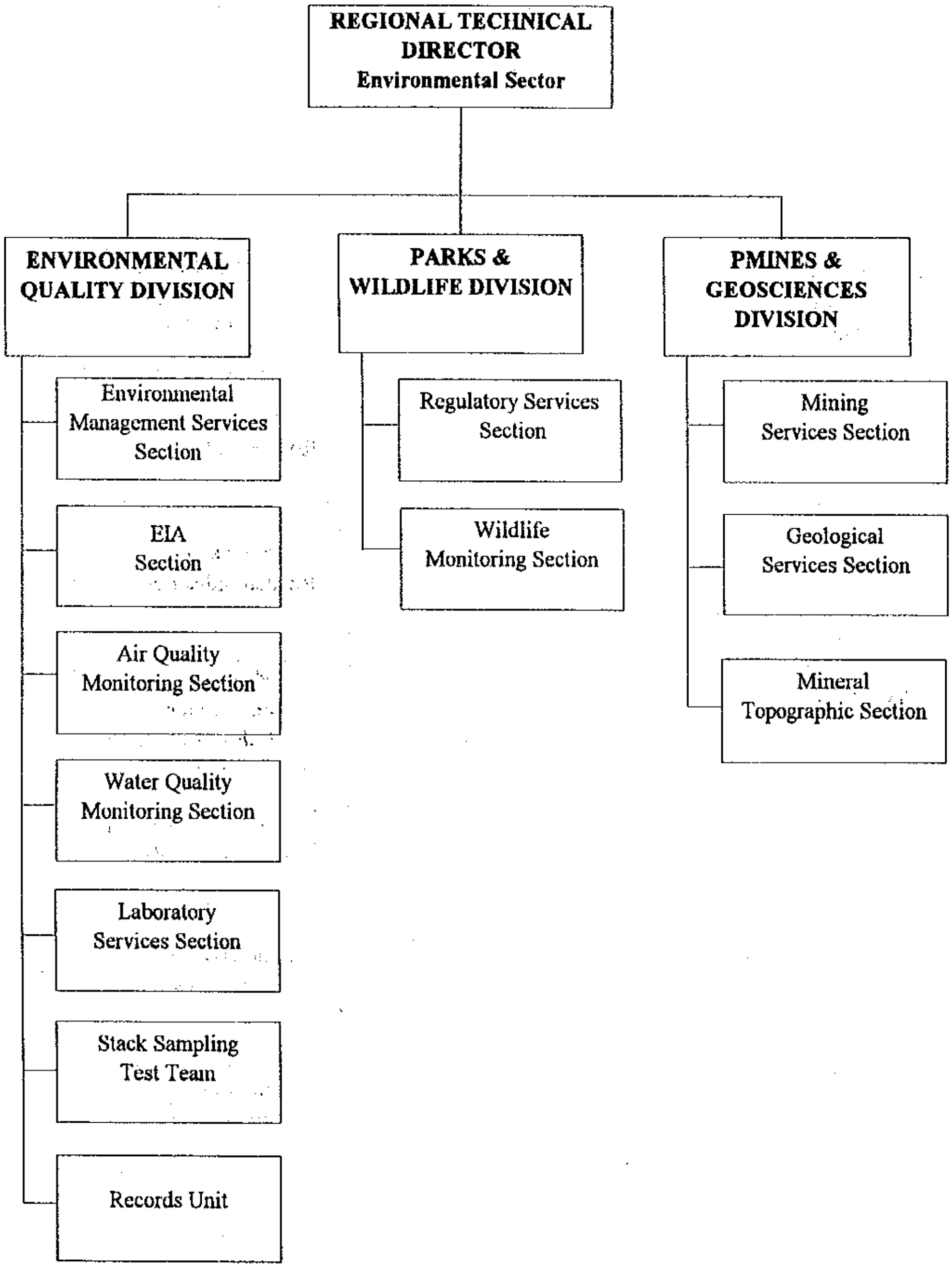
Source: DENR-EMB, 1994

Figure 6-3 Organization of DENR Field Office



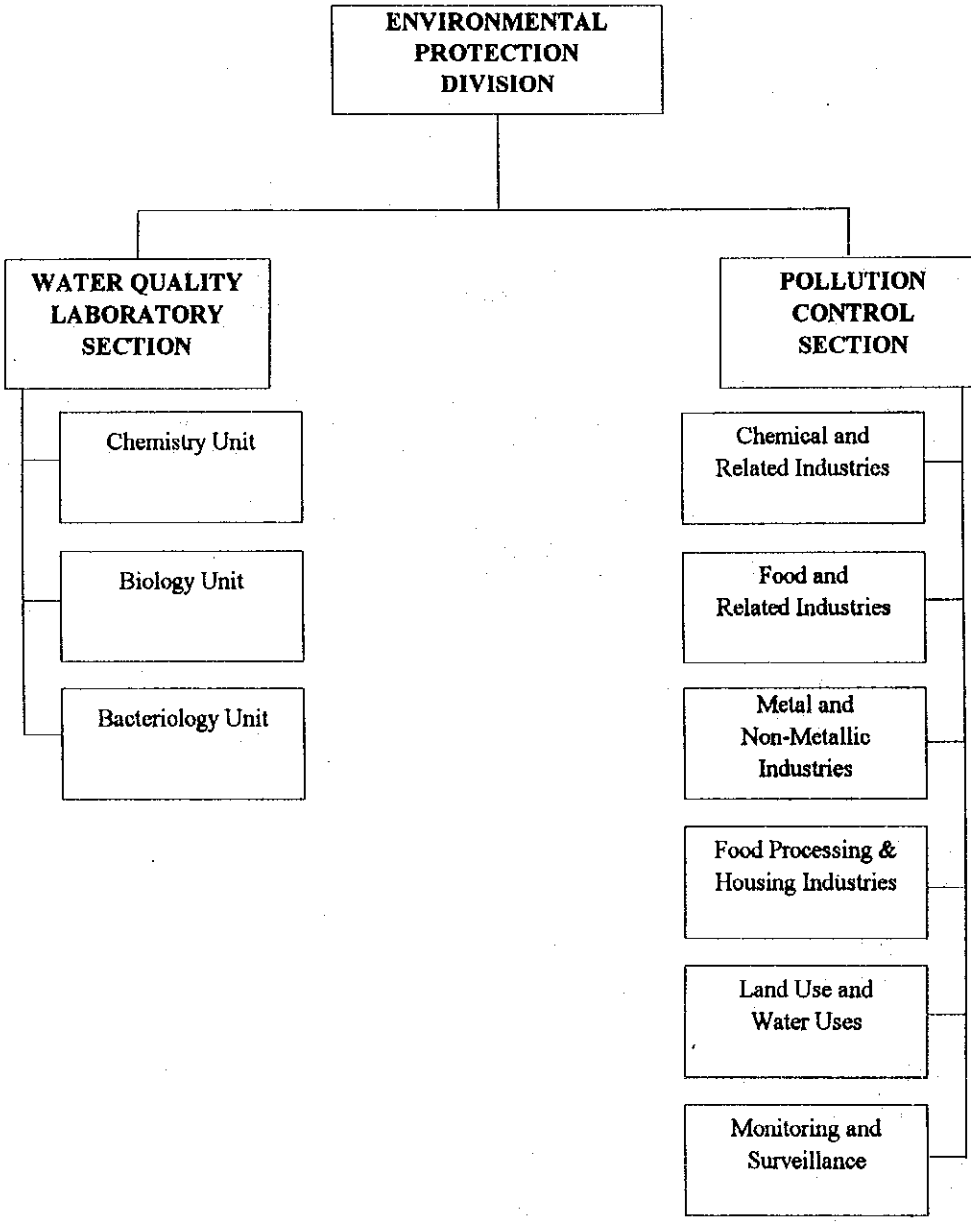
Source: DENR, 1993

Figure 6-4 Organization of EMPAS



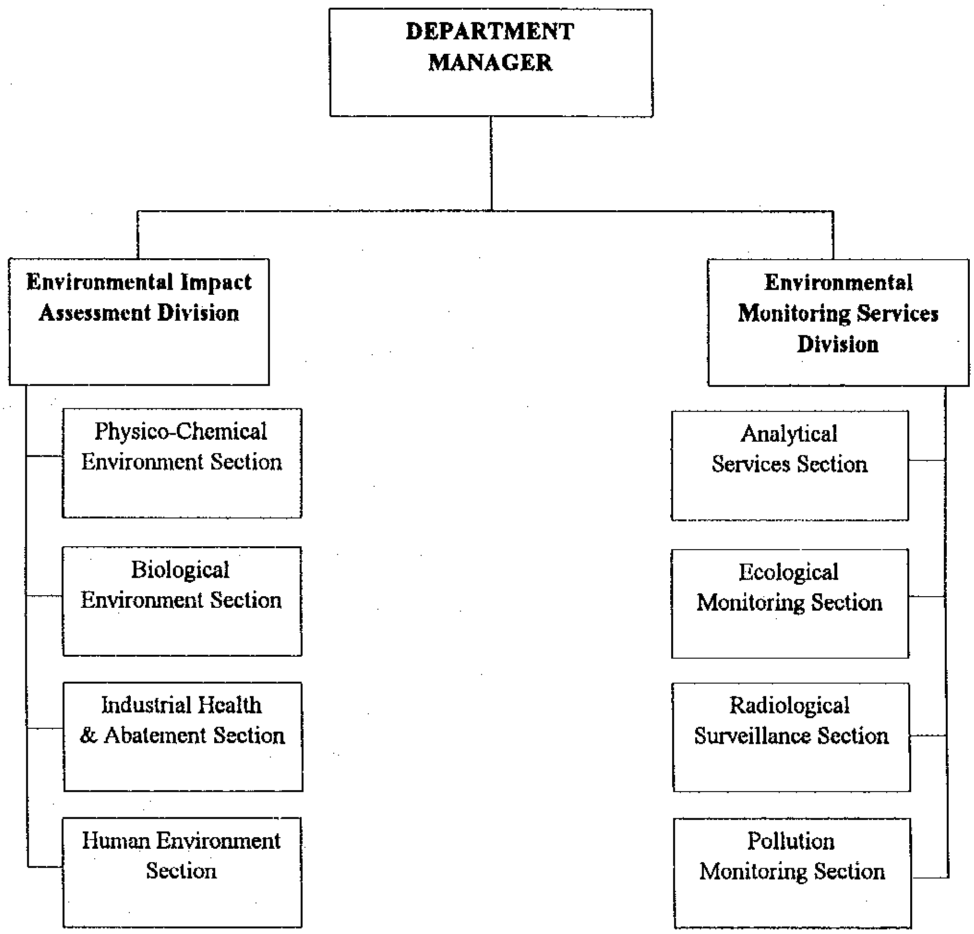
Source: DENR-NCR-EMPAS, 1994

Figure 6-5 Organization of EPD, LLDA



Source: LLDA, 1994

Figure 6-6 Organization of EMD, NPC



Source: National Power Corporation, 1994

6.1.2 Philippine Environmental Regulations and Standards

For the continued operation of the Malaya TPP located in the Municipality of Pililia, Province of Rizal, the following Philippine environmental regulations and standards are relevant:

1) Flue Gas Emission Control

a. DENR Administrative Order No. 14

DENR Administrative Order No. 14 or DAO 14 which took effect on April 24, 1993 promulgated both maximum emission limits/standards and ambient air quality standards for source specific air pollutants from stationary and industrial sources/operations. For the Malaya TPP, the air pollutant parameters of concern are sulfur dioxide(SO_2), nitrogen oxides as NO_2, carbon monoxide(CO) particulate matter and smoke.

Generally, the new emission standards are relatively more stringent compared to those promulgated in 1978 by the former Philippine National Pollution Control Commission.

Table 6-1 presents the emission limits/standards for the above mentioned parameters and the corresponding compliance schedule stipulated in DAO 14 relevant to oil-fired steam generating power plants like the Malaya TPP. The initial (July 1, 1993-January 1, 1996) sulfur-in-fuel specifications for oil-fired power plants for areas within and outside of Metro Manila are also indicated in Table 6-1. The use of low sulfur fuel oil is an alternative approach promulgated by the DENR for the control of SO_2 emissions. Pertinent to this DENR strategy, Section 60 (a) (2) of DAO 14 also stipulates the following significant provision:

"Two years after the affectivity of these revised regulations, the Secretary shall, after consultation with the Department of Energy or its equivalent, the national oil companies and the concerned government agencies and private entities, promulgate new and lower sulfur content specifications of fossil fuels as an alternative approach to control SO_2 emissions in existing stationary sources; provided that if no such requirement is promulgated after January 1, 1996, the Secretary shall require existing major sources to install appropriate SO_2 control equipment to meet the emission standards in accordance with Section 60 (b) (1) within five years: and provided finally that existing smaller fuel burning equipment shall comply with the requirements under Section 60 (c) or Section 61 of these regulations."

The new maximum permissible opacity standard for smoke stack emissions for stationary sources require compliance with Shade 1 of the Ringelmann Chart at all times. A variance to this requirement is provided for during normal operation wherein smoke density of less than Shade 3 is allowed during 1-hour (5 min. limit) and 24-hour (15-min. limit) observation periods.

For existing thermal power plants like the Malaya TPP, the DAO 14 emission standard requirements, however, have no practical significance to the power plant operator with the latest Memorandum Circular No. 29 issued by the DENR.

b. DENR Memorandum Circular No. 29

The DENR Memorandum Circular No. 29 dated May 31, 1994, which was communicated to the NPC in early August 1994 practically exempts existing thermal (and geothermal) power plants located in non-urban areas from complying with the DAO 14-prescribed emission standards. Instead, compliance to the National Ambient Air Quality Standards (NAAQS) will now only be required by the DENR subject to certain conditions.
The new NAAQS for source specific air pollutants from industrial sources/operations are given in Table 6-2.

Attachment-1 is a copy of Memorandum Circular No. 29 which provides the conditionalities required of existing thermal or oil-fired power plants such as the Malaya TPP.

With this DENR order, it is now incumbent upon the power plant operator, i.e. the NPC, to now conduct air quality modeling/plume dispersion studies for their existing thermal power generating units, particularly those located in non-urban areas. (Note: The Malaya TPP is located in a non-urban area as defined by the DENR.) The pre-scribed period of 30 days within the date of affectivity of this Memorandum Circular suggests immediate action on the part of NPC. The planned ROM scheme for the continued operation of the Malaya TPP shall therefore address this DENR requirement. Other requirements (monitoring program, equipment, etc.) pertinent to the conditions indicated in the DENR order, likewise, will have to be undertaken by the power plant operator in close coordination with the DENR. Compliance to the required ambient standards will have to be based from the results of air quality modeling validation studies for the Malaya TPP emissions including those coming from the nearby Philippine Petroleum Company (PPC).

Table 6-1 Emission Standard Requirements and Sulfur-in Fuel Specifications for Oil-Fired Steam Generating Power Plants: Timetable of Compliance

PARAMETER/YEAR	1978			1993	1994	1995	1996	1997	1998	1999	2000	2001
		1978 Regulations		DAO 14 April 24			New Fuel Specs ? Jan. 1					
PARTICULATE MATTER (mg/Ncm)												
Existing Sources												
Installed Before 1978 Urban/Industrial Areas	500	500	500	500	500	500	500	500	300	300	300	300
Other Areas	500	500	500	500	500	500	500	500	300	300	300	300
Installed After 1978 Urban/Industrial Areas	300	300	300	300	300	300	300	300	300	300	300	300
Other Areas	300	300	300	300	300	300	300	300	300	300	300	300
New Sources												
Urban/Industrial Areas	300	300	300	150	150	150	150	150	150	150	150	150
Other Areas	300	300	300	200	200	200	200	200	200	200	200	200
NITROGEN DIOXIDE (mg/Ncm)												
Existing Sources	2000	2000	2000	1500	1500	1500	1500	1500	1500	1500	1500	1500
New Sources	2000	2000	2000	500	500	500	500	500	500	500	500	500
CARBON MONOXIDE (mg/Ncm)												
Existing Sources	500	500	500	500	500	500	500	500	500	500	500	500
New Sources	500	500	500	500	500	500	500	500	500	500	500	500
SULFUR DIOXIDE (mg/Ncm)												
Existing Sources	250	250	250	1500	1500	1500	1500	1500	1500	1500	1500	1500
New Sources	250	250	250		1000	1000	1000	1000	700	700	700	700
							New Fuel Specs?					
SULFUR-IN-FUEL OIL SPECIFICATION (%)				Jul.1			Jan.1					
Metro Manila				3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	3.0
Outside Metro Manila				3.5	3.8	3.8	3.0	3.0	3.0	3.0	3.0	3.0

Table 6-2 National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations

*Pollutants (a)	Concentration ug/Ncm	(c) ppm	Averaging time (min.)	Method of Analysis/ Measurement (b)
1. Ammonia	200	0.28	30	Nesslerization/ Indo Phenol
2. Carbon Disulfide	30	0.01	30	Tischer Method
3. Chlorine & Chlorine compounds expressed as Cl_2	100	0.30	5	Methyl Orange
4. Formaldehyde	50	0.04	30	Chromotropic acid method or MBTH-Colorimetric method
5. Hydrogen Chloride	200	0.13	30	Volhard Titration with Iodine solution
6. Hydrogen Sulfide	100	0.07	30	Methylene Blue
7. Lead	20		30	AAS[b]
8. Nitrogen Dioxide	375 260	0.20 0.14	30 60	Griess-Saltzman
9. Phenol	100	0.03	30	4-Aminoantipyrine
10. Sulfur Dioxide	470 340	0.18 0.13	30 60	Colorimetric-Pararosaline
11.Suspended Particulate Matter - TSP PM - 10	300 200	- -	60 60	Gravimetric Gravimetric

Notes: (a) Pertinent ambient standards for Antimony, Arsenic, Cadmium, Asbestos, Nitric Acid and Sulfuric Acid Mists in the 1978 NPCC Rules and Regulations may be considered as guides in determining compliance.

(b) Other equivalent methods approved by the Department may be used.

(c) Ninety-eight percentile (98%) values of 30-min. sampling measured at 25°C and one atmosphere pressure.

c. National Ambient Air Quality Guidelines (NAAQG) and Standards

For the purpose of protecting the public health and welfare and reducing damage to property as well as providing an air quality management control strategy for emission limitation from mobile and stationary sources, location of commercial, industrial and residential facilities, and to assist in the promotion and use of an improved transportation system, the hereunder National Ambient Air Quality Guidelines in Table 6-3 are hereby established.

Table 6-3 National Ambient Air Quality Guideline for Criteria Pollutants

Pollutant	Short Term (a)			Long Term (b)		
	μg/Ncm	ppm	Averaging time	μg/Ncm	ppm	Averaging time
Suspended Particulate Matter (e) - TSP	230 (f)		24 hours	90	-	1 yr. (c)
PM-10	150 (g)		24 hours	60	-	1 yr. (c)
Sulfur Dioxide (e)	180	0.07	24 hours	80	0.03	1 yr.
Nitrogen Dioxide	150	0.08	24 hours	-	-	-
Photochemical Oxidants as Ozone	140	0.07	1 hour	-	-	-
	60	0.03	8 hours	-	-	-
Carbon Monoxide	35 mg/Ncm	30	1 hour	-	-	-
	10 mg/Ncm	9	8 hours	-	-	-
Lead (d)	1.5	-	3 months (d)	1.0	-	1 yr.

Notes: (a) Maximum limits represented by ninety eight percentile (98%) values not to be exceeded more than once a year.

(b) Arithmetic mean

(c) Annual Geometric Mean

(d) Evaluation of this guideline is carried out for 24-hour averaging time and averaged over three moving calendar months. The monitored average value for any three months shall not exceed the guideline value.

(e) SO_2 and Suspended Particulates are sampled once every six days when using the manual methods. A minimum number of twelve sampling days per quarter or forty eight sampling days each year is required for these methods. Daily sampling may be done in the future once continuous analyzers are procured and become available.

(f) Limits for Total Suspended Particulates with mass median diameter less than 25 - 50 μm.

(g) Provisional limits for Suspended Particulates with mass median diameter less than 10 microns and below until sufficient monitoring data are gathered to base a proper guideline.

2) Effluent Control

In March 1990, DENR Administrative Order No. 34 (DAO 34)and DENR Administrative Order No. 35 (DAO 35) were promulgated by the DENR for the revised water usage and classification, water quality criteria and effluent regulations.

For the Malaya TPP, the water quality and effluent parameters of major concern are the physical parameters: pH, temperature, oil and grease, BOD, DO, COD, salinity and conductivity. Heavy metals such as chromium, copper, mercury, arsenic, other trace elements and other potentially toxic substances associated with fuel oil used at the plant and waste water treatment also impact on the main receiving water body, the Laguna Lake, particularly at points within the immediate vicinity of the Malaya TPP.

The Laguna Lake is a multi-purpose resource. Its uses are for aquaculture (fishpens), irrigation, cooling water for industries and for transport of fuel, raw materials and finished products. The lake also serves as a sink for various types of wastes generated by industrial, community and agricultural activities within the watershed.

The present water quality of Laguna Lake generally meets Class C standards (A.C.S. Borja, 1991). Thus, the effluent from the Malaya TPP will have to comply with the Classification C effluent standards prescribed in DAO 35. As provided for in DAO 34 (March 1990) Class C beneficial uses are for Fishery Water (for the propagation and growth of fish and other aquatic resources), Recreational Water Class II (boating, etc.) and for Industrial Water Supply Class I (for manufacturing processes after treatment).

Tables 6-4, and 6-5 indicate the effluent standards for select toxic/other deleterious substances and for conventional and other pollutants in Inland Waters Class C, respectively. Standards indicated in the tables are specified for both Old or Existing Industry (OEI) and for New/Proposed Industry or waste water treatment plants to be constructed (NPI).

Table 6-4 Effluent Standards: Toxic and Other Deleterious Substance
(Maximum Limits for the Protection of Public Health)

Parameter	Unit	Inland Waters, Class C	
		OEI	NPI
Arsenic	mg/L	0.5	0.2
Cadmium	mg/L	0.1	0.05
Chromium (hexavalent)	mg/L	0.2	0.1
Cyanide	mg/L	0.3	0.2
Lead	mg/L	0.5	0.3
Mercury (total)	mg/L	0.005	0.005
PCB	mg/L	0.003	0.003
Formaldehyde	mg/L	2.0	1.0

Notes: (a) Except as otherwise indicated, all limiting values in this Table and as provided for in Section 4 of DAO 35 are maximum and therefore shall not be exceeded.

(b) OEI means old or Existing Industry

(c) NPI means New/Proposed Industry or waste water treatment Plants to be constructed.

Table 6-5 Effluent Standards: Conventional and Other Pollutants in Inland Waters Class C

Parameter	Unit	Inland Waters, Class C	
		OEI	NPI
Color	PCU	200	150
Temperature oC rise (max. rise in degree Celsius in RBW)		3	3
pH (range)		6.0-9.0	6.5-9.0
COD	mg/L	150	100
Settleable Solids (1-hour)	mg/L	0.5	0.5
5-Day 20°C BOD		80	50
Total Suspended Solids	mg/L	90	70
Oil/Grease (Petroleum Ether Extract)	mg/L	10.0	5.0
Phenolic Substances	mg/L	0.5	0.1
Total Coliforms	MPN/100 ml	15,000	10,000

Notes: (a) For color, discharge shall not cause abnormal discoloration in the receiving waters outside of the mixing zone.

(b) The COD limit generally applies to domestic waste water treatment plant effluent. For industrial discharges, the effluent standards for COD should be an a case to case basis considering the COD-BOD ratio after treatment. In the interim period that this ratio is not yet established by each discharges, the BOD requirement shall be enforced.

3) Noise Control

Section 78 of the 1978 Rules and Regulations of the National Pollution Control Commission prescribes ambient noise quality standards for classified general areas.

Table 6-6 indicate the maximum allowable noise levels in identified general areas. For the occupationally-exposed personnel at the Malaya TPP, excessive noise levels emanating from the turbine facilities/area could pose health hazards. Pumps, motors, air heaters and steam generating facilities are also expected to generate potentially excessive noise levels to workers continuously and directly exposed to such levels. Philippine occupational safety and health regulations provide that noise protective equipment be worn by the occupationally exposed workers.

Table 6-6 Environmental Quality Standards for Noise in General Areas

Category of Area	Daytime	Morning & Evening	Night Time
AA	50 dB	45 dB	40 dB
A	55 dB	50 dB	45 dB
B	65 dB	60 dB	55 dB
C	70 dB	65 dB	60 dB
D	75 dB	70 dB	65 dB

Notes: (a) Classification of General Areas

Class AA - Section or contiguous area which requires quietness, such as within 100 meters from school sites, nursery schools, hospitals, and special homes for the aged.

Class A - A section or contiguous area which is primarily used for residential purpose

Class B - A section or contiguous area which is primarily a commercial area.

Class C - A section primarily reserved as a light industrial area.

Class D - A section which is reserved as a heavy industrial area.

(b) The standards are applied to the arithmetic median of at least seven readings at the point of maximum noise level

(c) 24-Hour Period Division

Morning - 5:00 A.M. to 9:00 A.M.

Daytime - 8:00 A.M. to 10:00 P.M.

Evening - 6:00 A.M. to 10:00 P.M.

Nighttime - 10:00 P.M. to 5:00 P.M.

(d) For point or fixed sources of pollution, the noise level shall be measured at the boundary line of the factory site or establishment, or at least 30 meters from the boundary of a construction site.

4) Waste Disposal

The Malaya TPP generates waste treatment waste waters, oily wastes, fly ash, soot, and other chemical-laden wastes which when discharged into Laguna Lake, the receiving water body, could include potentially dangerous substances such as metals like chromium and copper. In one of its chemical forms, chromium (hexavalent) is very toxic to fish, animals and people.

DENR Administrative Order No. 29 (DAO 29) which provides the implementing rules and regulations of Republic Act 6969, otherwise known as the Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990, stipulates that the waste generator shall have to notify the DENR on the type and quantity of wastes generated with the same information provided to the DENR on a quarterly basis. The required obligations and responsibilities of waste generators are detailed in Section 26 of DAO 29 shown in Attachment-2.

5) Environmental Standards of NPC and LLDA

As a rule, NPC follows /complies with the environmental regulations and standards of the DENR, the Philippines' highest environmental authority. Likewise, the LLDA which has water quality management jurisdiction of Laguna Lake requires compliance with the DENR standards and regulations specifically DAO 34, DAO 35 and DAO 29.

DEPARTMENT OF
ENVIRONMENT AND
NATURAL RESOURCES

MANAGEMENT BUREAU

31 May 1994

AUG 01, 94

MEMORANDUM CIRCULAR NO. 19
Series of 1994

SUBJECT : APPLICABLE AIR QUALITY STANDARDS TO ALL EXISTING GEOTHERMAL AND THERMAL ELECTRIC POWER GENERATING PROJECTS

Pending rationalization of emission standards and to ensure a balance between environment and development concerns, it is hereby ordered that:

All existing geothermal and thermal power generating projects will only be required to comply with National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations as detailed in Table 4, Section 62 of DENR Administrative Order No. 14 (DAO 14), subject to the following conditions:

1. The power plant is located in a non-urban area;

2. The management of the project shall (a) within 30 days commence the conduct of studies on plume dispersion of its emissions, applying appropriate models to pinpoint theoretical maximum ground level concentration sites for ambient air sampling purposes and to determine appropriate buffer zones; and (b) verify such selected sites through actual ambient air sampling activities in coordination with the DENR within a period of one year upon the approval of the plume dispersion studies by the DENR;

3. The management shall provide automatic air sampling instruments for specific air pollutants which shall be determined by the DENR. These instruments shall be installed and operated continuously in at least two (2) verified sampling sites selected by the DENR;

4. The DENR may conduct inspection and quality assurance test on the air sampling activities anytime; and

5. Compliance monitoring shall commence after approval by the DENR of the monitoring program prepared by project management based on the air quality validation studies. Air sampling results shall be sent to the DENR every month. Should the ambient standards be exceeded as verified by DENR, the project's management shall immediately institute measures to reduce emissions such that ambient standards are met.

This Memorandum Circular shall take effect immediately.

ANGEL C. ALCALA
Secretary

RECEIVED
DATE 3 Aug 94
BY

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geothermal.wp6

Visayas Avenue, Diliman, Quezon City

T-168 L-196 T-9408-013

DENR Administrative Order No. 29: **Implementing Rules and Regulations of Republic Act 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990)**

SECTION 26. WASTE GENERATORS

1. All waste generators shall:

    a) Notify the Department of the Type and quantity of wastes generated in accordance with the form and in a manner approved by the Department and accompanied by a payment of the proposed prescribed fee; and

    b) Provide the Department, on a quarterly basis, with information to include the type and quantity of the hazardous waste generated, produced or transported outside, and such other information as may be required.

2. A waste generator shall continue to own and be responsible for the hazardous waste generated or produced in the premises until the hazardous waste has been certified by the waste treater as had been treated, recycled, reprocessed or disposed of.

3. A waste generator shall prepare and submit to the Department comprehensive emergency contingency plans to mitigate and combat spills and accidents involving chemical substances and/or hazardous waste. Those plans shall conform with the content of the guidelines issued by the Department.

4. A waste generator shall be responsible for training its personnel and staff on-

    a) The implementation of the plan required under Section 26(3); and

    b) The hazard posed by the improper handling, storage, transport, and use of chemical substances and their containers.

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 existing land uses and corresponding area coverage are shown in Figure 6-7.

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.

Table 6-7 shows the distribution of land uses within the 15 km. radius study area.

Table 6-7 Existing Land Uses Within 15 km Radius from Malaya TPP

Land Uses	Area (sq. km.)	% of Total
Built-Up Area	17.62	5.04
Riceland	94.26	26.98
Orchard	21.98	6.29
Scrub	66.24	18.96
Grassland	34.60	9.90
Forest	101.28	28.99
Swamps/Marshes	13.42	3.84
Total	349.40	100.00

Figure 6-7 Existing Land Uses and Corresponding Area Coverage

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.

Table 6-8 shows the population and household distribution per municipality covered by the area within the 15 km radius from 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.

Table 6-8 Population and Number of Households per Municipality Within 15 km. Radius of Malaya TPP

Province/Municipality	Total Population	Household Population	No. of Households
Rizal	134,529	134,341	24,909
1. Pililla	32,771	32,771	6,131
2. Jala-jala	16,318	16,318	3,035
3. Binangonan (portion)	22,873	22,782	4,036
4. Cardona (portion)	16,842	16,842	3,139
5. Tanay (portion)	38,456	38,359	7,159
6. Morong (portion)	5,507	5,507	1,066
7. Baras (portion)	1,762	1,762	343
Laguna	88,694	88,628	10,157
1. Mabitac	11,444	11,402	2,186
2. Famy (portion)	5,709	5,706	1,094
3. Siniloan (portion)	16,644	16,640	3,460
4. Pangil (portion)	8,597	8,597	2,180
5. Pakil (portion)	973	973	186
6. Lumban (portion)	837	837	151
7. Sta. Cruz (portion)	44,490	44,473	900
Grand Total	223,223	222,969	35,066

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.

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. A topographical map of the vicinity of the Power Plant is provided in Fig. 6-8. Photographs of the vicinity taken from the rooftop of the Power Plant building are also attached as Figs. 6-9, 6-10, 6-11, and 6-12. 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.

Figure 6-8 Topographical Map of the Vicinity of the Malaya TPP

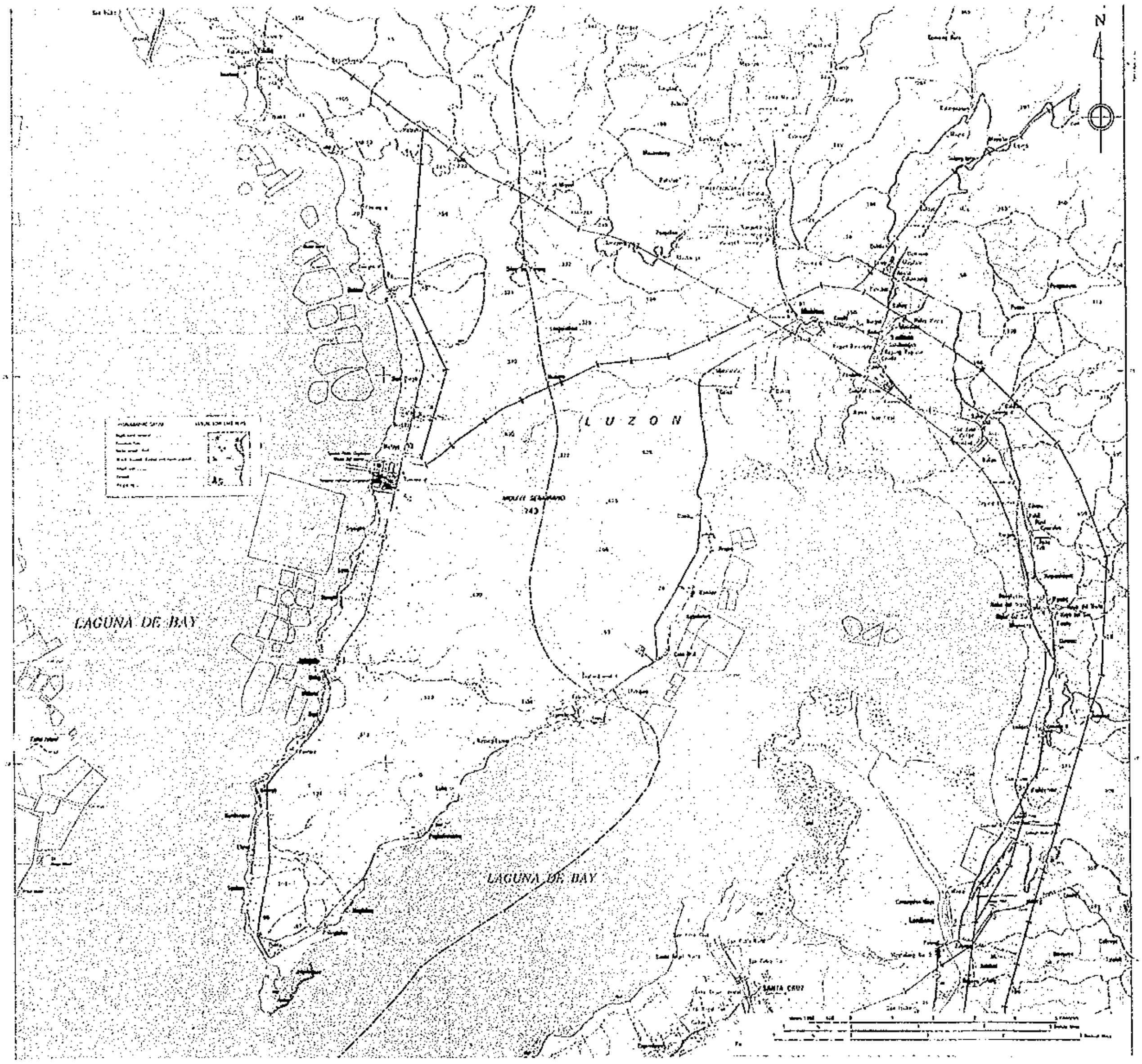


Figure 6-9 View from Malaya TPP (1)

Figure 6-10 View from Malaya TPP (2)

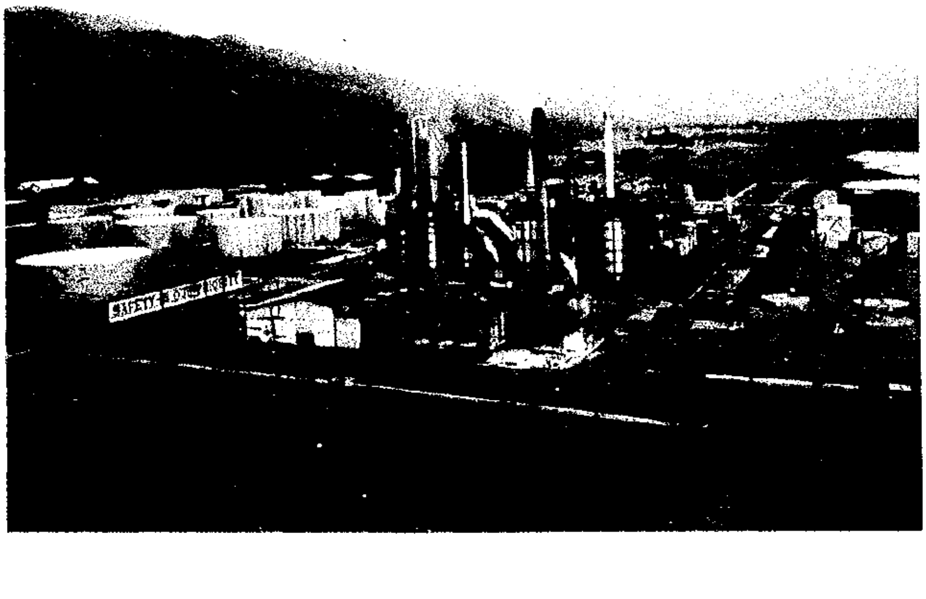


Figure 6-11 View from Malaya TPP (3)

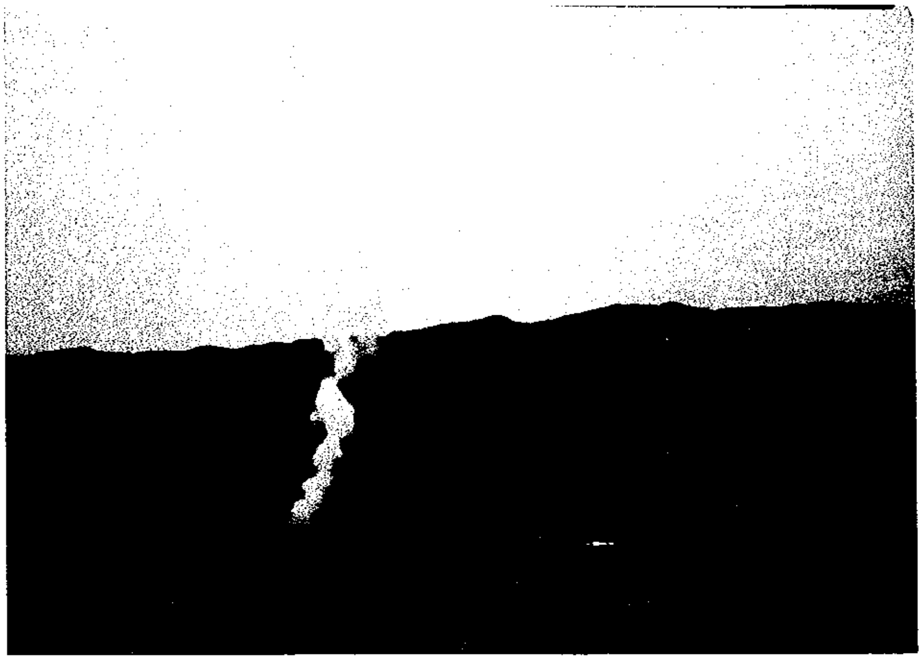
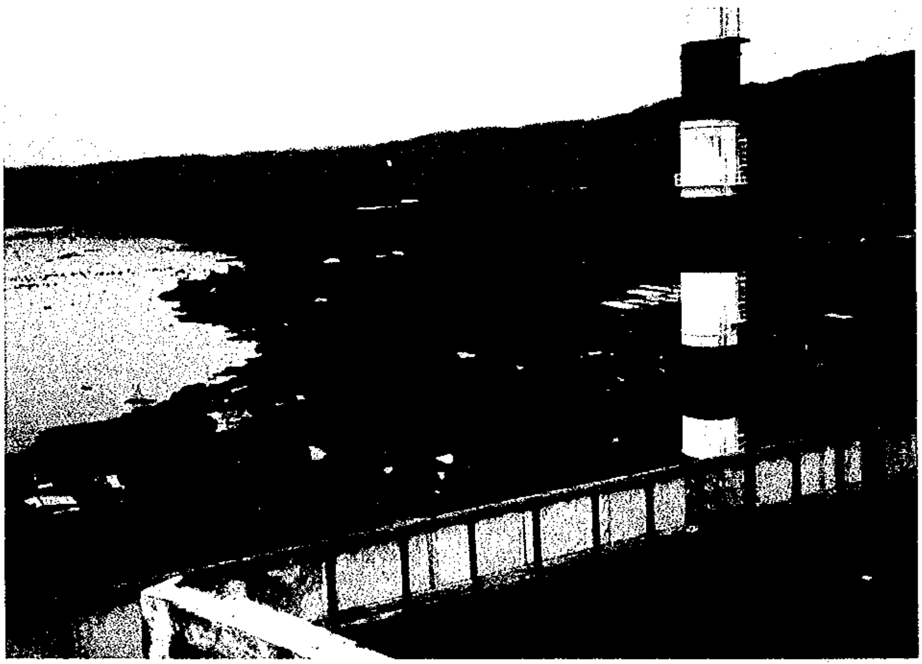


Figure 6-12 View from Malaya TPP (4)



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 6-9.

Table 6-9 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 x 10^3 1,046 x 10^3	1,059 x 10^3 1,186 x 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. The measured values of stack particulate concentration are provided in Table 6-10.

Table 6-10 Particulate Concentration from Stack Gas

Unit No.	Measuring Date	Output (MW)	Excess Oxygen (%)	Stack Particulate Concentration (mg/scm)
M-1	Jan. 26, '92	260	1.6	393
M-1	Feb. 04, '92	250	2.3	332
M-1 AVG.				363
M-2	Feb. 03, '92	290	1.1	274
M-2	Feb. 14, '92	290	2.5	266
M-2	Feb. 17, '92	290	2.1	242
M-2	Feb. 23, '93	200	3.2	351
M-2	Feb. 25, '93	200	4.2	369
M-2 AVG.				300

Emission standard: 500 mg/scm

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 indicated on Figure 6-13, and the results are shown in Table 6-11.

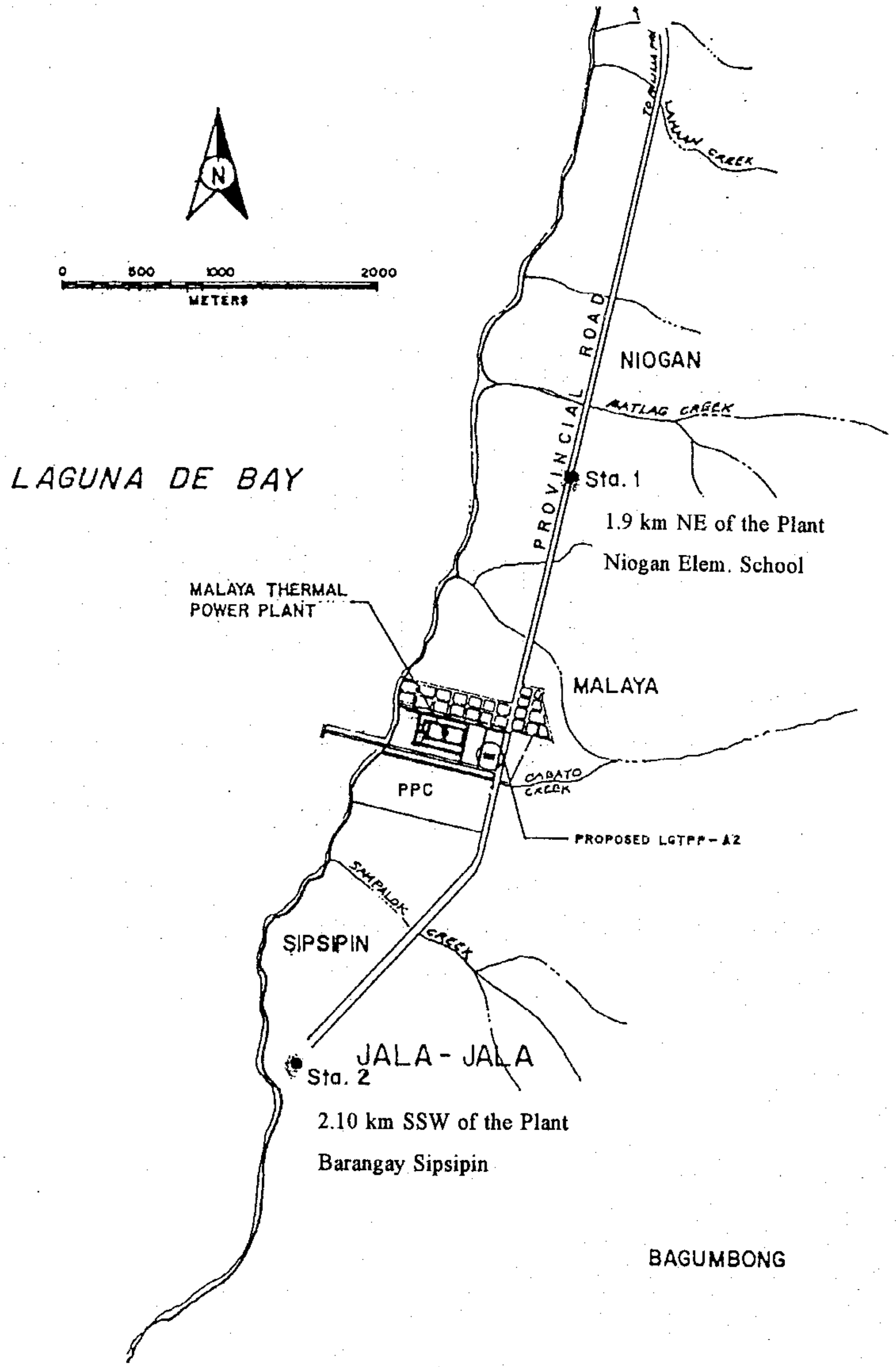
Table 6-11 Ambient Concentration Measured in the Vicinity of Power Plant

Sampling Station No.	Date of Sampling	Time of Sampling	Wind Direction	Concentration (μg/scm)			Plant Operating Date
				SO_2	NO_2	SPM	
Standards	-	-	-	850	190	250	-
1	6/8/88	1400 ~ 1500	SW	ND	ND	66.51	M-1: 213.75MW
		1502 ~ 1602		ND	ND	88.28	M-2: 281.25MW
	3/22/90	1020 ~ 1120	-	ND	ND	-	-
		1120 ~ 1220		ND	ND	-	-
2	6/8/88	1430 ~ 1530	SW	ND	ND	47.24	M-1: 213.75MW
		1540 ~ 1640		ND	ND	55.79	M-2: 281.25MW
	3/22/90	1030 ~ 1130	-	ND	ND	-	-
		1130 ~ 1230		ND	ND	-	-

Note: ND: Not detectable

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.

Figure 6-13 Vicinity Map Malaya Thermal Power Plant (Air Quality Monitoring Stations)



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 6-12.

Table 6-12 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

The diffusion formula of each one of these models is indicated below.

<u>Plume Model (windy state, wind velocity 0.5 m/s or higher)</u>

- Diffusion Formula

$$C(x, y, z) = \frac{Q_P}{2\pi\sigma_y\sigma_z U} \cdot \exp\left(-\frac{Y^2}{2\sigma_y^2}\right) \cdot F$$

$$F = \exp\left\{-\frac{(z+H_e)}{2\sigma_z^2}\right\} + \exp\left\{-\frac{(z-H_e)}{2\sigma_z^2}\right\}$$

where;

x	:	x coordinates of calculation point (m)
y	:	y coordinates of calculation point (m)
z	:	z coordinates of calculation point (m)
Q_p	:	Point smoke source intensity (Nm^3/s)
U	:	Wind velocity (m/s)
H_e	:	Effective smoke stack height (m)
C (x. y. z.)	:	Concentration (ppm) of calculation points (x. y. z.)

- Diffusion Parameters

Pasquill-Gifford diagram is used in the windy state. Its approximate functions are shown in Table 6-13.

Table 6-13 Pasquill-Gifford Diagram

$$\sigma_y(x) = \gamma_y \cdot x^{\alpha y}$$

Stability	α_y	Υ_y	Leeward Distance x (m)
A	0.901 0.851	0.426 0.602	0 ~ 1,000 1,000 ~
B	0.914 0.865	0.282 0.396	0 ~ 1,000 1,000 ~
C	0.924 0.885	0.1772 0.232	0 ~ 1,000 1,000 ~
D	0.929 0.889	0.1107 0.1467	0 ~ 1,000 1,000 ~
E	0.921 0.897	0.0864 0.1019	0 ~ 1,000 1,000 ~
F	0.929 0.889	0.0554 0.0733	0 ~ 1,000 1,000 ~
G	0.921 0.896	0.0380 0.0452	0 ~ 1,000 1,000 ~

$$\sigma_Z(x) = \gamma_Z \cdot x^{\alpha z}$$

Stability	α_z	Υ_z	Leeward Distance x (m)
A	1.122 1.514 2.109	0.0800 0.00855 0.000212	0 ~ 300 300 ~ 500 500 ~
B	0.964 1.094	0.1272 0.0570	0 ~ 500 500 ~
C	0.918	0.1068	0 ~
D	0.826 0.632 0.555	0.1046 0.400 0.811	0 ~ 1,000 1,000 ~ 10,000 10,000 ~
E	0.788 0.565 0.415	0.0928 0.433 1.732	0 ~ 1,000 1,000 ~ 10,000 10,000 ~
F	0.784 0.526 0.323	0.0621 0.370 2.41	0 ~ 1,000 1,000 ~ 10,000 10,000 ~
G	0.794 0.637 0.431 0.222	0.0373 0.1105 0.529 3.62	0 ~ 1,000 1,000 ~ 2,000 2,000 ~ 10,000 10,000 ~

- Diffusion Parameter Correction Factor

As σ_y of the Pasquill-Gifford diagram is usually a 3-minute collection value, correction (correction factor) to the diffusion width that is equivalent to the evaluation time value is required in the case of forecast of SO_2 concentration.

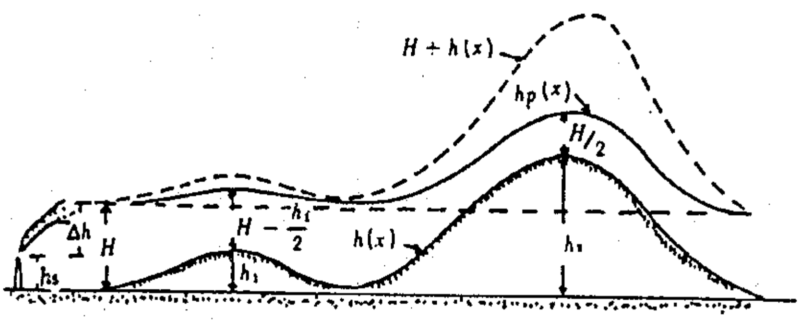
Maeda's correction factor 0.61 was used because this is forecast of 1-hour values.

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.

Figure 6-14 Relation between Smoke Axis and Topography with ERT Model

when h(x)≤H hp(x)=H+h(x)/2,
when h(x)>H hp(x)=H/2+h(x),



hs	:	Actual smoke stack height
h(x)	:	Topography height
Δh	:	Smoke rise height
hp(x)	:	Smoke axis height
H	:	Effective smoke stack height

Effective Smokestack Height

The CONCAWE formula was used for the windy state.

CONCAWE formula

$$\Delta H = 0.175 \cdot Q_H^{1/2} \cdot u^{-3/4}$$

where;

ΔH	:	Exhaust gas rise height (m)
Q_H	:	Discharged calorific value (cal/s)
u	:	Wind velocity at smokestack tip (m/s)

Furthermore,

$$Q_H = \rho C_p Q \Delta T$$

ρ:	Exhaust gas density at 0°C (1.293×10^3 g/m^3)
Cp:	Isopiestic specific heat (0.24 cal/°k/g)
Q:	Exhaust gas flow per unit tie (m^{3}N/s)
ΔT:	Difference in temperature between exhaust gas temperature (Tc) and atmospheric temperature (Tc-27°C)

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" shown below is used as the diffusion calculation formula.

$$C\ (X, Y, Z) = \frac{Q}{\sqrt{2\pi} \cdot \sigma_z \cdot U \cdot (2\pi\ r/16)} \times F$$

$$F = \exp\left\{ - \frac{(H_e - Z)^2}{2\sigma_z^2} \right\} + \exp\left\{ - \frac{(H_e + Z)^2}{2\sigma_z^2} \right\}$$

where;

X, Y, Z	:	Coordinates in East, North and vertical directions of concentration calculation point (m)
U	:	Wind velocity (m/s)
Q	:	Discharge intensity (cc/sec.)
He	:	Effective height (m)
σ_z	:	Width of diffusion from vertical direction (m)
r	:	Horizontal distance from smoke source (m)
C (X, Y, Z):		Concentration (ppm) at points (X, Y, Z)

- Calm State: Wind velocity 0.4 m/s or less

"Puff formula" shown below is used as the diffusion calculation formula.

$$C\ (r, z) = \frac{Q}{(2\pi)^{3/2} \cdot r} \times \frac{1}{r^2 + \frac{\alpha^2}{\gamma^2}(H_e - Z)^2} + \frac{1}{r^2 + \frac{\alpha^2}{\gamma^2}(H_e + Z)^2}$$

where;

α	:	Diffusion parameter in calm state
γ	:	Diffusion parameter in calm state

- Diffusion Parameter

σ_z shown in Table 6-13 was used as the diffusion parameter.

The diffusion parameter in the calm state is shown in Table 6-14.

Table 6-14 Diffusion Parameter in Calm State

Stability	α	γ
A	0.948	1.569
A - B	0.859	0.862
B	0.781	0.474
B - C	0.702	0.314
C	0.635	0.208
C - D	0.542	0.153
D	0.470	0.113
E	0.439	0.067
F	0.439	0.048
G	0.439	0.029

Source: Gross nitrogen oxides control manual [revised version]

Effective Smokestack Height

The CONCAWE formula is used in the windy state. In the windless state and when the upper wind velocity is less than 2.0 m/s, ΔH of wind velocity zero of Briggs formula and ΔH of 2.0 m/s of CONCAWE formula are calculated in correspondence to the gross nitrogen oxides control manual, and the effective smokestack height is obtained by making linear interpolation using the upper (smokestack height) wind velocity value.

- Windy State (Wind velocity 0.5 m/s or higher): CONCAWE formula

$$\Delta H = 0.175 \cdot Q_H^{1/2} \cdot u^{-3/4}$$

where;

ΔH	:	Exhaust gas rise height (m)
Q_H	:	Discharged calorific value (cal/s)
u	:	Wind velocity at smokestack tip (m/s)

Furthermore,

$$QH = \rho Cp Q \Delta T$$

ρ	:	Exhaust gas density at 0°C (1.293×10^3 g/m^3)
Cp	:	Isopiestic specific heat (0.24 cal/°k/g)
Q	:	Exhaust gas flow per unit tie (m^{3}N/s)
ΔT	:	Difference in temperature between exhaust gas (Tc) and atmospheric (Tc-27°C)

- Calm State (Wind velocity 0.4 m/s or less): Briggs formula

$$\Delta H = 1.4 \times QH^{1/4} (d0/dz)^{-3/8}$$

where;

$d\theta/dz$ = 0.003 °C/m (daytime)

= 0.010 °C/m (nighttime)

Meteorological Conditions

- Wind Direction

The wind direction is divided into 16 azimuths, and wind velocity of 0.4 m/s or less is handled as calm.

- Wind Velocity

The wind velocity is divided into seven classes as shown in Table 6-15, and the average value of these classes is used as the representative wind velocity.

Table 6-15 Division of Wind Velocity Classes

Wind Velocity Class	Wind Velocity Class Division Value	Remarks
1	0.4 m/s or less	Calm
2	0.5 ~ 0.9	Weak wind
3	1.0 ~ 1.9	Windy
4	2.0 ~ 2.9	Windy
5	3.0 ~ 3.9	Windy
6	4.0 ~ 5.9	Windy
7	6.0 m/s or higher	Windy

Source; "Manual of Areawide Nitrogen Oxide Total Pollutant Load Control" Published by Air Preservation Bureau, Environmental Agency, Japanese Government

- Atmospheric Temperature

The annual average atmospheric temperature (about 27°C) of the field was used as the atmospheric temperature.

Atmospherc Stability

The original stability is corrected for each division of the atmospheric layer in the vertical direction and used as the atmosphere stability as shown in Table 6-16.

Table 6-16 Atmosphere Stability Division

Stability State	Unstable						Neutral		Stable			Remarks
Original Stability Atmospheric Layer	A	A - B	B	B - C	C	C - D	D (Day)	D (night)	E	F	G	
Upper Layer	A	B	B	C - D	C - D	C - D	C - D	C - D	D	E	E	Fixed Source

Source; "Manual of Areawide Nitrogen Oxide Total Pollutant Load Control" Published by Air Preservation Bureau, Environmental Agency, Japanese Government

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 wind velocity of 2.5 m/s of the field, and the upper wind was estimated by exponent rule 0.25.

Wind rose, frequency of occurrence by wind direction and wind velocity, and frequency of atmosphere stability by wind direction and wind velocity are shown in Figure 6-15, Table 6-17, Table 6-18, and Figure 6-16.

Figure 6-15 Wind Rose

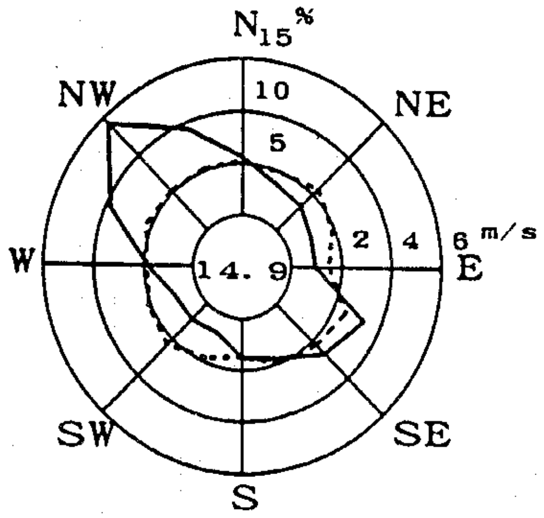


Table 6-17 Frequency of Occurrence by Wind Direction and Wind Velocity

Wind Velocity \ Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm	Total
0.5 ~ 0.9 m/s	76	41	33	33	35	65	66	62	67	41	34	46	122	207	248	196	-	1373
	(0.9)	(0.5)	(0.4)	(0.4)	(0.4)	(0.7)	(0.8)	(0.7)	(0.8)	(0.5)	(0.4)	(0.5)	(1.4)	(2.4)	(2.8)	(2.2)		(15.8)
1.0 ~ 1.9 m/s	185	135	92	89	123	244	237	156	192	56	45	60	115	227	460	279	-	2695
	(2.1)	(1.5)	(1.1)	(1.0)	(1.4)	(2.8)	(2.7)	(1.8)	(2.2)	(0.6)	(0.5)	(0.7)	(1.3)	(2.6)	(5.3)	(3.2)		(30.9)
2.0 ~ 2.9 m/s	117	95	97	76	42	166	171	111	60	43	56	55	70	158	216	130	-	1663
	(1.3)	(1.1)	(1.1)	(0.9)	(0.5)	(1.9)	(2.0)	(1.3)	(0.7)	(0.5)	(0.6)	(0.6)	(0.8)	(1.8)	(1.9)	(1.5)		(19.1)
3.0 ~ 3.9 m/s	67	40	50	15	5	136	81	44	11	17	31	28	62	120	169	109	-	985
	(0.8)	(0.5)	(0.6)	(0.2)	(0.1)	(1.6)	(0.9)	(0.5)	(0.1)	(0.2)	(0.4)	(0.3)	(0.7)	(1.4)	(1.9)	(1.3)		(11.3)
4.0 ~ 5.9 m/s	40	17	22	5		90	34	23	2	8	22	22	27	103	143	90	-	648
	(0.5)	(0.2)	(0.3)	(0.1)		(0.1)	(0.4)	(0.3)	(0.0)	(0.1)	(0.3)	(0.3)	(0.3)	(1.2)	(1.6)	(1.0)		(7.4)
6.0 m/s ~			1			11	8						3	10	12	9	-	54
			(0.0)			(0.1)	(0.1)						(0.0)	(0.1)	(0.1)	(1.0)		(0.6)
Total	485	328	295	218	205	712	597	396	332	165	188	211	399	825	1248	813	1299	8716
	(5.6)	(3.8)	(3.4)	(2.5)	(2.4)	(8.2)	(6.8)	(4.5)	(3.8)	(1.9)	(2.2)	(2.4)	(4.6)	(9.5)	(14.3)	(9.3)	(14.9)	(100.0)
Avg. Wind Velocity (m/s)	2.1	2.0	2.3	1.9	1.5	2.5	2.2	2.0	1.5	1.8	2.3	2.1	1.9	2.2	2.1	2.1	0.2	1.8

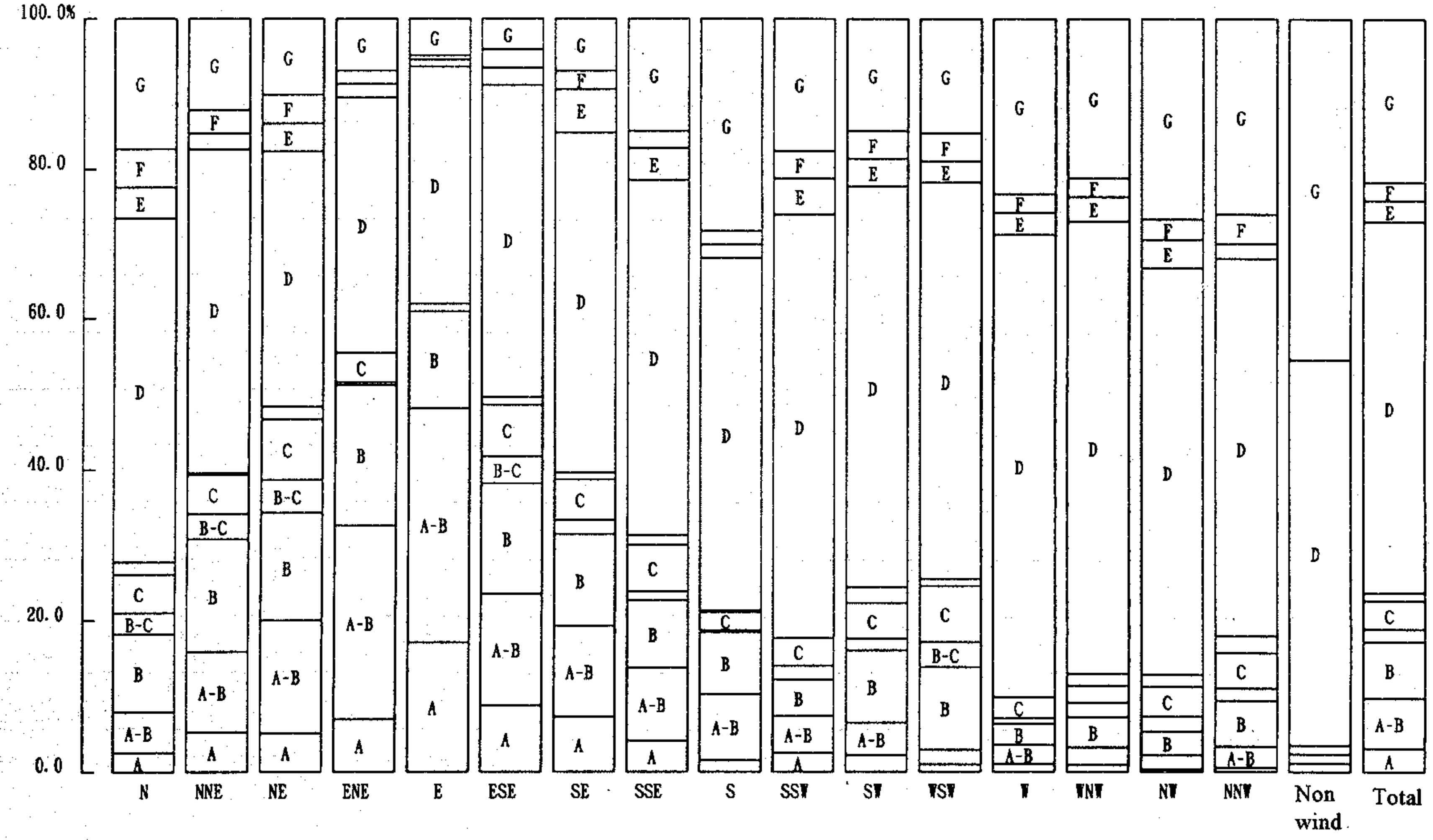
Note: Numbers in the table show frequency and these percentages with ( ).
Source: Observation data collected in Japan

Table 6-18 Frequency of Atmosphere Stability by Wind Direction and Wind Velocity

Stability \ Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm	Total
A	12	17	15	15	35	62	43	16	5	4	4	2	4	7	4	4	14	263
	(0.1)	(0.2)	(0.2)	(0.2)	(0.4)	(0.7)	(0.5)	(0.2)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.2)	(3.0)
A - B	26	35	44	56	64	106	72	38	29	8	8	4	10	19	23	23	15	580
	(0.3)	(0.4)	(0.5)	(0.6)	(0.7)	(1.2)	(0.8)	(0.4)	(0.3)	(0.1)	(0.1)	(0.0)	(0.1)	(0.2)	(0.3)	(0.3)	(0.2)	(6.7)
B	50	49	42	41	26	104	73	36	27	8	18	23	11	33	39	49	15	644
	(0.6)	(0.6)	(0.5)	(0.5)	(0.3)	(1.2)	(0.8)	(0.4)	(0.3)	(0.1)	(0.2)	(0.3)	(0.1)	(0.4)	(0.4)	(0.6)	(0.2)	(7.4)
B - C	14	11	13	1		26	11	5	1	3	3	7	3	16	24	13		151
	(0.2)	(0.1)	(0.1)	(0.0)		(0.3)	(0.1)	(0.1)	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)	(0.2)	(0.3)	(0.1)		(1.7)
C	25	17	24	8	2	49	32	24	8	6	9	16	11	18	49	38		336
	(0.3)	(0.2)	(0.3)	(0.1)	(0.0)	(0.6)	(0.4)	(0.3)	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)	(0.2)	(0.6)	(0.4)		(3.9)
C - D	8	1	5			8	6	5	1		4	2		13	20	18		91
	(0.1)	(0.0)	(0.1)			(0.1)	(0.1)	(0.1)	(0.0)		(0.0)	(0.0)		(0.1)	(0.2)	(0.2)		(1.0)
D	221	141	100	74	65	294	270	187	155	93	100	111	245	496	673	407	658	4290
	(2.5)	(1.6)	(1.1)	(0.9)	(0.7)	(3.4)	(3.1)	(2.1)	(1.8)	(1.1)	(1.1)	(1.3)	(2.8)	(5.7)	(7.7)	(4.7)	(7.6)	(49.3)
E	20	7	11	4	2	17	34	17	6	8	7	6	12	27	48	17		243
	(0.2)	(0.1)	(0.1)	(0.0)	(0.0)	(0.2)	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.3)	(0.6)	(0.2)		(2.8)
F	25	10	11	4	1	17	15	9	6	6	7	8	10	21	34	32		216
	(0.3)	(0.1)	(0.1)	(0.0)	(0.0)	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.4)	(0.4)		(2.5)
G	84	40	30	15	10	29	41	59	94	29	28	32	93	175	334	212	583	1888
	(1.0)	(0.5)	(0.3)	(0.2)	(0.1)	(0.3)	90.5)	(0.7)	(1.1)	(0.3)	(0.3)	(0.4)	(1.1)	(2.0)	(3.8)	(2.4)	(6.7)	(21.7)
Total	485	328	295	218	205	712	597	396	332	165	188	211	399	825	1248	813	1285	8702
	(5.6)	(3.8)	(3.4)	(2.5)	(2.4)	(8.2)	(6.9)	(4.6)	(3.8)	(1.9)	(2.2)	(2.4)	(4.6)	(9.5)	(14.3)	(9.3)	(14.8)	(100.0)

Note: Numbers in the table show frequency and these percentages with ( ).
Source: Observation data collected in Japan

Figure 6-16 Frequency of Appearance of Atmosphere Stability by Wind Direction



e) Results of Calculation

The results of calculation are as shown in Table 6-19 and Table 6-20. Figures 6-17, 6-18, and 6-19 show SO_2 concentration contours.

Table 6-19 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 6-20 Results of Calculation of Annual Average Value

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

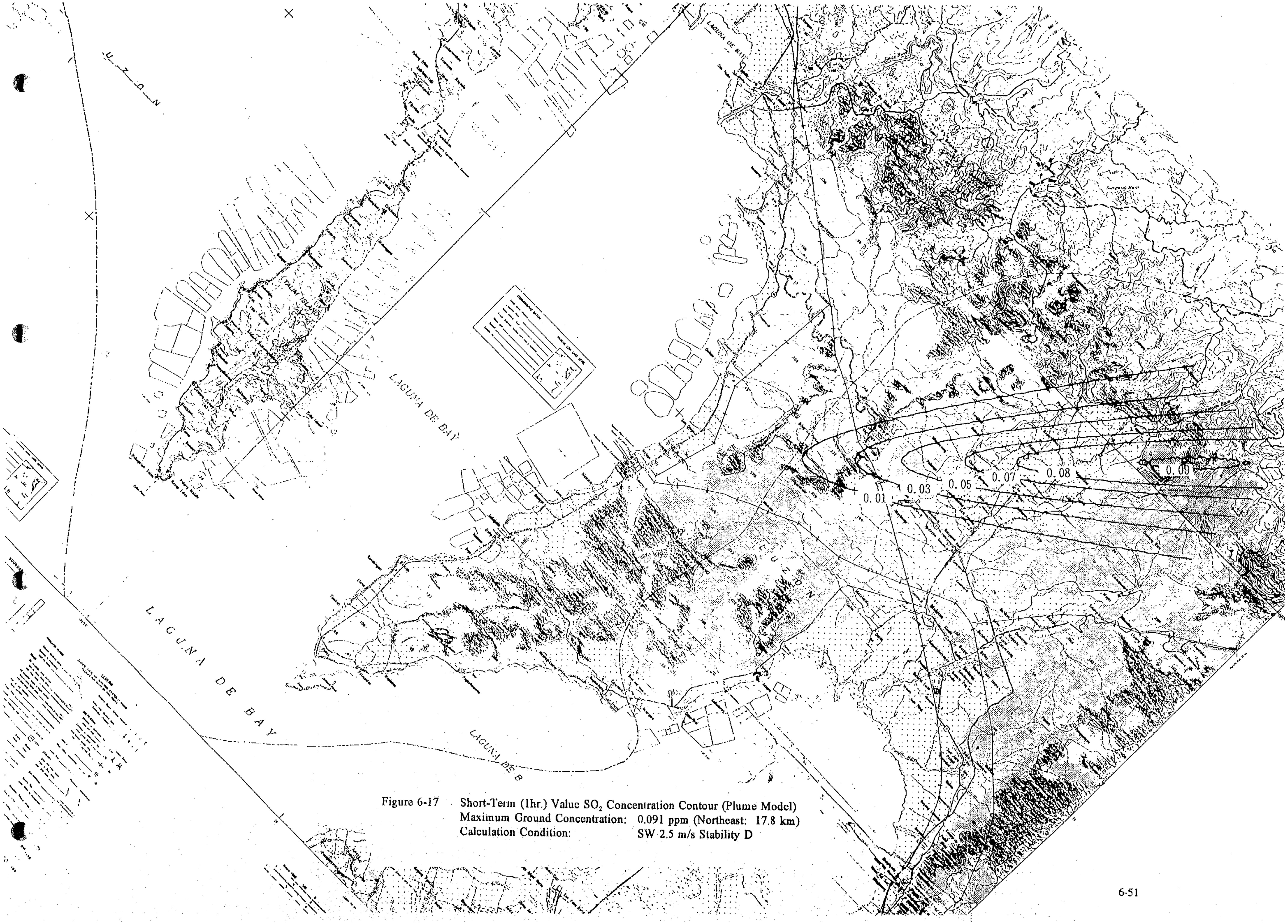


Figure 6-17 Short-Term (1hr.) Value SO_2 Concentration Contour (Plume Model)
Maximum Ground Concentration: 0.091 ppm (Northeast: 17.8 km)
Calculation Condition: SW 2.5 m/s Stability D

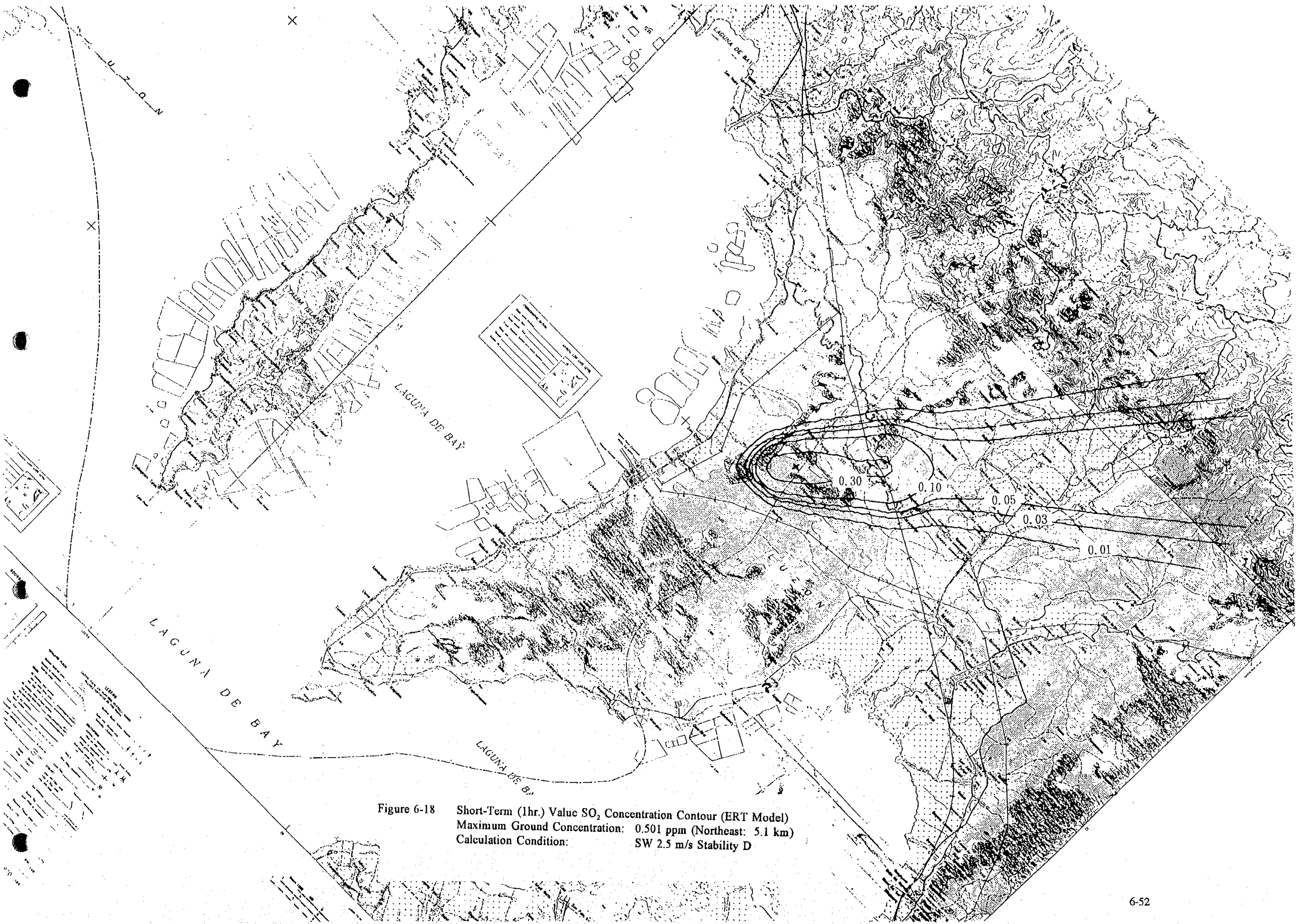


Figure 6-18 Short-Term (1hr.) Value SO_2 Concentration Contour (ERT Model)
Maximum Ground Concentration: 0.501 ppm (Northeast: 5.1 km)
Calculation Condition: SW 2.5 m/s Stability D

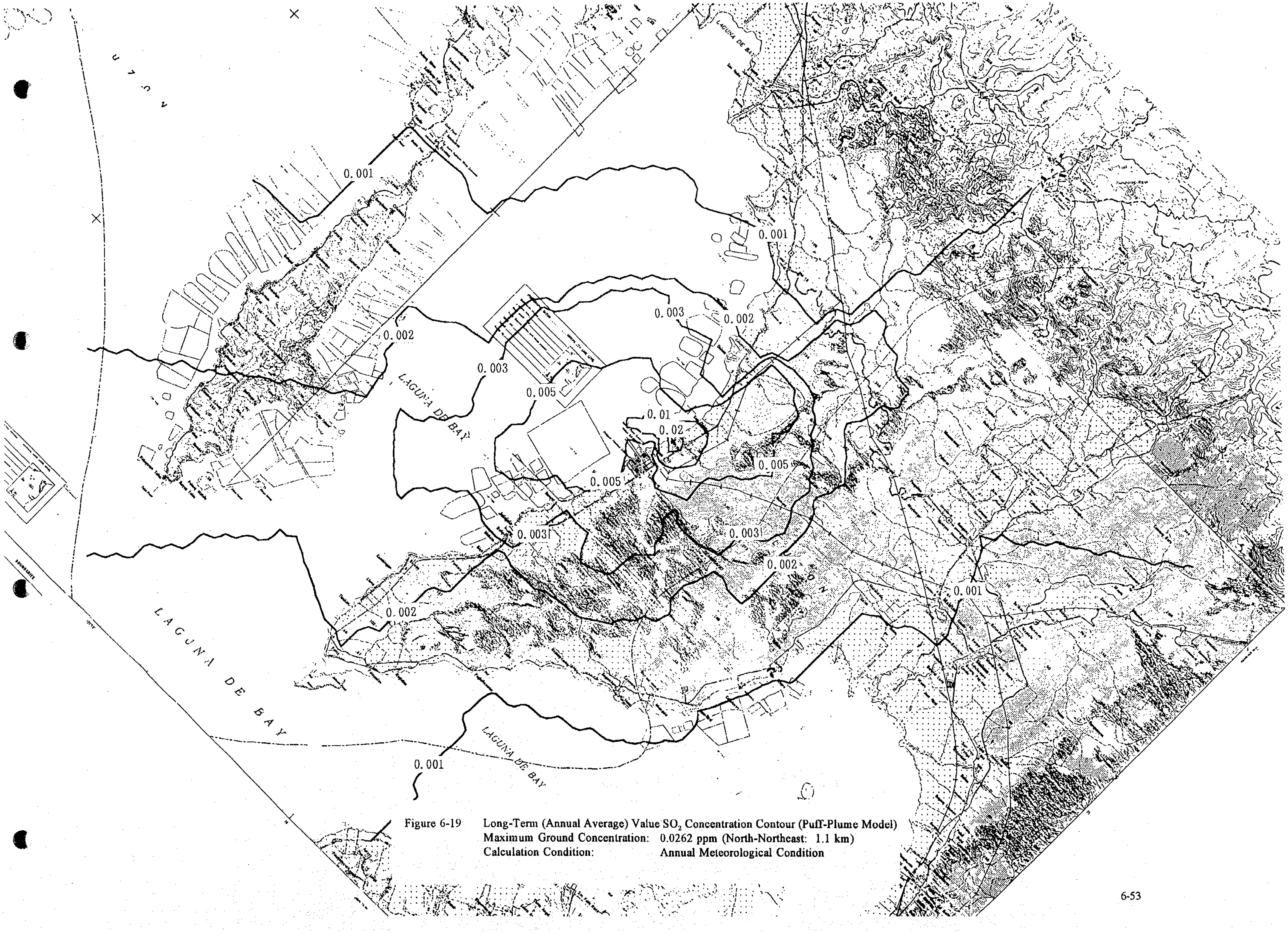


Figure 6-19 Long-Term (Annual Average) Value SO_2 Concentration Contour (Puff-Plume Model)
Maximum Ground Concentration: 0.0262 ppm (North-Northeast: 1.1 km)
Calculation Condition: Annual Meteorological Condition

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 (Δt=5°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. Photographs of the settling basin, neutralizing tank and drain port are provided as Figures 6-20, 6-21, and 6-22. Data of the Power Plant waste water quality, measured by a portable water quality checker during this site survey, are listed in Table 6-21. Also, the results of quality examination of waste water samples conducted in Japan are shown in Table 6-22.

Figure 6-20 Settling Basin

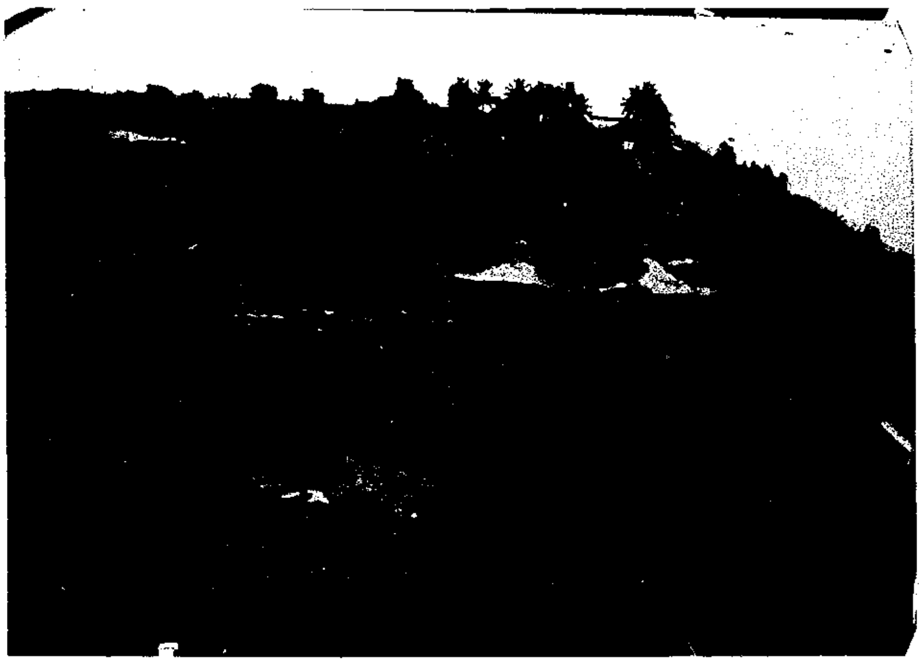


Figure 6-21 Neutralizing Tank

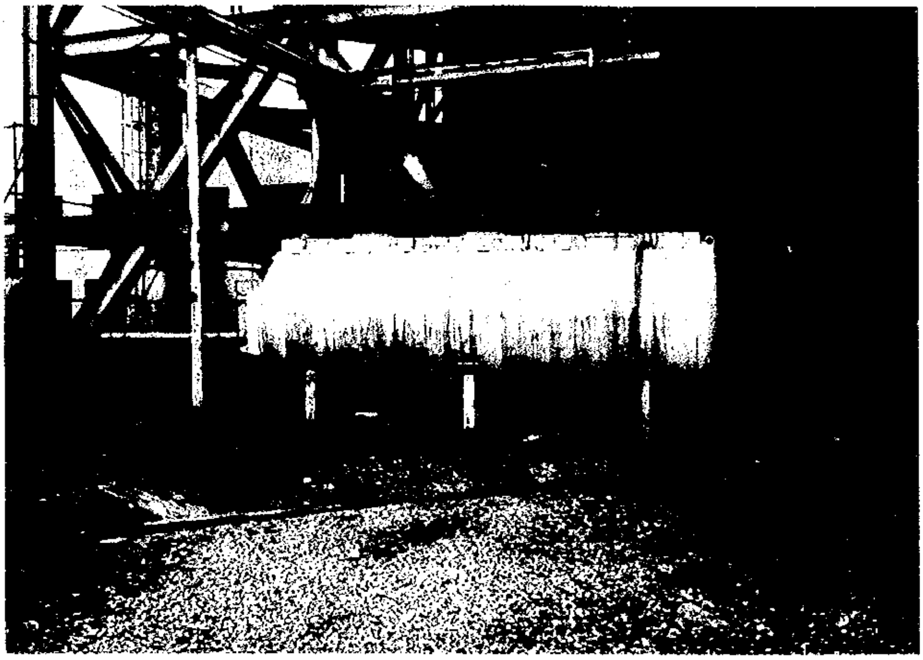


Figure 6-22 Drain Port

Table 6-21 Data of Waste Water Quality measured by Portable Water Quality Checker

Item (unit)		Waste Water	
	.	Before Neutralization	After Neutralization
pH		2.34	5.29
Conductivity	(μs/cm)	2,270	1,000
Turbidity	(NTU)	159	90
Dissolved oxygen	(mg/l)	6.76	4.42
Temperature	(°C)	25.5	28.1
Salinity	(%)	1.38	0.04

Measuring date: Sept. 08, 1994

Table 6-22 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. Sampling points for the survey are indicated in Figure 6-23. Also, the water quality data on Laguna Lake is listed in Table 6-23.

Figure 6-23 Sampling Points on Laguna Lake and Tributary Rivers

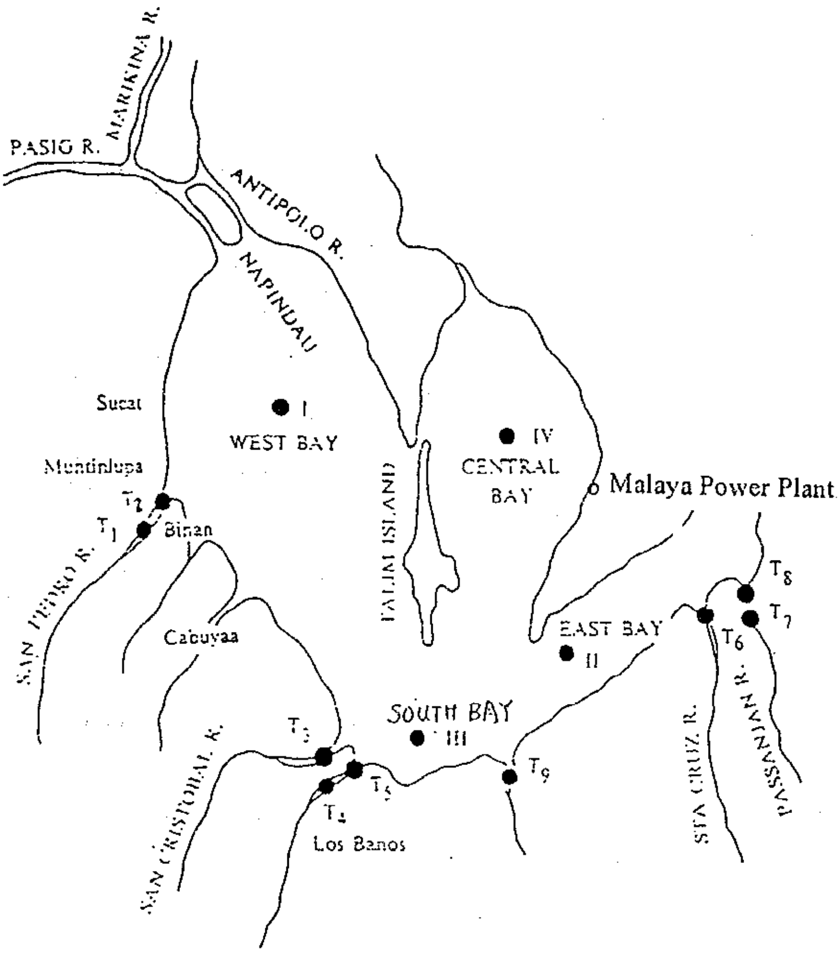


Table 6-23 Water Quality Data on Laguna Lake

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/m²/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.

Water quality data for Laguna Lake, obtained by using a portable water quality checker during this site survey, is listed in Table 6-24. Also, the results of quality analysis conducted in Japan of the Laguna Lake water samples brought back from the Power Plant is shown in Table 6-25.

Table 6-24 Measuring Data of Laguna Lake Water Quality by Portable Water Quality Checker

Item		Laguna Lake Water (at cooling water inlet at MTPP)
pH		7.24
Conductivity	(μs/cm)	1,090
Turbidity	(NTU)	93
Dissolved Oxygen	(mg/ℓ)	7.28
Temperature	(°C)	27.0
Salinity	(%)	0.04

Measuring date: Sept. 08, 1994

Table 6-25 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 6-26.

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 6-26 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. A photograph of the northern area is provided as Figure 6-24. 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 6-27. The noise measuring points are indicated in Figure 6-25.

Figure 6-24 View of the Northern Property Line

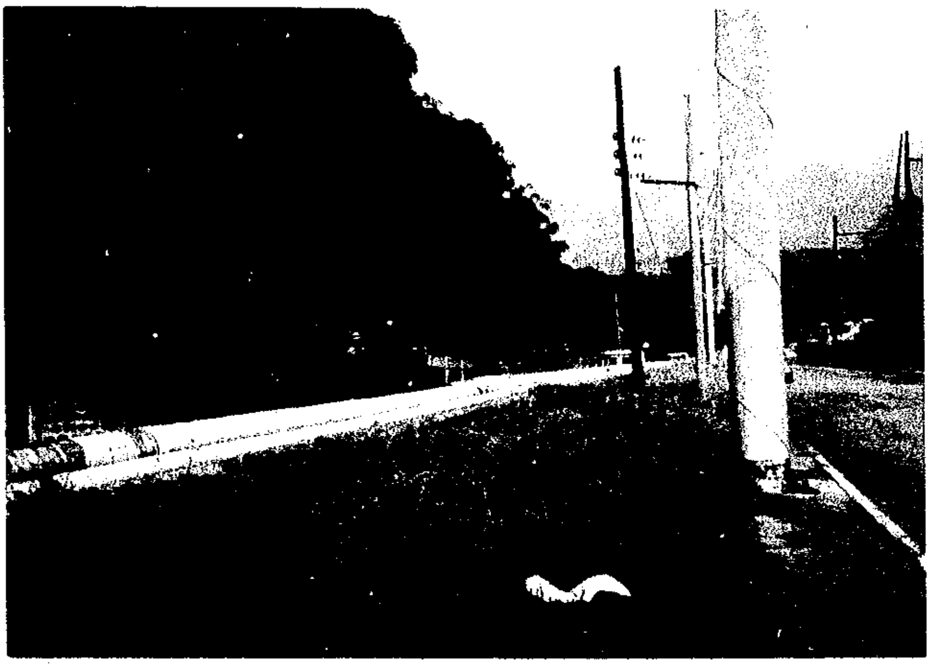


Figure 6-25 Noise Measuring Points

● : Measuring Point

Unit : dB

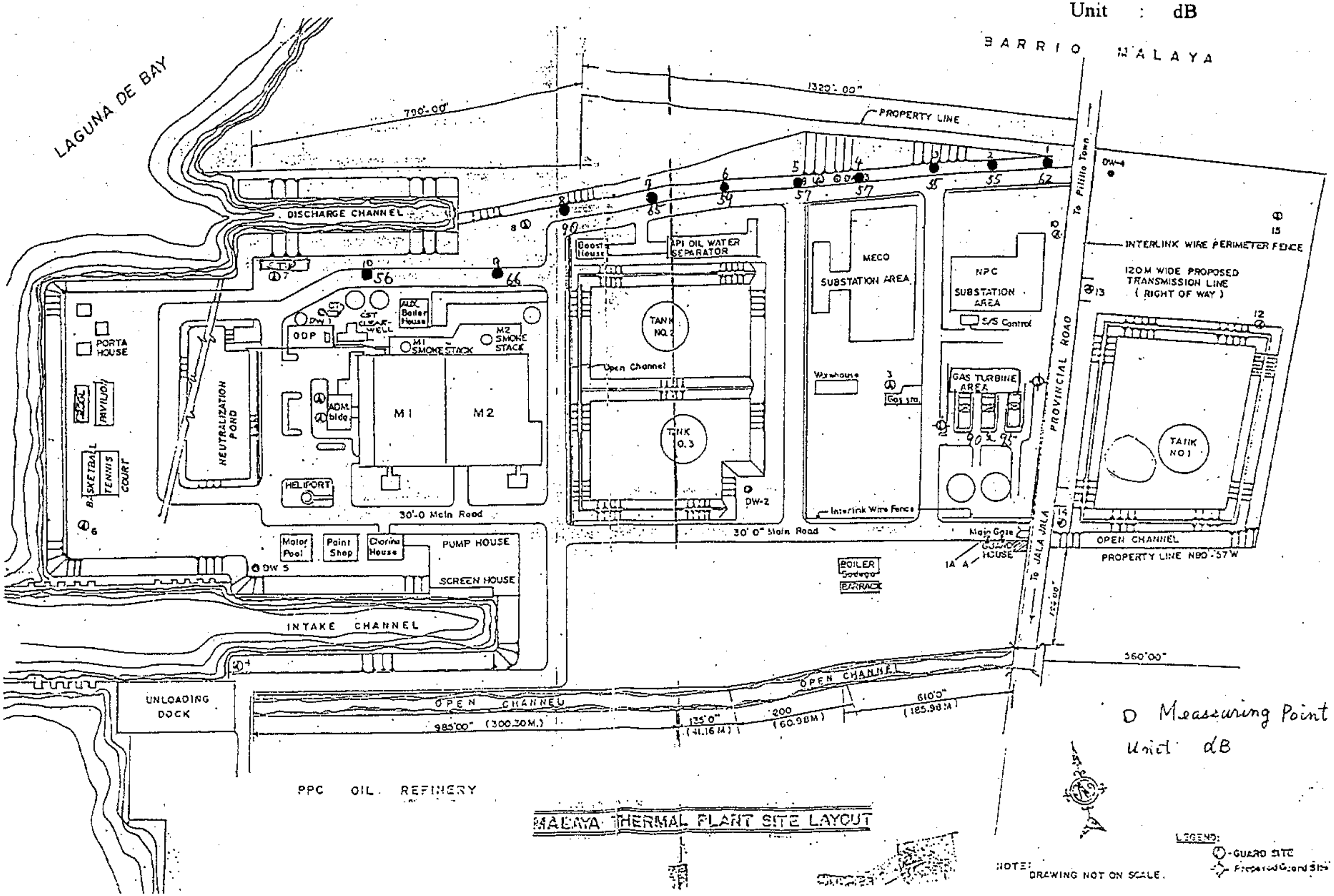


Table 6-27 Noise Level Measured along the Northern Property Line and in the Gas Turbine Area

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 6-28.

Table 6-28 Environmental Quality Standards for Noise in Class D

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

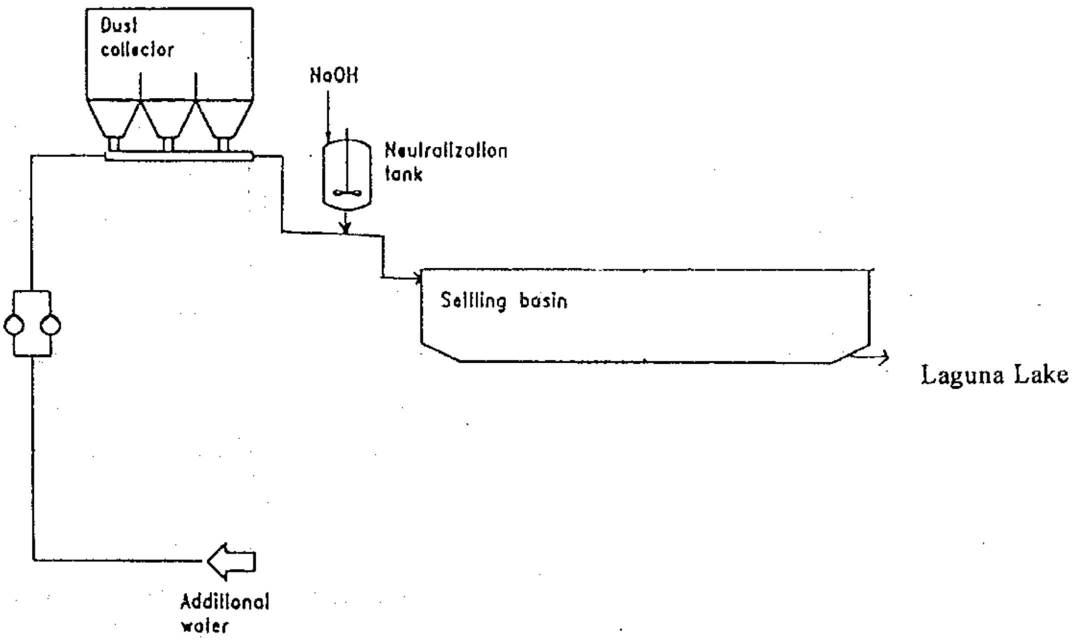
The noise level surveyed at the site was 55 ~ 66 dB, which, in general, is within the Class D daytime value of the environmental quality standards (75 dB).

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. The ash handling and disposal system is illustrated in Figure 6-26.

Figure 6-26 Ash Handling and Disposal System



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 6-29.

As seen from Table 6-21 of clause 6.2.3. 1), waste water from unburnt carbon ash treatment before neutralization is highly contaminated, indicating a pH value of 2.34 and turbidity of 159 (NTU). The waste water is neutralized by caustic soda, thereafter the components of turbidity are removed in the settling basin.

Table 6-29 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 6-22, 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 Malayas 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.