JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF INDUSTRIAL WORKS, MINISTRY OF INDUSTRY
THE KINGDOM OF THAILAND

STUDY ON PREVENTION AND CONTROL OF OFFENSIVE ODORS FROM SMALL AND MEDIUM SCALE FACTORIES IN THE KINGDOM OF THAILAND

FINAL REPORT
SUMMARY

JANUARY 1994

ENVIRONMENTAL TECHNOLOGIC CONSULTANT CO., LTD.

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Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on the Prevention and Control of Offensive Odors from the Small and Medium Scale Factories in the Kingdom of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Thailand a study team headed by Mr. Satoshi Makiyama of Environmental Technologic Consultant Co., Ltd., three times between October 1992 to September 1993.

The team held discussions with the officials concerned of the Thai Government, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the report was prepared.

I do hope that this report will contribute to the promotion of the program and enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Thai Government for their close cooperation extended to the team.

January 1994

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

January 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Kensuke Yanagiya,

Letter of Transmittal

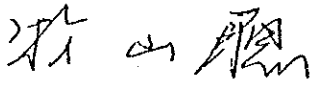
We are pleased to submit you the final report of the Study on Prevention and Control of Offensive Odors from Small and Medium Scale Factories in the Kingdom of Thailand.

The study was conducted by Environmental Technologic Consultant Co., Ltd., under a contract to JICA, during the period from October 1992 to January 1994. We have conducted the field study three times to hold discussions with the officials concerned of Thai Government and to carry out field survey adding odor measurement at selected small and medium factories with their close cooperations. Based on the results, this report was prepared to formulate a master plan for prevention and control of offensive odors from small and medium factories in the Kingdom of Thailand and to recommend the deodorization measures for the selected factories.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, the Ministry of International Trade and Industry. We would also like to express our deep gratitude to the officials concerned of the Ministry of Industry and other agencies, the Embassy of Japan in Thailand, the JICA Thailand Office and the selected factories for the close cooperations and assistance extended to us throughout our field study.

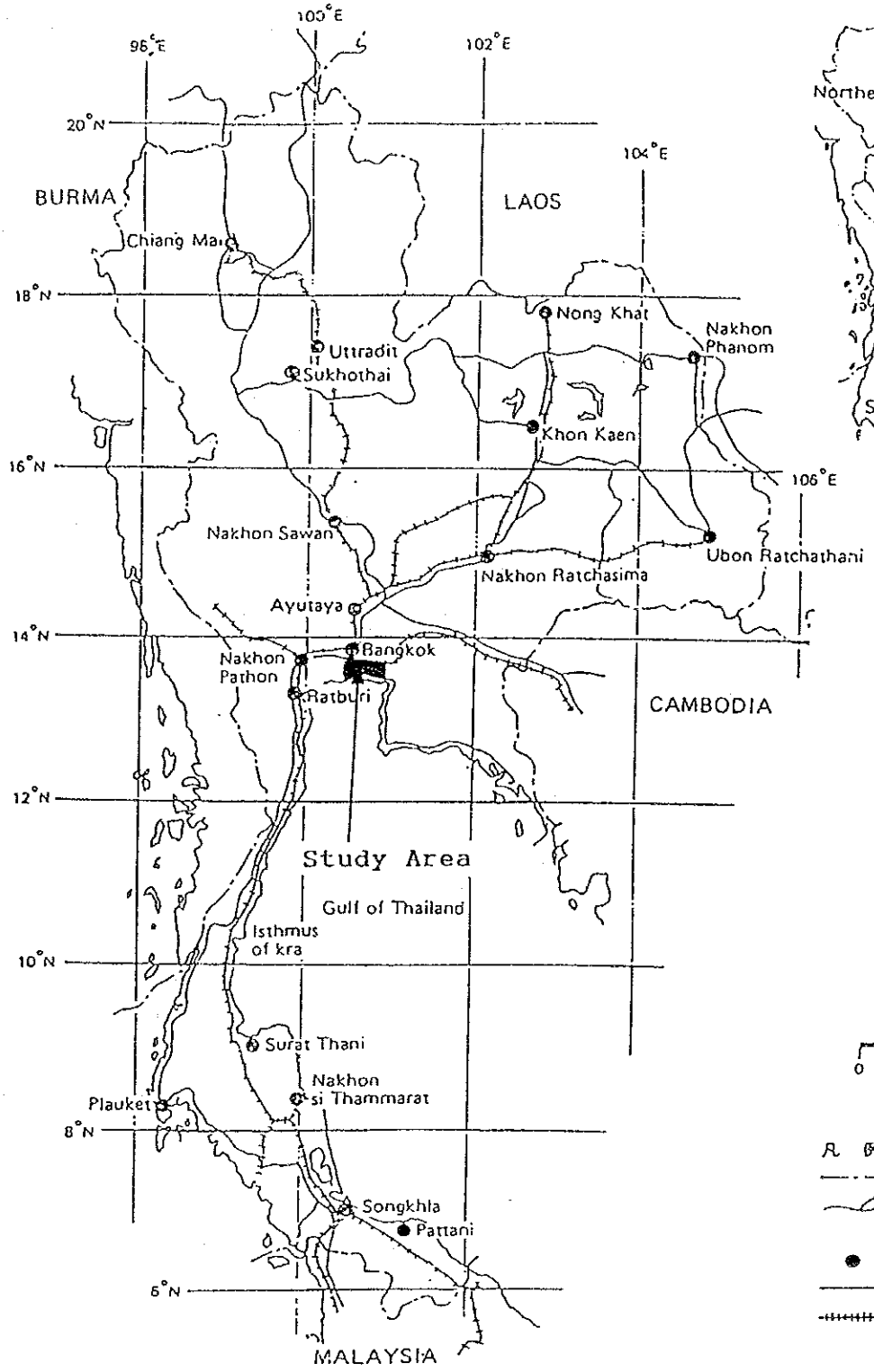
Finally, we hope that this report will contribute to the improvement for prevention and control of offensive odors in the Kingdom of Thailand.

Very truly yours,

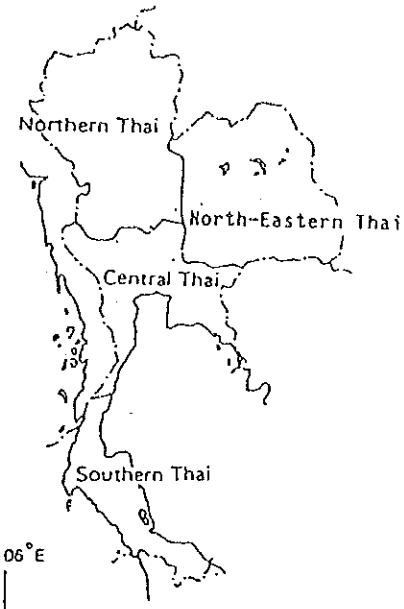


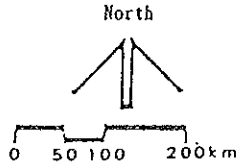
Satoshi Makiyama
Team Leader
The Study on Prevention and Control
of Offensive Odors from the Small
and Medium Scale Factories in the
Kingdom of Thailand

Map of Thailand



Regional Division





凡例

national boundary

river

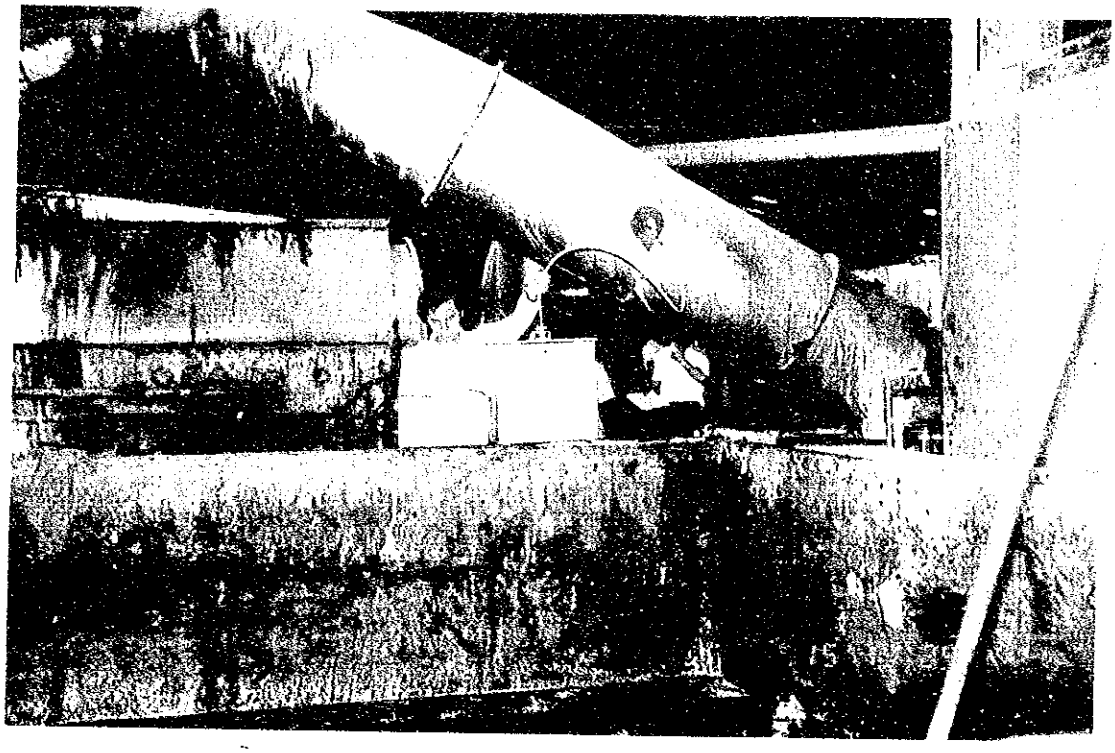
major city

major road

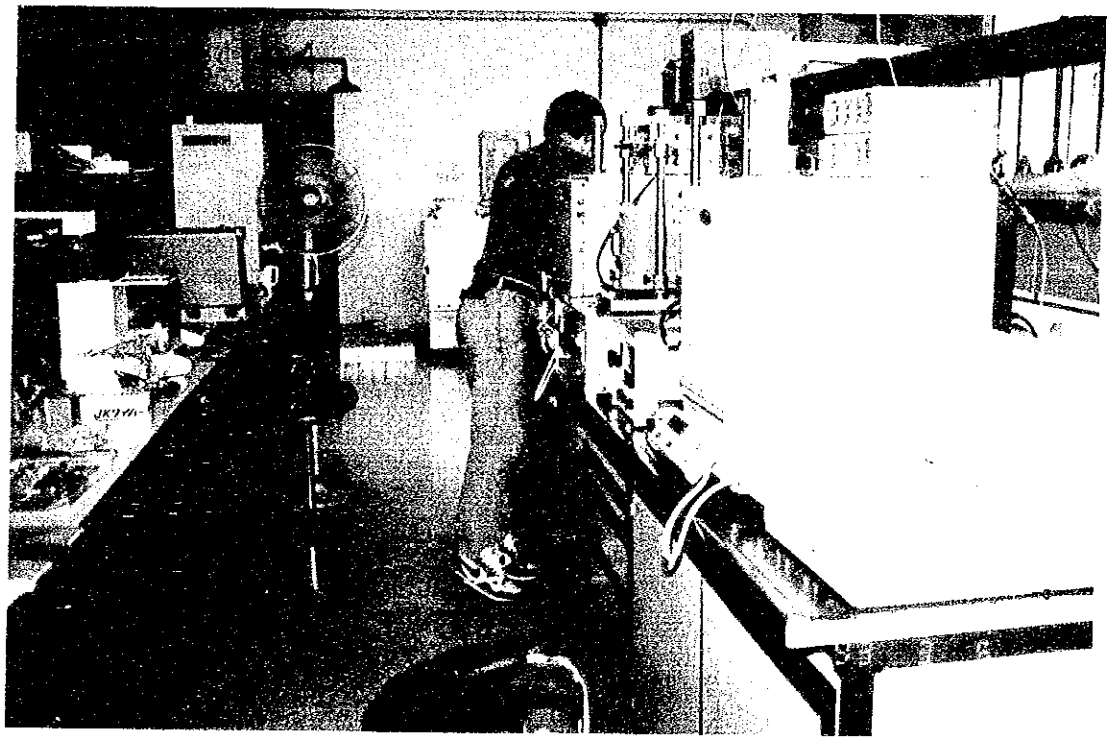
railway

Offensive Odor Sampling on Boundary Line

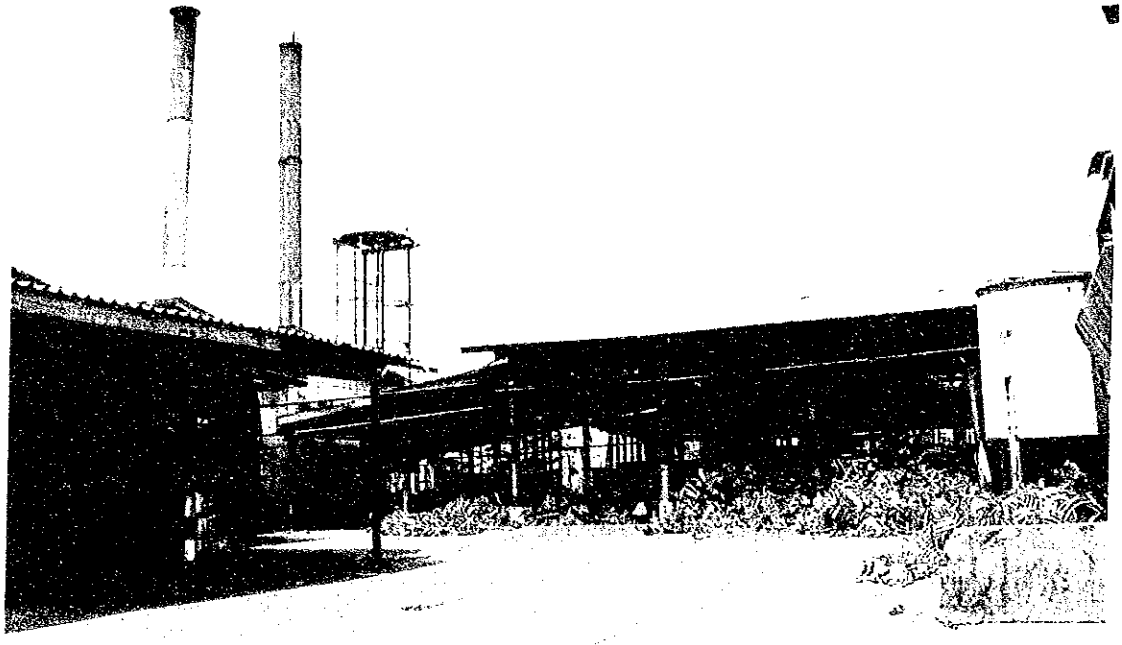
Panel Test of Odor Sensory Test in DIW



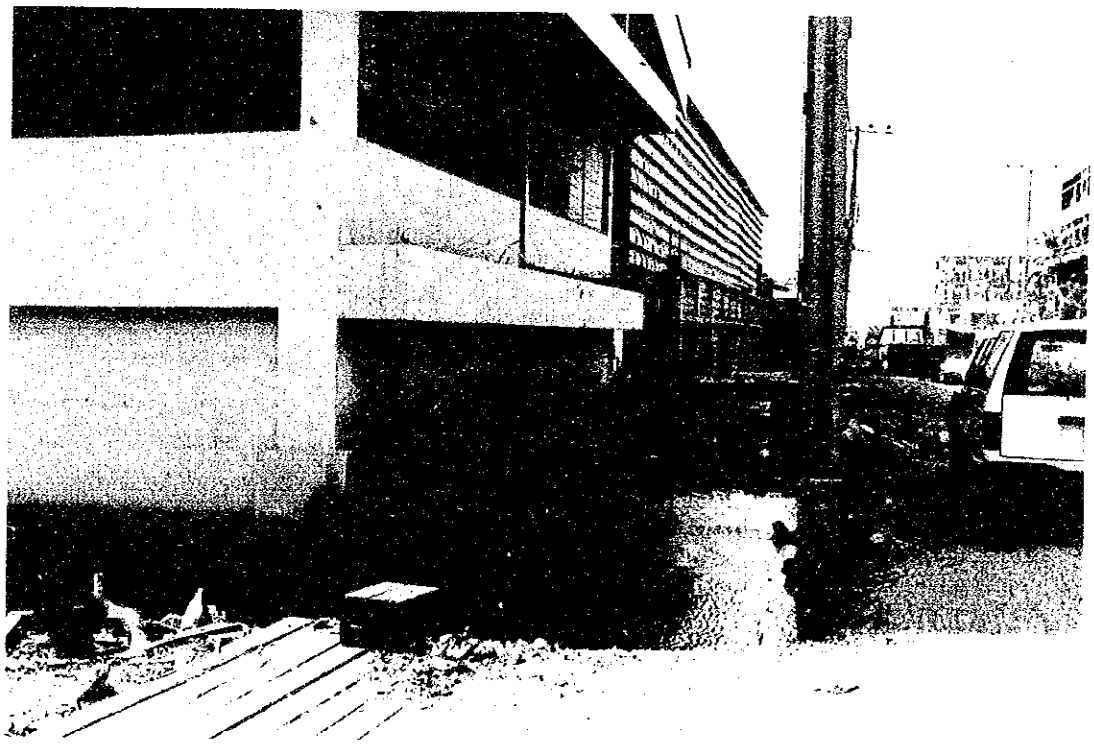
Offensive Odor Gas Sampling in Fish Meal Plant



Gas Chromatograph Analysis of Offensive Odors



Platform in Bone Meal Plant



Wastewater Canal of Tanneries

Table of Contents

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

In the Kingdom of Thailand, the environmental pollution such as water pollution, air pollution, noise has become serious problems due to the expands of urbanization and industrialization recently. Therefore, establishment of the measures against environmental pollution are urgently required especially around Bangkok.

Offensive odors from small and medium scale factories such as fish meal plant, bone meal plant, tannery and automobile painting factory is also one of above-mentioned environmental pollutions. The Government of Thailand is strongly requested to cope with such problem as the public complaints are increasing about offensive odors around the factories. However, the government was worried about insufficient information for establishing the measures such as odor emission standards and odor measurement method.

Accordingly, the Government of Thailand requested the Government of Japan to conduct the development study on offensive odor problems to establish the emission standards, to introduce technology transfer of odor measurement methods and to develop the deodorization measures.

In response to the request, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, dispatched the Project Identification Team in September 1990 and the Project Formation Team in May 1991, and the Preparatory Study Team signed the Scope of Work on the implementation of the study with the Ministry of Industry on July 2, 1992.

The Study on Prevention and Control of Offensive Odors from Small and Medium Scale Factories in the Kingdom of Thailand was performed on the background of above-mentioned processes from October 1992 to January 1994.

1.2 Objectives of the Study

The objectives of the Study are to examine the present state of offensive odors and the measures, to formulate a master plan for prevention and control of offensive odors, to recommend the deodorization measures of selected factories and to realize a technology transfer of odor measurement in the process of field survey.

1.3 Selected factories

In order to achieve the objectives, eight factories were selected from four industrial categories requested by Thai side to conduct the field survey and measurement of offensive odors as follows.

1) Fish meal
   a. Niwat Fish Meal [Samut Sakhon]
   b. Samutprakan Fish Meal [Samut Prakan]
2) Bone meal (rendering)
   a. Sungserm Bone Meal (Thaprautsahagen) [Samut Sakhon]
   b. Thai Bones Industry [Pathum Thani]
3) Tannery
   a. Lotus Leather and Trading (Kwang Ha Huad) [Samut Prakan]
   b. Q.C. Tannery [Samut Prakan]
4) Automobile painting
   a. Narong Rungrueng [Pravet, Bangkok]
   b. Tavon Garage [Nontaburi]

The factory survey was carried out also in the central tanning wastewater treatment plant as well as selected factories.

1.4 Terms of the Study

The study team consists of eight members headed by Satoshi Makiyama and performed the field study in Thailand three times as follows.

1) First Field Study
   October 26, 1992 ~ November 24, 1992
2) Second Field Study
   February 21, 1993 ~ March 3, 1993
3) Third Field Study
   August 29, 1993 ~ September 27, 1992

CHAPTER 2 MACRO-ECONOMICAL OVERVIEW

2.1 Economic Development

The Kingdom of Thailand is the constitutional monarchy country located in the middle of the Indochinese Peninsula with a total area of 513,115 km^2 and a total national population of 56,300,000 as of 1990.

Thai economy, used to be based on agriculture for long, has expanded consistently since World War II by remolding its industrial structure holding good economical balance so as to be abundant in variety and high in level. It showed stable growth with rates exceeding 10 % for three years since 1988 particularly. As a result, its GDP in 1990 attained 36,032 Bahts (approximately $1,440) per head. Thus, Thailand is expected to be the fifth NIES country after Singapore, Hongkong, Taiwan and Korea.

2.2 Trends in Each Industry

(1) Agriculture, forestry and fishery

Although the position of agriculture, forestry and fishery industries is declining year by year, the industries have still an important weight accounting for 61.6 % of employments in the share of all industries. In terms of product amounts (nominal GDP), the industry account for only 12.4 % in 1990 and the exports of the agricultural products including forestry and fishery amount to 154 billion Bahts accounting for 21.3 % of total export products in 1991. However, when added with the agricultural products such as canned products, the primary industry accounts for over 30 % in the total exports. Thus, agricultural, forestry and fishery products still constitute an important source of earning foreign currencies in the country.

The Government of Thailand, taking promotion of agro-industry, intends to strengthen and grow it further more strategically, considering that agricultural products and related products are an essential export commodity.

Livestock industry is growing, particularly in poultry farming. Chickens have shown a steep increase to be an important export commodity with synthetic enterprises that produces from feeds to broilers appearing.

With regard to fishery, shrimps or lobsters are increasing stably as the export products and exports of canned products such as tuna, shrimps and crabs expand rapidly. Export amount of fishery products in 1991 was 44.7 billion Bahts, 5.2 % of the total exports.

(2) Manufacturing industry

The manufacturing industry has established its position as the country's leading sector with steady increase after having surpassed the share of agriculture, forestry and fishery industry in 1991.

Clothing and textile have the largest weight in manufacturing, while agro-industry shows high growth. Thai manufacturing industry is closely associated with primary industry.

Rapid growth of manufacturing industry is contributed by the direct investment from overseas countries since 1987. Accompanied with the expansion of textile and agro-industrial products, the production of information devices such as integrated circuits, computers' components and audio visual electronic devices is also increasing from the end of 1980's.

The Government poses efforts in raising foodstuffs manufacturing industry from the viewpoint of development of internationally competitive agro-industry making use of agriculture, forestry and fishery products abundant in Thailand. Such products line includes sugar, canned tuna, frozen shrimps, canned fruits, processed meat, frozen cattlefishes, seasonings, edible oil, soft drinks, and tobacco.

Leather products and shoes manufacturing has advanced the technology improvement and developed as a promising industry, of which quality of the products is recognized by consumers inside and outside the country. The exportation is also in good conditions to reach 10,064 million Bahts of leather products, 20,213 million Bahts of shoes, accounting for 5.2 % of total exports in 1990. However, most of the companies are small and medium scale and produce the medium quality products. Some companies tie up with foreign companies for technological introduction to make the high quality products.

Automobile industry of Thailand had achieved the development under the government industrial policy promoting domestic production. The number of annual production is 77,000 of passenger car and 206,000 of commercial car in 1991.

Total number of automobile registration all over the country is 7,591 thousand, of which passenger car, taxi and service car amounts to 1,272 thousand, private van and truck 926 thousand, bus and truck 402 thousand, and motorcycle 4,778 thousand. In Bangkok metropolitan area, passenger car and taxi amount to 1,255 thousand accounting for 73.1 % of total number in whole country, ban and truck 298 thousand (32.2 %), bus and truck 134 thousand (33.3 %), and 2,362

thousand in total including motorcycle and other vehicles. Number of road traffic accident is 61,000 in the whole country and 33,000 in Bangkok city.

(3) Number of factories

According to the factory registration data with the Department of Industrial Works in 1991, total number of factories registered is 102,723 in the country. Among them, agricultural processing shares as much as 50.5 % , most of which are rice mills. Most of factories are small and medium size enterprises with employees not more than 200.

Total number of factories in Bangkok metropolitan area were 25,406 in 1989, of which 18,689 were located in Bangkok Metropolis, 3,156 in Samut Prakan, 1,026 in Samut Sakhon, 796 in Nontaburi and 733 in Pathum Thani.

Total number of feed mill manufacturing factories was 257 in the country, 71 of which were located in BMA. Tanning and furnishing leather manufacturing amounted to 152 in the country and 146 in Samut Prakan. Repair shop of motor vehicle and motorcycles amounted to 3,498 in whole country and 1,370 in BMA.

2.3 Industrial Development Plan

The industrial sector is the most significant contributer to the Thai economy. The Seventh National Economic and Social Development Plan (1991-1996) has emphasized the principle to sustain the country's economic growth at an appropriate level with stability and set the target of economic growth rate 8.2 % in total and 9.5 % in industrial sector.

CHAPTER 3 PRESENT STATE OF THE ENVIRONMENT AND ENVIRONMENTAL POLLUTION CONTROL

3.1 Present State of the Environmental Pollution

Thailand has achieved significant economic development in recent years. Environmental pollution problems has also become serious accompanied with industrialization and urbanization and immediate countermeasures are required, particularly in Bangkok metropolitan area. Such problems as water pollution by household drainage and industrial wastewater, air pollution and noise caused by automobile traffic and factories' emission gases, lack of waterworks and sewerage system and insufficient waste treatment capacities have arisen.

Despite such problems, the government has not been able to implement effective regulations to profit-pursuing activities by private sectors and to provide incentives for investments towards public works and pollution prevention facilities.

3.2 Outline of Environmental Policies

(1) Environmental Administration Organization

The Ministry of Science, Technology and Environment (MOSTE) is the dominant agency for the environmental administration in Thailand, while the regulations and guidances over each pollution sources are enacted by the pollution control sections in various Ministries having jurisdiction over the field.

MOSTE is responsible for environmental policy and planning and setting environmental quality standards. As for factory pollution, the Ministry of Industry (MOI) is

responsible for setting emission and effluent standards and enforcement of regulatory measures for pollution control.

With regards to local environmental administration, decentralization and delegation of environmental authority to provincial and local governments are promoted. However, they have not been functioning effectively due to the weakness of local administration organizations.

(2) Legal Systems for Pollution Control

Major laws that are intimately related to pollution control in Thailand are the Enhancement and Conservation of National Environmental Quality Act, B.E.2535 (Environment Act), the Factory Act, B.E. 2535, the Hazardous Substances Act B.E. 2535, and the Public Health Act B.E. 2484.

The Environment Act is a basic laws concerning environmental measures and establishes the framework for environmental protection and pollution control.

The Factory Act was enacted in 1969 in order to promote industrial development but was revised along with the Environment Act and the Hazardous Substance Act in 1992. The Act stipulates the procedures concerning the establishment and operation of factories and the Ministry of Industry implements regulations for pollution control in line with this Act.

The Hazardous Substance Act stipulates restrictions concerning the import/export, manufacture, sales, transport, treatment and use of specified hazardous substances.

The Public Health Act, enacted in 1945, establishes the functions and authorities of local administrative organizations with regard to matters of general public

health including environmental pollution.

(3) Assistance Measures

The Industrial Finance Corporation of Thailand (IFCT) and the Environmental Fund (EF) were established as assistance organizations concerned with pollution prevention measures and promotional systems are provided for the installation of pollution prevention facilities. However, they are currently enough effective as assistance measures for small and medium factories such as offensive odor source factories.

3.3 Present State of Offensive Odors and the Measures

According to data concerning pollution complaints (1988-1992) compiled by the Environmental Research and Training Center, the number of pollution complaints are on the rise and complaints about offensive odors are the most numerous, comprising 31 % of pollution complaints. Also, according to data (1991-1992) compiled by the Bangkok Metropolitan Administration, the number of complaints about offensive odors and noise comprise over 30 % of pollution complaints.

Since emission standards for offensive odors have not been enacted in Thailand, the regulations are implemented on the basis of the Factory Act and the Public Health Act. However, any concrete results have not achieved by these efforts.

CHAPTER 4 FACTORY SURVEY

4.1 Results of Factory Investigation

(1) Fish Meal Plant

Both of the fish meal plants discharge considerable amount of offensive odors because both factories have become too old as a whole, including production facilities and buildings.

Fish Meal Plant A is a factory with around 30 employees to produce fish meal of 80 tons per day from trash fish, fish scrap and the crusts of shrimp and crab. The production process employs a low-efficiency method in which multi-stage series of driers are combined for both boiling and drying processes. The plant has passed for about 15 years since it was constructed and the production facilities and the buildings are superannuated.

Fish Meal Plant B is a factory with around 50 employees to produce fish meal of 2,500 tons per year from trash fish and fish scrap, and of 720 tons per year from the crusts of shrimp and crab. The production system is a standard type in which the cooker and dryer are separated. The factory building made of reinforced concrete structure is comparably new and spacious.

In both factories, the deodorizers are equipped to treat the odors from cookers and driers in the main process line. However, the efficiency for deodorization is low and the measures is not sufficient to interrupt the offensive odors to the surroundings. The operation of production facilities is so intermittent because of the shortage of raw materials which is getting worse that the management of the factories

is unstable.

(2) Bone Meal Plant

Both of the bone meal plants have very old building and production facilities without any sufficient odor prevention measures and they have many troubles also in operation and management. The quality of odors is the most disgusting among four industries as a result of the characteristics of raw materials or animal bones. Offensive odors are generated from almost of all processes of the factories.

Bone Meal Plant C is a rendering plant with about 30 employees to produce bone meal of 90 tons per year and bone oil of five tons per year. The plant also produces the fertilizer, which is made by mixing and drying bone oil and lime, and salt-pickled animal hide. The production facilities are old-fashioned and superannuated. Much works depend on manual labor.

The capacity of cookers are too small to process fresh bones rapidly upon reception and the bone storage room is not installed. As a result, when animal bones arrive at the factory, offensive odors are generated from raw materials because they are stored outdoors. And steam-boiled bones are dried outdoors, when strong offensive odors are generated. Drying space of oil cake for fertilizer is also a strong offensive odor source.

Although a deodorization apparatus with simple water scrubbing process was installed for the cooker exhaust initially, it has been left in breakdown.

Bone Meal Plant D is a rendering plant with about 300 employees to treat animal bone of 24,000 tons per year. The plant is of large scale and has most of all processes for

rendering plant including complicated processes of producing and refining ossein and calcium phosphate as well as bone meal and bone oil.

The plant which has repeated to install its facilities gradually since it has founded, so the facilities are mixed with old and new processes. From outdated facilities, offensive odors are generated strongly. In particular, buildings and equipment of the processes for raw material reception, bone grinding, bone meal and bone oil production are too old and too inadequate to shield odors.

Although deodorization facilities are installed for the cooker exhaust and interior ventilation of the raw material storage house, the deodorization method is not suitable and the deodorizing performances are insufficient.

(3) Tannery

Most of tanneries are located in the tanning industrial complex in Samut Prakan. Major sources of offensive odors are wastewater from the preparation process before tanning, the drying process of tanned leather, of the dyeing process. From the point of prevention of offensive odors, the most important point is the procedures to treat the residues of treated fur and the wastewater from the raw fur washing, liming, and fur dregs shaving process. However, actually the wastewater from each factories is transferred to the central wastewater treatment plant without any treatment.

Tannery E is a factory with about 60 employees to produce leather of about 140,000 m^2 per year. The tanning process is normal but the space is so small that drier is provided for drying process of tanned leather.

Tannery F is a large scale factory with about 200

employees to produce leather of about 890,000 m² per year. The factory has two sites and the dying factory is under construction beside the tanning factory. The factory survey is conducted only for the tanning factory.

The tanning industry of Thailand has been developed rapidly until now. However, the recent performance of business shows the tendency of depression due to the pursuit of other developing countries such as China and Vietnam.

(4) Automobile Painting Factory

Both of the automobile painting factories are small scale car repair shops, where the source of the offensive odors is organic solvents for the most part. The environmental impact, however, is comparatively small because the factories are small.

Automobile Painting Factory G is a factory with about 70 employees. The business is thriving, while the space of workshop is narrow and messy. The painting room is too small to use for painting. The factory says the painting room is to be reconstructed.

Automobile Painting Factory H is the smallest factory with eight employees. The factory has passed only one year and over since constructed and install the modern painting room.

(5) Central Tanning Wastewater Treatment Plant

The industrial wastewater within the tanning industrial complex is not treated by each factory individually but flows into the central wastewater treatment plant located in the southern part of the industrial complex all together with the household wastewater and rainwater. The open canal is installed along the streets, but becomes the worst

offensive odor source because the wastewater from tanneries is discharged without any treatment and stagnant in the canal. Presently, improvement construction is being made to enclose the drains and to raise the level of the streets. The construction is being performed successively,

The plant was constructed in 1979-1982 and many of its facilities are over durability periods and superannuated. And the capacity of the plant is too small to treat increasing wastewater.

(6) Influences of Offensive Odors to the Surroundings

Two fish meal plants, two bone meal plants are two tanneries are located in industrial area and two automobile painting factories in the commercial area.

Fish Meal Plants A and B and Bone Meal Plant C extend the influence of offensive odors as far as about 100-200 meters leeward. Bone Meal Plant D spreads out its influence wider areas, about 500-1,000 meters far from the factory. Tanning industrial complex, where selected factories are located in with other dozens of tanneries, is full of offensive odors inside and outside of the factories without any regard to the intensity from each factories. Automobile painting factories have smaller influence of offensive odors as far as dozens of meters.

4.2 Measurements and Analyses of Offensive Odors

(1) Outline of Odor Measurement Survey

Odor measurement surveys were carried out in eight selected factories and central tanning wastewater treatment plant in Samut Prakan. Technical group was organized to conduct the survey and the technical transfer for the methods of measuring offensive odors.

Odor sampling was conducted on boundary line, at flue or smoke stack and the points inside of the factories where the odor generation seems to be great. The number of samples is shown in Table 4-33.

Table 4-1 Number of Sampling for Measurement and Analysis of Offensive Odors

	First		Second			Third			Total		
	S/T	D/T	S/T	D/T	G/C	S/T	D/T	G/C	S/T	D/T	G/C
Fish meal Plant											
A	5	7	8	13	4	—	—	—	13	20	4
B	5	6	8	14	4	—	—	—	13	20	4
Bone meal Plant											
C	6	10	8	7	3	—	—	—	14	17	3
D	9	11	—	22	—	8	23	3	17	56	3
Tannery											
E	5	9	—	13	—	7	13	3	12	35	3
F	5	7	—	9	—	7	8	2	12	24	2
Automobile Painting Factory											
G	3	4	—	—	2	2	2	—	5	6	2
H	2	2	3	—	3	—	—	—	5	2	3
Central Tanning Wastewater Plant											
I	2	2	—	—	—	—	—	—	2	2	—
Total	42	58	27	78	16	24	46	8	93	182	24

Notes : S/T Sensory Test
D/T Detection Tube Method
G/C Instrumental Analysis Method

(2) Methodology of Odor Measurement

Three methods were employed for odor measurement; sensory test (triangle odor bag method), detection tube method and instrumental analysis method.

Odor measurement survey was performed according to the following official methods of measuring offensive odors in Japan.

1) Sensory test :

Triangle odor bag method prepared by the Association of Study and Research on Odor Control

2) Detection tube method :

Manual of facile methods of measuring offensive odor substances (1990) prepared by the Environment Agency in Japan

3) Instrumental analysis method :

Notification No.47 (1989) of the Environment Agency, method of measuring offensive odor substances

(3) Results of Odor Measurement

Sensory test is a method to quantify the intensity of offensive odors using human olfactory sense. Result of the test is indicated as odor concentration which means diffusion magnification of the odors with odor free air to be no smell. According to the survey, the results of odor concentration is roughly corresponding with human olfactory sense.

On boundary line, odor concentration is desirably to be below the value of 10 and needs to be below 60 even in the industrial district, whereas actual results of measurement indicates beyond 10 at most points and still beyond 60 in some factories. Odor concentration of smoke stack should be under 300, and needs to be below 1,000 or 3,000 at the worst. However, the results at most points of odor sources are beyond 300; for example, odor concentration of flue gas

is 170,000 at inlet of deodorizer and 23,000 or 98,000 even at outlet of deodorizer in fish meal factories.

Detection tube method has been employed for measuring high concentration gases such as flue gases. most of the results of ammonia and hydrogen sulfide measured by detection tube are under detection limit value except the points at where the level of smell is considerably high.

Instrumental Analysis is a method to determine the concentration of offensive odors using gas chromatograph and other apparatus. Number of analysis items is 12; ammonia (NH_3), methyl mercaptan (MM), hydrogen sulfide (H_2S), methyl sulfide (DMS), methyl disulfide (DMDS), trimetylamine (TM), acetaldehyde (AA), styrene, propionic acid (PA), normal butyric acid (n-BA), normal valeric acid (n-VA) and isovaleric acid (i-VA) except for the automobile painting factories in which was analyzed for four items; acetone, toluene, ethylbenzene, and xylene.

The concentration of ammonia by instrumental analysis are about 0.2-0.7 ppm on boundary line and 40-362 ppm at outlet of deodorizer. However, most results of analysis for other substances by gas chromatograph are divided in value, and shows the value of below detectable limits even at the point where the concentration is supposed to be high.

At any rate, the results of sensory test is defined the best method to be able to indicate the intensity of offensive odors quantatively in each points and to reflect the value of olfactory sensation.

Table 4-2 shows the performance of failures to meet the Japanese regulation standards of offensive odors to evaluate the results because the standards are not established in

Thailand. Japanese standards are adapted for only on boundary line and at smoke stack but here includes the comparison in other places.

This Table shows the concentration of offensive odors are considerably high in almost of all factories. The results of odor measurement in Fish Meal Plant A and Bone Meal Plant C was in compliance with the standards on the boundary lines. However, this is simply because the sampling points are far from the odor sources and due to the weather conditions of the sampling. In other points any items failed the standards.

Table 4-2 Achievement and Failure to Meet Japanese Emission Standards of Offensive Odors

Sampling Points	Odor Concentration		Concentration of Odor Substances												
			NH3	MM	H2S	DMS	DMDS	TA	AA	Styrene	PA	n-BA	n-VA	i-VA	Toluene	Xylene
Fish Meal Plant A																
A-1 Boudary line	▲	18	○	○	○	○	○	○	○	○	○	○	○	○		
A-2 Inside workshop	●	7,300	▲	○	●	○	○	▲	▲	○	○	○	○	○		
A-7 Inlet of deodorizer	●	170,000	●	○	●	○	○									
A-3 Outlet of deodorizer	●	23,000	●	○	○	○	○	●	▲	○	○	○	○	○		
Fish Meal Palnt B																
B-1 Boundary line	●	390	○	○	○	○	○	▲	○	○	○	○	○	○		
B-4 Inside workshop	●	2,300	▲	○	○	○	○	●	○	○	○	●	○	▲		
B-6 Inlet of deodorizer	●	17,000	●	●	●	●	○									
B-7 Outlet of deodorizer	●	9,800	●	●	●	●	○	●	●	○	○	○	○	○		
Bone Meal Plant C																
C-2 Boundary line	○	< 10	○	○	○	○	○	○	▲	○	○	○	○	○		
C-4 Flue from autoclave	●	9,800	●	○	○	○	○	●	●	○	○	○	▲	○		
C-3 On courtyard	●	130	▲	○	○	○	○	▲	▲	○	○	○	○	○		
Bone Meal Plant D																
D-1 Boundary line	▲	44	○	○	○	○	○	○	○	○	○	▲	▲	○		
D-3 Beside crusher	●	73,000	●	●	●	●	▲	●	●	○	○	●	▲	▲		
D-5 Inside drying room	●	9,800	●	○	○	○	○	●	●	○	▲	●	●	●		
Tannery E																
E-1 Boundary line	●	690	○	○	●	○	○	○	○	○	○	○	○	○		
E-4 Inside workshop	●	1,700	▲	○	○	○	○	○	○	○	○	○	○	○		
E-11 Over canal	●	3,100	▲	●	●	○	○	○	○	○	○	○	○	○		
Tannery F																
F-1 Boundary line	▲	55	○	○	▲	○	○	○	○	○	○	○	○	○		
F-2 Inside workshop	●	980	▲	○	○	○	○	▲	○	○	▲	○	○	○		
Automobibe Painting Factory G																
G-2 Boundary line															○	○
G-4 Inside workshop															▲	▲
Automobibe Painting Factory H																
H-1 Boundary line	●	75													○	○
H-3 Inside workshop	●	73													○	○
H-4 Inside paint storage	○	17													○	○

Note : ○ In compliance with the standards ▲ Within the range of the standards ● Failure to the standards
Here the standards indicate the concentrations corresponding to 2.5 or 3.5 of odor intensity. (Refer to Table 6-4)

Chapter 5 PREVENTIVE MEASURES OF OFFENSIVE ODORS IN THE SELECTED FACTORIES

5.1 Fundamentals of Preventive Measures of Offensive Odors

Offensive odors occur as a mixture of trace amounts of various odor components. Offensive odors are thus difficult to remove once they are generated. Countermeasures against odor sources are therefore the most important aspect of offensive odor prevention measures. Production processes which minimalize the amount of odor generated must be adopted and suitable production management must be practiced. Also, in order to prevent leakage of odors outside the factory, efforts must be made to enclose the odor sources and to implement effective and efficient deodorization measures.

The following points should be considered upon taking measure for prevention of offensive odors from factories.

1) Investigate and grasp the exact sources of offensive odors as well as the odor emission rate, the substances causing offensive odors and the generation time.
2) Select production processes that do not emit offensive odors easily or improve the processing method. Production process should be designed to consider recycling and energy saving and to leave the capacity leeway.
3) Improve methods of managing raw materials and wastes to reduce odor emission rates.
4) Reduce the number of odor sources. Also, prevent odors from being discharged in a concentrated manner.
5) Odor prevention measures should be implemented step-by-step, starting with odor sources with the greatest effects and highest odor emission rates (gas flow rate x

concentration).

6) Enclose the odor sources to prevent the leakage and diffusion of offensive odors. It is desirable to take multiple enclosing measures at odor source equipment, in the room and in the entire factory building. Suitable duct work are also important to keep the building interior under negaive pressure.

7) Collect odor gases separately for each type of odors with similar properties or concentration at each odor source and deodorize the odors separately. For low concentration odors, discharge out of the high stack without treatment may be enough to diffuse in the air at times.

8) Collect odors efficiently by induction with an adequate flow of air. Excessive induction may have no effects at times.

9) Odor preventive measures should be sustainable to consider the cost and benefit.

10) Operate and maintain the deodorizing equipment adequately. Maintenance and inspection of the effects for deodorizer is also important as well as the condition of installation such as capacity and efficiency.

11) The target of odor preventive measures is not only to satisfy the legislative standards but also to get rid of public complaints. Evaluate the effect of the measures based on human olfactory sensation, not only on the removal rate of odor substances.

12) Select factory locations far from urban areas and with few residences in the surroundings in order to avoid complaints priorly.

13) Provide enough open space around the factory to provide buffering zones.

Odor prevention measures should be comprehensively rational in considering the effectiveness and sustainability. Major concepts of the measures are divided as follows. Among these measures, deodorization facility consists of the process of odor collection. treatment, discharge steps. Odors of low concentration may be accomodated for at times simply by dilution ventilation and deodorization may not be necessary.

1) Improvements of the production processes (processing capacity, processing method, etc.)
2) Improvements of the way of operating offensive odor generating facility (cleaning, inspections, repairs)
3) Improvements of operation and management (procedures of reception and storage of raw materials)
4) Enclosing of offensive odor generating facilities (equipment, buildings, etc.)
5) Installation or improvement of deodorization facilities
6) Provision of open areas for buffering purposes

5.2 Odor Trapping

Various offensive odor sources are present within a factory. These include equipment such as cookers and dryers, reception pits and repositories for raw materials, treatment facilities and outlets thereof for wastewater and wastes and repositories for products, by-products and wastes. Since the conditions of odor generation such as constituents, quantity and concentration of odors differ widely for each process, odor preventive measures must be implemented according to the characteristics of each source. Figure 5-1 shows an example of how odor preventive facilities may be arranged.

With regards to the deodorization of offensive odors, the rational procedure would be to trap the offensive odor

at locations as near as possible to the odor sources and to introduce the odors to the deodorization apparatus. Odor generating operations is desirably performed indoors.

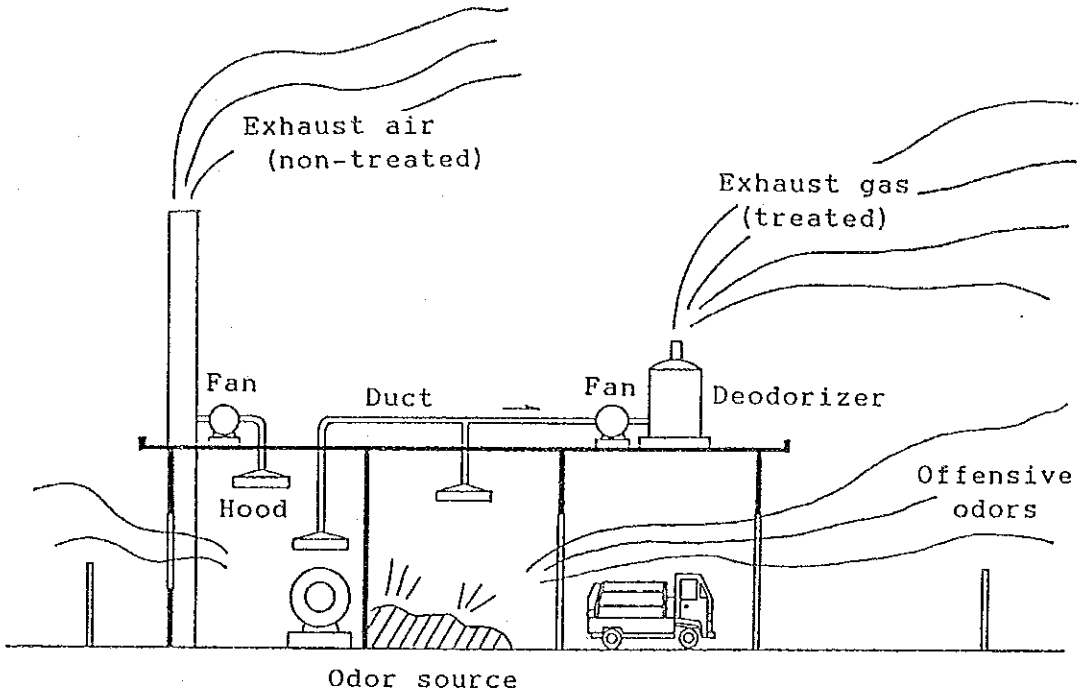


Figure 5-1 Schematic of Arrangement of Deodorization Facility

5.3 Deodorization Methods

Deodorization is a process for removing odor substances from exhaust gases and atmospheric gases. Deodorization methods and its features are shown in Table 5-1.

The most popular methods among those are chemical scrubbing, activated carbon adsorption and thermal combustion. Upon actually designing deodorization facilities or arrangements thereof, the deodorization methods are either used singularly or in combination according to the type, composition, emission rate, concentration of the

odors. For example, high concentration odors may be handled by thermal combustion while medium concentration odors may be handled by a combination of chemical scrubbing and activated carbon adsorption.

Table 5-1 Comparison of Deodorization Methods

Deodorization Method		Water Scrubbing	Acid Scrubbing	Alkali Scrubbing	Sludge Deodorization	Activated Carbon Adsorption	Soil-Filter Deodorization	Thermal Combustion	Catalytic Combustion	Ozone Oxidation
Odor Substance	NH_3	△	○	×	△	△	△	○	○	×
	H_2S	×	×	○	△	○	△	○	△	○
	Solvent	△	×	×	△	○	△	○	○	×
Concentration	High	○	△	△	×	×	△	○	○	△
	Low	○	○	○	○	○	○	△	△	○
Gas flow	High	○	○	○	△	△	×	×	△	×
	Low	△	△	△	○	○	○	○	○	○
Gas temperature	High	△	△	△	×	×	×	○	○	×
	Low	○	○	○	○	○	○	×	×	○
Maintenance		○	△	△	×	○	×	△	△	×
Load variation		○	○	○	×	○	×	△	△	○
Initial cost		○	△	△	△	○	×	×	×	×
Running cost		○	△	△	○	×	○	×	△	×

Note : ○ Effective or inexpensive

△ Moderate

× Ineffective or expensive

5.4 Recommendations for Preventive Measures of Offensive Odors in the Selected Factories

Since most of selected factories were superannuated and were not provided with adequate odor prevention measures, offensive odors were discharged inside and outside the factories. Although fundamental improvements of facilities are required to solve the offensive odor problem, it is very difficult for small and medium factories to furnish complete odor prevention measures on their own because of financial and other problems. The recommendations for preventive measures of offensive odors are made in view of this problem and prepared on the basis on the conditions of the factories. Although these may not represent the best solutions, considerable improvements should be possible through these measures. And deodorizer planning are also prepared for major odor sources of the factories.

The odor prevention measures proposed here are divided into short-term, medium-term and long-term measures. Short-term measures are made on the basis of the present production processes, facilities and operation conditions of these factories and represent measures that can be implemented immediately such as improvements in the way odor prevention facilities are operated and optimization of work management. Medium-term measures concern processes that are very important in terms of offensive odor generation conditions at each factory and represent measures that are considered as those which can be implemented by small and medium factories. Long-term measures concern offensive odor sources of the entire factory and include such measures as improvements in the production process, complete enclosure of odor generating facilities and introduction/expansion of deodorization facilities.

Deodorization facilities require the enclosing of odor sources and collection of odors as prerequisites. However, the degrees of enclosure of factory buildings of and equipments in selected factories are low. Therefore, improvements in the production process and modifications of building structures are required for the installation of deodorization facilities at these factories.

As a rule, the recommendations of the deodorization facilities presented here are concerned only with the greatest offensive odor sources at each factory and do not concern the odors that are generated from the numerous odor sources dispersed within the factory and the ventilated air within the buildings. The treatment capacities of the recommended deodorization facilities were set so that regulation standards in Japan and other advanced nations can be satisfied. However, it should be noted that simply installing deodorization facilities without implementing the other odor prevention measures may have little or no effect.

(1) Fish Meal Plant A

This factory is quite superannuated and requires fundamental improvements of the facilities including building and production processes in order to achieve odor prevention and removal.

1) Short term measures

a. Execution of regular cleaning inside and outside of the factory.
b. Proper disposal of solid wastes such as scraps of raw materials and products.
c. Dredging of the wastewater ponds.
d. Execution of repair, maintenance of the facilities.
e. Inspection and repairs of existing deodorizer, particularly the scrubber fillers and the sprays.

f. Continuous use of existing deodorizer. Presently the deodorizer is used only when the fish meal drier is in operation. The deodorizer should be used even after the drier is stopped.

2) Medium term measures

a. Securing of the platform water gradient and arrangement of wastewater ditch.
b. Repairing the wall and floor materials not to absorb odors and moisture.
c. Installation of sand settling tank, oil separator and screen before wastewater treatment facility.
d. Enclosure of the open parts of conveyors between driers.
e. Discharging of the odorous air in the drying room into outside through high stack.
f. Installation of roof ventilator for the factory building.
g. Modification of the wastewater ponds into aerobic lagoons
h. Modification of existing deodorizer (for drier exhaust) into chemical scrubber.

3) Long term measures

a. Remodeling of the factory building to enclose odor source thoroughly. Outer walls should be added to the factory building. Partition walls and shutters should be provided for rooms generating large amounts of odors. Concrete or block walls are recommended for walls.
b. Introduction of high performance deodorizer. The high concentration odors, the medium concentration odors the low concentration odors should be collected separately from each other and treated by methods suited to the quality, quantity, and concentration of each type of odor and then discharged.
c. For the drier exhaust, boiler type should be changed and

combustion deodorization should be performed.

d. Odors of the atmosphere within the factory may be accommodated for by simple deodorization methods or by discharging through a tall stack, provided that improvement in production management are made.

e. Overall modification of the wastewater treatment facility.

d. The introduction of western style processing methods.

e. The overall renewal factory building and equipment should be considered.

4) Deodorization planning

The greatest offensive odor source at the factory is exhaust from the fish meal drier. Although deodorizer are installed for the drier exhaust, these are not providing adequate effects. The odors leaking from the conveyors between the driers should also be trapped and treated together with the drier exhaust as well.

The gas flow drier exhaust was assumed to be 300m^3/min. and the leakage of odor gases from conveyors 200m^3/min. upon setting the recommended deodorization apparatus. The deodorization method should be a combination of the water scrubbing, acid scrubbing and alkali scrubbing methods for this plant. The schematics for the deodorizer is shown in Figure 5-2.

(2) Fish Meal Plant B

Since the building of the plant is comparatively new and the factory grounds is spacious, odor prevention measures may be implemented readily.

1) Short term measures

a. Execution of regular cleaning inside and outside of the factory.

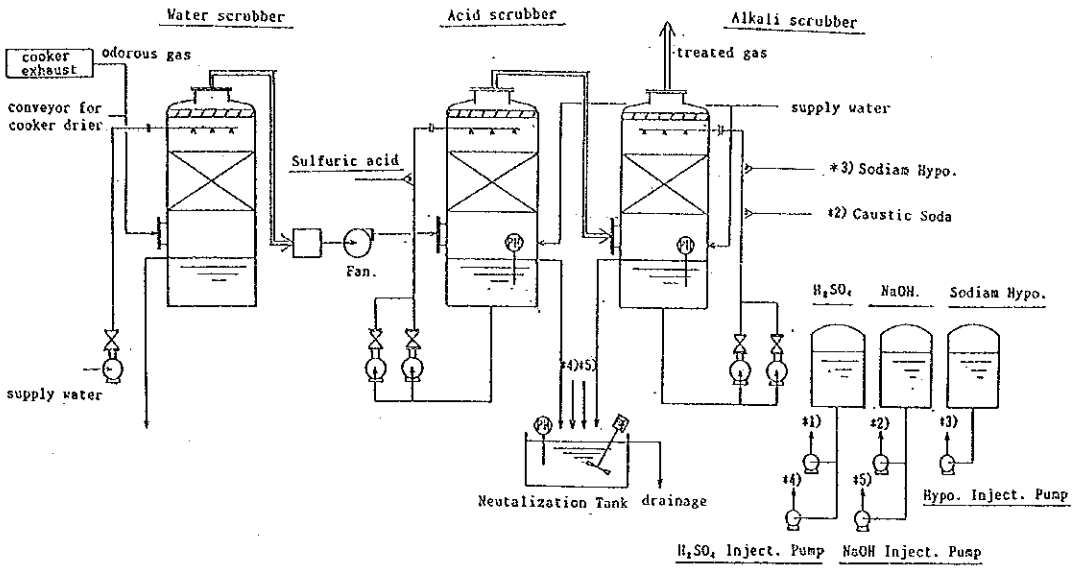


Figure 5-2 Process Flow of Deodorizer
(water scrubbing + acid scrubbing + alkali scrubbing)

b. Adequate disposal of solid wastes.
c. Dredging of the wastewater basins.
d. Repair, maintenance and renewal of the factory facilities.
e. Quick treatment of the carried-in raw materials and cleaning the pits.
f. Inspection and repairs of existing deodorizer, particularly the scrubber fillers and the sprays.
g. Continuous use of existing deodorizer

2) Medium term measures

a. Modification of the structural material of the raw material pit into a material that does not absorb moisture and odors.
b. Installation of sand settling tanks, oil separator and screens.
c. Enclosure of the openings of the conveyors.

d. Installation of roof ventilator for the factory building.

e. Modification of the wastewater ponds into aerobic lagoons.

f. Improvement of the efficiency of existing deodorizer by modification into chemical scrubbing type equipment.

3) Long term measures

a. Thorough enclosing of the factory. The raw material pit and other offensive odor sources should be enclosed. The factory building should have as few open parts as possible.

b. Expansion of deodorizing equipment capacity. Collection of indoor ventilated atmosphere. Discharge after suitable treatment.

c. For the exhausts from the cookers and dryers, the boiler type should be changed and modifications for combustion deodorization should be made.

d. Installation of wastewater treatment facility.

4) Deodorization planning

The sources of high concentration odors at the present factory are the cookers and dryers and the existing deodorizing equipment must be renewed as its capacity is too low. Therefore, on the occasion of the renewal of the deodorizing equipment, the exhausts from the conveyor from the cooker outlets to the dryers (air flow: 120m^3/min.) and the odors from the cookers for lobsters/shrimps and crabs (50m^3/min.) should also be treated besides odor from the cookers for fish (300m^3/min.).

The total gas flow was assumed to be 470m^3/min. upon setting the recommended deodorizer. A combination of water scrubbing, acid scrubbing and alkali scrubbing is recommended as the deodorizing method.

(3) Bone Meal Plant C

The present factory is quite superannuated and improvements in fundamental facilites are required for odor prevention. The short- and medium- term plans are centered around the operation of facilities and improvements in work management for the major offensive odor generating processes. However, in fundamental terms, improvements of the production processes, enclosing of the factory and installation of deodorizing equipment are necessary.

1) Short term measures

a. Execution of cleaning inside and outside of the factory.
b. Quick treatment of the carried-in materials.
c. No outdoor storage of materials and steam bones and installation of raw materials storage room.
d. Installation of a line of water spray tubes in the stack to deodorize the cooker exhaust.
e. Preparation of a condenser and its regular use.
f. Installation of a waste water pit and an oil separation tank for treatment of wastewaters leaking from cookers.
g. Reduction of the oil sludge drying area and quick treatment.
h. Installation of a hood and a stack above the cooker to discharge gas into the air.
i. Periodic cleaning of wastewater treatment facilities.

2) Medium term measures

a. Installation of a ventilator for the oil workshop building, and the equipment of a cover for the oil storage tank.
b. Remodeling of wastewater treatment facility.
c. Abolition of the oil pot.
d. Installation and enclosure of a storage building for steam bone drying. Installation of a chemical scrubbing tower for deodorization.

e. Expansion of the capacity of cookers for quick treatment of fresh bones.

3) Long term measures

a. Alteration of the production processes and machines in consideration of pollution measures.
b. Remodeling of factory buildings to enclose the odor sources.
c. Separation of odors generated in the factory into high concentration, medium concentration and low concentration odors and discharge after adequate treatment.
d. Combustion deodorization of cooker exhausts by the boiler.

4) Deodorization planning

The greatest odor source that needs to be deodorized at the present factory is the cooker exhaust. Although an apparatus for distilling and water scrubbing is installed below the chimney, since it is not functioning and since the treatment method is unsuitable, the deodorizing apparatus should be modified. Also the natural drying of bone powder and oil sludge within the grounds present a large odor source, odors should be collected from locations above the repositories of these products and treated together. The gas flow for the cooker exhaust was assumed to be 160m^3/min. and the gas flow for the ventilation of the bone meal and oil sludge repository was assumed to be 1,260m^3/min. upon setting the recommended deodorizer. A two-tower system for acid scrubbing and alkali scrubbing is recommended. The schematics for the deodorizer is basically the same as that shown in Figure 5-2.

Although the wastewater treatment facility, the raw material itself and the drying of steamed bones constitute

extremely large odor sources, since the treatment of these odors require large-scale improvements in facilities and management procedures, these are not included as subjects of the proposal.

(4) Bone Meal Plant D

This factory is a large-scale factory at which bone meal production, steamed bone powder production, ossein production, calcium phosphate production and other processes are formed. Among these the facilities for the ossein production and the calcium phosphate production are relatively new. However the facilities for the other porcesses are superannuated and require fundamental improvements.

The deodorizing facilities proposed in the short- and medium-term plans concern only those locations where large amounts of odors are generated. Although there are many other locations which require deodorizing facilities, these were not included in this proposal. In the long term, fundamental measures, including the relocation of the factory, may be necessary.

1) Short term measures

a. Execution of cleaning inside and outside of the factory.
b. Installation of a ventilator in the liming building
c. Dredging of the outdoor lagoon waste water channels and disposal of sludge.
d. Recovery of SS content in the wastewater and recycling it into resource material again.
e. Regular use of the scrubber for the exhaust from the autoclave and extension of its chimney to outdoors.
f. Installation of a hood above the oil cooker, and duct connection to the material storage warehouse scrubber.
g. Capacity upgrading of the water circulating pump for the

scrubber mentioned above

2) Medium term measures

a. Turning a part of the lagoon aerobatic

b. Enclosure of the steam bones and ossein chips hot air drying room, and installation of a set of deodorization equipment.

c. Deodorization by chemical scrubbing of the odor from the conveyor rear to primary crushing, the vibration screen and the flat pot autoclave.

d. Installation of the deodorization equipment for exhaust gas generated in drying the scum recovered in the waste water treatment facilities and the pressurize-floating equipment.

e. Modification of existing deodorization equipment for improved performance.

3) Long term measures

a. Enclosure of processes in the factory such as material storage, and renewal of the processes and the machines in consideration of production facilities and pollution control.

b. Local suction of process odors and installation of equipment for deodorization.

c. Combustion deodorization in the boiler of odor from the autoclave and the cookers.

d. Installation of deodorization equipment in the ossein production process building.

e. Consideration of factory relocation.

4) Deodorization planning

Since the present factory is large in scale, there are many locations that require the installation of deodorization equipment. Only the areas which generate the greatest amounts of odors were considered in the proposal.

Although deodorization facilities are required in many other processes only the following two deodorization systems were considered.

System No.1 concerns the vicinity of the bone crusher, autoclave exhaust and the drying room exhaust and the gas flow to be treated by this system was assumed to be 180m^3/min. A two tower system for acid scrubbing plus alkali scrubbing is recommended for this system.

System No.2 concerns the exhausts from the scum dryer for drying the scum generated by the wastewater treatment facility. The gas flow to be treated by this system was assumed to be 100m^3/min. Since the exhaust temperature is high and the main component is ammonia, acid scrubbing is recommended. The schematics for this deodorizer is basically the same as that shown in Figure 5-2 but a water scrubber is installed upstream for cooling the gas.

(5) Tannery E

The present factory is located in the tannery industrial estate. Measures that concern the industrial estate as a whole are required to handle the offensive odors in the factory surroundings.

1) Short term measures

a. Execution of cleaning inside and outside of the factory.
b. Quick discharge of the wastewater in the factory.
c. Enclosure of the storage of coating paint, and ventilation.

2) Medium term measures

a. Installation of a ventilator on the factory ceiling.
b. Installation of the screen and the oil separating tank to discharge of the factory wastewater after removing

fat and solids .

3) Long term measures

a. Enclose areas of the wet treatment process and conduct deodorization.

b. Reduce consumption of chemicals and water, provide closed systems for chromium-containing wastewaters and recover the chromium, etc.

4) Deodorization planning

Deodorization shall be planned based on the overall ventilation of the factory, centered around processes in which water is used. The gas flow to be treated is assumed to be 1,000 m^3/min. and the alkali scrubbing method is recommended as the deodorization method.

(6) Tannery F

The present factory is located in the tannery industrial complex. Measures that concern the industrial estate as a whole are required to handle the offensive odors in the factory surroundings.

1) Short term measures

a. Execution of cleaning inside and outside of the factory

b. Sure and quick discharge of the waste water in the factory.

2) Medium term measures

a. Discharge of the factory wastewater after removing fat and solids by passing through the screen and the oil separating tank.

b. Installation of a ventilator on the factory ceiling.

3) Long term measures

a. Enclose areas where odors may be generated such as that

for the wet treatment process and perform deodorization.

b. Reduce consumption of chemicals and water, provide closed systems for chromium-containing wastewaters and recover the chromium, etc.

4) Deodorization planning

The present factory is very spacious, with a large floorage and high ceilings. Since equipments are dispersed according to each process, the setting of areas of processes for which suction is to be performed and the attachment of ventilation hoods above such areas are recommended. The gas flow to be deodorized was assumed to be 4,400 m^3/min. and the alkali scrubbing method is recommended as the deodorization method.

(7) Automobile Painting Factory G

The installation and regular use of a painting room and the deodorization of paint fumes are required as odor prevention measures of an automobile painting factory. Since the present factory is small, improvements in work management are required. The major odor prevention measures that should be implemented are as follows:

a. Installation of a painting room and a paint warehouse.
b. Deodorization of gases vented from the painting room and the paint warehouse.
c. Installation of a ventilator on the factory ceiling.
d. Setting of specific and separate work areas for such processes as sheet iron processes and painting.
e. Enhancement of employee education on the use of fire.
f. Enlargement of factory area for smoother work traffic.

The exhaust from the painting room exhaust and the air vented from the warehouse are the targets of deodorization

and the air flow was assumed to be 130m^3/min. Since the odors to be deodorized are organic solvent odors, the activated carbon adsorption method should be effective. The schematics for the deodorizer using this method is shown in Figure 5-3. The mist generated in the painting work may block the activated carbon. Hence, it should be removed by a prefilter.

(8) Automobile Painting Factory H

A painting room is installed at this factory and general odor prevention measures are already implemented. In terms of odor prevention, that the painting work is performed at all times in the painting room should be ensured.

If the deodorization facility is to be improved the introduction of the activated carbon method is recommended.

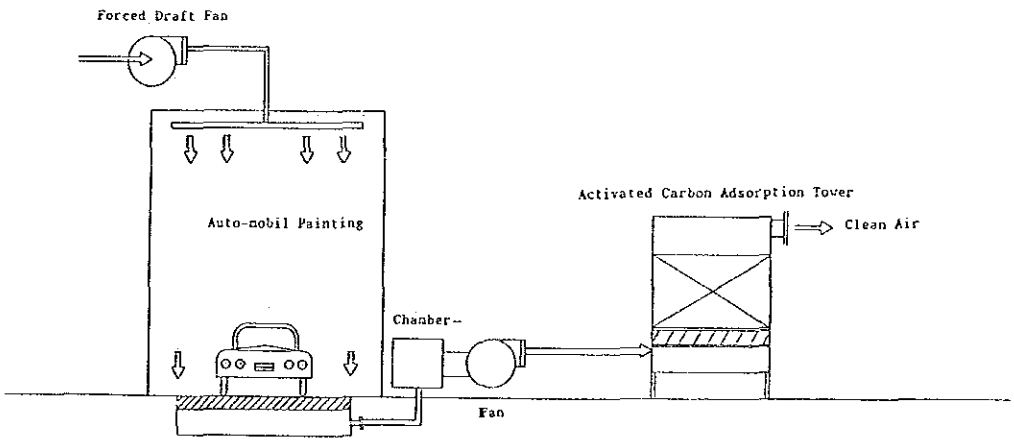


Figure 5-3 Process Flow of Deodorizer
(activated carbon adsorption)

(9) Central Tanning Wastewater Treatment Plant

The majority of the tanneries in Thailand are located at the industrial complex in Samut Prakan. A strong offensive odor drifts throughout the complex due to the offensive odors generated from the wastewaters discharged from all tanneries and from the canals next to the streets. In order to improve this condition, implementation of pollution prevention measures including odor prevention and removal by each individual factory should be made mandatory, the drains should be improved and collection/treatment systems for the wastes generated by the tanneries should be established.

The following measures are required to improve the canals:

a. The removal of solids, fat, chromium, etc. from the wastewater prior to discharge and the installation of removal facilities for this purpose should be made mandatory for all tanneries.

b. Remove the sludge accumulated in the canals, and clean them. Sufficient care should be taken in cleaning the conduits on safety measures because hydrogen sulfide is thick therein.

c. Sedimentation of solids and putrefaction of organic matter are progressed due to the slow flow within the drains. Increase the gradient of the channels or install intermediate pumping facilities.

d. The enclosing of the open drains to enclose offensive odors is presently in progress. The structural material for the drains should be such that it will resist degradation by hydrogen sulfide, chromium, etc.

e. Factory wastewater and rain water should be disposed of separately.

Expansions and improvements of the wastewater treatment plant are necessary since facilities are quite superannuated (11 years have passed since the plant was built) and since the wastewater quantity is increasing due increases in the number of tanneries within the estate.

The following are the major measures that should be taken to improve the central wastewater treatment plant:

a. Reinforcement of the treatment capacity. In specific terms, additional aeration tanks and settling ponds should be constructed, superannuated equipment should be renewed and additional aeration equipment should be installed etc.
b. Improvement of the sludge treatment method and establishment of sludge disposal methods.
c. The rain water should be separated from the tannery wastewater and disposed of and only the wastewater should be treated.
d. Reinforcement of the treatment plant management system. In specific terms, employees should be increased, maintenance equipment (water quality inspection devices, etc.) should be furnished, etc.
e. Furnishing of secondary pollution prevention facilities. Various parts of the treatment plant should be enclosed and trees should be planted in the area around the plant.

CHAPTER 6 MASTER PLAN FOR PREVENTION AND CONTROL OF OFFENSIVE ODORS

6.1 Principles of Offensive Odor Control Policy

Offensive odors are usually generated accompanying to industrial activities mainly in factories and other business establishments. Similarly to cases of air pollution and water pollution, the administrative policy and the regulations for prevention of offensive odors should be based the following principles.

a. Polluter-pays-principle
b. Prevention of occurring environmental pollution
c. Considerations for small or medium scale factories

6.2 Features of Offensive Odors

For studying regulation of offensive odors, the singularities of offensive odors should be considered as described below:

1) Low concentration of offensive odors and keen sensitivity of olfactory sense

Offensive odor is a smell to make people unpleasant, generated by gases like ammonia and hydrogen sulfide, which are called odor substances, stimulating human olfactory. Offensive odor substances is a sort of air pollution substances, but have very low concentration generally. When they are emitted in the air, people sense them even if they are very little. This constitutes offensive odor nuisance.

Twenty two (22) substances are designated as offensive odors substance presently in Japan.

2) Compositeness of offensive odor components

Offensive odor substances are generated in putrefaction and combustion of animal proteins and fats, and actual offensive odor is composed by combination of multiple components of these substances.

3) Individuals difference of olfactory sense and the fatigueaptness

Human olfactory sensitivity is so keen as to far exceed the analyzer sensitivity. Sense to offensive odor is largely different person-by-person, and fatigue and familiarity with the odor greatly affect nuisance felt by a person.

4) Difficulty of odor prevention or removal measures

Quantity of odor sensed by olfactory sense obeys Weber-Fechner's law, which states that sensed intensity is proportional to logarithm of stimulation intensity.

Based on this law, relation between concentration of odor substances and odor intensity is shown in Figure 6-1. As seen from this relation, odor intensity is decreased only to 30 % even when odorous substances are reduced from 100 % concentration to 1 % (removal ratio of 99 %). This fact constitutes difficulty in displaying effects of odor prevention and removal measures.

Since offensive odor is composed of many components and emitted through a complication mechanism of generation, it can not be prevented or removed with a single method but cooperative use of multiple methods.

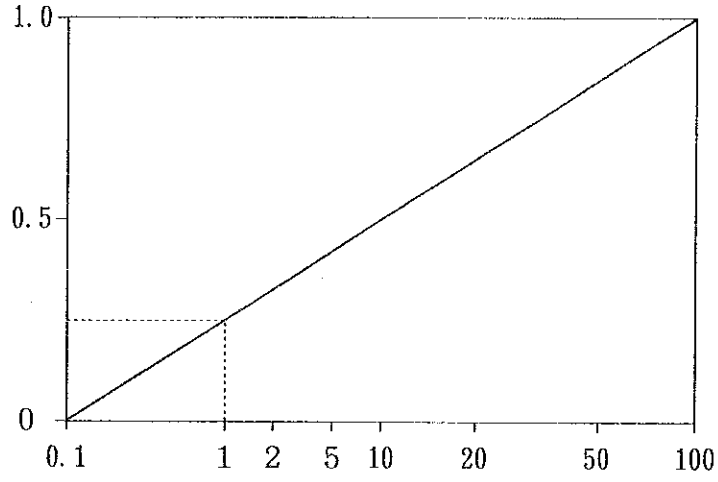


Figure 6-1 Relation of Odor Intensity and the Concentration of Odor Substances

5) Singularity of suffering from offensive odor

Ordinary offensive odor substances give no harm physically to human health, although ammonia and hydrogen sulfide do if their concentration is more than a specific value (as much as several tens or hundreds times of the threshold value). Hence, the suffering from offensive odor is limited to the psychological or sensory.

Offensive odor public nuisance is seldomly extended so wide as air pollution. But, it is prominently affected by wind direction and velocity, resulting in remarkable hourly fluctuations.

6) Varieties of generation source

Offensive odor generation sources are many and distributed in a lot of industries since offensive odor comes from putrefaction of animal proteins and fats or combustion and leaks of chemical substances. The industry apt to call public complaints includes medium and small enterprises. The sources are often hard to identify,

different from air or water pollutions.

It should also be noted that putrefaction proceeds rapidly and construction of the building is open in a hot and humid country like Thailand.

7) Difficulty of quantitative determination of offensive odors

Environmental concentration of offensive odor is so low in many cases that its quantity is often impossible to determine by chemical or instrumental analysis. And, most of odor substances are chemically unstable with relatively high reactivity. From this reason, odor sample is thickened and deprived of interference substances before analysis by gas chromatography. Since, however, this work is very complicated, highly reliable measurement is difficult.

Whereas sensory test is superior to instrumental analysis for determination of odor intensity, it cannot identify the causal substance and is affected by personal difference of olfactory sense and variation of weather conditions. Hence, sensory test is sometimes criticized of insufficient objectivity in the final results.

6.3 Prior Matters in the Master Plan

Prior items with priority in the master plan are summarized as follows.

1) Strengthening of the administrative system to supervise and control the odor source factories.
2) Standardization of the methods for measuring and analyzing offensive odors and development of the laboratories and odor measurement system.

3) Improvement and strengthening of the legal systems and administrative organizations for odor regulation.
4) Research and development of and spread the technologies for odor prevention of offensive odors and the spread.
5) Improvement and strengthening of the governmental assistance system for the factories to take measures of offensive odors.
6) Preparation of collective treatment facility of wastewater and solid wastes

6.4 Implementation Program of the Master Plan

This master plan has drawn up the fundamentals to be considered for the government of Thailand to establish the framework for prevention and control of offensive odors, such as preparation of legal system and administrative organization and promotion of prevention measures in Thailand.

Implementation flowchart of the master plan is shown in Figure 6-2.

(1) Short Term Program

1) Establishing the Committee for Study on Offensive Odors

To tackle the problems of offensive odors, the government of Thailand shall establish an administrative organization, the Committee for Study on Offensive Odors, to strengthen the basic study and research such as data collection and analyses of the cases of offensive odors, development of measuring offensive odors, field surveys of offensive odors in factories, and research and development of deodorization technologies. The committee shall be constituted with the concerned agencies and organization including the Department of Industrial Works, MOI, the

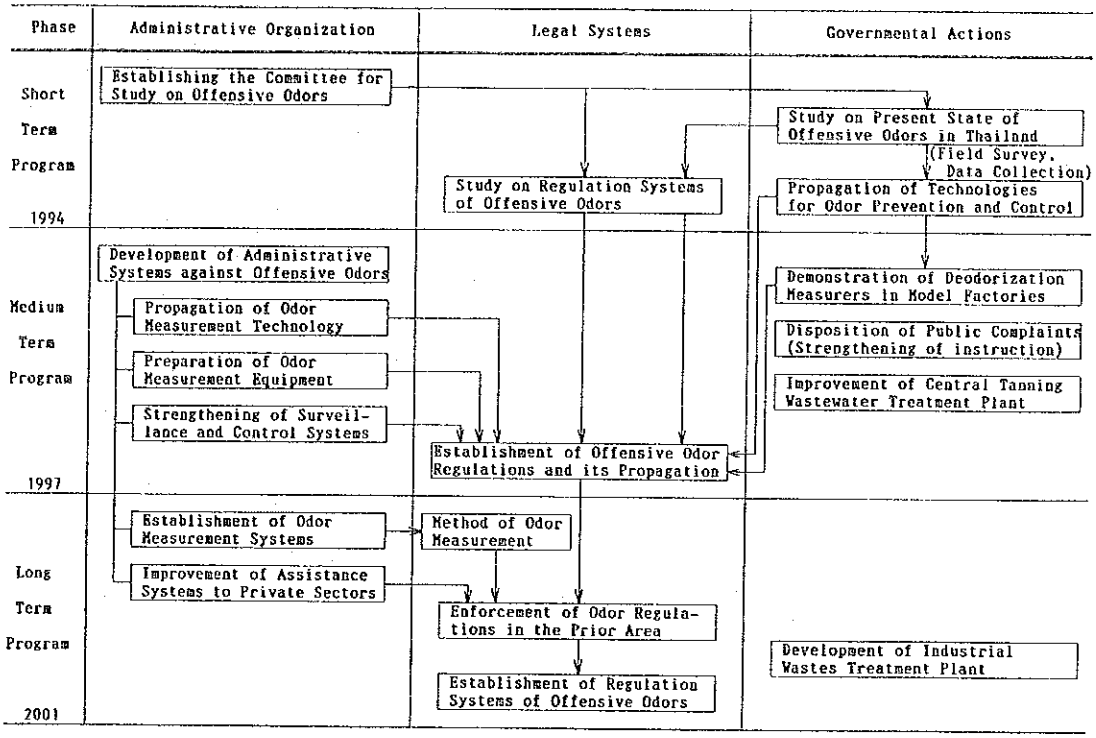


Figure 6-2 Implementation Program of the Master Plan

Department of Pollution Control, MOSTE, and the Environmental Research and Technologic Center, that had experienced to study and measure offensive odors.

The committee shall start the study and discussion for the government to establish the regulations to control offensive odors. Results of the study and discussions shall be reported in the periodical meetings, and the interim report shall be written up by about two years after the establishment.

2) Study on the present states of offensive odors

The committee shall start to perform the study to grasp the present states of offensive odors in Thailand with focusing the field survey of odor measurement. Odor measurement shall be conducted periodically, about one or two times a month, to master the method of odor measurement. The equipment for odor measurement and analysis in the Study

shall be set up in the new building of DIW.

In addition to the field survey the committee shall conduct the study such as data collection and analysis of the cases of offensive odors, inventory of odor source factories, investigation of public complaints, and questionnaire survey of the publics to compile the basic information for establishing the odor regulation systems in Thailand.

3) Propagation of deodorization technology

To propagate deodorization technology, the training shall be performed for the odor source factories and the staff of administration authorities concerned with offensive odors. The committee shall prepare the manual book to introduce the deodorization technology to the publics.

(2) Medium Term Program

1) Propagation of odor measurement technology

The administration for prevention and control of offensive odors is based on the technology of odor measurement and analysis. The training shall be performed on the staff official in charge of environmental administration to spread the odor measurement technology.

The official method of odor measurement shall be established to enact the regulation, after the experience for the Committee to perform the field survey of odor measurement.

To establish the method of odor measurement and to conduct the training of odor measurement technology, experts are to be introduced from the JICA or other foreign cooperation agencies.

2) Preparation of odor measurement equipment

To start the regulation against offensive odors, monitoring stations and odor measurement equipment shall be prepared. Five and more stations shall be prepared for the time being and the number of stations shall be increased together with expanding the area for regulation in the future.

3) Demonstration of odor prevention and deodorization measures in model factories

For propagation of the technology to prevent offensive odors, some model factories shall be selected to introduce the preventive measures of offensive odors. The measures shall be conducted in model factories to demonstrate the effects of deodorization technology which should be spread and promoted to other factories.

4) Establishment of legal regulation and the propagation

While Thailand has the laws and standards on air and water pollution control, there are no regulations in terms of offensive odors. Public complaints about offensive odors, however, is increasing so much that establishing the regulation is required.

The legal regulation against offensive odors shall be adapted to the current legal systems on pollution control that focus on air and water pollution. So it is desirable to improve the current legal systems by supplementing the provisions for regulation of offensive odors.

Moreover, the regulation should reflect the present states of the offensive odors in the source factories and the conditions of public damages around the factories. The government should establish the regulation and enforce it gradually by setting the feasible targets as well as fixing

indispensable and sufficient periods for the factories to prepare the regulation and propagation.

5) Improvement of central tanning wastewater treatment plant

Wastewater of tanneries, the most important sources of offensive odors in the factories, is not treated in each factories but introduced to the central wastewater treatment plant and treated all together. As the capacity of the plant has reached to the limit due to increase of the factories, it is required to improve the plant as well as wastewater canal.

6) Strengthening of surveillance and control systems

In order to cope with the increase of public complaints about offensive odors, the government should strengthen surveillance and control system against odor source factories.

(3) Long Term Program

1) Enforcement of the regulation of offensive odors

Offensive Odor Regulation shall be enforced with adequate suspension periods after the term of promulgation. Moratorium is set for the purpose of propagating the contents of regulation to the publics and establishing or revising the related laws and regulations.

For small and medium scale factories and business establishment, it is necessary to take special concerns such as expansion of moratorium. Moreover, the government authority should establish surveillance and control systems, measurement and analysis systems, and technical and financial assistance systems to the private sectors in order to start the regulation.

2) Establishment of odor measurement systems

The most important matter for the authority to enforce the regulation depends on the odor measurement systems to examine that the offensive odors from the factory satisfy the regulation standards. For this reason, the government should establish the official methods of odor measurement and develop the personnel and equipment for odor measurement in the administration before starting the regulation.

Odor measurement station shall be developed in order before the enforcement of the regulation to cover all factories in the regulation area.

3) Development of industrial wastes treatment plant

Every odor source factories should be responsible for the treatment of the wastewater and wastes, whereas some small and medium scale factories do not have enough capacity to provide the pollution control facility. The governmental authority should support and recommend installing the collective treatment facility or disposal plant which is more effective for pollution control than individual facilities in collaboration with the factories.

4) Establishment of assistance systems to private sectors

The governmental authority shall improve and strengthen the technical and financial assistance systems which promote the installation of deodorization facilities in odor source factories. In order to take special consideration to small and medium scale factories, current assistance systems for pollution control should be reconsidered and reformed.