

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

Project Document

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## 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
NO <sub>x</sub>	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
SO <sub>x</sub>	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

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.

## Chapter 2 Background of the project

### 2.1 Socio-economic conditions of Thailand

#### 2.1.1 Economic conditions

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
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

#### 2.1.2 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 live 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 particulate matters (TSP and PM10 and ground-level ozone (O<sub>3</sub>)). 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<sub>2</sub>, NO<sub>2</sub> and carbon dioxide (CO<sub>2</sub>) emissions. In non-urban areas, sources such as agricultural burning also contribute significantly to particulate pollution.

Pollution Control Department (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, SO<sub>2</sub>, 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 motorcycles are still remained (although the numbers of four-stroke motorcycles are increasing). In industrial sector, many small and medium sized enterprises 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. 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.

## **(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

### 2.3.1 National economic social development plan<sup>1</sup>

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 9<sup>th</sup> 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.

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<sup>1</sup> References: web site of Ministry of Foreign Affairs, Outline of Economy in Thailand (2002/2003, Bangkok Japanese Chambers of Commerce)

## 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

### 2.3.2 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 transferred 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 SO <sub>x</sub> , NO <sub>x</sub> and VOCs from industrial emission.

	Title	Year implemented	Donor	Thai organization	Content
JAPAN	Capacity building on environmental research	2005-2008	JICA	ERTC	<p>Related to this project and good coordination is essential. Project components are the following three elements.</p> <ul style="list-style-type: none"> <li>● Development of adequate air monitoring technology for VOCs</li> <li>● Understanding the situation of current VOCs pollution</li> <li>● Enhance research capacity on VOCs air pollution and health risk analysis.</li> </ul>
	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	<p>Preparing the strategy for mitigation of acid deposition including ambient air pollution. The components are the following three elements.</p> <ul style="list-style-type: none"> <li>● Review of Monitoring result</li> <li>● Develop inventory for “stationary source”, “Mobile source”</li> <li>● Simulation analysis “Acid deposition (Long Range model)” and “Ambient Air (Airviro)”</li> </ul>
	Third country training course on Emission Inventory and Modeling for Acid Deposition Assessment	2002-2006	JICA	DEQP & PCD	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 Resources and Environment

Function	Authorities
Policy / Management	<ul style="list-style-type: none"><li>• Administrative Vice-Minister Office</li><li>• Office of Natural Resources and Environmental Policy and Planning (ONEP)</li></ul>
Environmental Management	<ul style="list-style-type: none"><li>• Pollution Control Department (PCD)</li><li>• Department of Environment Quality Promotion (DEQP)</li></ul>
Natural Resource Management	<ul style="list-style-type: none"><li>• National Park, Wild Life and Plant Conservation Department</li><li>• Department of Mineral Resources</li><li>• Department of Marine and Coastal Resources</li></ul>
Water Resource Management	<ul style="list-style-type: none"><li>• Water Resource Department</li><li>• Ground Water Resource Department</li></ul>

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

### 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, 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 five stations around Bangkok with special attention on mobile sources. Though, there is few data that systematically assures its quality. Concentrations 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. (Installation 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 is 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. An example of emission standards defined by a sector law is the one established by Minister of Industry based upon the Industry Law.

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”. In order 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.

The interactive approach for clear definition of capacity development target and

goal setting is presented in Table 4.1.

**(4) Monitoring support**

**(5) 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.

**(6) Implementation policy on inventory study**

Inventory study provides basic data for understanding of the types of sources (stationary, mobile and area) that are responsible for VOCs emissions. Content of the inventory is as shown in Table 4.2.

Table 4.1 Inter active approach for technical cooperation

<b>Thai Side</b>	<b>Discussion</b>	<b>Expert team</b>
I. Prepare for plan on problem solving	←□ <b>Discussion on problem and approach on problem solving</b>	I. Advise on the specific problem and preparation on plan for problem solving
II. Submission of operation plan	←□→ <b>Discussion on plan</b>	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)	←□→ <b>Discussion on draft</b>	VI. Comment on draft and advise for improvement
VII. Report final draft	←□→ <b>Discussion on final draft</b>	VII. Comment of final draft and advise for improvement
VIII. Finalized the result	←□→ <b>Interactive evaluation</b>	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:

**a. Basic policy for development of VOCs monitoring plan**

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).

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	Screening prospective prioritized VOCs	About 40 components, with a focus on VOCs and aldehydes, listed on US EPA TO-14	Nationwide	<ul style="list-style-type: none"> <li>➤ Derive VOC usage by components from existing production and import/export statistics</li> </ul>	<ul style="list-style-type: none"> <li>➤ Brief inventory of VOCs</li> <li>➤ Prospective prioritized VOCs (approx. 20 components)</li> </ul>	The first year (2006)
2	Detailed inventory survey of prospective prioritized VOCs	Screening of prioritized VOCs	Prospective prioritized VOCs derived from brief inventory survey (approx. 20 components)	Nationwide	<ul style="list-style-type: none"> <li>➤ Estimate products or sources consumed, expected to release VOCs, from existing data.</li> <li>➤ Estimate average contents and release rate of VOC components by products.</li> <li>➤ Calculate amount of VOC released by products and sources and established detailed inventory</li> </ul>	<ul style="list-style-type: none"> <li>➤ Detailed inventory (by products / sources)</li> <li>➤ Prioritized VOCs (prospective regulated VOCs, approx. 5 components)</li> </ul>	The first year (2006)
3	Inventory survey of prioritized VOCs in the specific region		Prospective prioritized VOCs Prospective regulated VOCs (approx. 5 components) derived from detailed inventory survey	Specific area	<ul style="list-style-type: none"> <li>➤ “Door to door” survey in the specific area</li> </ul>	<ul style="list-style-type: none"> <li>➤ List up of prospective regulated offices</li> <li>➤ Inventory of prioritized VOCs in the specific region</li> </ul>	The second year (2007)

**(7) 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 characteristic, 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 outlines' 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. Development of draft environmental standards**

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) 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.'

**(8) Approach for selecting the priority VOCs.**

Selecting priority VOCs needs a broad view. Measures for VOCs have 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 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 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.

#### **(9) 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.	Estimate concentration of air pollutants released from the point source (Plume/Puff Model)

Type of Model	ADMER	METI-LIS
	Spatial resolution beyond the scope of 5×5km and monthly average exposure evaluation at 6 different time slots.	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.

#### (10) 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.

#### (11) 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 planned. 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 SO<sub>x</sub>, NO<sub>x</sub>, 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

4.2.1 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 manager 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.

#### 4.2.2 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 this 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.

## Chapter 5 Basic plan of the project

Basic framework of the project was made up and mentioned in the annex<sup>2</sup> 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

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<sup>2</sup> 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 VOCs countermeasure technology by industries
5	VOCs air diffusion monitoring	VOCs air diffusion monitoring VOCs countermeasure technology by industries
6	Health risk evaluation	Health Risk Evaluation
7	VOCs countermeasure technology by industries	Inventory survey VOCs countermeasure technology by industries

**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	By March 2006
2	STD gas	1	Ditto
3	Split / split less injector	1	By March 2006

4	ISTD gas	1	Ditto
5	6L canister	10	After May 2006
6	Flow regulated sampler 3hrs	1	Ditto
7	Flow regulated sampler 24hrs	1	Ditto
8	Sampling bag	10	Ditto
9	Sampling bag (tedlar bag)	10	Ditto

#### **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 30th, 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

#### 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) 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	<ul style="list-style-type: none"> <li>• Make review report of existing monitoring data.</li> <li>• Presentation of this report.</li> </ul>	
	Technology transfer of OA/QC in VOCs analysis	<ul style="list-style-type: none"> <li>• Pass the tests for QA/QC developed by the project team.</li> </ul>	Prepare QA/QC test.
		<ul style="list-style-type: none"> <li>• Senior staff gives technical guidance to other staffs.</li> <li>• The laboratory staffs can carry out QA/QC of VOCs analysis.</li> </ul>	Train senior staff.
	Emission inventory survey	<ul style="list-style-type: none"> <li>• Participation on preparing the specification.</li> <li>• Prepare a summary report and presentation in the seminars/workshops.</li> </ul>	<ul style="list-style-type: none"> <li>• Specification preparation</li> <li>• Bidding preparation</li> <li>• Supervision of the survey</li> </ul>
	Selection of the candidate of prioritized VOCs	Preparation of a summary report and explain to the stakeholders.	<ul style="list-style-type: none"> <li>• Making report regarding selection of prioritized VOCs.</li> <li>• Listing up of prioritized VOCs.</li> </ul>
	Outline of VOCs regulation	<ul style="list-style-type: none"> <li>• Prepare the outline of VOCs regulation.</li> <li>• Prepare minutes of the meetings and discussion.</li> <li>• Announce the outline to the Public at the homepage of PCD and etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Making guideline for the outline of VOCs regulation.</li> <li>• Assist to make the outline of VOCs regulation.</li> </ul>
	Monitoring plan	<ul style="list-style-type: none"> <li>• Prepare and collect necessary information for the plan.</li> <li>• Prepare minutes of the meetings and discussion</li> </ul>	Assist to make monitoring plan.
	Stationary monitoring with QA/QC	Conduct the monitoring.	Prepare technical guidance on monitoring.

	Items	Thai side	Japanese expert team
	Detail emission inventory survey regarding prioritized VOCs	<ul style="list-style-type: none"> <li>• Prepare minutes of the meetings and discussion</li> <li>• Prepare the summary of the result of the survey.</li> <li>• Announce the outline to the Public at the homepage of PCD etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Specification preparation</li> <li>• Bidding preparation</li> <li>• Supervision of the survey</li> </ul>
	Seminar/workshop	Presentation.	Presentation.
2007	Data book in terms of pollution status on VOCs	<ul style="list-style-type: none"> <li>• Develop data book.</li> <li>• Prepare summary and presentation.</li> <li>• Announce the summary to the Public at the homepage of PCD and etc.</li> </ul>	Developing guideline of data book.
	Selection of prioritized VOCs	<ul style="list-style-type: none"> <li>• Prepare report</li> <li>• Presentation in the seminars</li> </ul>	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	<ul style="list-style-type: none"> <li>• Prepare draft selection of the area.</li> <li>• Prepare record of selection process of the area.</li> </ul>	Prepare draft selection of the area.
	Revision and announcement of draft outline of VOCs regulation	<ul style="list-style-type: none"> <li>• Revision and announcement of draft outline of VOCs regulation.</li> <li>• Prepare minutes of the meetings and discussion</li> <li>• Public hearing.</li> <li>• Place in Homepage.</li> </ul>	Prepare guideline for draft outline of VOCs regulation.
	Seminar/workshop	Presentation.	Presentation.
	Monitoring in the detail survey area	<ul style="list-style-type: none"> <li>• Prepare report</li> <li>• Carry out monitoring with adequate QA/QC</li> </ul>	Prepare monitoring plan. Provide instruction record.
	Emission inventory survey in the detail survey area	Prepare outline of study report. Prepare presentation on the technical report.	<ul style="list-style-type: none"> <li>• Specification preparation</li> <li>• Bidding preparation</li> <li>• Supervision of the survey</li> </ul>
	Metrological data in the detail survey area	Collection of data and information.	Provide instruction.

	Items	Thai side	Japanese expert team
	Development of air diffusion modeling of VOCs in the detail survey area	<ul style="list-style-type: none"> <li>Operate modeling application software.</li> <li>Prepare report.</li> </ul>	Give technical guidance of modeling application software.
	Verification of the above model	<ul style="list-style-type: none"> <li>Prepare report on impact assessment in vicinity by VOCs diffusion modeling.</li> <li>Verification of simulated data and monitored data.</li> <li>Prepare report of risk evaluation of VOCs.</li> <li>Place in Homepage.</li> </ul>	<ul style="list-style-type: none"> <li>Prepare guideline of risk evaluation of VOCs.</li> <li>Prepare instruction record.</li> </ul>
	Control of reduction technology of VOCs	<ul style="list-style-type: none"> <li>Prepare a summary of reduction manual</li> <li>Prepare presentation on a summary.</li> <li>Place in Homepage.</li> </ul>	<ul style="list-style-type: none"> <li>Prepare guideline for reduction manual.</li> <li>Prepare instruction record.</li> </ul>
	Draft environmental and emission standard	<ul style="list-style-type: none"> <li>Prepare standard proposing report.</li> <li>Prepare supporting materials for proposal.</li> <li>Public hearing for proposal.</li> <li>Place in Homepage.</li> <li>Prepare and publicizing reply documents for public hearing.</li> <li>Prepare minutes of discussion on the operation process</li> </ul>	Assist in preparing standard proposing report.
	Final seminar to sum up the project	Hold seminars and presentation	Participate in seminars and support Thai side.

**(8) 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 extracts lessons learned. The mid-term evaluation is to be performed in FY2006 and terminal evaluation is a few months prior to the end of project in FY2007.