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PREPARATION OF INDUSTRIAL ASPECTS OF NATIONAL REPORTS FOR THREE COUNTRIES (ARGENTINA, EGYPT, THAILAND) FOR THE 1992 UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

US/INT/90/281

Part IV: Thailand*

Prepared for the Government of Thailand
by the United Nations Industrial Development Organization

Based on the work of Joanne Elliot and Chandra Nair,
UNIDO consultants

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* This document has not been edited.

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SECTORAL ANALYSIS FOR INPUT TO UNCED NATIONAL REPORT 1991

COUNTRY: **THAILAND**

SECTOR: **INDUSTRY (MANUFACTURING)**

DATE: **28/6/91**

PREFACE TO THE DRAFT INDUSTRIAL SECTOR REPORT

1. The attached paper is a draft annotated outline for the industrial sector report, the final version of which, once completed by the Ministry of Industry (MOI), will be one of the inputs to Thailand's UNCED National Report. The draft industrial sector report has been prepared by Ms. Joanna R. Elliott, a consultant with Environmental Resources Ltd. of London, with funding from UNIDO. The assistance provided took the form of a two week period of field work in Bangkok, with support from the UNIDO representative office, MOI, the Office of the National Enterprise Board (ONEB) and the Thailand Development Research Institute (TDRI).

2. A number of factors led to a revision of the consultant's terms of reference during the first week of the field work. In particular, the UNCED National Report was found to be in a far earlier stage of preparation than had been anticipated. No outline of the National Report, nor of any of the sectoral reports, had yet been drafted, and no instructions yet passed to the MOI as to the need for their input. Various meetings were held in the first week of the consultant's visit to initiate the process of drafting a summary outline for the industry sector report and agreeing MOI inputs. At a meeting involving the MOI, TDRI, UNIDO and the consultant, it was agreed that the revised terms of reference for the consultant would be to:

1. Assist the MOI in drafting an annotated outline for the industry sector report, focusing on the impacts of the industrialisation process in Thailand with respect to water, air, waste and other environmental issues. This work is to draw principally from the TDRI 11 volume study "Industrializing Thailand and its Impact on the Environment" and is to focus on Thailand's manufacturing industry. Dr. Samarn of the MOI's Department of Industrial Works (DIW) is to act as the consultant's counterpart, and will take responsibility for drafting the final version of the industry sector report after completion of the consultancy period on 28/6/91.

2. Assist the MOI team recently returned from the Nairobi meeting on CFC's to draft an input to the industry sector report for the UNCED National Report. Thailand's strategy for dealing with CFCs is principally the responsibility of the MOI. Responsibility for developing strategies to deal with the other greenhouse gases lies with the ONEB.

3. With respect to the first task above, it is important to define which industries and pollutants are to be covered in the industry sector review. In line with UN classifications and the TDRIs approach to the UNCED National Report, it was suggested that the consultant defines "industry" as manufacturing industry only. Power generation, mining & quarrying, construction, transport & communication, services, agriculture and forestry will be dealt with elsewhere in the National Report.

4. The 11 volume TDRI report on their 1990 end of year conference "Industrializing Thailand and its Impact on the Environment" is used as the primary data source for this study. However, the TDRI work does not necessarily represent the views of the MOI. In particular, some MOI representatives have raised questions about the quality of the TDRI statistical data, for example with respect to hazardous waste volumes. However, given the lack of alternative data, the TDRI work is indeed used widely through this industry sector report, supplemented wherever possible with data from other sources and comments by the MOI.

5. With the exception of CFCs, to be addressed in the second task above, it was agreed that the consultant should cover but not focus on greenhouse gas emissions. Greenhouse gas and ozone depletion issues will be dealt with at a multi-sectoral level in the National Report. The consultant has confined the scope of the attached paper to investigating the environmental impacts of manufacturing industry in terms of air emissions (of SPM, SO2 and NOx), water pollution, and waste disposal, and a preliminary review of CFC's and CO2 emissions from industrial sources.

6. In writing this paper we follow broadly the guidelines for UNCED report preparation entitled "Suggestion for Sectoral Analysis" (Attachment I (9 Nov 90), which elaborate the guidelines given in A/CONF.151/PC.8 and Add.1, based on General Assembly Resolution 44/228. The aim is provide a sectoral report that answers UNCED's main questions and provides the information that the Thailand sub-committee have indicated that they need from the MOI in order to complete the National Report.

7. It is expected that the contents of this preliminary paper will be further developed and refined by the MOI under the supervision of Dr. Samarn, and that a final industry sector report will then be submitted to the sub-committee to be used as one of several sectoral inputs to the UNCED National Report. In particular, the draft MOI action planned in chapter 4, detailing the proposed programme of actions and the implementation requirements for that programme, is very much a first draft and will be revised and added to by various members of the MOI.

8. The overall National Report will eventually be put together by the Thailand UNCED sub-committee, chaired by Dr. Dhira Phantumvanit of TDRI. The sub-committee now expect the report to be ready by the end of September 1991. They would like to request assistance with editing the final report, and are expected to ask for a further man-month of expert assistance during September, probably from UNDP.

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INTRODUCTION TO THE DRAFT INDUSTRY SECTOR REPORT

1. Following a period of policy adjustment and unsteady economic performance during the first half of the 1980s, the Thai economy has achieved an impressive record of economic expansion in the period since 1986, with rapidly growing exports, an investment boom, price stability and narrowing fiscal and external deficits. Underlying these vigorous and well balanced growth trends is a structural shift in industry that has made the economy distinctly export oriented and has established manufacturing as the main export sector. Rice, which had been the leading export commodity of Thailand for many years, was surpassed by textile products in 1985, and by 1987 textile exports were more than double rice exports. Helped by a large influx of foreign direct investment in advance manufacturing industries, Thai manufacturers are now moving into the higher technology and higher value added segments.

2. Industrialisation creates valuable economic benefits ranging from employment and income growth to export earnings and technological development, which ultimately results in improved quality of life for its beneficiaries. There is a price to be paid, however, in terms of industrial pollution of the country's air, water and terrestrial resources, which requires the investment of significant volumes of time and money to clean-up, and, if not cleaned up, rapidly lowers quality of life, thereby eroding the gains of economic development.

3. The government has tried to regulate industry to encourage it to control and treat its industrial wastes. Government intiatives have included the development of environmental regulations, effluent and ambient standards, environmental impact assessment (EIA) requirements and state owned waste treatment facilities. One particular success reported by the MOI has been an estimated 70% reduction in BOD loadings from industry in the Chao Phraya river over the past decade. However, the regulations and standards are not consistently enforced, and when they are, the actions are not necessarily effective. It has proved to be particularly difficult to control the wastes generated by small-medium scale factories. In addition, Thai culture does not easily lend itself to command and control approaches, and, moreover, the introduction and amendment of regulations is a very slow process that alone cannot meet the dramatic change and dynamic growth of Thai industry.

4. It is easy to understand why industry has not taken a more active role in industrial pollution until recently. The largest industrial growth spurt has taken place since 1986, and industry is only now acquiring a collective voice through the Federation

of Thai Industries (FTI), which is making improved environmental quality one of its primary objectives. At the same time, the Department of Industrial Works (DIW) has been experimenting with the privatisation of industrial hazardous waste treatment (at Bang Khuntien) with some success. The growing use of industrial estates under the auspices of the Industrial Estates Authority of Thailand (IEAT) offers another vehicle for dealing with industrial pollution. The improved economics and enforcement aspects of pollution control resulting from organising individual companies into estates is one of the primary goals of IEAT.

5. Until now, individual Thai citizens have been called on to bear the environmental costs of development in Thailand by foregoing traditional uses of surface water, breathing foul air, and risking injury from hazardous waste. While the industrial sector was in its infancy, the urban population was small and Thailand was struggling to industrialise, this was to some extent excusable. Today, however, Thailand has one of the most dynamic and rapidly growing industrial sectors in the world. Many observers have begun to speculate that Thailand may be the next country to join the ranks of the four Asian NICs, i.e. Korea, Taiwan, Hong Kong and Singapore. In line with its rapid development, Thailand's industrial sector is expected to take a greater responsibility for controlling its wastes and minimising its harmful environmental impacts.

6. The contents of the industrial sector report for Thailand are divided into four chapters as follows:

- Chapter 1 - The Growing Importance of Manufacturing Industry in Thailand. In Chapter 1 we answer questions A-D of the UNCED Sectoral Analysis guidelines. We present a review of the industrialisation of Thailand over the past 20 years, an overview of the development of industrial pollution and the pollution control framework, and a summary of the outlook for manufacturing industry and industrial pollution.

- Chapter 2 - The Environmental Impacts of Industrial Development in Thailand. In Chapter 2, we focus on question E of the UNCED Sectoral Analysis guidelines, and the detailed environmental considerations that face Thailand's manufacturing sector.

- Chapter 3 - Current Responses to Industrial Pollution. In Chapter 3, we address questions F-H of the UNCED Sectoral Analysis guidelines, assessing the success of current public and private sector control actions, and where possible, the cost-effectiveness of the mechanisms adopted to date.

- Chapter 4 - An Action Plan for the Future. In chapter 4, we turn to questions I-M of the UNCED Sectoral Analysis guidelines. A final version of chapter 4 is being prepared by the MOI and will detail the priorities now facing the sector, identify the MOI action programme and detail the financial and other requirements for programme implementation.

CHAPTER 1: THE GROWING IMPORTANCE OF MANUFACTURING INDUSTRY IN THAILAND

TRENDS IN THE STRUCTURE OF THE MANUFACTURING SECTOR

1. The structure of Thailand's economy has changed significantly in the last twenty years. Until the end of the 1970's, agriculture was still the leading sector, producing 24.5% of GDP in 1978, while manufacturing produced 20.0%. By 1988, the share of manufacturing had increased to 24.4% and that of agriculture had declined to 16.9%, a trend that is expected to be reflected in further increases in manufacturing share in the figures for 1989-90. Table 1.1 presents a statistical summary of production and employment trends in the Thai manufacturing sector.

Table 1.1 Production and Employment Trends in Thai Manufacturing Industry

	1970	1980	1990e	2000e
Production trends				
Self-sufficiency				
		DATA REQUESTED FROM UNIDO		
Number of employees				
Employment as % total				
Employment as % pop.				

Source: xxxxxxx

Ref: Sectoral Guidelines Question A

2. Thailand's manufacturing sector has undergone a process of continuous restructuring since government policy to promote industrialisation was initiated in the late 1950's. In the 1960's the government pursued a successful import substitution policy, resulting in rapid growth in the food processing, beverage and tobacco industries. To promote industrial development the government established the Industrial Finance Corporation of Thailand (IFCT) and the Board of Investment (BOI) in 1959 and 1960 respectively. In 1969 the Factory Act, with the first regulations for industrial pollution control, was decreed. Table 1.2 givens the number of factories registered with the Department of Industrial Works at the end of years 1969, 1979 and 1989. At the end of 1969 there were approximately 600 factories registered.

3. The 1970's saw domestic market saturation for many import substituting products and a shift towards export promotion. By the end of 1979, almost 20,000 factories were registered with the DIW. Export-oriented industries achieved high growth in the 1970's, particularly natural resource processing industries where

cheap labour formed the basis of Thailand's competitive advantage, such as textiles, garments and rubber. In the 1980's the most rapidly growing manufacturing industries in terms of value added have been those producing finished textile and leather products, food products, chemicals and chemical products, non-metallic mineral products and machinery (UNIDO, 1990), with the number of registered factories rising to over 50,000 by the end of 1989. In summary, over the past 20 years, Thailand has developed a broadly based manufacturing sector that is consistent with its global competitive advantages.

Table 1.2 Major Industries Registered with the Department of Industrial Works (exludes rice and milling factories)

Industry Group	1969	1979	1989	Share of Man. GDP in 1985-89
Food	112	4,200	10,099	14.9%
Beverages	3	60	232	9.5%
Tobacco	0	146	108	4.2%
Textiles	30	764	1,793	14.1%
Wearing apparel	4	226	1,989	10.9%
Footwear & leather	5	97	771	2.8%
Wood & cork	59	1,713	3,353	1.2%
Furniture & fixtures	11	405	1,586	1.2%
Paper & products	7	162	537	1.6%
Printing, publishing	21	817	1,674	1.5%
Chemical prods.	38	632	1,061	4.4%
Petroleum prods.	2	21	32	4.3%
Rubber & products	35	1,089	2,643	2.6%
Non-metallic mineral prods.	20	635	2,798	4.1%
Basic metal ind.	6	347	530	1.4%
Fabricated prods.	98	2,859	6,107	1.9%
Machinery	69	2,422	6,141	3.7%
Electrical machinery	9	409	1,121	3.3%
Transport equip.	30	1,028	6,553	5.7%
Miscellaneous	72	1,659	2,370	6.7%
Total	631	19,691	51,500	100%

Note: Any factory with more than 7 employees must be registered with and licensed by the DIW

Source: TDRI, 1990, Research Report No. 5

OVERVIEW OF POLLUTION TRENDS AND THE POLLUTION CONTROL FRAMEWORK

4. Table 1.3 gives an indication of the scale of increase in the number of polluting industries over the 20 year period 1969-1989. The rapid growth of manufacturing and the shifting structure is reflected in the growing percentage of industries classified as "polluting" by the DIW.

Table 1.3 The Growing Number of Air and Water Polluting Industries in Thailand

Industry	End of 1969	End of 1979	End of 1989
Water-polluting industries	159	5,393	20,221
Air-polluting industries	68	2,241	8,120
Overlapping (air- and water- polluting industries)	16	604	2,106
Sum of polluting industries	211	7,030	26,235
Polluting industries as % of total industries registered with the DIW (excludes IEAT industries)	33%	36%	51%

Source: TDRI, 1990, Research Report No. 5

5. The environmental repurcussions of growing industrial activity in the 1960's and early 70's were highly visible. Effluent discharged from large-scale sugar mills led to rapid increases in BOD loadings and caused heavy pollution along the Mae Klong River, leading to the establishment of Thailand's first central treatment facility at a cost of 21 million baht. The Office of the National Environment Board (ONEB) was established in 1975, followed by the establishment of the DIW's Industrial Environment Division and Factory Inspection Division later the same year. The ONEB has responsibility for overall planning, issuing standards and ambient environmental quality control. DIW is responsible for effluent and emission standards for industry and the control of all industrial activities in accordance with these standards.

6. The 1970's also saw the laying of the foundations of Thailand's environmental legislation. The Improvement and Conservation of National Environmental Quality Act of 1975 (NEQA), amended in 1978, created the ONEB, introduced the first set of ambient environmental standards and laid out the requirements for EIAs. The Factory Act was amended in 1975 to strengthen its environmental dimension, and now forms the

principle legislative mechanism for industrial wastewater pollution control, including provisions for legal sanctions against violators. The Public Health Act of 1941 embraces all sources of water, air and noise pollution, and its enforcement mechanisms are still the most effective legal controls for general pollution, including abatement orders, judicial injuntion and criminal prosecution.

7. The Industrial Estates Authority of Thailand (IEAT) was set up in 1972 to encourage and support Thailand's industrial growth by providing land and infrastructure services. In 1979 the IEAT Act empowered the IEAT to reclaim land and to oversee private industrial estates. The investment incentives for factories in industrial estates are given under the Investment Promotion Act of 1977 under the BOI's jurisdiction. The responsibility for environmental control of factories located on industrial estates lies with IEAT. The DIW has no authority in monitoring or enforcing the Factory Act for factories located on industrial estates. While environmental quality is emphasised in IEAT objectives, it has no environmental unit. As yet no industrial estates provide hazardous waste treatment facilities. Instead, the intention is that the hazardous waste facilities soon to be built by the DIW, will collect and treat the hazardous wastes generated on industrial estates.

8. The structural changes in industry and in the production materials used have lead to the emergence of new types of pollution problems in Thailand. The trend is a shift from traditional pollutants, such as BOD demand in wastewater, to more complex and toxic pollutants including heavy metals, toxic air and water pollutants, and hazardous wastes. Table 1.4 indicates the growth in the number of hazardous waste generating industries in the period 1969-1989.

9. Industrial promotion policies have accelerated the introduction of advanced technology industries into Thailand. The BOI has provided investors with priveleges and incentive packages in order to draw foreign investment, but has not used EIAs or assessments of pollution intensity among its formal selection criteria. An analysis of BOI-promoted industries indicated that the proportion of investment approved for hazardous-waste generating industries increased from 25% in 1987 to 55% in 1989.

10. Throughout the 1980's public awareness of environmental issues has grown, and public pressure is playing an increasingly important role in Thailand's development. Several incidents in the 1980's, including the burning down of a new tantalum plant during a riot, have led to a growing government emphasis on controlling hazardous wastes from industry, culminating in the construction of Thailand's first hazardous waste treatment centre in Bang Khuntien.

Table 1.4 The Growing Number of Hazardous Waste Generating Enterprises in Thailand

Industry Ranking	End of 1969	End of 1979	End of 1989
Rank 0 - Non-Hazardous (includes saw mills, sugar, tobacco, distilleries etc.)	42	625	936
Rank 1 - Small Volumes of Haz.Waste (includes some paper, textile activities)	206	6,358	16,120
Rank 2 - Moderate Volumes of Haz.Waste (includes spinning and dyeing, electroplating, car manufacture, electrical goods)	147	4,949	15,571
Rank 3 - Large Volumes of Haz.Waste or Small Volumes of very Toxic Waste (includes chemicals, fertliser & pesticides, plastics, drugs, and petroeum products)	236	7,558	18,873
Total	631	19,691	51,500

Source: TDRI, 1990, Research Report No. 5

11. Manufacturing industry, and therefore pollution from manufacturing industry, is heavily concentrated in the Bangkok Metropolitan Region (BMR) for economic reasons. By the end of 1989, more than 50% of factories registered with the DIW were located in the BMR. Two-thirds of the factories (and 88% of the workforce) in the most hazardous (though relatively stable) waste producing industries (basic metal, fabricated products, transport equipment, electrical machinery and chemicals) are located in the BMR. Of the 23 industrial estates formed or in an advance stage of planning by the end of 1989, 12 are located within the BMR region. On the negative side, such industrial concentration destroys environment's natural assimilative capacity through overloading. On the positive side, concentration gives rise to economies of scale in pollution control and treatment, and ensures that the rest of the country is relatively free of industrial pollution. MOI intends that the promotion of rural industrialisation in the Seventh National Plan (1992-1996), should ensure that hazardous waste generating factories are grouped together for convenient waste collection and treatment.

OUTLOOK FOR THAILAND'S MANUFACTURING INDUSTRY AND FOR INDUSTRIAL POLLUTION

12. The 1980's were characterised by rapid output growth in the textile, leather, chemicals, base metals and petrochemical industries, and these sectors are expected to form the basis of further rapid growth in Thailand's industrial sector through the 1990's. In both Korea and Taiwan, manufacturing accounted for about a quarter of GDP at the outset of their industrial take-offs. Thailand is now at this point, and many observers believe Thailand will achieve NIC status within the next few years (World Bank, 1989). Thailand is vulnerable to swings in energy prices and to downturns in the economies of its main export markets, particularly the U.S., but is successfully pursuing a policy of diversification of its industries and markets, and the growth of its manufacturing industry is believed to be sustainable.

13. The Seventh National Plan (1992-1996), now under preparation, will identify four main objectives for industrial and trade development (Chakramon, 1990). First, to sustain a high growth of industrialisation and trade with stability; second, to restructure and improve efficiency of production and marketing to strengthen the competitiveness of th economy; third, to promote rural industrialisation and to raise the standard of living; and, fourth, to control/prevent environmental pollution problems caused by the industrial sector. To achieve these objectives, three main industrial development strategies will be adopted. First, a deepening of Thailand's industrial sector by promoting basic industries (eg. steel, petrochemicals) and support industries (eg. capital goods); second, promotion of industrial development in the regions to raise the incomes of rural people; third, the prevention and control of environmental pollution.

14. Industrial pollution is expected to quadruple within the next 15-20 years (TDRI, 1990) and to have in increasing impact on human health, quality of life, ecosystem viability and the sustainability of Thailand's development activites. Forecasts done by TDRI using the DIW database suggest that total potential BOD loadings (including treated wastes) in Thailand's rivers from industrial sources will quadruple over the next 20 years from about 525,000 tonnes in 1991 to 1.9 million tonnes in 2010. This will be due primarily to expected rapid growth in sugar, pulp & paper, rubber, beverage, tapioca and tannery industries. However, an increasing percentage of these industrial wastes will be treated prior to release.

15. The volume of hazardous waste is expected to continue to grow at 12% p.a., tripling from about 2.0 million tonnes in 1991 to 6.0 million tonnes by the year 2001. Over 70% of the volume is heavy metal solid/sludge waste from the basic metal industry, which are relatively stable and can be disposed of by proper containment. The main factor underlying the anticipated rapid growth in waste volumes is anticipated rapid growth in the metal, fabricated product, transport equipment, machinery, chemical product, printing & publishing, textile, rubber and pulp & paper manufacturing industries. Air emissions from industry are also expected to grow rapidly, with emissions of SO2, NOx, SPM and CO2 increasing at 5-7% p.a.

16. The BMR currently accounts for an estimated 52% of Thailand's total industrial SO2 emissions, 44% of Nox, 44% of SPM and 54% of CO2 emissions. Industrial pollution is concentrated in the BMR and will continue to be so for the foreseeable future, as current economic and industrial policy is unlikely to reduce industrial concentration in the BMR (TDRI, 1990).

17. These factors set the framework for a more detailed look at industrial pollution in Thailand, the extent and success of existing control measures, and an action plan to tackle outstanding priorities. These areas are the subject of Chapters 2, 3 and 4.

CHAPTER 2: ENVIRONMENTAL IMPACTS OF INDUSTRIAL DEVELOPMENT

INTRODUCTION

18. Manufacturing has an impact on Thailand's natural resource base at many points through the cycle of converting raw materials into finished products, from extraction, energy consumption and the generation of waste from production processes and transporting the products, through to the impacts of the use and disposal of the products by their final consumers. All industrial wastes affect the normal life of ecosystems and the natural environment.

19. In this chapter we detail trends in manufacturing industry's contribution to air pollution, greenhouse gas emissions, water pollution and hazardous waste production, identifying the underlying causes of increased pollution levels and their likely impacts.

AIR POLLUTION FROM INDUSTRIAL ENERGY CONSUMPTION

20. With the exeption of CFCs, the air pollution and atmospheric emissions contributed by the industrial sector stem principally from fuel use patterns. The true environmental impacts of fuel consumption are those that occur through the whole lifecycle of each fuel. Thus the mining, oil and gas production, power generation, industrial and consumer sectors form a chain of energy extraction, production and consumption that has far wider environmental impacts than the activities of any one sector taken in isolation.

21. The main direct impacts of industrialisation on air quality come from the energy consumed during production processes. Burning fossil fuels releases four main pollutants to the air - sulfur dioxide (SO2), nitrogen oxide (NOx), suspended particulate matter (SPM) and carbon dioxide (CO2). These pollutants each have potentially harmful environmental impacts. High levels of SO2 emissions, for example, can have local, national and regional impacts on the health of humans, wildlife and vegetation, both directly and as a precursor to acid rain. High concentrations of NOx can cause or aggravate respiratory disease and NOx is also an important acid rain precursor. High concentrations of SPM can cause respiratory problems, as well as other impacts such as the soiling and deterioration of buildings.

22. In addition to environmental impacts stemming from fuel combustion, the industrial sector can also be the source of emissions of small quantities of highly noxious substances to the air, usually as the result of industrial accidents such as spillages or fires. One such recent accident is reported to have happened in Bangkok when a warehouse housing hazardous wastes burnt down.

GREENHOUSE EFFECT AND OZONE LAYER DEPLETION

23. The implications of the growing understanding of the greenhouse effect and of ozone layer depletion are likely to be at the top of global, regional and domestic policy agendas for the coming decades. In the industry sector report, we focus on industrial pollution control rather than on greenhouse gas emissions, as the latter are expected to be addressed at a multi-sectoral level in the UNCED National Report. However, we do address the CFC issue and the contribution of growing industrial energy consumption to national CO2 emissions.

24. The potential impact of CO2, comes from its role as a primary greenhouse gas, and hence a key contributing factor, along with methane and CFC's, to what has become known as the greenhouse effect. Globally, Thailand is not a major producer of greenhouse gases, producing an estimated 67 million tonnes of carbon annually, or about 1.1% of global emissions. In fact, the main source of Thailand's CO2 emissions is deforestation, estimated to account for about two-thirds of the country's total CO2 emissions. The remainder is accounted for largely by the power generating, transportation and industrial sectors. While the industrial sector is currently fourth in terms of sectoral contribution to CO2 emissions, the upwards trend in the energy intensiveness of Thai industry suggests that its consumption of fossil fuels is expected to grow at least in step with the pace of industrialisation in Thailand.

25. Releasing certain CFCs and halons to the earth's atmosphere contributes to both ozone layer depletion and the greenhouse effect. Table 2.1 gives the MOI's latest estimates for Thailand's consumption (assumed to be equivalent imports) of CFC-11, CFC-12, CFC-113 and Halon 1211. CFC-11, CFC-12 and CFC-113 together are estimated to account for over 80% of global ozone depletion.

Table 2.1 Thailand - Imports of CFCs and Halons

	Total Weight (Tonnes)			
	1986	1989	1990	1991e
CFC-11	500	1,070	1,520	3,090
CFC-12	1,000	1,925	2,730	4,140
CFC-113	1,000	2,000	3,030	3,270
Halon 1211	20	40	90	108
Total	2,520	5,030	7,370	10,608

Source: Virah, 1991
ERL Estimates for 1991 based on Jan-Apr data

26. Thailand does not manufacture CFCs or halons. Accurate import figures have been collected since the start of 1990, since when import licenses have been required for eight CFCs and halons, of which only the four identified above are actually imported into Thailand in any volume. Little information is yet

available on the options for recycling or replacing CFCs, or the costs to industrial output and growth of potential reduction measures.

27. Figures for the first four months of 1991 suggest that consumption of CFCs and halons is growing rapidly at about 44% p.a. Yet there are also signs that the pattern of CFC use is changing. The rate of growth of imports of CFC-113, used largely in metal industries, appears to be slowing significantly. The MOI believes this is because large foreign companies are already switching to cost-effective CFC substitutes. The rate of growth of CFC-12, used largely in the air-conditioning and refridgeration industries, is increasing. The MOI believes this is due to the rapid growth in demand for air-conditioning and refridgeration products, and the lack of CFC-12 substitutes.

28. Table 2.2 summarises the sectoral breakdown of CFC consumption. In the biggest sectors, notably refridgeration, air conditioning and solvents for the metals industries, many of the main importers are foreign companies. It is estimated that only 5% of CFC-113 imports are accounted for by Thai companies, with Japanese companies accounting for over 50% and American companies for 23%. With respect to CFC-12, primarily used by manufacturers of refridgeration equipment, more than 90% is imported by Japanese companies.

Table 2.2 Thailand - Consumption of CFC-11, CFC-12, CFC-113 and Halon 1211 by Industry in Thailand

	1990 CFC Imports (tonnes)	% of total	1990 ODU* Imports	% of total
Refridgeration	1,450	20%	1,450	21%
Air conditioning	1,250	17%	1,250	18%
Plastic foam products	1,130	15%	1,130	16%
Cleaning of components etc.	2,960	40%	2,370	34%
Aerosols	490	7%	490	7%
Firefighting equipment	90	1%	270	4%
Total	7,370	100%	6,960	100%

* ODU = Ozone depleting units

Source: Virah, 1991

29. Thailand's per capita CFC consumption was estimated at less than 0.1 kg at the time it ratified the Montreal Protocol in 1989, well within the 0.3 kg limit for classification as an Article 5 country. As an Article 5 country, it is entitled to 10 years delay in implementing Article 2's reduction plan. However, if current growth rates are maintained, per capita consumption

will exceed 0.3 kg by the end of 1993. Other reasons for beginning a CFC reduction programme as soon as possible include anticipated price rises and possible shortages in CFCs, and reduced developed country demand for products containing CFCs.

TRENDS IN VOLUMES OF ATMOSPHERIC EMISSIONS FROM INDUSTRIAL ENERGY CONSUMPTION

30. In this industrial sector report we concentrate on the four main atmospheric emissions, SO2, NOx, SPM and CO2, that result from fossil fuel combustion in manufacturing industry. Table 2.3 gives estimates for the sectoral breakdown of atmospheric emissions resulting from the combustion of commercial fossil fuels in Thailand in 1991. Adding a third of power generating emissions, gives a rough estimate of the industrial sector's total direct and indirect contributions to atmospheric emissions of 41% of SO2, 17% of NOx, 57% of SPM and 31% of CO2. Given that manufacturing industry consumes an average of 30% of electricity generated, it is apparent that the sector is a major contributor to air pollution in Thailand.

Table 2.3 Sectoral Contributions to Atmospheric Emissions 1991

Sector	SO2	NOx	SPM	CO2
Manufacturing	22	12	56	22
Mining & construction	1	1	-	1
Power generation	56	16	3	26
Transportation	17	64	19	32
Agriculture	3	2	-	5
Residential & commercial	1	5	22	14
Total	100%	100%	100%	100%

Note: from commercial fuel sources only

Source: TDRI, 1990, Research Paper, No. 5

31. Table 2.4 shows the projected growth pattern of manufacturing sector atmospheric emissions in the period 1991-2011. Air emissions from industry are expected to grow rapidly, with emissions of SO2, NOx, SPM and CO2 increasing at 5-7% p.a. The origin of industrial emissions will continue to be highly concentrated in the BMR, which currently accounts for an estimated 52% of Thailand's total industrial SO2 emissions, 44% of Nox, 44% of SPM and 54% of CO2 emissions.

32. There are many factors underlying growing the growing volume of emissions. The rate of economic growth, and of manufacturing

industry in particular, will continue to demand enormous inputs of energy. The energy intensity of Thai industry is growing - energy intensity has risen 15% since 1982, from 0.78 to 0.90 barrels of crude oil equivalent (COE) per million baht of real GDP. In part this is because the structure of Thai industry continues to shift towards heavier and higher value added industries which require higher inputs of fossil fuels, but it is also because energy efficiency and conservation have yet to become priorities for the Thai manufacturing sector. The relative price structure for fuels favours heavily polluting lignite over all fuels including fuel oil and natural gas, with many factories switching their boilers to lignite from fuel oil. However, it is DIW policy to prevent factories using coal or lignite from operating in populous areas.

Table 2.4 Forecast Air Emissions from Thailand's Industrial Sector (from direct use of fossil fuels i.e. excluding electricity consumption)

	Forecast Emissions from Manufacturing Sector Fossil Fuel Consumption (in 000's tonnes/year)					
	1991	1996	2001	2006	2011	Growth (%pa)
SO2	202	272	377	560	844	7.4%
NOx	63	88	115	160	229	6.7%
SPM	350	471	586	776	1,068	5.7%
CO2	24,529	32,785	39,867	51,070	68,185	5.2%

Source: TDRI, 1990, Research Report No. 5

WATER POLLUTION

33. The main impacts that industry has on water pollution come from the demands placed by a growing industrial sector on water supply and from the delivery of large volume of biodegradable and non-biodegradable wastewater back to the country's water systems. In terms of biochemical oxygen demand (BOD) it is waste from the residential sector, largely from the disposal of untreated sewage into local water systems, that actually accounts for more than 75% of estimated total annual BOD loads in Thailand (ERL, 1990). Residential discharges are concentrated in the BMR where over 10% of the population live. Manufacturing industry is estimated to generate less than 20% of total potential BOD loads, amounting to about 0.5 million tonnes p.a. Of this, the MOI estimates that about 70% is treated prior to discharge.

34. Table 2.5 gives TDRI's estimates of 1991 BOD loads by industrial sub-sector. The bulk of industrial biodegradable waste is generated by sugar, pulp & paper and rubber industries. Forecasts done by TDRI using the DIW database suggest that, unless treated, industrial BOD loadings in Thailand's rivers will quadruple over the next 20 years from about 525,000 tonnes in

1991 to 1.9 million tonnes in 2010. This growth will be due primarily to expected rapid growth in sugar, pulp & paper, rubber, beverage, tapioca and tannery industries (TDRI, 1990).

35. Many factors underly the rapid growth in BOD loads from industry. Structural trends show a continuing move towards industries requiring large volumes of water inputs to production processes, particularly food, textile and chemical industries. Industrial demand for water is growing rapidly, particularly in the BMR, and is putting pressure on river and groundwater resources. Water is still generally regarded as a free resource, and only limited progress has been made in applying water recycling techniques and technologies. In terms of wastewater treatment, most wastewater generating factories are now equiped with treatment facilities. Highly polluting factories are monitored and their waste reductions are reported as satisfactory by the MOI. However, control over small-medium sized factories is not yet sufficient. A number of industrial estates do now provide wastewater treatment plants; however, the success of their waste regulation is not officially reported to the MOI.

Table 2.5 Estimated BOD Loads By Industry Sector

Industry Sub-Sector	Number of Enterprises	Total BOD (1991 000's Tonnes)
Sugar	508	154
Pulp & paper	234	103
Rubber	44	96
Beverages	31	91
Tapioca	142	40
Slaughter	57	15
Canned fish & crustaceans	50	11
Tannery	143	11
Canned pineapple	131	4
Total	1,340	525

Source: TDRI, 1990, Research Report No. 5

SOLID WASTE

36. The main factors in solid waste generation are population size and income levels. The residential sector is the most significant contributor to non-hazardous solid waste volumes, though volumes from industry are growing. An estimated 5,400 tonnes of solid waste is generated daily in the BMR, of which about 4,200 tonnes is collected, either formally or informally, and less than 300 tonnes properly disposed of (The Nation, 23/6/91). What is not collected is generally thrown into streets, disused land, or waterways.

37. Thailand still relies primarily on open dumping and open air burning for solid waste disposal. This causes serious public health risks, as well as aesthetic problems, for nearby communities. Present projections of waste and available disposal facilities suggest that the BMR will run out of capacity in the next 6-7 years (TDRI, 1990). There are as yet no sanitary landfill sites in Thailand. Where solid wastes, along with organic and hazardous/clinical wastes, are disposed of in ordinary landfills, leachate can cause serious contamination of water supplies. A small proportion of industrial non-hazardous solid wastes are recycled, and the remainder normally disposed of together with municipal waste. Sometimes private contractors collect solid waste and dump or burn it on open land, thereby causing a nuisance to local communities.

HAZARDOUS WASTE

38. The industrial sector including extraction and service as well as manufacturing industries, is by far the largest generator of hazardous waste, accounting for an estimated 90% of the annual total for Thailand, estimated at 2.0 millions tonnes for 1991 in a recent TDRI study (TDRI, 1990). Table 2.6 gives estimated volumes and types of hazardous waste generated by key industrial sub-sectors for 1991.

39. We must emphasise that estimating volumes of hazardous wastes produced is extremely difficult, as the hazardous materials are carried in varying concentrations in water, or other waste. The TDRI volume figures are disputed by the MOI. According to the MOI, other studies of Thailand's hazardous waste give lower estimates; for example, extrapolating the results of a recent Watson Hawksley study of Samutprakarn Province gives a national estimate of only 0.3 million tonnes of hazardous waste (assuming Samutprakarn accounts for 8.4% of the total (TDRI, 1990)).

40. From the data available, an estimated two-thirds of industrial hazardous waste comes from the basic metals industry, which is relatively stable and lends itself to containment and treatment on site, though to date this is not widely done. Some of the most toxic wastes, including those from the electroplating industry, are collected and treated at the Bang Khuntien pilot treatment facitlity, which has the capacity to treat an estimated 40,000 tonnes of waste a year. The remaining waste is generally produced in small quantities and is currently dumped freely into river and landfills, or stored in drums on site with little or no treatment. A significant number of hazardous waste generating operations are small-medium scale, and many are businesses run from home. These are of particular concern because of the difficulty of controlling their discharges eg. photo-processing shops, electroplating shops and so on. The DIW is in the process of establishing two further treatment centres with the objective of minimising the volume of untreated hazardous waste.

Table 2.6 Estimated Hazardous Waste Volume by Industry Sub-Sector

Industry	000's Tonnes (1991)	Comments
Basic metal industry	1,310	heavy metal waste
Fabricated products	192	heavy metal sludge, acid waste, alkaline waste etc.
Transport equipment	111	primarily oils
Electrical machinery	87	heavy metal sludge, acid waste, alkaline waste etc.
Chemical products	65	oils, heavy metal sludge, acid waste etc.
Textiles	31	primarily oils
Printing & publishing	26	photo waste and solvents
Rubber and rubber products	15	oils and solvents
Paper and paper products	5	oils and solvents
Petroleum products	4	oils, inorganic sludge, heavy metal sludge etc.
Furniture	3	inorganic sludge
Wood-cork	1	inorganic sludge

Source: Engineering Science Inc., 1989

as reported in TDRI, 1990, Research Report No. 5

41. Table 2.7 summarises TDRI's projected growth in industrial hazardous waste to the year 2001. The volume of hazardous waste is expected to triple over the coming decade from about 2.0 million tonnes in 1991 to 6.0 million tonnes by the year 2001, as a result of rapid growth in the metal, fabricated product, transport equipment, machinery, chemical product, printing & publishing, textile, rubber and pulp & paper manufacturing industries.

42. The Cabinet has approved signing and ratification of the Basle Convention for controlling the transboundary movement of

hazardous wastes. The Thai Government is now a signatory to the Basle Convention and expects to ratify it once the process of adjusting Thailand's legislation accordingly has been completed.

Table 2.7 Summary of Real and Projected Hazardous Waste Quantities in Thailand

Waste Type	Estimated Quantity of Hazardous Waste (in 000's Tonnes/Year) 1986	1991	1996	2001	Growth %pa
Oils	124	219	388	686	8.9%
Liquid organic residues	0	0	0	1	8.0%
Organic sludge & solids	4	7	12	25	9.6%
Inorganic sludge & solids	12	19	32	54	7.8%
Heavy metal sludge & solids	824	1,448	2,536	4,418	8.7%
Solvents	20	36	67	124	9.6%
Acid wastes	81	125	196	312	6.9%
Alkaline wastes	22	34	54	86	7.1%
Aqueous organic residues	0	0	0	1	11.2%
Photo wastes	9	16	30	58	9.8%
Municipal wastes	7	12	19	31	7.7%
Infectious wastes	47	76	123	201	7.5%
Total hazardous waste	1,151	1,993	3,459	5,994	8.6%

Source: Engineering Science Inc., 1989

as reported in TDRI, 1990, Research Report No. 5

INDUSTRIAL LAND USE

43. A further environmental impact of industrial development is increased pressure on competing demands for land use. In Thailand, which has experienced rapid rates of deforestation over the past 20 years, these concerns are very important.

44. Currently, industrial sites occupy an estimated 1.5% of land

in the BMR. This figure is expected to rise to 5-10% in the year 2011. The growth of industry is one of several factors contributing to the continuing rapid growth in land prices.

INDUSTRIAL IMPACTS ON HUMAN HEALTH

45. Human health is at risk from industrial pollution and environmental damage in a number ways. Risks include those from water pollution, exposures to hazardous wastes and exposure to emissions of NOx and SPM, excessive doses of which may cause respiratory problems.

46. Water pollution and contamination of drinking water supplies are serious public health hazards. Recent investigations of water quality in Thailand's main rivers, which provide the primary water source for much of the population, show increasingly serious pollution. Certain stretches of the Chao Phraya river are now seasonally anaerobic, due primarily to discharges of untreated sewage, but also partially to industrial wastes. However, levels of toxic pollutants, such as heavy metals, are still within set safety limits for all rivers.

47. Environmental health and safety at work is a very important aspect of industrial development. From the research carried out to date, it is clear that some workers in Thai battery plants are receiving excessive lead exposures, and there have been cases of workers in Thailand's mining and dry-cell battery industries suffering from manganese intoxication.

48. From 1978-1987 the incidence rate of environmental health cases is reported to have increased from 2.00 to 8.88 per 100,000 of population. The increase is largely due to a rapid growth in the number of cases of insecticide poisoning, though there has also been a growing number of lead, manganese, mercury, arsenic, petroleum products, gas and vapour poisoning, as well as Caisson's disease and silicosis (DOH, 1990).

CHAPTER 3: REVIEW OF CURRENT RESPONSES TO INDUSTRIAL POLLUTION

ENVIRONMENTAL LEGISLATION AND INDUSTRIAL STANDARDS

49. The foundations of Thailand's environmental legislation were laid in the 1970's. The Improvement and Conservation of National Environmental Quality Act of 1975 (NEQA), amended in 1978, created the ONEB, introduced the first set of environmental standards and laid out the requirements for EIAs. The NEQA is considered the most important legislation for providing mechanisms for comprehensive, integrated environmental management, but somewhat lacking in its power of implementation and enforcement. For example, the EIA requirements, considered one of the most powerful tools for environmental protection, do not empower the ONEB to directly monitor and enforce EIA findings and recommendations.

50. The ONEB was established in 1975, followed by the establishment of the DIW's Industrial Environment Division and Factory Inspection Division later the same year. The ONEB was given primary responsibility for planning, standards setting and ambient environmental quality control, while the DIW controls all activities concerning industrial environmental services and the control and enforcement of the Factory Act, and of other environmental legislation as it applies to the industrial sector.

51. The Factory Act of 1969 was amended in 1975 to strengthen its environmental dimension, and now forms the principle legislative mechanism for requiring industries to limit and control their wastewater and hazardous waste pollution. A number of other acts have a bearing on industrial pollution issues; for example, the Poisonous Substances Act of 1967, amended in 1973, which legislates the control of all poisonous substances by the Ministries of Agriculture, Public Health and Industry.

52. The Industrial Estates Authority of Thailand (IEAT) was set up in 1972 to encourage and support Thailand's industrial growth by providing land and infrastructure services. In 1979 the IEAT Act empowered the IEAT to reclaim land and to oversee private industrial estates. The investment incentives for factories in industrial estates are given under the Investment Promotion Act of 1977 under the BOI's jurisdiction. IEAT is authorised to conduct permit approval for factories on estates and is responsible for the operation and monitoring of water treatment systems. The DIW has no authority in monitoring or enforcing the Factory Act for factories located on industrial estates. While environmental quality is emphasised in IEAT objectives, it does not have an environmental unit in its organisational structure for either planning or for enforcement and control.

53. National Ambient Air Quality (NAAQ) standards were established in 1981, and are summarised in table 3.1. The ONEB is the principal agency responsible for setting ambient environmental standards. The DIW is responsible for issuing industrial emission standards. A set of proposed industrial air emission standards has been prepared by the DIW and are given in Annex A to this sector report.

Table 3.1 National Ambient Air Quality Standards

Average values in mg/m3

Pollutant	1 hr	8 hr	24 hr	1 yr	Measurement method
CO	50	20	-	-	non-dispersive infrared detection
NO2	0.32	-	-	-	gas phase chemi-luminescence
SO2	-	-	0.3	0.1	pararosaniline
SPM	-	-	0.33	0.1	gravinetric
O3	0.2	-	-	-	chemi-luminescence
Pb	-	-	0.01	-	wet ashing

Source: TDRI, 1990, Research Report No. 7

54. In terms of water quality standards, the ONEB has set ambient standards and the MOI has set effluent standards and limits for individual factories. Currently, the industrial effluent standards are applied nation-wide, without taking account of variations in assimilation capacities for each river.

55. Development and application of ambient and effluent standards for water quality requires close coordination between a number of different authorities. Ideally, control of water quality requires consideration of all sources of pollution, with a river basin/catchment area approach.

MONITORING AND ENFORCEMENT

56. Thailand's manufacturing industry generates major quantities of water and solid waste pollutants. While monitoring and standards enforcement of large factories has improved greatly, there is still little monitoring or enforcement of small-medium scale factories, primarly because of capacity constraints at the MOI. The BOI's investment policy currently does not carry out environmental assessements of proposed projects, nor does it have a clear environmental policy.

57. Environmental control and management in Thailand involves a large number of agencies. Policy and planning and standards setting for the control of environmental pollution has progressed well at the central level, involving NESDB, ONEB and DIW, but coordination at provincial and local levels leaves room for improvement. Responsibility for enforcement of industrial pollution legislation lies primarily with DIW, IEAT and the Provincial Industrial Offices.

58. Effective monitoring and enforcement is constrained by a lack of trained staff, technical equipment and financial resources. There are a total of about 350 staff in the DIW involved in monitoring and enforcing controls over industrial pollution, giving a ratio of 1:150 for the number of DIW environmental staff to registered factories. These staff are all located in Bangkok and spend much time travelling from site to site. The DIW has an annual budget of only about 50 million baht ($2 million) for applying its industrial waste control and monitoring programme.

59. There are also shortfalls in the volume of resources that the private sector allocates to environmental issues. For example, in the 51,441 registered industrial plants in Thailand, there are only about 350 employees responsible for monitoring and enforcement.

60. The DIW uses a number of regulatory mechanisms in its waste and water pollution control activities. These include the factory licensing system, factory monitoring (end-of-pipe), license renewal or expansion, responding to complaints, advice on treatment system design, provision of central treatment facilities, and training for treatment operation.

61. In practice, factory licensing has proved to be fairly successful in forcing factories to build waste treatment facilities, but not in encouraging them to operate them continuously. Violation of effluent standards carries warnings with factory closure following repeated warnings. Factories that violate closure orders are sent to court, but the process usually takes a long time. In the case of a heavily polluting pineapple processing factory in Cha Am, it took two years of ignored warnings against wastewater dumping before the factory's license was revoked.

62. Of the 23 existing or planned industrial estates, none have an operating hazardous waste treatment facility. While all estates are reported to have wastewater treatment facilities, the level of treatment efficiency is not known.

EXPENDITURE ON ENVIRONMENTAL INFRASTRUCTURE

63. It appears that Thailand is not spending as much on environmental infrastructure as some of its competitors. Environmental degradation in the BMR in particular is partly due to the failure to provide environmental infrastructure in line with the demands of economic growth, and this in turn is due to a failure to develop mechanisms whereby the beneficiaries of development also pay for the costs of environmental protection. TDRI estimate that Thailand spends less than one quarter of one percent of its GDP on environmental protection, compared with 0.38-1.09% for certain other Asian countries and 1.28% for OECD countries. Table 3.2 details the TDRI data.

Table 3.2 Comparative Environmental Investments

	Capital, Operating and Maintenance Costs as % GDP		
	Waste and Water	Air & Other	Total
Average OECD	0.61	0.67	1.28
China	n.a.	n.a.	0.70
Indonesia	n.a.	n.a.	0.38
Korea	0.20	0.20	0.40
Singapore	n.a.	n.a.	1.09
Thailand	n.a.	n.a.	0.24

Source: TDRI, 1990, Synthesis Paper No. 3

64. As examples of investment in environmental infrastructure for industry, boxes 3.1 and 3.2 describe briefly the central treatment facility for Mae Klong sugar factories, built in 1973, and the Bang Khuntien hazardous waste treatment facility for the electroplating industry, built in 1988.

65. To date a total of 18 industrial estates are operating in Thailand, with a further 5 in advanced stages of planning. About three-quarters of industrial estates are privately owned. IEAT owns and operates all utilities on industrial estates, including wastewater treatment facilities at an average capital investment cost of about 75 million baht ($3m) per estate (ERL, 1990). IEAT are considering privatising these wastewater treatment services.

66. To deal with the serious and growing problems of industrial wastewaters and hazardous waste in the BMR, the DIW has plans for two more central hazardous waste facilities, with estimated capital costs of 200 and 350 million baht respectively ($8 and $14 million), and for 4 industrial wastewater treatment plants at a capital cost of about 350 million baht each ($14 million). Ideally the DIW would like to contract these on a concession basis from the private sector. However, negotiations with a private sector group fell through recently, and the Cabinet has approved DIW's new proposal to build the centres with funds from the fiscal budget. As with Bang Khuntien, the two new centres will be operated under leases by private sector companies. The same approach will be taken for the proposed wastewater treatment plants.

67. The DIW also has plans for a new industrial water supply project for the Samutprakarn area, to provide industries with "adequately clean" rather than "drinking water clean" water. For this project the authorities are seeking a private sector BOT contract, with the facility to be transferred to the government after a concession period.

Box 3.1: Mae Klong Central Waste Treatment Plant for the Sugar Industry

Effluent discharged from large-scale sugar mills led to rapid increases in BOD loadings and caused heavy pollution along the Mae Klong River, leading, in 1973, to the establishment of Thailand's first central treatment facility at a capital cost of 21 million baht.

DIW financed the development costs from the Sugar Fund, created from a tax on sugar sales and used to stabilise sugar prices. Each factory was required to pay a share of the capital costs in proporation to its share of waste volume, in the form of a 3 year loan at 7% interest.

DIW operated the 158 acre wastewater treatment site for the first seven years. Responsibility was then handed over to 14 full time employees under the direction of two sugar-factory committees. Major replacement costs are financed through direct charges to participating firms. Operating and maintenance costs used to be charged according to the volume of sugar can processed by each factory, but the charging system has now evolved to reflect the quality and waste loading characteristics of each factory's effluents.

Total treatment plant operating costs for 1986 were 1.02 million baht - less than 1% of factory revenues.

Source: TDRI, 1990, Research Report No. 5

Box 3.2: Bang Khuntien Hazardous Waste Treatment Facility

Bang Khuntien was established by the MOI in 1988 to deal with the problem of heavy metal contaminated wastewater generated by 200-300 small-medium scale electroplating factories scattered around Bangkok, through treatment and landfill disposal.

The facility was built using DIW funds at an estimated cost of 250 million baht (about $10m).

A private sector company, SGS Environmental Services, is operating Bang Khuntien under a 5 year operating lease from the MOI, and is responsible for all collection, transport, treatment and disposal of wastes. In its first 18 months 8,300 tons of hazardous waste was treated at the plant from 46 electroplating factories, 20 electronics factories and some assorted automobile and lamp manufacturers. The facility's capacity is about 40,000 tons p.a.

Under a MOI approved contract between SGS and each polluter, SGS levies a waste treatment fee to cover its own operating costs. Fees vary with type and quantity of waste and the distance from factory to treatment facility. The treatment fee is just sufficient to cover the company's operating costs, estimated at about 30 million baht p.a. ($1.2 million) and contains no capital cost repayment elements. The MOI estimates that a typical charge of 45 baht per tonne would actually have to be more like 300 baht per tonne to cover rent and other charges if the facility had been constructed by the private sector.

According to SGS the plant is now operating at capactiy and is profitable, though less attractive than their other businesses (consultancy and equipment supply). One of the major hurdles has been creating the right incentives to ensure that electroplating companies send their waste for treatment rather than dumping it. The mechanism now adopted is one where a fixed charge is levied amounting to about 70% of the treatment costs for each company's waste. However, further enforcement is probably required.

Source: ERL, 1990
TDRI, 1990, Research Report No. 5

MARKET MECHANISMS

68. To date there are few examples of the effective use of market mechanisms to control pollution in Thailand. Sometimes existing taxes, subsidies and charging structures actually appear to work against environmental goals, eg. the BOI's investment evaluation procedure does not discriminate between potential investors according to their potential environmental impacts. Another example is that, under current fee structures, water supply is subsidised for most industries, with many groundwater users getting their water for free because of lax enforcement.

69. Tariffs are one area in which market mechanisms are being used to control environmental damage and promote good environmental management in Thailand. For example, the Thai government has reduced import tariffs for pollution control equipment and CFC recycling equipment or CFC replacement technologies to 10% from 35%.

70. In terms of charges and subsidies for pollution control, Bang Khuntien is a good example of the provision of an effective subsidy for industrial hazardous waste treatment. The MOI is about to construct two further industrial hazardous waste treatment plants, with incinerator and landfill disposal, at Rachaburi and Chonburi. The captial costs for these facilities will again be provided by government, as discussions with potential private sector groups were not able to come up with an appropriate arrangment.

PRIVATE SECTOR RESPONSES

71. The private sector is responding to growing demands for industrial pollution control by both the government and the general public in a number of ways. Most obviously, the volume of capital expenditure on pollution control equipment is growing rapidly, to the extent that potential scale economies will soon be such as to allow the entry of domestic manufacturers in some equipment segments (ERL, 1991). The private sector is providing the bulk of environmental services needed by industry including EIA's and other consultancy services.

72. The business of providing environmental goods and services is a small but rapidly growing market in Thailand. Thai industry is estimated to spend 1-4% of total capital investment on pollution control facilities and equipment, giving an estimated market size of about $140 million in 1989 (ERL, 1990). Most of the players in the equipment market are foreign manufacturers, which account for an estimated 85% share of this market. To date only low-tech equipment, notably softeners, filters, ion ecxhange equipment, aerators, tanks and parts for clarifiers, are being produced in Thailand, largely due to the lack of scale economies. However, the trend is to local assembly and manufacture, with expected growth of 25% p.a. in this market expected to be sufficient to support the emergence of domestic equipment manufacturers.

73. There are signs that the private sector may be willing to privide an increasing number of environmental utilities to

industry, such as solid waste disposal, wastewater treatment and hazardous waste treatment and disposal. The experiences of Bang Khuntien and of the privatisation of some solid waste collection and disposal in Bangkok are seen to support this trend. A number of companies have been involved in discussions with the DIW over possible industrial waste treatment contracts in the BMR, though the success of such projects depends on their ability to reach target profits, which in turn depends on their ability to collect fees for their services.

74. The recycling industry is also growing, with some small scale successes, particularly in plastics recycling. Paper recycling plants are growing in number, eg. a recent $108 million Korean/Thai joint venture for turn imported waste newspaper into newsprint sufficient to meet 40% of domestic demand. The major constraints to be overcome as the recycling industry develops are the creation of markets in recycled products, the further development of recycling techniques and the creation of effective collection systems.

75. There is growing public awareness of the environmental problems facing Thailand, and of the role of the various contributing factors. Individual citizens are making highly publicised appeals to the public to behave more responsibly, particularly with respect to wastewater and solid waste disposal. Some individuals are even investing in their own household wastewaster treatment and recycling systems. However, these efforts are largely limited to the higher income groups and to the BMR geographic area.

MEASURES ADOPTED TO TACKLE INDUSTRIAL GREENHOUSE GAS EMISSIONS

76. The continuing rapid growth in the energy intensity of Thailand's industrial sector is of concern, primarily because if its implications for growth in atmospheric emissions from fossil fuel combustion. The Federation of Thai Industry has created an energy conservation centre to advise industry. The International Finance Corporation of Thailand (IFCT) is developing a fund to support energy efficiency and conservation measures in Thailand. Several NGOs are also increasingly active in this area. However, there is no evidence that the trend increase in industrial energy intensity can be slowed, and there are few examples of companies adopting energy saving measures or a "full environmental cost" approach to fuel choice. Industrial fuel choice is instead driven exclusively off relative prices and commerically available technolgies, which tend to favour highly polluting lignite, rather than fuel oil or gas. It is MOI policy to restrict industries that burn coal or lignite from being able to operate in residential areas.

77. With respect to CFCs, the main actions taken to date have been those to improve data collection, the reduction of tariffs on CFC recovery and recycling equipment, and a programme of awareness building. Early in 1990 a process was initiated whereby import licenses were required for all CFCs. Since then, reliable information has been compiled on imports of all CFC categories by industrial sub-sector. This information will be

fed into a number of proposed research projects and the development of a country paper, to be done with external assistance under the Multilateral Fund of the Protocol, as detailed chapter 4.

78. Thailand's CFC strategy is likely to contain a number of actions. Given the dominance of foreign companies and foreign/Thai joint ventures as consumers of CFC-113, it is expected that the private sector should take the lead in reduced consumption, particularly since many of the products are for export markets, where CFC reduction strategies will soon, if they don't already, prohibit the import of CFCs. Import figures for the first four months of 1991 suggest that this is already happening.

79. With respect to CFC-11 and CFC-12, the main reduction options are the availability of substitutes and the scope for preventing leakages, extending product life, and above all, for CFC recycling. In the refridgeration sector, prevention of leakages and improved quality control probably offer the optimum short term reduction strategy for CFC-12, with development of substitutes a longer term proposition. For CFC-11, largely used for insulation, alternative technologies are available, but at lower thermal efficiencies and higher cost.

80. In the air conditioning sector, alternative coolants are available, but are generally more expensive. Some air conditioning units are convertable, but many are not, and these include most of the models now being sold in Thailand. With respect to car air conditioning units, CFC-12 can be recovered and recycled. Nippon Denso is the one company that has invested in the necessary equipment so far, and it plans to extend its CFC recovery and recycling activities to cover 20 service centres. However, most installation and servicing is done by thousands of small, unregulated service shops. The MOI is planning to introduce regulation requiring all service stations to recover CFCs. The scale economies of recycling are such that small shops cannot afford to recycle used CFCs. However, larger private operators may be willing to offer recycling services to the smaller shops.

CHAPTER 4: AN ACTION PLAN FOR THE FUTURE

INTRODUCTION

81. At the time of the consultant's field work in Thailand, the preparations for the UNCED National Report, and for the UNCED Conference generally, were in a far earlier stage of preparation than had been anticipated. As a result, little had been done to compile the individual actions being contemplated by many of the MOIs departments into an MOI action plan for industrial pollution, nor to estimate the implied implementation requirements in terms of financial costs, technical assistance or training.

82. Dr. Samarn is currently preparing the first draft of an action plan for industrial pollution control, and he will redraft the contents of chapter 4 once this is ready. In drafting this early version of chapter 4, the consultant has relied on a preliminary version of Dr. Samarn's action plan as well as comments from discussions with Dr. Samarn, with officials at the MOI and other government agencies, with some UN officers and on the reseach work of TDRI. The following sections outline some of the key points that will probably appear in the final version of chapter 4. However, it must be emphasised that the following paragraphs do not necessarily represent the views of the MOI.

IDENTIFYING THE MOI's PRIORITY ENVIRONMENTAL TARGETS

83. From the previous chapters, it is clear that the rapid rate of industrial growth and the changing structure of Thailand's manufacturing industry call for a comprehensive programme of actions to tackle the potentially harmful environmental impacts of industrialisation, and that this programme should be an integral part of a nationwide approach to environmental protection. The MOI has identified the following as its environmental priority areas:

- **Hazardous waste.** The MOI gives high priority to the development and use of hazardous waste treatment and disposal facilities, particularly for industrial estates and for small-medium sized factories.

- **Water pollution.** The MOI will continue to give high priority to control of industrial BOD loadings and monitoring of use of wastewater treatment plants, as well as to the setting and enforcement of appropriate effluent discharge limits.

- **Air pollution.** The control of industrial emissions of SO2 and SPM are a priority target, particularly in populous area.

- **Greenhouse gases and ozone depleting substances.** The MOI is giving priority to the development of a country paper and action plan for ozone depleting substances, and to the development of national policies and action plans to deal with greenhouse gases.

84. Environmental issues are given a high priority in national development strategies. One of the key strategies in the Seventh National Plan (1991-1996) is going to be the prevention and control of environmental pollution caused by the industrial sector.

85. The MOI has the following goals in deciding its programme of actions to limit industrial pollution:

- o to ensure that all industrial waste is properly treated and disposed of;
- o to improve monitoring and enforcement, thereby helping to ensure that industrial wastes are stringently controlled;
- o to increase the involvement of private sector third parties in both waste control and in monitoring.

86. The MOI suggest that actions be taken according to a number of principles:

- o that ambient quality targets are to be seen as the main goal, with application of full range of mechanisms necessary to achieve this goal;
- o that the "minimum cost principle" should be followed i.e. the goal is to achieve the set ambient targets at the minimum cost to the economy as a whole;
- o that the polluter pays principle should form the basis of action; policy instruments should be self-financing with payments collected from polluters;
- o that private sector involvement should be encouraged by the development of demonstration waste treatment projects by the MOI.

87. These goals and principles are similar to those now being followed by many countries in their attempts to maximise sustainable rates of economic growth, and will be reflected in the MOI's action programme for the control of industrial pollution.

DEVELOPING AN ACTION PROGRAMME TO COMBAT INDUSTRIAL POLLUTION

88. The MOI's action plan to combat industrial pollution from 1992 onwards will make use of the full range of mechanisms available to the government. These mechanisms include legislation and standards setting, monitoring and enforcement, technology transfer, institutional strengthening and training, the use of market mechanisms such as charges and subsidies, and tapping all available funding sources, eg. those available through international negotiations.

89. In particular, it appears that there may be greater scope for using market mechanisms than is presently the case. To date, efforts to control industrial pollution have focused on developing the appropriate regulatory framework. Now that this is largely in place, the emphasis should be placed on monitoring and enforcement, as well as on using market mechanisms to create an appropriate framework of incentives for industries to limit and treat their own wastes. There should therefore be an investigation into the scope for greater use of market mechanisms for control of industrial pollution.

90. The MOI is recommending a number of regulatory policy adjustments and the use of appropriate market mechanisms. The actions proposed by the MOI include:

- The study and construction of industrial waste treatment centres with central government funding, which are then leased to the private sector to operate, with rents and fees paid to the government in order to cover the investment costs in the long term.

- A reduction in the maximum sulfur content in fuel oil and diesel oil from 3.5% to 2% immediately, with a goal of reducing it to 1% in the long run.

- Prohibition of the establishment of new highly polluting factories or the extension of existing facilities for existing highly polluting factories in the Bangkok area, to include any factories burning coal or lignite.

- Establishment of air emission standards for industry, as detailed in Annex A.

- Improved monitoring and enforcement of industrial pollution regulations and standards through actions to increase private sector activities and the strengthening of the DIW's resources.

- IEAT to set up industrial estates to accommodate high polluting factories, to facilitate the effective collection and treatment of industrial wastes.

- A review of BOI promotional policies, with additional incentives for environmentally responsible inwards investment. The BOI also to adopt EIA screening techniques for all proposed foreign investment.

ACTION PROGRAMME IMPLEMENTATION REQUIREMENTS

91. For the action plan being developed by the MOI, and in line with the UNCED sectoral analysis guidelines for preparation of sectoral reports, the MOI is currently assessing the implementational requirements for its action programme according to a number of criteria. The requirements for implementing the action programme are likely to include the inputs outlined in paragraphs 92 and 93.

92. **Technical and know-how requirements for corrective actions:** the MOI identifies a need for assistance with technology transfer, development of appropriate technologies, expert advice and expert training in the following technical areas:

- all aspects of hazardous waste treatment, including collection, transportation, treatment, disposal, waste exchange and manifest systems;
- clean technologies for all types of industries;
- organic waste treatment eg. for distilleries;
- air emission standards;
- odour control of wastewater treatment;
- textile wastewater treatment;
- micro-pollutant analysis;
- central industrial wastewater treatment facilities;
- privatisation techniques for industrial waste treatment and disposal facilities;
- CFC recovery and recycling techniques;
- CFC substitutes;
- greenhouse gas reduction technologies for industry.

93. **Institutional, human resource and training requirements:** the MOI identifies a number of requirements for integrating the environmental and development goals for the industrial sector, in particular:

- the DIW needs to increase its staffing levels to ensure proper monitoring and enforcement;
- more laboratories are needed to analyse waste effluents and emissions, both in the BMR and in other provinces;
- more well-trained environmental engineers and scientists are needed if the action programme is to be implemented;
- the capacity of domestic educational establishments must be increased in order to provide government agencies and the private sector with qualified environmental experts;
- more financial resource are therefore required if the DIW is to have the capacity to implement the MOI's action programme.

DEVELOPING A NATIONAL CFC POLICY

94. The MOI is in the process of initiating a number of research studies and a country paper on CFCs, with expected financial support from the Multilateral Fund of the Protocol. A UNEP/SIDA project has helped to draft the terms of reference for three research/pilot projects and for the country paper. The research/pilot projects will include demonstration projects for non-CFC solvent and foam applications, and for the recycling of CFCs in automobile air-conditioning units.

95. The country paper, funded with a grant from the Multilateral Fund and to be developed by consultants, in conjunction with the MOI, will form the basis of the MOI's action plan for CFCs in Thailand. It is expected that work on the country paper will begin in September 1991, and will probably last for about six months. In the meantime, the MOI will continue its programme of CFC data collection and awareness building.

ANNEX A: INDUSTRIAL AIR EMISSION STANDARDS PROPOSED BY THE DIW

No.	Substance	Sources	Proposed Standard
1	Particulate	o Boiler & furnace	
		-heavy oil as fuel	0.3g/Nm3
		-coal as fuel	0.5g/Nm3
		o Steel manufacturing	0.4g/Nm3
		o Cement and calcium carbide plants	0.4g/Nm3
		o Rock & gravel plants (capacity >50KT pa)	0.5g/Nm3
		o Other	
2	Smoke capacity	o Boiler & furnace	<40% Ringlemmann
3	Aluminium	o Furnace or smelter	0.3g/Nm3 (dust) 0.05g/Nm3 (Al)
4	Alcohol	any source	0.05 lb/min
5	Aldehyde	any source	0.05 lb/min
6	Ammonia	o Gas plant	25ppm
7	Antimony	any source	25mg/Nm3
8	Aromatics	any source	0.05 lb/min
9	Asbestos	any source	27ug/Nm3
10	Arsenic	any source	20ug/Nm3
11	Beryllium	any source	10ug/Nm3
12	Carbonyls	o Burning refuse	25ppm
13	Chlorine	any source	20mg/Nm3
14	Ethylene	o Production or usage	0.031b/min
15	Ether	any source	0.051b/min
16	Flourine	any source	0.03 lb/ton P205

cont'd/.....

ANNEX A: INDUSTRIAL AIR EMISSION STANDARDS PROPOSED BY THE DIW (cont'd)

No	Substance	Sources	Proposed Standard
17	Hydrogen chloride	any source	0.2g/Nm3
18	Hydrogen fluoride	any source	10mg/Nm3
19	Hydrogen sulphide	any source	100ppm
20	Cadmium	any source	1.0mg/Nm3
21	Copper	any source	0.3g/Nm3 (dust) 20mg/Nm3 (Cu)
22	Lead	any source	0.1g/Nm3 (dust) 30mg/Nm3 (Pb)
23	Mercury	any source	0.1mg/Nm3
24	CO	any source	1.0g/Nm3
25	SO2	o H2SO4 production o Other - Bangkok o Other - other area	500ppm 400ppm 700ppm
26	NOx	o Combustion o HNO3 production	1.0g/Nm3 2.0g/Nm3
27	Nitric acid	any source	70mg/Nm3
28	Organic material	any source	0.01 lb/min
29	Phosphoric acid	any source	3mg/Nm3
30	Sulfur trioxide	any source	35mg/Nm3
31	Sulfur acid	any source	35mg/Nm3

Source: Ministry of Industry,
TDRI, 1990, Research Report No. 7

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