No.

Pollution Control Department
Ministry of Natural Resources and Environment
The Kingdom of Thailand

Project for Development of Environmental and Emission Standards of VOCs (Volatile Organic Compounds) in the Kingdom of Thailand

Final Report

March 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

EX CORPORATION

SOWA CONSULTANTS INC

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08-027

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Attachments

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3. **Minutes of Meeting between Japanese expert team and Pollution Control Department of the government of Kingdom of Thailand on Technical cooperation for the Development of Environmental and Emission Standards of VOCs, March 10, 2006**
4. **Minutes of Meeting Between JICA Mid-term Evaluation Team and Pollution Control Department of Ministry of Natural Resources and Environment of the Government of Kingdom of Thailand on Technical Cooperation Project for the development of Environmental and Emission Standards of VOCs, February 13, 2007**
5. **Minutes of Meeting between JICA Expert Team and Pollution Control Department of Ministry of Natural Resources and Environment of the Government of the Kingdom of Thailand on Technical cooperation Project for the Development of Environmental and Emission Standards of VOCs, February 27, 2008**

Abbreviations

A	ADMER	Atmospheric Dispersion Model for Exposure and Risk Assessment
C	CO	Carbon Monoxide
	CP	Counter Part
	CRI	Chulabhorn Research Institute
D	DCM	Dichloromethane / methylene chloride
	DDC	Department of Disease Control
	DEQP	Department of Environmental Quality Promotion
	DIW	Department of Industrial Works
D	EDC	1,2- dichloroethane
	ERTC	Environmental Research and Training Centre
F	FTI	Federation of Thai Industries
G	GC/MS	Gas Chromatography/Mass Spectrometry
	GDP	Gross Domestic Product
H	HAPs	Hazardous Air Pollutants
	HC	Hydrocarbons
I	IEAT	Industrial Estate Authority of Thailand
	IMF	International Monetary Fund
J	JCC	Joint Coordinating Committee
	JCIA	Japan Chemical Industry Association
	JEMAI	Japan Environmental Management Association for Industry
	JPY	Japanese Yen
M	M/M	Man/Month
	M/P	Master Plan
	METI-LIS	Ministry of Economy, Trade and Industry - Low rise Industrial Source Dispersion Model
	MONRE	Ministry of Natural Resources and Environment
	MTP	Map Ta Phut
N	NEB	National Environmental Board
	NGO	Non Governmental Organization
	NOx	Nitrogen Oxides
O	ONEP	Office of the Natural Resources and Environmental Policy and Planning
P	P/D	Project Document
	Pb	Lead
	PCD	Pollution Control Department
	PCE	Tetrachloroethylene
	PM	Particular matters
	PO	Plan of operation
	PR	Public Relations
	PRTR	Pollutant release and transfer register
	PTIT	Petroleum Institute of Thailand
	PVC	Polyvinyl Chloride
Q	QA/QC	Quality Assurance and Quality Control
S	SO_2	Sulfur Dioxides

	SOx	Sulfur Oxides
	SPM	Suspended Particulate Matter
T	TAPCE	Thailand Air Pollution Center of Excellence
	TCE	Trichloroethylene
	THB	Thai Baht
U	US EPA	United States Environmental Protection Agency
V	VCM	Vinyl Chloride Monomer
	VOCs	Volatile Organic Compounds

1 Introduction

Volatile Organic Compounds (VOCs) are generally referred to as substances containing carbon and hydrogen, and having minimum vapor pressure of 0.13 kPa at standard condition of 1 normal atmosphere and 20 degree Celsius; under this definition, numerous organic compounds fall into this category. VOCs are released easily from a source to the ambient air and cause air pollution. In recent years, Thailand has faced environmental problems suspected to be caused by VOCs. Hence, understanding the current situation and taking appropriate measures are crucial. Two distinctive characteristics of VOCs should be noted; one being the harmful nature of inhaling the substances (called HAPs: Hazardous Air Pollutants) and another being property of precursor to particulates and photochemical oxidants from photochemical reaction. Hence, a comprehensive view supported by scientific data gathered by monitoring is necessary to establish environmental and emission standards and develop measures against VOCs pollution.

Under these circumstances, Pollution Control Department (PCD) of Ministry of Natural Resources and Environment (MONRE) requested technical cooperation to Japan for developing environmental and emission standards for VOCs. In response, JICA dispatched preparatory mission in June 2005 and both parties signed Minutes of Meeting. Then Record of Discussion was signed in November 2005. Following the approval of the project, JICA selected EX CORPORATION and SOWA CONSULTANT INC. as an experts team to implement the project

Project Document (P/D) on “Project for Development of Environmental and Emission Standards of VOCs (Volatile Organic Compounds) in the Kingdom of Thailand” was prepared by EX CORPORATION and SOWA CONSULTANT INC. under general guidance of JICA. The document describes background, strategy, approach and work plan for the project for common understanding between Thai side and Japanese side in the beginning. The project was to be carried out from March 2006 to March 2008.

The Project Document attached as Annex was agreed upon between Thai side and the JICA team in March 2006. Technical transfer activities by the expert team in the field began in May 2006 based upon the scopes and schedules specified in the agreed P/D. Since 24 months has passed from commencement of the project, now the project is closed on March 5, 2008, although PCD must continue monitoring work and implement the policy on HAPs pollution control.

This final report of the project aims at confirming actual achievement and transferring the lesson learned derived though the project to interested persons who are engaged in policy formulation and technical cooperation in the field of environmental management.

The report consists seven chapters; Chapter 2 summarized background and work plan, including goals, targets, actions, schedule, inputs, and implementation structure of the project.

Chapter 3 summarizes outputs and achievement made during the past 24 months while Chapter 4 shows actual operation, including comparison between original plan and achievement.

Chapter 5 describes actual input of resources to accomplish the overall goal and expected outputs defined in the Master Plan attached in the Record of Discussion signed in November 2005.

Chapter 6 summarizes efforts for effective implementation carried out by the project team and discusses lesson learned throughout the project. Chapter 7 states future issues and their recommended actions.

2 Background and Outline of the Project

2.1 Background of the Project

Since 1980s Thailand's economy expanded rapidly backed by aggressive foreign investments, and its annual economic growth has reached 9% on average from 1985 to 1995. On the other hand, the current account deficit has pushed up and so-called "economic bubble" has emerged especially in real estate sector. After the end of the babble economy, bad assets increased; leading to pressure to devalue Thai Baht. When foreign exchange shifted into floating rate system in July 1997, Thai Baht fell drastically that Thailand was eventually caught by severe economic crises.

The government of Thailand received aids from international community, including International Monetary Fund (IMF) and Japan, and tackled the problem for economic revitalization by bad-debt disposal and structural reform. The Thaksin administration, since February 2001, argued to expand domestic demand, in addition to traditional export oriented economy, and promoted rural area and medium-small sized enterprises. The policy on expanding domestic demand, as it seems, enhanced consumer purchasing power and economic growth reached 6.9% in 2003, and 6.1% in 2004. In 2004, GDP reached 163.5 billion U.S. dollars.

The economic structure of Thailand has changed dramatically since the late 1980s with a rapid industrialization. Share of agricultural sector in GDP has fallen from 23.2% in 1980 to less than 10% in 2000. On the contrary, ratio of GDP increased in manufacturing, commercial, and service sectors. It should be noted that agriculture sector employees the most people in 2000, or 48.4% of total population.

Thailand is facing various social challenges, some of which are described as follows;

a. Urbanization

There were only 9 cities that had population of more than 50,000 in 1996, but by 2004, the number increased to 22 cities, indicating that urbanization has steadily progressed in Thailand (although the growth rate is somewhat moderate than that of other Southeastern Asian countries, such as Indonesia, Philippines, or Malaysia). Currently, approximately 31% of Thai people live in the urban areas, while urbanization rate is estimated to increase to 40% by 2030. It is worth noting that population is concentrated in Bangkok (estimated to be 13% of total population). The urban areas face several serious environmental issues such as worsening pollution, waste, and living environment like water supply or sewage services, traffic congestion, deterioration of public safety, and squatter/slum are impending.

b. Environmental problems

Alongside rapid economic growth, urbanization, and industrialization, Thailand is experiencing industrial pollution, unsanitary urban environment, and destruction of natural environment. The detail is discussed in the following section

c. Air Quality

Major air pollutants in Thailand are dust, suspended particulate matters (PM_{10} and $PM_{2.5}$), sulfur dioxides (SO_2), lead (Pb), carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), and ground-level ozone (O_3). Emission sources of those pollutants are automobiles, power plants, factories, construction sites, forest fires, and open burning of agricultural wastes. Among mobile sources, two-stroke motorcycles, diesel trucks, and ageing buses contribute significantly to air pollution in urban areas. Central region of Thailand accounts for 60 - 70 percent of all industrial emissions in the country. Fossil fuel powered thermal sources continue to generate SO_2, NO_2 and carbon dioxide (CO_2) emissions. In non-urban areas, sources such as agricultural burning also contribute significantly to particulate pollution.

PCD has a monitoring network consisting of 53 sites nationwide. Air quality data from these monitoring stations reveal that many air pollutants, such as Pb, SO_2, and CO, are on the decrease. However, ozone and SPMs are still exceeding the environmental standards in many of these monitoring stations.

In transport sector, a very large fleet of old diesel buses and trucks emit large amounts of carcinogenic particulate matters. A large number of older 2-stroke motorcycle also remains (although the number of four-stroke motorcycles are increasing). In industrial sector, many small and medium sized enterprises still emit air pollutants while many industrial units have adopted cleaner production to reduce air pollution. Furthermore, non-point sources remain a major concern. In rural areas, open agricultural and forest burning emit large volumes of PMs.

d. Situation and issues on air and VOCs pollution before starting the project

VOCs emitted from the industries and vehicles are considered as one of the major sources for suspended particulate matters (secondary formation), which exceed the standard and requires immediate countermeasure and also triggers photo-oxidant reactions. Furthermore VOCs are hazardous air pollutants, which cause various acute health problems as well as carcinogenic risks. Under this situation, the Thai government considered VOCs as an important issue in ambient environmental matters. National Environmental Board instructed PCD to implement countermeasure for VOCs.

Map Ta Phut incident in 1997 was a well-known environmental problem related to VOCs. In this incident, tens of pupils in a school nearby the Map Ta Phut industrial estate were hospitalized due to serious air pollution. Source of the pollution was considered as VOCs. The school was forced to close and moved to another location. Source pollutants and source factory(ies) have not been identified at this moment. Even now there are various reports and claims regarding occurrence of fruit like smell (most likely aromatic VOCs) around the estate. According to MONRE, 40% of environmental complains are on odor and smell, and most of them are considered to be related to VOCs.

Before starting this project there was no ambient environmental standard set for VOCs, and a systematic monitoring of VOCs in ambient had not been developed. PCD and Environmental Research and Training Centre (ERTC) of MONRE had implemented limited monitoring of VOCs separately. PCD had started periodical monitoring at six stations around Bangkok with special attention on mobile sources. Though there was few data that systematically assured its quality, concentration of certain VOCs were considered to be at levels which health risk could not be ignored. Therefore, it was urgent matter for the government to confirm the necessity of the countermeasures.

2.2 Outline of the Project

P/D was developed by the JICA team in March 2006. The contents of the P/D were officially accepted after discussions between the JICA team PCD on March 7, and ERTC on March 7, 2006.

The project plan decided in the P/D is shown below.

Basic framework of the project was made up and mentioned in the annex of the minutes dated November 30, 2005 agreed between the Thai side and JICA Head Quarter Global Environment Department. The basic plan of the project is summarized as follows based on the minutes.

(1) Overall Goal

Overall Goal of the project is to take concrete actions on air pollution caused by VOCs.

(2) Project Objective

Project objective is an enhancement of capacity of MONRE to take countermeasures against VOCs air pollution by means of development of environmental and emission standards in Thailand. The following four items of indicators are listed in the P/D.

1. Priority compounds of VOCs to be monitored and controlled in Thailand are recognized by MONRE.
2. PCD has gained the technical capability to conduct routine monitoring of the priority VOCs, and ERTC has gained the capability to monitor the VOCs in the air in a wider area for research purpose.
3. Awareness of air pollution by VOCs is raised through PCD and ERTC activities.
4. PCD can propose environmental and emission standards for VOCs to the Pollution Control Committee.

(3) Outputs

Project objective is achieved when the following outputs are realized.

Output 1: Identification of the current status of air contamination by VOCs to set up environmental and emission standards in Thailand

Output 2: Proposal on environmental and emission standards of VOCs to the Pollution Control Committee

(4) Activities

a. Activities for Output 1

The following eleven activities for Output 1 are conducted.

1. To develop a study plan of air contamination by VOCs for PCD and ERTC
2. To review the existing emission inventory and monitoring data
3. To instruct VOCs monitoring technology necessary for understanding current situation
4. To establish management system for analytical accuracy in laboratory
5. To conduct the first inventory study for VOCs emission
6. To list priority VOCs compounds
7. To develop VOCs monitoring plan
8. To implement stationary monitoring and manage analytical accuracy in laboratory
9. To conduct and review detail inventory study for VOCs emission and the priority VOCs compounds
10. To establish data book regarding contamination status of VOCs in cooperation with ERTC
11. To organize seminars and workshops for disseminating the result of the study

b. Activities for Output 2

The following eleven activities for Output 2 are conducted.

1. To develop outline of VOCs regulation
2. To select priority VOCs compounds
3. To determine the detail study area

4. To revise and publicize outline of the first VOCs regulation
5. To implement inventory study regarding emission of priority VOCs in the detail study area
6. To identify metrological condition of the detail study area and develop air diffusion models for VOCs
7. To review result of monitoring data in the detail study area
8. To collect the data and information regarding health risks of VOCs
9. To examine control technology for VOCs reduction
10. To set up proposal on environmental and emission standards
11. To hold a final seminar to sum up the project

2.3 Policy of Project Operation

2.3.1 Strategy of the Project

Project objective is "to enhance the capacity to implement countermeasure for VOCs air pollution (including development of environment and emission standards) in MONRE". To meet the objective, project strategy set "clear definition of capacity development target and goal setting" with special attention on the following four points.

1. Need for simultaneous development of VOCs monitoring capacity and policy formulation capacity based on the monitoring results
2. Need to define targets and goals clearly for capacity development of Thai side
3. Development of stakeholder relationships
4. Interactive approaches for technical cooperation

2.3.2 Basic Approach / Implementation Policy

Basic approaches of the project are discussed as follows:

(1) Monitoring support

a. <u>Development of VOCs monitoring plan</u>

One of the characteristics of VOCs in the ambient air is that concentration may fluctuate greatly in both space and time. The project selects approximately 20 stationary monitoring sites for obtaining annual average for extended period of time. The average annual concentration of VOCs is needed when considering health effects from long-term exposures. In other words, if large number of data is gathered from short term monitoring in many monitoring sites, it is not adequate to base discussion on those data. From this point of view, monitoring plan shall be developed strategically. Using the result of preliminary inventory study as a reference, monitoring sites must be selected as ambient environmental concentration around the sources for priority VOCs. Consequently, the monitoring sites are selected based on assumption for the area that is most concerned from VOCs pollution. Due to these reasons, the monitoring sites for the project are carefully chosen with existing monitoring data, preliminary inventory data, and knowledge of the sources accumulated by PCD, ERTC and other agencies.

b. <u>Selection of target area for detailed VOCs study</u>

At the stage of detailed VOCs study, inventory survey for factories, source monitoring at emission point as well as boundary of the facility is planned. Therefore, monitoring at source may require many sampling sites, depending upon types of factories or other source types. As analyzing capacity at that stage is still limited, the size of detailed study area is expected to be about 10 factories (sources).

(2) Quality management support

QA/QC is essential for a trace analysis such as VOC analysis. VOCs analysis requires not only technical operational skills of the instrument, but also QA/QC system to ensure the precision and accuracy of analysis. Staff training is focused not only on basic analytical procedures, but also on the ability to grasp various issues in each step of the analysis, and take appropriate measures. Cooperation with ERTC laboratory including cross checking is also emphasized to realize the establishment of concrete analytical system.

(3) Inventory study

Inventory study provides basic data for understanding of the types of sources (both stationary, mobile and area) that are responsible for VOCs emissions.

(4) Development of policy framework paper

It is inevitable to secure scientific data and information to formulate proposed environmental and emission standards of the specified VOCs. It is very sensitive work to determine standard values of those substances that are mainly characterized by no threshold dose. On the other hand, determination of those values is formally done by authorized organization and committee based upon policy decision as result of the compromise among relevant stakeholders. In this project, the project team shall recognize as secretariat with having a role of only providing data and information in scientific form to decision makers.

The project team shall draw up policy framework paper on VOCs pollution control to respond to many questions which may be asked from stakeholders such as why prioritizes these substances, why comes up with proposed numerical value for environmental and emission standards, and why determines certain risk level for setting environmental standards and so forth. The paper shall describe concept of control measures, methodology and procedure of setting such standards and concept of employing suitable countermeasures to reduce HAPs in order to explain reasons of all decisions on VOCs pollution control.

(5) Approaches for selecting the priority VOCs

Selecting priority VOCs needs a broad view. A measure for VOCs has two distinctive aspects; measures for HAPs and measures for SPM and photochemical oxidants. The focus of measures may change during mid- and long-term policy development. Furthermore, measure and its approach may differ from the one type of VOC to the other types, and thus effectiveness of the measures needs careful review. Hence, there are four criteria for selecting the priority VOCs;

1. Viewpoint on health risk (such as carcinogenicity of specific VOCs)
2. Viewpoint on precursors to Suspended Particular Matters and Photochemical oxidants
3. Viewpoint on environmental concentration and amount released
4. Viewpoint on effectiveness of the measures (economical efficiency and their benefits)

This project focuses on health risk. While the team assumes the levels of toxicity of specific VOCs as priority criteria, verification of the concentration -- if it reaches cautious level from inventory study and monitoring survey -- is also important.

On the other hand, there may be a case where VOCs with low toxicity are discharged in large volume. In such case, it may be necessary to implement measure from mid- and long-term viewpoint.

(6) Application of Models

There are atmospheric dispersion models available in Japan, namely, ADMER <National Institute of Advanced Industrial Science and Technology- Atmospheric Dispersion Model for Exposure and Risk Assessment> and METI-LIS <Ministry of Economy, Trade and Industry –Low rise Industrial Source Dispersion Model>. The former is mainly used for analyzing regional exposure analysis while the later is mainly used for concentration analysis on proximity of the source. Since the project focuses on concentration near the proximity of the source, METI-LIS is mainly used. ADMER may also be used if background data is sufficiently available.

(7) Risk assessment

There are two procedures to carry out risk assessment. One is to rate the risk based on hazard posed from the chemical characteristics and condition of exposure, and the other is to follow two steps of preliminary assessment and a detailed assessment. There are also differences between methods of assessing overall risks and risks at a specific site. The project plans to utilize 'Preliminary assessment of environmental risk on chemical substances' published by Ministry of Environment Japan in 2002. In order to carry out risk assessment, it is necessary to collect data on amount of exposure only (other data (e.g. toxicity) are already available).

(8) Seminars/workshops and stakeholder relation

a. Seminars/workshops

As it is very important to share the outcome of the project with environmental administrators, researchers, and people from industries, a seminar/workshop in 2006 and two seminars/workshops in 2007 are planed. PCD should play the main role in the seminars/workshops, and the project team should assist PCD. The team will also assist to determine the content of the seminars/workshops.

b. PR activities

Web page shall be developed to publicize the project on VOCs. PR activities must be done in Thai language.

c. Stakeholder meeting

The project will, periodically, report the progress and output from the activities to the stakeholder meeting.

2.4 Implementation Organization

2.4.1 Implementation Structure

(1) Japan side

a. Experts

Experts shown in the table are dispatched.

Table 2-1 Experts Dispatched by JICA

	Fields
1	Policy making and Environmental Standard
2	Monitoring Plan /VOCs Control Technology
3	VOCs Analytical Technology in the Air & Automobile Exhaust Gas VOCs Analysis
4	Inventory Study & VOCs Control Technology (Chemical substance producer)

	Fields
5	VOCs Air Diffusion Monitoring VOCs Control Technology
6	Health Risk Evaluation
7	VOCs Control Technology (Industrial cleaning, laundry)
8	Detailed Inventory Study & Control Technology on EDC and VCM
9	Policy Making on Emission Control of Hazardous Air Pollutants of Automobile Source

No 9 expert was dispatched directory by JICA outside the contract with consultant team.

(2) Thailand side

Thai side organized the project team as bellow.

- Project Director:

  Dr. Supat Wangwongwatana, Director General of Pollution Control Department, Ministry of Natural Resources and Environment

- Project Manager:

  Ms. Mingquan Wichayarangsaridh, Deputy Director General of Pollution Control Department, Ministry of Natural Resources and Environment (March 2006 ~January 2008)

  Successor, Dr. Wijarn Simachaya, Director of Air Quality and Noise Management Bureau, Pollution Control Department (February 2008- March 2008)

- Project Staffs

  18 staffs shown in Table 2-2 were appointed in the project.

(3) Project team

Four sub-groups were established according to types of tasks. Table 2-3 shows each task group and member as the VOC Project team.

Table 2-2 Project Team and Member

	Task group & Member	Title	Remarks
Task:	**<u>Policy Formulation</u>**		
	Mr. Masato Ohno	Team leader of JICA expert	
	Mr. Phunsak Teeramongkol	Director of Ambient Air Quality Division	
	Mr. Panya Warapetcharayut	Director of Automotive Air Pollution Division	
	Dr. Pornsri Suthanaruk	Director of Environmental Quality and Laboratory Division	
	Dr. Patcharawadee Suwannathada	Director of Industrial Air Pollution Division	
	Dr.Kessinee Unapumnuk	Ambient Air Quality Division	Project Coordinator (Oct. 2007 -)
	Dr. Sarawut Thepanondh	Ambient Air Quality Division	Project Coordinator (- Sept.2007)

	Task group & Member	Title	Remarks
Task:	**Laboratory Analysis**		
	Mr. Yoshiharu Shirane	JICA expert	
	Dr. Pornsri Suthanaruk	Director of Environmental Quality and Laboratory Division	
	Ms. Jarinporn Tippamongkol	Environmental Quality and Laboratory Division	
	Ms. Amornphat Tadsanaprasittipol	Ditto	
	Ms. Waroonphan Jarupan	Ambient Air Quality Division	
Task:	**Monitoring**		
	Mr. Munehiro Fukuda	Sub leader of JICA expert	
	Ms. Waroonphan Jarupan	Ambient Air Quality Division	
	Mr. Ittipol Pow-armat	Automotive Air Pollution Division	
	Ms. Thitirat Pentakulchai	Ditto	
	Ms. Pilai Thiendate	Industrial Air Pollution Division	(-Jul.2007)
	Mr. Jirapat Theamjun	Ditto	
	Ms. Jarinporn Tippamongkol	Environmental Quality and Laboratory Division	
	Ms. Amornphat Tadsanaprasittipol	Ditto	
Task:	**Emission Inventory &Control Technology**		
	Mr. Yoshiharu Shirane	JICA expert	Mobile sources
	Mr. Shoji Nakamura	JICA expert	EDC & PVC
	Mr. Koichi Kawasaki	JICA expert	EDC & PVC
	Mr. Makoto Takahashi	JICA expert	Storage & combustion
	Mr. Shinsuke Okamoto	JICA expert	Industrial cleaning
	Mr. Akira Nakamura	JICA expert	Modeling
	Mr. Makoto Okazaki	JICA expert (Professor of Tottori University for Environmental Studies)	Countermeasure of mobile sources
	Dr. Sarawut Thepanondh	Ambient Air Quality Division	Project Coordinator (- Sept.2007)
	Dr. Jariya Sukhapan	Industrial Air Pollution Division	
	Ms. Orrawan Manoonwong	Ditto	
	Mr. Danrongrith Kanjanop	Ditto	
	Mr. Jirapat Theajun	Ditto	
	Ms. Chuennadda Chulamanee	Ditto	
	Ms. Manwipa Kuson	Automotive Air Pollution Division	
	Mr. Ittipol Pow-armat	Ditto	

Project Coordinator & Contact Person
Dr. Sarawut Thepanondh (~September 2007)
Dr. Kessinee Unapumnuk (October 2007~)

2.4.2 Project Activities and Role Sharing

Role sharing of PCD & ERTC, JICA expert team are shown in Table 2-3. Also, work flow of the project activities are shown in Figure 2-1.

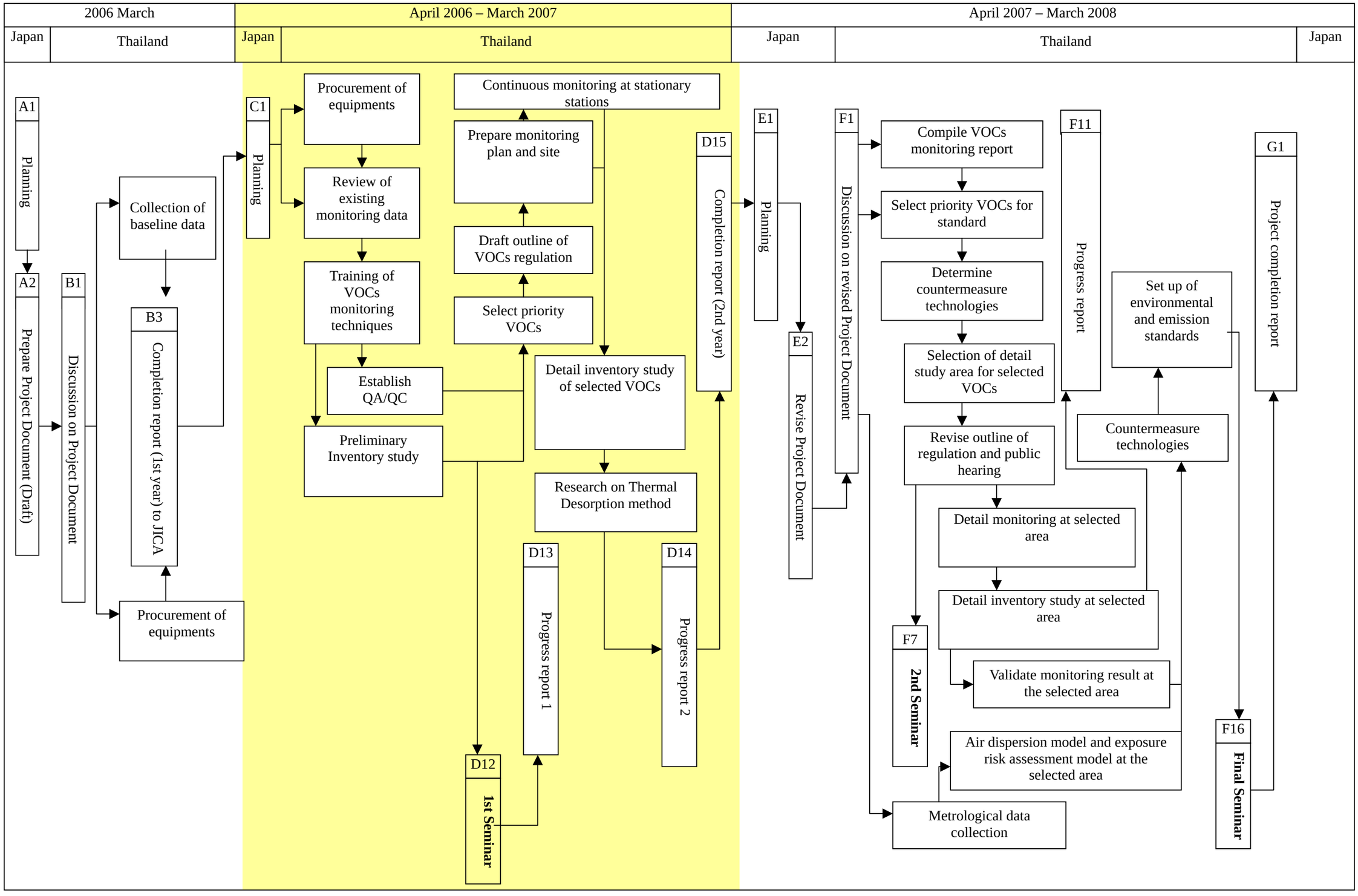
Table 2-3 Role Sharing of the Project

	Items	PCD & ERTC	JICA Expert Team
From March 2006 to February 2007	Equipment procurement		• Procure equipments in Thailand
	Monitoring review report	• Prepare review report of existing monitoring data • Presentation of this report	
	Technology transfer of OA/QC for VOCs analysis	• Pass the tests for QA/QC developed by the project team	• Prepare QA/QC test
		• Technical guidance by senior staffs • QA/QC of VOCs analysis by the laboratory staffs	• Train senior staffs
	Emission inventory study	• Participate in preparing the specification • Prepare a summary report and give presentation in the seminars/workshops	• Prepare the specification • Bidding preparation • Supervise the survey
	Selection of the candidate priority VOCs	• Prepare a summary report and explain to stakeholders	• Prepare a report regarding selection of candidate priority VOCs • List candidate priority VOCs
	Outline of VOCs regulation	• Develop outline of VOCs regulation • Prepare minutes of meetings and discussion • Inform public of outline of the regulation on PCD webpage etc	• Prepare guideline for outline of VOCs regulation • Support for establishment of outline of VOCs regulation
	Monitoring plan	• Collect necessary information for the plan • Prepare minutes of the meetings and discussion	• Support for development of monitoring plan
	Stationary monitoring with QA/QC	• Implement the monitoring	• Develop technical guidance for monitoring
	Detail emission inventory study regarding candidate priority VOCs	• Prepare minutes of the meetings and discussion • Prepare the summary of the result of the survey • Inform public of the inventory study on PCD webpage etc	• Develop the specification • Bidding preparation • Supervise the survey
	Seminar/workshop	• Give presentation	• Give presentation

	Items	PCD & ERTC	JICA Expert Team
From April 2007 to February 2008	Data book in terms of pollution status on VOCs	• Develop data book. • Prepare summary and presentation. • Announce the summary to the Public on PCD webpage etc.	• Assist developing of data book.
	Selection of prioritized VOCs	• Prepare report • Presentation in the seminars	• Develop guideline and reference material of selection of prioritized VOCs.
	Selection of detail survey area in consideration of prioritized VOCs	• Prepare draft selection of the area. • Prepare record of selection process of the area.	• Prepare draft selection of the area.
	Revision and announcement of draft outline of VOCs regulation	• Revision and announcement of draft outline of VOCs regulation • Prepare minutes of the meetings and discussion • Public hearing • Place draft policy framework on web	• Prepare guideline for draft outline of VOCs regulation
	Seminars/Workshops	• Presentation.	• Presentation.
	Monitoring in the detail study area	• Prepare report • Carry out monitoring with adequate QA/QC	• Prepare monitoring plan. • Provide instruction record
	Emission inventory survey in the detail study area	• Prepare outline of study report • Prepare presentation on the technical report	• Specification preparation • Bidding preparation • Supervision of the survey
	Metrological data in the detail study area	• Collection of data and information.	• Provide instruction
	Development of air diffusion modeling of VOCs in the detail survey area	• Operate modeling application software • Prepare report	• Give technical guidance of modeling application software
	Verification of the above model	• Prepare report on impact assessment in vicinity by VOCs diffusion modeling • Verification of simulated data and monitored data. • Prepare report on risk evaluation of VOCs. • Place on PCD webpage	• Prepare guideline of risk evaluation of VOCs • Prepare instruction record
	Control technology of priority VOCs	• Prepare a summary of reduction manual • Prepare presentation on summary • Place on webpage	• Prepare guideline for reduction manual • Prepare instruction record

	Items	PCD & ERTC	JICA Expert Team
	Draft environmental and emission standards	• Prepare standard proposing report • Prepare supporting materials for the proposal • Public hearing for proposal • Place on the web • Prepare and publicizing documents for public hearing • Prepare minutes of discussion on the operation process	• Assist in preparing standard proposing report
	Final seminar to sum up the project	• Hold seminars and presentation	• Participate in seminars and support Thai side

Figure 2-1 Work Flow of Project Implementation (Original)



2.4.3 Management, Monitoring and Evaluation of the Project

To realize effective implementation of the project, PCD and JICA expert team agreed upon holding a weekly meeting. In case a problem would arise, it was decided that both side should discuss to find the solution. The meeting ensures the good communication at operational level between PCD and the JICA Expert Team.

On the other hand, VOCs Steering Committee was expected to be appointed which monitors and evaluates the project annually, in place of Joint Coordinating Committee (JCC) at higher level. However due to political reasons, the committee was never appointed.

JICA was to dispatch mid-term evaluation team and final evaluation team during the project. The purpose of the mid-term evaluation was to evaluate the progress of the project and to discuss any necessary action. The final evaluation was to jointly identify lesson learnt and future issues based on five criteria. The mid-term evaluation was performed in February 2006 and terminal evaluation was conducted in begging of December 2007.

Mid-term evaluation team of JICA requested to reorganize the Joint Coordinating Committee to Thai side in February 2007. After discussion, it was agreed not to set up JCC because the committees appointed for Map Ta Phut issues such as Health Effect Committee can play a similar roles expected for JCC and organization of separate JCC for VOCs may complicate the administrative procedure as well as increase the burden of PCD as secretariat.

3 Major Outputs of the Project

3.1 Achievement of Objectives

Table 3-1 shows the overall goal, indicators for evaluation of the project set in the Master Plan, and status on achievement regarding indicators in the final stage of the project.

Table 3-1 Goal, Indicator, and Status of the Objectives

Overall Goal	Indicator	Status
Overall Goal of the project is to take concrete actions on air pollution by VOCs	Priority compounds of VOCs to be monitored and controlled in Thailand are recognized by MONRE.	Fully recognized 20-candidate priority VOCs were set up in Jury 2006. 7 priority VOCs ware selected in February 2007
	PCD has gained the technical capability to conduct routine monitoring of the prioritized VOCs and ERTC has gained the capability to monitor the VOCs in the air in a wider area for research purpose.	PCD acquired the capability. VOCs stationary monitoring at BKK and MTP has been continuing beyond the duration of monitoring for the project.
	Awareness of air pollution by VOCs is enhanced through the project activities.	Enhancing in not only for MONRE but also for other organizations and private sectors. Many participants attended the first, second and third seminars
	PCD can propose environmental and emission standards of VOCs to the Pollution Control Committee (or National Environmental Board in case of environmental standards)	The environmental standards were drafted in February 2007 Emission standards are being drafted.
Output 1: Elucidation of the VOCs air contamination status for setting up environmental and emission standards in Thailand	Monitoring and analysis is conducting with good QA/QC management.	QA/QC system has been established and implemented.
	VOCs monitoring data book is produced	Data book has been completed and will be released soon.
	VOCs inventory report is produced	1st & 2nd inventory report were completed in 2006 3rd inventory report was completed in February 2008.
Output 2: Proposal of environmental and emission standards of VOCs to the Pollution Control Committee (or National Environmental Board in case of environmental standards)	Outline and road map VOCs regulation and control is formulated	Policy framework paper on VOCs pollution control is drafted as the result of the project implementation.
	Priority VOCs are selected based on stationary monitoring, inventory study and health risk evaluation.	9 priority VOCs ware selected in February 2007.
	Draft environmental standard are formulated after evaluating health risks of VOCs.	Draft environmental standards of priority VOCs were examined from the viewpoint of health risk in February 2007
	Draft emission standard are formulated after examining applicability of VOCs control technology	Emission standards of specified VOCs based upon the result of specific study on emission and its control technology has been drafted.

Note: As for environmental standards, National Environment Board is competent authority to stipulate them according to Section 32 of National Environmental Quality Law. Draft environmental standards of 9 priority VOCs were proposed to NEB in March 2007.

3.2 Achievement of Activities

Activities in order to accomplish the output set in the Master Plan of the project were clarified in the Project Document in March 2006. Table 3-2 indicates the achievement of activities made to date.

Table 3-2 Status of Outcomes and Activities

Output		Activity	Present status
1	Identification of the current status of air contamination by VOCs to set up environmental and emission standards in Thailand	To develop a study plan of air contamination by VOCs for PCD and ERTC	23 monitoring sites (13 PCD, 10 ERTC) Completed (Jul. '06)
		To review the existing emission inventory and monitoring data	Completed (Apr. - May, '06)
		To instruct VOCs monitoring technology necessary for understanding current situation	Completed (May - Jul. '06)
		To establish management system for analytical accuracy in laboratory	Completed (May '06-Feb. '07)
		To conduct the first inventory study for VOCs emission	Completed (Jul. '06)
		To list candidate priority VOCs compounds for regulation.	20 candidate VOCs selected in Jul. '06
		To develop VOCs monitoring plan	Completed (May-Jul. '06)
		To implement stationary monitoring and manage analytical accuracy in laboratory	Completed (Aug. '06-Aug. '07)
		To conduct and review detail inventory study for VOCs emission and the candidate priority VOCs compounds	Completed (Aug. '06-Jan. '07)
		To establish data book regarding contamination status of VOCs in accordance with ERTC	Completed in Feb. '08
		To organize seminars and workshops for disseminating the result of the survey	The 1st, the 2nd and 3rd seminar was completed
2	Proposal on environmental and emission standards of VOCs to the Pollution Control Committee	To draft policy framework of VOCs regulation and control	Report on policy framework was completed in Feb. '08
		To select VOCs compounds for standard	9 priority VOCs were selected in Feb. '07
		To determine the scope of specific study	Completed in Feb. '07
		To implement inventory study regarding emission in the specific study	Completed in Feb. '08.
		To identify meteorological condition of the specific study area and apply air diffusion modeling for VOCs	Completed in Oct. '07
		To review result of monitoring data in the specific study area	Completed in Sept. '07
		To collect the data and information regarding risks of VOCs on health	Completed in Jul. '06, and Oct. '07.
		To examine control technology for VOCs reduction	Completed (Aug. '07 – Jan. '08)

3.3 Reports on the Project

The list of official reports based upon P/D of the project, which were submitted to PCD, is shown in Table 3-3.

Table 3-3 List of Reports Delivered

	Title	Delivered	Copies
FY 2005	Project Document	Mar. 2006	15
FY 2006	Progress Report I	Oct. 2006	15
	Progress Report II	Mar. 2007	15
FY 2007	Project Document (revised)	May 2007	15
	Progress Report III	Nov. 2007	15
	Final report	Mar. 2008	15

3.4 Major Outputs of Technical Cooperation

Major outputs of technical cooperation by JICA Experts team are listed in Table 3-4. Remarkable achievement is that these outputs were mainly produced by the initiative of PCD and ERTC counterparts.

Table 3-4 List of the Major Outputs

	Title
1	SOP (Standard Operating Procedure) for VOCs analysis by Canister-Preconcentrator-GC/MS system
2	Inventory report of VOCs (1st Phase)
3	Monitoring plan for priority VOCs candidate species
4	Inventory report of VOCs（2nd Phase）
5	Report of Seminar/Workshop (2006)
6	VOCs ambient air monitoring report (Data book of VOCs)
7	Draft of Policy framework report on Atmospheric VOCs management in Thailand
8	Monitoring result of priority VOCs in specific study area
9	Inventory report of priority VOCs
10	Report of Seminar/Workshop (2007)
11	Air pollution modeling report for exposure & risk assessment at the specific study area
12	Guideline for approach of emission source survey
13	Technical evaluation report/brief manual of VOCs reduction technology
14	Draft environment and emission standards
15	Manual on risk communication
16	Report on risk assessment
17	Report of final seminar

3.5 Workshops and Seminars

3.5.1 Workshops & Training Course

The expert team provided several workshops for specific topics on VOCs emission, control technology and air diffusion modeling to staffs of PCD. Materials of these workshops are attached in this report and can also be retrieved from enclosed CD-ROM.

Table 3-5 Workshops

Date	Subject	Lecturer	Attendants (number of participants)
May 23, '06	QA/QC of canister sampling for VOCs	Mr. Munehiro Fukuda (JICA expert)	PCD staffs (14)
Jun. 5, '06	Inventory study on VOCs	Mr. Shoji Nakamura (JICA expert)	PCD staffs (25)
Jun. 22, '06	Environmental Risk Assessment and Counter Measures to VOCs	Mr. Shirane and Mr. Okamoto (JICA expert)	PCD staffs (25)
Sept. 9, '06	PRTR in Japan	Mr. Shinsuke Okamoto (JICA expert)	TEI, TRF, The Toxicological society of Thailand, PCD, DIW, Industrial Estates, and Industry (50)
Sept. 13-14, '06	Risk Assessment on VOCs as HAPs	Mr. Akira Nakamura and Mr. Takahashi (JICA expert)	PCD staffs
Jun. 6, '07	Development of EDC・VCM Emission Standard	Mr. Shoji Nakamura (JICA expert)	PCD staffs (13)
Jun 6, '07	Vinyl Chloride Process	Mr. Koichi Kawasaki (JICA expert)	PCD staffs (12)
Jun. 29, '07	Intermediate Report of Specific Survey on EDC & VCM	Mr. Shoji Nakamura (JICA expert)	PCD staffs (11)
Jul. 11,'07	Benzene Emission from Stationary Sources	Mr. Makoto Takahashi (JICA expert)	PCD staffs (18)
Jul. 20, '07	Emission from Degreasing Facility	Mr. Shinsuke Okamoto (JICA expert)	PCD staffs (17)
Aug, 21, '07	METI-LIS (Step by step demonstration)	Mr. Akira Nakamura (JICA expert)	PVC producers in MTP and PCD staffs (15)
Aug. 27, '07	Vehicle Emission Control in Japan	Dr. Makoto Okazaki (JICA expert)	PCD staffs (11)
Aug. 30 '07	METI-LIS (Step by step demonstration)	Mr. Akira Nakamura (JICA expert)	PCD staffs (2)

Training Course in ERTC "Monitoring of VOCs in Ambient Air"

Jul. 26, '07	Management of HAPs/VOCs in Japan	Mr. Yoshiharu Shirane (JICA expert)	Private Sectors (40) University (10), Government (25), including PCD/ERTC

3.5.2 Seminars

Three seminars were held during the project period to disseminate the result of the project to relevant stakeholders and public. Most of preparation and management tasks of the seminar were completely done by PCD staffs in collaboration with JICA expert team.

a. First Seminar

First seminar was held on September 15, 2006 at Miracle Grand Hotel in Bangkok. The seminar drew wide range of participates from representatives of central/local governments, industries, academics and NGOs. Total number of participants reached 134 – 57 from governmental bodies, 64 from private companies and NGOs, and 13 from academics.

These figures proved the importance of the project in Thailand, considering the seminar was originally planned for only 100 participants. Representatives from Embassy of Japan, JICA Thai office, and Ministry of Environment Japan, also participated and contributed to the success of the seminar.

Topics and speakers of the seminar are as follows:

Program of 1st seminar on September 15, 2006

Topics and Speakers
1. Opening Remarks Dr. Monthip Sriratana Tabucanon; Director General Pollution Control Department Mr. Narihito Yaegashi; JICA Deputy Resident Representative Mr. Toyomu Nakano; 1st Secretary of Embassy of Japan in Thailand
2. Policy framework of VOCs management in Thailand Dr. Supat Wangwongwatana; Deputy Director General Pollution Department
3. Countermeasures on chemical substances in Japan by air pollution control law Mr. Masanori Kida; Deputy Director of Air Environmental Division, Ministry of Environment, Japan
4. Determination Ambient VOCs Using Passive Canister-Preconcentrator-GC/MS Ms. Wanna Laowagul (ERTC)
5. Systematic evaluation tool for QA/QC criteria of VOCs analysis Mr. Sirapong Sooktavee (ERTC)
6. Development of VOCs Monitoring Plan Ms. Waroonphan Jaruphan (PCD)
7. Comparison of Ambient VOCs Sampling Techniques Ms. Jarinporn Tippamongkol (PCD)
8. Establishment of VOCs Emission Inventory in Thailand: A Report on Methods and Early Results Dr. Sarawut Thepanondh (PCD)
9. Health risk assessment of VOCs in air -- Toxicity assessment of VOCs species Mr. Akira Nakamura (JICA Expert) -- Expoure assessment and air dispersion modeling Mr. Makoto Takahashi (JICA Expert)

b. Second Seminar

Second Seminar was held on October 26, 2007 at Miracle Grand Hotel in Bangkok. Themes of the seminar are as follows.

- Introduction of VOCs sampling and analysis method developed in the Project
- Introduction of VOCs monitoring result from August 2006 to August 2007
- Introduction of second inventory study of candidate priority VOCs
- Explanation of the activities for establishment of emission standard
- Explanation of ambient standard of selected priority VOCs

It seems that concern for VOCs is growing among relevant parties. The seminar drew wide range of participants from representatives of central/local governments, industries, academics and NGOs. In consequence, total number of participants reached 160 - 75 from governmental bodies, 72 from private companies and NGOs, and 13 from academics. The seminar evaluation forms were distributed to 160 participants. There was about 74 evaluation forms returned at the end of the day.

Topics and speakers of the seminar are as follows:

Program of 2nd seminar on October 26, 2007

Topics and Speakers
1. Opening Remarks Dr. Supat Wangwongwatana; Director General Pollution Control Department
Mr. Mr. Katsuji Onoda; Resident representative of JICA Thailand Office
2. Explanation of guideline for ambient VOCs monitoring Ms. Amornphat Tadsanaprasittipol (PCD)
3. PCD-ERTC Joint VOCs Status Report Ms. Waroonphan Jaruphan (PCD)
4. 2nd Phase Emission inventory Dr. Jariya Sukhapan (PCD)
5. Voluntary Emission Reduction Experience in Japan Mr. Yoshiharu SHIRANE (JICA Expert)
6. On Going Activities and Next Step of Project Ms. Manwipa Kuson (PCD) Dr. Jariya Sukhapan (PCD) Ms. Jarinporn Tippamongkol (PCD)
7. Ambient VOCs Standard Mr. Phunsak Tiramongkon (PCD)
8. Closing Remarks Ms Mingquan Wichayarangsaridh; Deputy Director General Pollution Control Department

All the presentation materials from this seminar are attached.

There were active responses from participants toward seminar. Most participants expressed that seminar was very useful and relevant to their work. They also considered that the most important issue in VOCs management in Thailand is awareness of society, industry and government cooperation, and understanding of current situation.

Most of the question and comments were related to the ambient VOCs standards of Thailand and relevant issues such as mitigation measures, countermeasures and VOCs management policy from PCD and the details for VOCs analysis and monitoring procedures, etc.

There were suggestions on utilization of emission inventory results from the project along with the collection of major domestic emission value for the development of VOC emission standards in Thailand. Mitigation measures and VOCs management policy for mobile and industrial sources should result in the reduction of ambient VOCs concentration especially for benzene and 1,3-butadiene concentration. Mitigation measures includes, for example, the reduction of benzene content in gasoline, the installation of vapor recovery unit (VRU) at gas stations, the implementation of EURO 4 strategy, the development of control and management plan for open burning, and the introduction of fugitive emission controls. Results and outcomes of the project should be opened to public for further utilization.

c. Final Seminar

Final seminar (3rd seminar) is held on February 29, 2008 at Miracle Grand Hotel in Bangkok. Program of the seminar is as follows.

Program of 3rd seminar on February 29, 2008

Topics and Speakers
1. Opening Remarks Ms. Mingquan Wichayarangsaridh, Deputy Director General of Pollution Control Department
Mr. Jun Yamada, Economic Minister, Representative of Japan Embassy Representative of Japan Embassy Mr. Akira Okuyama; Deputy Resident representative of JICA Thailand Office
2. Policy Frameworks for VOCs Control Deputy Director General of Pollution Control Department
3. Project Overviews Dr. Wijarn Simachaya
4. Current situation of VOCs Mr. Phunsak Tiramongkon
5. Japanese Recent Practice in Setting Guideline for hazardous Air Pollutants Dr. Pornsri Suthanaruk
6. ERTC Research on VOCs Issue Ms. Wanna Laowagul of ERTC
7. Proposed DCM TCE PCE Emission Standards Dr. Patcharawadee Suwanathada
8. Specific Study/Proposed EDC VCM Emission Standards Dr. Jariya Sukhapan
9. Mobile Sources Control Measures Ms. Manwipa Kuson
10. Closing Remarks Deputy Director General of Pollution Control Department

Over 200 representatives from governmental bodies, institutions, private companies, and NGOs are participated.

3.6 Others

(1) Health Effect Committee

In the original plan of the project, PCD are expected to submit a proposal for environmental and emission standards to Pollution Control Committee and then to National Environmental Board.

However, since late 2006, when National Cancer Institute disclose very high cancer rate at the area, environmental issue in Map Ta Phut started to receive more social attention. In this regard, PCD has submitted the proposal to declare Map Ta Phut as the "Pollution Control Area" to National Environmental Board. Proposal was not accepted, however, the Board decided to set up two high level committees inviting various stakeholders. One is Health Effect Committee and another is Pollution Management Committee.

One of the mandates of Health Effect Committee was to propose standards for VOCs considering the urgent nature of Map Ta Phut problem. The committee was chaired by former adviser to a environmental minister and composed of officers from PCD, Ministry of Industry, Labor, Public Health, National Cancer Institute, NGO, various academic experts, industry and local groups.

Table 3-6 summarized the committee meetings relevant to the project. On the 2nd meeting, the committee determined to announce the ambient annual standards for 9 VOCs. Then, on the 3rd meeting, the committee assigned a working group to review the appropriateness of the

9 VOCs annual standards. The working group is chaired by Prof. Thongchai Pansawad and consists of members from DDC, DIW, DEQP, IEAT, CRI, PTIT, Air Quality and Noise Information System and PCD.

Table 3-6 Health Effect Committee

No	Date	Issues related to the project
1st meeting	Jan. 30, '07	• Overview of current studies and situation related to health effects and air pollutions in Map Ta Put area.
2nd meeting	Feb. 15, '07	• Determination of 9 ambient VOCs standards. • Assign 1st working group to integrate the result from studies and research in Thailand regarding the relationship of health effect and air pollution.
3rd meeting	Mar. 13, '07	• Assign 2nd working group to review the appropriateness of ambient annual VOCs standards and propose surveillance/guideline values for 20 VOCs in ambient.
6th meeting	Jul. 3, '07	• Decline the proposal from the 2nd working group on the revision of ambient benzene and 1,3 - butadiene standards.

(2) Stakeholder meeting

JICA experts believe that involvement of various stakeholders is essential process for successful establishment and implementation of the environment and emission standards. For this reason, it was encouraged to promote extensive stakeholder relation.

Following meetings were held to involve various stakeholders in the process.

- Stakeholders meeting inviting ERTC, DIW, ONEP, IEAT, Thailand Research fund and others on May 24, 2006.
- TAPCE (Thailand Air Pollution Center of Excellence) meeting on June 2, 2006.
- 1st seminar of the project on September 15, 2006.
- Stakeholder meeting organized on June 14, 2007. Participants were from DEQP, DIW, IEAT, Thailand Research fund and private sectors including FTI.
- 2nd seminar of the project on October 26, 2007
- 3rd seminar of the project on February 29, 008

4 Actual Operation of the Project

4.1 Plan of Operation and Actual Achievement

Original tentative plan of operation (P/O) agreed between Thai side and JICA, shown in Table 4-1, was attached in the minutes in November 30, 2005. JICA expert team examined effective implementation of the project prior to commencement of the project, then proposed the revised P/O in the P/D to Thai side in the meeting in March 2006. Revised P/O shown as Table 4-2 was consequently agreed by both Thai side and JICA team.

Major differences from the original P/O are summarized as following.

1. Action (8) "Conducting stationary source monitoring" of the expected output 1 was found as necessary action for collecting basic information to set up emission standards so that this action was incorporated into action (1) "In-depth of monitoring of the priority VOCs (ambient, stationary and mobile)" of the expected outputs 2.
2. Formulation of policy framework paper was added as additional action of output 1 and 2 to express the policy on pollution control of VOCs as hazardous air pollutants to public in order to built consensus on setting up environmental and emission standards of VOCs among relevant stakeholders.

All actions were conducted in accordance with the revised P/O, however, actual duration and date of completion was generally extended or delayed from the planned ones.

Most remarkable inconceivable event happened during the project implementation was that action (4) "Finalizing the target parameters of VOCs for setting up environmental and emission standards" and action (6) "Setting up proposed numerical targets of environmental and emission standards" of expected outputs 2 was conducted ahead of the schedule due to argent action required to respond to air pollution issues in Map Tu Phut of Rayong province.

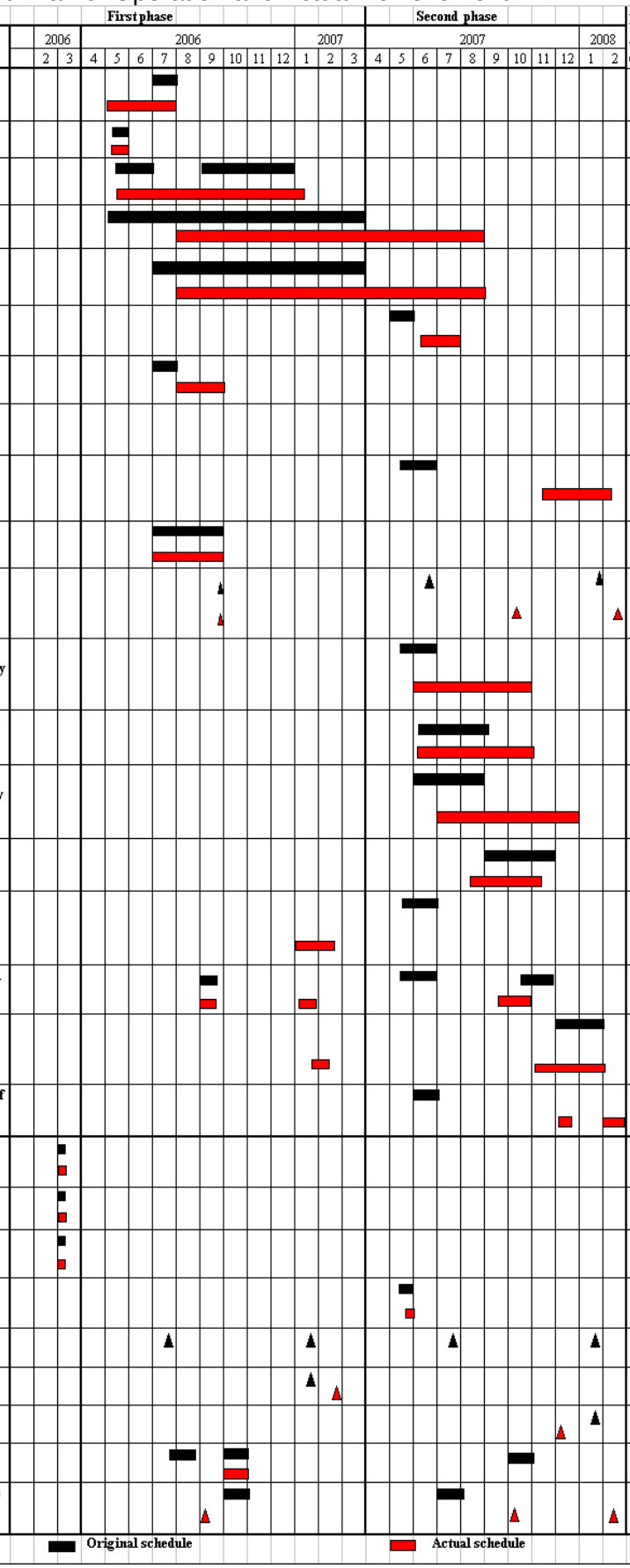
Actual achievement of activities can be referred to Table 4-2.

Table 4-1 Tentative Plan of Operation

Purpose	Expected Outputs	Activities	Schedule			Duration of Activities (Month)
			1st year	2nd year	3rd yea	
MONRE's capacity to take countermeasures against VOCs air pollution including development of environmental and emission standards in Thailand is enhanced.	1. Elucidation of the VOCs air contamination status for setting up environmental and emission standard in Thailand	(1) Joint planning of investigation of VOCs contamination with ERTC				1
		(2) Review of existing data				12
		(3) Development of VOCs emission inventory				12
		(4) Conduction background monitoring				9
		(5) Investigation of contamination status of VOCs				9
		(6) Preparation of modeling including collection of necessary data				6
		(7) Listing up the prioritized VOCs				3
		(8) Conducting stationary source monitoring				6
		(9) Drafting of contamination status report on VOCs in coordination with ERTC				3
		(10) Organizing seminar(s) for dissemination the result of the investigation				1
	2. Proposal of environmental and emission standard of VOCs to the Pollution Control Committee	(1) In-depth of monitoring of the prioritized VOCs (ambient, stationary and mobile)				6
		(2) Development of VOCs emission inventory for the prioritized VOCs				12
		(3) Simulation modeling for the prioritized VOCs				6
		(4) Finalizing the target parameters of VOCs for setting up environmental and emission standards				6
		(5) Collection of information on health risk and control technology				6
		(6) Setting up proposed numerical targets of environmental and emission standards				3

Table 4-2 Revised Plan of Operation and Actual Achievement

Purpose	Expected Outputs	Activity	Duration of Activities(Month)	Duration of Activities(Month)
MONRE's capacity to take countermeasures against VOCs air pollution including development of environmental and emission standards in Thailand is enhanced.	1. Elucidation of the VOCs air contamination status for setting up environmental and emission standard in Thailand	(1)Joint planning of investigation of VOCs contamination with ERTC	1	3
		(2)Review of existing data	1	1
		(3)Development of VOCs emission inventory	6	8
		(4)Conduction background monitoring	9	13
		(5)Investigation of contamination status of VOCs	9	13
		(6)Preparation of modeling including collection of necessary data	1	2
		(7)Listing up the candidate prioritized VOCs	1	2
		(8)Conduction stationary source monitoring	0	0
		(9)Drafting of contamination status report on VOCs in coordination with ERTC	2	3
		Policy support / Preparation of outline of VOCs regulation	3	3
		(10)Organaizing seminar(s) for dissemination the result of the investigation	1	1
	2. Proposal of environmental and emission standard of VOCs to the Pollution Control Committee	Collection of basic information on countermeasure technology for the priority VOCs pollution control	2	4
		(1)In-depth of monitoring of the prioritized VOCs (ambient, stationary and mobile)	3	5
		(2)Implementation of inventory survey of the prioritized VOCs in the specific survey region	3	6
		(3)Simulation modeling for the prioritized VOCs	3	3
		(4)Finalizing the target parameters of VOCs for setting up environmental and emission standards	2	1.5
		(5)Collection of information on health risk and control technology	4	4
		(6)Setting up proposed numerical environmental standard and emission standard	2	4
		Policy support / Revision and disclosure of outlines regarding the VOCs regulation	1	1.5
		Explanation and discussion on project document		
		Collection of baseline data		
		Support for procurement of provided equipments		
		Explanation and discussion on project document (Revised edition)		
		Steering committee (every 6 months)		
		Mid-term evaluation (Jan. 2007)		
		Joint Final evaluation study		
		Training in Japan (July-Aug, Oct. 2006)		
		Web site preparation (after each seminar)		



4.2 Detailed Implementation Schedule and Achievements

Upon the commencement of the project, PCD and JICA expert team agreed the implementation schedule of the project. The schedule agreed was incorporated in the P/D which was submitted to PCD in the beginning of March 2006. Items of activities in detail are shown in the Figure 2-1. Original schedule had to be adjusted to fit to the actual conditions and progress of the project.

Overall progress was satisfactory following the original schedule. There was, however, delay in drafting policy framework paper due to various reasons. One major reason was the Map Ta Phut issue, which became urgent social problem. It also affected the timing to propose priority VOCs species and environmental standards proposal for them. They are originally scheduled to take place in May 2007 and in November 2007, respectively. In reality, proposal for priority VOCs species as well as environmental standards was prepared in February 2007. In order to respond to the urgent need of the Map Ta Phut problem, schedule of the project after April 2007 had to be re-adjusted. Project document was revised and discussed in May 2007 to reflect such changes.

Stationary monitoring continued up to August 2007 as start of the monitoring was delayed in the beginning. Specific study on VOCs source including Map Ta Phut was completed by August 2007. Study of control technologies, air diffusion modeling and risk assessment was implemented in parallel and completed by January 2008.

Table 4-3 shows both original schedule and actual achievements.

Table 4-3 Implementation Schedule

		Activities	Place	Original schedule	Achievement
First (Fiscal) Year	A1	Formulation of work plan of the project (in Japanese)	Japan	End of Feb. 2006	As scheduled
	A2	Preparation of Project Document (draft)	Japan	End of Feb. 2006	As scheduled
	B1	Explanation and discussion on the Project Document in Thailand	Thai	Beginning of Mar. 2006	As scheduled
	B2	Collection of baseline data in Thailand	Thai	Beginning of Mar. 2006	As scheduled
	B3	Report on achievement of the first year (in Japanese)	Japan	Middle of Mar. 2006	As scheduled
	B4	Support for procurement of provided equipments	Thai	End of Feb. 2006	As scheduled
Second (Fiscal) Year	C1	Revision of work plan (in Japanese)	Japan	Beginning of May 2006	As scheduled
	D1	Procurement of attachment to analytical equipments	Thai	Beginning of May 2006	As scheduled
	D2	Evaluation and review of results of the existing monitoring	Thai	Beginning of May 2006	As scheduled
	D3	Acquisition of monitoring technology necessary to identify current VOCs condition	Thai	From beginning of May to end of May	From beginning of May to end of Aug.
	D4	Establishment of QA/QC system of analysis	Thai	From beginning of May to middle of Jun.	As scheduled
	D5	First inventory study on VOCs	Thai	From beginning of May to end of May	From beginning of May to middle of Jun.
	D6	Selection of the priority VOCs	Thai	From end of May to middle of Jun.	Middle of Aug.
	D7	Deliberation and formulation of VOCs policy framework	Thai	From end of May to middle of Jun.	Postponed Completion in end of Feb. 2008
	D8	Selection of monitoring sites	Thai	End of Jun	Beginning of Jul.
	D9	Implementation of monitoring and QC/QA system	Thai	From beginning of Jul. 2006 to middle of Feb. 2007	From end of Jul. 2006 to end of Aug. 2007

		Activities	Place	Original schedule	Achievement
	D10	Implementation of the 2nd step inventory study on the candidate VOCs	Thai	From middle of Aug. to end of Oct.	From middle of Aug. 2006 to end of Jan. 2007
	D11	Research on Thermal Desorption method	Thai	From middle of Aug. to end of Nov.	As scheduled
	D12	First seminar/workshop	Thai	Beginning of Sept.	As scheduled
	D13	Progress report (vol.1) on the project	Thai	Middle Oct.	As scheduled
	D14	Progress repot (vol.2) on the project	Thai	End of Feb. 2007	As scheduled
	D15	Report on achievement of the second year (in Japanese)	Japan	Middle of Feb. 2007	As scheduled
Third (Fiscal) Year	E1	Work plan (in Japanese)	Japan	Beginning of May 2007	As scheduled
	E2	Revision of the Project Document	Japan	Beginning of May 2007	As scheduled
	F1	Explanation & discussion on project document (Revised edition)	Thai	Middle of May 2007	As scheduled
	F2	Data book in terms of pollution status on VOCs	Thai	From beginning of May to end of Jun 2007	From beginning of Nov. 2007 to middle of Feb. 2008
	F3	Selection of the priority VOCs	Thai	From beginning of May to end of Jun 2007	End of Feb. 2007
	F4	Collection of basic information on countermeasure technology for the priority VOCs pollution control	Thai	From beginning of May to end of Jun 2007	From beginning of may to end of Sept.
	F5	Selection of area for the specific study concerning the priority VOCs	Thai	During Jun	As scheduled
	F6	Revision and disclosure of VOCs policy framework	Thai	During Jun	Postponed Completion in end of Feb. 2008
	F7	The second seminar/workshop	Thai	Middle of Jun	Beginning of Oct.
	F9	Implementation of inventory study of the priority VOCs in the specific study area	Thai	From beginning of Jun to end of Aug.	From middle of Jun to end of Sept. 2007
	F10	Collection of meteorological information in the specific study area	Thai	During May 2007	As scheduled
	F11	Progress repot (vol.3) on the project	Thai	Middle of Sept.	End of Nov.
	F12	Implementation of atmospheric diffusion modeling for exposure risk evaluation in the specific study area	Thai	From beginning of Sept. to end of Nov.	From middle of Aug. to middle of Oct.
	F13	Verification of monitoring result in the specific study area	Thai	During Nov.	From middle of Oct. to Beginning of Nov.
	F14	Examination of VOCs emission reduction technology	Thai	From beginning of Oct. to end of Nov. 2007	From beginning of Sept. 2007 to end of Feb. 2008
	F15	Proposition of draft environmental standard and emission standard regarding the priority VOCs	Thai	From beginning of Dec. 2007 to end of January 2008	As for environmental standard, middle of Feb. 2007 As for emission standard, middle of Nov. to end of Jan. 2008
	F16	The third seminar	Thai	End of Feb. 2008	As scheduled
	F17	Final report on the project	Thai	End of Feb. 2008	As scheduled
	G1	Final Report on achievement of the project (in Japanese)	Japan	Beginning of Mar. 2008	As scheduled

4.3 Records of Discussion

Table 4-4 shows meetings held during the project period to discuss and stare the project operation. All records of meeting are attached in this report.

Table 4-4 Meeting Related to the Project

	Name	Purpose	Place	Date
1	Official meeting with PCD and JICA expert team	Discussion of project document	PCD meeting room	Mar. 2, 2006
2	Stakeholder meeting	Discussion of development of environmental and emission standards of VOCs project	Ditto	May 24, 2006
3	Joint mid team evaluation meeting	Evaluation of progress of the project	Ditto	Feb. 13, 2007
4	Stakeholder meeting	Discussion of development of environmental and emission standard	Ditto	Jun. 14, 2007
5	Final evaluation meeting	Evaluation of the entire progress of the project	Ditto	Jan. 12-14, 2008
6	Official meeting with PCD and JICA team	Finalizing of VOCs project and discussion of lesson leaned	Ditto	Feb. 27, 2008

5 Input of Resources

5.1 Actual Inputs

Amount of inputs from JICA side was determined by JICA based on the discussion between Thai side and JICA preliminary team for proceeding the project.

Inputs by both sides throughout the project is summarized as follows.

Table 5-1 Inputs

	Thai Side	JICA Side			
		Experts	Training	Equipment	Other Expense
	Number of CP assigned	M/M	Number of trainee from PCD	1,000 JPY	1,000 JPY
FY 2005	15 (PCD) + 8 (ERTC)	0.46	0	0	0
FY 2006	15 (PCD) + 8 (ERTC)	20.56	5	4,030	5,060
FY 2007	18 (PCD) + 8 (ERTC)	28.49	0	1,928	8,143
Total	18 (PCD) + 8 (ERTC)	49.51	5	5,958	13,203

Note: FY means Japanese Fiscal Year
Figures shown for FY'07 are original planned value.

5.2 Dispatch of Japanese Experts

The following numbers of experts were dispatched and assigned

- Two (2) short-term experts in beginning of March 2006
- Seven (7) short-term experts from April 2006 to March 2007
- Nine (9) short-term experts from April 2007 to March 2008

For details of actual performance, it is shown in Table 5-2.

Table 5-2 Dispatch of Japanese Experts

	Expert Name	**Expertise**	**Duration**	**Man/Month**
Japanese Fiscal Year 2005				
1	Masato Ohno	Chief Adviser/Environmental Standard	Mar. 5, '06 – Mar. 11, '06	0.23
2	Munehiro Fukuda	Monitoring /VOCs Countermeasure Technology	Mar. 5, '06 – Mar. 11, '06	0.23
Total				**0.46**
Japanese Fiscal Year 2006				
1	Masato Ohno	Chief Adviser/Environmental Standard	May 14, '06 – Jun. 7, '06	0.83
			Sept.10, '06 - Sept. 23, '06	0.47
			Nov. 2, '06 - Nov. 17, '06	0.53
			Feb. 2, '07 - Feb. 21, '07	0.67
2	Munehiro Fukuda	Monitoring /VOCs Countermeasure Technology	May 14, '06 - Jul. 8, '06	1.87
			Aug.14, '06 - Sept. 16, '06	1.13
			Dec. 14, '06 - Dec. 28, '06	0.50
			Jan. 18, '07 - Feb. 16, '07	1.00

	Expert Name	Expertise	Duration	Man/Month
3	Yoshiharu Shirane	VOCs Analytical Technology in the Air & Automobile exhaust gas VOCs Analysis	May 14, ‘06 - Jul. 27, ‘06	2.50
			Aug.20, ‘06 - Oct. 14, ‘06	1.87
			Oct. 22, ‘06 - Dec. 9, ‘06	1.63
			Jan. 23, ‘07 - Feb. 21, ‘07	1.00
4	Shoji Nakamura	Inventory Study 1/VOCs Countermeasure (Chemical substance producer)	May 23, ‘06 - Jul. 7, ‘06	1.50
			Oct. 29, ‘06 - Nov. 16, ‘06	0.63
			Jan. 30, ‘07 - Mar.3, ‘07	1.10
5	Akira Nakamura	Health Risk Evaluation	Sept. 6, ‘06 - Sept.20, ‘06	0.50
6	Makoto Takahashi	VOCs Air diffusion Monitoring /VOCs Countermeasure (storage facility)	Sept. 6, ‘06 - Sept.20, ‘06	0.50
7	Shinsuke Okamoto	Inventory study 2 / VOCs Countermeasure Technology by Industries (Industrial cleaning, laundry) / coordinator	June 18, 2006 - July 7, ‘06	0.67
			Aug. 22, 2006 - Sept. 20, ‘06	1.00
			Oct. 29, 2006 - Nov. 17, ‘06	0.67
	Total			**20.56**
Japanese Fiscal Year 2007				
1	Masato Ohno	Chief Adviser/Environmental Standard	Jun. 2, ‘07 - Jun. 21, ‘07	0.67
			Dec. 2, ‘07 - Dec. 16, ‘07	0.50
			Feb. 2, ‘07 - Mar. 2, ‘07	0.93
2	Munehiro Fukuda	Monitoring /VOCs Countermeasure Technology	May 13, ’07 - Jul. 1, ‘07	1.67
			Nov. 21, ’07 - Dec. 20, ‘07	1.00
			Jan 30, ‘07 -Mar. 2, ‘07	1.10
3	Yoshiharu Shirane	VOCs Analytical Technology in the Air & Automobile exhaust gas VOCs Analysis	Apr. 22, ’07 - Jun. 19, ‘07	1.97
			Jul. 24, ‘07 - Sept.22, ‘07	2.03
			Oct. 14, ’07 - Dec. 12, ‘07	2.00
			Jan.3, ’08 - Feb.1 ‘08	1.00
4	Makoto Okazaki	Countermeasure policy for mobile source	Aug. 20, ’07 - Sept.18, ‘07	1.00
			Dec. 10, ’07 - Dec. 19, ‘07	0.33
5	Koichi Kawasaki	Detailed Inventory Study & Countermeasures on EDC and VCM	Jun. 3, ‘07 - Jul 2, ‘07	1.00
			Aug. 22, ‘07 - Sept. 20, ‘07	1.00
6	Shoji Nakamura	Inventory Study 1/VOCs Countermeasure (Chemical substance producer)	May 27, ‘07 - Jul. 10, ‘07	1.50
			Aug. 22, ‘07 - Sept. 20, ‘07	1.00
			Oct. 14, ‘07 - Nov. 9, ‘07	0.90
			Dec. 4, ‘07 - Dec. 28, ‘07	0.83
7	Akira Nakamura	Health Risk Evaluation	Aug. 13, ‘07 - Sept.1, ‘07	0.67
			Oct. 15, ‘07 - Nov. 3, ‘07	0.67
8	Makoto Takahashi	VOCs Air diffusion Monitoring /VOCs Countermeasure (storage facility)	July 2, ‘07 - July 21, ‘07	0.67
			Sept. 9, ‘07 - Sept. 28, ‘07	0.67
			Nov. 12, ‘07 - Dec. 1, ‘07	0.67
9	Shinsuke Okamoto	Inventory study 2 / VOCs Countermeasure Technology by Industries(Industrial cleaning, laundry) / coordinator	July 15, ‘07 - Aug. 11, ‘07	0.93
			Oct. 21, ‘07 - Jan. 25, ‘07	3.23
			Feb. 17 ‘07 - March 2, ‘07	0.57
	Total			**28.49**
Grand Total				**49.51**

5.3 Training of PCD Staffs in Japan

JICA offered training for PCD staffs in Japan in five fields as agreed in the Minutes dated on November 30, 2005. The JICA team and Thai side team set the purpose and training items clearly for each trainee.

- Policy development (Management of VOCs)
- Emission inventory study
- Modeling
- Risk on health
- Control technology

Following five members of PCD were selected to be dispatched to Japan for the training and research on hazardous air pollutants and VOCs control in Japan for two weeks from October 15 to October 28, 2006.

Ms. Suthanaruk Pornsri	Head of Laboratory Section, PCD
Mr. Theramongkol Phunsak	Chief of Industrial Air Pollution Division, PCD
Mr. Sangdow Seksan	Acting Director of Air Quality Division, PCD
Ms. Kuson Manwipa	Environmental Officer, PCD
Mr. Tepanondh Sarawut	Environmental Officer, PCD

Note: Title is at the time of training.

The training was carried out as planned. Results from the training were summarized (although not in form of report) in Japan. On September 11, in-house workshop was held in PCD to share the information/knowledge gained during the Japan training.

Table 5-3 Training Program

Visiting Institution	Place	Purpose of a visit
Japan Ministry of Environment (MOE)	Tokyo	• Policy on HAPs and VOCs control in Japan. • Procedure of environmental standards setting • Scheme of voluntary VOCs management • Framework of PRTR system and its implementation
Japan Environmental Sanitation Center (JESC) http://www.jesc.or.jp/en/index.html	Kawasaki city, Kanagawa prefecture	• Quality control and quality assurance of HAPs analysis in Japan
The Japan Environmental Management Association for Industry (JEMAI) http://www.jemai.or.jp/english/index.cfm	Tokyo	• Status on actions for VOCs counter measures by industry sector in Japan • Development of atmospheric diffusion modeling (METI-LIS) in Japan

Visiting Institution	Place	Purpose of a visit
Sophia University; Institute for Studies of the Global Environment Professor Dr. Shusin Nakasugi	Tokyo	• Process of setting environmental standard of particular HAPs in Japan • Role of special committee for investigation of potential risk of particular HAPs
Nihon Environmental Services Co., Ltd. http://www.n-kankyo.com/english/english.html	Yokohama city, Kanagawa prefecture	• Observation of VOC analysis and QC/QA by private laboratory
Japan Chemical Industry Association (JCIA) http://www.nikkakyo.org/index.php3?sessLang=English	Tokyo	• Status on management for emission and release control of particular HAPs in Chemical Industry Group of Japan
Chiba Prefectural Government Division of Air Pollution Control http://www.pref.chiba.jp/english/index.html	Chiba City, Chiba Prefecture	• Experience of HAPs pollution control by the Prefectural Government • HAPs and VOCs Monitoring conducted by the Prefectural Government
Center of Environmental Study of Chiba Prefecture	Ichihara City, Chiba Prefecture	• Status on studies of HAPs pollution in ambient air in Chiba prefecture. • Canister sampling
Sumitomo Chemical Co., Ltd. Chiba Factory http://www.sumitomo-chem.co.jp/english/index.html	Ichihara City, Chiba Prefecture	• Counter measures for controlling EDC/VCM and VOCs emission. • PRTR and responsible care activities • Environmental friendly products
Office of Kawasaki City Environmental Department Pollution Monitoring Center	Kawasaki city, Kanagawa Prefecture	• Experience and history of tackling heavy air pollution in Kawasaki city which was most polluted in air in Japan 40 years ago. • Current actions on VOCs and HAPs control, PRTR, risk communication • Observation of monitoring center of the City
EX CORPORATION	Tokyo	• Discussion on policy formation of HAPs pollution control

5.4 Provided Equipments for the Project

Equipments provided by JICA are shown in Table 5-4. These are small part of machinery equipments to detect depressed concentration of particular VOC species. Main equipments ware procured by PCD or ERTC with their own budgets. In addition, consumables such as nitrogen gas for operation were also bought by PCD or ERTC with their own budget throughout the project.

Table 5-4 Provided Equipment for VOCs Analysis

	Equipment	Place and Use	No.	Date of Delivery	Date of receiving inspection	State of utilization and control	Value
1	Spare part for pre-concentrator	PCD Laboratory Additional parts for VOC analysis	1	Mar-06	9 Mar-06	Working well	
2	Split/Splitless injector	PCD Laboratory Parts for GC/MS	1	Mar-06	9 Mar-06	Working well	
3	STD gas	PCD Laboratory Standard gas for analysis	1	Jun-06	16-Jun-06	Used effectively and expired	JPY 136,000
4	ITSD gas	PCD Laboratory Internal standard gas for analysis	1	Jun-06	16-Jun-06	Used effectively and expired	JPY 472,500
5	6L canister	PCD Laboratory VOCs sampling containers	10	Jun-06	16-Jun-06	Using effectively	THB 280,000
6	Flow regulated sampler 3hrs	PCD Laboratory Flow regulator for Canister sampling (3hrs)	1	Jun-06	16-Jun-06	Using effectively	THB 40,500
7	Flow regulated sampler 24hrs	PCD Laboratory Flow regulator for Canister sampling (24hrs)	1	Jun-06	16-Jun-06	Using effectively	THB 40,500
8	Sampling bag	PCD Air Pollution Department Grab sampling for smoke stack	10	Jun-06	16-Jun-06	Used effectively	THB 16,000
9	Sampling bag (tedlar bag)	PCD Automobile Laboratory Grab sampling for automobile	10	Jun-06	16-Jun-06	Used effectively	THB 16,000
10	Manual diluter	PCD Laboratory Adjustment of samples and standard gases	1	Jun-06	14-July-06	Using effectively	JPY 650,000
			1	Aug-06	1-Sep-06		THB 24,000 (Pump)
11	VOC Monitor	PCD Air Pollution Department Fugitive VOCs measurement	2	May-07	18-May-07	Using effectively	JPY 1,928,000

5.5 Local Expenditure

5.5.1 Japanese Side

Total operational cost spent for the project in Thailand, excluding dispatch cost of Japanese experts, was about 27 million yen. Actual cost in each year is summarized in Table 5-5.

Table 5-5 Project expense in Thailand

	Items	Value 1,000 JPY
FY 2005		0
FY 2006	Equipments	4,030
	Subcontract	5,060
	Other expenses	2,493
	Sub-total	11,583
FY 2007	Equipments	1,928
	Subcontracts	8,143
	Other expenses	4,968
	Sub-total	15,039
Total	Equipments	5,958
	Subcontracts	13,203
	Other expenses	7,461
	Ground total	26,622

Note: FY means Japanese Fiscal Year
Equipments costs include office equipments in addition to equipment cost for VOCs analyses. Other expenses include seminar costs, transportation, translation, and secretary cost etc.

Following four studies were contracted out to local consultants to efficiently operate the project. The outputs of the studies in form of CD-ROM are submitted to PCD as attachments of the final report.

Table 5-6 Contracted Works

	Study Name	Duration	Name of contractor
1.	First step inventory study	May '06 – Jun. '07	Thai Environment Institute
2.	Second step inventory study	Jul. 06 – Jan. '07	Ditto
3.	Monitoring of VCM and EDC emission in the specific study area	Jun '07 – Sept. '07	SECOT Co., Ltd.
4.	Detailed inventory survey on TCE, DCM, and PCE	Jul. '07 – Jan.'08	Thai Environment Institute

5.5.2 Thai Side

As agreed in the Minutes on November 30, 2005, Thai side has provided overhead cost necessary for the implementation of the project. The cost beard by the Thai side includes, 1) building and facilities necessary for the implementation of the project, 2) office space and necessary facilities for the JICA experts and meetings, 3) facilities and services such as electricity, gas, water, telephone, internet access and furniture, and 4) other facilities mutually agreed upon as necessary. The Minutes also stated that Thai Government took necessary measures to meet the running expenses for the implementation of the project. Thai side has completely undertaken the obligation of bearing cost for project implementation according to above Minutes.

6 Special Efforts for Project Implementation and Lesson Learned

6.1 Efforts for Efficient and Effective Implementation

JICA team placed special importance on following five points to implement the project efficiently and effectively.

1. Clarification of mutual role and duty
2. Keep good communication and information sharing
3. Mutual confirmation of plan and schedule of activities
4. Mutual confirmation of progress
5. Sharing scientific knowledge of VOCs air pollution control

PCD and JICA expert team established four devices to cope with above points.

First one was that four specified sub teams were set up in accordance with each objective, role and duty, and a leader was appointed in each sub team to manage activities assigned.

Secondly, the web based e-mail account for VOC project team within PCD internet web-site was set up to facilitate good communication among all members and share information.

Thirdly, weekly meeting to mutually monitor plans, schedule and progress of each team was set up and was regularly held. All records of every weekly meeting were delivered to all members though the web-email.

Fourthly, the joint team organized number of workshops on specific topics of VOCs pollution control, including risk assessment in order to share necessary knowledge for control of VOCs as HAPs.

6.2 Lesson Learned

The joint evaluation report, which was submitted to PCD in middle of December 2007, pointed out following several points as lesson learned through the project.

1. The following conditions, which were fortunately met in this Project, can be considered as keys to success;
   i. Mounting public concerns to the existing environmental issue generate motives and incentives internally and enable to allocate sufficient resources by the government as a whole.
   ii. Existence of commitment and leadership of the Director General as a head of the C/P organization; the great capability and dedication of staff as well; strong relationship and good cooperation with stakeholders and relevant agencies.
2. A project that supports policy formulation requires not only to focus on policy instruments themselves, but to identify technical capacities needed in the related field and develop them to make policy instrument workable, in this case i.e. monitoring, modeling, risk assessment, emission countermeasures and the inventory study, and enhance such capacities.
3. The technical cooperation by JICA for the last decade through environmental cooperation projects including ERTC successfully contributed to enhance the technical capacities of the Thai side as a whole, and, in fact, this greatly contributed to the smooth commencement of the Project.

JICA expert team would like to put some additional comments. It is obvious that the project received favorable conditions socially and internally which contributed smooth achievement of the project goal. Furthermore, it cannot be overemphasized that the Master Plan of the project, which was mutually agreed in November 2005, manipulated all related activities to incorporate into expected outputs and overall goal. Second point mentioned in the joint evaluation report as above is essential to lead the project forward to the goal. To come up with proposed numerical environmental and emission standards for the prioritized VOCs based upon scientific manner, monitoring, inventory, risk assessment and examination of control technology were inevitable elements of the project. Figure 6-1 indicates essential elements of the project to achieve the expected outcomes. All elements were included precisely as package in M/P prior to commencement of the project.

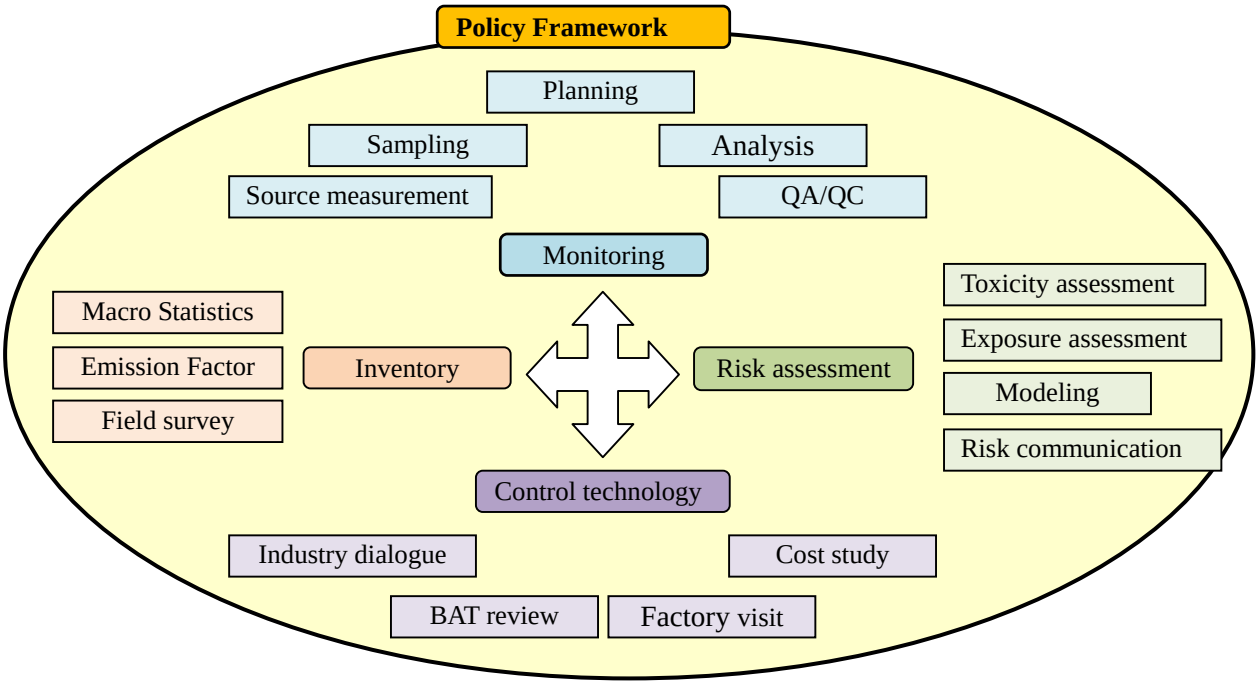


Figure 6-1 Constituent Element for Building Policy on the Specified VOCs Pollution Control

There are two points of lesson learned through the project.

The most important point is that JICA experts shall not to act as a player in policy and decision making and shall stay only in technical support role to PCD staff. If an expert mistook his role as a player, various negative effects are anticipated.

Second point is the additional input of highly qualified expert in the field of manufacturing process of EDC and VCM and of policy on mobile source control of HAPs. It was very effective that JICA headquarters allowed flexible arrangement of dispatch of experts proposed by the team according to actual situation.

7 Next Step and Future Issues

JICA expert team would like to recommend several actions as immediate follow up of the project activities as follows.

7.1 Monitoring Issues

(3) Enhancement of current monitoring activity

It is obvious that current monitoring network and number of sampling site is not sufficient to cover national level monitoring. In order to enhance the national level monitoring of VOCs, followings are suggested.

a. **Develop methodology for tube sampling as alternative to canister sampling**

Develop alternative methodology for VOCs will help increasing the national level capacity significantly. In this regards, tube sampling - thermal desorption GC/MS method is promising as its expected throughput is higher than canister method. As PCD laboratory is now equipped with suitable analytical instrument for such methodology, it is highly recommended to develop and validate the methodology for tube sampling. Cooperation with ERTC is also highly recommended.

b. **Training of private, public and academic laboratories**

Currently only PCD laboratory and ERTC have capability for VOCs monitoring at adequate QA/QC management. It is urgently required to plan training program for other laboratories in private, public and academic sectors. The training program shall be implemented in close cooperation with ERTC. Initial trainee shall be limited to the laboratories with sufficient knowledge and experience of trace organic analysis by GC/MS to maximize the training effectiveness and efficiency. As VOCs ambient monitoring requires extensive care on QA/QC and GC/MS instrumentation, from zero knowledge training may be very time consuming. As first step, five laboratories, at least, shall be trained.

c. **Establish inter-laboratory QA/QC program**

During the course of JICA project, arrangement was made for inter-laboratory QA/QC program between PCD laboratory and ERTC. This program shall be continued and expanded to include those laboratories trained under the training program.

(4) Expansion of target VOCs species for monitoring

VOCs species monitored so far are limited to those non-polar VOCs species under US EPA TO-14a method. They represent the most important group of VOCs, however, they do not cover all the important species. Example is aldehyde and alcohol group. Especially acetaldehyde and formaldehyde are critical from the viewpoint of their expected level of concentration from the previous data and emission sources. Introduction of gashol for vehicle fuel also may have significant implication. To monitor, aldehyde, methodology other than Canister - GC/MS is required. Therefore, development of monitoring capacity for aldehyde and alcohol related VOCs is important. It is suggested to cooperate with ERTC to develop the methodology.

(5) Source emission monitoring

a. **Clarification of source testing methodology**

When proposing emission standard and control, it is essential to clarify the measurement method. Source monitoring is normally at relatively high concentration, direct sampling and injection to GC or GC/MS is acceptable.

b. **Improvement of automobile lab sampling system**

JICA expert, Mr. Y. Shirane, already made improvement proposal to PCD mobile laboratory to reduce the background contamination level. It is urgently required to follow this proposal.

c. **Enhancement of emission factor experiments data**

JICA expert, Prof. Okazaki, made proposal to enhance the current data on emission factor experiment at mobile laboratory. After sampling system is improved, it is recommended to follow the proposal.

7.2 Inventory Issues

a. **Recompilation of data based on consistent industry code**

Inventory data for TCE and DCM has not yet compiled with proper industry code. It is recommended to recompile the data.

b. **Investigation of DCM use in pesticide industry**

In 3rd phase inventory study, a factory producing pesticide consume over 300 ton/year of DCM. It has significant impact on final inventory data, if the case is special and limited to the factory, or is common to other pesticide factory. It is recommended to continue the survey on this matter.

c. **Enhancement of inventory data from other industry.**

In general, 3rd phase inventory study has limited data in other (other than auto, electric and metal/machine) industry. It is recommended to increase the input data on this sector.

d. **Preparation for PRTR system**

It is inevitable to introduce PRTR system for the management of chemical including VOCs. Currently PCD solid waste bureau is preparing for the introduction of PRTR system in Thailand. It is recommended that Air and Noise bureau also participate in the preparation process.

7.3 Policy and Risk Issues

General study and research on risk management shall be enhanced. In particular, review and examination of individual research paper is essential to select fundamental data, such as unit risk for the own decision. Organization of expert committee is suggested.

Attachments

Project for Development of Environmental and Emission Standards of VOCs (Volatile Organic Compounds) in the Kingdom of Thailand

Project Document

Revised

May 2007

EX CORPORATION

SOWA CONSULTANTS INC.

Contents

Abbreviations

BOD	Biological Oxygen Demand
CP	Counter Part
DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Works
DMR	Department of Mineral Resources
DO	Dissolved Oxygen
ECNEQ	Enhancement and Conservation of National Environmental Quality Act
ERTC	Environmental Research and Training Center
GDP	Gross Domestic Product
GPP	Green Partnership Program
HAPs	Hazardous Air Pollutants
IEAT	Industrial Estate Authority of Thailand
IMF	International Monetary Fund
JCIA	Japan Chemical Industry Association
JEMAI	Japan Environmental Management Association for Industry
JETRO	Japan External Trade Organization
M/M	Man/Month
MONRE	Ministry of Natural Resources and Environment
NEB	National Environmental Board
NEDO	New Energy and Industrial Technology Development Organization
NESDB	National Economic and Social Development Board
NGO	Non Governmental Organization
NOx	Nitrogen Oxides
ONEP	Office of the Natural Resources and Environmental Policy and Planning
PCD	Pollution Control Department
PCE	Tetrachloroethylene
PM	Particular Matter
PRTR	Pollutant Release and Transfer Register
QA/QC	Quality assurance and quality control
SOx	Sulfur oxides
SPM	Suspended particulate matter
TCE	Trichloroethylene
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WHO	World Health Organization

Chapter 1 Introduction and summary of revision

VOCs (Volatile Organic Compounds: VOCs) are defined by WHO (World Health Organization) as organic compounds having boiling point below 240 – 260 degree Celsius; under this definition, numerous organic compounds fall into this category. VOCs are released easily from a source to the ambient air and cause air pollution. In recent years, Thailand has faced environmental problems suspected to be caused by VOCs. Hence, understanding the current situation and taking appropriate measures are crucial. Two distinctive characteristics of VOCs should be noted; one being the harmful nature of inhaling the substances (called HAP: Hazardous Air Pollutants) and another being property of being a precursor to particulates and photochemical oxidants from photochemical reaction. Hence, a comprehensive and multiple views supported by accumulation of scientific data gathered by monitoring is necessary to establish environmental emission standards and develop measures against VOCs.

Under these circumstances, Pollution Control Department (PCD) of Ministry of Natural Resources and Environment has requested Japan technical cooperation to develop environmental and emission standards for VOCs. In response, JICA dispatched preparatory mission in June 2005 and both parties signed Minutes of Meeting. Then Record of Discussion was signed in November 2005. Following the approval of the project, JICA selected EX corporation and SOWA consultant inc. as an experts team to implement the project

This project document was prepared by EX corporation and SOWA consultant inc. under general guidance of JICA. The document describes background, strategy, approach and work plan for the project for common understanding between Thai side and Japanese side at the beginning. The project is to be carried out from March 2006 to February 2008.

Initial period of project activities were successfully implemented according to the schedule. Major achievement of the project from the first phase were, establishment of VOCs monitoring capacity with adequate QA/QC management, development of monitoring plan and commencement of the monitoring, progress in development of VOCs policy framework, and 1st and 2nd step inventory study.

An important change is the situation related to the project occurred in late 2006 - early 2007. High cancer rate at Map Ta Phut area reported by the National Cancer Institute raised high social and political concern for VOCs regulation. PCD has proposed to declare the Pollution Control Area at Map Ta Phut to the National Environmental Board, but decision was made not to do so. On the other hand, importance of VOCs was well recognized and the Health Effect committee was

established. One mandate of the committee is to set the standard for VOCs. Intermediate evaluation of the monitoring data clarified the prevailing VOCs species. The data from monitoring and inventory data were utilized to present proposal of environmental standard to the Health Effect committee. Accordingly, the committee decided to select 9 VOCs species for environmental standard and presented to the national Environmental Board. Therefore the activities of the project need to reflect the updated situation. Input for expert and equipment were slightly modified and activities plan was rearranged to meet the urgent need of the current situation. The project document was revised in May 2007 to incorporate the progress and change of the various situation.

Chapter 2 Background of the Project

2.1 Socio-economic conditions of Thailand

4.1.2 Economic conditions

Since 1980s Thailand's economy expanded rapidly backed by aggressive foreign investments and its annual economic growth has reached 9% on average from 1985 to 1995. On the other hand, the current account deficit has pushed up and so-called "economic bubble" has emerged especially in real estate sector. After the end of the babble economy, bad assets increased; leading to pressure to devalue Thai Baht. When foreign exchange shifted into floating rate system in July 1997, Thai Baht fell drastically that Thailand was eventually caught by severe economic crises.

The government of Thailand received aids from international community, including IMF and Japan, and tackled the problem for economic revitalization by bad-debt disposal and structural reform. The Thaksin administration, since February 2001, argued to expand domestic demand, in addition to traditional export oriented economy, and promoted rural area and medium-small sized enterprises. The policy on expanding domestic demand, as it seems, enhanced consumer purchasing power and economic growth became 6.9% in 2003, and 6.1% in 2004. As of 2004, GDP reached $163.5 billion.

The economic structure of Thailand has changed dramatically since the late 1980s with a rapid industrialization. Share of agricultural sector in GDP has fallen from 23.2% in 1980 to less than 10% in 2000. On the contrary, ratio of GDP increased in manufacturing, commercial, and service sector. It should be noted that agriculture sector employees the most people in 2000, or 48.4% of total population.

Table 2.1 Major Economic Indicator of Thailand (2002-2004)

	Unit	2002	2003	2004
Real GDP Growth Rate	%	5.3	6.8	6.1
Total Value of Nominal GDP	US billion $	126.77	142.95	163.51
GDP per capita (Nominal)	US $	199.42	226.55	252.15
Consumer Price Index (base=2002)		100	101.8	104.6
Manufacturing Production Index (base=2000)		110.5	126.0	139.9
Unemployment Rate	%	2.4	2.2	2.1

	Unit	2002	2003	2004
Trade Balance	US billion $	2.74	3.76	1.25
Exchange Rate (End of Date, against US$)	Baht/US$	43.15	39.59	39.06
External Debt	US billion $	59.46	51.78	51.31

（Reference; JETRO）

4.1.2 Social condition

Thailand is facing various social challenges, some of which are described as follows;

(1) Urbanization

There were only 9 cities that had population of more than 50,000 in 1996, but by 2004, the number increased to 22 cities, indicating that urbanization has steadily progressed in Thailand (although the growth rate is somewhat moderate than that of other Southeastern Asian countries, such as Indonesia, Philippines, or Malaysia). Currently, approximately 31% of Thai people lives in the urban areas , while urbanization is estimated to increase the rate to 40% by 2030. It is worth noting that population is concentrated in Bangkok (estimated to be 13% of total population). The urban areas face several serious environmental issues such as worsening pollution, waste, and living environment like water supply or sewage services, traffic congestion, deterioration of public safety, and squatter/slum are impending.

(2) Environmental problems

Alongside rapid economic growth, urbanization, and industrialization, Thailand is experiencing industrial pollution, unsanitary urban environment, and destruction of natural environment. The detail is discussed in section 2.2.

2.2 Conditions of the Environment

(1) Air Quality

Major air pollutants in Thailand are dust, suspended particulate matters (PM10 and PM2.5), sulfur dioxides (SO2), lead (Pb), carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), and ground-level ozone (O3). Emission sources of

[1] Reference: JICA, World Bank, and others

those pollutants are automobiles, power plants, factories, construction sites, forest fires, and open burning of agricultural wastes. Among mobile sources, two-stroke motorcycles, diesel trucks, and ageing buses contribute significantly to air pollution in urban areas. Central region of Thailand accounts for 60 - 70 percent of all industrial emissions in the country. Fossil fuel powered thermal sources continue to generate SO2, NO2 and carbon dioxide (CO2) emissions. In non-urban areas, sources such as agricultural burning also contribute significantly to particulate pollution.

Pollution Control Department, or PCD, has a monitoring network consisting of 53 sites nationwide. Results of air quality data of these monitoring stations reveal that many air pollutants, such as Pb, SO2, and CO, are on the decrease. However, ozone and SPM are exceeded the standard in many of these monitoring stations.

In transport sector, a very large fleet of old diesel buses and trucks emit large amounts of carcinogenic particulate pollution. A large number of older 2-stroke motorcycle also remains (although the number of four-stroke motorcycles are increasing). In industrial sector, many small and medium sized enterprises still emit air pollutants while many industrial units have adopted cleaner production to reduce air pollution. Furthermore, non-point sources remain a major concern. In rural areas, open agricultural and forest burning emit large volumes of PM.

(2) Water Quality

Similar to air pollution, degradation of water quality, especially in and around Greater Bangkok, where there are numerous factories and large population resides, has become a serious issue. Various parameters such as Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and coliform in many rivers in central Thai, including Chaopraya River, Tachin River, Me-Klong River, and Bang Pakong River, show alarming numbers. In some places, the water is only usable for transportation. Chaopraya River and Gulf of Thailand has been receiving heavy metal effluents from up stream for long time and pollutants have accumulated. Sources of these pollutants are factory effluents (local industries engaged in sugar refining, pulp and paper, rubber, leather and so on), domestic wastewater, and discharges from fish farming, hog farm, and restaurants.

There are also locations where severe water degradation has been seen in local cities in rural areas. In addition to discharges from local factories and domestic wastewater, agricultural effluent that contains agricultural chemicals is deteriorating water quality, particularly in dry season when river flow becomes less. Tourist areas, such as Phuket and Koh Samui have difficulties handling the

volume of waste generated by tourists, and much of the garbage ends up in water ways. Deteriorating water quality is adversely affecting human health, agriculture, and fishery.

Industrial parks, factories, and large commercial facilities have waste water treatment facilities. However their treatment in general does not meet the effluent standards. Thai government in 1995 established Wastewater Management Authority for promoting the development of wastewater treatment plant (mainly for domestic wastewater). However, treatment rate in urban areas remains only 30% and operated treatment plants are not aptly operated due to financial constrains. Thai government is moving toward decentralization in environmental administration. Department of Industrial Works that holds jurisdictions over factories has relocated their inspectors to local authorities. Furthermore, Ministry of Natural Resources and Environment is tackling water quality control, though the effort has yet show results.

(3) Waste Management

Presently 22 million tons of waste is generated from households, factories, commercial facilities, and hospitals. If current trend continues to 2010, solid waste will have increased by 25%, and hazardous waste by 35%. Hence, waste management poses serious problems for urban environment. Collection of solid waste has seen some improvement; but the treatment is not appropriate. For example, it is only in recent years that municipal waste from Greater Bangkok, which is sent to neighboring provinces, is covered by soil. Except Bangkok, 90 % of all municipal wastes generated in other cities are disposed of by simply piling up or by 'open dumping,' methods. Recyclable wastes are recycled by both formal and informal recyclers. According to a survey by World Bank, recycling rate is 11%.

As for hazardous waste, the amount of hazardous waste treated and disposed of (by licensed businesses by DIW) remains relatively low. Most of the waste is treated/disposed by non-licensed entities on low cost and/or by inappropriate treatment methods. Furthermore, volume of hazardous waste is stored or disposed at the factory that generates such waste. Thus, illegal dumping of hazardous waste can be seen in many places even now.

(4) Destruction of Natural Environment

Prior to 1950, more than half of Thailand was covered by forest. However, the forest area has disappeared rapidly from deforestation (including illegal timbering),

developments (including agriculture, water source, and tourism), and forest fires. At present, forest area covers only 25% of total landmass in Thailand. The Government of Thailand amended the forest law in 1989. In addition to the loss of forest, Thailand also suffers from loss of mangrove forests for maritime development or shrimp farming, adversely affecting biodiversity.

2.3 National Strategy on the Environment

4.1.2 National Economic Social Development Plan[2]

Development plan of Thailand is drawn in 'National Economic Social Development Plan'. The 5-year plan is prepared by National Economic and Social Development Board, or NESDB. In response to a recommendation of World Bank in 1957, the first 5-year development plan was prepared in 1961 and since then the development plan scheme has continued for more than 40 years. Presently, the Thai government is implementing its 9th 5-year development plan (from Oct. 2001 to Sep. 2006). The first (1961 - 1966) and second (1967 - 1971) emphasized development through economic growth. The average annual GDP growth rate for the same period reached 8.0%. However, negative aspects like widening gaps in income levels also became evident. Accordingly, the government also started to emphasize social development and environmental protection. Amendment to the 8th development plan focused on measures against the economic crisis in that period. Poverty eradication and ease in income gaps are also stressed in the current 9th development plan.

The 9th plan consists of 9 chapters including 'development vision and directions', 'revising strategy for sustainable rural and city development structure', 'strategies for natural resources management and environmental protection', 'strengthening international competitiveness, development of scientific technologies and its strategies,' and 'actual management of the project.

[2] References: web site of Ministry of Foreign Affairs, Outline of Economy in Thailand (2002/2003, Bangkok Japanese Chambers of Comers)

Strategy Target

- Protection, recovery and development of local economy by improving natural resources and environmental management
- Protection and recovery of natural resources
- Recovery and protection of local environment, art, culture, and tourism resources. Improving living quality and local economy
- Development of cities and local community by effective pollution control

4.1.2 Enhancement and Conservation of the National Environmental Quality Policy and Plan

Framework of environmental policy in Thailand was established in 1975 with 'Enhancement and Conservation of the National Environmental Quality Act B.E.2535' that was amended in 1992. The law was again amended in 1997. The blue print of mid- and long-term environmental management was provided and current national environmental policy and plan was established. 'Enhancement and Conservation of the National Environmental Quality Policy and Plan B.E.2540-2559' defines framework and guidelines of national environmental protection for year 1997 through 2016. The act was prepared by National Environmental Board, or NEB, and approved on November 20, 1996. The policy and plan is composed of the following 6 main policies.

Policy 1: Policy on natural resources
Policy 2: Policy on environmental conservation and pollution control

- Reduce and control pollution from civic life, agriculture, and industry
- Strengthen solid and hazardous waste management practices
- Strengthen administrative and management structure for environmental pollution

Policy 3: Policy on conservation of natural scenic area
Policy 4: Policy on imminent environment
Policy 5: Policy on environmental education and publicity
Policy 6: Policy on environmental technologies

The plan to realize the 'Enhancement and Conservation of the National Environmental Quality Policy and Plan B.E.2540-2559' (1997-2016) was established. Current plan is called Environmental Quality Management Plan (1999-2006). It focuses on protection of natural resources, soil, land use, water resources, air and

water quality, solid waste, and night soil.

2.4 Related projects in the sector

Table 2.2 summarizes related projects in the sector.

Research cooperation on VOCs contamination (NEDO, 1997) studied the status of Chlorinated VOCs management in the industries in Thailand, and transfer technology on survey, monitoring, analysis, and transport modeling of VOCs in groundwater as well as treatment technology on contaminated groundwater. After the study, PCD revised the environmental standard of groundwater to include VOCs. In 2000, new standard became effective by notification No. 20 from NEB.

Capacity building project for environmental research (JICA, 2005) focuses on the VOCs in air as the target of research. The current project focuses on policy and administrative aspect. Hence, these two projects complement each other. It is important to ensure the linkage and coordination of the two projects.

Table 2.2 Related projects in the sector

	Title	Year implemented	Donor	Thai organization	Content
JAPAN	Environmental Research and Training Center (ERTC) project	1991-1997	JICA	DEQP ERTC	Project to assist environmental monitoring and analytical laboratory. Transferred the technology on basic skills in environmental monitoring and analysis in air, water, toxic substances, etc.
	Research cooperation on air pollution modeling technology in industrial estate.	1993	NEDO JEMAI	DEQP ERTC	Developed air pollution diffusion analytical system for the model industrial estate and transfered the technology on the following. Development of air pollution diffusion program, installation on the work station, preparation of program operation and practice.
	Research Cooperation on Investigation of Volatile Organic Compounds (VOCs)	1997	NEDO JEMAI	ERTC, IEAT, DMR, PCD	Utilization and management situation of Chlorinated VOCs such as TCE and PCE in the industries in Thailand, and transfer technology on survey, monitoring, 3D diffusion modeling of VOCs in groundwater in the selected industrial estate.
	Research cooperation on air pollution monitoring at the model industrial estate	1998	NEDO JEMAI	IEAT	Transferred the technology on environmental monitoring, source study, impact assessment and source countermeasure at the model industrial estate to improve planning and countermeasure on air pollution by SOx, NOx and VOCs from industrial emission.

	Title	Year implemented	Donor	Thai organization	Content
JAPAN	Capacity building on environmental research	2005-2008	JICA	ERTC	Related to this project and good coordination is essential. Project components are the following three elements. ● Development of adequate air monitoring technology for VOCs ● Understanding the situation of current VOCs pollution ● Enhance research capacity on VOCs air pollution and health risk analysis.
	Development of air pollutants emission data base	2005-2006	JETRO JEMAI	DIW	The project is to prepare inventory of air pollutants emission. For VOCs the objectives are focusing on auto mobile repair factories through questionnaire and field surveying, understanding current situation of emission and proposing its countermeasure.
	The acid deposition control strategy in the Kingdom of Thailand	2002-2003	JICA	PCD	Preparing the strategy for mitigation of acid deposition including ambient air pollution. The components are the following three elements. • Review of Monitoring result • Develop inventory for “stationary source”, “Mobile source” • Simulation Analysis “Acid deposition (Long Range model)” and “Ambient Air (Airviro)”
	Third country training course on Emission Inventory and Modeling for Acid Deposition Assessment	2002-2006	JICA	DEQP ERTC	To enhance the knowledge and understanding on acid deposition problem as well as to develop the abilities and skills on emission inventory and modeling for acid deposition assessment to the participants from East Asian Region.

	Title	Year implemented	Donor	Thai organization	Content
OTHERS	Country partnership on environmental development	2004-2007	IBRD	MONRE and others	Objective is to provide strategic and cooperative approach for promotion of environmental quality to meet the mid-term agenda on environmental sector. Major field includes air, water and waste management, global issue (global warming, etc.) and assistance to institution and organization For air quality; to reduce dust and SPM in Bangkok, formulation of reduction plan from diesel vehicle, capacity development of related organization (PCD, MOT, Police, public transportation), enforcement of automobile inspection mechanism, organization of workshop.

Chapter 3 Current conditions and issues in the project sector

3.1 Institutional Framework for the Environmental Administration

With structure reform of 2002, Ministry of Science, Technology and Environment was divided into science and technology field and environmental field. The environment was integrated into institutions on natural resources and the Ministry of Natural Resources and Environment was created. Functions and authorities of the Ministry are shown below.

Table 3.1 Function and Authorities of Ministry of Natural Resource and Environment

Function	Authorities
Policy / Management	• Administrative Vice-Minister Office • Office of Natural Resources and Environmental Policy and Planning (ONEP)
Environmental Management	• Pollution Control Department (PCD) • Department of Environment Quality Promotion (DEQP)
Natural Resource Management	• National Park, Wild Life and Plant Conservation Department • Department of Mineral Resources • Department of Marine and Coastal Resources
Water Resource Management	• Water Resource Department • Ground Water Resource Department

Duties of the Pollution Control Department (PCD) are as follows:

- Submit opinions for the formulation of national policy and plans for the promotion and conservation of environmental quality with respect to pollution control. ONEP is responsible for the development of policy and plans.
- Make recommendations for the establishment of environmental quality standards and emission/effluent standards. (Emission standards for factories are defined by DIW. Emissions from other specific fields are controlled by authorities of that field.)
- Monitor environmental quality and prepare an annual report on the state of pollution
- Develop appropriate systems, methodologies, and technologies for the application in the management of solid waste, hazardous substances, water

quality, air quality, noise level, and vibration

- Address public complaints on pollution, etc.
- Perform other functions on pollution control as specified by the Enhancement and Conservation of National Environmental Act, B.E. 2535 (1992) and other related laws

Duties of Department of Environment Quality Promotion, or DEQP, are described as follows;

- Promote environmental education and public relations for environmental conservation
- Develop environmental information and database
- Provide environmental information to the government, private institutions, and citizens.
- Research an appropriate technologies for environmental protection
- Transfer of environmental technologies
- Other duties specified by the law

3.2 Current situation and issues on air and VOCs pollution

Thailand is facing serious air pollution problem, especially in urban areas, due to rapid industrialization, urbanization and motorization. The government has set ambient air standard and implemented countermeasures for Carbon Monoxide, Carbon Dioxide, Nitrogen Dioxide, Sulfur Dioxide, SPM, PM-10, Ozone and Lead. As a result, the situation has improved to a certain level for Nitrogen Dioxide, Sulfur Dioxide and others. Ozone and SPM still exceed the standard value at many of the monitoring locations.

VOCs emitted from the industry and vehicles are considered as one of the sources for suspended particulate matters (secondary formation), which exceed the standard and requires immediate countermeasure and also triggers photo-oxidant. Furthermore VOCs are hazardous air pollutants, which cause various acute health problem as well as carcinogenic risk. Under this situation, the Thai government

considers VOCs as an important issue in ambient environmental matters. National Environmental Board has instructed PCD to implement countermeasure for VOCs.

Map Ta Put incident in 1997 was a well known environmental problem related to VOCs. In this incident, tens of pupils in a school nearby the Map Ta Put industrial estate were hospitalized due to serious air pollution. Source of the pollution was considered as VOCs. The school was forced to close and moved to another location. Source pollutants and source factory has not been identified yet. Even now there are various reports and claims regarding occurrence of fruit like smell (most likely aromatic VOCs) around the estate. According to MONRE, 40% of environmental complains are on odor and smell, and most of them are considered to be related to VOCs.

As there is no ambient environmental standard set for VOCs, a systematic monitoring of VOCs in ambient has not been implemented. PCD and ERTC of MONRE have implemented limited monitoring of VOCs individually. PCD started periodical monitoring at six stations around Bangkok with special attention on mobile sources. Though, there is few data that systematically assures its quality. Concentration of certain VOCs are estimated to be at levels at which health risk cannot be ignored. Therefore it is urgent matter for the government to confirm the necessity of the countermeasures.

3.3 Air Pollution Control System

To date, there has not been only regulation aiming at specific VOCs. Moderate emission standards have been imposed for total VOCs targeting for facilities dealing with fuel oils, including oil refinery, oil tank, and gas stations. (Installment of vapor recovery system is not anticipated). To control emission of total VOCs, PCD is promoting voluntary measures to install VOCs recovery facilities at some oil refineries and gas stations.

Establishment of environmental standards is specified by National Environmental Board, or NEB, as stipulated in the 'ECNEQ, or Enhancement and Conservation of the National Environmental Quality Act 1992.' (See section 2.3.2). When establishing environmental standards, relevant authorities should submit a respective proposal to NEB for its approval. However, PCD plays a central role in developing and submitting such proposal.

There are two parallel systems in Thailand for establishing emission standards.

One is defined by ECNEQ, and the other is defined by sector laws. On ECNEQ, emission standards are prescribed through discussion at Pollution Control Committee (PCC) and decided by NEB. However, such emission standards -- proposed by PCD -- does not hold any penalties. PCD staff has no clear authority to enter and inspect suspected emission sources, except for cases where the source is located within pollution control specified area.

An example of emission standards defined by a sector law is the one established by Minister of Industry based upon the Industry Law. For this standard, the Minister can issue an order to halt operation or improvement order for those enterprises who violate the standard. Furthermore, the authority can perform an onsite inspection.

In spite of this, ECNEQ provides coordination when there are two different emission standards for the same item. More strict standards are to be imposed in such cases.

Chapter 4 Project Strategy

4.1 Strategy of the Project

Project objective is “To enhance the capacity to implement countermeasure for VOCs air pollution (including development of environment and emission standard) in MONRE”. To meet the objective, project strategy is “clear definition of capacity development target and goal setting” with special attention on the following three points.

(1) Need for simultaneous development of VOCs monitoring capacity and policy formulation capacity based on the monitoring results

Key of environmental administration is to measure environmental quality and understand the situation. In Thailand, public administration for air pollution countermeasure was established. However, regulation for new hazardous air pollutant from recent industrialization, is necessary as stated before. Therefore, for VOCs including hazardous air pollutant, it is required to develop capacity for environmental monitoring and at the same time use the result to formulate the policy.

(2) Need to define clearly targets and goals for capacity development of Thai side

The project aims to assist the capacity development of environmental administration and has challenging objective of simultaneous enhancement of monitoring and policy formulation. In order to achieve the objective, target of capacity development shall be clearly defined and its current capacity shall be assessed through the dialogue between Thai side and the expert team to prepare the enhancement approach and method.

(3) Development of stakeholder relationship

Dialogue with the stakeholders, such as related government agencies, universities, researchers, industries, community and NGOs, is important. Through the dialogue, all parties are expected to recognize the benefit of new regulation and standard for VOCs and eventually accept them. Development of such relationship is an important capacity required for the regulatory agency. For this purpose, various opportunities to present the output of the project with other stakeholders will be utilized.

Following interactive approach for clear definition of capacity development

target and goal setting is presented.

Table 4.1 Inter active approach for technical cooperation

Thai Side	Discussion	Expert team
I. Prepare for plan on problem solving	← • **Discussion on problem and approach on problem solving**	I. Advise on the specific problem and preparation on plan for problem solving
II. Submission of operation plan	← • → **Discussion on plan**	II. Comment on the plan prepared and advise on modification
III. Revise operation plan	• →	III. Confirmation of operation plan
IV. Implementation	← •	IV. Provide related information
V. Implementation	← •	V. Monitor the progress, provide comment and advise
VI. Summarize and report result (draft)	← • → **Discussion on draft**	VI. Comment on draft and advise for improvement
VII. Report final draft	← • → **Discussion on final draft**	VII. Comment of final draft and advise for improvement
VIII. Finalized the result	← • → **Interactive evaluation**	VIII. Confirmation on final draft and evaluation
IX. Next step		Completion

4.1.1 Basic approach / implementation policy

Basic approaches of the project are discussed as follows:

(1) Monitoring support

a. <u>Basic policy for development of VOCs monitoring plan</u>

One of the characteristics of VOCs in the ambient air is that concentration may fluctuate greatly in both space and time. The project will select approx. 20 monitoring sites for obtaining annual average of the sites by fixed-point observation for extended period of time. Concentration of VOCs needs to be discussed with average annual value for considering health effect from long-term exposures. In other words, if large number of data is gathered from short term monitoring in many monitoring sites, it is not adequate to base

discussion on those data. From this point of view, monitoring plan shall be developed strategically. Using the result of preliminary inventory study as a reference, monitoring sites must be selected as ambient environmental concentration around the sources for important VOCs. Consequently, the monitoring sites will be selected based on assumption for the area that is most concerned from VOCs pollution. Due to these reasons, the monitoring sites for the project will be carefully chosen with existing monitoring data, preliminary inventory data, and knowledge of the sources accumulated by PCD, ERTC and other agencies.

It is assumed, at this stage, approx. half of the monitoring stations may be within or around Bangkok area, while other half may be around the industrial area such as Map Ta Put.

b. Basic policy on selection of target area for detailed VOCs study

At the stage of detailed VOCs study, inventory survey for factories, source monitoring at emission point as well as boundary of the facility is planned. Therefore, monitoring at source may require many sampling sites, depending upon types of factories or other source types. As analyzing capacity at that stage is still limited, the size of detailed study area is expected to be about 10 factories (sources).

(2) Basic policy on quality management support

QA/QC is essential for trace analysis such as VOC analysis. Accurate result of analysis is required to use the data of the VOCs analysis widely. VOCs analysis requires not only technical operational skills of the instrument, but also QA/QC system to ensure the precision and accuracy of analysis. Staff training will be focused not only on basic analytical procedures, but also on the ability to grasp various issues in each step of the analysis, and take appropriate measures. Cooperation with ERTC laboratory including cross checking is also emphasized to realize the establishment of concrete analytical system. As need for monitoring of VOCs was recognized by many stakeholders, various laboratories started to monitor VOCs in early 2007. Therefore QA/QC activity needs to be extended to those laboratories who started VOCs monitoring.

(3) Implementation policy on inventory study

Inventory study provides basic data for understanding of the types of sources (both stationary, mobile and area) that are responsible for VOCs emissions. Content of the inventory is shown below.

Table 4.2 Contents of Inventory Survey

	Category	Purpose	Targeted VOCs	Area	Method	Output	Year
1	Brief inventory survey of VOCs all over the country (completed in 2006)	Screening prospective prioritized VOCs	About 40 components, with a focus on VOCs and aldehydes, listed on US EPA TO-14	Nationwide	➢ Derive VOC usage by components from existing production and import/export statistics	➢ Brief inventory of VOCs ➢ Prospective prioritized VOCs (approx. 20 components)	The Second Year (2006)
2	Detailed inventory survey of prospective prioritized VOCs (completed in Mrach 2007)	Screening of prioritized VOCs	Prospective prioritized VOCs derived from brief inventory survey (approx. 20 components)	Nationwide	➢ Estimate products or sources consumed, expected to release VOCs, from existing data. ➢ Estimate average contents and release rate of VOC components by products. ➢ Calculate amount of VOC released by products and sources and established detailed inventory	➢ Detailed Inventory (by products / sources) ➢ Prioritized VOCs (prospective regulated VOCs, approx. 5 components)	The Second Year (2006)
3	Inventory survey of prioritized VOCs in the specific region		Prospective prioritized VOCs Prospective regulated VOCs (VCM, EDC, TCE, PCE, DCM and Benzene from stationary sources)	Specific area	➢ “Door to door” survey in the specific area	➢ List up of prospective regulated offices ➢ Inventory of prioritized VOCs in the specific region	The Third Year (2007)

(4) Development of draft outline on VOCs regulations

Three independent steps are required to develop VOCs regulation.

1) Selection of target substances (based on inventory, monitoring, hazardous nature, etc.)

2) Establishment of standard.

3) Regulatory measures including following policy option such as;
Nationwide control vs. Specific area focused control
Concentration based emission control vs. Structure control
Control all sources vs. Control priority source
Cost and technology option;
Control applicable to current framework vs. Control requiring new framework

The draft outline below will describe the items above and can be used as working document to develop the regulation.

a. Development of draft outline

As mentioned earlier, Thai's ownership of the project is a primary element for the success of the project. In this sense, Japanese side will assist PCD when developing a draft outline on VOCs regulations.

In general, VOCs regulation would contain the following items; a) 'Establishment of Target Substances,' b) 'Environmental Standards,' c) 'Specification of Special Facilities for Targeted VOCs,' d) 'Emission Standards,' e) 'Official Methods of Sampling & Analysis,' f) 'Regulating Mechanisms,' and g) 'Guidelines for the Measures.' Among these items, following items are especially important for successful regulation; 1) Establishment of Target Substances, 2) 'Environmental Standards,' 3) 'Determination of specific facilities for Targeted VOCs,' and 4) 'Emission Standards.' Japanese side will assist PCD in defining these items

The draft outline should be first prepared in around June 2006. It shall be revised in around June 2007 and disclosed for public comments. Content of the draft outline could contain the following.

1. Introduction 2. Current situation of and necessity of measures for VOCs pollution in Thailand

3. Inventory of VOCs source in Thailand
4. Current trend of VOCs regulation in the world
5. Philosophy and objects of VOCs regulation
6. Policy on VOCs regulation
   6.1 Approach (and selection) of establishing target VOCs
   6.2 Approach of establishing environmental standards
   6.3 Approach of selecting target facility for emission regulation
   6.4 Approach of establishing emission standards
7. Policy on controlling non-target VOCs
   7.1 Basic approach
   7.2 Target VOCs for voluntary control VOCs
   7.3 Promotion of voluntary emission control measures
8. Measures for the future
   8.1 VOCs regulation in the future (revision and addition of environmental and emission standards)
   8.2 Establishment of PRTR system
   8.3 Promotion of study / research

The draft outline will be prepared in the following steps: 1) 'confirmation of the content of the outline,' 2) 'rough sketch of the content of the outline,' 3) 'preparation of first draft outline' and 4) 'preparation of second draft outline.' The second draft outline prepared in 2007 will be disclosed for public comments in 2007 and/or 2008. The draft outline will be finalized after such procedures.

b. <u>Development of draft environmental standards</u>

Development of draft environmental standards (assumed HAPs of VOCs here) is composed of selection of targeted VOCs (for the standards), and determination of the concentrations. Establishment of the later may be done with following procedures.

i. Understanding of the basic items of the substances (physico-chemical characteristics, usage of the substance, health effect)
i. Toxicity assessment information
   1. Carcinogenicity and mutagenicity (qualitative and quantitative evaluation)
   2. Toxicity other than carcinogenicity (qualitative and quantitative evaluation)
ii. Exposure assessment

1. Origin of air pollutants
2. Ambient concentration (basic information and data for the project)
3. Receptor condition surrounding source (data for the project)
4. Exposure assessment

iii. Overall evaluation and establishment of draft standards

1. Related information (toxicity evaluation and environmental standards)
2. Overall evaluation and draft recommendation

For the environmental standards related to human health, scientific knowledge shall be emphasized. Japan determined its environmental standards based on report from an expert committee on health risk in Central Environmental Council. The project needs PCD's solid understanding of these elements through series of works.

Establishment of the environmental standards will be discussed in Pollution Control Committee before submitting the draft to NEB. Thus, gaining cooperation from external organization and expert is desirable to receive objectivity. With due consideration to the MONRE's intentions, the team plans to recommend establishing an expert panel for this purpose, if necessary..

c. Establishment of emission standard

In Japan the facilities that emitted specific substances, i.e. benzene, trichloroethylene, and tetrachloroethylene were defined first. Then regulated standards (emission standards) for each type of facility were determined.

If the facility is assumed to emit comparatively large amount of such substances, it is designated as the specified facility. Technologies to reduce volume of emission from these facilities should also be available for both practical and financial reasons. The authority should be able to designate the facility as such. Facility size can be added as a condition for determining the target facility, depending upon a type of facility.

As for controlling standards for specified substances, the values in the standards are determined in such a way that one can meet the standards with realistic measures. Incidentally, such standards can be defined as concentration or volume at exhaust or methods of maintenance and management. In Japan, the

standards are chosen for emission concentration at source. Since structure of the facility, maintenance practices, and/or utilizing types of raw materials all contribute to the concentration from a facility's emission, how the firm takes the necessary measure is left with their ingenuity.

In Japan, value for emission standards were set with due consideration to following points.

1. Large emission sources are targeted for regulation as their impact is also huge.
2. The emission standards are set at concentration levels that are achievable with available technology and financial capacity of the source facility. (Applicability of the technology differs from new and existing facilities)
3. In case a substance is released to ambient air at the concentration set as emission standards, the maximum concentration on the ground should not exceed its environmental standard

Information necessary to establish the emission standard is as follows:

1. Emission source of targeted VOCs by type of industry and process (number of VOCs related enterprises and production volumes)
2. Concentration of VOCs emission attainable by applying control technologies.
3. Evaluation of effect on the surrounding environment by emission at the concentration level specified in the standard
4. Condition of targeted sources of the VOCs regulated (facility conditions and gas volume, etc.)
5. Emission standard in other countries

The emission standards for VOCs should be determined with reference to prior studies by gathering and understanding Thai's own information. Information on standard setting in Japan is also provided to assist in a comprehensive investigation and evaluation of the standards. Thai side and the expert team collaborate to develop the draft standards. The information used in the process is also to be utilized by 'Pollution Control Committee.'

(5) Approach for selecting the priority VOCs.

Selecting priority VOCs needs a broad view. Measures for VOCs has two distinctive aspects; measures for HAPs and measures for SPM and photochemical oxidants. The focus of measures may change during mid- and long-term policy development. Furthermore, depending on the type of VOCs, measure and its approach may differ from the other type of VOCs, and effectiveness of the measures needs careful review. Hence, there are four criteria for selecting the priority VOCs;

- Viewpoint on health risk (such as carcinogenicity of specific VOCs)
- Viewpoint on precursors to Suspended Particular Matters and Photochemical oxidants
- Viewpoint on environmental concentration and amount released
- Viewpoint on effectiveness of the measures (economical efficiency and their benefits)

This project focuses on health risk. While the team assumes the levels of toxicity of specific VOCs as a priority criteria, verification of the concentration if it reach cautious level from inventory study and monitoring survey is also important.

On the other hand, there may be a case where VOCs with low toxicity are discharged in large volume. In such cases, it may be necessary to implement measure from mid- and long-term view point. Thus, the selection procedure will be carried out based on health risk as the priority criteria.

(6) Application of Models

There are atmospheric dispersion models available in Japan, namely, ADMER <National Institute of Advanced Industrial Science and Technology-Atmospheric Dispersion Model for Exposure and Risk Assessment> and METI-LIS <Ministry of Economy, Trade and Industry –Low rise Industrial Source Dispersion Model>. The following table summaries the characteristics of these two models. The former is mainly used for analyzing regional exposure analysis while the later is mainly used for concentration analysis on proximity of the source. PCD should understand the characteristics of these models. Since the project focuses on concentration near the proximity of the source, METI-LIS will be mainly used. ADMER may also be used if background data is sufficiently available.

Table 4.3 Types of Model

Type of Model	ADMER	METI-LIS
Feature of Model	・ Estimate long-term average concentration distribution in relatively vast area such as Kanto or Kansai area. ・ Spatial resolution beyond the scope of 5×5km and monthly average exposure evaluation at 6 different time slots.	・ Estimate concentration of air pollutants released from the point source (Plume/Puff Model) ・ Accuracy is limited within about 2km radius from the source of origin ・ Capable of estimating long-term and short-term concentration
Application potential in Thailand	・ Access to information of source origin and weather condition ・ Input Thailand's information (information of source origin) as geographic information (latitude / longitude)	・ Access to information of source origin and weather condition
Note	・ Not capable of estimating change of concentration in the space within a range of 5× 5km. (Inapplicable to estimate at the location adjacent to the source of origin).	・ Inapplicable to rough terrain.

(7) Risk assessment

There are two procedures to carry out risk assessment. One is to rate the risk based on hazard posed from the chemical and condition of exposure, and the other is to follow two steps of preliminary assessment and a detailed assessment. There are also differences between methods of assessing overall risks and risks at a specific site. The project plans to utilize 'Preliminary assessment of environmental risk on chemical substances' published by Ministry of Environment Japan in 2002. Database on exposure is necessary to be established for the project, while other available data can be utilized as existing information. In order to carry out risk assessment, it is necessary to collect data on amount of exposure only (other data (e.g. toxicity) are already available).

Various risk assessment methods also needs to be understood by Thai side.

(8) Seminars/workshops and stakeholder relation

a. Seminars/workshops

As it is very important to share the outcome of the project with environmental administrators, researchers, and people from industries, a seminar/workshop in 2006 and two seminars/workshops in 2007 are planed. PCD should play the main role in the seminar/workshop, and the project team should assist the Thai side. The team will also assist to determine the content of the seminar/workshop.

b. PR activities

Dedicated web page shall be developed to publicize the project on VOCs. The site may co-host the technical cooperation project carried out at ERTC. PR activities must be done in Thai language. Furthermore, 'project news' will be prepared.

c. VOCs steering committee

MONRE is in the process of formulating VOCs steering committee. The project will report the progress and output from the activities periodically to the committee.

4.1.2 Point of concerns

(1) Assisting Capacity Development (CD) and coordinated implementation with Thai side

The project is to be implemented through ownership of Thai side.

(2) Coordination with other project at Ministry of Industry

Green Partnership Program, or GPP, which focuses on environment and energy cooperation, has been carried out by Ministry of Economy, Trade and Industry, Japan and Ministry of Industry, Thailand. In this program, emission database on ambient air is under development from 2005 in a 2-year period with the cooperation of DIW. The database contains SOx, NOx, PM as well as VOCs. Coordination with this program carried out by the Ministry of Industry, Thailand, and standards and regulations imposed by the MONRE is highly desirable to attain maximum effectiveness. Thus, the coordination with this program is very important.

4.2 Implementation Structure

4.1.2 Thai side

The organizations related to the project are the Pollution Control Department (PCD) and Department of Environmental Quality Promotion (DEQP) under MONRE. However, PCD is responsible for the project as a whole. Personnel involved in this project are staffs of Air Quality & Noise management Bureau and laboratory section of PCD and staff of Air research section of ERTC. The staffs of ERTC will mainly participate in the activities of elucidation of the VOCs air contamination in the project. The director and manger of the project are as follows.

Project Director, Director General of PCD

Project Manager; Deputy Director General of PCD

They are responsible for the implementation of the project. Japanese experts will give technical assistance, give recommendation and advices to the project director, the project manager and staffs.

4.1.2 Project Operation and Management

Meeting will be held between Thai side and Japanese side at least once a year for discussing following points.

- To monitor and check the activities and progress and examine the outputs of the project
- To change the opinion for the issues which may occur in the progress of the project and to consider the solutions.

To consider the change of the project outputs, activities and so on, if necessary. Member of Japanese side includes representative of JICA HQ Department of Global Environment, representative of JICA Thai Office, and chief adviser of the Japanese Expert Team. Mid-term evaluation conducted in February 2007 suggested the establishment of joint steering committee for the project, for which member shall be selected from the concerned agencies. Accordingly, Thai side shall arrange for the committee.

Chapter 5 Basic Plan of the Project

Basic framework of the project was made up and mentioned in the annex[3] of the record of discussion dated November 30th, 2005 between the Thai side and JICA Head quarter Global Environment Department. Basic plan of the project is summarized as follows based on the record of discussion.

(1) Overall Goal

Overall Goal of the project is to take concrete actions on air pollution by VOCs. The indicator is formulating environmental and emission standards for VOCs.

(2) Project Objective

Project objective is the enhancement of the capacity of MONRE to take countermeasures against VOCs air pollution including development of environmental and emission standards in Thailand. Following four items of indicators are listed

- Priority compounds of VOCs to be monitored and controlled in Thailand are recognized by MONRE.
- PCD has gained the technical capability to conduct routine monitoring of the prioritized VOCs and ERTC has gained the capability to monitor the VOCs in the air in a wider area for research purpose.
- Awareness of air pollution by VOCs is enhanced through the project activities.
- PCD can propose environmental and emission standards of VOCs to the Pollution Control Committee

(3) Outputs

Project purpose could be achieved through the accomplishment of the following outputs.

Output 1: Elucidation of the VOCs air contamination status for setting up environmental and emission standards in Thailand

Output 2: Proposal of environmental and emission standards of VOCs to the Pollution Control Committee

[3] MASTER PLAN and TENTATIVE PLAN OF OPERATION

(4) Activities

1) Activities in terms of Output 1

The following eleven activities in terms of Output 1 will be conducted.

- Joint planning of investigation of VOCs contamination with ERTC
- Review of existing data
- Development of VOCs emission inventory
- Conduction background monitoring
- Investigation of contamination status of VOCs
- Preparation of modeling including collection of necessary data
- Listing up the prioritized VOCs
- Conducting stationary source monitoring
- Drafting of contamination status report on VOCs in coordination with ERTC
- Organizing seminar(s) for dissemination the result of the investigation.

2) Activities in terms of Output 2

The following eleven activities in terms of Output 2 will be conducted.

- In-depth of monitoring of the prioritized VOCs (ambient, stationary and mobile)
- Development of VOCs emission inventory for the prioritized VOCs
- Simulation modeling for the prioritized VOCs
- Finalizing the target parameters of VOCs for setting up environmental and emission standards
- Collection of information on health risk and control technology
- Setting up proposed numerical targets of environmental and emission

(5) Inputs

1) Japanese sides

a. Experts

Experts shown in below table will be dispatched.

	Field as planned	Experts to be dispatched
1	Chief Adviser/Environmental Standard	Chief Adviser/Environmental Standard
2	Monitoring Plan /VOCs Countermeasure Technology	Monitoring Plan /VOCs Countermeasure Technology
3	VOCs Analytical Technology in the Air	VOCs Analytical Technology in the Air
4	Inventory Survey	Inventory Survey 1・VOCs Countermeasure Technology by Industries 1
5	VOCs Air diffusion Monitoring	VOCs Air diffusion Monitoring・VOCs Countermeasure Technology by Industries 2
6	Health Risk Evaluation	Health Risk Evaluation
7	VOCs Countermeasure Technology by Industries	Inventory Survey 2・VOCs Countermeasure Technology by Industries 3

Based on the progress made in the first phase of the project and countermeasure for the prioritized VOCs , expert assignment will be modified as follows.

	Experts to be dispatched
1.	Chief Adviser/Environmental Standard
2.	Monitoring Plan /VOCs Countermeasure Technology
3.	VOCs Analytical Technology in the Air/Mobile source VOCs testing
4.	Inventory Survey 1・VOCs Countermeasure Technology by Industries 1(Chemical production facility)
5.	VOCs Air diffusion Monitoring・VOCs Countermeasure Technology by Industries 2 (Storage facility, combustion facility)
6.	VCM and EDC inventory Survey at Map Ta Phut
7.	Health Risk Evaluation
8.	Inventory Survey 2・VOCs Countermeasure Technology by Industries 3 (Cleaning facility, Laundry facility)
9.	VOCs Countermeasure Technology (Mobile source)

b. Utilization of local institute, consultants etc.

Local consultants will be utilized for the effective implementation of the project. Local institutes or consultants will subcontracted for the preliminary study for the prioritized VOCs and the detail emission inventory.

c. Equipment

Equipments that will be provided by JICA are shown in the following table. In addition, equipment necessary for the project activity might be provided as per need by the experts.

Table 5.1 Equipment list

	Equipment	Quantity	Time of provision
1	Spare part for pre-concentrator	1	2006
2	STD gas	1	2006
3	Split / Split less injector	1	2006
4	ITSD gas	1	2006
5	6L canister	10	2006
6	Flow regulated sampler 3hrs	1	2006
7	Flow regulated sampler 24hrs	1	2006
8	Sampling bag	10	2006
9	Sampling bag (tedlar bag)	10	2006

In addition to the above, following equipment will be provided by JICA to support the specific study.

	Equipment	Quantity	Time of provision
1	VOC monitor	2	2007
2	UV lump (11.7eV)	4	2007

d. Counterpart training in Japan

JICA will offer the training for Thai side in Japan in five fields as agreed in the Record of discussion dated in November 30h, 2005. The expert team and Thai side team will set clearly the purpose and training items for each Thai trainee based on a dialog with the Thai side. The expert team will support Thai side to submit training report and make presentation in the seminars.

- Policy formulation (Management of VOCs)
- Emission inventory study
- Modeling
- Health risk
- Control technology

Counterpart training was successfully completed in October,2006.

2) Thailand sides

a. Thai side

- Project Director (Director General)
- Project Manager (Deputy Director General)
- Project Staffs

b. Facility and equipments for laboratory

Office, facility and equipments for analysis and monitoring works excluding JICA supplied equipment will be provided by Thai side.

c. Local cost

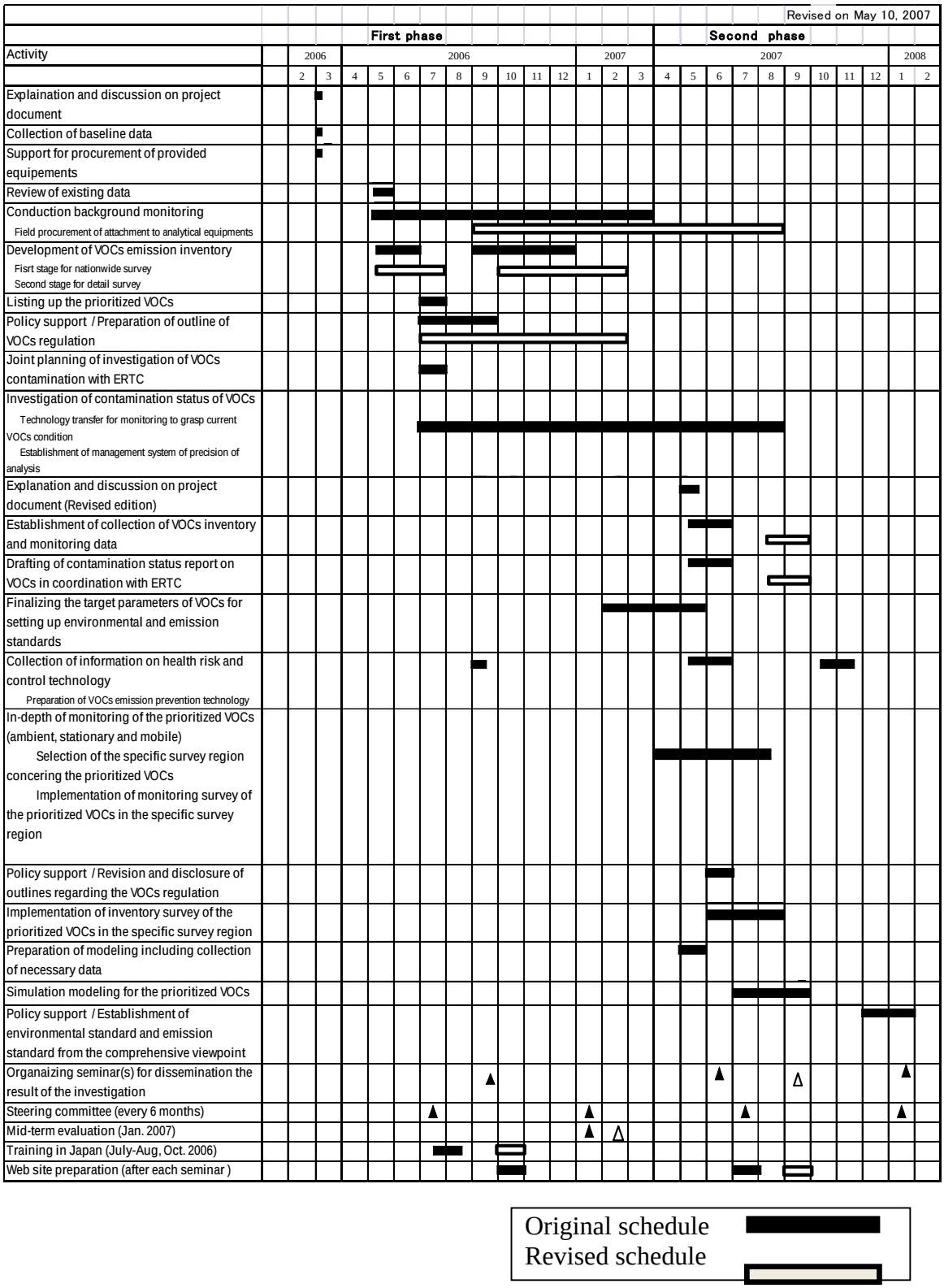
As agreed on Minutes of Meeting signed by both the Thai side and the Japanese side on November 30, 2005, Thai side will provide overhead cost necessary for the implementation of the project. The cost beard by the Thai side will include, 1) buildings and facilities necessary for the implementation of the project, 2) office space and necessary facilities in the buildings for JICA experts and meetings, 3) facilities and services such as electricity, gas, water, telephone, internet access and furniture, and 4) other facilities mutually agreed upon as necessary. The Minutes also states that Thai Government will take necessary measures to meet the running expenses necessary for the implementation of the project.

(6) Important Assumptions and Risk Analysis

The project assumes the following as an important assumption and pre-condition.

"Priority of countermeasures on VOCs in the Thai environmental policy will not change".

(7) Schedule of the Project



(8) Project Activities and sharing of roles

Indicators for evaluation of capacity development of Thai side are shown in the following table. The Japanese expert and Thai side will evaluate the achievements mutually.

Table 5.2 Verifiable Indicators of Outputs and Duties

	Items	Thai side	Japanese Expert Team
2006	Equipment procurement		Procure equipment in Thailand slated for the project.
	Monitoring review report	• Make review report of existing monitoring data. • Presentation of this report.	
	Technology transfer of OA/QC in VOCs analysis	• Pass the tests for QA/QC developed by the project team.	Prepare QA/QC test.
		• Senior staff gives technical guidance to other staffs. • The laboratory staffs can carry out QA/QC of VOCs analysis.	Train senior staff.
	Emission inventory survey	• Participation on preparing the specification. • Prepare a summary report and presentation in the seminars/workshops.	• Specification preparation • Bidding preparation • Supervision of the survey
	Selection of the candidate of prioritized VOCs	Preparation of a summary report and explain to the stakeholders.	• Making report regarding selection of prioritized VOCs. • Listing up of prioritized VOCs.
	Outline of VOCs regulation	• Prepare the outline of VOCs regulation. • Prepare minutes of the meetings and discussion. • Announce the outline to the Public at the homepage of PCD and etc.	• Making guideline for the outline of VOCs regulation. • Assist to make the outline of VOCs regulation.
	Monitoring plan	• Prepare and collect necessary information for the plan. • Prepare minutes of the meetings and discussion	Assist to make monitoring plan.

	Items	Thai side	Japanese Expert Team
	Stationary monitoring with QA/QC	Conduct the monitoring.	Prepare technical guidance on monitoring.
	Detail emission inventory survey regarding prioritized VOCs	• Prepare minutes of the meetings and discussion • Prepare the summary of the result of the survey. • Announce the outline to the Public at the homepage of PCD etc.	• Specification preparation • Bidding preparation • Supervision of the survey
	Seminar/workshop	Presentation.	Presentation.
2007	Data book in terms of pollution status on VOCs	• Develop data book. • Prepare summary and presentation. • Announce the summary to the Public at the homepage of PCD and etc.	Developing guideline of data book.
	Selection of prioritized VOCs	• Prepare report • Presentation in the seminars	Develop guideline and reference material of selection of prioritized VOCs.
	Control technology of prioritized VOCs	Cooperate to prepare information note.	Prepare information note on relationship between VOCs and their sources.
	Selection of detail survey area in consideration of prioritized VOCs	• Prepare draft selection of the area. • Prepare record of selection process of the area.	Prepare draft selection of the area.
	Revision and announcement of draft outline of VOCs regulation	• Revision and announcement of draft outline of VOCs regulation. • Prepare minutes of the meetings and discussion • Public hearing. • Place in Homepage.	Prepare guideline for draft outline of VOCs regulation.
	Seminar/Workshop	Presentation.	Presentation.
	Monitoring in the detail survey area	• Prepare report • Carry out monitoring with adequate QA/QC	Prepare monitoring plan. Provide instruction record.

	Items	Thai side	Japanese Expert Team
	Emission inventory survey in the detail survey area	Prepare outline of study report. Prepare presentation on the technical report.	• Specification preparation • Bidding preparation • Supervision of the survey
	Metrological data in the detail survey area	Collection of data and information.	Provide instruction.
	Development of air diffusion modeling of VOCs in the detail survey area	• Operate modeling application software. • Prepare report.	Give technical guidance of modeling application software.
	Verification of the above model	• Prepare report on impact assessment in vicinity by VOCs diffusion modeling. • Verification of simulated data and monitored data. • Prepare report of risk evaluation of VOCs. • Place in Homepage.	• Prepare guideline of risk evaluation of VOCs. • Prepare instruction record.
	Control of reduction technology of VOCs	• Prepare a summary of reduction manual • Prepare presentation on a summary. • Place in Homepage .	• Prepare guideline for reduction manual. • Prepare instruction record.
	Draft environmental and emission standard	• Prepare standard proposing report. • Prepare supporting materials for proposal. • Public hearing for proposal. • Place in Homepage. • Prepare and publicizing reply documents for public hearing. • Prepare minutes of discussion on the operation process	Assist in preparing standard proposing report.
	Final seminar to sum up the project	Hold seminars and presentation	Participate in seminars and support Thai side.

(9) Management, monitoring and evaluation of the project

To realize optimal implementation of the project, each group will hold a weekly meeting. Monthly meeting is to be held for leaders of the groups to monitor

the result and progress of the project, and if a problem rises, the problem is to be discussed to find the necessary solution. This is important from the viewpoint of cooperation between PCD and the JICA Team. Monthly co-meeting must be held to check and verify the progress of the project.

On the other hand, both sides will evaluate the annual monitoring and its evaluation. JICA is to dispatch mid-term evaluation team and terminal evaluation team at the time of Joint Coordinating Committee meeting. The purpose of the mid-term evaluation is to evaluate the progress of the project and make necessary adjustment of the project according to the progress. The Terminal evaluation is performed for 5 criteria and extract lessons learned. The mid-term evaluation was performed in February, 2007 and terminal evaluation is a few months prior to the end of project in FY2007.

RECORD OF DISCUSSIONS BETWEEN JAPAN INTERNATIONAL COOPERATION AGENCY AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF KINGDOM OF THAILAND ON JAPANESE TECHNICAL COOPERATION FOR THE DEVELOPMENT OF ENVIRONMENTAL AND EMISSION STANDARDS OF VOCS

Based on the Minutes of Meeting signed on 24 June, 2005, between the Thai authorities concerned and the Preparatory Study Team organized by Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA Thailand Office had discussions with Thai authorities concerned to confirm the matters on desirable measures to be taken by JICA and Thai Government for the successful implementation of the Project for Development of Environmental and Emission Standards of VOCs (hereinafter referred to as "the Project").

As a result of the discussions, and in accordance with the provisions of the Agreement on Technical Cooperation between the Government of Japan and the Government of Thailand signed on November 5, 1981 (hereinafter referred to as "the Agreement") and the Embassy of Japan's Note No. 208/17 dated May 2, 2005 and the Ministry of Foreign Affairs of Thailand's Note No. 0210/12418 dated May 13, 2005, JICA and the Thai authorities concerned agreed the matters referred to in the document attached hereto.

Bangkok, November 30, 2005

Mr. Mikiharu Sato
Resident Representative,
Japan International Cooperation Agency
(JICA) Thailand Office

Mr. Apichai Chvajarernpun
Director General,
Pollution Control Department,
Ministry of Natural Resources and Environment

THE ATTACHED DOCUMENT

I. COOPERATION BETWEEN JICA AND GOVERNMENT OF THAILAND

1. The Government of Thailand will implement the Project in cooperation with JICA.
2. The Project will be implemented in accordance with the Master Plan which is given in Annex I. The tentative plan of operation is also shown in Annex II.

II. MEASURES TO BE TAKEN BY JICA

In accordance with the laws and regulations in force in Japan and the provisions of Article III of the Agreement, JICA as the executing agency for technical cooperation by the Government of Japan, will take, at its own expense, the following measures according to the normal procedures of its technical cooperation scheme.

1. DISPATCH OF JAPANESE EXPERTS

JICA will provide the services of the Japanese experts as listed in Annex III. The provisions of Article IV of the Agreement will be applied to the above-mentioned experts.

2. PROVISION OF MACHINERY AND EQUIPMENT

JICA will provide machinery, equipment and other materials necessary for the implementation of the Project as listed in Annex IV. The provision of Article VIII of the Agreement will be applied to the Equipment.

3. TRAINING OF COUNTERPART PERSONNEL IN JAPAN

JICA will receive Thai counterpart personnel connected with the Project for technical training in Japan as listed in Annex V. Both side confirmed that the official request for training in Japan will be submitted by PCD.

III. MEASURES TO BE TAKEN BY THE GOVERNMENT OF THAILAND

1. The Government of Thailand will take necessary measures to ensure that self-reliant operation of the Project will be sustained during and after the period of Japanese technical cooperation, through full and active involvement in the Project by all related authorities, beneficiary groups and institutions.

2. The Government of Thailand will ensure that the technologies and knowledge acquired by the Thai nationals as a result of Japanese technical cooperation will contribute to the economic and social development of the Kingdom of Thailand.
3. In accordance with the provisions of Article IV, V, VI of the Agreement, the Government of Thailand will grant in Thailand privileges, exemptions and benefits to the Japanese experts referred to in II-1 above and their families.
4. The Government of Thailand will take necessary measures to ensure that the knowledge and experience acquired by the Thai counterpart personnel from technical training in Japan will be utilized effectively in the implementation of the Project.
5. In accordance with the provisions of Article IV-(b) of the Agreement, the Government of Thailand will provide the services of Thai counterpart personnel and administrative personnel as listed in Annex VI.
6. In accordance with the provisions of Article IV-(a) of the Agreement, the Government of Thailand will provide the office space and facilities as listed in Annex VII.
7. In accordance with the laws and regulations in force in the Kingdom of Thailand, the Government of Thailand will take necessary measures to meet the running expenses necessary for the implementation of the Project.

IV. ADMINISTRATION OF THE PROJECT

1. Pollution Control Department (PCD) will take overall responsibility for the Project.
2. Director General of PCD as the Project Director will bear overall responsibility for the administration and implementation of the Project.
3. Deputy Director General of PCD as the Project Manager will be responsible for the managerial and technical matters of the Project.
4. The Japanese experts will give necessary technical guidance and advice to the Thai counterpart personnel on technical matters pertaining to the implementation of the Project.
5. Meetings will be held between the Thai side and Japanese side at least once a year for discussing following points.

   (1) To review the overall progress and achievements of the Project

   (2) To exchange views on major issues arising from or in connection with the Project

   (3) To work out the modification of activities depending on the necessity

6. PCD will nominate the counterparts of the Project for training in Japan and the counterparts trained in Japan should present the results to PCD.

V. DURATION OF COOPERATION

The duration of technical cooperation for the Project under this attached document will be twenty-four (24) months starting from the earlier date when the first Japanese expert arrive at the Kingdom of Thailand or the first Thai trainee leave Thailand.

VI. JOINT EVALUATION

Evaluation of the Project will be conducted jointly by JICA and the Thai authorities concerned, in the last three months of the Project in order to examine the level of achievement.

VII. MUTUAL CONSULTATION

There will be mutual consultation between JICA and the Thai authorities concerned on major issues arising from, or in connection with this attached document.

VIII. MEASURES TO PROMOTE UNDERSTANDING AND SUPPORT FOR THE PROJECT

For the purpose of promoting support for the Project among the people of the Kingdom of Thailand, PCD will take appropriate measures to make the Project widely known to the people of the Kingdom of Thailand.

LIST OF ANNEX

ANNEX I MASTER PLAN

Project title: The Development of Environmental and Emission Standards of VOCs

1. Overall goal

Concrete actions on air pollution by VOCs will be taken

<Indicators>

- Development of environmental and emission standards of VOCs

2. Project purpose

MONRE's capacity to take countermeasures against VOCs air pollution including development of environmental and emission standards in Thailand is enhanced.

<Indicators>

- Priority compounds of VOCs to be monitored and controlled in Thailand are recognized in MONRE
- PCD has a technical capability to conduct routine monitoring of the prioritized VOCs
- Awareness of VOCs is enhanced through PCD activities
- PCD can propose environmental and emission standards of VOCs to the Pollution Control Committee

3. Project outputs

(1) Elucidation of the VOCs air contamination status for setting up environmental and emission standards in Thailand

(2) Proposal of environmental and emission standards of VOCs to the Pollution Control Committee

4. Project Activities

4.1 Activities under Output 1

(1) Joint planning of investigation of VOCs contamination with ERTC

(2) Workshop to share information on VOCs related activities in Thailand

(2) Review of existing emission inventory and monitoring data

(3) Development of VOCs emission inventory

(4) Conducting background monitoring

(5) Investigation of contamination status of VOCs

(6) Preparation of modeling including collection of necessary data

(7) Listing up the prioritized VOCs
(8) Conducting stationary source monitoring
(9) Drafting of contamination status report on VOCs in coordination with ERTC
(10) Organizing seminar(s) for disseminating the result of the investigation

4.2 Activities under Output 2
(1) In-depth monitoring of the prioritized VOCs (ambient, stationary and mobile)
(2) Development of VOCs emission inventory for the prioritized VOCs
(3) Simulation modeling for the prioritized VOCs
(4) Finalizing the target parameters of VOCs for setting up environmental and emission standards
(5) Collection of information on health risk and control technology
(6) Setting up proposed numerical targets of environmental and emission standards

Note:
MONRE: Ministry of Natural Resources and Environment
ERTC: Environmental Research and Training Center

ANNEX II TENTATIVE PLAN OF OPERATION

This Tentative Plan of Operation (hereinafter referred to as "P/O") has been formulated for the purpose of realizing the detailed schedule of the activities in the Master plan. The P/O will be reviewed annually by the meeting with Thai and JICA side.

Purpose	Expected Outputs	Activities	Schedule			Duration of Activities(Month)
			1st year	2nd year	3rd year	
MONRE's capacity to take countermeasures against VOCs air pollution including development of environmental and emission standards in Thailand is enhanced.	1. Elucidation of the VOCs air contamination status for setting up environmental and emission standards in Thailand	(1) Joint planning of investigation of VOCs contamination with ERTC				1
		(2) Review of existing data,				12
		(3) Development of VOCs emission inventory				12
		(4) Conducting background monitoring				9
		(5) Investigation of contamination status of VOCs				9
		(6) Preparation of modeling including collection of necessary data				6
		(7) Listing up the prioritized VOCs				3
		(8) Conducting stationary source monitoring				6
		(9) Drafting of contamination status report on VOCs in coordination with ERTC				3
		(10) Organizing seminar(s) for disseminating the result of the investigation				1
	2. Proposal of environmental and emission standards of VOCs to the Pollution Control Committee	(1) In-depth monitoring of the prioritized VOCs (ambient, stationary and mobile)				6
		(2) Development of VOCs emission inventory for the prioritized VOCs				12
		(3) Simulation modeling for the prioritized VOCs				6
		(4) Finalizing the target parameters of VOCs for setting up environmental and emission standards				6
		(5) Collection of information on health risk and control technology				6
		(6) Setting up proposed numerical targets of environmental and emission standards				3

Technical assistance from Japanese experts to these activities will be implemented as given in Annex III.

ANNEX III TENTATIVE TERMS OF REFERENCES OF JAPANESE EXPERT

1. List of Japanese Expert

The short-term experts who will fulfill the following specialties will be dispatched.

(1) Chief advisor/Policy formulation for Development of Environmental and Emission Standards of VOCs

a) Qualifications

- Age : More than 40 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 8 years of working experience in VOCs monitoring
- Project management and coordination skills
- Chemical material management regulations/policy skill

b) Job description

- To take responsibility for the activities on JICA expert team
- To support the development of VOCs standards with MONRE
- To suggest the report of Project once a six months
- To prepare data and information for the evaluations
- To manage the activities of other JICA Expert
- To manage the schedule of the Project

(2) Monitoring (Sampling and Analysis) for VOCs

a) Qualifications

- Age : More than 30 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 5 years of working experience in VOCs monitoring (Sampling and Analysis)
- VOCs analysis skill using for Canister method and HPLC

b) Job description

- To establish monitoring plan in collaboration with C/P
- To provide technical assistance for sampling and analysis of VOCs
- To assistance for Quality Control /Quality Assurance of VOCs analysis

(3) Emission inventory study

a) Qualifications

- Age : More than 30 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 5 years of working experience in emission inventory
- Study skill for chemical material inventory

b) Job description

- To review existing emission inventory and monitoring data
- To develop VOCs emission inventory

(4) Modeling

a) Qualifications

- Age : More than 30 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 5 years of working experience in modeling
- Modeling skill

b) Job description

- To prepare modeling including collection of necessary data
- To simulate a modeling for ambient VOCs

(5) Health risk

a) Qualifications

- Age : More than 30 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 5 years of working experience in Health risk evaluation on chemical material

b) Job description

- To support collection of data and information on health risk
- To evaluate health risk on ambient VOCs

(6) Control technology for VOCs

a) Qualifications

- Age : More than 30 and up to 65 years
- Academic degree : Bachelor Degree or above
- Experience : At least 5 years of working experience in Control technology for ambient VOCs

b) Job description

- To support collection of data and information on control technology for ambient VOCs
- To summarize control technology

Other fields of short-term experts unspecified in the list will be determined through the discussion between both sides whenever the necessity arises.

ANNEX IV LIST OF EQUIPMENT

The following equipment is scheduled to be provided to Thailand during the project period, subject to the limitation of budget allocation.

- Spare parts for pre-concentrator (1 set)
- Split/Splitless injector (Accessary of Gaschromatograph mass spectrometer (GC/MS)) (1 set)
- Standard gas/Internal standard gas for using VOCs analysis (1 set)
- Other equipment which are mutually agreed upon as necessary

Note:

(1) The above-mentioned equipment is limited to that necessary for the transfer of technology by the Japanese expert.

(2) Content and specifications of the above-mentioned equipment will be decided through mutual consultations within the allocated budget of Japanese fiscal year.

ANNEX V COUNTERPART TRAINING

The training of counterpart personnel in Japan will be conducted for enhancing the capability covering following points, subject to the limitation of budget allocation.

- Policy formulation (Management of VOCs)
- Emission inventory study
- Modeling
- Health risk
- Control technology

Note:

Contents and term of the above-mentioned counterpart training will be decided through mutual consultations within the allocated budget of Japanese fiscal year.

ANNEX VI LIST OF THE THAI COUNTERPART AND ADMINISTRATIVE PERSONNEL

1. Project administrative management counterpart

(1) Project Director

Mr. Apichai Chvajarernpun	Director General, PCD

(2) Project Manager

Dr. Supat Wangwongwatana	Deputy Director General, PCD

2. Technical Counterpart

Air Quality and Noise Management Bureau, PCD

(1) Ms. Mingquan Wichayarangsaridh	Director
(2) Mr. Seksan Sangdao	Director, Ambient Air Quality Division
(3) Dr. Sarawut Thepanondh	Environmental officer, Ambient Air Quality Division
(4) Ms. Waroonphan Jaruphan	Environmental officer, Ambient Air Quality Division
(5) Mr. Ittipol Paw-armart	Environmental officer, Automobile Air Pollution Division
(6) Ms. Manwipa Kuson	Environmental officer, Automobile Air Pollution Division
(7) Ms. Thitirat Pentakulchai	Environmental officer, Automobile Air Pollution Division
(8) Ms. Pilai Thiandat	Environmental officer, Industrial Air Pollution Division
(9) Dr. Jariya Sukhapan	Environmental officer, Industrial Air Pollution Division
(10) Mr. Jirapat Theamjun	Environmental officer, Industrial Air Pollution Division
(11) Dr. Pornsri Suthanaruk	Head, Environmental Quality and Laboratory Section
(12) Ms. Jarinporn Tippamongkol	Environmental Officer, Environmental Quality and Laboratory Section
(13) Ms. Amornphat Tadsanaprasititpol	Environmental Officer, Environmental Quality and Laboratory Section

(Contact persons)

(1) Dr. Sarawut Thepanondh	Environmental officer, Ambient Air Quality Division
(2) Ms. Waroonphan Jaruphan	Environmental officer, Ambient Air Quality Division

3. Other personnel will be assigned if necessary

ANNEX VII LIST OF BUILDINGS AND FACILITIES

1. Buildings and Facilities necessary for the implementation of the Project
2. Office space and necessary facilities in the buildings of the Project for JICA experts and meetings
3. Facilities and services such as electricity, gas, water, telephone, internet access and furniture necessary for the Project activities
4. Other facilities mutually agreed upon as necessary

Minutes of Meeting
Between JICA Expert Team
and
Pollution Control Department
of Ministry of Natural Resources and Environment
of the Government of the Kingdom of Thailand
on Technical cooperation Project
for the Development of Environmental
and Emission Standards of VOCs.

The Japanese Expert Team (hereinafter referred to as "the Team") organized by the Japan International Cooperation Agency had a final meeting with Pollution Control Department of the Government of Kingdom of Thailand (hereinafter referred to as "Thai side") on technical cooperation for the development of Environmental Standards of VOCs (hereinafter referred to as "the Project").

As a result of discussion, the Team and Thai side came to the understanding concerning the matter referred to in the document hereto.

Bangkok, February 27, 2008

Mr. Masato Ohno
Chief Adviser
JICA Expert Team

Dr. Supat Wangwongwatana
Director General
Pollution Control Department
Ministry of Natural Resource and Environment

The Attached Document

1. The Team explained the draft Final Report and also presented the major outputs to be submitted to Thai side. The comments from Thai side will be reflected if the comments are submitted one day before the Team leaves Thailand.

2. Thai side presented activities and lessens learned from the project as well as their future plans. All presentations are attached.

3. The Team expressed appreciations to Thai side for the enthusiastic work done by Pollution Control Department (PCD) staffs to bring the project to a success. Also, PCD staffs' efforts for data collection, analysis, and scientific approach taken in the process were noted.

4. Thai side noted the mutual cooperation between PCD and ERTC were realized through the implementation of the project. It was also noted that Thai side believes that the project brought many outputs that can be utilized immediately, and expressed the hopes to share the information and experiences with neighboring countries.

Appendix: list of participants:

Presentation files from Thai side

Appendix:

List of Participants:

No.	Name	Organization
1	Dr.Supat Wangwangwatana	Director General /PCD
2	Mr.Ogawa	JICA
3	Ms.Kinoshita	JICA
4	Ms.Waraporn	JICA
5	Ms.Wanna Laowagul	ERTC
6	Dr.Pornsri Suthanarak	PCD
7	Ms.Amornphat Tadsanaprasittipol	PCD
8	Ms.Manwipa Kuson	PCD
9	Mr.Panya Warapetcharayut	PCD
10	Ms.Waroonphan Jaruphan	PCD
11	Mr.Phansuk Theramongkol	PCD
12	Mr.Munehiro Fukuda	JICA
13	Mr.Masoto Ohno	JICA
14	Mr.Shin Okamoto	JICA
15	Dr.Wijarn Simachaya	PCD
16	Ittipol Paw-armart	PCD
17	Ms.Hathairatana Garivait	ERTC
18	Ms.Jariya Sukhapan	PCD
19	Ms.Thitima Thititumsatean	PCD
20	Ms.Patcharawadee Suwanathada	PCD
21	Ms.Jiraporn Jittamanonkul	JICA