Ⅴ．本格調査の測定事項と方法

Ⅴ．本格調査の測定事項と方法

1．　収集すべきデータ

本計画遂行の核となる大気汚染拡散シミュレーションモデルの入力及び検証のために必要なデータは、大きく分けて発生源・気象・環境濃度関係の三つである。これらに関して、サムットプラカン県で利用可能な既存データはほぼ皆無と言ってよい。従って、いずれも現地での本格調査期間中に収集することとなるが、調査の規模には自ずと限度があり、また現地の実情に照らして調査の困難な範囲も存在する。そこで、調査可能性を考慮しつつ、計画の枠組みを設定し、それに必要なデータの収集について以下に述べる。

2．　発生源データの収集

調査対象汚染質と拡散モデル

SO_2・NO_x ……プルーム・パフモデル

SPM　　……CMB（化学質量平衡）法

考慮すべき発生源とデータ収集方法

(1)　SO_2

①　石炭・石油（ガソリン灯油除く）燃焼施設を有する工場・事業場

…… 300社を選定（タイ側より提供される企業リストで業種別・規模別に）、個別聴取（立入調査）により調査する。調査不能も予想し、実質的には 200社以上を調べ上げる。

調査項目：

稼動時間、燃料種類・使用量、 S分、煙突位置、煙突高さ・口径、排出速度、排煙温度等。

（重油等の品質ごとの含有 S分について、別途サンプルを持ち帰り分析する。排出速度等不明の場合は推算による。）

必要人員の例：

２人・３チーム・８社／日・８（～９）日

予め全社へのアンケート発送と回収をタイ側に依頼、個別聴取しない工場・事業場についてはタイ側資料と立入調査結果を参考にして推定する。

②　道路交通

……最小限の交通量調査として、県内５地点で２期各１日、車種別（大型・小型トラック、バス、乗用車）通過台数、平均通過速度を計測する。

（車種別ディーゼル構成比、燃料中 S分、単位燃料当たり走行距離に関するデータを別途収集）

必要人員の例：

4人・5チーム・1日（7～19時）・2期（乾期及び雨期）

③ 船舶・家庭燃料・隣接地区煙源

……本調査の範囲で根拠ある数値データを得ることは困難と考えられるので、バックグラウンドとして取扱い、風向別環境濃度の解析等を通じて寄与度を推定する。ただし、チャオプラヤ川のプラプラデーン郡の国道の渡し船のうちフェリーボートについては交通量が多くかつ容易に把握できるので調査対象とする。

(2) NO_x

① 工場・事業場

……SO_2 と同時に資料を収集し、燃焼施設種別、燃料種類・使用料等から推算する。石炭石油以外の燃焼施設（例えば LNG燃焼発電所）も NO_xは排出するので主要なものは個別調査に含めること。

② 道路交通

……交通量——SO_2 の項参照

排出係数——何らかの算出根拠となるデータをタイ側に提出してもらい、日本側データを参考にして推定する。例えば、添付資料 "Air and Noise Quality Management" を参考にする。

③船舶等

……SO_2 の場合と同様に扱う。

(3) SPM

① 工場・事業場

……SO_2 に関する個別調査と同時に排煙中の粉塵除去装置、その他の防塵設備の設置状況を調査し、改善の方策を検討する際の基礎資料とする。

② 土壌

……砂塵の寄与率を確定するための成分分析用に5種類程度のサンプルを採取する。

③ 自動車排気

……燃料中の金属成分について、サンプルを持ち帰り分析する。タイにおける使用エンジン構造の特徴を調査しておく。

3. 気象データの収集

測定項目

日射量・放射収支量・風向・風速・乱流強度

測定方法と注意事項

(1) 日射量・放射収支量

日射計、放射収支計各1台を同じ場所に設置する。通常の測定法に従って設置すればよい

が、降雨や出水対策には注意を払うこと。機種選定に際しても、雨に強く保守が容易である点を確認すること。

(2) 乱流強度

超音波風速計を前項と同じ地点に設置して測定する。周辺の樹木等の影響を避けるため、測定高度を 20mとする必要がある。屋上に設置できるようなビルディングの選定は困難であり、従って地上に 20mポールを立てる。地盤の確保に注意が必要。

(3) 風向・風速

日本では通常、環境測定局ごとに風速計を設置しているが、本調査地域では測定局用地の選定が容易でなく、後述の候補地の一部は風速測定適地とは言えない。また、調査地域は極めて平坦であるうえ、測定局配置はチャオプラヤ川沿岸に集中することになるため、その区域内の風速はほぼ一様と見ることができる。そのため、前項の乱流測定と同時に得られる風速のほか、2地点のみに微風向風速計を設置することとした。

10m ポールを立て、その上で測定する。

(4) タイ側データ

通年測定期間のバンコク気象台における観測記録（特に天気、気温、雨量等）を入手する。

4. 環境濃度データの収集

測定項目

通年調査……SO_2 , NO_x , SPM

短期調査（3回）……SPM 成分

測定方法と注意事項

(1) 通年測定機材

機種（測定原理）については、現地の気象条件下の使用に適し、また、タイ側が標準測定法として既にバンコク等で採用している蛍光光度法（SO_2）、ケミルミ法（NO_x）によるものが望ましい。また、タイでは SPMの通年測定の実績はないが、世界的に標準測定法となりつつあるβ線吸収法の採用が可能と考えられる。

(2) 通年測定用補助機材

環境通年測定値と風速測定値を毎時1回拾い出し、電話回線により集中監視局に送る装置（データ・ロガー）、及び集中監視局として電送された各測定局データを順にプリンターに出力する装置（合わせてテレメトリック・プリンターと呼ぶ事にした）。

電話は専用回線設置が困難と思われるので、既存回線を利用し優先的に割り込む構造とする。

測定局を適切な既存建屋内に収納できない場所についてはエアコン付収納庫。

(3) 短期測定機材

SPM の通年測定で得られるのは時間当たり総重量のみであり、成分はわからない。CMB 法による各種発生源の寄与率割り出しのためには環境濃度を成分別に知る必要がある。そのため通年調査開始時と継続中２回の計３回にわたり、各15日以上の SPMサンプリングを行い、日本に持ち帰って分析する。

サンプリング日数は捕集状況を見て決定する。

使用機材は測定局１点につきロウボリウム・サンプラー２台（金属、炭素分析用）、アンダーセンサンプラー（粒径分布測定）とする。

なお、タイ側において可能であれば、ロウボリウム・サンプラーを活用して通年サンプリングを行い、SPM 総量の年変化を求め、β線式の結果と比較する。化学分析についてもタイ側に任せる。

(5) 測定局の地点選定

地方の役所や学校が立派なビルディングである我が国と異なり、タイではその種の建物に測定機を設置することは建物構造と安全の面から不可能である。規模の大きな工場内に敷地を借用することは可能かと思われたが、工業地域内で特定煙源や幹線道路の影響を避けることは非常に困難であり、一方、工業地域から１～２kmも離れると道路も電源もない水田や湿地帯になるため、我が国の常識に沿って測定局の配置を計画することは不可能である。結局、電源と安全と必要な広さの面から５点の候補地を選定し、ONEB側に借地交渉を委託した。

1) Bang Na 高層気象台構内

構内にあるONEB環境測定局建屋内に濃度測定機器を設置。日射計・放射収支計を露場内に、超音波風速計を周辺に設置予定。

2) Bang Plee 郡役場構内

役場前広場に濃度測定機器と微風向風速計を設置。収納庫が必要。

3) Samut Prakan県庁構内

濃度測定機器、収納庫。

4) 南バンコク火力発電所構内

濃度測定機器と微風向風速計を設置。

収納庫必要。

5) Phra Pradaeng 警察署構内

濃度測定機器、収納庫。

(6) 測定データ活用上の注意点

測定計画を見渡すと発生源データの充足に大きな制約がある。例えば自動車排気からの NO_x 排出量は大まかな推定によらざるを得ない。また、固定発生源の排出量はもちろん、

発生源リストも完備しておらず、本調査において何らかの方法で確定しなければならない。これらの基礎データを本格的に整備することは別個の独立したプロジェクトに匹敵するものであり、本調査の枠内で完璧を期すことは困難である。

このような状況から、各汚染質に関する作業の目標は次のように設定されよう。

1) 通年測定による現状環境レベルの把握は基準値や他所との比較でその妥当性を検討する。

2) SO_2 に関しては、バックグラウンドの寄与が多少大きいことが予想されるものの、現状のモデルシミュレーションにより諸発生源と環境濃度との関連を明らかにする。これにより確定されたモデルによって、将来改善を想定した煙源条件に対応する環境改善を予測する。

3) NO_x に関しては、発生源データが推定値にならざるを得ないことから、モデルの検証は行わず、SO_2 に関して確定されたモデルを準用する。NO、NO_2 の変換は考慮せず、NO_xとして扱う。実測環境レベルに対し主要固定源（一定規模以上の工場）と自動車の寄与率がどの程度かをモデルにより試算する。将来に関しては、SO_2 の場合の将来想定の一部（例えば高煙突化）についてのみ予測計算を行い、煙源におけるNO_x 低減技術とその効果については資料収集、紹介にとどめる。

4) SPM に関しては、CMB 法により発生源の種類別寄与率を明らかにし、化学分析の結果と合わせ、人為源による SPM汚染のレベルがどの程度であり、どのような改善が可能かを優先順位も考慮しつつ論じる。

VI. 本格調査における留意点

VI. 本格調査における留意点

1. 事前準備

(1) 業務指示書の作成

調査結果はタイ側を十分納得させるものでなければならない。このため、調査報告書が単なる数字の羅列に終わらぬ様、業務指示書の作成に際しては、十分配慮する必要がある。

(2) 調査用機材の調達

大気環境測定用機材の調達に際しては、タイ国の環境基準（ガイドライン）に定める測定方法に適合する機材を選定することが望ましい。

(3) ONEB側の準備作業

本格調査団の現地到着以前にONEB側が行わなければならない作業（機材の保管、設置用地の確保等）については、インセプションレポートを可能な限り早く送付する等ONEBと十分な連絡を取り、遺漏の無いように行わしめる必要がある。

2. 現地調査

(1) 調査目的

事前調査団とタイ側との協議において、個々の事業場における公害対策の改善指導について、タイ側から要望があった。しかし、本件調査の目的は、タイ王国政府が大気汚染管理計画を策定する際に必要となるデータ、情報等を提供することですでに合意しており、また、個別事業場に対する公害の改善指導を本格調査団が行うことは、日本政府による内政干渉と受け取られる可能性もあり、本件調査においてこれを行うことは適当ではない。従って、本格調査団に対し、タイ側から再度同様の要望があっても、安易に受け入れることのないよう、十分に指導監督していく必要がある。

(2) 調査対象汚染質

タイ側より、本件調査の対象物質であるSO_x、NO_x、SPM に加え、騒音、臭気、HCについても調査対象とするよう要望があった。これについてもSO_x、NO_x、SPM に限定することで合意しており、本格調査団に対し、再度要望があっても、本件調査では実施しないよう指導監督していく必要がある。

(3) 工業省への協力要請

工業省は工場に対する監督権限を有しているのでおり、工場調査等において調査の円滑な推進に同省の協力が必要と判断される場合には、ONEBを通じて協力を要請することが望ましい。

(4) 環境データ及び気象データ

通年の観測データとして評価するためには、いずれの観測局においても年間6000時間以上

の有効データが必要である。

3. 国内作業

（ONEB側分担作業の進捗状況の把握）

工場調査、観測局の保守等、調査団帰国後にタイ側が実施する作業については、その進捗状況等を適切に把握できるよう、タイ側と十分連絡を取り合う必要がある。

4. 報告書作成

最終報告書においては測定データ解析結果が膨大な分量になることが予想されるので、本調査の目的に鑑み、報告書は解説編と資料編に大別する。調査の経過、調査の各要素の手法説明、測定結果は資料編に収め、解説編では S/Wに示された調査の目的と項目を全面に出し、必要に応じ資料編を引用・再録しつつ、測定結果から各項の結論に至る論理的流れを重視した記述とすることが望ましい。

Ⅶ. SCOPE OF WORK

1. Scope of Work
2. Minutes of Meeting

SCOPE OF WORK

FOR

THE STUDY ON THE AIR QUALITY MANAGEMENT PLANNING

FOR

SAMUT PRAKAN INDUSTRIAL DISTRICT

IN THE KINGDOM OF THAILAND

AGREED UPON BETWEEN

OFFICE OF THE NATIONAL ENVIRONMENT BOARD,

MINISTRY OF SCIENCE, TECHNOLOGY AND ENERGY

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Bangkok, March 19, 1987

Sanit Ruyabhorn

(Mr.Pravit Ruyabhorn)

Secretary - General

Office of the National Environment Board

Ministry of Science, Technology and Energy

富田堅二

(Dr.Kenji Tomita)

Leader of the Preliminary

Study Team

The Japan International

Cooperation Agency

I. INTRODUCTION

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement the study on the air quality management planning for Samut Prakan Industrial District in the Kingdom of Thailand (hereinafter referred to as "the Study"), within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement of Technical Cooperation between the Government of Japan and the Government of Thailand signed on 5 November, 1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "J I C A"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the authorities concerned of the Kingdom of Thailand.

Office of the National Environment Board (hereinafter referred to as " O N E B "), Ministry of Science, Technology and Energy shall act as counterpart agency to the Japanese study team (hereinafter referred to as "the Team") and also as coordinating body in relation with other relevant organizations for the smooth implementation of the Study.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are to provide the Government of the Kingdom of Thailand with the necessary data and recommendations to establish an air quality management plan on the emissions mainly from industrial sources in Samut Prakan Industrial District. (hereinafter referred to as" the District")

III. SCOPE OF THE STUDY

In order to achieve the above objectives, the Study shall cover the following items :

1. To study the background and relevant conditions
   (1) Present system of the air quality control.
   (2) Governmental policy for industrialization.
   (3) Relation with the national development plan.
   (4) Available data and statistics.
   (5) Relevant laws and regulations.

2. To survey for the present situation of air pollution in the District

   (1) Monitoring survey for the District.
      a. Monitoring of meteorological conditions.
      b. Monitoring of ambient conditions on SOx,NOx and SPM.
   (2) Survey for emission sources related to SOx,NOx and SPM in the District.

3. To analyze the data and conditions

(1) Evaluation of the present conditions of air pollution in the District.

(2) Assessment of the future conditions of air pollution in the District.

(3) To analyze the main sources and their contribution ratio.

4. To recommend the management plan for improvement of the air quality in the District

(1) Method for reduction of the emissions from industrial sources.

(2) Planning for the monitoring system.

(3) Economical evaluation for the industrial activities caused by the reduction of the emissions.

(4) Necessary data and information for the short term and long term air quality control and management strategies.

5. Conclusions and recommendations

IV. STEPS AND SCHEDULE OF THE STUDY

1. Steps

Step 1 : Preparatory office work in Japan

Step 2 : Field work in Thailand

Step 3 : Home office work in Japan

Step 4 : Presentation of and discussion on the Draft Final Report

2. Schedule

As shown in Annex.

V. REPORTS

JICA will prepare and submit the following reports to the Government of Thailand :

1. Progress Reports written in English at the each end of the Step 2 : 10 copies
2. Draft Final Report and its summary written in English within twelve (12) months after commencement of the Step 3 : 15 copies
3. Final Report and its summary written in English within two (2) months after the receipt of comments on the Draft Final Report by Thailand : 30 copies

VI. UNDERTAKING OF THE GOVERNMENT OF THE KINGDOM OF THAILAND

1. In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand dated November 5, 1981, the Government of the Kingdom of Thailand shall accord benefits to the Team as follows ;

(1) to permit the members of the Team to enter, leave and sojourn in Thailand for the duration of their assignment therein and exempt them from alien registration requirements and consular fees.

(2) to exempt the members of the Team from taxes, duties and any other charges on equipment, machinery and other materials brought into and out of Thailand for the conduct of the

Study.

(3) to exempt the members of the Team from income taxes and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Team for their services in connection with the implementation of the Study.

(4) to bear claims, if any arises against the members of the Team resulting from, occuring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

2. To facilitate smooth conduct of the Study, ONEB shall take necessary measures in cooperation with other relevant organizations ;

(1) to secure permission for entry into private properties or restricted areas for the conduct of the Study.

(2) to secure permission for the Team to take all data and documents (including photographs and maps) related to the Study out of Thailand to Japan.

(3) to provide the medical services as needed. (Its expenses will be chargeable on members of the Team.)

(4) to ensure the safety of the members of the Team when and as it is required in the course of the Study.

(5) to make the best efforts to ensure the securities of machinery, equipment and materials brought into Thailand for the conduct of the Study.

3. ONEB shall, at its own expense, provide the Team with the following:

(1) available data and information related to the Study.

(2) counterpart personnel.

(3) suitable office space with necessary equipment.

(4) suitable sites and spaces for monitoring stations, laboratory facilities and storage.

(5) local transportation facilities.

(6) utilities such as electric power supply for the monitoring stations and points.

(7) workers for setting up the monitoring stations and points.

(8) daily operation of the monitoring stations and points.

(9) credentials or identification cards.

VII. UNDERTAKING OF JICA

For the implementaion of the Study, JICA shall take following measures;

1. to dispatch, at its own expense, study teams to Thailand
2. to pursue technology transfer to the Thai counterpart personnel in the course of the Study

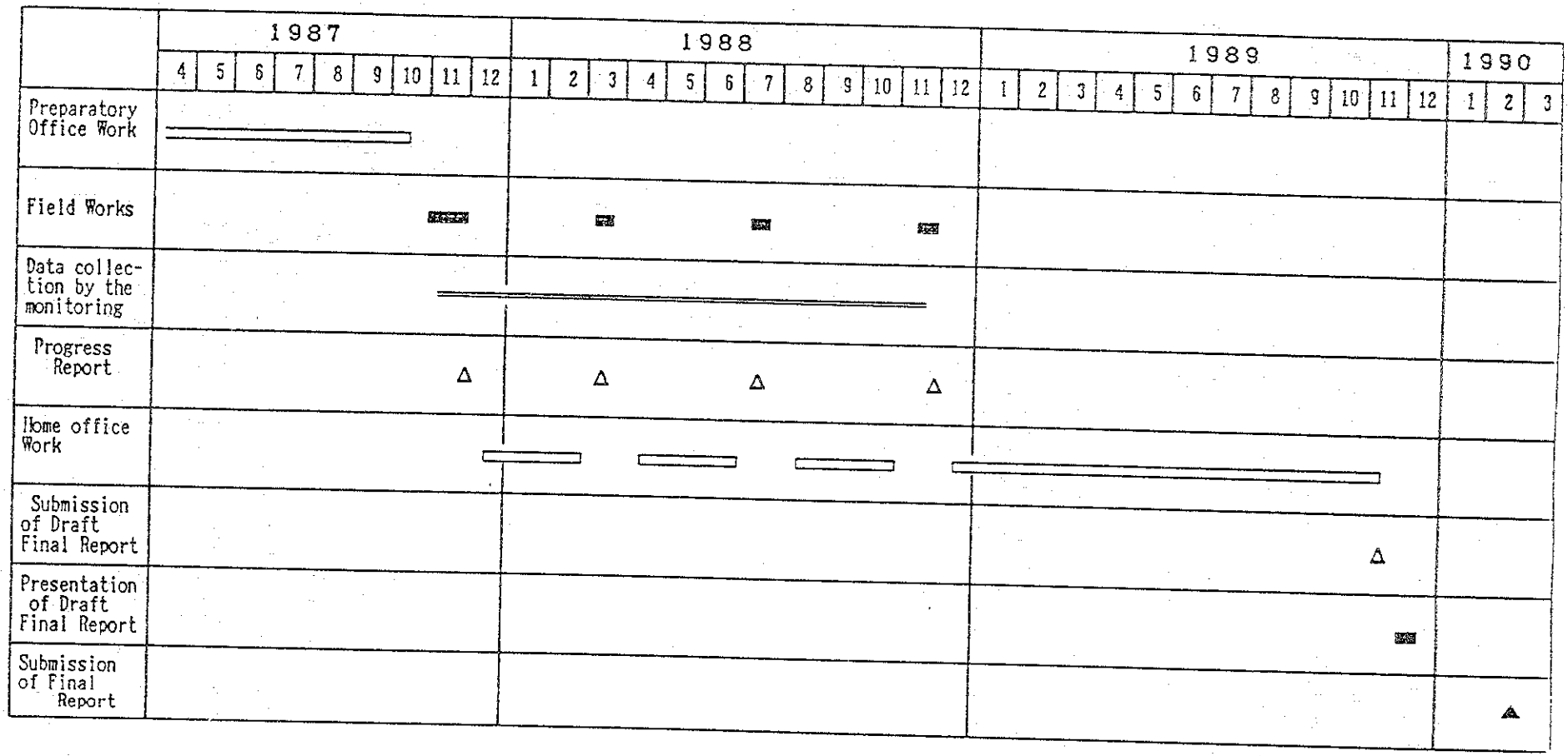
VIII. OTHERS

JICA and ONEB will consult with each other in respect of any matter that may arise from or in connection with the Study.

Annex

Tentative Schedule of the Study.

Monitoring Survey ═══ Work in Japan ▭ Work in Thailand ▬



MINUTES OF MEETING

FOR

THE STUDY ON THE AIR QUALITY MANAGEMENT PLANNING

FOR

SAMUT PRAKAN INDUSTRIAL DISTRICT

IN THE KINGDOM OF THAILAND

Bangkok, March 19, 1987

Pravit Ruyabhorn

(Mr.Pravit Ruyabhorn)
Secretary - General
Office of The National Environment Board
Ministry of Science, Technology and Energy

富田堅二

(Dr.Kenji Tomita)
Leader of the Preliminary
Study Team
The Japan International
Cooperation Agency

The Japanese Preliminary Study Team on the Air Quality Management Planning for Samut Prakan Industrial District in the Kingdom of Thailand (hereinafter referred to as "the P/S Team") has visited Thailand from March 9 to 21 , 1987 and exchanged views and discussions with the authorities concerned of the Government of the Kingdom of Thailand.

As the result of a series of discussions, the Leader of the P/S Team and the Secretary-General of Office of the National Environment Board (ONEB) both have agreed on the Scope of Work for the Study (hereinafter referred to as "the S/W") on March 19,1987.

The followings are the matters posed in the course of the meeting with the P/S Team and ONEB regarding the S/W.

1. Information on Emission Sources

1.1 The P/S Team requested for the preliminary information on the emission sources in the District.

ONEB agreed that the above information including Name of Factory, Type of Industry, Name of Owner/Manager, Location, Indication on the Map, Consumption of Raw Materials, Capacity of Production, Capital Investment, Number of Workers, etc., should be made available by the end of April 1987.

1.2 The P/S Team and ONEB agreed that in the course of the Study, survey to the emission sources will be implemented by ONEB under the guidance of the Team and the format of the questionnaire to the emission sources will be prepared by the Team.

2. Monitoring Stations and Points

Based on the joint field survey by the P/S Team and ONEB, the following monitoring stations and points were proposed. The P/S Team confirmed that the necessary measures for the preparation of these

monitoring sites should be taken by ONEB as soon as possible.

1) Bang Na

The site at the Bang Na Meteorological Office, Department of Meteorology, Ministry of Communications.

2) Bang Plee District

The Site at the Bang Plee District Office.

3) Muang District

The site at the Samut Prakan Provincial Government Office.

4) Muang District

The site at the South Bangkok Power Station.

5) Phra Pradaeng District

The site at the police station of Phra Pradaeng District.

In the cases that one or more of these proposed sites are not available, ONEB will find alternative sites and inform JICA as soon as possible.

3. Instruments and Materials

The P/S Team and ONEB agreed that the following instruments and materials are necessary for the Study, and ONEB requested these instruments and materials to be donated to ONEB after the completion of the Study without the request by Form A-4.

1) Continuous measurement instruments for SOx	: 5 sets
2) Continuous measurement instruments for NOx	: 5 sets
3) Continuous measurement instruments for SPM	: 5 sets
4) Low-volume air samplers	: 10 sets
5) Andersen air samplers	: 5 sets
6) Pyranometer	: 1 set
7) Net radiometer	: 1 set

8) Anemometers : 3 sets

9) Telemetric printer with five (5) dataloggers : 1 set

10) Others

4. Schedule

4.1 ONEB requested that the schedule of the Study should be shortened.

4.2 Related to the above, the P/S Team explained the details of the schedule of the Study and ONEB is satisfied with the explanations.

5. Technology Transfer

ONEB requested that two (2) ONEB officers to work with data analysis and modeling in Japan for the period of one month or more at the expense of the Government of Japan.

The attendance list is in Annex 1.

Annex 1.

LIST OF ATTENDANCES

JAPANESE SIDE

1. DR. KENJI TOMITA

   LEADER, SPECIAL TECHNICAL ADVISOR

   JAPAN INTERNATIONAL COOPERATION AGENCY

2. MR. KYO SAISU

   ENVIRONMENTAL PROTECTION POLICY

   MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY (M.I.T.I.)

3. DR. TAKEHIRO ISEI

   MEASUREMENT AND ANALYSIS TECHNIQUES

   NATIONAL RESEARCH INSTITUTE FOR POLLUTION AND RESOURCES (M.I.T.I.)

4. MR. HIROSHI YOSHIKADO

   ENVIRONMENTAL ASSESSMENT

   NATIONAL RESEARCH INSTITUTE FOR POLLUTION AND RESOURCES (M.I.T.I.)

5. MR. KIYOTO KUROKAWA

   COORDINATOR

   INDUSTRIAL SURVEY DIVISION, JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF ATTENDANCES

THAI SIDE

1. MR. SIRITHAN PAIROJ-BORIBOON

   DIRECTOR OF ENVIRONMENTAL QUALITY STANDARD DIVISION

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

2. MR. PORNCHAI TARANATHAM

   CHIEF OF INDUSTRY, ENERGY AND MINERAL RESOURCES SECTION

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

3. DR. SANGSANT PANICH

   ACTING-CHIEF OF AIR AND NOISE SECTION

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

4. MRS. NOPPAPORN PANICH

   ENVIRONMENTAL OFFICER

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

5. MRS. JANTANEE WATTANAKOM

   ENVIRONMENTAL OFFICER

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

6. MR. KHUNCHAI KRIENGKRAI-UDOM

   ENVIRONMENTAL OFFICER

   OFFICE OF THE NATIONAL ENVIRONMENT BOARD

7. MR. PAILIN PAIROH

   PROGRAMME OFFICER

   DEPARTMENT OF TECHNICAL AND ECONOMIC COOPERATION

Ⅷ. 參考資料

PROJECT TITLE : Air Quality Management Planning for Samuth Prakarn Province, Thailand

REQUESTING AGENCY : Office of the National Environment Board (ONEB) Ministry of Science, Technology and Energy

PROPOSED SOURCE OF ASSISTANCE : The Government of Japan

1. Background Information and Justification for the Project

According to a data book published in this year 1985 in Japan, a considerable number of Japanese enterprises (including joint ventures with THAI Companies) have already run business in Samuth Prakarn Province. At present, this province can be stated as the only industrial province in Thailand. There, industries numbering more than 2000 with 94 different types of industry (of the total of 99) are located. The SAMUTH PRAKARN Province is going to extend the registration of population, factories and automobiles. The environmental conditions in this province is consequently deteriorated rapidly which raises concerns from related authorities which have received complaints from local residents all the time. It is considered essential that a study be undertaken on their possible environmental effect. Studies on water pollution in this area have been conducted to obtain central treatment facilities with an appropriate operation system. However, air pollution problems in Samuth Prakarn Province have been taken place but so far no remedial actions or any management plans for air pollution in this area are existed. One reason may be the fact that industries have been located without proper zoning. Together with lack of long-term environmental control program, the province suffers from all kinds of environmental problems.

To eshablish an air quality management plan for Samuth Prakarn Province, it is necessary that technical and financial supports have to be available.

2. Detail of the Project

2.1 Goal

Air Quality in Samuth Prakarn Province shall be clean and safe for human health from the pollution resulted from industrial activities and vehicles within 3 years after implementation of the expected management or action plan to be established in this project.

2.2 Objectives

(1) To study air pollution effects which resulted from factories and automobiles in Samuth Prakarn Province,

(2) To study possible improvement of air quality in this area with the following aims;

(i) develop appropriate air quality standards (healthy and applicable) of both emission and ambient ones for this industrial zone,

(ii) establish a series of priorities and a schedule of activities as part of an overall short-and long-term management plan,

(iii) establish a comprehensive monitoring program,

(iv) prepare short-term and long-term air quality control and management strategies,

(v) recommend the requirements and improvement to be imposed on each source of pollution in Samuth Prakarn Province.

(3) To conduct the project as an On-the-Job training programme for NEB and related agencies' staff/personnels especially in air pollutant analysis, data handling, and monitoring system.

2.3 Results Expected Upon Completion of the Project

After the completion of the project, Thailand shall have a master plan of air pollution management for Samuth Prakarn Province which will serve as an important tool for area-wised environmental protection, and serve as a management model for other industrial areas.

2.4 Recommended Sources of Information and Data Related to the Project (for Project Verification)

(1) Records of complaints at the Provincial Industrial Office of Samuth Prakarn Province and related agencies.

(2) Air Quality data of Samuth Prakarn area conducted by Office of the National Environment Board and Department of Health.

(3) Middleton, John T..Air Pollution Control in Thailand, ONEB, 1979

(4) Others; e.g. Industrial Inventory, Population Statistics, etc.

2.5 Project Sites

The target area is Samuth Prakarn Province and Office operation is at ONEB.

2.6 Project Work Plan and Activities

(1) Study the climatic and meteorological conditions for one year at Samuth Prakarn Province, particularly wind velocity, wind direction, temperature, and solar and net radiation.

(2) Determine the environmental effects in terms of air quality and noise distribution from industrial complex and automobiles in Samuth Prakarn and surrounding areas. This will be accomplished by the theoretical analysis method by microcomputer of environmental effects, particularly a gas diffusion model for air quality and sound distribution model for noise pollution.

(3) Prepare the detailed emission inventories for industries and automobiles.

(4) Installation of permanent monitoring stations;

(i) to install permanent monitoring stations in typical places of Samuth Prakarn Province in order to obtain the necessary data,

(ii) monitoring of the following items of air quality,

a) meteorological data in some typical points,

b) SO_x, SPM, at necessary number of points in the Province,

(iii) to study the systematic and effective monitoring system based upon the experience and practices in Japan, taking into consideration problems expected to be occurred in adapting the system into the local site.

(5) Study the related regulations for environmental improvement.

(6) Study the emission control system against air pollutions, especially cost benefits, operation and maintenance method,

(7) Study for alternatives of air quality standards for Samuth Prakarn Province.

(8) Cost estimation of technical facilities against air pollution and assess the best applicable air pollution control technology and economic impact on the industries.

(9) Prepare short-term and long-term air pollution management strategies including priorities and schedule of the activities for appropriate abatement and control of the air pollution.

2.7 Tentative Work Plan and Schedule:

Task Description \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Existing Air Quality and Meteological Study (available existing data and field measurements)				△		*			*			*				○		□
2. Data analysis and environmental impact assessment																		
3. Emission inventories																		
4. Study on related regulations and air pollution control system																		
5. Study on alternatives of air quality standards and their expected impacts.																		
6. Prepare short-term and long-term management plan																		

△ Inception Report

* Progress Report

○ Interim Report

□ Final Report

3. Assistance Requested

Request for Japanese experts and necessary equipments to fulfill the objectives and the tasks described in items 2.2 and 2.6

タイ王国サムットプラカン工業地区大気汚染管理計画事前調査

事前調査団派遣対処方針

国際協力事業団　鉱工業計画調査部

工業調査課

昭和６２年３月４日

Ⅰ．　要請の背景及び事前調査団派遣の経緯

1．タイ王国は、1960年代より強力に工業化を推し進めてきたが、急激な工業化により様々な社会問題をかかえる事となった。

これらの対策のうち環境問題に対しては、1975年に国家環境質保全向上法が制定され、国家環境委員会(ONEB)が設立された。

2．首都バンコクに隣接する、サムットプラカン県はタイ湾に面し、工場の立地条件に恵まれ、日本から進出した企業も含め約3000社が立地するタイ王国内最大の工業県である。

3．しかし、環境値、排出基準値の管理に対しては、他国のそれをそのまま借用した、ガイドラインとしてのものしかない。

また、現在の環境値が具体的にどの程度であるか、測定する技術が不足している為、管理が行い得ない状況にある。

4．同地域は、今後も工業化が進展する事から、タイ側は昭和60年 8月、我が国に同地域の大気汚染管理計画の策定に関する技術協力を要請した。

Ⅱ．　事前調査団派遣の目的

1．要請の背景、内容の調査・確認

2．プロジェクトの内容調査・確認

3．本格調査にかかる S/Wの協議・署名

4．本格調査実施のための関連情報の収集

Ⅲ．　要請の内容

上記プロジェクト選定確認調査団訪問時（昭和61年 3月）表明されたタイ側の要請概要は次の通りである。

1．サムットプラカン県の工場及び自動車に起因する、大気汚染及び騒音の影響を調査する。

2．同地区の大気環境の改善可能性調査

(1) 同地区に適切な大気環境、排出基準値

(2) 対策に優先度及びスケジュール

(3) 総合的監視計画

(4) 短期、長期の大気汚染管理計画

(5) 発生源に課すべき削減計画

3．日本におけるカウンターパートの研修

Ⅳ．　調査団の構成・・・・・・・別紙

Ⅴ．　調査日程・・・・・・・・・別紙

Ⅵ．　S/M 案・・・・・・・・・・別紙

Ⅶ. 対処方針

1. タイ側の要請内容に対する日本側の調査実施基本方針

(1) 調査の範囲

1. 調査の対象汚染質は、必要に応じて、SO_x、NO_x、SPM とする。
2. 騒音について要望があれば、自動車は含めず、特定工場の騒音に限定する。
3. 本地区に於ては、住居と工場の無秩序な立地も問題とされているが、工場立地、土地利用計画の作成立案などは、調査の範囲に含めない。
4. 住民の苦情についての調査は要請が出ても、含めないが既存の資料があれば参考とする事ができる。
5. 上層気象（上空二千メートル程度）の測定（気球測定）は原則として行わない。ただし大気乱流測定（高度30メートル程度）は必要に応じて行い得るものとする。
6. 排出源調査を行う工場の数は、数百社程度と想定されるが、調査の内容にもよるので、実施可能な範囲で調査団の判断で決める事ができるものとする。

(2) 調査方法

1. 具体的環境基準値の決定については、タイ側の内政問題でもありタイ王国政府の判断にゆだねる。
2. タイ側より大気拡散モデルなどの電算機ソフトの提供を求められた場合は、著作権の問題もあるのでことわる。
3. タイ側と日本側の作業分担のなかで、工場群に対するアンケート調査は、内容手法については日本側が指導し、実際の個別面接調査における実行、回収、集計についてはタイ側が責任を持つこととする。
4. 調査に必要な調査機材は、タイ側に調査終了後供与できるものとし、機材の通関には万全を期するため、タイ側よりA_4フォームを提出するように求めその旨ミニッツに記載する。
5. 測定機材のメインテナンス費用（電気代、保守要員の人件費等）はタイ側が負担することとし、工場のアンケート調査にかかる費用は原則としてタイ側負担とするが、本格調査の期間内で調査回収が可能とみられる場合は、調査団の判断で日本側も一部又は全部、負担できるものとする。

(3) その他

1. カウンターパート及び S/Wの署名者について

   タイ側のカウンターパート機関は、国家環境委員会事務局(ONEB)となっているが、タイ国における工場監督は、工業省となっていると思量されるところ、それらの業務所管（責任体制）及び本件プロジェクトへの協力体制について、タイ側の確認をとりつける。また、署名者についても上記の点を確認のうえ、工業省の署名参加要請を

検討し、柔軟に対応できるものとする。

2. 調査期間について

タイ側より調査期間の短縮を要請された場合、事前調査団の調査結果及び調査範囲についての、タイ側との協議結果を踏まえて、調査団の判断に一任する。

3. カウンターパート研修について

タイ側よりカウンターパートの日本における研修を要請された場合は、聞き置くに留める。但し、要請のあった旨をミニッツに書きおくことが要請された場合は、ミニッツに記載できるものとする。

Questionnaire
for
the Study on the Air Quality Management Planning for Samuth Prakarn Province in the Kingdom of Thailand

by
The Preliminary Survey Team,
JICA

Note: "the Province" ; Samuth Prakarn Province
"the Study" ; the Study on the Air Quality Management Planning for the Province

1. Policy of the Central and Local Governments

1.1 Distinction of the roles for the management of environment between central and local governments.

1.2 Subsidy system for the investment to the installation of pollution control equipment and facilities by private sectors.

1.3 Present laws, rules, regulations for environment management and pollution control by the authorities of the Province.

1.4 Administrative organization chart of the Province.

2. Present Situation of Man-Power (Researchers, Engineers, Technicians and Operators) for the Measurement and Analysis of Environments

2.1 ONEB

2.2 IWD,MOI

2.3 the Province

2.4 Chulalongkorn University

2.5 Others

3. Present Situation of Research Instiutes, Laboratories and Observatories related to Environment Management

3.1 ONEB

3.2 IWD, MOI

3.3 the Province

3.4 Chulalongkorn University

3.5 Others

4. Present Situation of Energy

4.1 Consumption and sulphur content of oil and coal used in the Province.

4.2 Consumption of substituted energy for oil (Natural gas, firewood etc)

5. Meteorological and Ambient Data in the Province

5.1 Wind direction

5.2 Wind velocity

5.3 Temperature

5.4 Humidity

5.5 Solar radiation

5.6 SO_x

5.7 SPM

6. Maps necessary for the Study

6.1 Plan of Bangkok and vicinity

6.2 Plan of the Province

6.3 Distribution of plants and factories in the Province

6.4 Location of smokestacks in the Province

6.5 Road indication in the Province

7. List of the Existing Equipment and Facilities available for Measurement, Analysis and Observation in the Study

Item	Specification	No	Location of installation

8. Proposed Monitoring Station for the Study

8.1 Proposed sites for monitoring station in the Province

8.2 Condition of electricity available for the station (voltage, frequency, powerfailure, etc)

8.3 Availability of telephone line for the station

ANSWER TO THE QUESTIONNAIRE

1. POLICY OF CENTRAL AND LOCAL GOVERNMENTS

1.1 ALL POLICIES ARE FROM CENTRAL GOVERNMENT. LOCAL GOVERNMENTS ONLY ACT ACCORDING TO DIRECTION TO CENTRAL GOVERNMENT.

1.2 NO SUBSIDY SYSTEM. POLLUTION CONTROL OR ENERGY SAVING MACHINES MAY BE TAX-REDUCED (THROUGH A COMMITTEE IN THE MINISTRY OF SCIENCE, TECHNOLOGY AND ENERGY, BUT THE COMPANIES MUST MAKE A REQUEST.

1.3 AUTHORITIES OF THE PROVINCE HAVE NO LAW REGARDING ENVIRONMENTAL MANAGEMENT (SEE 1.1), BUT IN SOME CASES ISSUE REGULATIONS FOR POLLUTION CONTROL (USUALLY IN CASES OF COMPLAINTS), BUT THIS IS USUALLY DONE WITH CONSULTING WITH CENTRAL GOVERNMENT. THIS IS BECAUSE PROVINCIAL AUTHORITIES HAVE NO ENVIRONMENTAL PEOPLE AND LITTLE EXPERIENCES.

1.4 GIVEN IN THE BOOKLET.

2. PRESENT SITUATION OF MANPOWER

2.1 ONEB AIR (13) WATER (ABOUT 15) SOLID WASTE (8) CANNOT CLASSIFY AS RESEARCHERS/ENGINEERS SINCE ONES WORK IS NOT IN THOSE LINES, CAN BE CLASSIFIED AS TECHNICIANS.

2.2 IWD, MOI AIR (20) AS ENGINEERS (YOU ALREADY NOTED)

2.3 PROVINCE 5 INSPECTORS

2.4 CHULALONGKORN U. PLEASE INQUIRE DR. SURIN

2.5 OTHERS RESEARCHERS IN UNIVERSITY BUT THEY WORK FOR MANY VARIETY OF PROJECTS, ENGINEERS, TECHNICIANS & OPERATORS ARE ALSO NOT "PURE" ENVIRONMENTALISTS BUT WORK ACCORDING TO GRANTS, PROBLEMS, SUCH AS BANGKOK METROPOLITAN ADMIN, DEPT. OF PUBLIC HEALTH. GOVERNMENT OFFICERS LIKE THESE ARE NOT RESEARCHER OR

ENGINEERS / TECHNICIANS / OPERATORS, BUT WORK ON CASES. IF YOU ASK WHO WORK IN AIR POLLUTION WE CAN SAY THAT IN THE WHOLE COUNTRY THERE ARE 2 OR 3 ACTIVE RESEARCHERS AT CHULALONGKORN UNIVERSITY, AND ONLY TWO AGENCIES MONITOR AIR POLLUTION IN BANGKOK, ONEB (13 PEOPLE) AND DEPT. OF PUBLIC HEALTH. COURSES IN AIR POLLUTION ARE GIVEN AT CHULALONGKORN UNIVERSITY (ASSOC. PROF WONGPAN LIMPASENI AND DR. WICHITRA JONGWISAL), KASETSART UNIVERSITY, MAHIDOL UNIVERSITY (DR. SANGSANT PANICH FROM ONEB) AND AIT (DR. PAKIT KIRAVANICH, FORMER DEPUTY-SECRETARY GENERAL OF ONEB, NOW INSPECTOR GENERAL OF MINISTRY OF SCIENCE TECHNOLOGY AND ENERGY). THAT IS ALL.

3. PRESENT SITUATION

ONLY ONEB TAKES ACTIVE ROLES IN ENVIRONMENTAL MANAGEMENT WITH WORKS FOR EASTERN SEABOARD AIR QUALITY MANAGEMENT PLANNING AND OTHERS. IWD AND PROVINCE DO NOT HAVE ANY, AND UNIVERSITIES PRACTICALLY HAVE VERY LITTLE TO DO WITH AIR POLLUTION. MOST WILL BE INTERESTED IN WATER POLLUTION, AS THEY ARE TRAINED THAT WAY.

LABORATORIES FOR AIR POLLUTION - ONEB (LARGEST)
- CHULALONGKORN U. VERY SMALL
- DEPT. OF PUBLIC HEALTH "
- MOI, IWD "

EVERY AGENCIES IN THAILAND REGARD ONEB AS CENTER AND MOST COMPLETE LABORATORY AND AIR POLLUTION NETWORK. BUT ONEB IS NOT FOR PURE RESEARCH!

ONLY TWO Ph.D. IN AIR POLLUTION IN COUNTRY (DR.WICHITRA JONGWISAL AT CHULALONGKORN UNIV., (AIR POLLUTION CONTROL ENGINEERING) AND DR.SANGSANT PANICH (ONEB - AIR POLLUTION

MODELLING) AND VERY FEW MASTER'S DEGREE. NO DEGREES IN AIR POLLUTION OFFERED IN THAILAND EXCEPT SOME THESES ARE DONE IN AIR POLLUTION BUT NOT VERY DEEP SINCE PROFESSORS ARE NOT EASILY AVAILABLE.

4. PRESENT SITUATION OF ENERGY

4.1 CANNOT ANSWER THE CONSUMPTION AS WE HAVE NO DATA. FOR THE WHOLE COUNTRY OIL HAS ABOUT 3% S CONTENT FOR FUEL OIL AND 1% FOR OTHERS (DIESEL, GASOLINE). ALMOST NO S FOR NATURAL GAS. COAL IS NOT USED IN LARGE QUANTITIES. IN PROVINCE ONLY OIL, AND NATURAL GAS.

4.2 FIREWOOD IS NOT USED WIDELY ANY MORE (EXCEPT FOR SMALL INDUSTRIES - BUT FIREWOOD IS GETTING MORE EXPENSIVE).

5. METEOROLOGICAL AND AMBIENT DATA

AVAILABLE DATA ARE ALREADY GIVEN TO YOU.

6. MAPS

WILL MAIL TO YOU IN 1 MONTH.

7. LIST OF EXISTING EQUIPMENT AND FACILITIES

ACCORDING TO YOUR OBSERVATION TOURS.

ONEB MAINTAIN ONE STATION FOR AIR POLLUTION MONITORING AT BANGNA WHICH YOU ALREADY VISITED. (ALSO THE LOCATION OF METEOROLOGY STATION).

8. PROPOSED MONITORING STATION

8.1 ACCORDING TO YOUR OBSERVATION TOURS.

8.2 220 V., 50 HZ, GOOD MAINTENANCE OF ELECTRICITY IN THE PROVINCE.

8.3 AVAILABILITY OF TELEPHONE LINE : IF THE EXISTING LINE CAN BE USED TOGETHER WITH TELEMETER, WITHOUT LOSS OF SERVICE TO OTHER USERS THERE SHOULD BE NO PROBLEM. HOWEVER IF NEW LINES

HAVE TO BE INSTALLED THERE MAY BE SOME PROBLEM (TELEPHONE INSTALLATION FOR NEW LINES TAKE QUITE LONG TIME IN SOME AREAS).

Number of factories in Samuth Prakarn with air pollution (Industrial work Department) as end of 1985

Type or industry	Number	Those which cause complaints
seed and grain shelling	4	-
seed and grain curing	8	3
seed and grain storage	6	4
rock and gravel mill	1	1
rice mill	3	-
flour mill	9	2
agricultural product processing	6	2
noodle plant	13	-
food additive manufacturing	44	2
feedmill plant	7	7
preparation of material for feedmill prant(I.E.FISHMEAL PLANTS)	24	13
wood and timber preparation	69	2
bullaing material made of wood	44	1
wood utensils	40	2
furniture manufacturing	51	3
paper industry (not pulp mill)	9	2
non-agriculture chemicals (I.E.H_2SO_4)	25	7
agriculture chemicals(I.E.PESTICIDES)	9	3
plastic manufacturing	8	4
paints and varnish	27	3
wetting agents, emulsifiers	16	2
incense	8	1
tyres (FOR AUTOMOBILES)	13	4
rubber products	13	2
rubber treatment (ANY TYPES)	40	3
cement or plaster production	1	-
concrete products	32	1
asbestos products	2	1
iron and steel industry (LARGE & SMALL)	106	14
nonterrous metal production	38	19
metal furniture	16	1
metal utensils	43	5
metal tubing for householas	9	-
small metal shops	21	2
enamelling, japaning, lacquering	27	12
light bulbs	8	-
electric wires	14	4
battery production	12	7
spare parts for bi-and-tricycles	46	4
TOTAL	872	143

『THAILAND NATURAL RESOORCES PROFILE』
by THAILAND DEVELOPMENT RESEARCH INSTITUTE (JDRI)
Jon. 1987

9 Air and Noise Quality Management

9.1 OVERVIEW AND INVENTORY

Emission Sources

Air pollutant emissions originated mainly from the burning of fuels such as petroleum products, lignite and coal, which are collectively classified as "modern" or "commercial" energy, whereas those from the burning of fuel wood, bagasse, paddy husk and charcoal, are called "traditional" energy.

In 1982, which is taken as the base year for this study, secondary energy[1/] consumption amounted to about 17,400 MMLCOE (Table 9.1). Most energy was used in the transport (29.4 percent) and household sectors (28.2 percent), followed by industry (21.1 percent). Agriculture accounted for about 10.8 percent, the service sector 7 percent and fisheries 3.5 percent.

Modern energy accounted for 62.4 percent of total secondary energy consumption in 1982. The most important type of modern fuel is petroleum products, which accounted for 52.2 percent of total secondary energy use in 1982, followed by electricity (8.1 percent) and lignite/coal (2 percent) (Table 9.2). The balance of 37.6 percent is in the form of traditional energy, which continues to be a very significant energy source, particularly in households. Charcoal is the most important type, estimated at 15.4 percent of total secondary energy, followed by fuel wood (14.3 percent), bagasse and paddy husk (7.9 percent in total).

Source Characteristics

While the volume of emissions is the primary factor in air pollution, impacts are also influenced by air pollutant dispersion and the nature of the affected area.

Transportation sources have the greatest impact on air pollution, due to their dominant role in fuel consumption, large emission factors (Table 9.3) and concentration in populated areas. In 1985, there were more than three million motorized road vehicles, including two-wheel and three-wheel motorcycles. They continue to be the cause of city-wide air pollution problems, including smog.

The household sector, which ranks second in terms of energy demand (28 percent of total secondary energy in 1982), has much less impact on air quality. Urban households, which account for only four percent of total secondary energy use, derive most energy from charcoal (47 percent) and electricity (34 percent). Most air pollutant emissions in this sector come from rural households, which account for 24 percent of total secondary energy,

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1/ Secondary energy is defined as the energy delivered to the end-user; e.g. electricity, petroleum products, natural gas as fuel to industry, charcoal to households. (NESDB, 1985).

Table 9.1 Secondary Energy Demand by Sector, 1982

Sector	Amount (MMLCOE)	Share (%)
Agriculture	1,890	10.8
Fisheries	611	3.5
Industry	3,684	21.1
Transport	5,119	29.4
Service	1,224	7.0
Household: Urban	696	4.0
Rural	4,218	24.2
Total	17,441	100.0

Source: NESDB, 1985

Table 9.2 Energy Demand, 1982

Type of Energy	Amount (MMLCOE)	Share (%)
MODERN		
Petroleum Products	9,130.6	52.2
Gasoline	(1,753.3)	(10.0)
Diesel	(4,008.2)	(23.0)
LPG	(419.8)	(2.4)
Fuel oil	(1,501.1)	(8.6)
Kerosene	(421.0)	(2.4)
Jet Fuel	(1,000.2)	(5.7)
Natural Gas	0.0	0.0
Electricity	1,415.6	8.1
Coal/Lignite	344.3	2.0
Sub-Total	10,863.5	62.4
TRADITIONAL		
Bagasse	1,243.1	7.1
Charcoal	2,691.5	15.4
Fuel Wood	2,500.1	14.3
Paddy Husk	143.0	0.8
Sub-Total	6,577.7	37.6
TOTAL	17,441.2	100.0

Source: NESDB, 1985

mostly from charcoal (52 percent) and fuel wood (39 percent). Rural household sources, however, are widely dispersed, hence any adverse impact is limited to the local community.

Industrial processes may emit particulates and other pollutants such as hydrogen sulfide, organic solvents, heavy metals and odor.

Power generation supplies about 8.1 percent of the total secondary energy requirements. Although new power plants are usually located in remote areas, there are two existing ones with the total generating capacity of 637.5 MW in Bangkok Metropolis (national power generation capacity totaled 5,853 MW in 1984).

Estimated Emissions from Combustion Sources

Emissions from combustion sources in 1982, which was taken as the base year, were estimated from energy consumption and emission factors. The emission factors were based on *Rapid Assessment of Sources of Air, Water and Land Pollution* (WHO Geneva, 1982), supplemented by the US EPA's *Air Pollutant Emission Factors* (EPA, AP-42, 1976). These factors are given in Table 9.3. No emission control was assumed for the base case.

The amount of energy used in this study is based on *Macroeconomics Situation and Prospects for Energy Demand in Thailand, 1985-2001* (Table 9.4). Its definitions of energy, which include electricity as secondary energy, have been adopted here.

On a country-wide basis, only major air pollutants are included in the estimates. These pollutants are particulates, sulfur dioxide (SO_x), nitrogen oxides (NO_x), hydrocarbons (HC) and carbon monoxide (CO). Almost all of these pollutants except particulates are accounted for by fuel burning sources. For particulates, the cement and iron industries are the major industrial sources, while transportation of agricultural products and open field burning are the major fugitive dust sources. The inventory focused on fuel burning sources, and included industrial processes where appropriate.

Table 9.3 Emission Factors for Combustion Sources (kg/ton of fuel)

Sources	Type of Fuel	SPM	SO_2	NO_x	HC	CO
Power plants	Fuel oil residue	1.04	69.6	13.2	0.13	0.66
	Natural gas	0.29	0.056	11.5	0.019	0.32
	Lignite	56	30	7	0.5	0.5
	Coal	1.2	13.3	9	0.15	0.5
Industrial and commercial furnaces	Diesel	2.13	20.1	7.5	0.41	0.59
	LPG	0.38	0.0068	2.6	0.65	0.35
	Fuel oil distillate	2.13	60.3	7.5	0.41	0.59
	Kerosene	3	3.4	2.3	0.4	0.25
	Natural gas	0.34	0.056	3.6	0.058	0.32
	Coal/lignite	56	30	3	0.5	1
Domestic furnaces	LPG	0.42	0.0068	1.8	0.17	0.44
	Fuel oil distillate	1.42	60.3	1.8	0.41	0.71
	Kerosene	3	3.4	2.3	0.4	0.25
	Bagasse	8	-	0.6	-	-
	Fuel wood	13.7	0.5	5	1	1
Vehicles	Gasoline	2.0	0.54	10.3	14.5	377
	Diesel	2.4	19	11	2.6	43.5
	LPG	0.03	-	0.52	0.28	1.7
Boats	Diesel	-	2.7	27	5.1	11

Sources: WHO, 1982 and USEPA 1976.

The results of the inventory exercise are shown in Table 9.5. It can be seen that transportation sources represent the major emission source of CO (60 percent) and HC (46 percent), as well as NO_x (23 percent). Transportation is solely responsible for high ambient CO concentrations along busy streets in major cities. It is also largely responsible for photochemical smog formation, due to the reaction of HC and NO_x in sunlight. Power generation sources (assuming no emission control) and industrial sources combined account for 82 percent of SO_x emission, 54 percent of particulates emission and 44 percent of NO_x emission. The siting of power plants and industrial plants away from highly populated areas helps reduce their overall impact. However, the two power plants cited earlier and industrial plants in Bangkok have been identified as the principal air polluters.

Household and agricultural sources emit a significant proportion of the particulates (42 percent, when combined), due to poor combustion of traditional fuels, such as fuel wood and bagasse. However, these sources are widely distributed and in most cases have no impact on the public, apart from the energy consumers themselves.

To put the air pollution problem in Thailand into perspective, the country's emissions are compared with those of the United States, and the Organization for Economic Cooperation and Development (OECD) countries (Table 9.6). In terms of sheer magnitude, Thailand emits about

Table 9.4 Composition of Energy Demand by Type of Energy in 1982, Base Case (MMLCOE)

Type of Energy	Agri-culture	Fisheries	Industry	Trans-portation	Service	Household		Total
						Urban	Rural	
Petroleum products	324.6	557.6	2,222.3	5,041.6	639.1	86.2	232.2	9,103.6
Gasoline	88.7	1.5	346.2	966.0	350.9	0.0	0.0	1,753.3
Diesel	185.1	535.2	268.6	2,925.6	93.7	0.0	0.0	4,008.2
LPG	1.8	8.1	60.5	147.8	90.9	82.9	27.8	419.8
Fuel oil	5.2	0.0	1,493.9	2.0	0.0	0.0	0.0	1,501.1
Kerosene	43.8	12.8	53.1	0.0	103.6	3.3	204.4	421.0
Jet fuel	0.0	0.0	0.0	1,000.2	0.0	0.0	0.0	1,000.2
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	38.1	0.2	623.0	38.7	355.7	235.0	124.9	1,415.6
Coal/lignite	0.0	0.0	344.3	0.0	0.0	0.0	0.0	344.3
Modern	362.7	577.8	3,189.6	5,080.3	994.8	321.2	357.1	10,863.5
Bagasse	1,243.1	0.0	0.0	0.0	0.0	0.0	0.0	1,243.1
Charcoal	0.0	7.6	1.5	0.0	147.7	325.8	2,208.9	2,691.5
Fuel wood	141.1	45.1	493.0	39.0	81.7	48.7	1,651.5	2,500.1
Paddy husk	143.0	0.0	0.0	0.0	0.0	0.0	0.0	143.0
Traditional	1,527.2	52.7	494.5	39.0	229.4	374.5	3,860.4	6,577.7
Total	1,889.9	610.5	3,684.1	5,119.3	1,224.2	695.7	4,217.5	17,441.2

Source: NESDB, 1985.

Table 9.5 Estimated Emission from Combustion Sources (tons/year and percent)

Year	Sources	SPM	SO_2	NO_x	HC	CO
1982	Transport	7,515	47,339	35,390	17,952	406,570
	%	3	15	23	46	60
	Power generation	96,300	153,087	43,027	1,054	2,143
	%	33	48	28	3	0
	Industry	62,701	106,735	23,970	6,569	110,212
	%	21	34	16	17	16
	Service	4,221	2,145	5,114	1,525	108,937
	%	1	1	3	12	16
	Fisheries	0	1,220	12,204	2,305	4,972
	%	0	0	8	6	1
	Agriculture	54,022	3,607	8,166	1,882	34,666
	%	19	1	5	5	5
	Household	67,109	2,997	24,843	4,942	4,941
	%	23	1	16	13	1
	Total	291,868	317,130	152,714	39,229	672,441

Table 9.6 Comparative Air Pollutant Emissions between Thailand, USA and OECD Countries.
(thousand tons/year)

Source	Area(km^2)	SPM	SO_2	NO_x	HC	CO
Thailand[a]	513,115	291.9	317.1	152.7	39.2	672.4
USA[b]	9,363,123	7,500	21,000	20,000	-	74,000
OECD[c] Countries	32,047,000	16,000	55,000	37,000	-	149,000

Source:
a. Rough estimates taken from Table 9.5.
b. Council on Environmental Quality, USA (1983).
c. OECD, (1985).

1.5 percent of the total SO_2 emission in the United States. However, this is already a point of concern, considering that Thailand is only one-eighteenth the size of the USA. In addition, the level of industrialization in Thailand is much lower. The comparative figures also show the high level of particulates in Thailand, which is about 4 percent of the amount in the USA. This is due to the fact that during the past two decades, effective emission control in the USA has significantly reduced the amount of particulates released into the air.

Conditions for Air Pollution

Due to the release of air pollutants into the atmosphere, adverse impact might occur both to human health and the quality of the environment. The dispersion of air pollutants will largely determine the route of pollution and its degree of severity. Natural dispersion of air pollutants depends on local geography and on meteorological factors such as wind pattern, air stability and mixing height.

Most parts of Thailand where industrial plants are situated are on flat plains, which allows free air movement to disperse air pollutants. In addition, the coastal areas, including Bangkok, can enjoy the added benefit of a land-sea breeze, which brings in fresh air from the sea and dispels air pollutants out over the sea.

Only the mountainous areas of the North induce an accumulation of pollutants in "air basins" in the valleys surrounded by hilly ranges. Due to natural mountain-valley wind patterns, pollutants can be trapped and accumulated in these "air basins". Chiang Mai, for example, is noted for its smoky air from domestic fuel burning in the early morning and late evening. Smoke from houses at the foot of the hills can be observed close to the ground, hardly dispersing.

The northeast and southwest monsoons are dominant throughout Thailand and determine the direction of pollutant dispersion in a particular season. Due to these counter-flow patterns the impact from air pollution from a stationary source will not last throughout the year. In the case of Bangkok Metropolis, it is geographically located off the northeast-southwest axis from the industrial city of Samut Prakan. Hence air pollutants released from the factories there, can cause less adverse effects to the environmental quality of the capital city. This is also due to the green area of Bangkrajao which is kept as a buffer zone to trap air pollutants blowing

towards Bangkok.

Information on atmospheric stability and mixing height is meagre and inadequate. The potential for natural dispersion or accumulation of pollutants depends on these two major factors. For better air quality management, better knowledge and understanding of the relationship between meteorological conditions and air pollution would be necessary.

Physical dispersion of pollutants through tall stacks has been practiced for quite a few decades throughout the world. The tallest stacks in Thailand are 150 meters high, in use at the lignite power plants at Mae Moh, Lampang province.

One of the major global issues of air pollution is "acid rain" which is much debated in both Western Europe and North America. Efforts to disperse pollutants into the atmosphere have backfired when SO_2 and NO_x emissions eventually fall back to earth as acid precipitation. This is due to the high volume of total emissions, more than 21 million tons of SO_2 and 20 million tons of NO_x emitted annually in the USA alone, as shown in Table 9.6. Due to the limited industrial sources of air pollution, acid rain has, so far, not been an issue in Thailand.

Noise Sources

Noise pollution from transportation is an obvious nuisance in Bangkok and to a lesser degree in other major cities. The main source of noise is from motor vehicles, particularly motorcycles. In the last ten years, the number of registered motor vehicles of all kinds in Bangkok has increased from 400,000 in 1976 to more than one million in 1985. In addition, high-speed boats (long-tailed boats) are the major cause of noise pollution along the canals and rivers.

Surveys from the curb side have indicated a high level of noise, exceeding 85 dBA, most of the time (ONEB, 1977; Chalermchai, 1977). The existing standard, however, stipulates that the noise level at 7.5 meters from a motor vehicle is not to exceed 85 dBA. Measurements of the noise from motor-tricycles conducted by ONEB show the range of 87.2 ± 4.2 dBA for those using liquid fuel, and 81.2 ± 4.3 dBA for those using LPG, due to more complete combustion. These comparative records confirm the reduction in the noise level when LPG replaces liquid fuel in a motor-tricycle.

Table 9.7 Number of Vehicles Exceeding Noise Standard

Vehicle type	Number surveyed	Exceeded noise standard	
		Number	%
Motorcycle	143,710	30,450	21
Motor tricycle	9,130	1,357	15
Bus	10,865	689	6
Truck	4,103	720	18
Motorboat	757	51	7
Total	168,565	33,267	20

Source: Bureau of University Affairs, 1985.

Since motorcycles are believed to be the major culprit generating noise, measurements of new motorcycles at their assembly plants were conducted (ONEB, 1985). The results show the low range of 70.8 ± 3.8 dBA. Tampering of exhaust pipes thus has been identified as the major cause of noise pollution.

From March 1984 through March 1985, the Bureau of University Affairs conducted a pollution campaign to spot-check the noise level of 168,565 motor vehicles in the Bangkok area (Table 9.7). The worst offender was the motorcycle with more than 21 percent of the total number inspected violating the noise standard. Truck and motor-tricycles were also identified as other major polluters.

Regarding noise from motorized boats, a study by Chulalongkorn University (1983b) showed that 80 percent of the 120 boats surveyed exceeded the noise level of 90 dBA at 7.5 meters set by the Harbor Department (the noise limit was revised to 85 dBA in 1985). The community noise level averaged over 24 hours [Leg (24)] was recorded at 72.8 ± 5.2 dBA and the public response varied from mildly disturbed to moderately disturbed. Audiometric monitoring of boat operators showed that many had hearing loss due to exposure to extreme noisy conditions (122 dBA at 0.5 meter).

A noise survey at the Bangkok Airport recorded higher noise levels from military aircrafts at 120 dBA while those generated from commercial flights were at 108-118 dBA. (Wismitanunt 1976).

9.2 PRESENT STATUS AND FUTURE TRENDS

Present Status of Air Quality

National ambient air quality standards were promulgated in 1981 to protect human health. Six pollutants were specified: carbon monoxide, ozone, sulfur dioxide, suspended particulates, nitrogen dioxide and lead (Table 9.8). Their sources and effects are well known, and are used as a basis for standard setting although few studies on local conditions have been carried out locally.

Most of the ambient air quality monitoring works in Thailand have been conducted in Bangkok. However, work has started in other cities and industrial regions such as Chiang Mai, Hat Yai and the Eastern Seaboard.

In Bangkok, there are two separate networks of permanent air monitoring stations. The first network, under the joint operation of the Ministry of Public Health and the Faculty of Engineering, Chulalongkorn University (MPH/CU), was started in 1978. It consists of three monitoring stations, located selectively in residential, commercial and industrial areas of Bangkok. As it is a part of the WHO/UNEP global air monitoring system, the data have been analyzed and published by WHO periodically. The second network, under the Office of the National Environment Board (ONEB), was started in 1983 and consists of eight stations. The air quality situation and trends observed are described in the following subsections:

Suspended particulate matter

Data on suspended particulate matter from all ONEB stations in 1983 and 1984 are shown in Table 9.9. In 1983 seven 24-hour samples exceeded 0.33 mg/m^3, which is the national ambient air quality standard. Comparatively, in 1984, none exceeded the standard.

From the Ministry of Health/Chulalongkorn University network a large number of daily particulate concentrations exceeded the standard (0.33 mg/m^3). Annual geometric mean of particulate concentration also exceeded the long-term standard (0.10 mg/m^3).

From 1979 to 1984, it was observed that annual particulate concentrations, as well as maximum daily concentrations, were increasing (Figure 9.1) At Chulalongkorn University, the annual particulate concentration has increased from around 0.099 mg/m^3 to 0.184 mg/m^3 between the years 1980 and 1984. Air pollution in terms of particulates at the other two sites (Ladprao and Samrong) was even more severe, with annual concentrations of 0.197 mg/m^3 and 0.234 mg/m^3 in 1984.

Particulates are believed to originate mainly from fugitive dust. Higher particulate concentrations are usually observed near roadways. An ONEB survey along major streets in Bangkok in 984 found that all ten sites exceeded the short-term particulate standard (0.33 mg/m^3) (ONEB, 1985d). The situation is

Table 9.8 NEB Air Quality Standards.

Pollutant	NEB Standards	Characteristics	Principal sources	Principal effects
Carbon monoxide (CO)	8 hour: 20 mg/m^3 1 hour: 50 mg/m^3	A colorless, odorless gas with a strong chemical affinity for hemoglobin in blood	Incomplete combustion of fuels and other carbon-containing substances, such as in motor vehicle exhaust; natural events such as forest fires or decomposition of organic matter	Health: Some reduced tolerance for exercise, impairment of mental function, impairment of fetal development, death at high levels.
Photochemical oxidants (O_3)	1 hour: 0.2 mg/m^3	Colorless, gaseous compounds which can generate photochemical smog.	Atmospheric reaction of chemicals under the influence of sunlight	Health: Aggravation of respiratory and cardiovascular illnesses, irritation of eyes and respiratory tract, impairment of cardiopulmonary function. Other: deterioration of rubber, textiles, and paints; impairment of visibility; leaf damage and reduced growth of premature plants.
Sulfur dioxide (SO_2)	Annual (geometric mean): 0.1 mg/m^3 24 hour: 0.3 mg/m^3	A colorless gas with a pungent odor; SO_2 can oxidize to form sulfur trioxide, which forms sulfuric acid with water	Combustion of sulfur-containing fossil fuels, smelting of sulfur-bearing metal ores, industrial processes, volcanic eruptions	Health: Aggravation of respiratory diseases, including asthma, chronic bronchitis, emphysema; reduced lung function; irritation of eyes, respiratory tract; increased mortality. Other: Corrosion of metals; deterioration of electrical contacts, paper, textiles, leather, finishes and coatings, building stone; formation of acid rain; leaf damage, reduced growth in plants; impairment of visibility

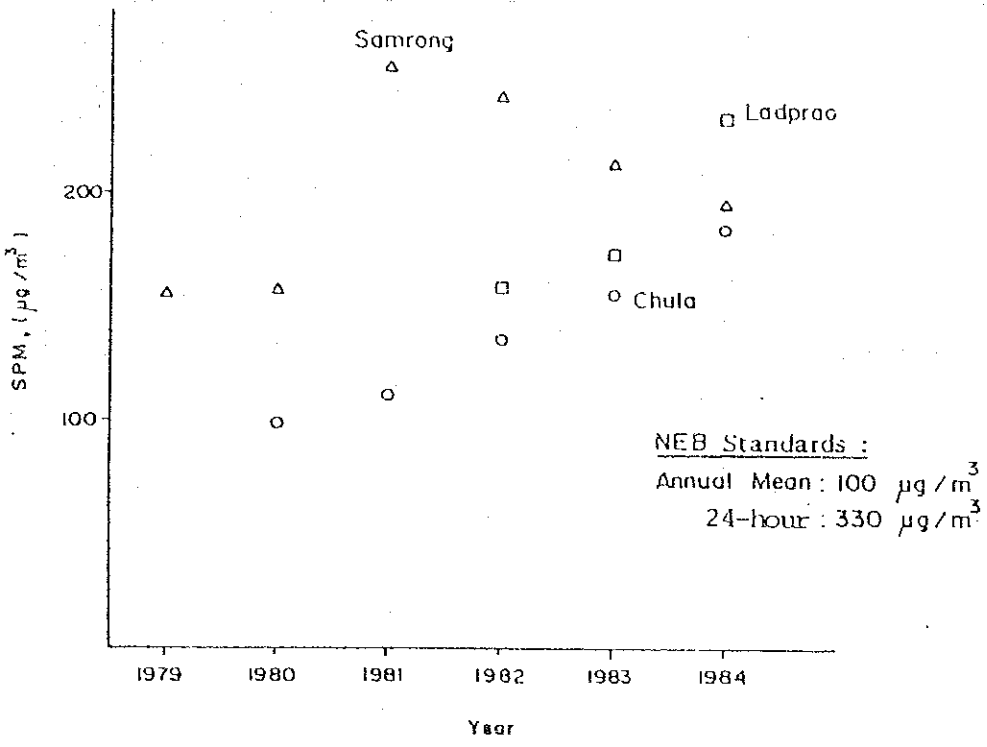
Table 9.8 (contd.)

Pollutant	NEB Standards	Characteristics	Principal sources	Principal effects
Total suspended particulates (TSP)	Annual (geometric mean): 0.1 mg/m^3 24 hour: 0.33mg/m^3	Any solid or liquid particles (diameter ranging from 0.3 to 100 microns) dispersed in the atmosphere, such as dust, pollen, ash, soot, metals, various chemicals	Stationary combustion, especially of solid fuels; construction activities; industrial processes; atmospheric chemical reactions; smoking tobacco; forest fires, wind erosion, volcanic eruptions	Health: Directly toxic effects or aggravation of the effects of gaseous pollutants; aggravation of asthma or other respiratory or cardiorespiratory symptoms; coughing, chest discomfort; increased mortality Other: soiling deterioration of building materials, other surfaces; impairment of visibility; cloud formation; interference with plant photosynthesis
Nitrogen dioxide (NO_2)	1 hour: 0.32mg/m^3	At high concentrations, a brownish-red gas with a pungent odor, often formed from oxidation of nitric oxide	Motor vehicle exhaust, high-temperature stationary combustion, atmospheric reactions	Health: Aggravation of respiratory illnesses. Other: fading of paints, dyes; impairment of visibility; reduced growth, premature leaf drop in plants; formation of acid rain
Lead	24 hour:0.01mg/m^3	A nonferrous heavy metal occuring in air as vapor, aerosol, or dust	Available in nature; lead mining, smelting, processing; motor vehicle emissions; manufacture of lead products (e.g. batteries)	Health: Accumulation in body organs; anemia; kidney damage; central nervous system damage.

Table 9.9 Bangkok Air Quality Data for Suspended Particulate Matter (SPM), 24-hour concentration

Site	Type of Area	Year	SPM (mg/m^3) Min	Mean	Max
ONEB Network					
1. ONEB	residential	1983	0.030	0.107	0.240
		1984	0.050	0.102	0.160
2. Ladprao Chankasem	residential	1983	0.030	0.121	0.410
		1984	0.030	0.117	0.300
3. Bansomdej	mixed	1983	0.040	0.136	0.500
		1984	0.010	0.118	0.270
4. Ratburana	industrial	1983	0.030	0.103	0.420
		1984	0.040	0.126	0.260
5. Saovapa	commercial	1983	0.040	0.094	0.420
		1984	0.050	0.098	0.240
6. Sukhumvit	residential	1983	0.040	0.114	0.280
		1984	0.040	0.096	0.200
7. Bangna	industrial	1983	0.040	0.115	0.390
		1984	0.040	0.143	0.250
8. Ladkrabang	rural	1983	-	-	-
		1984	0.020	0.062	0.130
MPH/CU Network					
1. Samrong	industrial	1979	0.063	0.156	0.364
		1980	0.019	0.158	0.413
		1981	0.068	0.253	0.706
		1982	0.096	0.243	0.897
		1983	0.074	0.215	0.999
		1984	0.057	0.197	0.767
2. Chulalongkorn University	residential	1978	0.072	0.152	0.293
		1979	0.084	0.150	0.350
		1980	0.022	0.099	0.386
		1981	0.043	0.112	0.288
		1982	0.054	0.136	0.403
		1983	0.072	0.155	0.394
		1984	0.076	0.184	0.458
3. Ladprao	residential	1979	0.090	0.184	0.409
		1982	0.039	0.159	0.305
		1983	0.043	0.163	0.405
		1984	0.063	0.234	0.622

Figure 9.1 Annual Average Particulate Concentrations at MPH / CU Stations



similar in other cities, such as Chiang Mai and Hat Yai, where curb side particulate levels always exceed the national standard (Table 9.10).

Due to its relatively larger size, fugitive dust does not pose a serious health hazard since it can not penetrate deep into the respiratory system. However, particulates do cause irritation and allergy. The sheer unpleasantness breathing in particulates and black smoke is so evident that it warrants rectifying measures.

Table 9.10 Particulate Concentrations near Major Streets in Cities in 1983, 24-Hour Average

Site	Maximum Values (mg/m^3)
Bangkok	0.23 - 1.05
Chiang Mai	0.41 - 0.47
Hat Yai	0.42 - 0.45

Lead

Lead analysis by ONEB showed that the daily concentration of lead in Bangkok ranged from 0.01 to 1.96 µg/m³ in 1983, and from 0.07 to 3.60 µg/m³ in 1984 (Table 9.11). For MPH/CU stations, daily lead concentrations between 1979 and 1984 ranged from 0 to 1.5 ug/m³, well below the standard of 10 µg/m³.

A downward trend in lead concentration was apparent at both MPH/CU Stations, as shown in Figure 9.2. At Samrong, an industrial area, annual lead concentration decreased from 0.914 µg/m³ to 0.072 ug/m³ between 1979 and 1984, while the maximum daily lead

Table 9.11 Lead Concentration in Bangkok.

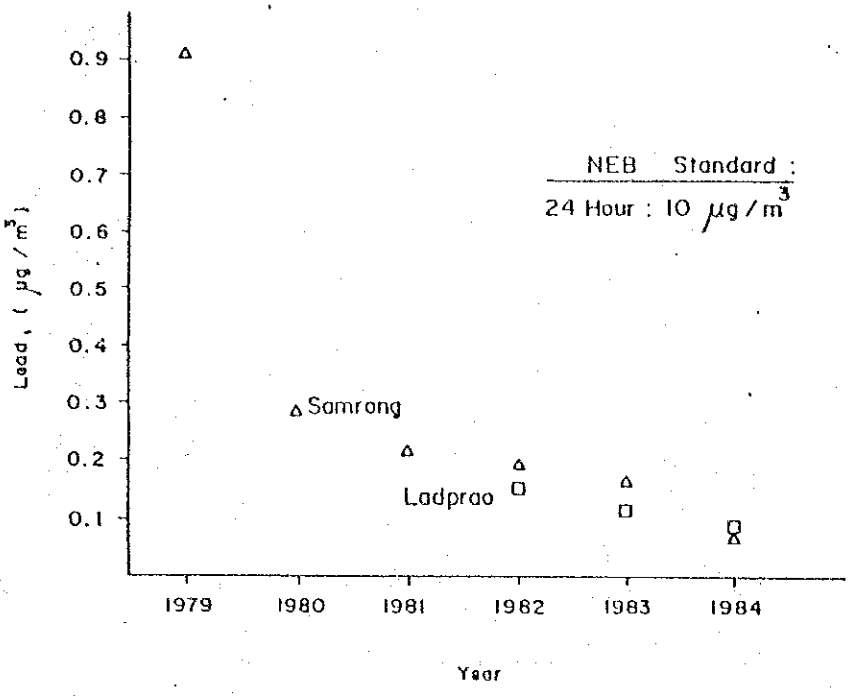
Site	Area	Year	Lead ($\mu g/m^3$) Min	Mean	Max
ONEB Network					
1. ONEB	residential	1983	0.13	0.40	1.12
		1984	0.12	0.28	0.64
2. Ladprao Chankasem	residential	1983	0.08	0.36	0.75
		1984	0.08	0.31	0.85
3. Bansomdej	mixed	1983	0.01	0.30	1.96
		1984	0.07	0.29	0.85
4. Ratburana	industrial	1983	0.02	0.32	1.33
		1984	0.08	0.27	0.94
5. Saovapa	commercial	1983	0.21	0.74	1.70
		1984	0.10	0.37	1.90
6. Sukhumvit	residential	1983	0.04	0.42	1.40
		1984	0.12	0.40	1.70
7. Bangna	industrial	1983	0.02	0.33	1.20
		1984	0.07	0.67	3.60
8. Ladkrabang	rural	1983	-	-	-
		1984	0.07	0.24	1.01
MPH/CU Network					
1 Samrong	industrial	1979	0.432	0.914	1.516
		1980	0.009	0.289	1.146
		1981	0.011	0.258	1.231
		1982	0.050	0.201	0.986
		1983	0.000	0.171	0.699
		1984	0.006	0.072	0.375
2 Ladprao	residential	1982	0.018	0.156	0.715
		1983	0.000	0.120	0.361
		1984	0.000	0.092	0.417

concentration also decreased, from 1.516 $\mu g/m^3$ to 0.375 $\mu g/m^3$.

Lower lead emissions have been brought about indirectly by greater consumption of LPG and diesel oil, which are cheaper than leaded gasoline. Direct lead emission control was initiated by the Ministry of Commerce in 1984, with the reduction of the lead limit for gasoline from 0.84 to 0.45 grams per liter. This caused a further drop in ambient lead concentrations in 1984.

High lead concentrations are found at curb side near traffic. A survey by DMR

Figure 9.2 Annual Average Lead* Concentrations at MPH / CU Stations



in 1984 at ten locations in central Bangkok found 24-hour lead concentrations in the range of 1 to 5 µg/m³. It could be concluded that lead concentrations decrease rapidly with distance from roadways. A recent survey for the Expressway and Rapid Transit Authority (Thorani Tech, 1986) at ten locations, with samples taken at a distance between 5 to 20 meters from curb side, shows lead concentrations (24-hour) between 0.1 and 0.5 µg/m³.

It can be concluded that the level of lead in ambient air is within the safe limit, presenting no immediate danger to general public health.

Carbon monoxide

Motor vehicle emissions are the major source of carbon monoxide. Along narrow congested streets, CO can build up to harmful levels and cause headache, angina attack, and theoretically, at very high concentrations, death. CO, however, disperses very rapidly within ten meters from the traffic and the effects of CO from streets rarely extend much further.

The 8-hour average carbon monoxide concentrations recorded at all ONEB monitoring stations were less than 6 mg/m³ in 1983 and less than 10 mg/m³ in 1984. These stations are all located at fair distance from the traffic. Curb side CO concentration is of greater concern. In 1984, the CO standard (20 mg/m³ for an 8-hour average) was exceeded at Pratunum Intersection, Soi Asoke and Nanatai Intersection. ONEB also found other major cities, such as Chiang Mai and Hat Yai, experiencing high CO

concentrations along major streets (Table 9.12).

Table 9.12 Carbon Monoxide Concentration near Major Streets of selected Cities in 1983, 8-Hour Average

Location	Maximum Values (mg/m^3)
Bangkok	27-37
Chiang Mai	16-18
Hat Yai	6-27

Source: ONEB, 1985e.

When meteorological conditions allow good dispersion of air pollutants, as on open roads, CO concentration remains low. Factors leading to high CO build up are excessive vehicle emissions and physical obstruction to wind movement, such as tall buildings on narrow streets. The exhaust emission standard for CO was set at 6 percent by volume when measured at idle. However, CO emissions are believed to be falling, due to better engine design of new automobile models, for lower fuel consumption and better emission control.

A vehicle emission survey by ONEB (1985) found that about 28 percent of all cars on the street exceeded the 6 percent emission standard while only 6 percent of new cars exceeded the standard (Table 9.13). In a 1980 survey by ONEB, as many as 54 percent of used cars exceeded the 6 percent CO limit. This encouraging trend, as mentioned earlier, can be attributed to the improvement in the engine design of new car models.

Another contributing factor to the reduction of CO is the changing pattern of energy use in the transportation sector. Under Thailand's energy price differential policy, cheaper fuels, diesel oil and LPG, are gaining in popularity with consumers. Diesel and LPG-fueled internal combustion engines emit much less CO than gasoline engines. ONEB (1985a) found that about 85 percent of LPG-fueled motor-tricycles emitted less than 1 percent CO.

Table 9.13 CO Emission Survey

CO	New Car		Used Car	
%	No.	%	No.	%
< 1	20	21	75	17
1-2	15	15	54	12
2-3	21	22	49	11
3-4	14	14	46	11
4-5	13	14	33	8
5-6	8	8	55	13
> 6	6	6	123	28
Total	97	100	435	100

Source: ONEB, Survey of Air Pollution Problem due to Highway Traffic in Bangkok, 1985.

Sulfur dioxide

Sulfur dioxide combined with particulates may cause respiratory illness, and in extreme cases, death. While levels of particulates are high in Bangkok, ambient sulfur dioxide is usually very low due to the widespread use of low sulfur fuels in energy consuming sectors. Potential risks are in areas near power plants and industrial boilers.

ONEB stations showed very low sulfur dioxide concentrations, which never exceeded 0.03 mg/m^3 for a 24-hour average. The MPH/CU station at Chulalongkorn University observed a maximum daily concentration of 0.07 mg/m^3 over four years of monitoring, between 1981 and 1984, which is well below the short term-standard of 0.3 mg/m^3. The annual mean SO_2 concentrations are around 0.009 to 0.0015 mg/m^3 as compared to the long-term standard of 0.1 mg/m^3 (Table 9.14). Therefore sulfur dioxide pollution is not a major threat to health.

Ozone

Ozone is a product of photochemical reactions among hydrocarbons, nitrogen

Table 9.14 Sulfur Dioxide 24-Hour Concentration, Bangkok

Site	SO_2 (mg/m^3)			
	Year	Min	Mean	Max
Chula-longkorn University	1981	0.002	0.009	0.070
	1982	0.002	0.013	0.048
	1983	0.004	0.015	0.061
	1984	0.004	0.015	0.048

Note: MPH/CU network.

oxides and other gases, under conditions of intense sunlight. The reaction takes about two hours to formulate, during which time the wind may transport the product away from the source. ONEB stations did not detect ozone levels greater than the detectable limit of 0.02 mg/m^3 in 1983 and observed a peak concentration of 0.1 mg/m^3 at noon in 1984. The levels of ozone detected were always below the one hour standard of 0.2 mg/m^3.

Due to its mobility, there is a need for further study on the local ozone formation and its transportation before any conclusion can be made. At present, however, there does not appear to be cause for alarm.

Community Noise Situation and Trends

Noise criteria

Noise can be defined as any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying. The human ear does not respond linearly to increases in sound pressure; the response is essentially logarithmic. Therefore, noise measurements are expressed by the term "sound pressure level" (SPL_s), which is the logarithmic ratio of the sound pressure to a reference pressure, and is expressed in terms of decibel (dB). The reference level is 0.0002 microbar, the threshold of human hearing. The logarithmic decibel scale is also useful to describe a very wide range of audible sound in terms of small numbers. Table 9.15 provides a summary of various sound pressures and the corresponding decibel level with examples of noise sources (Canter, 1977).

Table 9.15 Sound Pressure and Sound Pressure Level (SPL) Perceived for different Sources of Noise

Sound pressure (μbar)	SPL (dBA)	Example
0.0002	0	Threshold of hearing
0.0063	30	Studio for speech broadcasting
0.02	40	Very quiet room
0.063	50	Residence
0.2	60	Conventional speech
0.63	70	Street traffic at 30 m
1.0	74	Passing automobile at 6 m
2.0	80	Light truck at 6 m
6.3	90	Subway at 6 m
20	100	Loom in textile mill
63	110	Loud motorcycle at 6 m
200	120	Peak level from rock and roll band
2000	140	Jet plane on the ground at 6 m

Source: Canter, 1977.

In most noise research, the A-weighted sound level (dBA) is used. The dBA, in which greater emphasis is given to medium and high frequencies, to which the human ear is most sensitive, correlates well with the subjective impression of loudness. A 10 decibel increase in the sound level doubles its subjective intensity (that is its loudness or noisiness), whereas a doubling of the acoustic energy results in an increased of three decibels only.

Impacts of noise on health are cumulative and the energy-equivalent noise level (L_{eq}) refers to the

Box 9.1 How Pollution Control Costs Stack Up for EGAT

Lignite, or brown coal, is increasingly used in electricity generation in Thailand, with significant implications for air quality in lignite-burning areas. Lignite consumption looks set to continue growing, given that it accounts for well over half (57 percent) of the country's proven and possible energy resources. The overwhelming bulk (87 percent) of these reserves are found in the Mae Moh basin, where lignite-fuelled power generation is now concentrated.

With 825MW of installed power generation capacity, accounting for about 5.7 million tons of lignite annually (up from just 433,000 tons in 1975), the Electricity Generating Authority of Thailand (EGAT) is the biggest lignite user. And when a further 900MW of generation capacity comes on stream in 1990, EGAT's annual power consumption is expected to increase to about 12.5 million tons.

Work by the Office of the National Environment Board (ONEB) has found significant environmental impacts both in the production and use of lignite. As far as air pollution is concerned, the main problem during lignite production is suspended dust, once the lignite is burned the problems are dust, sulfur dioxide (SO_2) and nitrogen oxides (NO_x). It is estimated that the total flue gas emissions from a 150MW lignite-fired power station total 240.5 kilograms per second.

The pollution control strategy adopted by the electricity generation industry has involved the use of "tall stacks", very tall chimneys which help disperse air pollutants over a much larger area. The first three EGAT lignite-burning units, each rated at 75MW, were fitted with 80-meter stacks, costing 20 million baht each. The other four existing units, of 150MW apiece, are fitted with 100-meter stacks, each costing 35-40 million baht. The next units, each of 300MW capacity, will be fitted with 150-meter stacks, which will cost at least 35 million baht apiece.

The dispersal of pollutants like SO_2, however, is only a stopgap solution. While there are no signs of "acid rain" problems emerging in Thailand, the "tall stack" policy has led to widespread environmental acidification in Europe, Scandinavia and North America. Even dust can cause problems unless further control measures are introduced. EGAT, in fact, already uses electrostatic precipitators, which can remove up to 99.5 percent of the particulates in flue gas emissions, in its seven operational units. For the first three units, the precipitators cost 60 million apiece, while the price went up to 80 million baht each for the precipitators installed in the next four units. A figure of 118 million baht has been given for the precipitation equipment for EGAT's first 300MW plant.

To ensure compliance with air quality standards, EGAT has two mobile laboratories which monitor air quality in the Mae Moh area. The capital cost involved in setting up these laboratories was 11 million baht, and EGAT estimates that it has invested another 10 million baht in environmental monitoring and testing equipment. Increasingly, too, EGAT carries out Environmental Impact Assessments (EIAs) for major new power generation projects. In 1985, for example, it completed an eight million baht EIA covering the entire spectrum of environmental impacts from power generation at Mae Moh.

Box 9.1 (contd.)

If there is growing pressure to control SO_2 emissions, EGAT has a number of options. First, it can switch to low-sulfur (two percent sulfur, or lower, rather than three percent) lignite, which is available in the Mae Moh basin. Another, potentially complementary, approach would be to remove some of the sulfur from the lignite before it is burnt, although this would cut SO_2 emissions by only 30 percent. A more effective, and more expensive approach, would be to use flue gas desulfurization. This involves scrubbing the sulfur out of flue gas emissions with wet limestone or lime spray drying.

According to ONEB, the costs of electrostatic precipitation work out at around 0.042 baht per KWh of electricity generation. Flue gas desulfurization, which might remove 90 percent of the SO_2 emissions, would be much more expensive, at 0.22 baht/KWh.

Overall, then, the control of SO_2 would be the most expensive air pollution control challenge for EGAT. If SO_2 controls were to be required, the weighted average cost of electricity would rise to 1.3815 baht/kWh, representing a 0.033 baht/kWh increase. EGAT's prices already include 0.0063 baht/kWh for the cost of dust control. Just for comparison, SO_2 controls would raise electricity prices by around 2.6 percent, which represents a fairly small increase when compared with the 17.75 percent increase in 1981 and 5.64 percent increase in 1982.

The total costs of SO_2 control are potentially high, but it is worth noting that they would represent a relatively small proportion of EGAT's revenues (less than three percent), in the unlikely event that EGAT had to bear all the costs involved. It is also worth noting, however, that they would represent a considerably larger share of EGAT's net profits (21.2 percent of 1985 net profits, for example). There is currently no evidence that EGAT'S SO_2 emissions are exceeding the natural absorptive capacity of the atmosphere, but the growing use of lignite suggests that a close eye should be kept on the emission implications. If action has to be taken, the evidence suggests that it need not cripple the economy.

equivalent steady noise level that, in a stated period of time, would contain the same noise energy as the time-varying noise during the same time period. If the measuring time is 24 hours, the index would be referred as Leq(24). ONEB has not yet established a community noise standard. In this report, noise assessment will be referenced to the community noise standard Leq(24), equal to 70 dBA, adopted by the USEPA.

Community Noise Impacts *

Surveys and opinion polls in many countries have found that the disturbance most frequently cited by respondents is noise in the home (OECD, 1985). The prime offending source of noise in terms of the number of people disturbed is road traffic, followed by neighborhood and aircraft noise.

As stated earlier, a large proportion of Thai vehicles violate the noise source standards, and motorcycles are the worst offenders. These sources of noise are increasing at a considerable rate. The total number of vehicles in this country increased from 1.5 million to 2.7 million between years 1978 and 1983. The estimated number of vehicles in 1986 is around 3.2 million, of which nearly 70

percent are motorcycles (Figure 9.3). In Bangkok alone, the estimated number of motorcycles is around 560,000 units, or nearly half the total number of 1.2 million motor vehicles reported in 1986.

While there is a dearth of information on community noise levels, there are several surveys on curb side noise levels in Bangkok. ONEB carried out a curb side noise survey at four locations on busy streets in 1985 and found that noise levels at all four sites exceeded the Leq(24) standard of 70 dBA. Two of these sites, Wang Burapa and Wongwien Yai, also had average noise levels greater than 85 dBA, which is the noise source standard (Table 9.16).

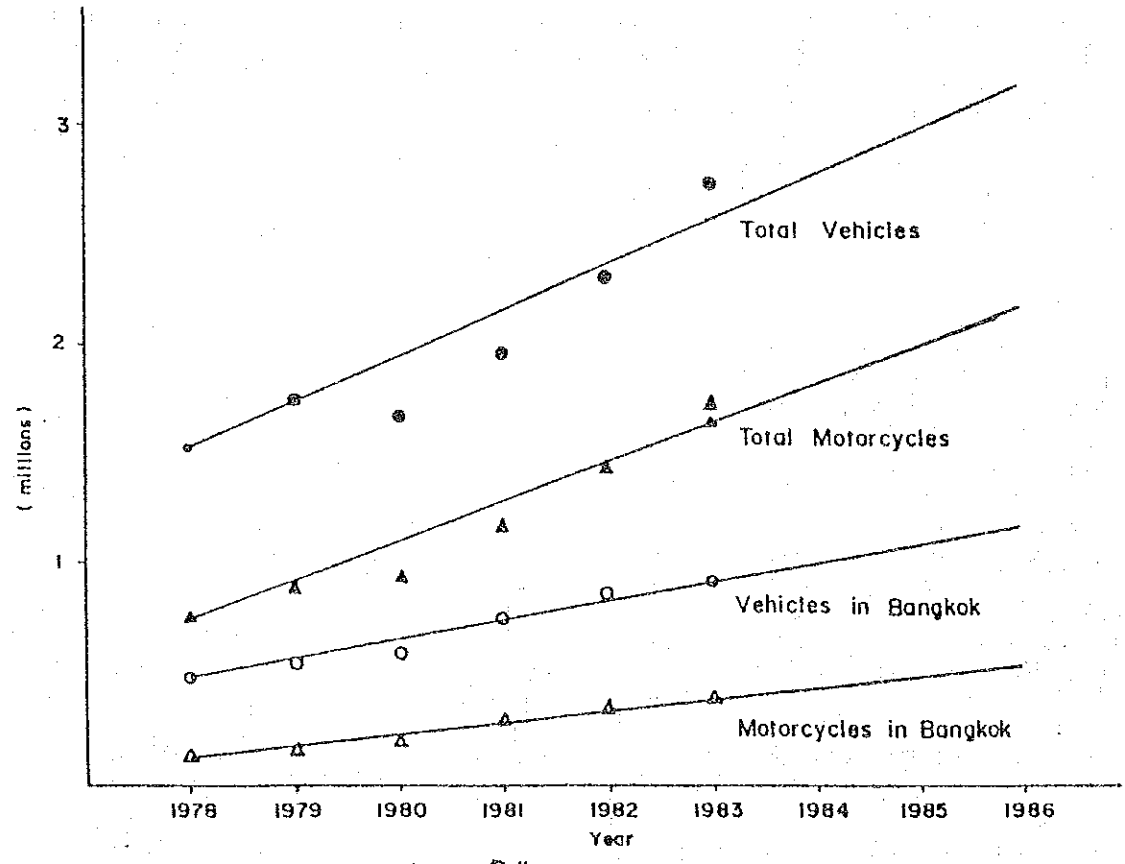
Information on community noise level from the study by Chulalongkorn (1983) and Thorani Tech (1986), as summarized in Table 9.17 and 9.18, showed that most sites along main streets had Leq between 60 to 70 dB, while some houses located

Table 9.16 Curbside Noise Levels in Bangkok

	Location	Leq(24) dBA
1.	Wang Burapa	87.6
2.	Odeon	77.9
3.	Wongwien Yai	89.3
4.	Krung Thon Bridge	77.1

Source: ONEB (1985)

Figure 9.3 Number of Vehicles in Thailand and Bangkok



Source : Registration Division , Police Department.

close to streets or busy intersections had noise levels exceeding 70 dB.

Away from the sources, noise level decreased with distance from busy streets. ONEB (1981) surveyed 41 sois (lanes) and found that as distance from the street increased from 100 meters to 800 meters, the average noise level went down from 68 dBA to 54 dBA (Figure 9.4).

Waterway transportation is an essential part of the Thai life style, and noise nuisance from commuter boats inevitably has an impact on those living along canals and rivers. A survey by Chulalongkorn University (1983) found that the average noise level Leq(24) equaled 72.8 $\pm$ 5.2 dB(A), with louder noise experienced along small canals rather than on the Chao Phraya River.

Noise Nuisance and Hearing Loss

ONEB has received numerous complaints on noise nuisance from traffic, construction and industry. Affected areas are residential houses, schools, hotels. Examples are: Wat Thepsirin School classroom noise level at the range of 76-95 dB(A); and a house in Soi Ruamrudi, close to the expressway, recorded Leq(24) noise levels of 77.9 dB(A). These noise levels are unacceptable and cause nuisance to classroom activities, and to working and living conditions alike.

Examination of 85 motorboat operators by Chulalongkorn University (1983) found that 70 persons or 82 percent had hearing loss. The damage was found to correspond with the number of years spent driving the boats. All operators working more than 15 years had hearing loss. However, in the beginning the hearing loss occurred outside normal conversation frequency and it was generally too late when these boat operators found that they had problems in hearing.

Table 9.17 Noise Levels along Port-Dindaeng Expressway

No.	Site	dBA 24 hours				
		L_{eq}	L_{dn}	L_{10}	L_{50}	L_{90}
1.	Din-Daeng Flat	78.4	70.9	81.0	75.3	68.0
2.	Kamolsuksa School (Din-Daeng)	74.0	63.9	77.0	69.0	61.2
3.	Nitiprinya School (Din-Daeng)	59.3	63.4	62.5	56.8	52.5
4.	Opposite to Makkasan railway station	60.8	65.2	63.7	58.1	51.5
5.	Petchaburi Road Interchange (South West side)	67.3	72.0	70.0	64.6	58.0
6.	Petchaburi Road Interchange (South East side)	68.0	73.6	70.6	65.4	60.0
7.	Imperial Hotel	63.0	66.9	66.2	55.7	48.1
8.	International Red Cross (Soi Ruamrudee)	66.3	69.8	68.8	58.5	47.1
9.	Rama IV Road Interchange (North side)	68.9	73.9	71.2	66.8	61.3
10.	Rama IV Road Interchange (South side)	72.5	76.6	74.9	67.5	57.3
11.	Close to Chong-Nonsee railway (Port Interchange)	61.0	61.4	64.6	52.6	42.0
12.	Klong Toei Nivet (Port Interchange)	57.1	61.0	59.9	54.6	48.4
13.	Pra Harutai Convent	58.2	61.0	59.7	54.5	49.4

Notes: L_{eq} = equivalent noise level
L_{dn} = weighted average daytime (0700 to 2200) and nightime (2200 to 0700) noise level
L_{10} = 10 % of the time the stated level is exceeded
L_{50} = 50 % of the time the stated level is exceeded
L_{90} = 90 % of the time the stated level is exceeded

Source: Chulalongkorn University, 1983.

Table 9.18 Noise Levels along the Present and Proposed Expressway Routes

Location	Distance from the near curb of the expressway or road (m)	Noise Levels (dB) for 24 hours				
		L_{eq}	L_{dn}	L_{10}	L_{50}	L_{90}
Sacred Heart Convent School	33	68.5	74.3	70.5	66.0	59.5
Soi Ruam Rudi	10	66.0	71.3	69.5	62.0	53.0
Sukumvit Soi 66	10	72.5	76.0	76.0	70.0	58.0
Seri Housing Estate	20	51.7	55.1	53.2	46.4	40.3
Siam Cement Housing	2	59.7	64.1	62.2	57.2	50.6
Chanvit School	60	54.4	58.0	55.2	48.8	45.5
Nipat Vittaya School	16	59.0	62.2	62.7	54.9	44.8
Urupong Apartment	40	61.8	66.0	64.4	60.1	53.5
Ngamwongwarn Road	15	67.2	72.2	70.3	64.9	56.0
Changwattana Road	57	61.8	66.1	62.6	56.0	48.0
Mahidol University	10	68.6	75.1	71.4	65.2	53.9

Source: Thorani Tech, 1986.

Noise Trends

As urbanization proceeds and noise sources multiply, more people will be exposed to louder noise for longer periods. If the vehicle growth rate continues at the present rate, the number of vehicles in the whole kingdom will be around 6.5 million, with 2.5 million vehicles in Bangkok alone by the year 2000. While there are no data on number of people exposed to loud noise, the percentage will increase as quiet lanes are turned into busy streets.

Development of housing communities near Bangkok Airport will locate people closer to the noise source. Since the airport will remain there for the foreseeable future, it seems inevitable that more complaints on aircraft noise will come from the growing population in the area.

9.3 LEGAL AND INSTITUTIONAL FRAMEWORK

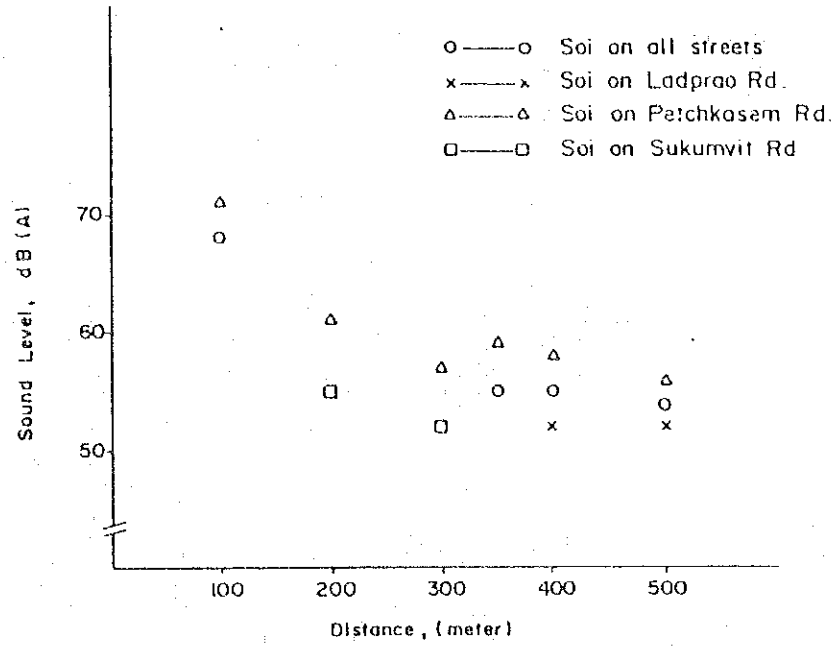
Laws and Regulations

Air quality standards

Ambient air quality standards are the basic criteria which govern the air pollution control and management program. To achieve the desired air quality standards, the control of emission sources is most important.

Emission standards set the limit on the amount or concentration of pollutants which may be released to the atmosphere.

Figure 9.4 Average Sound Level in Sois at Various Distances from Main Streets



Source: ONEB, Survey of Sound Levels in Soi, 1981.

The only emission standards in force are for mobile sources which limit CO emission to 6 percent idle and limit smoke concentration at 40 percent on the Bosch Scale or 52 percent on the Cartridge Scale. At present, there are no industrial emission standards, although ONEB has already drafted emission standards for oil refinery, cement, and iron smelting and rolling plants. For other industries, the Department of Industrial Works (DIW) has adopted emission guidelines which cover all substances and apply to all industries.

The standard setting process usually requires information on the available control technology. The vehicle exhaust survey by ONEB in 1980 indicated that as many as 54 percent of all cars monitored at idle exceeded the standard 6 percent by volume of carbon monoxide in the exhaust gas. A subsequent survey by ONEB in 1985, showed a reduction in CO emission with about 28 percent of all cars exceeding the 6 percent standard. However, the improvement was not due to the regulation, since enforcement had been conspicuous only by its absence. Presumably, better engine design in new cars has contributed significantly to CO reduction. This improvement in emission comes about as car manufacturing standards improve worldwide.

There are significant gaps in ambient air quality standards between Thailand and UESPA (Table 9.19). Standards need to be reviewed in accordance with the changing magnitude and sources of air pollution.

Table 9.19 Comparison of Ambient Air Quality Standards

Pollutants	Time average	Thailand (mg/m^3)	US EPA (mg/m^3)
Carbon monoxide (CO)	1 hour	50	40
	8 hour	20	10
Hydrocarbon (HC)	1 hour (6-9 am)	-	0.16
Photochemical oxidants (O_3)	1 hour	0.2	0.24
Sulfur dioxide (SO_2)	24 hour	0.3	0.365
	1 year	0.1	0.080
Total suspended particulates (TSP)	24 hour	0.33	0.26
	1 year	0.1	0.075
Nitrogen dioxide (NO_2)	1 hour	0.32	-
	1 year	-	0.1
Lead	24 hour	0.01	-
	3 month	-	0.0015

Noise standards

After much debate and revision, noise source standards for land and water vehicles were set at 85 dB(A) when measured at 7.5 meters from the vehicles (January 1985). While new vehicles straight from the assembly lines were found to pass the standards, the survey found that as many as 20 percent of all vehicles in actual use exceeded the standards.

There is presently no community noise standard, although the subject has been much deliberated by the NEB. While the proposed noise standard is based on land use zoning, there is no classification of land-use in Bangkok or in other cities.

The US EPA community noise standard Leq(24) at 70 dB(A) is usually adopted as the standard in noise assessment. The findings from the many studies undertaken in OECD countries on the effects of noise and its wider repercussions point to the fact that in order to comply with desirable limits for well-being indoor, the outdoor level should never exceed 65 dB(A) (Leq by day). In the case of new residential areas, the outdoor level should never exceed 55 dB(A) (Leq by day) (OECD, 1985).

9.4 KEY ISSUES

Acid Rain

"Acid rain" is the term commonly used to describe the deposition of acidic or acid-forming compounds in either their dry or wet forms. These compounds are derived primarily from natural and man-made emissions of sulfur dioxide (SO_x), nitrogen oxides (NO_x) and hydrocarbons (OECD, 1985).

Every year, large quantities of SO_x and NO_x are discharged into the atmosphere from the combustion of fossil fuels such as coal, lignite and oil. In Thailand about 48 percent of the SO_x is emitted by electricity-generating power plants and another 34 percent from other industrial sources. Industrial and utility boilers emit about 44 percent of the NO_x, and transportation vehicles generate another 23 percent (Table 9.5). Since large numbers of industrial plants and transportation vehicles are found in Bangkok, large proportions of the country's overall SO_x and NO_x emissions are from Bangkok (one third of SO_x and a quarter of NO_x emissions).

Usually, much of the sulfur and nitrogen emitted is deposited within a short distance. Effects on local areas include material corrosion and crop damage.

A portion of SO_x and NO_x emissions may be transported several hundred kilometers by prevailing winds. After being chemically transformed into sulfates and

nitrates, the acidic compounds may be deposited as dry or wet particles. This has become an international issue in Northern America and Europe.

It is important to note that normal rainfall is slightly acidic, with a pH sometimes as low as 5.0. However, low pH in rainfall does not automatically mean that the water in lakes and streams will become acidic. Many watersheds have a natural ability to buffer acidity. As the acid rainfall moves through the watershed, alkaline soils can neutralize the acidity. However, some watersheds, particularly those at high altitudes and with thin soils, have less ability to buffer deposited acids.

There is very little information on the background pH values of rainfall or water resources to indicate the present situation regarding acid rain in Thailand. The potential for acid rain however, is small since the amount of SO_x and NO_x emission is relatively small. The acidic compounds are mostly deposited within a short distance due to the fact that only a few tall stacks are in operation in the country.

Lead in Gasoline

There is a trend towards the reduction of lead in gasoline worldwide. While lead-free gasoline is used in USA, the amount of lead allowed in gasoline varies from country to country. In Thailand, the Ministry of Commerce lowered the limit of lead in gasoline from 0.84 mg/l to 0.45 mg/l in 1984.

After combustion, about 75 percent of the lead additives in gasaline are emitted in the car's exhaust. Most of the lead is emitted as particulates, mainly smaller than 10 μm. Due to its size, only 6 percent of lead is deposited within 30 meters from roadways and much of lead emission remain in the air for a longer period. Concentrations of lead in ambient air range from 1 to 5 μm/m³ at curb side to around 0.1 to 0.5 μg/m³ further from the traffic. The level of lead is within the standard limit of 10 μg/m³ for 24-hour average values.

Annual lead concentrations found at Samrong (MPH/CU Network) fell from 0.914 μg/m³ to 0.072 μg/m³ between the years 1979 and 1984, due to the partial substitution of leaded gasoline by the increasing demand on LPG and diesel oil. The reduction of lead in gasoline also caused a significant drop in lead-in-air concentration in 1984. The concentrations of lead in Bangkok were found to be well within the safety limit. The contribution of lead in gasoline to the transportation sector's overall health impact should be minimal in comparison to other pollutants and other sources.

Air and Noise Pollution from Transportation

Transportation is the leading cause of complaints about air and noise pollution in Bangkok and other major cities. With rapid modernization and expanding urbanization, the number of vehicles has increased at 10 percent annually. These emission sources have encroached on people both at work and at home.

High levels of CO concentration, often exceeding the relevant standard, were found in major cities (Table 9.12). While congested traffic and wind dispersion are also important factors, a large percentage of cars were found to violate the emission standards (Table 9.13). However, it was found that new cars produced less emissions, due to better engine design. Replacement of the stock of motor vehicles should progressively reduce the average CO emission from cars.

Noise of motorcycles from assembly lines is within set standards. Noise violation by motorcycles in actual use is due to tampering with exhaust pipes. Although an industrial standard for exhaust pipes (TIS 340-2528) has been

Box 9.2 Turning a Deaf Ear to Noise

One of the first things a newcomer to Bangkok notices is the high noise level in the city streets. Buses, trucks and motorbikes all seem to compete to break the sound barrier. And visitors are not the only ones who find the constant blare of the traffic unacceptable: most of the complaints made to the authorities about air and noise pollution focus on road traffic. The increasing pressures are indicated by the fact that the number of road vehicles has been increasing at a rate of about 10 percent a year in Thailand. The number of vehicles nearly doubled in six years, growing from 1.5 million in 1978 to 2.7 million in 1983.

If you ask the average person in Bangkok to pinpoint the worst offenders, he or she will almost certainly mention motorcycles. Of the estimated 1.2 million vehicles in Bangkok in 1986, around 560,000, or nearly half, were motorcycles. And their number has been increasing by over 10 percent a year.

For all types of vehicles, research has shown that they generally meet the relevant noise standards when they first leave the assembly line. But follow-up surveys have shown that some 20 percent of the vehicles on the road exceed the noise standards, either because they have been poorly maintained or because, in the case of many motorcycles, their exhausts have been tampered with-specifically to increase their noise output. An ONEB survey in 1977 found that 16 percent of motorcycle exhausts studied had been tampered with.

Trucks and buses, meanwhile, tend to be more significant in terms of vibration, although they also make an important contribution to the dark smoke and other air pollutants which blight city streets. The Police Department is responsible for on-street enforcement of the appropriate standards, but its resources are simply not up to the task.

Given that the traffic forecasts suggest that Thailand will have around 6.5 million vehicles in the year 2000, with 2.5 million of those in Bangkok, it is clear that steps will have to be taken to contain the problem. The real human health impact is perhaps best illustrated by the "drivers" of Bangkok's motorized (and very noisy) "long-tailed" boats. A study of 85 boat-owners found that 82 percent had hearing loss, with the extent of hearing loss reflecting the number of years they had been in the business. All those who had been in it for 15 years or more were suffering from hearing loss. But because the hearing frequencies used in everyday conversation are among the last to go, the victims generally fail to realize what is happening until it is too late.

Clearly, the problem is an enormous one. But immediate steps could be taken to cut down on gratuitous noise pollution. Tougher enforcement of noise laws against motorcycles, for example, could be coupled with efforts to encourage manufacturers to make their exhaust systems tamper-proof. Bangkok and Thailand's other major cities would not become silent overnight, but even the longest journeys start with a first step.

set, a careful examination is needed on the problem of after-use practice. The major causes of noise problems arising from vehicles can be summarized as three-fold: (1) tampering with exhaust pipes or mufflers to deliberately increase the noise emission level; (2) lack of attention in maintaining worn-out exhaust systems; and (3) inadequate enforcement, either through on-street checks or annual inspection during registration renewal.

If noise abatement is the objective, then drastic and strict measures will have to be undertaken to ensure a quieter environment. The measures will have to be directed against the three major causes mentioned above. Judging from past performance in the enforcement of standards, it is not expected that enforcement will get any better in the near future, although an action plan has been proposed by ONEB (1985e) to strengthen the manpower and resources needed to enforce the emission regulation. As to the problems of tampering and maintenance, the solution will lie in the design of tamper-proof and maintenance-free exhaust systems, such as the use of stainless-steel and permanently welded inner tubes. This is especially the case for motorcycles and public transport, where the vehicles are normally poorly maintained.

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SECTION A : IMPROVEMENT AND CONSERVATION OF NATIONAL ENVIRONMENTAL QUALITY ACT

1. Duties of the National Environment Board

The National Environment Board has the duties as follows:

(1) to submit policy and opinion concerning the improvement and conservation of environmental quality to the Council of Ministers;

(2) to consider the implementation of policy in respect of the schemes or projects concerning the environmental quality;

(3) to consider and submit opinion on projects of Government agencies, State enterprises and private organizations, which may have adverse effect on the environmental quality, to the Council of Ministers of Government agencies concerned;

(4) to submit plans for the development, improvement and conservation of environmental quality to the Council of Ministers;

(5) to give advice to the Prime Minister on matters to be prescribed in the Notification issued under section 17 or the Order issued under section 20 of this Act;

(6) to recommend the standards of environmental quality to Government agencies having the statutory power to prescribe them as well as to recommend measures for the prevention and conservation of environmental quality in various respects to the Government agencies concerned;

(7) to recomend any amendment of or improvement to the law concerning the prevention and conservation of environmental quality to the Council of Ministers;

(8) to co-ordinate works between Government agencies, State enterprises and private organizations on matters concerning the environmental quality;

(9) to submit opinion to the prime Minister for consideration and order in the case where any Government agency or State enterprise violates or does not comply with the laws, rules or regulations concerning the conservation of environmental quality, which may cause extensive damage;

(10) to submit report on the national situation of environmental quality to the Council of Ministers at least once a year;

(11) to consider any other matter concerning the environmental quality as the Council of Ministers or the Prime Minister may request;

(12) to perform other functions as may be designated by law to be those of the National Environment Board.

In the performance of above-mentioned duties, the National Environment Board may entrust the Office of the National Environment Board with the operation or submission of recommendations to the National Environment Board for further proceedings.

2. Components of the National Environment Board

The National Environment Board consists of the Deputy Prime Minister designated by the Prime Minister as the Chairman, the Permanent-Secretary of Ministry of Defence the

Permanent-Secretary of Ministry of Agriculture and Co-operatives, the Permanent-Secretary of Ministry of Communications, the Permanent-Secretary of Ministry of Interior, the Permanent-Secretary of Ministry of Science, Technology and Energy, the Permanent-Secretary of Ministry of Public Health, the Permanent-Secretary of Ministry of Industry, the Secretary-General of the National Economic and Social Development Board, not more than five persons qualified in ecology and not more than five representatives of independent institutions on organizations or other persons appointed by the Council of Ministers as members and the Secretary-General of the National Environment Board as member and Secretary.

Members appointed from the representatives of independent institutions or organizations or other persons shall not be a government official, official of a State enterprise or local government official having, or receiving regular salaries.

3. Duties of the Office of the National Environment Board.

Office of the National Environment Board has the duties as follows:

(1) to perform the works as may be entrusted by the National Environment Board

(2) to study and analyse the environmental conditions and quality to be used for planning and determining the standard of the national environmental quality as well as to formulate guidelines for the enhancement of the national environmental quality;

(3) to recommend the National Environment Board for adopting measures with a view to improving and enhancing the national environmental quality;

(4) to check and evaluate the result on the compliance with or enforcement of the laws, rules and regulations concerning the prevention and conservation of environmental quality by Government agencies, State enterprises and private organizations in order to report to the National Environment Board.

(5) to receive for consideration and remedy a petition from any person who has been aggrieved or damaged by an act which has adverse effect on the environmental quality;

(6) to perform the duty as the centre of co-ordination and public relations in respect of the environmental quality within the country and with foreign countries;

(7) to encourage or carry out the study, research and propagation of problems of the environmental quality in co-operation with educational establishments and other agencies:

(8) to promote and encourage the study of the environmental quality at every level of education;

(9) to perform other functions as may be designated by law to be those of the Office of the National Environment Board.

4. Authorities under the Improvement and Conservation of National Environmental Quality Act

4.1 The National Environment Board shall have the power to require Government agencies, State enterprises and other persons to submit documents on the survey of consequences affecting the environmental quality and documents or data concerning the projects and schemes for its consideration and may, in this connection, summon a person concerned to give explanation

thereof. If it is of the opinion that any project or scheme may cause gross damage to the environmental quality, it shall recommend remedial measures to the Council of Ministers.

4.2 The National Environment Board or the Office of the National Environment Board may invite any person to give fact, explanation, or technical opinion or advice as it deems fit and may ask for co-operation from any person with a view to ascertaining any fact or surveying any activity which may have adverse effect on the environmental quality.

4.3 The National Environment Board may appoint an ad hoc committee to consider or carry out any matter as may be entrusted by the National Environment Board. The as hoc committee may appoint a sub-committee to consider or carry out any matter as may be entrusted by the ad hoc Committee.

4.4 According to section 17 of this Act, the Prime Minister shall, with the advice of the National Environment Board, have the power to issue Notifications in the Government Gazette, prescribing the followings:

(1) categories and magnitude of projects or activities of Government agencies, State enterprises or private organizations, which are required to submit report concerning the study and measures for the prevention of and remedy for the adverse effect on the environmental quality during the preparation stage (EIA report) to the National Environment Board for consideration and approval before further proceedings;

(2) standards of environmental quality which, by law, are not within the scope of power and duty of any Government agency:

(3) methods to be used for checking environmental quality.

4.5 Section 18 states that in the case where there is a Notification regarding the EIA, the official invested by law with the power and duty to consider and grant a permit or renewal of a permit to any person in order to enable him to carry out any project or activity shall submit a report concerning the study and measures for the prevention of and remedy for the adverse effect on the environmental quality during the preparation stage of such applicant to the Office of the National Environment Board for consideration and approval before further proceedings.

After the said official has submitted a report concerning the study and measures for the prevention of and remedy for the adverse effect on the environmental quality during the preparation stage under paragraph one, the Office of the National Environment Board shall consider the report within ninety days from the date of receiving such report. If the Office of the National Environment Board does not finish its consideration within the said period, it shall be deemed that the Office of the National Environment Board has granted its approval to it in accordance with the first paragraph.

In the case where the Office of the National Environment Board gives its approval under paragraph one, the said official shall grant the permit or renewal of permit to the applicant.

In the case where the Office of the National Environment Board does not give its approval under paragraph one, the said official shall delay the grant of permit or the renewal of permit to the applicant until such person has submitted measures for the prevention of and remedy for the adverse effect on the environmental quality to which the Office of the National Environment Board Can give its approval.

After such person has submitted measures for the prevention of and remedy for the adverse effect on the environmental quality under paragraph four, the Office of the National Environment Board shall consider the said measures within thirty days from the date of the submission; if the Office of the National Environment Board does not finish its consideration within the said period. It shall be deemed that the Office of the National Environment Board has granted its approval thereto under paragraph four and the said official shall grant a permit or a renewal of permit to the applicant.

4.6 For the purpose of carrying out the activities under section 18, the National Environment Board may request any Government agency, or Government educational institution, as it thinks fit, to make a report concerning the study and measures for the prevention of and remedy for the adverse effect on the environmental quality.

The National Environment Board may authourize an expert in the study of the adverse effect on the environmental quality to make a report of study and measures for prevention of and remedy for the adverse effect on the environmental quality.

The application for and the grant of a permit, the qualifications of the expert, the order suspending or revoking the permit, and the control of the activities of a licensee shall be in accordance with the rules, conditions, and methods prescribed in a Ministerial Regulation and the fees for the application for and the grant of a permit shall be in accordance with those prescribed in the Ministerial Regulation.

4.7 The highest power is stated in section 20 that if there is an emergency arising from environmental pollution, which, if left unremedied, will be dangerous to life, or will cause personal injury or damage to the properties of the people or the State, the Prime Minister shall have the power to issue an order prohibiting the person from causing such danger or damage or the person who may be in danger or suffer any damage from acting in any way which will intensify the severity of such environmental pollution, or issue an order that certain acts be carried out in order to stop or reduce the severity of the environmental pollution during the emergency.

The Prime Minister may delegate the power to issue the order under paragraph one to the Changwat Governor to exercise such power within the Changwat area on behalf of the Prime Minister by issuing the order to that effect and publishing it in the Government Gazette.

After the Prime Minister has issued the order under paragraph one or the Changwat Governor acting on his behalf has issued the order under paragraph two, the said order shall be published in the Government Gazette without delay.

4.8 Section 21 states that in the case where there is a reasonable ground for suspecting that there is violation of or non-compliance with any law, rule or regulation concerning the control of environmental quality, the order of the Prime Minister or of the Changwat Governor acting on behalf of the Prime Minister under section 20, the competent official shall have the power to enter any premises or vehicle during sunrise and sunset or during office hours in order to inspect the said violation or non-compliance.

In the performance of duty by the competent official under paragraph one, the owner or occupier of premises or vehicle or any person concerned shall provide him with reasonable facility.

4.9 The performance of duty under section 21 shall be done in the presence of the occupier of the premises or vehicle, if such person cannot be found, it shall be done in the presence of at least two other persons requested by the competent official to attend as witnesses.

4.10 In performing his duty, the competent official must produce his identity card at the request of the person concerned.

An identity card of competent official shall be in such form as prescribed in a Ministerial Regulation.

4.11 In performing his duty, the competent official shall be official under the Penal Code.

4.12 The Prime Minister shall have charge and control of the execution of this Act and shall have the power to appoint competent officials, issue Ministerial Regulations prescribing fees not exceeding the rates attached hereto a prescribing other Activities and issue Notifications for the execution of this Act.

Penalties: (1) Whoever violates or fails to comply with a Notification of the Prime Minister issue under section 17 (2) shall be liable to imprisonment for a term not exceeding one month or to a fine not exceeding one thousand baht or to both.

(2) Whoever violates or fails to comply with an order issued under section 20 shall be liable to imprisonment for a term not exceeding six months or to a fine not exceeding ten thousand baht or to both.

In the case where the person who violates or fails to comply with said order is the person who causes danger or damage, he shall be liable to imprisonment for a term not exceeding five years or to a fine not exceeding fifty thousand baht, or to both.

(3) Whoever obstructs or fails to provide facility to a compete official in the performance of his duty section 21 shall be liable to imprisonment for a term not exceeding one month or to a fine not exceeding one thousand baht or to both.

Sources: (1) Improvement and Conservation of National Environmental Quality Act. BE 2518, published in the Government Gazette, Vol. 93, Part 40, Special Issue, dated February 19, B.E. 2518 (1975)

(2) Improvement and Conservation of National Environmental Quality Act. (No. 2), B.E. 2521, published in the Government Gazette Vol. 95, Part 156, Special Issue, dated December 31, B.E. 2521 (1978)

(3) Improvement and Conservation of National Environmental Quality Act. (No. 3) B.E. 2522, published in the Government Gazette Vol. 96, Part 40, Special Issue, date March 23, B.E. 2522 (1979)

SECTIONS B : REQUIREMENTS REGARDING THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

1. Type and Sizes of Projects or Activities Requiring Environmental Impact Assessment (EIA) Reports

Items	Types of Projects or Activities	Sizes
1	Dam or Reservoir	storage volume greater than 100,000,000 cubic meters or storage surface area greater than 15 square kilometers
2	Irrigation	irrigated area greater than 80,000 rais (12,800. hectares).
3	Commercial Airport	all sizes.
4	Hotel or Resort Facilities environmentally sensitive area such as areas adjacent to rivers coastal areas, lakes or beaches or in the vicinity of national parks	greater than 80 rooms
5	Mass Transit System and Expressway as defined by the Announcement of the Revolutionary Party No. 290, 24 November B.E. 2515	all sizes.
6	Mining as defined by the Mineral Act No. 1 B.E. 2510, No. 2 B.E. 2516 and No. 3 B.E. 2522	all sizes.
7	Industrial Estate as defined by the Industrial Estate Authority of Thailand Act, B.E. 2522	all sizes
8	Commercial Port and Harbour	with capacity for vessels of greater than 500 ton-gross.
9	Thermal Power Plant	Capacity greater than 10 MW.
10	Industries	
	(1) Petrochemical Industry	greater than 100 tons/day of raw materials required in production processes of oil refinery and/or natural gas separation.
	(2) Oil Refinery	all sizes.
	(3) Natural Gas Separation of Processing	all sizes.
	(4) Chlor-Alkaline Industry requiring NaCl as raw material for production of Na_2CO_3, NaOH, HCl, Cl_2, NaOCl and Bleaching Powder	production capacity of each or combined product greater than 100 tons/day

Items	Types of Projects or Activities	Sizes
	(5) Irons and/or Steel Industry	requiring from are and/or scrap iron as raw materials for production greater than 100 tons/day or using furnaces with combined capacity greater 5 tons/batch.
	(6) Cement Industry	all sizes.
	(7) Smelting Industry other than Iron and Steel	production capacity greater than 50 tons/day.
	(8) Pulp Industry	Production capacity greater than 50 tons/day.

Source: Notification of the Ministry of Science, Technology and Energy, B.E. 2524 issued under Improvement and Conservation of National Environmental Quality Act, B.E. 2518 as amended in B.E. 2521, published in the Royal Government Gazette (Special issue), Vol. 98, part 158, dated September 27, B.E. 2524 (1981)

2. License for Preparation of Environmental Impact Assessment Report.

2.1 Qualification of Applicant.

The EIA reports which are required to be approved for permitting procedure can be prepared only by the persons or parties who have license from the National Environment Board. The applications for the license is limited to the following applicants:

(1) Educational institution or Research Institution as juristic person under thai laws.

(2) Juristic person under Thai laws as follows:

(a) All share holders of Registered ordinary Partnership must be thai nationality

(b) Unlimited responsibility share holder of limited partnership must be thai nationality and capital of limited partnership not less than 51% must belong to share holder who is the person with thai nationality.

(c) Committee of Limited company not less than half must be thai nationality and capital of such company not less than 51% must belong to share holder who is ordinary person with thai nationality.

(3) Juristic person under foreign laws must join juristic person as in article (1) or article (2) who is granted a license in order to be eligible for preparing EIA report.

(4) State Enterprises, as established by a specific Act, only for their own activities.

(5) Mining Industry Council, as established in accordance with the law, only for the members' activities.

The applicant in article (1) and article (2) must have head office in Thailand. The applicant in article (2) and article (3) must be in the business of research and technical consultation.

2.2 Qualification of Expert

The applicant mentioned above must have at least one full-time expert taking responsibility for preparation of EIA report and he/she must meet the following qualifications:

(1) The expert is holder of not less than a Bachelor degree or equivalent in

(a) Environmental science, Ecology or Sanitary science

(b) Environmental engineering or Sanitary engineering.

(c) Environmental economics.

(2) The expert must have experience in the field of improvement and conservation of environmental quality in accordance with the notification of the National Environment Board as follows:

(a) The expert with Doctoral degree or equivalent must have experience in the field of improvement and conservation of environmental quality for not less-than 1 year.

The expert with Master degree or equivalent must have experience in the field of improvement and conservation of environmental quality for not less than 3 years.

The expert with Bachelor degree or equivalent must have experience in the field of improvement and conservation of environmental quality for not less than 5 years.

(b) The expert must have worked in this field in government sector, State Enterprises, International organization, Foreign Government agencies or in the business of environmental consultation and he/she must be involved in preparation of the following reports, fully or partially:

1) Report concerning study and measures for protection and improvement of impacts on the environment.

2) Planing, management, study and research concerning environment such as pollution, Ecology, Conservation, Arts and Culture.

(c) The qualification of expert must be approved by a committee appointed by the Secretary-General of the National Environment Board. This committee is composed of not less than 5 but not more than 8 persons.

(d) The applicant must be able to prove to the committee that his/her expert has enough experience in the field of the required qualifications. Office of the National Environment Board will submit the recommendation concerning the expert to the National Environment Board for licensing.

(3) The expert has not been involved in false or fraudulent EIA report during the past three year.

The National Environment Board has authorities to accept expert who does not qualify as described in (1) under certain condition.

2.3 Qualification of Staffs

The applicant must have at least three full-time staffs taking responsibility for preparing EIA report and these staffs must meet the following qualifications :

(1) They must be graduated in Science, Engineering, or Social Science.

(2) They have not been involved in false or fraudulent EIA report during the past three years.

2.4 Conditions Prescribed in License

Permiting a person to prepare EIA report, the National Environment Board can prescribe the conditions which licensee must perform and the scope, nature, and type of activities that licensee is allowed to prepare EIA reports.

2.5 Suspending the License

The National Environment Board has authorities to suspend the license, when:

(1) The licensee prepares a report carelessly which may cause damage to public

(2) The licensee allows expert or staff who has been suspended or revoked the license to prepare EIA report

(3) The licensee violates or fails to comply with the condition prescribed in the license.

The suspension in article (1) is not less than 6 months, but not more than 12 months at a time and the suspension in article (2) or article (3) is not less than 3 months but not more than 6 months at a time, depending on situation.

2.6 Revoking the License

The National Environment Board has authorities to revoke the license when:

(1) The licensee lacks qualification as described in article 2.1,

(2) The licensee does not provide expert(s) or staffs as described in article 2.2 and 2.3.

(3) The significant information in application form fails to reflect the fact, fully or partially,

(4) The licensee, who once was suspended the license, violates regulation in article 2.5 again,

(5) The licensee prepares false or fraudulent report,

(6) The licensee violates or fails to comply with this ministerial regulation,

(7) The licensee violates or fails to comply with the conditions prescribed in license and such conditions state that the license will be revoked if the licensee violates or fails to comply with the conditions.

Source: (1) Ministerial Regulation No. 2. (B.E. 2527) issued under Improvement and Conservation of National Environmental Quality Act, B.E. 2518 as amended in B.E. 2521, published in the Royal Government Gazette, Vol. 101, Part 184, dated December 12, B.E. 2527 (1984)

(2) Notification of the National Environment Board No.7/2528 by virtue of article 4(1) (b) of Ministerial Regulation no. 2 (B.E. 2527) issued under Improvement and Conservation of National Environmental Quality Act, B.E. 2518 as amended in B.E. 2521.

(3) Ministerial Regulation No.3 (B.E. 2529) issued under Improvement and Conservation of National Environmental Quality Act, B.E. 2518, published in the Royal Government Gazette, Vol. 103, Part 140, dated August 8, B.E. 2529 (1986)

1. Air Quality Standards

1.1 National Ambient Air Quality Standards

Pollutants	1 hr average value mg/m3	8 hr average value mg/m3	24 hr average value mg/m3	1 yr average value mg/m3	Methods of Measurement
Carbon Monoxide (CO)	50	20	—	—	Non-Dispersive Infrared Detection
Nitrogen Dioxide (NO_2)	0.32	—	—	—	Gas Phase Chemiluminescence
Sulfur dioxide (SO_2)	—	—	0.30	0.10*	Pararosaniline
Suspended Particulate Matter (SPM)	—	—	0.33	0.10*	Gravimetric
Photochemical Oxidant (0_3)	0.20	—	—	—	Chemiluminescence
Lead (Pb)	—	—	0.01	—	Wet Ashing

Note: * = Geometric mean value.

Sources: (1) Standard: Notification of Office of the National Environment Board,No.2, dated November 6, B.E. 2524, published in the Royal Government Gazette, Vol. 98, Part 197, dated December 1, B.E. 2524 (1981) P. 4322-4323.

(2) Methods of Measurement: Notification of the Ministry of Science, Technology and Energy, issued under Improvement and Conservation of National Environmental Quality Act B.E. 2518, B.E. 2521, published in the Royal Government Gazette, Vol. 98, Part 197,dated December 1, B.E. 2524 (1981) P. 4299-4306.

1.2 Emission Standards

1.2.1 Industrial Emission Standards

In order to avoid industrial nuisance problems, the intensity of smoke at the mouth of the stack shall not exceed 40 percent of total blackness by the Ringlemann scale except for the short periods of time during starting of operation, soot blowing, or other malfunctions of the soot control system.

Penalty : According to Factory Act No.2, B.E. 2518 (1975) which rules that violator are subjected up to one month imprisonment or fined not more than 10,000 baht or both.

Source: Notification of the Ministry of Industry No.4, B.E. 2514 (1971) issued under the Factory Act B.E. 2512 (1969) dated August 11, B.E. 2514 (1971), published in the Royal Government Gazette, Vol. 86 (Special issue) dated August 14, B.E. 2514 (1971)

1.2.2 Motor Vehicle Emission Standards

Organization	Parameters	Emission Standards		Measuring Methods (summary)
		Measuring Systems	Maximum Permissible Limit (%)	
(1) ONEB (Office of the National Environment Board)	Black Smoke	Bosch	40	1) No-load acceleration at 3/4 of maximum rotating speed. Use maximum value of the two measurements. or 2) On test bench, running with full-load at 60% of the maximum rotating speed. Use average valve of the two measurements.
		Hartridge	52	
	CO	Non-Dispersive Infrared Detection	6	1) Idling 2) Average value of the two measurements
(2) The Police Department	Black Smoke	Smoke meter	40	At proper rotating speed
(3) Department of Land Transport	Black Smoke	Bosch	40	The same as ONEB.
		Hartridge	52	,,
	CO	Non-Dispersive Infrared Detection	6	The same as ONEB.

Source:

(1) ONEB Standards: Notification of Office of the National Environment Board, Dated December 14, B.E. 2522 (1979) published in the Royal Government Gazette, Vol. 97, Part 35, dated March 4, B.E. 2523 (1980) P. 736-737.

Method of measurement: Notification of the Ministry of Science Technology and Energy, issued under Improvement and Conservation of National Environmental Quality Act. B.E.2518, B.E. 2521 dated February 7, B.E. 2523 (1980), published in the Royal Government Gazette, Vol. 97, Part 35, dated March 4, B.E. 2523 (1980) P. 715-718.

(2) The Police Department: Notification of the Police Department issued under the Announcement of the Revolutionary Party No. 16., dated February 3, B.E. 2527 (1984), published in the Royal Government Gazette, Vol. 101, part 20, dated February 16, B.E. 2527 (1984) (special issue) p. 4-5.

(3) Department of Land Transport: Notification of the Department of land Transport No. 49/2525, issued under Land Transport Act B.E. 2522, dated November 5, B.E. 2525 (1982)

1.2.3 Boat/Ship/Vessel Emission Standards

Black smoke emissions shall not exceed 40% by Bosch or 52% by Hartridge System when measuring at 2/3 of maximum rotating speed.

Penalty: Two hundred baht for first violation and two thousand baht for second violation.

Source: Notification of the Harbour Department No. 177/1984 dated August 3, B.E. 2527 (1984), effective January 1, B.E. 2528 (1985)

2. Noise Standards

2.1 Community Noise Standards : none

2.2 Noise Emission Standards

2.2.1 Motor Vehicle Noise Standards

Organization	Type of motor vehicle	Standards and methods of measurement	Remarks
(1) ONEB (Office of the National Environment Board)	all type	1) The noise level shall not exceed 85 dBA measured at 7.5 meters from the exhausted pipe or 100 dBA at 0.5 meter from the exhausted pipe. 2) Use maximum value of the two measurement. 3) The motor vehicle is stationary and engine conditions during measurement vary accordings to type of engine as follow: a) **diesel engine:** maximum rotating speed b) **gasoline engine:** no-load acceleration at 3/4 of maximum rotating speed c) **motorcycle:** If maximum rotating speed is more than 5,000 rev./min, the measurement shall be done at 1/2 of maximum rotating speed. If the maximum rotating speed is less than 5,000 rev./min, the measurement shall be done at 3/4 of maximum rotating speed.	Details of tested field, equipment and calibration and others are stated.
(2) The Police Department	only motor vehicle under the responsibility of the Police Department	Motor vehicle is stationary and in normal used engine condition. The noise level shall not exceed 85 dBA measured at 7.5 meters for the exhausted pipe or 100 dBA measured at 0.5 meter from the exhausted pipe.	No other details on tested field, equipment and calibration are stated.

Organization	Type of motor vehicle	Standards and methods of measurement	Remarks
(3) Department of Land Transport	only motor vehicles under the responsibility of Department of Land Transport	The motor vehicle is stationary. Both engine conditions of diesel and gasoline engine during measurement and also the noise level standards are the same as stated in ONEB's standards and methods of measurement.	Details on tested field, equipment and calibration are stated more or less the same as ONEB

Penalty: (1) **ONEB** : none

(2) **The police Department**

Whoever violate the regulation for the first time will be fined for five hundred baht for motor vehicle, two hundred baht for motorcycle and for the second time the fine will be two thousand baht

(3) **Department of Land Transport**

The fine will be within fifty thousand baht.

Source: (1) **ONEB** : Already approved by the National Environment Board, to be issued under the Notification of the Office of the National Environment Board and Notification of the Ministry of Science, Technology and Energy.

(2) **The Police Department**

Notification of the Police Department, dated February 3, B.E. 2527 (1984), published in the Royal Government Gazette Vol. 101, Part 20, dated February 16, B.E. 2527 (1984) (special issue) P. 4-5.

(3) **Department of Land Transport**

Notification of the Department of Land Transport No. 78/1984 dated September 14, B.E. 2527 (1984).

2.2.2 Boat/Ship/Vessel Noise Standards

The standard is 85 dBA, measuring at 7.5 meters away from the vessel when the vessel is under stationary state with the mode of no-load acceleration at 2/3 of the maximum rotating speed or 100 dBA at 0.50 meter with the same condition.

Penalty: Two hundred baht for first violation and two thousand baht for the second violation.

Source: Notification of the Harbour Department No. 177/1984 dated August 3, B.E. 2527 (1984), effective January 1, B.E. 2528 (1985)

2.3 Noise Standards in Workplace

2.3.1 Standards by Ministry of Interior

Noise level (dBA)	Exposure time (hours per day)	Remark
91	less than 7	Ear plugs or ear muffs are needed in case of nessesary.
90	7 - 8	
80	more than 8	
140	not allow	

Penalty: Any employer and employee who violates or neglects to act in compliance with the prescription of the Ministry of Interior issued under Article 2 of the Announcement of the Revolutionary Party shall be liable to a term of imprisonment not exceeding six months or to a fine of not over twenty thousand baht, or both.

Source: Notification of the Ministry of Interior, issued under the Announcement of the Revolutionary Party No. 103, dated November 12, B.E. 2519 (1976), published in the Royal Government Gazette, Vol. 89, Part 148, dated November 30, B.E. 2519 (1976).

2.3.2 Standards by Ministry of Industry

- Ear plugs or ear muffs shall be provided to worker who works in the factory with noise level exceeded 80 dBA.
- Ear guard shall be provided to worker who works in the workplace that may be dangerous to pinna and ear canal.
- The factory shall control or eliminate odor, noise, vibration, dust, soot and smoke to the level that do not cause any nuisance, trouble, damage or health problem to the nearby community.

Penalty: According to Factory Act No. 2 B.E. 2518 (1975) which rules that violators are subjected up to one month imprisonment or fined not more than ten thousand baht or both.

Source: Notification of the Ministry of Industry No. 4 (B.E. 2514) issued under the Factory Act B.E. 2512 (1969), dated August 11, B.E. 2514 (1971), published in the Royal Government Gazatte Vol. 88 (special issue) dated August 14, B.E. 2514 (1971).

タイ王国サムットプラカン工業地区大気汚染管理計画
事前調査報告書

昭和62年 4月発行
編集兼発行者 国際協力事業団
新宿区西新宿 2-1-1 新宿三井ビル内
電話番号 346-5288
郵便番号 163

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