ENVIRONMENTAL QUALITY MANAGEMENT FOR SELECTED SMALL AND MEDIUM SCALE INDUSTRIES IN URBAN AREAS OF ASEAN: ASSESSMENT, PROBLEMS, RECOMMENDATIONS

UNITED NATIONS ENVIRONMENT PROGRAMME

Regional Office for Asia and the Pacific
Bangkok, Thailand

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F O R E W O R D

This publication is a result of the technical collaboration between UNEP and ASEAN under the ASEAN Environment Programme (ASEP) which has been on-going since December 1978. It is aimed at strengthening regional capability in pollution control and promoting appropriate environmental quality management programmes to serve the needs of ASEAN.

Priority areas under ASEP endorsed by the ASEAN First Ministerial Meeting on the Environment, 30 April to 1 May 1981, in Manila are:

1) Marine Environment (East Asian Seas Programme);
2) Environmental Management including Environmental Impact Assessment;
3) Nature Conservation and Terrestrial Ecosystems;
4) Industry and Environment;
5) Environmental Education and Training;
6) Environmental Information.

Bangkok, Thailand
March 1982

United Nations Environment Programme
Regional Office for Asia and the Pacific

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This paper was prepared by Dr. F.A. Uriarte, Jr., UNEP Consultant. The views expressed herein are those of the author and do not necessarily reflect those of UNEP.

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1. INTRODUCTION

1.1 Terms of Reference

This study was made in connection with the proposed ASEAN/UNEP Workshop on Environmental Quality Management for Small and Medium Scale Industries in Urban Areas. The study's objective was to prepare a background paper for the Workshop in accordance with the following terms of reference:

(i) To assess the environmental quality management situation and needs of small and medium scale industries in urban areas of ASEAN countries. Such industries may include, but are not limited to, electroplating, paints manufacturing, battery manufacturing, and foundries.

(ii) To evaluate the problems both technical and economic which so far had prevented effective abatement measures by the industries, and present regulatory practices of government.

(iii) To recommend joint collaborative programmes for ASEAN which will improve the environmental quality management of small and medium scale industries in urban areas of ASEAN countries.

1.2 Assignment Schedule and Methodology

To carry out the study, the consultant visited Thailand from 2 to 16 December 1981, Singapore from 4 to 9 January 1982, Malaysia from 10 to 23 January 1982, the Philippines from 1 to 14 February 1982, and Indonesia from 15 to 28 February 1982. This report was prepared from 1 to 12 March 1982 at the UNEP Regional Office in Bangkok, Thailand.

To attain the study's objective, information and data were obtained in three ways: firstly, by visiting a number of small and medium scale factories and meeting with the owners, plant managers and/or their representatives; secondly, through meetings and discussions with individuals from the public and private sectors but particularly with government officials involved in environmental policy making and enforcement; and thirdly, by going through annual reports on the state of the environment of ASEAN countries, previous studies on related topics and a host of other books, technical papers and other publications.

The brief descriptions of all factories visited are presented in Appendix A.1; the list of persons met during the visits to the five ASEAN countries is in Appendix A.2; and the list of references is in Appendix A.3.

/2.

2. ASSESSMENT

2.1 Definition of Small and Medium Scale Industry

The definition of small and medium scale industry varies in different countries according to the respective economic and social structures of each country and according to the purposes for which the definition is used. The most common, and to some degree the most useful, definition is the one used by lending institutions for the purpose of providing loans.

In Thailand, the Small Industry Finance Office (SIFO) defines small industries as those industrial enterprises whose fixed assets do not exceed two million baht. There are four categories of industrial enterprises, namely, manufacturing, servicing, handicrafts, and cottage industries, and the SIFO does not take into consideration the number of employees in classifying the size of the industry.

A 1978 study on "Development of Small and Medium Manufacturing Enterprises in Thailand" (Ref. T.5) defines small and medium industries in terms of the size of employment. A small industry is defined as one which employs between 10 to 49 persons while a medium industry is one which employs between 50 to 199 persons. The same study reports the unofficial definition of small industry proposed by the Division of Industrial Service, formerly known as the Small Industry Service Institute. It defines a small industry, in a rather qualitative manner, as one which is modern, in which the owner manages the business and in which business functions are not compartmentalized.

In Singapore, the Economic Development Board (EDB) provides a quantitative definition of a small industry through its Small Industries Finance Scheme (SIFS). The EDB-SIFS provides financial assistance to small but viable enterprises involved in manufacturing, e.g., heat treatment, electroplating, etc. It defines a small industry as one with fixed productive assets, such as factory buildings, machinery and equipments and loose tools for production, not exceeding S$ 2 million.

In Malaysia, the Federation of Malaysian Manufacturers and MIDF Industrial Consultants (A.2.3/Nos. 13 & 14) provide an unofficial definition of small and medium industries. Small industries are generally considered as those with a paid-up capital of M$ 250,000 or less and medium industries as those with paid-up capital greater than M$ 250,000 but less than M$ 2 million.

In the Philippines, the Commission on Small and Medium Industries of the Ministry of Industry defines small industry as any manufacturing or industrial service enterprise with assets between ₱ 0.1 to ₱ 1.0 million and medium industry as any enterprise with total assets of more than ₱ 1.0 million but less than ₱ 4 million.

In Indonesia, the Directorat Jenderal Aneka Industri, Departemen Perindustrian (A.2.5/No. 8) defines a small industry as one with fixed productive assets on building, machinery and equipment of not more than Rp 70 million. For the small industry to avail of loans from KIK, an institution which provides "soft" loans, the industry must be owned and operated by native Indonesians.

Presented in Table 2.1 is a summary of the various definitions of a small industry in the five ASEAN countries. It is apparent from this table that, with the exception of Singapore, the other four ASEAN countries seem to have nearly the same limits in defining a small scale industry. The limit for Singapore is, however, nearly ten times the average for the other four ASEAN countries. Thus, what may be considered as medium industry in Thailand, Malaysia, Indonesia, and the Philippines, is still considered a small scale industry in Singapore for purposes of securing "soft" loans from the government.

From the viewpoint of environmental pollution, the delineation between small and medium scale industry on one hand, and a large industry on the other is more difficult. No official definition exists among the five ASEAN countries. The closest attempt to a quantitative definition is found in Thailand (A.2.1/No. 6) where the Industrial Works Department of the Ministry of Industry generally classifies industries with B.O.D. loading of less than 100 kg per day to be small and medium scale and industries with higher B.O.D. loading as large scale industries. This classification is, however, limited to industries which produce effluents high in organic matter. Industries which produce effluents high in toxic chemical, heavy metals, and other inorganic pollutants cannot be classified under this system.

For the purposes of the present study, the definition in terms of the size of employment seems to be the most expedient since data on the paid-up capital or the fixed assets of the factories are not easy to obtain. Thus, a small industry is defined, in this study, as one with less than 50 employees while a medium industry employs 50 but less than 200 employees.

/Table 2.1

Table 2.1 Summary: Definition of Small Industry

	Paid-up capital/fixed assets (US$)
Indonesia	102,000
Malaysia	109,000
Philippines	118,000
Singapore	955,000
Thailand	88,500

Conversion

US$ 1.00	=	685 Rupiah
	=	2.30 M$
	=	8.50 ₱
	=	2.095 S$
	=	22.60 Baht

Source: Deak-Perera Far East Ltd., Hong Kong; Based on free money market rates quoted in HK money market, 5 February 1982.

2.2 Importance of Small and Medium Industries

In the ASEAN, there is a growing awareness of the economic importance of small and medium industries. Being labour intensive, small industries provide a means of creating employment opportunities at a relatively low capital cost. Experience in the Philippines, for example, indicates that small- and medium-scale enterprises average a low capital outlay of about US$1,000 to US$4,000 per job created. On the other hand, a World Bank Study (Ref. P.9) shows that the outlay of capital resources per job created in modern, large-scale Western industries averages about US$15,000. In the capital-poor and labour-rich ASEAN countries, with the exception of Singapore, the low capital-to-labour ratio best suits ASEAN needs.

Small industries contribute significantly to the strengthening of the industrial structure by allowing the utilization of resources which otherwise would remain idle. Such resources include capital, labour, raw materials, and, more important, entrepreneurship, the seedbeds of which are in small-scale enterprises.

In the Philippines, the Ministry of Industry, through the Commission on Small and Medium Industries and in co-operation with the Development Bank of the Philippines' Special Industrial Guarantee and Loan Fund Programme for Small-Scale Enterprises, aims to establish up to 10,000 small and medium manufacturing and industrial enterprises over the next five years. By 1986, it is projected that over 250,000 new jobs will be created in the course of such development.

In Thailand, a 1978 study (Ref. T.5) reveals that small and medium industries contribute at least 55 per cent of the total value added of the manufacturing sector or more than 10 per cent of the gross domestic product. The study estimates that industries employing between 10 to 49 persons account for at least 30 per cent of the total employment of the manufacturing sector. If small industries employing less than 10 persons are included, the share is more than 50 per cent and if the medium industries are included, the total share is between 75-80 per cent of the total employment of the manufacturing sector.

Based on a 1980 report (Ref. T.4), of the 65,000 factories registered with the Department of Industrial Works, Thailand, about 15,000 are located in the Greater Bangkok area and 98 per cent of these are small-scale industries. These small industries include electroplating, printing, textile, dyeing, polishing, wood finishing, window and door framing, rubber and plastic products, foundries, moulding and stamping and general services for machine and automobile repairing.

/The situation

The situation in the Philippines and Thailand are probably common among the ASEAN countries. Since it is easier for entrepreneurs to get into industry by starting small and since the conditions in the capital cities of the ASEAN countries are more favourable, i.e., availability of infrastructure facilities, proximity to a large market, and easier access to financial sources, then small industries tend to converge in the capital cities of Bangkok, Manila, Kuala Lumpur, and Jakarta. For this reason and because of the employment generated by the small and medium industries, the economic impact of these industries is greatest in the highly urban, capital cities of the ASEAN.

2.3 Environmental Quality Management Situation

The environmental quality management situation of small and medium scale industries in urban areas of ASEAN countries will be presented for four selected industries, namely, electroplating plants, battery manufacturing plants, foundries, and paint factories. Brief descriptions on other industries not listed in the terms of reference will also be made, including tanneries, batik factories, fish meal plants, and rubber processing plants. While all types of small and medium industries in urban areas of ASEAN cannot be covered within the limited time of the study, it is expected, however, that the types of industries listed above are sufficient to make a substantially accurate assessment of the environmental management situation. The depth of treatment for each industry depends on two things: one, the explicit importance given to it by the terms of reference, i.e., the explicitly enumerated industries are given relatively more extensive treatment than others; and two, the importance and commonness of the industry among the five ASEAN countries. For these two reasons, electroplating plants are discussed more extensively among the four selected industries, and tanneries among the other small and medium industries. Batik factories are not common among all five ASEAN countries and are present mostly in Malaysia and Indonesia. Similarly, rubber-processing plants are found mostly in Singapore and Malaysia, and these industries are discussed only very briefly.

In assessing the environmental quality management situation in the ASEAN, the different nature of the situation in Singapore should be considered. The situation is not surprising considering the land area, government structure, and state of economy of Singapore. In more specific terms, there are two things that set Singapore apart from the other four ASEAN countries with respect to the environmental quality management situation for small and medium industries. These are: one, the city has central sewage collection, treatment and disposal systems; and two, the state has a land use, urban renewal, and industry relocation programme that is already in an advance stage of implementation. It is in this context that the environmental quality management situation for small and medium industries in the ASEAN will be viewed.

2.3.1 Electroplating plants

Electroplating plants produce effluents containing varying amounts of heavy metals, toxic cyanides, acids, alkalis, solvents, oils, and suspended solids. Depending on the plating process involved, the wastewaters contain varying amounts of Cr, Ni, Cu, Zn, Cd, Sn, and others. A recent ESCAP report (Ref. G.1) and numerous other publications (Ref. S.15, S.16, G.6, G.7) provide numerous data and information on the electroplating processes, the volume, nature, and characteristics of wastewater effluents and air emissions, the current pollution abatement methods and estimated costs of pollution control. The environmental damages caused by toxic metals and cyanides, including that of mercury, and their effects on the biota have been the subject of numerous studies and reports (Ref. P.12, G.6, G.7, G.8, G.9, G.10) and these are not covered here. The discussion is specifically on the environmental management situation of small and medium electroplating plants in urban areas of ASEAN.

Among the ASEAN countries, Thailand appears to have the most number of small electroplating plants. The total number of these plants in Thailand is not known but it is estimated that a large fraction of these plants are located in the Greater Bangkok area. A 1979 report (Ref. T.6) estimates that annually, metal finishing industries in Bangkok discharge about 12 tonnes of heavy metals into the watercourses. The report lists a total of 116 metal-discharging plants in the Bangkok area which discharge varying amounts of Cr, Ni, Zn, Cu, and cyanides. These are summarized in Table 2.2.

It is quite evident from Table 2.2 that most of the metal-discharging plants are plants that do Ni plating (82 shops), followed by Cr plating (75 shops), and Cu plating (54 shops). Majority of the shops do Cu/Ni/Cr plating, Ni/Cr plating, or Ni/Ni plating.

Two electroplating plants were visited in Bangkok (A.1.1/Nos. 1 and 2). Of the two, one has no treatment facilities while the other has some facilities. The general assessment of the environmental pollution situation for the two plants are:

/Table 2.2

Table 2.2 Metal-discharging Plants in Bangkok Area

District	No. of Factories	Cr	Ni	Zn	Cu	Others
Pomprap	10	9	9	3	3	1
Pra Nakhon	1	0	0	0	1	0
Phayathai	13	0	0	0	0	13
Pathum Wan	5	4	4	1	1	0
Bang Rug	8	6	6	1	4	1
Yannawa	11	9	10	2	5	0
Huay Khwang	1	1	1	0	0	0
Bangkhen	4	2	3	-	2	1
Bang Kapi	2	0	0	0	0	2
Phra Khanong	11	10	11	3	7	0
Min Buri	1	1	1	0	1	0
Bangkok Noi	2	2	2	1	2	-
Bangkok Yai	15	7	9	5	7	1
Klong San	6	6	6	0	4	0
Thonburi	6	5	5	1	5	0
Rat Burana	6	4	5	2	4	0
Bang Khun Thian	7	4	5	3	4	1
Phasi Charoen	7	5	5	2	4	1
Total	116	75	82	24	54	21

(i) It is doubtful if the treatment facilities effectively remove heavy metals and cyanides from the wastewater. The alkaline oxidation of cyanide using chlorine and the acid reduction of hexavalent chromium require some degree of pH and oxidation-reduction potential control. These conditions were not observed during the visit.

(ii) It is apparent that the shops lack trained personnel to properly operate the treatment facilities.

(iii) The design and construction of the treatment facilities can be improved substantially to make them effective.

(iv) Toxic heavy metals and cyanides do, indeed, reach the watercourses due to the absence of adequate treatment facilities.

In the Philippines, the environmental pollution problem from small and medium scale electroplating plants, although quite significant, is not as severe as in Thailand mainly because there are fewer shops of this scale in the Philippines. The requirements of industry for metal-plated materials are met by "in-house" electroplating plants. Thus, a large automobile or appliance factory normally has its own electroplating section to supply the factory's requirements. Sub-contracting to small shops, although present in substantial number, is not as large as in Thailand. It is estimated that there are no more than thirty small electroplating shops in the Metro Manila area.

Three small electroplating shops were visited in the Metro Manila area (A.1.4/Nos. 6, 7 & 8). All three have inadequate ventilation and do not have wastewater treatment facilities. The owners and/or operators of shops gave the following reasons for the lack of treatment facilities:

(i) The effluents require no treatment since it contains only spent rinse water.

(ii) There is no space for the treatment facilities.

(iii) The treatment facilities cost too much and with the volume of their business they cannot afford to buy or construct one.

(iv) The <u>only</u> problem with their wastewaters is that they are acidic. This problem is solved by adding caustic soda to the wastewater before it is discharged into the drain.

A 1979 study on small and medium scale metal-working industries in the Philippines and Thailand (Ref. T.3) reports that more metal working shops in Thailand have electroplating sections than metal working shops in the Philippines. Table 2.3 compares the kind of plating, the volume of the largest tank, electrical capacity per tank, and the number of tanks for shops in Thailand and the Philippines which have electroplating sections.

It is quite evident from Table 2.3 that the small and medium scale electroplating industry is much more developed in Thailand than in the Philippines. In Thailand, Zn, Cr, and Ni-Cr plating predominate while in the Philippines the market seems to be quite variable with some shops doing more than a few types of plating - indicating that the shops cater to "day-to-day" type clients rather than fairly long term type sub-contracts from regular clients.

The sizes of tanks used in Thailand are also more or less uniform, i.e., within 1 to 3 m^3 range while, in the Philippines, some use very small tanks while the others use very large tanks. This apparent standardization of tank sizes indicates higher level of organization and greater degree of development in the practice of the trade in Thailand compared with the Philippines.

The higher electrical capacity per tank and the greater number of shops with more than six tanks indicate that the volume of work for independent electroplating shops is, indeed, very much higher in Thailand than in the Philippines.

These data further confirm the observation made by the Industrial Works Department, Ministry of Industry staff (A.2.1/No. 6) that among the small and medium scale industries in Thailand, the electroplating shops constitute the biggest problem with respect to water pollution.

In Malaysia, small and medium electroplating plants also pose serious environmental pollution problems. A January 1982 study (Ref. M.8) reports that there may be as many as 100 operating electroplating shops in the Klang Valley, including the greater Kuala Lumpur area. The same study estimates the amount of hazardous sludges that are produced by various sources, including electroplating plants. The data are shown in Table 2.4. These data are not confined to small and medium industrial sources but it is reasonable to assume that a substantial portion of the load comes from these sources.

/Table 2.3

Table 2.3 Comparison Between Electroplating Shops in the Philippines and Thailand

Kind of plating	Philippines (%)	Thailand (%)
Zn	7.7	13.9
Cr/Ni-Cr	30.8	72.2
Lead	7.7	0
more than 2	15.4	5.6
more than 3	0	5.6
more than 4	23.1	0
Volume of largest tank (m^3)		
less than 1	30.8	5.6
1 to 3	30.8	72.2
4 to 7	7.7	13.9
8 to 10	0	2.8
11 to 20	0	5.6
more than 20	15.4	0
Electrical capacity per tank (amperes)		
less than 200	38.2	8.3
201 to 500	15.4	47.2
500 to 1200	15.4	27.8
1201 to 3000	7.7	13.9
greater than 3000	0	2.8
Number of tanks		
1	15.4	0
2	15.4	8.3
3	23.1	11.3
4	0	16.7
5	7.7	19.4
6 and more	23.1	44.4

Table 2.4 Hazardous Sludge Production in the Klang Valley

	Sludges, m^3/annum	
	Survey	Proj. 1982
Metal Finishing		
Galvanizing	127	353
Acid pickling	4,520	6,000
Electroplating	330	495
Anodizing	3,000	4,500

The 1973 and 1977 surveys of the Klang River basin and Juru River basin (Ref. M.1), respectively, are quite revealing. It has been estimated that the Klang River basin receives about 3,600 kg/day of toxic heavy metals from various industrial sources while the Juru River basin receives Hg, Pb, Zn, Cr, and Cd amounting to 23 kg/day.

Three electroplating plants were visited in Malaysia, all located within the Greater Kuala Lumpur area (A.1.3/Nos. 9, 10, and 11). All three plants have no wastewater treatment plants and discharge rinse waters directly into the storm drains. One shop does mostly Ni plating for parts of railway coaches. The other specializes in hard chrome plating of machine parts but will soon expand to Ni and Zn plating. The third shop is quite large with 20-30 employees and is capable of doing Ni, Cr, Zn, and Ag/Ni plating. Because of the absence of treatment facilities, these plating shops are sources of toxic heavy metals and cyanides.

In Indonesia, conditions which are substantially similar to those in the Philippines, Thailand, and Malaysia exist, with respect to pollution control in small and medium scale electroplating plants.

Two electroplating plants were visited in the Greater Jakarta area. One has no pollution control facilities while the other has a simple neutralization tank. The shop with no treatment plant does mostly Zn/Ni plating and the wastewater effluent contains Zn, Ni, cyanide, oils, acids and alkalis. The other shop does mostly Ni/Ni/Cr plating which means that the effluent contains Ni, Cr, cyanides and acids.

Among the five ASEAN countries, the environmental pollution control situation of small electroplating shops is most different in Singapore. Eight electroplating plants were visited (A.1.2/ Nos. 1-8) in Singapore, four with wastewater treatment facilities and four without. However, the four without treatment facilities discharge their effluents into the city's sewerage system instead of a nearby watercourse. Of the four shops with wastewater treatment facilities, two shops appear to have adequate facilities and sufficiently trained operators to effectively treat the wastewaters while the facilities of the other two shops need upgrading to be fully effective.

Table 2.5 provides a summary of all the electroplating plants visited in the ASEAN. It is quite apparent from the table that substantial control of environmental pollution from electroplating plants has been achieved in Singapore through the installation of treatment facilities. It is worth noting that the four plating shops with pollution control facilities are all located in industrial estates, i.e., recently relocated from their original sites.

/Table 2.5

Table 2.5 Summary of Electroplating Plants Visited

	Type of Plating	No. of Employees	Years in Site	Pollution Control Facilities
Thailand				
T.1	Cu, Ni, Cr	6-8	>20	none, to klong
T.2	Cu, Ni, Cr	2-3	>30	yes, very inadequate
Singapore				
S.1	Al anodizing	2-3	>18	none, to central sewer
S.2	Ni, Cr	12-13	>20	none, to central sewer
S.3	Ni, Cr	2-3	>10	none, to central sewer
S.4	Ni, Zn, black Zn	10-12	~ 5	none, to central sewer
S.5	Cu, Ni, Sn	9	2-3	yes, about S$ 5,000
S.6	Zn	3	2-3	yes, about S$ 8,000
S.7	Zn	3	2-3	yes, needs improving
S.8	Zn, Sn	7	2-3	yes, needs improving
Malaysia				
M.9	Ni, Cr	4	>30	none, to drain
M.10	Ni, Cr, Zn, Ag	20-30	6-7	none, to drain
M.11	hard Cr	10	~ 5	none, to drain
Philippines				
P.6	Zn	50	~ 4	none, to drain
P.7	Cu, Ni, Cr	12	~10	none, to drain
P.8	Cu, Ni, Cr	8-10	5-8	none, to drain
Indonesia				
I.1	Zn, Ni	10	~ 3	none, to river
I.2	Ni, Cr	40	>15	yes, very inadequate

Deserving special mention is the wastewater treatment plant of MFI Enterprise in Ang Mo Kio Industrial Park II (A.1.2/No. 5). The batch-operated wastewater treatment plant is quite compact and very well-designed. It consists of two concrete collection sumps for acidic and alkaline wastes, and elevated mixing-settling tank made of fiberglass, and a sand filter located underneath the elevated tank. Wastewater is pumped from the collection sump into the mixing tank where treatment chemicals are added. Once precipitation of metal hydroxides is complete, the mixer is turned off and settling takes place. The settled sludge is drained off into the sand filter which has a filter cloth on top for easy removal of the filtered solids. The treated effluent is drained off into the sewer.

The data presented in Table 2.5 indicate that in the ASEAN, with the possible exception of Singapore, the control of environmental pollution from small electroplating shops appears to be grossly inadequate. With more than 100 small plating shops in the Greater Bangkok area, nearly 100 operating shops in the Klang Valley in Malaysia, about 50 in Singapore, and in the order of 30 plating shops each in Metro Manila and Jakarta, the management of environmental pollution from these small shops cannot be ignored. On the contrary, specific measures must be taken since these shops cannot be further allowed to discharge heavy metals and toxic chemicals indiscriminately without causing long-term deleterious effects on the environment.

2.3.2 Battery manufacturing

Dry cell battery manufacturing plants produce effluents which normally contain Zn and Hg while automotive and motorcycle battery manufacturing plants produce effluents high in Pb. Two separate studies (Ref. T.7, T.8) in Thailand provide actual data on the concentrations of heavy metals from these industries while a number of pollution control handbooks provide supplementary information (Ref. G.6, G.7). The Thailand studies report that for dry cell battery plants, the effluent may contain 2.4 to 578 mg/l of Zn and 4.1 to 1650 μg/l of Hg; for storage battery plants, the effluent may contain 4.9 to 11.7 mg/l of Pb.

A 1977 study in Thailand (Ref. T.7) on the pollution from storage battery and dry cell factories, reports that there are 23 dry cell battery plants and 16 lead storage battery plants in Thailand. The results of the study are summarized below.

/No. of factories

	No. of factories	
	Storage	Dry Cell
No. of factories	16	23
No. with adequate WWTP	2	0
No. ordered to construct WWTP	3	4
No. ordered to improve WWTP	1	0
No. which stopped operation	2	3
Factories under survey	4	5
Factories to be surveyed	2	6

It is quite evident from the data that in 1977, only 2 out of 39 battery plants had adequate wastewater treatment plants. Furthermore, it is worth noting that 2 storage battery plants and 3 dry cell battery plants had stopped operation.

Notwithstanding the 1977 data from Thailand, the present study indicates that environmental pollution from small and medium scale battery manufacturing plants in the ASEAN, although still significant, appears to be less serious than from electroplating plants. This is the result of two factors: one, there are fewer small and medium scale battery manufacturing plants compared with electroplating plants; and two, most battery plants have, at present, at least primary treatment for their effluents.

Discussions with operators and owners of small and medium scale battery manufacturing plants in the Philippines, Malaysia, and Indonesia reveal that the smaller plants are becoming less and less competitive with modern, large-scale, fully automated battery manufacturing plants which are normally owned by multi-national companies. Notwithstanding the lower cost of labour available to small scale factories, advanced technology and the economy of scale enable multi-national companies to produce better, and sometimes cheaper, batteries. Unlike small electroplating plants which thrive and grow as sub-contractors to larger manufacturing plants, small battery manufacturers do not cater to the sub-contracting business and, on the contrary, are in open competition with the larger manufacturing plants. Furthermore, while battery manufacturing is very sensitive to economies of scale, the electroplating process is not. Thus, unlike electroplating, small battery manufacturing plants appear not to have a bright future in the long term. In this

/connection,

connection, the environmental pollution problems associated with small battery manufacturing plants are expected to decline as economic pressures force the shutdown of uneconomical plants.

These observations agree with the data on firms granted promotion certificates by the Board of Investment, RTG from 1960 to 1980 (Ref. T.10). These data are tabulated below:

	No. of Employees	Capitalization Million Baht
ESB Thailand Co., Ltd.	11	0.3
Yuasa Battery (Thailand) Co., Ltd.	246	9.0
National Thai Co., Ltd.	662	37.0
Siam Battery Industry Co., Ltd.	65	10.0
Associated Battery Mfrs. (Thailand)	230	7.5
Siam G.S. Battery Co., Ltd.	200	14.0
Sam Fah Battery Co., Ltd.	938	12.0

In terms of capitalization, only one may be considered small scale while in terms of the number of employees two would qualify as small and medium scale battery manufacturing plants. The majority, 71 per cent to 86 per cent, of the battery plants given incentives are large scale factories.

Table 2.6 shows a summary of the battery manufacturing plants visited in the ASEAN. The plant in Thailand (A.1.1/No. 3) is actually, by definition, a large-scale multi-national battery manufacturing plant since it has more than 200 employees. The plant in Indonesia (A.1.5/No. 5) is medium scale with the number of employees close to, but not exceeding, 200. Singapore appears not to have any small or medium scale battery manufacturing plant of any significance and no such plant was visited. Singapore seems to have reached that point where only the large and modern battery manufacturing plants can operate competitively.

Worthy of special mention is the battery manufacturing plant in the Philippines (A.1.4/No. 1). This plant buys old lead storage batteries and recovers the lead by re-melting in a furnace. The lead is formed into billets and used in the production of new battery plates. From an over-all environmental management viewpoint, the factory prevents lead in old batteries from leaching into land and/or watercourses by recycle and re-use.

/Table 2.6

Table 2.6 Summary of Battery Manufacturing Plants Visited

	Type	Years in Operation	No. of Employees	Pollution Control Situation
Thailand A.1.1/No. 3	Lead storage	-	>200	adequate
Malaysia A.1.3/No. 5	Lead storage	>15	40	air pollution control: none water pollution control: sedimentation
Philippines A.1.4/No. 1	Lead storage	>12	35	air pollution control: spray scrubber water pollution control: sedimentation
Indonesia A.1.5/No. 5	Dry cell	>20	200	ventilation good; water pollution control: sedimentation

The over-all assessment of the environmental management situation for small and medium scale battery manufacturing plants in the urban areas of ASEAN follows:

(a) Battery manufacturing plants contribute to the total amount of Pb, Hg, and Zn discharged by industries. A significant portion of this comes from small and medium scale factories but this is expected to decrease in the future since economic problems may force the phasing out of small, inefficient battery plants.

(b) Most small and medium battery plants have only primary treatment facilities, and the control of environmental pollution from these factories require substantial upgrading.

2.3.3 Foundries

The typical small and medium scale foundries in the ASEAN produce gray iron castings using cupola furnaces. Either charcoal, coke, or wood is used as fuel. The main source of pollution is the cupola furnace which emits combustion gases laden with particulates.

In the Philippines (Ref. T.3), there are approximately 190 small and medium scale foundries throughout the country and about 40 per cent are concentrated in Metro Manila. A typical foundry produces gray iron casting using cupola furnace having a capacity ranging from 100 to 300 kg per hour. More than 70 per cent of the foundries employ only from 5 to 30 workers. In cases that the firm has to make patterns, natural sand moulds are made using manual moulding methods ranging from 2 to 9 hours per mould of moulding time. Moulds are dismantled and the casting finished by hand with the aid of simple hand tools. Sand for moulds are recycled an average of three times. An average employee produces 0.5 to 1.0 ton per month at an average cost of ₱ 12.00 per kg.

In Thailand (Ref. T.3), there are approximately 300 small and medium scale foundries throughout the country with the number in the greater Bangkok area twice that of all the other regions combined. A typical foundry handles at least two non-ferrous metals in its crucible furnace in addition to gray iron castings from its cupola furnace. The typical production capacities are 500 kg to 3.0 tons per hour for both the cupola and crucible furnaces. The firm does not normally make patterns per job. In case it does, natural sand moulds are made using manual moulding methods. Dismantling of moulds and finishing of casted products are done manually with the aid of simple hand tools. Sand are recycled three or more times. An average employee handles 0.6 to 1.0 ton of castings per month at an average production cost of Bht. 10.00 per kg. Majority of the foundries employ about 30 people but a large number are medium scale with 100 to 199 workers.

Table 2.7 provides a summary of data on foundries visited in Singapore and the Philippines.

In one area in Metro Manila, i.e., Caloocan City, there are almost a dozen small and medium scale foundries which operate both the cupola-type and the tilting-type crucible furnaces. The cupola furnaces are equipped with wet-cap type spray scrubbers which are installed at the outlet of the stacks. The tilting-type crucible furnaces are provided with fume hoods which are connected to cyclonic scrubbers. Induced-draft blowers draw the fumes into the scrubber. The water used in the scrubbers is collected in

/Table 2.7

Table 2.7 Summary of Foundries Visited

	Type	Years in Site	Employees	Pollution Control
Singapore A.1.2/No. 14	two cupola furnaces 10-15 tonnes/ week	>20	100	spray scrubbers
Philippines A.1.4/No. 3	one cupola furnace 0.5 tonne/ load; two tilting-type; furnaces for bronze casting	>20	20	wet-cap scrubber for cupola; cyclonic scrubber for tilting-type furnace
A.1.4/No. 4	one cupola furnace 1.5 tonnes/ load; three tilting-type furnaces for bronze casting	>25	90	wet-cap scrubber for cupola; cyclonic scrubber for tilting-type furnace

large concrete tanks and recirculated. The collection tanks also serve as sedimentation tanks for the removal of suspended solids. Fresh water is added to make up for the amount of water evaporated in the scrubbers and the blowdown. The blowdown constitutes a wastewater disposal problem but the amount is normally quite small to be of much concern. Simple sedimentation normally provides substantial control.

In Singapore, the cupola furnaces are normally equipped with conventional spray chamber-type water scrubbers. The combustion gases are drawn from the furnace into a spray chamber using induced-draft blowers. The clean gases are then directed back into the stack and discharged into the atmosphere. Since Singapore is provided with a sewerage system, disposal of the spent scrubbing liquid poses no problem since it can be discharged directly into the sewers.

In Thailand, foundries have relatively newer machinery and equipment compared with the foundries in the Philippines (Ref. T.3) and casting by small and medium scale foundries is also relatively more active. Scrubbers are also the most common method of air pollution control.

In Malaysia and Indonesia, small foundries do not seem to attract the same attention from government regulatory agencies as in Thailand, the Philippines, and Singapore. In Malaysia, for instance, air pollution from fish meal plants and sawmills seems to occupy a higher order of priority. The same may be true in Indonesia, where pollution from tanneries and batik factories seems to be of higher priority.

A problem inherent in the operation of foundries is monitoring for compliance. Most small and medium scale foundries operate only one or two days per week, or in some cases, only a few days per month. Although the furnaces are equipped with scrubbers, it is difficult to ascertain if the scrubbers are actually utilized during operation. In many cases, owners of small foundries, who are overeager to minimize operating costs, do not run the pumps for the water spray nor the induced-draft blowers for the gaseous emissions. Detection is difficult since the operation is normally over by the time air pollution complaints reach the government regulatory agency.

A second problem is found in the case of the wet-cap scrubbers for foundries in the Philippines. Pollution control inspectors of the National Pollution Control Commission (A.2.4/ No. 6 and No. 7) reveal that isokinetic stack sampling to determine particulate removal efficiency of the wet-cap scrubbers cannot be done since the scrubbers are placed at the top of the stacks. Monitoring of smoke density using the Ringlemann Chart

/is,

is, therefore, resorted to. Nevertheless, inspectors have expressed satisfaction over the performance of most wet-cap scrubbers. For small foundries which operate only a few days every month, these scrubbers seem to provide substantial reduction in particulate emission.

The over-all assessment of the environmental management situation for small and medium scale foundries in the ASEAN is that substantial progress seems to have been achieved by regulatory agencies in Singapore, the Philippines, and Thailand in minimizing air pollution from these sources. In a manner similar to the electroplating plants, small foundries thrive in the urban areas to meet sub-contracting needs of larger industries. About 35 per cent of small and medium scale foundries in the Philippines and Thailand have invested only between US$ 35,000 to US$ 60,000 on machinery and equipment - thus making the industry within easy financial reach of entrepreneurs. Because small and medium scale foundries exist in large numbers in the urban areas of ASEAN and because the number is expected to grow as a result of industrialization, environmental pollution control for foundries will also increase in importance.

2.3.4 Paint factories

Paint factories may be classified into two general types: one, those factories which produce the resins and pigments that they use for making paints; and two, those that purchase from outside sources all the resins and pigments that they use for making paints. Factories that belong to the first type operate batch-type polymerization reactors which must be provided with air pollution control facilities. In addition, wastewaters are produced during the washing and cleaning of the reactors. The gaseous emissions and wastewater effluents arising from the operation of the reactors are not present in paint factories of the second type. Factories belonging to the second category are concerned mostly with wastewaters coming from the cleaning of containers used for the mixing of various paint pigments. Depending on the type of paint produced, the wastewaters may contain oil-based paints or water-based paints.

Small and medium scale paint factories in ASEAN normally purchase their resins and pigments from outside sources instead of producing them. These factories, therefore, produce wastewaters mostly from the cleaning of containers used for mixing or storing paints at various stage of production.

Experience in the Philippines (Ref. P.13, P.14) shows the following characteristics of the wastewaters from the two types of paint factories:

/First Type

	First Type	Second Type
pH	5.8-9.5	4.8-5.9
C.O.D., mg/l	2,030	590
B.O.D., mg/l	1,000	300
Suspended Solids, mg/l	280	370
Total solids, mg/l	1,190	1,610

Depending on the types of paints produced, wastewater effluents from paint factories may contain moderate levels of heavy metals such as Hg and Pb. Data from a study in Thailand (Ref. T.8) indicate the following levels: Hg, 43 to 8,954 µg/l; Pb, 103 to 870 µg/l; and Zn, 140 to 550 µg/l.

Scrubbers are the most common type of air pollution control devices used for controlling emissions from paint factories. For oil-based paint wastewaters, solvent recovery by evaporation is one of the best proven process since this results not only in pollution control but also in the recovery of valuable solvent. For water-based paint wastewaters, treatment by coagulation-flocculation followed by clarification is the most common. In some instances, an aerobic pond precedes chemical treatment in order to decrease the B.O.D. of the final treated effluent. In most instances, $FeCl_3$ seems to be the most effective coagulant although organic polyelectrolytes are used, together with $FeCl_3$, as coagulant-aid and flocculant.

Although the number of small paint factories in the urban areas of ASEAN is not known, it may be quite safe to assume that they are very few in number and that they apparently do not cause significant environmental pollution problems. This becomes the obvious conclusion when government environmental regulatory agencies are unable to identify any small scale paint factory worth visiting.

Data on paint factories in Thailand which have been granted promotion certificates by the Board of Investment, RTG from 1960-1980 (T.10) indicate that there are a total of 18 firms. Of these, only one has capitalization of less than Bht. 1.0 million, six with less than or equal to Bht. 5.0 million, and eleven with more than Bht. 5.0 million. In terms of number of employees, however, all 18 plants have less than 200 employees. With capitalization of more than Bht. 5.0 million, most paint factories are indeed really large scale manufacturing plants, notwithstanding level of employment, since the low employment level is presumably the result of modernization and automation.

/Table

Table 2.8 presents a summary of some data obtained on three factories visited in Singapore, the Philippines, and Indonesia. The initial observation that small paint factories do not seem to cause environmental pollution problems of enough significance to be of concern to government regulatory agencies is further supported by data from Table 2.8. Of the three plants visited, one is obviously large scale with about 800 employees while the two are medium scale with 100 and 150 employees, respectively. However, although the Philippine factory has only 150 employees, it is actually a modern, multi-national owned and operated factory which has fixed assets of much more than ₱ 4 million.

It is quite interesting to note that all of the factories visited seem to have solved all their wastewater disposal problems. The Singapore factory claims that the wastewaters from oil-based paints are sold to buyers who apparently use the waste to facilitate clearing of forests in Malaysia. The waste solvent is sprayed on forested areas to be burned for clearing. The water-based paint wastewater is treated by coagulation-flocculation, using $FeCl_3$ and an organic polyelectrolyte, followed by sedimentation and sand filtration. The treated effluent discharges into the city's sewer system.

The Philippine factory has complete air and water pollution control facilities. Air emissions are controlled using scrubbers; solvent is recovered from oil-based paint wastewater and the water-based paint wastewater is treated by oxidation-precipitation using $KMnO_4$.

The Indonesian factory has no treatment facilities at all but claims that both the oil-based and water-based paint wastewaters are sold to makers of low quality, dark coloured paints. These claims are difficult to verify but the re-use of the wastewaters is completely feasible provided a market exists for low quality, dark colour paints.

The over-all assessment of the environmental management situation for small and medium scale paint factories in the urban areas of ASEAN follows:

(a) The data suggested that the number of small paints factory is low and as a result they do not constitute a significant factor in the over-all environmental pollution situation.

(b) The larger number of paints factory belong to the medium and large scale category. These factories normally have access to the technology to control pollution being multi-national in nature.

/Table 2.8

Table 2.8 Summary of Paint Factories Visited

	Type	Years in Site	Employees	Pollution Control
Singapore A.1.2/No. 11	oil-based and water-based paints	>30	100	Type 1 batch type coagulation-clarification treatment for water-based paint wastewater; oil-based waste sold to buyers; no information on air pollution control system.
Philippines A.1.4/No. 2	oil-based and water-based paints	>3	150	Type 1 spray scrubber for air pollution control; oxidation-precipitation for water-based paint wastewater; solvent recovery system for oil-based paint.
Indonesia A.1.5/No. 7	oil-based and water-based paints	>30	800	Type 2 both oil-based and water-based wastewater sold to makers of lower quality, dark coloured paints.

(c) The environmental management situation for small and medium scale paint factories is, in most instances, well under control.

2.3.5 Other small and medium industries

In addition to the four types of industries explicitly enumerated in the terms of reference, four other types of industries were studied. The selection of the other four types of industry depended largely on the recommendations of the environmental regulatory agencies in each ASEAN country. As a result, factories belonging to the following four industries were visited: tanneries in Singapore, Malaysia, the Philippines, and Indonesia; batik factories in Malaysia and Indonesia; fish meal plants in Malaysia and the Philippines; and rubber processing plants in Singapore and Malaysia. Other small industries such as a photo processing laboratory in Malaysia, car repair and rust-proofing shops in Singapore were visited but these will not be discussed here. Brief descriptions of all factories visited, including some large scale factories in Indonesia and Malaysia, are presented in Appendix A.1.

Needless to say, the level of treatment in presenting the other four small and medium industries cannot be as deep as those for electroplating, battery, paint, and foundry. To be able to do so would require efforts not possible within the time frame of the present study. Furthermore, such level of treatment is not necessary in arriving at substantially accurate assessments of the problems and needs of small and medium industries in ASEAN with respect to environmental pollution control and abatement.

Tannery. Among the other small and medium industries, tanneries appear to be the most important from the point of view of environmental pollution control. During the meeting of the UNEP Designated Officials for Environmental Matters in September 1978 (Ref. G.11), the Hides, Skins and Leather Industry was selected as one of the six sub-areas of importance for the purpose of preparing operational guidelines on identifying environmental impacts. The UNEP report provides information on the processing operations, health and safety considerations, environmental considerations, and effluent treatment methods.

A recent UN-ESCAP report (Ref. G.2) also discusses the characteristics of wastewater effluents from the vegetable and chrome tanning processes, the potential environmental problems from production processes, and the current pollution abatement technology and costs.

/Among

Among the environmental considerations in tanneries are odours, liquid effluents, and solid wastes. Liquid effluents vary in characteristics depending on the processing methods but they are generally high in organic content (B.O.D. as high as 4,000 mg/l), high in suspended solids (TSS of 8,000-10,000 mg/l), and contains chromium in the order of 50-300 mg/l. Solid wastes include constituents of the hides and skins removed during processing consisting of dirt, grit, manure, hair, hide, scraps, flesh, non-collagenic proteins and salt. Unpleasant odours are normally the result of the release of hydrogen sulfide from the effluents containing sulfides and from the anaerobic action on organic substances.

Table 2.9 provides a summary of some data obtained during the visits to tanneries in Singapore, Malaysia, the Philippines, and Indonesia.

In Thailand (Ref. T.4), 96 tanneries which have a total processing capacity of 240,000 tons of hide per year, discharge approximately 20,000 kgs/day of B.O.D. Majority of the tanneries are located at Bang Poo, Samut Prakarn. The Industrial Works Department of the Ministry of Industry has been working with tannery groups for the construction of joint treatment facilities. Two tannery associations have been formed and the treatment plants are under construction. Upon completion, the B.O.D. loading from the tanneries is expected to be reduced by about 95 per cent.

The situation in Singapore differs from other ASEAN countries as a result of the fact that the city is served by central sewage collection, treatment, and disposal facilities. Since tannery effluents contain mostly organic pollutants, they can be discharged into the sewerage system after primary treatment. This is the case of the two tanneries visited in Singapore.

Worthy of special mention is the solid waste disposal practice in one tannery in Singapore. The firm keeps a crocodile farm within the factory compound and organic solid wastes, consisting of skin scraps, excess fats and flesh and other non-collagenic proteins, are fed to the crocodiles. This solves the problem of organic solid wastes disposal while supplying the farm with feed material. Upon reaching maturity, the crocodiles are slaughtered for their hides which command a good price.

/Table 2.9

Table 2.9 Summary of Tanneries Visited

	Type	Years in Site	No. of Employees	Pollution Control
Singapore A.1.2/No. 9	chrome and vegetable tanning	40	29	bag filters for air pollution control, coagulation-flocculation for wastewater; discharge to sewer of treated effluent.
A.1.2/No. 10	no tanning; salting and liming of skin for export	40	25	crocodile farm for disposal of fats and meat; wastewater treatment plant no longer operating, discharge to sewerage system.
Malaysia A.1.3/No. 6	chrome and vegetable tanning; finished leather goods	15	400, total 150, tannery	excess fats and flesh hauled to landfill; simple sedimentation for wastewater; bag filters for dust control.
Philippines A.1.4/No. 9	chrome and vegetable tanning	35	140	primary settling, aerated lagoon, polishing for wastewater.
Indonesia A.1.5/No. 6	chrome and vegetable tanning	8	200	no pollution control facilities.

In general, tannery effluents are biodegradable and biological treatment processes are normally used. The activated sludge process is the most versatile, but high power costs and greater complexity of operation are its main disadvantages. In the Philippines, biological oxidation using aerated lagoons are the most common method of treating tannery effluents. The treatment plant normally consists of settling ponds and mechanically aerated lagoons followed by polishing ponds. High speed or high rpm mechanical, floating surface aerators are the most popular. Although the cost of operation is lower than that for activated sludge treatment plants, aerated lagoons require large land areas and, therefore, has limited applicability. Nevertheless, this treatment system seems to work well in the Philippines.

In Malaysia, small and medium tanneries have primary treatment facilities while information obtained in Indonesia indicate that most tanneries do have pollution control facilities.

The over-all assessment of the environmental management situation of small and medium tanneries in the ASEAN follows:

(a) Small and medium tanneries contribute significantly to environmental pollution in the form of objectionable odours; liquid effluents containing organic matter, suspended solids, phenols, sulfides, oil and grease, and chromium; and solid wastes.

(b) Since the liquid effluents are biodegradable, the presence of central sewage treatment systems solves most of the wastewater treatment problem since tannery effluents can be discharged into the sewer after primary treatment. This is the case in Singapore.

(c) Thailand and the Philippines appear to have attained substantial progress in controlling pollution from tanneries, but a lot of improvements are still needed.

(d) Malaysia has started looking into the problem of small and medium tanneries while Indonesia should now initiate steps towards effectively controlling pollution from small and medium tanneries.

Batik factories. Traditional "batik" prints are produced as follows: first, wax is applied on portions of the cloth to be made into a batik; second, the cloth is immersed in a dye bath during which the dye is absorbed on the unwaxed portions of the cloth; third, the wax is removed by immersing the dyed cloth in hot water; and fourth, the dyed cloth is rinsed, dried, and folded. Several colours can be applied on the cloth by repeating the first three steps and, as in the previous case, only the unwaxed

/portions

portions absorb the dye. To obtain the rather complex chiaroscuro of colours typical of batik wax is applied by using a metal pattern called cap (pronounced chap) or by hand painting or both. To produce good batik, the wax patterns are applied on both sides of the cloth.

The various steps in the batik making process that contributes to wastewater production are: one, the de-waxing operation using hot water produces an overflow containing floating, molten wax; two, the dyeing operation produces spent dye solution; three, the rinsing process produces an overflow containing some wax and other extraneous material; and fourth, general housekeeping wastewaters which contain spills from the dye baths, waxes, and dirt.

The combined wastewater effluent is normally highly coloured, turbid, and with floating waxy substances. The B.O.D. is definitely high, perhaps in the range of 400-1,000 mg/l.

Among the ASEAN countries, Malaysia and Indonesia have the most number of batik factories, perhaps numbering in the hundreds. Being a highly traditional industry, batik factories are mostly small and medium scale in size. Singapore has a number of batik factories which have been relocated into industrial estates and served by the city's sewerage system.

Table 2.10 presents a summary of some data obtained from batik factories visited in Malaysia and Indonesia. All three factories have no wastewater treatment facilities and information obtained indicate that most, if not all, small and medium batik factories do not have wastewater treatment plants. Since there are hundreds of these factories, their effluents contribute significantly to environmental pollution.

Of particular interest is the fact that a number of batik factories recover the wax that floats on the surface of the hot water during the de-waxing operation. This wax is either reused together with virgin wax or sold to outside buyers. This is of great interest since any attempt to develop the technology for a cost-effective method of treating batik factory effluents should start with an efficient method for the recovery, and subsequent reuse, of the wax.

The over-all assessment on the environmental management of small and medium scale batik factories are:

(a) Water pollution arising from the discharge of untreated wastewaters appears to be significant in view of the reported number of batik factories in Malaysia and Indonesia.

/Table 2.10

Table 2.10 Summary of Batik Factories Visited

	Type	Years in Site	No. of Employees	Pollution Control
Malaysia				
A.1.3/No. 12	cap and hand application of wax	>10	5-6	no pollution control facilities
Indonesia				
A.1.5/No. 3	cap and hand application of wax	35	200	no pollution control facilities; with wax recovery
A.1.5/No. 4	cap and hand application of wax	35	40-60	no pollution control facilities; with wax recovery

(b) A cost-effective technology to recover used wax more efficiently from the de-waxing operation should be the logical first step in wastewater treatment.

(c) Because of the presence of central sewerage facilities in Singapore, and the absence of or the presence of only a few batik factories in the Philippines and Thailand, these countries do not have the same problems as Malaysia and Indonesia with respect to pollution from batik factories.

Fish meal plants. The recent UN-ESCAP report (Ref. G.5) on the methods and costs of industrial pollution control in the fish processing industry discusses the manufacturing processes, sources and characteristics of environmental pollutants, potential environmental problems from fish processing, and current pollution abatement technology and costs. The section on fish meal processing discusses the production of fish meal using offal from groundfish plant and trash fish as principal raw materials.

In most ASEAN countries, fish meal plants are small and use trash fish or reject fish as principal raw materials. The trash fish include fishes which are no longer suitable for human consumption or very small fishes which cannot be sold.

The first step in fish meal processing is cooking. In very small fish meal plants in Malaysia, cooking is done in batches using wood for fuel. In most medium scale fish meal plants, continuous cookers are used, using steam coils for heating. After being cooked, the solid fraction of the cooked material is seprated from the liquid fraction by filtration (in the case of small plants) or by a screw press. The solid fraction is dried, ground, and bagged as fish meal for sale.

In small fish meal plants in Malaysia, drying is done in rotary dryers which are heated directly by burning wood. The dryer is enclosed in brick furnace walls and wood is burned inside the brick furnace directly under the rotating steel drum dryers. In bigger fish meal plants in Malaysia and the Philippines, the drum dryers are steam heated.

Ten small fish meal plants were visited in Malaysia and the Philippined, and some of the data gathered are summarized in Table 2.11. Eight of the small fish meal plants are located near each other and are all adjacent to the sea. All eight plants have no odour control facilities nor wastewater treatment plants. The wastewaters are discharged back to the sea. The ninth plant in Malaysia is located inland and has relatively more modern manufacturing facilities, as described in Appendix A.1.3, but this has also no pollution control facilities.

/Table 2.11

Table 2.11 Summary of Fish Meal Plants Visited

	Type	Years in Site	No. of Employees	Pollution Control
Malaysia				
A.1.3/No. 1	wood-fired, directly heated dryers; similar plants in same area	>6	9-12	all 8 plants have no facilities for controlling odour; no facilities for treating wastewater; water goes back to sea.
A.1.3/No. 2	steam heated dryers	13	35	padi husk-fired boiler has no control device; no odour control facilities; no wastewater treatment plant.
Philippines				
A.1.4/No. 5	steam heated dryers	9	31	two-stage water scrubber for odour pollution control; settling tank for wastewater and spent scrubber water; no control device for wood-fired boiler; also uses oil-fired boiler.

The fish meal plant in the Philippines has a two-stage spray scrubbers for odour control and a settling tank for wastewater effluents.

The future outlook of the fish meal processing industry in ASEAN is quite bright. The ESCAP paper (Ref. G.5) reports that as of 1977, the three ASEAN countries, namely Indonesia, the Philippines, and Thailand, belong to the top 13 fishing nations of the world. Fish production in the ASEAN increased by 588 per cent from 1950 to 1975 compared with the world's 351 per cent increase during the same period.

It is likely that with the increasing fish production in ASEAN, more fish meal plants will be established in the future. For this reason, appropriate technologies for the control of environmental pollution from these plants should be further developed and adapted to the needs of small and medium scale plants. Odour emission control using seawater as scrubbing liquid for fish meal plants located near the sea should be encouraged. For plants located inland, scrubbers using chlorine water or dilute $KMnO_4$ solutions may be installed to minimize odours. However, the design of pollution control facilities must emphasize the use of appropriate, low-cost technologies to suit the needs of small fish meal plants in ASEAN.

The over-all assessment of the environmental management situation of small and medium fish meal plants in ASEAN is that present pollution control facilities are inadequate; and because all indications point to a growing number of similar plants developing in the ASEAN, closer attention should be given by regulatory agencies to this industry.

Rubber processing plants. The processing of raw rubber into Standard Singapore Rubber (SSR) or into Standard Malaysian Rubber (SMR) produces effluents high in settleable, suspended, and floating solids. A small processing plant with a capacity of 20 tonnes per day produces as much as 250-600 m^3 of wastewater per day.

Depending on the quality of the treated effluent that is required, various physical-chemical treatment methods may be applied. The use of a series of simple settling-flotation tanks removes most of the settleable and floating solids. Chemical treatment by coagulation with alum and flocculation using an organic polyelectrolyte followed by clarification produces a very clear effluent.

Two rubber processing plants were visited, one in Singapore and another in Malaysia. A summary of some data obtained is presented in Table 2.12.

/Table 2.12

Table 2.12 Summary of Rubber Processing Plants Visited

	Type	Years in Site	No. of Employees	Pollution Control
Singapore				
A.1.2/No. 13	raw rubber processing to SSR	40	300	very large lagoon as source of process water and receptor of wastewater; process water passes through sand filters; wastewater passes through settling-flotation tanks before entering lagoon.
Malaysia				
A.1.3/No. 4	raw rubber processing to SMR	30	51	settling-flotation tanks only; turbid supernatant goes to drainage.

Based on the observations made and information obtained from the discussions with people connected with the rubber processing plants visited, the total number of small and medium scale rubber processing plants is small. The plant in Singapore, which has been on its present site for more than 40 years but is due for relocation within the next few years, claims to be the only one of its kind in Singapore. In Malaysia, most rubber processing plants are large and fully integrated. On these bases, the over-all assessment of the environmental management situation of small and medium rubber processing plants in ASEAN is that these factories do not constitute a significant factor in the over-all environmental consideration.

2.4 Technical and Economic Problems

Except in a few cases, the problems that have prevented the effective abatement of environmental pollution from small and medium industries in the ASEAN are more economic, rather than technical, in nature. Nevertheless, the two factors are very closely interlinked, since the common goal of environmental engineers is to develop technical solutions to environmental pollution problems that will be economical. Thus, the term "appropriate technology", when used in environmental pollution control in the developing nations, has assumed the meaning of a pollution control technology that is economically viable.

In the case of small and medium industries, the technical and economic aspects of pollution control assume a somewhat different dimension.

First, small industries are generally located in the highly urban centres and, in the case of ASEAN countries, in the already congested capital cities of each country. Availability of infrastructure facilities, proximity to a large market, and easier access to financial sources are the primary reasons for this.

Second, small industries start and thrive without the benefit of long-range project planning and feasibility studies. Entrepreneurs eager to cash-in on attractive business ventures normally want to start immediately and in the most expeditious manner. In addition, the limited capital cannot sustain prolonged and exhaustive pre-operating project planning and projections.

Third, being unable to take advantage of the "economies of scale", small industries maximize profits by minimizing overhead and "unnecessary" expenditures.

/Fourth,

Fourth, small industries are unable to attract people with comparatively high level of technical know-how. Thus, the development of in-house know-how in a non-manufacturing process such as pollution control is quite remote and small industries normally require outside technical assistance for its pollution control.

Fifth and last, small industries have very limited capital which is normally sufficient only to purchase raw materials and keep inventory of raw materials, materials-in-process, and finished products. Thus, any requirement for additional capital investment on "non-productive" items such as pollution control equipment normally upsets cash flow and, therefore, the capital must come from outside sources.

2.4.1 Technical and management problems

Three technical and management problems which so far have prevented effective control of pollution from small and medium industries have been identified. These three problems are: one, the problem concerning personnel; two, the problem concerning monitoring; and three, the problem concerning space.

The first and the most important problem is the lack of sufficiently trained personnel to insure the proper and effective operation of the pollution control facilities. Three examples will be cited to illustrate the importance of this problem.

The first example is found in the treatment of wastewaters from electroplating plants. Of the several methods available for eliminating cyanides from plating wastes, the alkaline chlorination process is the most widely used. It is also the treatment method best suited for the batch treatment of wastes from small electroplating shops. However, to insure that the cyanides are indeed oxidized to carbon dioxide and nitrogen, the treatment is carried in two stages. The first stage is carried out at high pH, normally between 9.5-10.5. Sufficient chlorine is added to reach an oxidation-reduction potential (ORP) of about 400 mv. During the first stage, the cyanides are oxidized to cyanates. To further oxidize the cyanates, which are still toxic, the second-stage treatment is carried out at a lower pH, normally between 8.0-8.5. Sufficient chlorine is added to reach an ORP of about 700 mv. Failure on the part of the treatment plant operator to follow the required conditions will result in either not oxidizing the toxic cyanides completely or producing a gaseous substance even more toxic than cyanide. When the first stage treatment is carried out at a pH much higher than 10.5, the rate of oxidation becomes very slow and the cyanides may not be completely oxidized to

/cyanates.

cyanates. However, if the pH is much lower than 8.5, toxic, gaseous cyanogen chloride is produced which is even more harmful than cyanide. In a batch-operated wastewater treatment plant of a small electroplating shop, where automatic pH and ORP controllers/indicators are not found, well-trained personnel are needed not only to insure effective oxidation of cyanides but also to prevent a worse situation from occurring.

The second example is found in the treatment of foul odours from the dryers of fish meal plants. Obnoxious odours may be oxidized in scrubbers using dilute, alkaline $KMnO_4$ solution or chlorine-water solution as scrubbing liquid. When chlorine-water solution is used, control of the chlorine dosage is important. Too little chlorine results in incomplete treatment while the use of too much chlorine may control fish meal odours but at the same time release toxic chlorine gas into the atmosphere. Again, properly trained personnel are needed to insure effective and optimum treatment.

The third example is found in the chemical treatment of effluents using the coagulation-flocculation process. This type of treatment is used in many industries, e.g., treatment of water-based paint wastewaters, removal of suspended solids from rubber processing wastewaters, etc. When organic polyelectrolyte flocculants are used, dosage control is extremely important. Unlike metal salt coagulants whose effectiveness remains more or less constant when applied at dosages beyond the critical coagulation concentration, organic polyelectrolyte flocculants have optimum dosage levels. Adding too little or adding too much results in the redispersion of flocs and ineffective flocculation. The use of well-trained plant operators is, therefore, necessary to insure optimum performance.

The second problem which has contributed to the ineffective abatement of pollution from small and medium industries is the lack of an effective monitoring system to insure compliance. Because of their size and the manner they are dispersed in urban areas, small factories are difficult to track down. In Bangkok, it is reported (Ref. T.6) that only 50 per cent of small plating shops are registered. The rest are unlicensed and are difficult to monitor. In Singapore, an electroplating plant was just recently discovered to be operating without MOE permit in a flatted factory (A.1.2/No. 4). Since flatted factories are allowed to accommodate only "dry" industries, the aforementioned plant has been scheduled for relocation.

The problem of monitoring is not confined merely to the identification and location of small factories. It also involves the effective supervision of small factories to insure that they do indeed operate their pollution control facilities once these

/are

are installed. To further illustrate the problem, the case of a small electroplating plant may be cited. By force of law, the plant may be required to install a wastewater treatment plant. The daily volume of wastewater being small, a batch-operated treatment plant is installed. When pollution control inspectors come and the treatment plant is not operating, it is easy to claim that the batch treatment is over. However, it is difficult to ascertain if indeed the wastewater underwent treatment or was discharged directly into the drain.

A similar situation exists in the case of a small foundry that operates its furnace only a few days each month. It is difficult to ascertain if, during the short period that the furnace was in operation, the scrubbing liquid pump and the induced draft blower were indeed turned on. It is easy, indeed quite tempting, to try to save on electricity by not operating the control equipment during the short duration that the furnace is in operation.

The third problem is the lack of space. In general, the bigger the space available, the more options there are on the type of treatment and on the engineering design of the plant. When space is available, less expensive treatment options, such as, lagooning, may be considered. Land application of treated or partially treated effluent, as practiced in one battery manufacturing plant in Thailand (A.1.1/No. 3), can reduce over-all treatment cost but this is, very obviously, possible only when land is available. Finally, when biological treatment is needed, as in the case of tannery effluents, the amount of space available may be crucial in determining whether a viable treatment system can be designed and implemented.

An excellent example illustrating the impact of space in determining whether a viable treatment system can be achieved, is found in the two rubber processing plants in Singapore and Malaysia (A.1.2/No. 13, A.1.3/No. 4). In the case of the Singapore plant, the space available is large so that a large impounding lagoon was built. River water and rainwater collected from the roofs of the factory buildings are stored in the lagoon. Process water is pumped from the lagoon through two sets of rapid sand filters and used in the factory. The effluent goes through a series of settling/flotation tanks and then goes back to the lagoon. Since the lagoon is large, a nearly closed system of water use and re-use is achieved. This system is not possible in the Malaysia plant since the space available is smaller.

Of the many types of small and medium industries visited in the ASEAN, electroplating plants, battery manufacturing plants, and foundries have the most severe problem regarding space.

2.4.2 Economic problems

The economic problem which has so far prevented effective pollution abatement measures by small and medium industries in the ASEAN is the relatively high initial capital and operating costs associated with the installation and operation of pollution control facilities.

Published data on actual capital investments and operating costs for pollution control facilities in ASEAN countries are very meagre, even for large industries. For small and medium industries, published data are almost non-existent.

Presented in Tables 2.13 and 2.14 are cost data obtained from discussions with owners and/or operators of small and medium industries in ASEAN. Since 90 per cent of factories visited in the ASEAN have no or inadequate pollution control facilities, accurate and extensive cost data cannot be obtained. Some caution must be exercised in the use and interpretation of the data in the aforementioned tables since owners of small shops tend to "underestimate" initial investment figures on manufacturing facilities and "overestimate" cost figures on pollution control.

Table 2.13 compares the installed cost of manufacturing equipment and machinery with the installed cost of treatment plant machinery and equipment. The data indicate that the installed cost of M&E for the pollution control facilities ranges from 4 to 10 per cent of the installed cost of M&E for the manufacturing plant. For electroplating plants in Singapore the range is from 5 to 10 per cent.

Table 2.14 presents the estimated operating costs for the treatment plants of some electroplating shops in Singapore. The unit costs range from S$1.80 per m^3 to S$4.50 per m^3, or an average of S$2.60 per m^3 of wastewater treated.

A recent paper published in Singapore (Ref. S.15) reports that for a small electroplating plant discharging approximately 10 m^3 of effluent per day, the operating cost is about S$20.00 or S$2.00 per m^3. This figure agrees well with the data from the present study. However, the same paper states that the capital investment for a <u>conventional</u> treatment plant is in the order of S$25,000 to S$60,000.

The aforementioned cost data may be compared with those reported for a large-scale metal and plastic processing plant in Singapore (Ref. G.3). This plant manufactures metal and plastic components used in the assembly of electronic and household equipment. The manufacturing process includes die casting, machining, injection moulding, chemical nickel plating, copper

/Table 2.13

Table 2.13 Installed Machinery and Equipment Cost for Some Small Industries

		Manufacturing M&E Cost	Treatment Plant M&E Cost	Per Cent
A.1.2/No. 5	Electroplating	S$ 100,000	S$ 5,000	5
A.1.2/No. 6	Electroplating	S$ 80,000	S$ 8,000	10
A.1.2/No. 8	Electroplating	S$ 90,000	S$ 6,000	6.7
A.1.4/No. 1	Battery	₱ 500,000	₱ 50,000	10
A.1.4/No. 3	Foundry	₱ 1,500,000	₱ 100,000	6.7
A.1.4/No. 4	Foundry	₱ 2,000,000	₱ 80,000	4

Table 2.14 Operating Cost Data for Treatment Plants of Electroplating Shops in Singapore

	Operating Cost S$/month	Volume of Wastewater m^3/month	Unit Cost S$/$m^3$
A.1.2/No. 5	600.00	180	3.30
A.1.2/No. 6	500.00	110	4.50
A.1.2/No. 8	800.00	440	1.80
Average	630.00	240	2.60

plating, nickel plating, chromium plating, drying, and assembling. The main wastewater sources are: cyanide wastewater, 2 m^3/hr; chromate wastewater, 3.5 m^3/hr; chemical nickel wastewater, 0.2 m^3/hr; acid/alkali wastewater, 14 m^3/hr. The treatment plant consists of cyanide oxidation, chromium reduction, nickel precipitation, acid/alkali neutralization, coagulation, classification, and filtration. The treatment plant costs S$900,000 or approximately 13 per cent of the total capital cost of the whole factory. The operating cost per month is S$9,000.00 or S$0.63 per m^3 of wastewater treated.

It is quite evident from these data that the unit treatment costs for the effluents of small electroplating shops are in the order of 3 to 4 times the unit treatment costs for comparable large scale plants.

When compared with the cost of potable water, the high cost of industrial wastewater treatment becomes even more evident. In Singapore, the highest rate for potable water is S$0.66 per m^3 which is only about 25 per cent of the cost of wastewater treatment for small electroplating shops.

Presented in Tables 2.15, 2.16, 2.17 and 2.18 are data on operating and initial costs for selected industries in the Philippines (Ref. P.20). The data clearly indicate that as the wastewater volume or gaseous emission rate decreases, the unit treatment cost increases. The implication is quite obvious: smaller plants which discharge less effluents and produce less emissions have higher unit treatment costs.

When compared with the cost of potable water, as shown in Table 2.19, the average unit wastewater treatment costs for four types of industries are generally 3 to 5 times that of the average cost for potable water. These data fall within the same range as those obtained for Singapore.

/Table 2.15

Table 2.15 Unit Operating Costs of Wastewater Treatment Plants in the Philippines

Factory Code	WW Volume (m^3/day)	Direct Costs (₱/m^3)	Indirect Costs (₱/m^3)	Total Costs (₱/m^3)
A. Metals, Appliances				
A.1	654	0.41	0.44	0.85
A.2	330	1.41	0.95	2.36
A.3	218	2.14	1.11	3.25
A.4	40	2.18	1.12	3.30
B. Paints				
B.1	114	1.90	0.82	2.72
B.2	2	11.01	15.40	26.41
C. Textile				
C.1	392	1.21	0.41	1.62
C.2	164	1.04	0.56	1.60
C.3	113	1.84	1.07	2.91
C.4	41	3.03	2.49	5.52
D. Food				
D.1	110	2.04	1.94	3.98

Table 2.16 Unit Operating Costs of Air Pollution Control Facilities in the Philippines

Factory Code	Emission Rate (cfm)	Direct Costs (₱/million ft^3)	Indirect Costs (₱/million ft^3)	Total Costs (₱/million ft^3)
A.1	27,300	6.87	2.44	9.31
E.1	13,064	18.23	7.02	25.25
E.2	5,500	13.38	3.91	17.29

Table 2.17 Initial Costs of Wastewater Treatment Plant in the Philippines

Factory Code	Initial Costs (million ₱)	WW Volume (m^3/day)
A. Metals, Appliances		
A.1	0.853	654
A.2	0.936	330
A.3	0.745	218
A.4	0.091	40
B. Paints		
B.1	0.383	114
B.2	0.077	2
C. Textile		
C.1	0.486	392
C.2	0.207	164
C.3	0.245	113
C.4	0.317	41
D. Food		
D.1	0.596	110

Table 2.18 Initial Costs of Air Pollution Control Facilities in the Philippines

Factory Code	Initial Costs (million ₱)	Emission Rate (cfm)
A.1	0.280	27,300
E.1	0.320	13,064
E.2	0.105	5,500

Notes on Tables 2.15 to 2.18:

1. Legend of the different manufacturing plants included in the list:

Factory Code	Product/Activity
A.1	aluminum anodizing
A.2	assembly of household appliances
A.3	manufacture of kitchen ranges
A.4	metal finishing
B.1	manufacture of paints and resins
B.2	manufacture of paints, varnishes, alkyds
C.1	textile
C.2	textile
C.3	blankets and towels
C.4	carpets
D.1	soy sauce
E.1	soft PVC sheets
E.2	matches

2. Direct operating costs include cost of chemicals, power, and labour.

3. Indirect operating costs include cost of maintenance and repairs, depreciation of equipment, and insurance.

4. Total operating costs consist of direct and indirect operating costs.

Table 2.19 Average Total Operating Costs of Wastewater Treatment Plants in the Philippines

	Total Costs (₱/m^3)
Metals and Appliances	2.44
Paints	14.56
Textile	2.91
Food	3.98
Potable Water	0.80

3. RECOMMENDATIONS

3.1 General Approaches and Solutions

The problems which have so far prevented the effective abatement of environmental pollution from small and medium scale industries in the urban areas of the ASEAN have been identified. These problems are: lack of an effective monitoring procedure to insure compliance; lack of sufficiently trained personnel to insure the proper operation of pollution control facilities; inadequate space within the plant premises; and inadequate financial resources to fund the cost of pollution abatement and control.

One approach to solving the environmental pollution from small industries is to treat the effluents collectively. Collective treatment achieves four objectives: one, it minimizes the problem of monitoring since there are fewer treatment plants and these treatment plants are bigger and more easily identifiable; two, it minimizes the problem of lack of trained personnel since fewer treatment plants require fewer people; three, it solves the problem of space since the location of the common treatment facilities can be properly planned in advance to insure that adequate space is available; and four, the "economics of scale" is achieved which should reduce the cost of pollution abatement for each individual factory.

There are two ways to implement the collective treatment process. These are: one, by relocating existing or locating new industries of the same type in one place and providing them with common pollution control facilities; and two, by collecting the wastewater effluents from a group of small factories which are, more or less, in the same general area, and building a common wastewater treatment plant. Both of these methods have been tried previously with varying degrees of success (Ref. T.4, G.4, A.1.2/No. 12).

In Thailand (Ref. T.4), a central treatment plant has been constructed, under the supervision of the Industrial Works Department, for the combined treatment of wastewaters from eleven sugar factories. The IWD has also been working with tannery groups to get them together for the construction of common wastewater treatment facilities.

In Singapore (A.1.2/No. 12), the relocation of industries, which is part of the urban renewal programme of the government, has resulted in some grouping of similar types of industries in different industrial estates. For instance, car and motorcycle repair shops, including car rustproofing shops, have been

/relocated

relocated into five industrial estates. One of these is Alexandra Industrial Estate. Each section of this industrial estate has been provided with a common oil-trap. The oily wastewaters from the repair shops flow into these oil-traps where the oils are removed from the wastewater before it discharges into the estate's sewerage system. Singapore's Ministry of Environment, Sewerage Department prepared the standard-design for the oil traps and supplied the plans and specifications, free of charge, to the industrial estate authority.

The aforementioned cases are examples of the first method of achieving collective wastewater treatment. An example of the second method is found in Osaka, Japan (Ref. G.4) where small paint factories have formed a co-operative which operates a common wastewater treatment plant. Trucks collect oil-based paint wastewaters from each member's factory and deliver the combined wastewaters into the co-operative-owned and operated plant for treatment and recovery of the solvent. The recovered solvent is allocated back to each member factory.

Another effort in the same direction is the project of the Thailand Institute of Scientific and Technological Research (TISTR) to study the feasibility of collecting wastewaters from a number of small electroplating shops and transporting to a central treatment for metal recovery. A previous study (Ref. T.11) concluded that local collection and setting up of common treatment centres appears feasible and practical in some areas within Bangkok.

Industrial estates. The setting up of industrial estates can provide economic solutions for the treatment and disposal of wastes from small and medium industries. It can also provide some distance between the people and the factories and thus minimize the effect of the factories' operations on the day-to-day environment of the people. The experience in Singapore has shown the effectiveness of industrial estates in minimizing environmental pollution. One of Singapore's latest efforts is the phasing out of sawmills in urban areas and relocating them in Sungei Kadut Industrial Estate (Ref. S.1). This exercise was completed in 1980. Of the 37 sawmills relocated, 32 have commenced operation in the new site and 5 in various stages of construction.

In Thailand, the Industrial Estate Authority of Thailand (IEAT) appears to be quite successful in attracting small and medium industries into the industrial estates. There are four industrial estates in Thailand (Ref. T.9), two of which belong to IEAT, namely Lat Krabang Industrial Estate and Bang Chan Industrial Estate. The third, Bang Poo Industrial Estate is a co-operative venture between IEAT and a private group, Thailand Industrial Development Co., Ltd. The fourth industrial estate, Nava Nakhon Industrial Estate, is privately owned.

Of the 52 factories in Bang Chan Industrial Estate, 22 have fifty or less employees (small scale), and 17 have 51-200 employees (medium scale). Thus, seventy-five per cent of the total number of factories belong to the small and medium scale category.

At the Lat Krabang Industrial Estate, out of the total of 19 factories, 16 are considered small scale, 2 medium scale, and only one may be considered large scale. Therefore, about 95 per cent of the total are small and medium industries.

Finally, of the 14 factories in Bang Poo Industrial Estate where employment data are available (total number of factories is 20 but data are not available for 6), 13 belong to small and medium scale category.

While Singapore has been quite successful in relocating existing industries into industrial estates which have central sewage treatment systems, and while Thailand appears to be quite successful also in attracting new small and medium industries into industrial estates, the feasibility of relocating existing industries in the urban areas of ASEAN countries (with the exception of Singapore, of course) into industrial estates depends on a large number of conditions, many of which are external to purely environmental pollution control considerations. The feasibility of relocation depends on strong determination on the part of the national government and on such government programmes as urban renewal and land use. Other factors, like availability of raw materials, supply of qualified labour, and accessibility of the new site also play important roles.

The feasibility of industrial relocation for the sole purpose of providing common pollution control facilities cannot be generalized. It is an option that each government regulatory agency should consider because of potential economic advantages with respect to pollution control. The experience of Singapore in this regard should be studied by the other four ASEAN countries.

On the other hand, the feasibility of wastewater collection into a common treatment plant is very site specific that a generalization of its applicability to all ASEAN countries is not possible. Each case must be studied carefully since its feasibility depends on various factors like proximity of plants to each other, traffic conditions, availability of space close to majority of the plants, and willingness of plant owners to co-operate. The experience in Osaka, Japan and the result of the Thailand study should provide information and guidance to similar efforts in the future.

3.2 Joint Collaborative Programme

To improve the environmental quality management of small and medium industries in urban areas of the ASEAN, a multi-level programme is proposed. On the ASEAN level, the programme consists of two types of projects. The first type of project involves the preparation of manuals on the design and operation of pollution control facilities for each type of small industry. The purpose of the manual is to enable the user to design and operate pollution control facilities for small factories with the minimum of assistance from outside professionals.

The second type of project involves the holding of ASEAN trainor's training courses on the principles, design, and operation of pollution control facilities for each type of small and medium industry. The objective of the trainor's training course is to produce trained professionals who can conduct the training of engineers and/or technicians from small and medium industries in their own respective countries.

Based on the information obtained during the present study, it is recommended that the first two projects deal with the electroplating industry. Thus, it is recommended that the first project involve the preparation of Design and Operation Manual: Pollution Control Facilities for Small Electroplating Plants; the second project involve the holding of a seminar on: ASEAN Trainor's Training Course on the Design and Operation of Pollution Control Facilities for Small Electroplating Plants.

Depending on the success of the first two projects, the ASEAN-level programme may be continued to include the other small and medium industries. The list, according to priority, may include: tannery, foundry, fish meal plant, batik factory, battery plant.

The ASEAN-level programme must be followed by national-level and/or industry-level programmes. These programmes involve the conduct of a number of national-level and industry-level training courses to be attended by the owners, operators, or technical personnel from small and medium industries. The objectives are to train these people in the design and operation of pollution control facilities for their factories and to initiate the formation of industry associations.

It is recommended that the participants in the ASEAN trainor's training course conduct these national- and industry-level training courses. Again, because of its importance, the first training course must be on the pollution control in the electroplating industry.

/3.2.1

3.2.1 Justification

The problems which so far have prevented the effective abatement of environmental pollution from small and medium industries have been identified. These are: lack of trained personnel, inadequate financial resources, inadequate space, and difficulty in monitoring. The proposed joint collaborative, multi-level programme addresses these four problems.

The first type of project involves the preparation of design and operation manual for pollution control facilities for each type of small industry. In the case of the electroplating plants, for instance, a major problem is inadequate space. The design manual for small electroplating plants should, therefore, describe and specify basic treatment plant designs that are compatible with the normally limited space available. Modular treatment plants or elevated treatment facilities may be designed to fit the limited space. Design techniques aimed at solving the space problem may be elaborated in the manual.

The proposed ASEAN Trainor's Training Course addresses the problem of lack of trained personnel. Using the Design and Operation Manual as the main textbook, the trainor's training course aims to produce a sufficient number of well-trained professionals who will, in turn, conduct the training of operators and technicians from small and medium industries in their respective countries.

With guidance from the design manual and technical know-how from the training course, small industries may no longer need the often costly services of outside consultants for the design and supervision of construction of their pollution control facilities. At the very least, consultants' services can be kept to the barest minimum. Under this condition, the overall cost of pollution control is reduced, thereby helping alleviate the problem of inadequate financial resources.

The national and industry level training seminars will also provide a venue for organizing small industries into formal groups or associations. Once such associations are formally organized, identification of individual factories and monitoring of pollution control compliance through the industry associations can be implemented. A self-monitoring system may be encouraged through the association. In addition, dissemination of information is facilitated through the associations.

The likelihood of forming an industry association during a national seminar or workshop is evident from the success of the Seminar on the Electroplating and Metal Finishing Industry in Singapore organized by the Science Council of Singapore in

/March

March 1980 (Ref. S.15). In a survey conducted by the Working Committee on Electroplating and Metal Finishing of the Science Council, an "overwhelming number of the establishments express their support for the formation of a body or association of electroplaters and metal finishers in Singapore."

An excellent example demonstrating the effectiveness of small industry associations in coping with common problems is found in the Philippine Hog Raisers Association, Inc. (Ref. P.12). Through the association, the member hog farms retained the services of a leading engineering consulting firm in the Philippines to design wastewater treatment plants for twenty member hog farms. The result was that each member farm paid only fifty per cent of what similar farms had to pay individually for the same type and quality of services. At present, the same association is discussing with a number of equipment suppliers and contractors for the purchase of equipment needed to implement the prepared plans and designs. With the potential volume of sales, it will not be surprising if the association again obtain offers which are financially advantageous to its members.

It is likely that if an association of electroplating plants is formed, substantial reduction in the cost of designing and constructing the pollution control facilities can be achieved considering the large number of existing electroplating plants in the urban areas of ASEAN. For this reason, it is important that the national-level and industry-level training seminars be used as venues for organizing industry associations.

3.2.2 <u>Design and operation manual</u>

The purpose of the design and operation manual is to enable the user, who has some engineering or technical background, to design, supervise the construction of, and operate pollution control facilities for small and medium factories with no assistance from, or at most, with the minimum of assistance from outside professionals.

In the case of small electroplating plants, the manual may follow the outline presented below.

(i) <u>Introduction</u>

This chapter should outline the contents of the manual and provide guidance on how to best use the manual.

(ii) Fundamentals of electroplating

This chapter should include brief discussions on the basic principles of electroplating, various metal pretreatment methods and practices, and the common electroplating processes, namely, nickel, electroless nickel, chromium, hard chromium, copper, zinc, brass, silver, gold, cadmium, and tin plating.

(iii) Environmental pollution sources and health hazards

This chapter may have three sections: one, a discussion on the occupational safety and health hazards for workers in an electroplating shop, e.g., handling of toxic cyanides, mixing of acids and alkalis, inhalation of fumes, dermatitis or "chrome holes" from chromic acid, etc.; two, a discussion on the nature, characteristics, and amounts of wastewaters; and three, a discussion on the environmental damage that may be caused by pollution from cyanides and heavy metals.

(iv) Design and specification of pollution control facilities

This chapter may have two sections. The first section should discuss the proper design of ventilation systems and chemical fumes control system. Typical cases should be illustrated with pictures and drawings and a sufficient number of sample design calculations and equipment specifications should be presented. The second section should discuss the design of wastewater pollution control system. This should include typical plans, drawings, and specifications including sample calculations. The modular design concept should be discussed.

(v) Operating procedures for pollution control facilities

This chapter should provide detailed instructions on chemical dosages, chemical preparation and addition, pH control and measurement, ORP control and measurement, sludge disposal procedures, and equipment maintenance and trouble shooting. Simple analytical methods for monitoring treated water quality should also be presented including recommended monitoring procedures. Procedures for acid/alkali wastewater separation should be presented in detail.

The design and operation manuals for the other industries may follow the general outline presented here.

3.3.3 ASEAN trainor's training course

The objective of the ASEAN trainor's training course is to produce a number of sufficiently trained professionals who will conduct the training of engineers and technicians from small and medium industries in the design and operation of pollution control facilities.

The general format of the training course may be the same for all industries or it may be modified as experience is gained from previous training courses. For the electroplating industry, the following format is recommended.

(i) Composition/qualification of participants

Four participants from each ASEAN country, or a total of 20 participants, should attend the training course. The suggested composition follows: two from government regulatory agencies, one from the academic community, and one from a consulting company or research institution. The participant should preferably be a chemical or environmental engineer or, at least, have a technical or engineering background.

(ii) Duration/format of training course

Five weeks of intensive training should be sufficient provided the participants are carefully selected and have the right academic background. The Design and Operation Manual that has been prepared previously shall be used as the main textbook and reference material. The first week shall consist of intensive lectures on the principles of electroplating, environmental pollution sources from electroplating plants, and design principles and methods. The second and third weeks shall involve lectures, visits to some small electroplating plants, and on-the-job training on the operation of electroplating plants and pollution control facilities. The fourth week and part of the fifth week shall be the preparation of design projects. The participants shall be divided into five groups and each group will be assigned to design a wastewater treatment plant for an electroplating plant of their choice, which they visited the previous week. The last three or four days of the fifth week shall be devoted to visiting small, medium, and large scale electroplating plants that have adequate treatment facilities and the preparation of the design report by each participant.

(iii) Venue

It is recommended that the first Trainor's Training Course on Pollution Control in the Electroplating Industry be conducted in Malaysia and Singapore.

On-the-job training on the electroplating process and the operation of pollution control facilities can be provided using the facilities at the Standards and Industrial Research Institute of Malaysia (SIRIM), specifically the Metals Industry Technology Development Center. The facilities are located in Shah Alam, near Kuala Lumpur and consist of complete electroplating lines for all types of plating, modern instrumentation, and, most of all, complete air and water pollution control equipment.

By holding the first part of the training course in Malaysia, the participants can obtain first-hand knowledge of the operation of small electroplating plants which do not have treatment facilities while at the same time use the complete and modern facilities at SIRIM for on-the-job training.

The second part which will be held in Singapore will consist of visits to small, medium, and large scale electroplating plants which have pollution control facilities. Among the plants that may be visited are: Kyowa Singapore Pte, Ltd. (large scale); MFP Enterprise, Tse Lup Metal Works, Sin Wah Co. Metal Works (all small scale); and other medium scale plants.

3.2.4 National and/or industry level training seminars

The objectives of the national and/or industry level seminars are two-fold: one, to train owners, operators, and/or technicians from small and medium industries in the design and operation of pollution control facilities for their own factories; and two, to provide a venue for the organization of industry associations.

The format for the training seminars shall be designed by the participants of the ASEAN Trainor's Training Course, as part of their obligation to the sponsoring government agency for the privilege of attending the ASEAN training course. It is suggested that maximum use be made of the ASEAN Design and Operation Manual. The manual may be translated into the national language of each country, if desired.

3.2.5 Funding

It is recommended that UNEP provide the funds for preparing the first design and operation manual for electroplating plants. The manual may be titled: UNEP Design and Operation Manual I: Pollution Control Facilities for Small Electroplating Plants.

For the first ASEAN Trainor's Training Course, funds may come from UNEP, UNIDO, and/or ESCAP. UNEP may provide funds for the consultants who will conduct the training programme and give the lectures. UNIDO may provide funds for the expenses for the duration of the training course. Counterpart funding may be provided by each government for the transportation of trainors from each country. Since the facilities at SIRIM are part of a Japanese government grant through JICA, counterpart funds may be requested from JICA for the expenses during the operation of the facilities.

The national level and industry level training programmes may be funded mostly by each government in the ASEAN. UNEP assistance may come in the form of copies of the design and operation manual for distribution to participants.

3.3 ASEAN Workshop on Environmental Quality Management for Small and Medium Scale Industries in Urban Areas

It is recommended that the proposed ASEAN workshop on environmental quality management for small and medium scale industries in urban areas be replaced by the two projects described in Section 3.2. These are: the preparation of the "UNEP Design and Operation Manual I: Pollution Control Facilities for Small Electroplating Plants" and the holding of the first "ASEAN Trainor's Training Course on the Design and Operation of Pollution Control Facilities for Small Electroplating Plants."

Since the ASEAN Workshop was originally contemplated to be held in Malaysia sometime in July or August 1982, it is strongly suggested that UNEP immediately initiate the preparation of the first manual so that the first ASEAN trainor's training course can be held in August or September.

/Since

Since all the ASEAN countries may be sending representatives to the proposed ESCAP-sponsored workshop/seminar on industrial pollution control to be held in Thailand in June 1982, it is further recommended that the present report be presented during this ESCAP-sponsored meeting together with the colour slides of small and medium industries taken by the consultant during the duration of his ASEAN consultancy assignment.

APPENDICES

A.1 BRIEF DESCRIPTION OF FACTORIES VISITED

A.1.1 Thailand

1. Niatang Commerce
   Bangkok

This is a small electroplating shop located at the back of an electrical parts and goods store. The shop consists of two floors. On the second floor are facilities for cleaning, polishing, and buffing while on the ground floor are the electroplating facilities. There are about 6 to 8 workers, depending on the volume of orders received by the shop. The shop is a family-run business which has been operating for more than twenty years.

The shop can make Cu, Ni, and Cr plating - mostly for automobile parts. It has a wastewater treatment plant fabricated mostly from used 55-gallon drums. The treatment plant consists of facilities for mixing, congulation-precipitation and sand filtration. Wastewater is collected in a tank and treatment is carried in batch - the facilities though were not in use during the visit. The final effluent goes directly into a nearby "klong".

2. Electroplating Plant
   Bangkok

This is an even smaller electroplating shop with only two or three workers including the owner. It has been operating for more than 30 years with skills passed on from father to son. The shop makes Cu, Ni and Cr plating, mostly for motorcycle, bicycle, and automobile parts. It has no wastewater treatment plant and the effluent goes directly into the adjacent klong.

The facilities are quite old and makeshift. One tank, for instance, has been made out of a used plastic tank with the electrodes just placed on top of the tank.

/3.

3. Associated Battery Manufacturers (Thailand) Co., Ltd.
85/2 Moo 13, Sukhapiban 2
Bang Chan, Minburi
Bangkok

This is a medium-sized and modern battery manufacturing plant located in one of the several industrial estates in Thailand. It produces automobile and motorcycle batteries. Both air and water pollution control facilities appear sufficient. The wastewater treatment plant consists of settling tanks, aeration tanks, and filtration facilities. The treated effluent is clear and is used for watering the lawn.

To control the fumes in the section where the batteries are charged, a foaming agent is added on top of the liquid inside the tanks. This foaming solution is discharged with the wastewater and causes the foaming of the treated effluent.

A.1.2 Singapore

1. Yong Hup Electroplating
36 Birch Road (0821)

This shop makes Zn, Cu, Ni and Cr plating and Al anodizing but mostly anodizing of machine parts. It is a small shop with only 2 to 3 employees. It has been on this site for 18 years already.

The shop operates using six plating tanks of various sizes. It consumes about 90 cubic meters of water per month. It has no wastewater treatment plant but is connected to the sewer for its wastewater disposal.

2. Nam Kwong Electroplating
102 Jellicoe Road (0820)

This shop does mostly Ni plating of electronic parts but sometimes does Cr plating. It is larger than the first shop with 12-13 employees. It has also been on this site for more than 20 years.

/Although

Although it is a family-owned factory, the children are not following suit. The shop consumes about 250 cubic meters of water per month. As in the first shop, there is no wastewater treatment plant and the wastes are discharged into the sewer.

3. Mei Champ Electroplating Co.
   17 Genting Lane (1334)

This shop does Ni-Cr plating of furniture and bicycle parts, but mostly subcontracts from adjacent small shops. It is small with only 2-3 employees. It has been on the site for more than 10 years. One worker interviewed stated that she would rather have the shop closed down than have it transferred to an industrial estate.

The shop operates using one Ni bath and one Cr bath.

4. Alcino Industrial Co.
   4th Floor, Ching Shine Industrial Bldg.
   Shaw Road

This shop engages in Ni, Zn, and Zn with black dye plating of TV-radio components. It is located in a private flatted factory building which is supposed to house only dry industries. The Ministry of Environment (MOE) discovered only recently that the factory is in a flatted factory building - it does not have any MOE permit.

The factory has exhaust blowers. It has no wastewater treatment plant but is connected to the sewer for its wastes disposal.

5. MFP Enterprise
   Ang Mo Kio Industrial Park II

This factory does Cu, Ni, and Sn plating of electronic parts. It has a total of nine employees, six of which are in production. The shop has been operating for two years on this site which is about 1250 sq. meters in area and which they rent for S$1,000 per month. The factory costs about S$100,000 with a total operating cost of approximately S$10,000 per month. This includes the monthly water bill of S$150.

/It

It has a well-designed wastewater treatment plant which costs S$5,000. Operating cost is S$500-700 per month, mostly on chemicals. Treatment consists of the standard precipitation - neutralization process. Acid and alkaline wastes are separated in two concrete sumps. Wastewater is treated batchwise in a mixing tank where treatment chemicals and either acid or alkaline wastes for pH correction are added. After settling, the supernatant is discharged and the sludge drains into a sand filter at the bottom. A filter cloth is used on top of the sand filter for easier removal and handling of the sludge.

6. Tse Lup Metal Works
   Ang Mo Kio Industrial Park II

This shop does Zn plating in one section. The other sections do mostly stamping of small metal parts. It has only three employees.

It has a wastewater treatment plant which consists of two mixing tanks and one sand filter. Separation of the CN and Cr streams is practiced. Although the design and layout of the wastewater treatment plant are less impressive than that of the MFP Enterprise (A.1.2/No. 5), this costs S$8,000 with an operating cost of about S$500 per month. The water bill of the plant is about S$110 per month.

7. Sin Wah Co. Metal Works
   Ang Mo Kio Industrial Park II

This plant makes ironing boards at the rate of 700 pieces per month. It also operates one plating tank once a month for Zn plating of parts of the ironing boards. The work force consists of the owner, his son, and one other employee.

Wastewater treatment consists of precipitation and neutralization in one big tank, and removal of the precipitated solids by pumping into the cartridge filter. The cartridges are discarded later. The filter consists of 4 cartridges, each costing S$5.00.

8. Cheng Electroplating Industry
   Ang Mo Kio Industrial Park II

This shop does Zn and Sn plating. There are a total of seven workers in the plant, including the owner. Monthly water consumption amounts to about S$400.

The wastewater treatment plant consists of three tanks where precipitation and neutralization are done. Equipment costs of the wastewater treatment plant is about S$6,000, and operating cost is about S$800 per month.

9. Seng Hong Tannery
   16 Sin Koh St. (1233)

This plant is the only leather tannery in Singapore, doing both chrome and vegetable tanning. It has 29 employees. It has been on this site for 40 years but expects to be transferred to an industrial estate 2-3 years from now. The factory costs S$ 3 million and has a capacity of 1.5 tons per day.

There is a wastewater treatment plant which was built in 1972-1974 at a total cost of about S$100,000. Operating cost for the treatment plant amounts to S$200 per month. Water consumption per month is 300 cubic meters at an average cost of S$0.66 per cubic meter. There is no odour in the factory premises.

10. Chye Seng Tannery Ltd.
    269 Lorong Chuan (1955)

Although called a tannery, this plant does not do any tanning - only preserving of sheep's wool. The skin comes from a local abattoir for salting and liming. The skin fats and meat are removed manually, placed in containers and then fed to crocodiles. There are about 50 crocodiles in the site which take care of their disposal of excess fats and meat. The preserved meat are baled and sent to their tannery in Tokyo. The compound is big and kept clean but some flies and some odour are still present. The owner's house is in the same compound.

/The factory

The factory has a wastewater treatment plant which is no longer operating. They discharge their wastewater into the sewer and pay sewer fees to the Ministry of Environment.

There are plans to transfer the factory to Jurong in the near future. One employee (30 years in employ) who was interviewed says that it is alright, although travel time will increase since most of them live in the Ang Mo Kio area near the present factory site.

11. Federal Paint Factory
1 Jalang Kilang Timor (0315)

The factory produces both oil-based and water-based paints, mostly marine and decorative paints. It has 100 employees and is located in the middle of a housing district.

Wastewater from oil-based paints, e.g., waste solvents, are sold at S$40-50 per 200-litre drum. Buyers use the waste solvents for spraying onto fields which will be burned for clearing. However, the factory intends to install a solvent recovery system within two years.

Wastewater from water-based paints go to a treatment plant which is batch operated. This consists of a rectangular collection tank which also serves as a mixing and settling tank. When the tank is full, the agitator is turned on. Ferric chloride ($FeCl_3$) is added and coagulation takes place. After coagulation, the mixer is turned off and settling takes place.

The supernatant is pumped into a rectangular sand filter and the filtrate goes to the sewer which is connected to the domestic sewage treatment plant of the city. The remaining settled slurry is pumped - using the same submersible pump - into an elevated circular metal clarifier. The thickened sludge goes into another sand filter while the supernatant goes to the first sand filter. Sludge is disposed of with other solids by hauling by private contractors to approved landfill sites. The treated effluent is clear and suitable for sewer discharge but possibly not to a controlled watercourse.

12. Alexandra Industrial Estate

A number of car repair and motorcycle repair shops, including rust-proofing shops, were visited. Repair shops have been relocated into five industrial estates, one of which is Alexandra.

/Shops

Shops which have oily wastewaters are provided with a wash area or have gutters which lead to oil traps. Each section of the estate is provided with an MOE-designed oil trap. The oil trap is designed with three sections. Servicing is done by the estate authority but MOE inspectors make regular visits.

Shop floors are designed so as to prevent spillage of oily water on the streets. Repairs made outside the shops are strictly prohibited. Solid wastes are hauled by the estate owner to control bins from which MOE-operated trucks pick them up.

13. Tropical Produce Co. (PTE) Ltd.
1801 Upper Boon Keng Rd. (1438)

This factory does only pre-processing of rubber using wet and dry process. It is old, having been operational for about 40 years, and is located in a large 12-hectare compound. It has 300 employees operating in two shifts to produce 120 tonnes per day. It is also due for relocation in 1984 to an industrial estate.

The dry process for rubber processing uses no water and produces no pollution.

The wet process uses water from the river mixed with collected rain water. A very large lagoon collects and impounds river water and rain water from the roofs of buildings. Water from the lagoon is pumped through two rapid pressure sand filters before use as process water. Backwash water goes back to the lagoon. This process water is used in the initial stages while city water is used in the final stages of spray.

The used process water goes into a series of settling-flotation concrete tanks. Floating pieces of rubber are collected and reprocessed for use in low-quality rubber products. The underflow goes back to the lagoon.

14. Kwang Soon Wing Kee Engineering Works
63 Soon Wing Road

The plant produces 10-15 tonnes per week of cast iron fittings. It has been on this site for more than 20 years, surrounded by flatted factories. The factory has more than 100 employees.

/The plant

The plant has a cupola furnace equipped with two scrubbers. However, the efficiency cannot be evaluated since the cupola furnace was not operating during the time of the visit.

A.1.3 Malaysia

1. Sam Heng and
   Liam Huat Hin
   Jalan Bagan
   Sungei Besar, Kuala Lumpur

We visited a number of small fish meal factories, all located beside the sea more than 100 kms outside Kuala Lumpur. There are about eight factories in the same area. The factories were not operating during the time of the visit since they were still awaiting the arrival of the fishing vessels. The vessels were expected to arrive at about 1800 hours that day.

Sam Heng has 9 employees during operation (7 hired help and 2 family members) and processes 10-15 piculs raw fish daily. The factory has been operating on the site for nearly six years. Wood (mostly rubber trees) is used for fuel, costing about M$150 per 4 tonnes. It is estimated that 1 picul of fish meal consumes M$ 5 worth of wood.

The process of producing fish meal is as follows: The fish are first washed and then fed into the rotary dryers. The small-sized fish are processed into fish meal since they cannot command good prices at the fish market. Wood is fed into the furnace for heating. Steam comes out of the feeding end of the dryer while combustion gases go out through a stack. The fish becomes nearly pulverized as a result of the turning inside the dryer. The dried fish meal is collected at the other end of the dryer and then sent to a grinder and placed in sacks.

The fish meal is sold at about M$ 55 per picul. Thus, at a daily production rate of 15 piculs, sales will be M$875 per day. At 20 days per month, monthly sales will be M$16,500.

The pollution problems of the fish meal factories are the following: the wash water used for washing the fish is discharged without treatment, the flue gases from the furnace which uses wood for fuel contain particulates, and the steam/vapours from the fish meal that is being dried produces foul odour.

2. Straits Fish Meal
Sekincam, Sabak Bernam

This factory which started operation in 1969 has 35 employees at present and processes 800 piculs raw fish daily or an average of 2000 piculs per month. During the visit, the factory was not operating since it was awaiting delivery of fish. With enough fish, the factory operates 16-24 hours daily. It buys raw fish at M$ 10 per picul and sells the fish meal for M$ 62 per picul.

The factory uses padi husk from a nearby padi mill for fuel. Padi husk is purchased at M$ 1.50 per lorry load - the plant uses about 500 lorries load per month.

To control particulates from the boiler, the plant proposes to install a multi-tube cyclone. At present, however, there is no control device. The factory is far from the sea, hence wastewater from washing of the fish is a problem since there is presently no wastewater treatment plant. Another problem is the odour from the dryer.

The paid husk boiler costs M$400,000. Total equipment cost for the factory is about M$ 1 million.

3. Kilang Padi Perkongsian LPN
Bt. 2, Jalan Bernam
Tanjung Karang

This is a government-owned and operated rice milling factory. The mill processes about 100,000 sacks of padi per season (6 months) - each sack weighing 1.2 piculs. The mill/dryer operates 24 hrs/day in three shifts employing a total of 40 people.

The process involves drying and milling. Light diesel oil is used for drying the padi from 28 per cent to 14 per cent moisture.

Dust collection is quite extensive serving most of the dust-producing equipment. Control is by simple cyclones. The only existing dusting problem is at the padi receiving section. However, dusts are confined within the area.

No external pollution problem exists, except solid waste disposal. Padi husks accumulate outside the mill. For the light husks (i.e., empty grains), open burning is practiced.

4. Ban Lee
Jalan Kelang Lama
Kuala Lumpur

The factory processes raw rubber scrap into SMR (Standard Malaysian Rubber) mostly for export. It has been on the site since 1949 producing 20 tonnes per day. It employes 11 people plus 40 contractual workers.

Water is supplied from three deep wells. Some recirculation of process water is practiced but the volume of the final effluent is still substantial. Wastewater treatment consists only of a series of settling/flotation tanks. The final effluent which goes out into the drain is still quite turbid and brownish.

Odour is present in the storage area for scrap rubber but is mostly confined in the area. Only a slight odour is perceptible outside. However, occasionally foul odour persists outside due to the long storage of scrap rubber.

5. Swee Thye Battery Manufacturing Sdn. Bhd.
3 Jalan 215, Petaling Jaya

The plant has been on the site since 1967 producing 400 units of lead storage batteries and 100,000 units of plates per month. It has 40 employees and the estimated plant equipment cost is M$400,000-500,000.

City water is used in the mixing of lead oxide powder. Wastewater goes into a series of settling tanks. Solids are recovered from the bottom of the tanks every two months while the overflow goes into the storm chain.

One environmental problem of the plant is turbidity and the presence of Pb in the final effluent. Another problem is the fumes that may affect the health of the employees. Fumes are discernible in the section where the batteries are being charged. The owner, however, claims that employees are tested for Pb levels in their bloodstream every six months.

/6.

6. Kulit Kraft
   5 Jalan 19/1
   Petaling Jaya

The plant has been on the site for 15 years producing finished leather goods such as shoes, bags, and others. It uses both chrome and vegetable tanning processes to produce 5000 sq. meters of finished leather every month. It has 400 employees. For the purpose of estimating the total plant cost, it would be useful to know (information was supplied by the owner) that a similar plant with a capacity of 3000 sq. meters per day costs approximately M$ 35 million.

City water is used as process water at the rate of 50,000-60,000 GPD. For vegetable tanning, mangrove bark from Kenya and Mozambique is used.

The wastewater treatment plant consists only of a series of simple settling tanks. The final effluent goes into the storm drain. The tanks are cleaned every two months and the solids are hauled by a contractor together with the other waste solids. Excess fats and flesh (approx. 1 ton/day) from the raw hides which are removed mechanically are disposed of similarly as solid waste.

During the visit, the wastewater tanks were full of scum and the final effluent was still dirty. Odour which was present within the plant premises was, however, not discernible outside.

7. JKR Kuari
   Batu Caves, Kuala Lumpur

During the visit, the plant was under maintenance shutdown. The problem arose from the blasting of nearby limestone rocks which has been stopped due to government regulations. The plant now processes only granite rocks brought in by trucks from Bukit Lanjan which is about 8 miles from the plant site.

The plant produces 700-800 T/D of crushed aggregates and 200-400 T/D of pre-mix aggregates. It has 144 employees.

The factory at the present site will be closed down by the later part of 1982 for transfer to another site at Kajang.

/The plant

The plant seems to have adequate dust control facilities: spray nozzles were observed in the transfer points, conveyors are adequately covered, and the crushing and screening sections have filter bags with a 100-HP blower. The pre-mix section also has adequate control facilities.

8. Photolab
Sungei Wang, Kuala Lumpur

This is a small photo processing store which processes approximately 400 rolls of film daily. It uses automatic processing and printing equipment from Japan.

The estimated water consumptions are: 1000 GPD for the processing machine and 1000 GPD for the printing machine. There is no treatment for the effluent from the machines. Instead, the wastewater flows into the drain outside the shopping complex building through 3-inch diameter PVC pipes.

9. Malaya Railway
Sentul, Kuala Lumpur

This is a very large company with a small electroplating section and a much bigger machine shop and fabrication section. The shop does Ni and Cr plating, but mostly Ni plating. It services only in-house requirements for door handles, and other Ni-plated parts of train coaches. There are three workers in the plating section and one worker in the buffing section.

The shop is well-ventilated and the process tanks are well-laid out with most of them provided with a canvas cover during operation. During the visit, there were no water spillages and the workers seem to be quite careful to avoid spillages.

There is no wastewater treatment plant but the effluent seems to be quite dilute since rinsing water continuously flows from a tap.

10. Electrovac Metal Industries Sdn. Bhd.
23 Jalan Segambut Pusat, Kuala Lumpur

This is a fairly large electroplating shop which has been on the site for 6-7 years. It has 20-30 employees and plates mostly machine parts (hard chrome), bolts, and nuts.

/The plant

The plant has several baths - 3 Ni, 2 Cr, 3 Zn, and 1 Ag/Ni. All of the baths have a standard honeycomb filter which is re-used and then thrown out after 2-3 times of use. Some are even equipped with mist blowers but these were not operating at the time of the inspection.

There is presently no wastewater treatment plant but space is still available at the site for the installation of one. The volume of the final washing water is observed to be large and this goes directly to the drain.

The first and the second rinsing effluents are segregated: the first rinse wastewater goes to a drain at the back of the factory while the second goes to a drain in front of the factory.

11. Interbumi Metals Sdn. Bhd.
    15 Lorong Segambut Tengah 2
    Kuala Lumpur

This shop has been on the site for 5 years, doing mostly machine parts (hard chrome). It is quite small with only 10 employees and 3 Cr tanks. There is no wastewater treatment plant.

It will soon be leaving this site to transfer to a bigger place where they will start doing Ni, Cr, and Zn plating. There is still no provision for a wastewater treatment plant at the new site. The space is very small but a small treatment plant can still fit.

12. Anggerik Villa
    Jalan Genting Klang, Selangor

This is a small batik factory with only 5-6 employees. It is the only batik plant in the area which is a tourist stop. Other batik factories are located in another area.

Water is used for preparing the dye solutions, heating the wax, and washing the clothing materials.

The volume of the wastewater is small, mostly spillages and housekeeping water. There is no wastewater treatment plant and the wastewater goes directly to the nearby fields.

/13.

13. Corinthian Industries (Malaysia) Sdn. Bhd.
    Jalan Kapar

This factory has been on the site since 1974, producing 4000 cu. meters per month of kiln-dried polished lumber using roughly-cut lumber as the raw material. The finished lumber with a maximum size of 10-inch x 2-inch is used mostly as door components. The plant has a total of 376 employees, of which 320 are production workers.

All the machines are equipped with a dust collection system costing a total of approximately M$60,000. About 50 per cent of this total cost is for the imported components such as the cyclone and fan. The other 50 per cent is for the locally-assembled 49-cell multicyclone and its accessories.

A separate air pollution control equipment is provided and this, together with the boiler/furnace, costs around M$300,000. Fifty per cent of the sawdust is used in the boiler, and the excess is collected in a separate cyclone and burned. The resulting stack emission is approximately 0.5 on the Ringelmann Chart.

A.1.4 Philippines

1. Honest Parts and Metal Enterprises
   16th St., Quirino Avenue
   Bo. Tambo, Paranaque
   Metro Manila

The factory produces lead storage batteries and battery plates (200,000 pieces per month) using lead from old, discarded batteries. Lead recovered from the plates of old batteries is melted in a furnace and formed into billets. The billets are re-melted and formed into plates onto which lead oxide is pasted. Lead oxide powder is purchased from regular sources. Old and discarded batteries are purchased at ₱ 20-₱ 30 per piece for car batteries and ₱ 80 per piece for large batteries used for trucks.

The factory started operation in 1970 and has presently 35 employees. The smelting furnace is equipped with a locally fabricated venturi scrubber. The forming room has forced ventilation connected to a spray scrubber. The wastewater from house cleaning and spillage contains lead oxide. This is sent to a settling tank and the lead oxide recovered and re-melted in the furnace together with scrap lead plates.

/The pollution

The pollution control facilities cost about ₱50,000 while the machinery for manufacturing cost about ₱500,000.

2. Ault and Wiborg Co. (Far East)
   Los Pinas, Metro Manila

The company manufactures automotive paints and printing inks and has both water-based and oil-based paints. It has 150 employees and has been on the present site for the past three years.

The factory has adequate air and water pollution control facilities. Air pollution control facilities consist of a spray scrubber system while water pollution control facilities consist of two parts: for the solvent-based paints, the factory recovers the solvent from the wastewater by evaporation and the sludge disposed-of with other solid wastes. For the water-based paints, the wastewater goes into an oxidation-precipitation treatment system. Wastewater is collected in a tank and treated with $KMnO_4$ at the rate of 6 grams $KMnO_4$ per litre of wastewater. The mixture is agitated for 24 hours, and allowed to stand for 3 days. The clear and treated supernatant is discharged while the sludge is collected, placed in drums and disposed-of to a landfill area.

3. U.S. Foundry Corporation
   51 M.H. del Pilar St.
   Caloocan City, Metro Manila

The foundry has one cupola furnace for cast iron with a capacity of 500 kg per load, and several tilting-type furnaces for bronze casting. It has 20 employees and has been in operation in the same location for the past twenty years. The cupola furnace is provided with a "wet-cap" scrubber while the two tilting-type furnaces have a cyclonic scrubber for pollution control. The control devices appear to be adequate. The owner estimates the initial capital cost for the manufacturing facilities at ₱ 1.5 million and the air pollution control devices at ₱100,000, installed cost.

4. Gold Star Foundry
   Maria Clara St.
   Caloocan City, Metro Manila

The foundry has one cupola furnace for cast iron with a capacity of 1.5 tonnes per load, and three tilting-type furnaces for bronze casting. It has 90 employees and has been in operation in the same location since 1953. The cupola furnace is equipped with a "wet-cap" type scrubber while the tilting-type furnaces have a cyclone-type scrubber. Air pollution control appears adequate. The manager estimates the initial cost of productive fixed assets at ₱ 2 million and the pollution control device at ₱80,000, installed.

5. Mabolo Merchandising
   Mabolo St., Santolan
   Malabon, Metro Manila

The factory produces fish meal from rejected fish. Fish is brought in by trucks to the site, rendered in steam-heated cookers, dried and ground using hammer mills. The factory has 31 employees and has been in operation since 1973. The four units of cooker-dryers are equipped with a two-stage spray scrubber for air pollution and odour control. Steam is produced using a wood-fired boiler which has no pollution control device. When wood supply is low, an oil-fired boiler is used.

Wood is purchased at ₱0.80 per piece while the fish mean is sold at ₱3.90 per kilo. Initial capital investment for the manufacturing facilities is placed at ₱2.0 million. The pollution control system can be improved but at present it serves to at least decrease odour and air pollution problems.

6. Metal Finishing Corporation
   Cordero St., 7th Avenue
   Caloocan City, Metro Manila

The factory can do zinc galvanizing of pipes (G.I. pipes) and other construction materials such as tension rods, bolts, and brass, copper, nickel and chrome plating of furniture parts. It is a relatively new factory having been established only four years ago, although the new owners acquired the factory only in 1982. It has a total of 50 employees and consumes a

/maximum

maximum of 80,000 gallons of water per day. Water is supplied from its own deep well. When working in three shifts, the factory can process about 80 tonnes of materials to be electroplated per day.

The factory is generally poorly lit and ventilated. It has no wastewater treatment plant.

7. United Plating, Inc.
   Bonifacio Drive
   Caloocan City, Metro Manila

The factory can do Cu, Ni, and Cr plating. Most of the articles electroplated are furniture parts and motorcycle mufflers. The factory has been in operation at the present site since 1972 and, at present, it has 12 employees. It consumes a maximum of 12,000 gal/day of water from its deep well and processes about 5 tonnes/day of articles. The factory building is quite old, poorly lit and poorly ventilated. It has no wastewater treatment plant.

8. Las Buenas Manufacturing
   20 Macopa St.
   Malabon, Metro Manila

The factory can do Cu, Ni, and Cr plating. The products plated are mostly furniture and bicycle parts. It is a small plating shop inside a fairly old building located within residential areas. It has no pollution control facilities.

9. Hermoso Hermanos Corp.
   Bo. Banga, Meycauayan, Bulacan

This is a leather tannery which started operations in 1945. It has 140 employees and the cost of the manufacturing facilities is approximately ₱12.6 million.

The wastewater treatment process consists of primary settling, aeration using a surface aerator, and polishing in a lagoon before final discharge. The total cost of the pollution control facilities is estimated at ₱900,000.

/A.1.5

A.1.5 Indonesia

1. P.T. Inti Cycle Industry
   Jl. P. Jayakarta No. 19
   Jakarta

The factory consists essentially of two sections: manufacturing section and electroplating section. Steel wires are cut and made into bicycle and motorcycle spokes and then finished by Zn and Ni electroplating. The factory has about 67 workers, ten of which work in the electroplating section. It has been in operation for the past three years and produces about 30,000 to 40,000 gross of spokes per year. One gross sells for about Rp 1,400. The rectifier has a maximum capacity of 1200 amps. but nominally only 900 amps. on a continuous basis.

In the manufacturing section, the machines use lubricating oil at the rate of about 400 litres per month. Used oil is recovered at the rate of about 200 litres per month and sold at approximately Rp 15,000 per 200 litres. This may be compared with new oil which is purchased at about Rp 120,000 per 200 litres.

About 200 meters from the factory is Angka river. The factory has no wastewater treatment plant. The rinse water overflows from tanks and contains Zn, Ni, cyanide, oils, acids and alkalis. Space can be made available if a treatment plant is to be constructed. Ventilation in the factory is fair.

2. Hans Electro Plating
   Jl. Gunung Sahari No. 92
   Jakarta

The factory has two sections: the fabrication section and the electroplating section. Furniture parts are fabricated from steel tubes and then finished using Ni/Ni electroplating. The factory also accepts sub-contracting jobs for electroplating. One big sub-contract is for the Ni/Ni/Cr electroplating of car bumpers.

The owners have been in the business for the past 15 years (probably pioneers in electroplating in Indonesia) and the factory has been operating at the present site for the last 5 years. It employs 40 people and consumes about 40 m^3/day of deepwell water (for pre-cleaning) and city water (for post rinsing).

The factory has a dual-chamber, concrete wastewater treatment plant - it was not operating though during the time of the visit. The treatment plant is used mainly for neutralization and costs about Rp 100,000.

The factory can also accept Zn plating but does mostly Ni/Ni/Cr plating. Car bumpers are given at least 20 microns of coating while furniture parts get 11 microns of coating.

The owner estimates that to put up a similarly-sized factory, equipment and chemicals alone should cost at least US$200,000. The factory electroplates about 500 car bumpers per month and 50,000 motorcycle wheels per month in addition to furniture parts.

Factory ventilation is adequate but housekeeping can be improved by preventing too much water spillage.

3. P.T. Batik Hajadi
Jl. Palmerah Utara 46
Jakarta

The factory produces batik the traditional way. The factory is relatively large with about 200 workers, and it has been in operation for the past 35 years. Typical of any batik factory, the wastewaters come from the following sources: (i) spent water from the de-waxing process; (ii) spent liquor from the dye vats; and (iii) general housekeeping wastewater and spillages.

In this factory, the wax that floats on the surface of the hot water during the de-waxing process is skimmed-off and collected in a separate container. This is then sold to buyers, possibly to other batik factories which produce lower quality batik.

The combined wastewaters are coloured, turbid, and with some floating wax. These are collected in a large tank, allowed to stand, and the supernatant overflows to a nearby storm drain.

Ventilation inside the factory is fair and the workers seem to be able to move about freely within the space available.

/4.

4. Batik Mira
   22, M.P.R. Raya, Cilandak
   Jakarta

This is a relatively smaller batik factory with only 40-60 workers. The factory itself is located behind the residence of the owner and is in what looks like a residential section of the city.

The wax that floats during the de-waxing process is also skimmed off and recovered. The recovered wax is re-used by mixing 50 per cent virgin wax and 50 per cent recycled wax.

There is no wastewater treatment plant and the wastewater, which contains some dyes, wax, and some particulates, discharges into the storm drain.

According to the owner, a very fine lady, her business of batik making has been passed on from her grandmother, to her mother and then to her. Their family has been in the business for more than 35 years.

5. Goldstar Battery Factory
   Jl. Bintang Mas No. 5
   Km. 48, Nanggewar Cibinong

The factory produces about 10,000 to 20,000 dry cell batteries with employees totalling nearly 200. It has a minimum of mechanization and makes maximum use of labour whenever possible. The company has been in operation for more than 20 years, with a factory in Jakarta, but has been in the present site for less than a year. The move is in line with the government's policy of industrial disposal and to avail of the cheaper labour in the new site.

The plant makes Zn casing from Zn ingots, carbon electrode from carbon black powder, and in sufficiently mechanized to produce and assemble the rest of the battery components.

Rainwater is collected in plastic containers and is used in the preparation of the electrolyte. There is very little wastewater produced - mostly from housekeeping in the electrolyte preparation area. A simple sedimentation tank is provided for the wastewater effluent.

The estimated cost of the machinery is about Rp 100 million.

6. P.T. Suka Jujur Leather Factory, Ltd.
   Nanggewer Cibinong

The factory processes about 750,000 ft^2 per month of skins, mostly goat and sheep skins, using the chrome tanning (about 90 per cent) and vegetable tanning (about 10 per cent) processes. It has about 220 workers and has been in operation since 1974.

The wastewater contains substantial amounts of suspended solids, organic matter, and colour and discharges without treatment into a nearby river. Odour is confined mostly within the work area - particularly at the receiving de-hairing areas.

The factory is currently undergoing substantial expansion with the acquisition of new machines, mostly from Europe.

Since the factory's volume of wastewater is quite large and contains not only organic matter but chromium, as well, it contributes heavily to water pollution in the area.

7. Pacific Paint Factory, Ltd.
   Jl. Gunung Sahari XI
   Jakarta

The factory manufactures mostly decorative paints, both solvent-based and water-based. It buys its resins and pigments from outside sources and merely mills and mixes the pigments to produce the desired colours.

Approximately 50 200-litre drums of solvent-based and water-based waste paints are produced from the washing and cleaning of containers. These are placed in containers and are sold to small paint shops which produce only dark coloured, low quality paints which are used as primer paint in some applications.

For as long as there is a market in Indonesia for low quality dark coloured paints, the factory should not cause water pollution problem.

The factory has been operating for over 30 years and at present has about 800 employees.

8. P.T. Unilon Textile Industries
   Jalan Raya Banjaran
   Km. 10.2 Kab. Bandung

The factory is a large integrated textile mill producing synthetic and synthetic/cotton blends of fibres and fabrics. It has been on the site for 9 years and employs approximately 2,000 people. The estimated total plant cost is US$ 10 million, with fully-automated equipment from the spinning to the finishing mill.

There is a complete wastewater treatment plant for its effluent discharges, consisting of two major steps: the chemical treatment step for the 30 m^3/hr flow of the highly-polluted and coloured wastewaters from the sizing, desizing, scouring, and dyeing sections; and the neutralization step for the 90 m^3/hr combined flow from the chemical treatment step and other less-polluted non-coloured wastewaters from the plant.

The chemical treatment consists of collection, addition of $FeSO_4$ (1000 mg/l dosage) and a flocculant (1-2 mg/l dosage) for colour removal, and flotation/sedimentation. The effluent goes to the neutralization tank where lime/sulfuric acid is added for pH correction. The sludge from the sedimentation tanks and floated solids from the flotation tank are pumped into sludge drying beds.

The treatment facilities are adequate and even equipped with auxiliaries, such as chemical metering pumps, a provision for scum-breaking, and sampling points and observation mirror at the flotation tank.

The treatment achieves a fairly good degree of colour and suspended solids removal, judging from the physical characteristics of the final effluent during the time of the visit. The effluent, as it discharges into the nearby river, is only slightly coloured and with a turbidity level which is much lower than that of the receiving body of water.

The total cost of the wastewater treatment plant is estimated at US$500,000. The cost of treatment chemicals is about Rp 120/m^3.

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A.2 LIST OF PERSONS MET DURING CONSULTANCY

This list does not include persons working in or connected with the factories or manufacturing plants visited.

A.2.1 Thailand

1. Dr. Reynaldo M. Lesaca
   Deputy Regional Representative for
   Asia and the Pacific
   United Nations Environment Programme

2. Dr. Dhira Phantumvanit
   Regional Adviser for Asia and the Pacific
   United Nations Environment Programme

3. Dr. Pakit Kiravanich
   Deputy Secretary General
   Office of the National Environment Board

4. Dr. Saksit Tridech
   Division of Environmental Quality Standards
   Office of the National Environment Board

5. Mr. Tawee Pienchob
   Division of Environmental Quality Standards
   Office of the National Environment Board

6. Mr. Boonyong Lohwongwatana
   Chief, Technical Sub-division
   Industrial Works Department
   Ministry of Industry

7. Mr. Chira Panupong
   Deputy Secretary
   Board of Investment

8. Mr. Vitoon Ninnansoontorn
   Division Chief, Office of the Governor
   Industrial Estate Authority of Thailand

9. Mr. Ch. Boonsong
   Industrial Service Institute
   Department of Industrial Promotion

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10. Dr. Saeng Sanguanrang
    Consultant
    Industrial Finance Corporation of Thailand

11. Mr. Issra Shoatburakarn
    Industrial Environment Division
    Department of Industrial Works
    Ministry of Industry

12. Dr. Chongrak Polprasert
    Associate Professor
    Environmental Engineering Division
    Asian Institute of Technology

13. Dr. Subin Pinkayan
    President
    Southeast Asia Technology Co., Ltd.

14. Dr. Wilfredo Clemente II
    Regional Programme Officer
    United Nations Development Programme

A.2.2 Singapore

1. Dr. Fong Seck Kong
   Interim Co-ordinator
   ASEAN Experts Group on Environment
   Ministry of the Environment

2. Ms. Gracie Wee
   Ministry of the Environment

3. Mr. Lim Hung Siang
   Higher Executive Engineer
   Anti-Pollution Unit
   Office of the Prime Minister

4. Dr. Tan Ban Huat
   Engineer
   Anti-Pollution Unit
   Office of the Prime Minister

5. Mr. Chiang Kok Meng
   Chief Engineer
   Pollution Control Section
   Sewerage Department
   Ministry of the Environment

6. Mr. Roland Chan
   Engineer
   Pollution Control Section
   Sewerage Department
   Ministry of Environment

7. Mr. Foong Chee Leong
   Executive Engineer
   Pollution Control Section
   Sewerage Department
   Ministry of Environment

8. Dr. Adhityan Appan
   Associate Professor
   School of Civil and Structural Engineering
   Nanyang Technological Institute

9. Mr. Koh Hee Song
   Manager
   Ulu Pandar Refuse Incinerator

A.2.3 <u>Malaysia</u>

1. Mr. S.T. Sundram
   Director General
   Division of Environment
   Ministry of Science, Technology and Environment

2. Mr. Goh Kiam Seng
   Director, Air Pollution Control
   Division of Environment

3. Mr. A. Maheswaran
   Director, Water Pollution Control
   Division of Environment

4. Mr. Tan Meng Leng
   Principal Assistant Director
   Air Pollution Control
   Division of Environment

5. Mr. Godwin Singam
   Principal Assistant Director
   Water Pollution Control
   Division of Environment

6. Ms. Choong May Chan
   Division of Environment

7. Ms. Safeeyah Baba
   Division of Environment

8. Dr. Rahim Bidin
   Standards and Industrial Research
   Institute of Malaysia

9. Dr. Ong Khong Seng
   Standards and Industrial Research
   Institute of Malaysia

10. Mr. Tan Choon Kok
    Standards and Industrial Research
    Institute of Malaysia

11. Dr. Leong Chee Lu
    Standards and Industrial Research
    Institute of Malaysia

12. Dr. Chong Chok Ngee
    Standards and Industrial Research
    Institute of Malaysia

13. Mr. Lee Cheng Suan
    Senior Assistant Director
    Federation of Malaysian Manufacturers

14. Mr. Senathi Rajah
    Acting General Manager
    MIDF Industrial Consultants Sdn. Bhd.

15. Dr. H. Nakamura
    Western Pacific Regional Centre, PEPAS
    World Health Organization

16. Dr. Antonio Rivera-Cordero
    Environmental Planner
    Western Pacific Regional Centre, PEPAS
    World Health Organization

17. Mr. Tadashi Tanimoto
    Technical Adviser
    National Water Resources Study for
    Malaysian Government

/A.2.4

A.2.4 Philippines

1. Dr. Celso R. Roque
   Executive Director
   National Environmental Protection Council
   Ministry of Human Settlements

2. Ms. Veronica Villavicencio
   Deputy Executive Director
   National Environmental Protection Council

3. Brig. Gen. Guillermo Pecache
   Commissioner
   National Pollution Control Commission
   Ministry of Human Settlements

4. Atty. Hipolito Talavera
   Deputy Commissioner, Enforcement
   National Pollution Control Commission

5. Mr. Pedro Viray
   Officer-in-Charge
   Office of Deputy Commissioner, Monitoring
   National Pollution Control Commission

6. Mr. Rudy Villanueca
   Air Pollution Control Section
   National Pollution Control Commission

7. Mr. Leandro Q. Querubin
   Air Pollution Control Section
   National Pollution Control Commission

8. Mr. Bienvenido Garcia
   Vice President
   TEST Consultants, Inc.

9. Mr. Benedicto Adan
   Vice President
   TEST Consultants, Inc.

10. Dean Marino M. Mena
    Dean, College of Engineering
    University of the Philippines

11. Dr. Leopoldo V. Abis
    Executive Director
    National Engineering Center
    University of the Philippines

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A.2.5 <u>Indonesia</u>

1. Dr. Ir. Herman Haeruman
   Assistant State Minister
   Ministry of Development Supervision
   and Environment

2. Mr. Rachmat Wiradisuria
   Assistant Minister
   Ministry of Development Supervision
   and Environment

3. Dr. R.T.M. Sutamihardja
   Deputy Assistant Minister I
   Office of the State Minister for
   Development Supervision and Environment

4. Mr. Nabiel Makarim
   Office of the Assistant State Minister
   for Development Supervision and Environment

5. Mr. M.S. Kismadi
   Office of the Assistant State Minister
   for Development Supervision and Environment

6. Ms. Masnellyorti Hilman
   Ministry of Development Supervision
   and Environment

7. Ms. Sri Hudyastuti
   Ministry of Development Supervision
   and Environment

8. Ir. Susanto Sahardjo
   Kasub Dit. Aneka Pengolahan Pangan
   Direktorat Jenderal Oneka Industri
   Departemen Perindustrian

9. Ms. Nadia Widjaya
   Direktorat Jenderal Oneka Industri
   Departemen Perindustrian

10. Mr. Bianpoen
    Urban and Environmental Research Center

11. Ms. Ruth Ariani Purwadisastra
    Urban and Environmental Research Center

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12. Mr. Soedirman
    National Institute of Industrial Hygiene,
    Occ. Health and Safety

13. Ms. Taty Nurdjarmen
    Center of Environmental Studies
    Bandung Institute of Technology
    Bandung

14. Mr. E. Surasana
    Bandung Institute of Technology
    Bandung

15. Mr. Badruddin Mahbub
    Environment and Water Quality Branch
    Institute of Hydraulic Engineering
    Directorate General of Water Resources
    Development
    Ministry of Public Works
    Bandung

16. Mr. Andre Mambo
    P.T. Unilon Textile Industries
    Bandung

17. Mr. Aaron Dadang Hidayat
    P.T. Unilon Textile Industries
    Bandung

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