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THAILAND

Report

Prepared for the Government of Thailand
under UNDP-financed TSS-1 facility

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The report was co-ordinated by the Asia and the Pacific Programme, Area Programmes Division, based on the work of Mr. W. Lütkenhorst, Regional and Country Studies Branch, and Ms. I.M. Daniel, Environment Coordination Unit, of UNIDO. International consultants involved in the study include: P. Brimble, P. Clements-Hunt, P. Hesp, D. O'Connor and Th. Pietschmann. The following national consultants were involved: Surin Setamanit, Suthirak Sujarittanonta and Charit Tingsabadh.

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INTRODUCTION

The present report was prepared by UNIDO upon request of UNDP Bangkok and funded under TSS-1 resources. The study had as its main objectives:

- to analyze the patterns and sources of industrial pollution in Thailand;
- to review the legal and institutional framework in which industry-related environmental issues are tackled and managed;
- to highlight the role of the private sector in this context;
- to suggest priority areas for policy and institutional action to be taken to prevent and control industrial pollution; and
- to propose technical co-operation inputs to be provided by the donor community.

The report was prepared by staff of UNIDO with special inputs provided by a number of researchers, inter alia, from the Institute of Environmental Research, Chulalongkorn University, and from the Environmental Business Group (EBG). The active co-operation of both UNDP and the concerned agencies of the Thai Government is gratefully acknowledged.

The report is structured along the following lines.

Chapter 1 presents the available empirical evidence on the major types of pollution as caused by different sub-sectors of industry as well as the location of polluting industries with special emphasis on the role of industrial estates. Evidence clearly shows the poor state of the country's air, soil and, especially water resources due to pollution, including - yet not confined to - industrial pollution.

Chapter 2 gives a summary account of recent changes in the relevant legislation and in the 'division of labour' between the agencies and institutions concerned, in particular the new arrangements in force which give MOSTE an enhanced policy role in environmental protection. This chapter also reviews the various incentives available to encourage pollution prevention and control and puts special emphasis on outlining the role and capabilities of private industry in this respect.

Chapters 3 and 4 deal with more specific issues. Chapter 3 reviews the contribution of foreign direct investment to industrial pollution and the role played by the Board of Investment in managing this increasingly important segment of manufacturing in the country. In addition to desk research, this chapter draws on the results of a series of interviews with leading transnational corporations active in Thailand (see Annex B). Chapter 4 provides an in-depth review of the environmental issues emanating from one industrial sub-sector of great significance, the electronics industry. In this context, it also briefly analyzes some of the implications of the Montreal Protocol on Substances that Deplete the Ozone Layer, of which Thailand is a signatory.

Chapter 5, in an attempt to synthesize the main issues which surfaced in the preceding chapters, introduces an economic perspective to pollution prevention and control policies and provides action recommendations both for an integration of environmental and economic policies and, more specifically, for the strengthening of required institutional capabilities. It also puts forward some proposals on how the donor community could assist the Thai authorities and Thai industry in combating industrial pollution more effectively. The first of these proposal calls for a high-level meeting to be convened to address strategic policy and institutional issues raised by this report. The other proposals are more operational and highlight programmes or programme areas for potential technical co-operation.

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CHAPTER 1

INDUSTRIAL POLLUTION IN THAILAND

1.1 Background

Thailand emerged as one of the fastest growing economies in the world in the 1980s with double digit growth rates of GDP in the late 1980s and GDP growth rates between 7 and 8 per cent in 1991 and 1992 which are also forecast for 1993. In terms of GDP, Thailand is the sixth largest economy in Asia (excluding the former Soviet Union) after China, the Republic of Korea (ROK), India, Taiwan Province of China, and Indonesia. Using the United Nation's purchasing power parity concept, GDP per capita in Thailand increased from 16 per cent of that of the USA in 1985 to 22 per cent by 1990, the largest improvement of 125 countries investigated by the World Bank.[1] In terms of growth of current GDP Thailand ranked third in 1991, slightly below Malaysia and the ROK but ahead of other major Asian economies including Taiwan Province, Indonesia, China, Singapore and Hong Kong.[2]

Similar to other South East Asian countries, the economic boom of recent years went hand in hand with significant progress in industry, with export-led manufacturing and foreign direct investment playing a crucial role. Growth in manufacturing, mainly due to growth of manufactured exports, outstripped GDP growth rates by 1 to 2 per cent every year.[3] The share of manufacturing in GDP (measured in constant 1980 dollars) increased from 15.7 per cent in 1970 to an estimated 25.4 per cent in 1993 indicating that manufacturing was one of the driving forces behind the success of Thailand's economy in recent years.[4] Ministry of Industry (MOI) records show that the number of industrial operations continued to grow in the early 1990s (from 95,000 in 1989 to 103,000 in 1991) (Table 1-1), suggesting that growth in industrial production was not only the result of the expansion of existing production sites but also of the creation of new enterprises.

The importance of industry for the level of income and living standards is reflected in the regional distribution of GDP which strongly (positively) correlates with the level of industrialization. While GDP per capita in 1991 was only Bt 9,493 ($ 375) in the hardly industrialized North East, it reached Bt 87,032 Bt ($ 3,441) in the highly industrialized Bangkok Metropolitan Area[5], double the national average of Bt 42,043 ($ 1,652). This is about two thirds of income levels achieved by poorer OECD countries (Portugal or Greece) or highly advanced developing countries such as the ROK.[6]

Although industry has played a critical role in economic development and in enhancing the economic welfare of large sections of the Thai population by creating new employment opportunities and contributing to the fast modernization of the country, rapid industrial development has also shown serious negative side effects in terms of environmental degradation. Water pollution is the most conspicuous problem in this respect. Indeed, the natural limits of the country's "absorptive capacity" for pollution is increasingly becoming a central issue and a real bottleneck for further development, - thus calling for more efforts to be undertaken to prevent, control and reduce pollution in Thailand.

Increased spending on environmental protection will become unavoidable. Thailand spent less than 0.24 per cent of GNP on environmental protection in the late 1980s, compared with levels of around 0.4 per cent in countries such as the ROK or Indonesia and levels of around 1.3 per cent in OECD countries[7], going up to 2.8 per cent of GNP in some EFTA countries (Austria), which are characterized by a strong tourism industry.[8] Whereas tangible progress has been achieved in the past two decades in improving Thailand's physical infrastructure, and progress was made on the social front in improving the living standards of large sections of the Thai population, the environmental degradation - so far - could not be halted and is increasingly endangering the progress achieved in other areas.

Table 1-1: Major industries registered with the Department of Industrial Works (DIW) (by year end 1989-1991)

TSIC[a/]	Major Industry Group	End 1989	End 1990	End 1991
311-312	Food	54,580	54,658	54,646
313	Beverages	244	256	276
321	Textiles	1,671	1,902	2,147
322	Wearing Apparel	1,693	1,896	2,014
323-324	Leather products & Footwear	360	392	424
331	Wood and cork	4,803	5,229	5,548
341	Paper and paper products	473	524	753
342	Printing publishing & allied	1,499	1,572	1,595
351-352	Chemical products	564	614	650
353-354	Petroleum products	1,536	1,793	2,027
355-356	Rubber and rubber products	684	749	811
361-369	Non-metallic mineral products	1,511	1,879	2,253
371-372	Basic metal industries	561	593	670
381	Fabricated products	5,375	5,815	6,239
382-383	Machinery and electrical machinery	6,680	7,281	7,590
384	Transport equipment	6,116	6,787	7,373
385-390	Miscellaneous	6,421	7,055	7,680
	TOTAL	94,772	98,995	102,723

Source: Ministry of Industry, Department of Industrial Works.
a/ Thailand Standard Industrial Classification.

At the same time, it needs to be stressed that rising living standards, rising levels of education and a highly successful family planning policy, have helped Thailand to keep its population growth in check. The overall stagnation in population growth does not however prevent agglomerations such as the Bangkok Metropolitan Area from growing at ecologically unsustainable rates. Suburban settlements around Bangkok experienced annual population growth rates of more than 18 per cent in the late 1980s (average 1985-1988: 18.5 per cent).[9] However, the overall stabilization of the population means that - compared with most other developing countries - agglomeration problems which aggravate overall environmental problems can be brought under control more easily.

Shifts in what are perceived to be the most serious development bottlenecks are well documented in Thailand's national development plans. Whereas in the early phase of development deficiencies in the physical infrastructure (roads, telecommunication, energy etc.) were regarded as the main shortcomings, the range was later broadened to include social as well as technological and - increasingly - environmental issues.

Environmental problems associated with economic progress were recognized first in the Third Plan (1972-1976) which in general emphasized further improvements in economic structure, with particular attention to rural development and aimed at maintaining economic stability through increased production as well as

alleviation of social problems. The Plan resulted in the establishment of the Technology and Environment Planning Division within the National Economic and Social Development Board in 1975. The Division was to formulate not only a Science and Technology Development Plan but also an Environmental Plan as integral part of the National Economic and Social Development Plan. This contributed to the creation of a general environmental awareness process.

The Fourth Plan (which ended in 1981) again stressed the importance of promoting social justice by reducing socio-economic disparities and improving mass welfare as well as scientific and technological progress. But it also called for the rehabilitation of environmental conditions in the country. The Ministry of Science, Technology and Energy was established in 1979 as the central policy making, planning, coordinating and promoting body in the Government. The Office of the National Environment Board was transferred from the Prime Minister's Office to this Ministry.

In the Fifth Plan (1982-1986), the emphasis on environmental issues was further increased, an Environment Plan (and a Science and Technological Plan) being an explicit part of the National Development Plan. The Plan again concentrated on rural development, increased efficiency in production leading to increased exports and import reduction, reduction of income disparities and poverty eradication. The key to the country's development objectives was again seen in the strengthening of national scientific and technological capability in order to maintain a proper balance between development and environmental quality.

In the Sixth Plan (1987-1991), environmental issues had definitely surpassed the era of being considered of only secondary importance. The government started to take environmental issues very seriously. Industrial and community development were identified as the main sources of air pollution, water pollution and solid wastes.

The Seventh Plan (1992-1996), finally, formulated a comprehensive and at the same time pragmatic approach to environmental problems, giving more emphasis to the enforcement of environmental laws, strengthening the polluter-pays principle, setting reduced standards for exhaust fumes and the lead content in petrol as well as targets for carbon monoxide and nitrogen oxide and for the reduction of hazardous waste volumes by 40 per cent by the end of 1996. It supports relocation of pollution-generating industries from the Bangkok Metropolitan Area to other designated areas in the country.[10] The creation of an "environment-friendly industrial sector" is a major objective. The Seventh Plan led to a tightening of environmental standards and some progress in the enforcement of environmental laws. In 1993 a number of factories (among the larger producers, inter alia, a steel pipe plant[11], a paper production plant and a decorative stone producer) were ordered to temporarily close for failing to comply with environmental standards[12]. As of April 1993, 17 (larger) plants faced penalties for hazardous emissions.[13] In May 1993 a further 170 factories were ordered by the DIW (Department for Industrial Works) to set up waste treatment facilities within a period of two years or face closure. Most of the major pollution generating plants such as oil refineries, petrochemicals, chemicals etc. already have waste treatment facilities.[14]

A good indicator for the actual attempts being made by industry to reduce pollution is the ET (environmental technology) market. The ET market volume in Thailand - although still relatively small - is now growing at around 25 per cent yearly, i.e. more than double the growth rate of manufacturing in Thailand. Estimates for the growth of the ET market turnover in recent years even range from 30 per cent to 50 per cent annually. So far, the main beneficiaries of increased action taken to fight pollution in Thailand were companies from Japan, the USA and Europe which hold a combined market share of around 70 per cent of the Thai ET market (with 25 per cent each for Japan and the USA and some 20 per cent for Europe). A further 10 per cent of the market is held by companies from East and South-East Asian countries with Singapore alone accounting for a market share of around 5 per cent. Thai companies were only able to cover about 20 per cent of the fast growing Thai ET market.[15]

Although progress is being made, the actual amounts spent for pollution control are still modest despite massive increases, and the technologies used have as yet little to do with the concept of "cleaner production", especially in small and medium sized industries. Industrial pollution is still largely considered to be a mere end-of-pipe problem with end-of-pipe technology being used to mitigate the effects of industrial pollution instead of cleaner production technologies which reduce pollution.

1.2 Water Pollution

Environmental surveys clearly indicate that major rivers which drain into the Inner Gulf such as the Chao Phraya, the Mae Klong and the Ta Chin, are severely polluted, mostly by domestic and industrial sewage (Table 1-2). This is no longer "only" an environmental problem but increasingly a health problem as well, affecting large sections of the Thai population. Although recognizing the importance of domestic sewage, the government identified industrial plants as prime sources of water pollution.[16] This would however include pollution by fertilizers and pesticides as well as sewage by domestic households using industrial products. Recent studies attribute 25 per cent of total water pollution to the industrial sector.[17] While some progress has been made in reducing waste-water output of (large-scale) industry in Thailand in recent years water quality in many Thai rivers, particularly the Chao Phraya and Tha-Chin, as well as along coastal areas where industrial establishments are located, deteriorated significantly during the 1970s and 1980s, below acceptable standards for consumption, fisheries and even industrial use.[18]

Water pollution is usually determined by the amount of biological oxygen demand (BOD) and chemical oxygen demand (COD), faecal coliform bacteria, the level of acidity, the amount of phosphorus and the oil and grease content. As far as data are available, they all indicate a significant deterioration of Thailand's rivers. As in many other countries the main sources of nutrient pollution and eutrophication are not industrial discharges but domestic sewage and agricultural wastes whose discharge is less strictly controlled. Although limited increase in fertilization actually benefits fisheries through increased food supply, over-fertilization gives rise to excessive algal blooms which not only endangers fisheries but also reduces the rivers' ability to neutralize industrial waste biologically.

The Chao Phraya - a major river which runs through the Bangkok Metropolitan Area - has dissolved oxygen (DO) levels of 0.2 mg/l in its lower section, i.e. it is almost anaerobic. In the Seventh Development Plan the Thai Government aims at an increase of DO levels to 4 mg/l by 1996. The dirtiest rivers in developed countries on average have DO levels at around 7 mg/l, in developing countries the dirtiest rivers - on average - still have DO levels above 4 mg/l.[19] One of the dirtiest rivers in Europe, the Rhine, for instance, still had 4 mg/l of DO at the time of its strongest pollution in 1972. Its water quality had improved to 9 mg/l by 1986 after major efforts to reduce wastewater inflow. The extremely bad water quality of the Chao Phraya and other rivers are however not only the consequence of high levels of pollution: they also lack water due to severe droughts which have increased in intensity in recent years as a result of widespread deforestation, negatively affecting the country's fragile eco-system.

The extremely low levels of dissolved oxygen go hand in hand with high levels of coliform bacteria (the indicator used to measure pathogenic bacteria) of more than 700,000 per 100 ml in the lower section of the Chao Phraya. Only a few rivers in the world surpass the 100,000 limit. In most countries rivers have a concentration of coliform bacteria of less than 10,000 per 100 ml.[20] In order to be considered "clean" the concentration should not surpass 5,000 per 100 ml. An analysis of water samples taken from the river showed the existence of Vibrio leptospira (causing acute diarrhoea), Candidada albicans (causing skin disease), and Hepatitis virus A.[21]

The situation of the Tha-chin river is not much better. It has a similar problem of very low dissolved oxygen levels in its lower section (DO of 0.8) and overall high levels of coliform bacteria (around 240,000 in its middle section and still more than 160,000 in its lower section). The Mae Klong and the Bang Pakong rivers - although far from clean - come at least close to levels of pollution which can be regarded as acceptable.

Recent reports have classified the Ping river as far below standard. The river is affected by pollution from households, resorts, condominiums, restaurants as well as some 50 factories which dump their untreated waste directly into the river.[22] Apart from deforestation which in times of drought has reduced flow from the watershed and thus the river's capacity, water from the river is being drained for use in unmonitored ways. This has resulted in a reduction of its size by one third and a corresponding increase in the concentration of pollutants.[23]

Table 1-2: Water quality of major Thai rivers, 1987-1989

	Standard			1987			1988			1989		
	DO (mg/L)	BOD (mg/L)	Total Coliform (MPN/100mL)	DO (mg/L)	BOD (mg/L)	Total Coliform (MPN/100mL)	DO (mg/L)	BOD (mg/L)	Total Coliform (MPN/100mL)	DO (mg/L)	BOD (mg/L)	Total Coliform (MPN/100mL)
Chao Phraya												
Upper	6	1.5	5,000	5.7	1.6	8,000	5.2	1.7	8,200	5.8	1.0	18,666
Middle	4	2	20,000	3.0	1.8	29,000	3.4	1.8	13,000	2.4	2.4	35,000
Lower	2	4	n.a.	0.3	4.0	71,000	0.8	3.8	242,000	0.2	2.8	705,000
Thachin												
Upper	6	1.5	5,000	5.1	2.7	91,666	5.0	2.0	24,000	5.0	2.9	24,000
Middle	4	2	20,000	1.0	2.4	39,500	1.6	2.8	160,500	1.6	2.6	240,000
Lower	2	4	n.a.	0.6	4.0	92,400	0.5	3.6	164,000	0.8	2.7	161,000
Mae Klong	4	2	20,000	5.0	2.2	53,300	5.1	1.8	23,100	5.3	2.0	25,800
Bang Pakong	4	2	20,000	3.7	1.3	9,680	3.6	1.7	9,314	4.1	1.2	9,800

Source: National Environment Board (1990).

Such water pollution does not only affect the country's rivers but also its coastline. It is thus - inter alia - also a threat to Thailand's booming tourist industry. Red tide outbreaks in the Gulf of Thailand have already been reported. While not yet fully studied, environmental degradation was obviously a major cause. Pattaya and Phuket, Thailand's two major developed coastal tourist resorts, have been declared "special pollution control zones", giving increased powers to the authorities to take action.

As pointed out earlier, the largest burden for these rivers in terms of BOD load has - so far - been wastewater discharged from domestic and agricultural sources. For the Mae Klong river it has been calculated that about 93 per cent of total BOD loading resulted from domestic wastewater (1990). The corresponding figure for the Chao Phraya river was about 75 per cent, and the Bang Pakong river and Thachin river also showed significant amounts of BOD loading from agricultural and domestic sources. Only 3-5 per cent of domestic urban wastewater in Bangkok undergoes treatment before discharge[24] - significantly less than in the industrial sector.

This should not be used as an excuse to ignore industrial pollution. As mentioned above, studies indicate that industrial wastewater accounts for about 25 per cent of the total wastewater volume and BOD load in Thailand. Of all factories in Thailand, 44 per cent were considered significant "water polluting industries" in 1989, as opposed to 31 per cent a decade earlier. The number of water-polluting factories more than tripled during the decade. Water-polluting industries doubled their output between 1979 and 1989.[25] The increasing number of small and medium sized enterprises does not make the task of pollution prevention and control any simpler.

Various attempts have been made to estimate the amount of pollutants being discharged into the country's water system by industry. The most widely quoted country-wide study is that undertaken by the Office of the National Environment Board in the mid-1980s. According to that study, based on data of 1986, i.e. before the latest industrial boom had taken place, about 516,000 tonnes of organic substances were discharged every year into Thailand's water system by industry. The highest BOD load was found in the Bang Pakong river, closely followed by the Chao Phraya river, the East Coast Gulf, and the Mun.[26]

Conventional industrial BOD loading is primarily caused by sugar, tapioca, distillery and brewery, pulp and paper, mono-sodium glutamate as well as rubber factories. The total number of these factories was about 1,300 in 1989. It is estimated that these industries alone discharged about 0.5 million tonnes of BOD into the rivers in 1991; unless major attempts at reduction are made, a further increase to about 1.9 million tonnes by the year 2010 is to be expected
(Table 1-3).

Combining reports on BOD load (based on the 1986 figures provided by the DIW) and statistics of Thailand's industrial structure (based on UNIDO's global econometric database) it can be seen that food processing and beverages were not only responsible for the highest levels of conventional water pollution in absolute terms; they also showed high BOD/MVA or BOD/employee ratios. To a slightly lesser degree, this was also true for the paper industry. (See Table 1-4.)

These results reflect the situation in the mid 1980s. It has to be pointed out that significant improvements have taken place since, as water treatment systems became more widely spread in the country, also in processing plants. Furthermore, the comparison may be misleading insofar as only BOD load (i.e. "conventional pollution") is measured. The chemical industry and other industries which are heavy users of chemicals, such as textiles, tanning, electronics etc., in addition pollute rivers with far more hazardous waste, which will be discussed later.

The majority of polluting industries are located in the Bangkok Metropolitan Area and nearby provinces, including Ayuthaya and Pathumthani Samutprakarn. Many industries in these provinces discharge large volumes of wastewater into the Chao Phraya which contributes to the extremely low water quality of that river, especially in its lower section and during periods of drought.

Table 1-3: Major industrial polluters and BOD loadings (1991-2010)

Industry	1989[a/]		1991	1996	2001	2006	2010
	Number	Workers					
Sugar	508	30,443	153,740	232,425	321,089	436,445	565,811
Pulp and paper	234	17,849	102,711	161,991	233,460	331,051	443,955
Rubber	44	10,381	96,526	137,525	177,664	225,155	276,039
Beverages	31	17,376	91,277	130,947	171,303	220,496	273,656
Tapioca	142	14,249	40,245	61,780	86,661	119,610	156,972
Slaughter	57	5,018	15,482	18,211	19,575	20,702	21,957
Canned fish and crustaceans	50	5,902	10,910	15,619	20,432	26,300	32,641
Tannery	143	1,627	10,628	20,863	40,341	78,353	136,258
Canned pineapple[b/]	131	51,597	3,716	4,642	5,299	5,952	6,625

a/ Data taken from the Department of Industrial Works database.
b/ Number of factories and workers represents all canned fruit & vegetables industries.

Table 1-4: Biochemical Oxygen Demand (BOD) load from industry (selected industries) (1986)

	BOD (tonnes)	In percentage of subtotal	MVA in mio $ (current prices)	BOD/MVA	Workforce	BOD t/employee
Food	288,786	55.9	2,395	121	500,600	0.58
Beverages	203,468	39.4	771	264	58,970	3.45
Textiles	8,408	1.6	1,288	7	315,000	0.03
Wearing apparel	3	0.0	1,045	0	324,700	0.00
Wood and cork	1,409	0.3	190	7	50,230	0.03
Paper and paper products	11,463	2.2	126.2	91	27,480	0.42
Chemical products	2,138	0.4	376.2	6	53,220	0.04
Rubber products	548	0.1	205	3	31,790	0.02
Nonmetallic mineral products	11	0.0	306	0	20,670	0.00
Transport equipment	38	0.0	464	0	51,480	0.00
Miscellaneous	109	0.0	601	0	7,740	0.01
Others industries	..		3,767			
Subtotal - main water polluting industries	516,381	100.0	7,767	66	1,441,880	0.36
All manufacturing	..		11,534	..	1,890,300	..

Sources: Department of Industrial Works, quoted in TDRI, The Greening of Thai Industry: Producing More and Polluting Less, 1990; UNIDO Global Econometric Database 1993.

The government has already reacted and started to actively monitor the effluents from factories. But with more than 100,000 factories in the country the task is immense, especially given the limited human and financial resources. In 1984, the Office of National Environment Board (ONEB) drafted so-called "stream standards", which became a useful instrument for stream classification and monitoring. Effluents from factories are generally sampled and analyzed quarterly to check compliance with the Ministry of Industry's (MOI) standards. For specific locations with serious water pollution, more frequent sampling has been introduced. In addition, all industrial polluters have to install suitable wastewater treatment facilities to obtain operating permits from the DIW, which are then valid for a period of 3 years. As a result, over 80 per cent of the factories in Thailand are reported to have installed some kind of wastewater treatment system.[27] All large industries employ wastewater treatment processes in order to comply with the effluent standards established by the MOI. Non-compliance has already led to a number of temporary closures of factories.

Thai factories mainly use activated sludge systems, aerated lagoons and various types of chemical systems for treatment. First promising results have also been achieved by experimenting with biogas systems. Recently, the Committee of the Science Society of Thailand has called for an increasing change to "bio-technological processes" for pollution reduction.[28]

According to information provided by the MOI, about 90 per cent of organic substances from large factories on the Chao Praya river are now removed by wastewater treatment processes. Agro-industrial plants have especially reduced pollution significantly since the early 1980s, mainly through the introduction of oxidation tanks, resulting in a 60-90 per cent reduction of these factories' BOD load. However, this only applies to large and medium-sized factories which are officially registered. The situation is different for small industrial enterprises. Thus, it was reported that in the late 1980s the majority of the then more than 23,000 factories in Bangkok still discharged their wastewater into rivers and canals without adequate treatment.[29] Although that percentage may have decreased in the 1990s, the waste-water problem is far from being solved. Many wastewater treatment systems are in practice either not operational or inadequate. Most of Bangkok's industrial wastewater is still discharged in untreated or only partially treated form into public waters.[30]

Various governmental agencies, including the MOI, Ministry of Public Health (MOPH) and the ONEB conduct water quality monitoring. The MOI is responsible for industrial effluent monitoring throughout Thailand. De facto priority has been placed in effluent quality monitoring within and around the Bangkok area given the high level of industrialization and contamination in that area. At the next stage, however, increased monitoring of factories outside the Bangkok area will become unavoidable if the laws are to be properly enforced. It has also to be noticed that few efforts have been made so far to regulate and check the discharge of domestic sewage, which partly offsets progress made to reduce industrial effluents.

The characteristics of the wastewater differ strongly depending upon the type of industry, the major water pollutants discharged from factories still being organic substances. However, as the industrial structure changes, the pollutants are likely to become more aggressive and thus in many cases more dangerous. The share of hazardous-waste generating factories has increased from 29 per cent in 1979 to 58 per cent in 1989.[31] Growth industries which would contribute to higher shares of highly toxic chemicals and heavy metals include electronics, plastic products, rubber products, leather and leather goods industries, as well as transport equipment, paper and paper products and chemicals.

Section 1.5 will discuss both fluid and solid hazardous wastes in more detail. In the present context however it should be pointed out that manufacturing is likely to become increasingly a source of effluents containing heavy metal. So far, the concentration of heavy metals in biological samples has been within safety limits and agriculture is the main source (through pesticides, and especially fungicides). But the discovery of natural gas in the Gulf of Thailand in the late 1980s has boosted heavy industry on the Eastern Seaboard Area and heavier pollution of the coastal line with heavy metals seems to be only a question of time - unless environmental standards are strictly adhered to.

Hazardous wastewater is also generated by several industries which are already well established in Thailand such as electroplating, dyeing, metal smelting and the chemical industries. It may come as a surprise that so-called "clean industries" such as electronics which are likely to play an increasingly important role are also sources of hazardous wastewater. But the electronics industry is highly chemical intensive, using a wide range

of toxic chemicals in the various phases of the manufacturing process such as cleaning, diffusion, chemical vapour deposition and etching (as in the case of semiconductor manufacturing). A large quantity of solvents and cleaners is used to keep the work place clean. Major hazardous wastes generated include chlorinated solvents, ferons, photoresist developers, contaminated vacuum pump oil, copper etchants, chromic and fluoroboric acids, solder strippers, fusing fluids, waste oils etc.[32] (See also Chapter 4 of this report).

In other words, structural change is likely to reduce the share of BOD ("conventional pollution") but not likely to reduce the overall environmental burden. It may be assumed that in future Thailand's water bodies will have to cope with more toxic effluents, unless strong and long-term government policies force companies to minimize the toxic content of wastewater from the very beginning of industrial operations.

1.3 Air Pollution

Like water pollution, air pollution has increased dramatically in recent years. Over the 1981-1991 period emissions of SPM (suspended particulate matter) increased by around 35 per cent, of CO_2 by some 90 per cent, SO_2 by some 170 per cent and NO_x by some 250 per cent. Although air pollution is a serious problem, it is - so far - still largely concentrated in certain areas of the country, notably Bangkok. In 1991 CO_2 emissions per head for Thailand as a whole were about 1.9 tonnes per year, significantly below the world average (5 tonnes) and below emissions of most West European countries.

CO_2 growth (6.5 per cent p.a.) however was not only slightly above the East Asian average, but far higher than in developed countries (0.5 per cent p.a.).[33] An international comparison of increases in NO_x, SPM and SO_2 emissions shows an even worse picture for Thailand, although data covering the same time period are not available. Over the 1970-1990 period, emissions of NO_x increased by 0.6 per cent p.a. in OECD countries, compared with increases of 9.6 per cent p.a. in Thailand (1981-1991). This is mainly caused by the dramatic expansion of car traffic. Emissions of SPM declined by 4.5 per cent p.a. (1970-1990) in the OECD while Thailand experienced annual increases of some 3 per cent (1981-1991).

A similar situation exists for SO_2 emissions which have dramatically increased in Thailand due to the excessive use of cheap lignite for fuel. Lignite has the lowest cost per kilo tonnes of oil equivalent but emits more gaseous pollution than any other fuel type[34]: 4-5 times more SO_2, 1.5 times more NO_x and twice as much SPM as coal. While emissions from SO_x declined by 2.3 per cent p.a. (1970-1990) in the OECD, Thailand suffered growth rates of 5.5 per cent p.a. (1981-1991).[35]

While Thailand experiences dangerously high air pollution growth rates, with air pollution reaching or surpassing safety limits for human health in some areas, notably in Bangkok, data suggest that traffic is the main cause. Lead concentrations, for instance, increased more than five-fold during the 1980s, resulting in blood lead levels ranging from 16-40 ug/deciliter, i.e. more than three times the level in developed countries. During the same period, carbon monoxide emissions in Bangkok increased six times to a maximum of 53 mg/m^3, slightly surpassing the NEB (National Environment Board) standard of 50 mg/hour. In terms of SPM, Bangkok's industrial areas show values of some 240 microgrammes/m$_3$. Only a few towns in China, Iran and Malaysia are reported to show similar or worse figures. In all other countries, SPM levels are significantly lower. The situation is better in residential areas of Bangkok, where "only" some 100 micrograms per cubic meter of SPM are measured - which is still up to twice the developed country level. On the other hand, the annual mean concentration of SO_2 (14 to 15 microgrammes/m$_3$) in residential areas in Bangkok (1987-1990) is rather low compared to many other towns in developed and developing countries, where concentrations of 40 to 50 microgrammes/m$_3$ are no exception.[36]

A statistical analysis of pollution data (SO2, NO2, CO2, SPM) shows that industry, excluding energy production, plays a major role in the country's pollution only with respect to suspended particulate matters (SPM: 57 per cent of total) (estimates for 1991). On the other hand, the shares for industry (excl. energy production), according to 1991 estimates by the TDRI, are rather low for NO_x (13 per cent), SO_2 (22 per cent) and CO_2 (23 per cent). Apart from SPM, the share of manufacturing in total pollution is below its share in GDP, especially in the case of NO_x (see Table 1-5 and Annex - Tables A-1 to A-8).

Table 1-5: Air pollution of industrial subsectors

	1991 estimate for SO_2		1991 estimate for NO_2		1991 estimate for CO_2		1991 estimate for SPM		
	Tonnes	Share	Tonnes	Share	Thousand tonnes	Share	Tonnes	Share	Air pollution (unweighted average)
Total	970,994		538,886		111,163		650,532		
of which manufacturing in per cent		20.8		11.8		22.1		53.8	27.1
Manufacturing	201,681	100.0	63,435	100.0	24,529	100.0	349,807	100.0	100.0
- Food	34,741	17.2	15,045	23.7	12,72[illegible]	51.9	127,353	36.4	32.3
- Textile	30,225	15.0	3,818	6.0	1,553	6.3	3,780	1.1	7.1
- Wood	2,249	1.1	355	0.6	233	1.0	430	0.1	0.7
- Paper	17,123	8.5	5,446	8.6	997	4.1	28,294	8.1	7.3
- Chemicals (excl. oil refining)	7,049	3.5	1,886	3.0	1,095	4.5	3,691	1.1	3.0
- Non-metal	85,024	42.2	33,216	52.4	6,349	25.9	181,402	51.9	43.1
- Basic metal	8,640	4.3	1,495	2.4	587	2.4	3,153	0.9	2.5
- Other	16,630	8.3	2,173	3.4	992	4.0	1,703	0.5	4.1

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.
a/ The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

Around 14 per cent of MVA is produced by air-polluting industries[37] as compared to around 40 per cent of MVA produced by water-polluting industries. Industrial air-pollution is thus still less of a threat than water pollution. But it is growing: major air-polluting factories accounted for 21 per cent of all factories in the late 1980s, up from 15 per cent a decade earlier. Air-polluting factories doubled their output over the 1979-1989 period. The number of air-polluting factories, however, more than tripled over the 1979 - 1989 period, indicating a fast rise in "small polluters" which have remained largely unchecked so far.

Overall it can be said that the major air-polluting industries are those using fossil fuels as energy sources. In the Bangkok Metropolitan Area and vicinity (Bangkok, Samut Prakarn, Pathum Thani, Nakhon Pathom, Nontha Buri and Samuit Sakhon) a total of 27,000 factories exist with about 5,000 boilers using all types of fuels (mostly fuel oil). The total use of fuel oil in the area is approximately 400 million litres per month, of which about 60 per cent is used for electricity generation and the remainder for manufacturing purposes.

Industrial fuel use alone generates about 7,200 tonnes of SO_2, 90 tonnes of CO_1, 990 tonnes of NO_x, and 180 tonnes of SPM per month. Additional air pollution is caused by such industries as steel milling in the Samut Prakarn area, fishmeal plants (odours) and furniture manufacturers. However, air pollution from industrial activities has so far not been a real health threat, with the exception of the case of SO_2 emissions from the Mae Moh Power Plant in the north of Thailand in 1992/93 when people of several villages suffered from respiratory problems.

In general, the problem of air pollution stems from the lack of capacity to enforce air pollution regulations as well as from poor area planning, in particular in Bangkok. A formal emission standard for industries has not yet been adopted by the Ministry of Industry. Decisions are made on case by case basis, leaving many sources of pollution untouched.

The main sources of industrial air pollution are fuel use and process emissions. At present there are very few emission controls for fuel users. The main problems result from high sulphur content of fuels (which also contributes to acid rain) as well as inefficient boilers and heaters. In addition, in areas such as the Samut Prakarn Industrial District south of Bangkok, stacks have been found to be rather low which leads to a strong concentration of gases in the immediate neighbourhood of factories. Given the proximity to residential areas, many people therefore suffer from the pollution caused by industrial fuel use.

The major emissions from manufacturing processes are dust from steel and cement industries (notably the steel industry in Samut Prakarn) and from cement and rock crushing industries in Sara Buri in the central part of Thailand. Since these industries are usually rather large (with the exception of the rock crushing industries) they can afford to have pollution control equipment.

There is also the odour problem, mainly in connection with agro-industries. Fishmeal and tapioca pelletizing plants are good examples. The technology to solve the odour problem is usually not easily available as this type of factories is not very common in developed countries. Thus inexpensive, ready made solutions do not exist.

A more serious problem is odour from solvents. Especially in the cities, where small industries thrive, odours from solvents (e.g. thinner used for furniture making and fiber glass car bodies) cause problems which have only recently been given attention. Apart from relocation, the solution is to install "after burners" or carbon absorption units, but these tend to be too expensive for small scale enterprises. They thus find it hard to comply with environmental standards. Moreover, while governmental agencies have gained experience in enforcing regulations in large industries, interaction with SSI is still far from effective. This increasingly creates problems as the number of "small polluters" is rising fast.

In order to determine the air pollution impact of industrial growth, the "pollution elasticity of MVA growth" was calculated (Table 1-6). In terms of this indicator, industry actually fared rather well during the 1981-1991 period. One per cent growth in MVA only led to an increase in industrial SO_2 of 0.85 per cent while 1 per cent growth of GDP increased SO_2 pollution by 1.25 per cent. Figures for industrial CO_2 emissions similarly only increased by 0.76 per cent for each per cent MVA growth. NO_2 elasticity was also better than average although above 1. Figures for total suspended particulate matters however were very unfavourable, a 1 per cent growth of MVA leading to an increase of 1.57 per cent of SPM while 1 per cent growth of GDP only increased SPM by 0.63 per cent during the decade.

Overall, the increase of pollution per unit of MVA growth was less for energy production activities (power generation, refining) than for manufacturing activities as such, indicating that in energy production larger production units led to both economies of scale and the faster introduction of basic emission control equipment. More importantly, the figures also seem to reflect that government pressure to contain air pollution was stronger on the power sector than on manufacturing, which is a less serious polluter, as pointed out above. Nevertheless, in absolute terms energy production remains the heavier polluter. The low price of lignite does not motivate energy producers to switch over to less polluting alternatives and has even prompted manufacturing enterprises to convert their boilers to the use of cheap lignite.

A breakdown of total emission volumes by industrial subsectors reflects the strength of different industrial subsectors. The country's largest industrial subsector, food processing, is also the largest single air polluter in the manufacturing sector. For SO_2 and CO_2 - according to TDRI estimates - the second largest polluter is textiles, and for NO_x and SPM the paper industry.

The highest growth rates for pollution between 1986 and 1991 were registered for SO_2 in wood processing, non-metallic minerals and chemicals, for NO_x and CO_2 in paper, non-metallic minerals and chemicals, and for SPM in non-metallic minerals, paper, textiles and chemicals. The lowest increase in all four types of pollutants investigated occurred in food processing.

Table 1-6: Air pollution elasticity ratio

	SO_2 elasticity of MVA	NO_x elasticity of MVA	CO_2 elasticity of MVA	SPM elasticity of MVA	Air pollution elasticity of MVA (unweighted avg.)
Manufacturing of which:	1.13	1.26	0.88	1.26	1.13
- Food	0.92	0.88	0.81	0.85	0.87
- Textile	0.97	1.01	0.96	1.44	1.10
- Wood	1.41	1.18	1.02	0.95	1.14
- Paper	1.38	2.43	1.57	4.03	2.35
- Chemicals (excl. oil refining)	1.54	1.49	1.35	1.06	1.36
- Non-metal	1.20	1.54	1.06	3.79	1.90
- Basic metal	0.95	1.06	1.04	1.32	1.09

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17.
UNIDO, Global Econometric Database 1993.

These figures partly reflect the growth of different industries in the 1980s. In order to determine the "environmental efficiency" of growth, i.e. growth with the lowest increases in pollution, the elasticities for SO_2, NO_2, CO_2 and SPM were calculated. The pollution elasticity for SO_2 was highest (1.54 per cent) in chemicals, suggesting that production increases were not achieved in "environmentally efficient" ways. Bad results were also registered for wood processing and the paper industry. Increases in the output of food processing and textiles, on the other hand, seem to have been less damaging to the environment in terms of SO_2 output with elasticity ratios of 0.92 and 0.97, respectively.

NO_x elasticity shows a similar picture. Paper, non-metal products (which includes the cement industry) and chemicals had very high pollution elasticity rates (above 2) while food processing, followed by textiles, fared again rather well with ratios close to 1, indicating an increase in pollution in line with economic growth.

The only deviation from the general picture was found with respect to SPM pollution. Once again food processing fared well while paper production as well as non-metallic products showed very bad results. However, in this case textiles had an elasticity ratio of about 1.5, worse than the chemical sector which came close to 1.

Summarizing the above results in a combined air-pollution elasticity index (unweighted average of SO_2, NO_x, CO_2 and SPM elasticity ratios), it is clear that - so far - pollution growth has remained lower than MVA growth only in food processing. All other industrial subsectors seem to have increased production in environmentally inefficient ways. The highest air pollution elasticity ratios (i.e. the lowest degrees of environmental efficiency) were recorded in the paper industry, followed by the non-metallic minerals industry (cement) and the chemical industry. Proportionate increases of pollution and industrial growth were registered in textiles and in basic metal industries; in the latter case this reflects increased use of air pollution control equipment in recent years.

1.4 Solid Wastes

Where Thai local authorities have waste collection services, these normally take care of industrial solid waste as well. However, some specific types of solid waste, such as large quantity process waste, hazardous waste, etc. must be disposed of by industries themselves. The problems of industrial solid waste often start with the lack of information concerning its quantity and quality, in particular its toxic content. Results of random testing of locations in different industrial areas in and around Bangkok in late 1992 by a US environmental engineering consul[illegible]ncy firm showed high concentrations of heavy metal

Waste disposal of industries operating in industrial estates is usually better controlled, solid waste disposal being carried out by the industrial estates. Normally, the industrial estates employ solid waste landfill and/or incinerators for disposal. Some industrial estates also have the municipality handle their solid waste disposal. Handling of one major type of solid waste, excess sludge from wastewater treatment plants, has already become a serious problem for large industrial estates due to the lack of land for controlled sludge disposal.

1.5 Hazardous Waste

The manufacturing sector is by far the largest generator of hazardous waste in Thailand. In terms of volume, 90 per cent of all hazardous waste is generated by manufacturing. In the mid 1980s, 1.2 million tonnes/year of hazardous waste were produced by the 14 branches which are the major sources of this waste. By the early 1990s, estimates had risen to 2 million tonnes and it is feared that the volume of hazardous wastes will be some 6 million tonnes by the year 2001 (Table 1-7).

At 15 per cent, the annual growth rate of hazardous waste exceeds the overall growth rate of industrial output. Thai manufacturing, as pointed out before, is still largely characterized by the absence of "clean technologies" which could help to prevent or at least minimize such waste. With a far smaller production base than Japan, the sector generates more hazardous waste than the manufacturing industry of Asia's economic superpower.[39] Table 1-8 presents the characteristics and quantity of hazardous wastes from major industries in Thailand. Nearly two-thirds of all registered factories in Thailand produce some kind of hazardous waste, and about 17,000 factories are estimated to be heavy polluters.

By far the largest single element of hazardous waste are heavy metal sludges which account for more than 70 per cent of total hazardous waste volume, followed by oils, acid wastes, infectious waste and solvents which account for some 25 per cent. Heavy metal sludges are mainly generated by basic metal industries (nearly 90 per cent). Around 70 per cent of acid waste is accounted for by the manufacture of fabricated products and 25 per cent by electrical machinery, including electronics. Pollution with solvents occurs in nearly all industries but plays a major role in the printing, paper, machinery and chemicals

Table 1-7: Summary of projected hazardous waste quantities by waste type

Waste Type	Hazardous Waste Quantities (tonnes/year)			
	1986	1991	1996	2001
Oils	124,194	219,467	387,893	686,358
Liquid Organic Residues	187	311	522	876
Organic Sludges & Solids	3,737	6,674	11,951	21,533
Inorganic Sludges & Solids	11,698	19,254	32,043	54,080
Heavy Metal Sludges & Solids	823,869	1,447,590	2,536,030	4,418,030
Solvents	19,783	36,163	66,532	124,306
Acid Wastes	81,051	125,428	196,510	311,714
Alkaline Wastes	21,952	34,235	54,024	86,198
off Spec products	12	25	52	107
PCB	- [a]	-	-	*
Aqueous Organic Residues	116	242	499	1,037
Photo Wastes	8,820	16,348	30,398	57,809
Municipal Wastes	7,231	11,787	19,090	31,093
Infectious Wastes	46,674	76,078	123,219	200,699
Total	1,151,729	1,993,602	3,458,763	5,993,840

[a] Assumes no PCB materials imported into Thailand after 1975.

Table 1-8: Hazardous waste from major industry (1991), estimates

Industry	Oils	Liquid Organic	Organic Sludge	Inorganic Sludge	Heavy Met. Sludge	Solvent	Acid waste	Alkaline Waste	Off Spec. Prod.	PCB	Aqueous Organic Waste	Photo Waste	Total
Basic metal industry	-	-	-	-	1,310,720	-	-	-	-	-	-	-	1,310,720
Fabricate products	1,860	-	-	6,991	80,305	831	80,868	20,838	-	-	-	-	191,693
Transport equipment	102,663	-	-	2,209	-	5,397	660	-	-	-	-	-	110,929
Electrical machinery	1,261	-	-	3,166	35,463	778	36,686	9,500	-	-	-	-	86,854
Chemical products	27,462	311	4,830	1,540	17,656	3,984	5,822	3,311	25	-	242	-	65,183
Machinery	43,340	-	-	281	-	6,364	6	288	-	-	-	-	51,278
Textiles	30,702	-	-	-	-	-	-	-	-	-	-	-	30,702
Printing, publishing, allied	-	-	1,342	-	-	8,652	-	-	-	-	-	16,348	26,342
Rubber-rubber products	7,869	-	-	-	-	6,950	-	-	-	-	-	-	14,819
Petroleum products	2,357	-	75	-	-	2,870	-	-	-	-	-	-	5,301
Miscellaneous nec.	930	-	427	1,224	1,031	327	-	-	-	-	-	-	3,939
Furniture - fixtures	23	-	-	92	1,137	10	1,386	298	-	-	-	-	2,946
Wood-cork	-	-	-	2,678	-	-	-	-	-	-	-	-	2,678
Nonmetallic mineral	-	-	-	1,076	-	-	-	-	-	-	-	-	1,076
Beverage	-	-	-	-	-	-	-	-	-	-	-	-	-
Wearing apparel	-	-	-	-	-	-	-	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather prod. - footwear	-	-	-	-	-	-	-	-	-	-	-	-	-
Food	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	219,467	311	6,674	19,251	1,446,312	36,163	125,428	34,235	25	-	242	16,348	1,904,459

Source: Engineering Science, Inc. et al. (1989).

industry which together are responsible for about 90 per cent of this type of pollution. For liquid organic residues, organic sludge, aqueous organic residues and off-spec products the chemical industry is the prime source. More than 70 per cent of organic sludge is also generated by the chemical industry. Pollution with oil is again found in all industrial subsectors but transport equipment and machinery alone account for two-thirds of the total, followed by textiles and chemicals, each of which is responsible for about another 1/8 of total pollution.

1.6 Location of Polluting Industries

Rapid industrial growth has been concentrated in and around Bangkok Metropolitan Region (BMR), largely due to the availability of better infrastructure and an economic support system consisting of a large number of small and medium-sized enterprises which are both cost-efficient and flexible, guaranteeing industry a steady supply of inputs including basic industrial services. The Bangkok Metropolitan Region and the adjacent provinces account for more than two-thirds of all registered industrial enterprises.

The Central Bangkok Region accounts for about half of the country's total air pollution. Together with the surrounding central region, Bangkok has a share of some 80 per cent of total emissions. Over two-thirds of the top five hazardous waste producing industries, i.e. basic metal industries, transport equipment and vehicle assembly, electrical machinery and electronics, and chemicals (in particular agro-chemicals) are found in and around Bangkok. The Bangkok Metropolitan Region itself, with one-half of Thailand's industrial establishments, is estimated to produce more than 70 per cent of Thailand's toxic waste. This could however change soon, as large-scale heavy industrial and petrochemical developments elsewhere, particularly on the Eastern Seabord, have a high hazardous waste potential.

Attempts made by the Government to decentralize industry, i.e. reduce its concentration in the Bangkok Metropolitan Region, are beginning to show results. In 1991, 63 per cent of the 1,062 newly registered industrial enterprises were located outside the metropolitan area. Bangkok itself accounted for only 20 per cent of newly registered industrial enterprises in Thailand in 1991 (see Table 1-9).

To keep industrial pollution under control while pursuing a policy of decentralization, the Government encourages location of new enterprises outside Bangkok in designated Industrial Estates. Implementation of this policy is in the hands of the Industrial Estates Authority (IEAT) and the Board of Investment (BOI). The IEAT is responsible for the operations of industrial estates which are managed by the Government or by joint ventures, while the BOI promotes private industrial compounds. The estates are equipped with a variety of wastewater and solid waste disposal facilities. More details may be found in the sections on IEAT and BOI in Chapter 2.

Table 1-9: Distribution of newly registered factories by region (1989-1991)

Region	1989	1990	1991
Greater Bangkok	19.72	20.09	19.84
Central	16.49	17.17	18.00
Eastern	4.65	4.68	4.76
North	16.14	15.91	15.80
Northeast	34.54	33.70	33.08
South	8.46	8.45	8.52
Total	100.0	100.0	100.0

Source: Computed from data of Factory Control Division, Ministry of Industry.
a/ Excluding rice mills.

Table 1-10 : Number of industries estates under operation by IEAT (end-1991)

Industrial Estate	Number of factories	
	General industry zone (GTZ)	Export processing Zone (EPZ)
1. Bang Chan	38	0
2. Bang poo 1	224	44
Bang poo 2	86	0
3. Lat krabang 1-2	56	10
Lat Krabang 3	62	73
4. Northern Region	39	78
5. Bang Phlee	110	0
6. Map Ta Phut	39	0
7. Laem Chabang	38	33
8. Well Grow	121	39
9. Bangpakong 2	111	0
10. Bo-Win 1	33	37
Bo-Win 2	92	0
11. Samut Sakhon	76	0
12. Hi-Tech	55	55
13. Banpa-in	52	44
14. Saharattanakorn	41	19
15. Nong Kae	69	37
16. Kaeng Khoi	60	23
17. Gate way	193	126
18. Eastern	75	35
Total	1,670	653

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19. However, this comparison is not completely correct, as in the World Bank study the DO levels of rivers as a whole and not of some severely polluted sections had been taken. (World Bank, Development and the Environment, World Development Report 1992, Washington 1992, p. 46.)

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CHAPTER 2

ENVIRONMENTAL LEGISLATION, INSTITUTIONAL FRAMEWORK AND INCENTIVE SYSTEM

2.1 Relevant Legislation and Implementing Agencies

2.1.1 Introduction

Public concern about rapid environmental degradation in Thailand became a political issue during the 1970s which has gained in importance ever since. As a result, a number of environmental laws and notifications were enacted, and other laws include environmental paragraphs. A list of these is given in Section 2.1.2.4. Three major laws with a direct impact on manufacturing will be reviewed in more detail: the "Improvement and Conservation of National Environment Quality Act" (NEQA) (1975/1978/1992), the "Factory Act" (1969/1992) and the "Hazardous Substances Act" (1967/1992).

The impressive array of environmental laws and other regulations has a number of shortcomings which will be dealt with later. However, one major point should be made here. Much of the relevant Thai legislation and many of the associated standards are based on US environmental regulations which are often too stringent to be enforceable, given the level of development of Thai companies. As a result, the regulations are often ignored altogether, and this seems to have been at least partly tolerated by the authorities in the past[1]. Strict legislation can only be efficient with adequate monitoring and enforcement, and authorities have only recently started to take a tougher stand against violations of environmental rules.

The main agencies involved in the implementation of the regulations will also be discussed. These are the National Environment Board (NEB) under the Ministry of Science and Technology and the Environment (MOSTE), and DIW, working under MOI. Other institutions dealing with specific environmental issues are the Board of Investment (BOI), the Industrial Finance Corporation of Thailand (IFCT), the Industrial Estates Authority of Thailand (IEAT), the Department of Health (DOH), the Public Works Department (PWD), the Office of Industrial Services and Waste Treatment as well as the Office of Toxic Substances (both under MOI), and the Office of the National Economic and Social Development Board (NESDB). Most of these will be discussed as well.

The above list indicates another main weakness of environmental legislation and control in Thailand: implementation is spread over a variety of Governmental bodies with conflicting jurisdiction and there is as yet no central environmental agency. Whether the newly formed Ministry of Science, Technology and Environment will be able to play this role is still to be seen.

2.1.2 Legislation review

2.1.2.1 Enhancement and Conservation of National Environmental Quality Act

This central piece of environmental legislation in Thailand was first enacted in 1975 and amended in 1978 and 1992. NEQA, as enacted in 1975, resulted in the establishment of the National Environment Board (NEB) and the Office of the National Environment Board (ONEB) to serve as its secretariat. The Board did not only comprise high ranking Government officials, such as a Deputy Prime Minister as Chairman and Permanent Secretaries of the ministries concerned, but also representatives of the private sector. This was a clear indication that rules to improve the environmental situation in Thailand would not be imposed on industry but elaborated in close co-operation with private industry.

The Act empowered the National Environment Board (NEB) to formulate recommendations on environmental policies and environmental plans, to establish standards which had not already been laid down by other responsible agencies as well as to co-ordinate environmental policies; the amendment of 1978 added

the handling of environmental impact assessments (EIAs) for major projects.[2] Furthermore, NEQA provided for punitive measures against companies in case of non-compliance with environmental regulations.

The most important element of the law are the definitions of industrial categories which require an environmental impact assessment (EIA) before licensing.[3] These are shown in Table 2-1.

Table 2-1: Industries requiring an environmental impact assessment

Industry Type	EIA required if
Petrochemical Industry	> 100 tonnes/day of raw materials input required in oil refining and natural gas separation production processes
Oil refineries	all sizes
Natural gas separation	all sizes
Chlorine Alkaline Industry	> 100 tonnes/day production capacity of each or combined product
Iron and Steel Industry	> 100 tonnes/day ore or scrap metal input or furnaces with combined capacity of < 5 tonnes/batch
Cement Industry	all sizes
Smelting industry	> 50 tonnes/day production capacity
Pulp Industry	> 50 tonnes/day production capacity

Source: DEG, Commission of the European Communities, Thai-European Cooperation, Thailand -Environmental Technology Study, Vol. 1, Cologne 1993, p. 77.

The requirements for an EIA however did not empower the NEB to directly monitor and enforce the EIA findings and recommendations, so that the theoretically most powerful tool of the NEB lost most of its importance. If the industry did not implement the changes recommended by the NEB, the latter could only refuse to approve a renewal of the license later on - meanwhile, environmental damage would continue. Even worse, the NEB was not vested with direct authority to prevent implementation of projects with unsatisfactory EIAs. Although the 1975 Act thus established an organization and - in theory - empowered it to take full responsibility concerning environmental matters, weak points in the legislation prevented the NEB from being an effective institution.

The Board was also empowered to establish environmental standards; but if the other responsible Government agencies did not adopt them, the standards could not be enforced. Moreover, it had no direct power over polluters which were under the jurisdiction of other ministries (in many cases the Ministry of Industry) which significantly reduced the scope of NEB action. If other ministries were slow to take action, the Board could in practice do nothing about it. Additionally, there were problems relating to the decentralization of power to the provincial level, further restricting the powers of NEB.

These difficulties led to an amendment of NEQA in 1978, followed by a major amendment which came into force in mid-1992. The amended Act of 1992 contains some important (new) features:

- Improved rights for individuals to fight polluting activities and their consequences;

- Improved public participation in the promotion and conservation of environmental quality through registration of non-governmental organizations (NGOs);
- Establishment of an Environmental Fund;
- Explicit power for the NEB to prescribe environmental quality standards, binding for other government agencies;
- Incorporation of provincial environmental planning into the central environmental planning process;
- Provisions for establishing special protected areas;
- Strengthening of the EIA procedures;
- Establishment of a powerful Pollution Control Committee;
- New rules concerning the use of central wastewater treatment plants;
- Improved monitoring, inspection and control possibilities;
- Extended use of the concept of "strict liability" to remove legal bias in favour of polluters;

Some of these provisions will now be discussed in more detail.

Improved rights for individuals to fight polluting activities

Special rights concerning the environment are accorded to individuals, as stipulated in Section 6 of the Act, which (under certain conditions) gives individuals a legal basis for being compensated by the state for environmental damage suffered. Individuals are furthermore given the right to petition against environmental degradation and the right to obtain information from the authorities in matters concerning the environment (except classified information). The latter point, however, has not yet been put into practice as the accompanying "Information Act" so far has not been promulgated.

Improved public participation

Section 7 stipulates, inter alia, that NGOs are entitled to be registered with MOSTE, which gives them improved access to information and financial assistance for doing research with respect to environmental protection in Thailand. NGOs often play the role of a local ecological civil rights movement; like the green movements in Europe, they act as a public pressure group against environmental degradation. They were largely responsible for improved public awareness on environmental issues in Thailand in the past. Strengthening the role of NGOs is therefore seen as a cost-efficient way of creating additional environmental monitoring activities. NGOs may receive grants or loans from the Environmental Fund (see below) with the explicit approval of the NEB.

Establishment of an Environmental Fund

A new Environmental Fund was established in the Ministry of Finance (Section 22 of the Act). Priority in disbursement is for loans and grants to other government agencies or local administrations for pollution control. In theory, the law does not exclude (subsidized) loans to private institutions or enterprises for this purpose as well. But basically, the polluter pays principle is applied to private enterprise (see below). Moreover, in practice most of the Fund is needed for improving public facilities. So far, Bt 5,000 million (some US$ 200 million) have been allocated to four projects involving the construction of central wastewater treatment and waste disposal plants in the tourist centers of Phuket and Pattaya as well as in Hat Yai and Songkhla.

Environmental quality standards

The provision in Section 32 empowers the NEB to prescribe by notifications, to be published in the Government Gazette, environmental quality standards relating to water quality (covering fresh, coastal and ground water) as well as standards concerning ambient air, noise and vibration. For special environmentally protected areas, Section 33 provides the NEB with power to prescribe even higher standards. The new provisions are aimed at eliminating the previous problem of NEB standards not being adopted by other Government agencies.

Decentralization of environmental quality management planning

Section 35 establishes the responsibility and power of the Minister of Science, Technology and the Environment to formulate an "Environmental Quality Management Plan" to be approved by the NEB and published in the Government Gazette. In this context, the incorporation of the provincial governors into the environment quality management planning process is particularly important. Section 37 stipulates that it is the duty of the Governor of a *Changwat* (province), covering a designated area for conservation and environmental protection, to formulate an Action Plan for Environmental Quality Management at the *Changwat* level, to be submitted for approval to the NEB which thus maintains its overall co-ordination responsibility on matters of the environment.

The responsibility for preparing environmental quality management plans has thus been decentralized to provincial and local levels, in particular to areas which have been designated as "environmentally conserved areas" or as "pollution control areas". This has significantly increased the environmental awareness of authorities at the provincial level. Governors have already started to change their attitudes and inter alia begun to request technical assistance and advice on pollution control, which they had hardly ever done before. Even more important, some provincial authorities began to stop irresponsible waste discharge by enterprises shortly after the new law was promulgated (such as the discharge of incinerated waste by a distillery in Ayudhya province close to the raw water intake of the metropolitan water works.)

Protected areas

Section 43 empowers the Minister of Science, Technology and Environment, with the approval of the NEB, to designate additional conservation and environmentally protected areas outside the limits of national parks or wildlife reserves. Protective measures for such designated areas, as described in Section 44, include prescriptions concerning land use, prohibition of certain activities or projects, as well as detailed requirements for environmental impact assessments. Section 45 provides MOSTE with powers to ask for a cabinet authorization to take measures to solve environmental problems in an area where no action is taken by other government agencies.

Strengthening environmental impact assessments (EIAs)

This is mainly done by streamlining the procedures. Section 48 specifies that within 15 days the Office of Environmental Policy and Planning must examine an EIA report and appoint committee experts to review it. These have to fulfill their duties within 45 days. Failing to keep the time limits automatically constitutes approval of the report. Section 50 authorizes the committee of experts or officials assigned by the committee to carry out project-site inspections.

Pollution Control Committee

Section 52 establishes a Pollution Control Committee, with the Permanent Secretary of MOSTE as Chairman. The Committee has the power, as stipulated in Section 53, to prepare and submit an action plan for pollution control to the NEB; to propose incentives regarding taxation and private investment as well as recommendations on service fee rates for central wastewater treatment or central waste disposal services. It can also make recommendations on the issuing of ministerial regulations specifying the types and categories of hazardous wastes.

Section 55 explicitly empowers MOSTE to prescribe emission or effluent standards, on the advice of the Pollution Control Committee.

There is an important provision that existing standards prescribed by other laws shall not be less stringent than the standards prescribed under NEQA by MOSTE. Agencies responsible for enforcing other laws must ensure this conformity (Section 56). This rule firmly establishes the leading role of the Ministry of Science, Technology and Environment with respect to environmental standards.

Polluter-pays-principle

The Polluter-Pays-Principle (PPP) has become the general underlying principle of NEQA which is reflected in a number of provisions made in several sections under air, noise and water pollution. Section 64 shifts all responsibility for achieving relevant targets exclusively to the polluter.

Section 68 makes it mandatory for the owners or possessors of air-polluting firms to install and operate an on-site facility for air pollution control. Similarly, Section 70 establishes the duty of those responsible for water polluting activities to install and operate on-site wastewater treatment or waste disposal equipment. Sections 71 and 72 requires owners or possessors of firms causing effluents to use central waste treatment facilities and pay service fees unless they have their own sewage treatment systems. Failure to use available central facilities leads to daily fines four times the normal fee for such services (Sections 90-92).

Monitoring, inspection and control

Section 80 requires the owner or possessor of the source of pollution to collect statistics and data and submit reports summarizing the results of his treatment facility. In order to check the validity of those reports, Section 82 empowers pollution control officials to enter all premises to perform their duties. These officials, however, can only recommend the authorities to take legal action against violators or to close down the operations. The final decision remains with the authorities.

Section 93 empowers local authorities or responsible government agencies to collect service fees for waste treatment facilities as well as to penalize non-compliance with environmental rules. Fines (as well as the fees) do not have to be remitted to the Treasury. This rule should raise the interest of institutions at the grass-root level in making companies adhere to environmental standards.

Liability

A central issue of environmental legislation is the liability for environmental damage. In this context it is interesting to compare already existing and still valid provisions made by the Civil and Commercial Code (CCC) and the additional new provisions under the amended NEQA. As will be shown, NEQA indeed seems to fill some of the gaps in the CCC, although leaving a number of questions unanswered. NEQA defines "pollution" to cover wastes, hazardous substances and other polluting matters if they cause harm to environmental quality or health of the people. Radiation, heat, light, noise, odour, vibration and other nuisances which occur or are discharged from a pollution source, also come under the law. NEQA however only deals with claims for environmental damage to public property. Environmental damage to private property comes under CCC.

Article 420 of the CCC states that "for compensation the plaintiff has the burden of proof to show that the accused's intention or negligence results in the damages to the plaintiff." This burden of proof by the plaintiff, as experience has shown, has made court cases against powerful industries extremely difficult to win, de facto reducing the industry's need to upgrade its pollution control systems. Even worse, Article 420 cannot be used if damage is not apparent as when a plaintiff suffers from inhaling daily toxic smoke from a factory but does not yet suffer from clearly identifiable health problems.

Furthermore, according to Article 20, the accused must be proven to have had the intention or at least shown negligence which resulted in the damage to the plaintiff. This is always very difficult to prove in environmental cases. In a few instances, Article 437 can help, which adopted the concept of the Common Law concerning "strict liability" in which the plaintiff does not have to prove that the damage he has suffered is due

to the accused's intention or negligence. Article 437 covers, apart from vehicle accidents, damage due to goods such as gas bottles or explosives which are inflammable or can easily explode. Owners of such goods are strictly liable unless they can prove that the damage was unavoidable, which in general is not easy for them to do. To use Article 437 in all cases involving pollution is however not possible. Pollution from molasses, for example, significantly contributes to the BOD load of Thai rivers. But molasses by itself is not hazardous, and Article 437 can therefore not be used in this or most other cases of organic pollution.

A similar situation arises with regard to Article 1337 which stipulates that an owner of a property that suffers damage from others has the right to take action to remedy the damage without forfeiting his right for compensation. According to this Article the plaintiff does not have to prove whether the damage was due to intention or negligence of the accused (concept of strict liability). However, Article 1337 only covers cases concerning "property" in the narrow sense and has so far not been interpreted by the courts in a way which could apply to the majority of environmental damage cases.

Section 96 of the NEQA stipulates that the owner or occupier of a pollution source is liable for damage irrespective of whether or not the damage was intended or due to negligence, unless it can be proven that the damage was unavoidable or the result of war ("concept of strict liability"). However, the liability for the damage caused is limited. Section 96 stipulates that compensation only covers expenses for removing the pollution. Although this is an important step forward and helps to solve the old problem that authorities could not even sue for damage to public property, Section 96 does not cover expenses to restore the environment in its original condition. For instance, in the case of the pollution of a river where a large number of fish are killed, only the expenses to restore water quality can be claimed; the polluter is not obliged to pay for restocking the river with fish.

This, can - under certain conditions - be achieved with a clause in Section 97 which stipulates that those responsible for unlawful action or negligence which damages natural resources belonging to the public or the government, must compensate the value of the natural resources which were lost to the government. It has to be proven that the pollution was indeed unlawful. In the case of pollution which, for example, killed fish but did not violate any existing law or regulation, the polluter is only responsible for the cost of cleaning up the river (Article 96).

There are other serious shortcomings in this law. One of the most important is the question of the relationship between causes and effects in cases where pollution results from a group of industries of the same type which does not allow to blame any particular polluter. Another unsolved problem is whether or not the law allows for Class Action, where the verdict of the court for a case would be binding for all others. In that case, each plaintiff does not have to bring their cases to court, which may be a highly impractical procedure. Moreover, individuals suing companies are in a far weaker position than a group of affected people acting together as plaintiff, if only because individuals are likely to lack the financial means.

Finally, a further significant improvement would be to allow companies to sue their competitors for "unfair trade" practices if this involves ecologically damaging activities. Private companies are likely to react fast if they find competitors attempting to cut costs unlawfully by ignoring official ecological standards. In contrast to individuals, companies would also have the financial means to sue such competitors on a more equal basis and could provide the courts with evidence of any unlawful behaviour. The much larger chances of being detected and identified as a polluter and of being involved in long and expensive court cases should lead to a far more cautious approach of many companies with respect to the environment and a faster introduction of "clean technologies".

2.1.2.2 Factory Act

The second central law for industry with respect to environmental legislation is the Factory Act (B.E.2535), making DIW and the MOI responsible in a number of areas, including the maintenance of environmental standards. The Act and its amendments allow the MOI to regulate the discharge of pollutants as part of the factory licensing procedures.[4] While the NEQA aims to protect and to seek compensation for damage done to the environment, the Factory Act directly aims at controlling factory establishments and operations. The four

chapters of the Act deal with the establishment, operation, control, licensing and penalties of factories. Apart from Government-owned enterprises which do not fall under it, factories of nearly all sizes and types are subject to it. A factory is defined as having one or more machines with at least 5hp, or employing seven or more workers.

Since the amendment in the mid-1970s, the environmental dimension of the Act was significantly strengthened. The 1992 Act further streamlined the establishment procedures of factories by classifying industries into three groups in accordance with the complexity of factories, their pollution potential and the possibilities to control their emissions.

The provisions under the law empower the Ministry of Industry to prescribe rules which can range from setting location criteria - including the designation of industrial zones - to the selection of process and production technologies and waste treatment processes to fulfill emission and effluent standards.Section 32 allows the Minister, upon approval of the Cabinet, to prohibit the construction or expansion of certain industries for the purpose of safeguarding the environment (as well as the safety of the public).

Section 39 specifically empowers the MOI to issue regulations that impose limits on the discharge of air pollutants, effluent or wastes from factories, and to set standards for accident prevention and occupational health and safety. The Permanent Secretary or any person designated by him is empowered to order the closing of the entire or some parts of a factory in case of non-adherence to standards set by the MOI. DIW has the power to withhold factory licences on environmental grounds and to issue notifications for treatment of wastewater and legal sanctions against violators. Penalties for managers which engage in business without valid permits can include fines up to Bt 200,000 (some US$ 8,000) and imprisonment of up to 2 years (Section 50). If engineers or architects continue to work in a factory which has been ordered to stop operations, they are subject to the same penalties as company owners or managers. The new Factory Act - like the NEQA - incorporates the concept of strict liability.

The Factory Act has become the principal legislative mechanism for industrial wastewater control. The law is less effective in other areas as no binding air quality standards exist for industry (apart from emission standards for smoke stacks, 1971), and as toxic substances regulations (e.g. the Notification concerning Industrial Toxic Substances, 1971) are too general and fail to address the issue of public safety.[5]

2.1.2.3 Hazardous Substances Act

Several laws and ministries deal with hazardous substances, creating areas of unclear jurisdiction, which in turn leads to inefficient management due to overlapping responsibilities and lack of proper co-ordination. In spite of the new Hazardous Substances Act (1992), the Toxic Substances Acts of 1969 and 1973 are still in force, further complicating the legal situation.

The Hazardous Substances Act is supposed to control the import, export, manufacture, marketing, storage, transport and use of poisonous substances and to establish an integrated approach to hazardous waste. Section 5 identifies the responsible ministers under this Act: the Ministers of Defense, Agriculture and Co-operatives, Interior, Public Health, and Science, Technology and Environment. A Hazardous Substances Committee is established (Section 6) comprising all Director-Generals of concerned departments and ministries as well as seven experts appointed by the Cabinet. The Director-General of DIW is appointed as the Secretary of the Committee, thus also indirectly involving the MOI. Section 7 stipulates the duties and powers of the Committee which include recommendations to the Minister of Industry to publish a list of hazardous substances and lay down conditions for dealing with them. These conditions are binding for all Government agencies concerned. Section 18 establishes a Hazardous Substance Information Centre in the MOI.

Hazardous substances are classified in 4 categories (Section 18):

1) Those requiring compliance with established criteria and procedures;

2) Those whose possession requires advance notification to the authorities and compliance with criteria and procedures established by them;

3) Those which require permits before production, import or export possession;

4) Those whose production, trade or possession are prohibited.

The law has a major escape clause. Section 44 empowers the responsible Minister, with the approval of the Hazardous Substance Committee, to exempt certain substances if their characteristics or quantities are not deemed very harmful, or if complying with the provisions of the Act would cause an inappropriate burden. All hazardous substances belonging to government agencies, public enterprises, the Thai Red Cross and similar institutions can also be exempted.

Chapter 3 of the Act deals with liabilities and duties. To be liable under the Hazardous Substance Act, the violation must involve substances which the Minister of Industry has notified in the Government Gazette as being hazardous substances (Section 58). Sections 59-62 establish duties of producers, importers, exporters and possessors of hazardous substances and precautionary measures to be undertaken.

Sections 63-69 assigns liability to producers, importers, carriers or persons in possession of hazardous substances unless it is proved that injury is caused by force majeure or fault of the injured person. It is thus unnecessary for the plaintiff to prove that the damages were the result of the accused's negligence or intention. This makes the Hazardous Substances Act a powerful instrument for fighting pollution.

Section 65 stipulates that the employer, principal, hirer or owner of a business are all jointly liable for wrongful acts committed under the law. Similarly, Section 66 establishes joint liability of the producer, importer, wholesaler, retailer, middle-man and any person taking part in the distribution of hazardous substances. These clauses are intended to improve and speed up the legal procedures for damages. Those actually responsible for the violation of the law however have a liability towards others required to pay compensation in a joint liability case.

Section 67 sets a three year limit for claims. Section 69 empowers the State Prosecutor to institute the claim for compensation on behalf of the State in cases where damages from hazardous substances are inflicted upon persons, animals, plants, or the environment in general.

Chapter 4 covers penalties for violations. Sections 70-89 stipulate penalties for various offences ranging from failure to submit documents to offences involving forbidden hazardous substances. The latter may lead to imprisonment up to ten years and/or fines up to BT 1 million (some US $40,000).

2.1.2.4 Other legal provisions

Apart from the laws which were reviewed in some detail above there are other legislative provisions which have an impact on industrial pollution, of which the most important are the "Groundwater Act" (1977), which governs drilling and the use of groundwater as well as the disposal of wastewater into an aquifer through a well; the "Navigation in Thai Waters Act", which governs solid waste and chemicals dumping in public waters, the "Penal Code" (1953) which governs damage and pollution of waterways and public drainages; and the "Investment Promotion Act" which will be discussed in more detail in Chapter 3 of this report.

Other relevant laws are the "Public Health Act" (1941), the "City Planning Act" (1975), the "Groundwater Act" (1977), the "Cleanliness and Tidiness of the Country Act" (1960), the "Minerals Act" (1967), the "Land Transportation Act", the "Industrial Estate Authority of Thailand Act" (1979), the "Building Control Act" and the "Promotion of Investment Act" (1977). In addition, a number of notifications should be mentioned,

including the "Notification concerning Industrial Emission Standards for Smoke Intensity at Stack Mouths (1971), "Notification concerning Industrial Toxic Substances" (1971), "Notification concerning Industrial Effluent Standards" (1979/1982), "Notification concerning National Ambient Air Quality standards" (1981), "Notification concerning Transport, Storage and Disposal of Toxic Substances" (1982), "Notification concerning Duty Reduction on Energy Efficient and Environmental Technology" (1983/1988), "Notification concerning Air Emission Standards for CO from Mobile Sources" (1988) and the "Notification Concerning Factory Wastes (1988)".

2.1.2.5 Standards

On the basis of the laws reviewed above, in particular NEQA and the Factory Act, DIW and ONEB, have established a number of environmental quality standards. With respect to industrial effluents, these are comparable with those in Western Europe and the USA. In contrast, general ambient standards, in particular those concerning air quality, tend to be rather lenient.[6] Furthermore, Thailand relies mostly on effluent standards which affect end-of-pipe solutions but not the source technology. The introduction of "clean technologies" to achieve reduced emissions is thus normally not required.

Water Standards

Effluent standards exist for industrial effluents, discharge into deep wells, domestic and building effluents, and for waste dumping into water courses. Industrial effluent standards were set by the Ministry of Industry in 1978 and 1982 (Table 2-2). Very strict standards for BOD load exist for tanning and fish canning, and the manufacture of frozen food, starch, noodles and pulp. Furthermore industrial effluent standards deal with items such as oil, formaldehyde, chlorine, H_2S (sulfide), HCN (cyanide), phenol, suspended and dissolved solids, and heavy metals. Overall wastewater standards tend to be rather high. Toxic discharges such as fluoride, free ammonia, ammoniacal nitrogen or phosphates are not yet covered, but standards have been recommended by ONEB to the MOI.

In order to enforce those standards, regulations stipulate the need for qualified supervisors and operators of pollution control facilities of the following types of polluting factories:

- Industrial plants discharging wastewater in excess of 60 m^3/hour or having a BOD load of effluent of over 100 kg/day;

- Industrial plants using heavy metals in the production process and discharging wastewater in excess of 50 m^3/day. (Specific maximum heavy metals contents have been set as well);

- Industrial plants dealing with iron and steel, using dry furnaces or acids or other polluting substances in the production process, with a production capacity higher than 100 tonnes/day or using steel smelters with a total capacity of 5 tonnes/batch;

- Petrochemicals plants using more than 100 tonnes/day of raw materials input, industrial plants separating or processing natural gas, cement or engaged in crude oil refining;

- Industrial plants producing chlorine-alkali with daily output in excess of 100 tonnes, industrial plants engaged in ore smelting or metals production with daily output in excess of 50 tonnes and industrial plants producing paper pulp in excess of 50 tonnes/day.

Emission standards control only the concentration of pollutant in effluents, not the total volume of wastewater discharged. Industries using high amounts of water can thus easily dilute and discharge large pollutant volumes without adapting their technology. The effluent standards of 1982 only set dilution ratios in the case of pollution with suspended solids.

Apart from general industrial effluent standards, special effluent standards were established by the Ministry of Industry concerning discharge into deep wells following the requirements of the Deep Well Act. The Department of Mineral Resources is the executing agency under this law. It is a uniform standard applicable

Table 2-2: Industrial effluent standards

Parameters	Unit	Allowable limits	Note
1) pH value	-	5-9	-
2) Permanaganate value	mg/L	< 60	
3) Dissolved solids	mg/L	< 2,000	
4) Sulfide as H_2S	mg/L	< 0.2	
5) Cyanide as HCN	mg/L	< 0.2	
6) Heavy Metals			
- Zn	mg/L	< 5.0	< 3.0*
- Cr	mg/L	< 0.5	< 0.2*
- As	mg/L	< 0.25	
- Cu	mg/L	< 1.0	
- Hg	mg/L	< 0.005	< 0.1*
- Cd	mg/L	< 0.03	< 0.1*
- Ba	mg/L	< 1.0	
- Se	mg/L	< 0.02	< 0.02*
- Pb	mg/L	< 0.2	< 0.02*
- Ni	mg/L	< 0.2	< 0.2*
- Mn	mg/L	< 5.0	
- Ag	mg/L	none	< 0.02*
7) Tar	-	0	
8) Oil and Grease	mg/L	< 5.0	
9) Formaldehyde	mg/L	< 1.0	
10) Phenol and Cresols	mg/L	< 1.0	
11) Free Chlorine	mg/L	< 1.0	
12) Insecticides	mg/L	0	
13) Radioactivity	mg/L	0	
14) Suspended Solids	mg/L	< 30	
15) BOD 5 days, at20°C	mg/L	< 20	
16) Temp	°C	< 40	

Source: Ministry of Industry
Note: < = not more than; * = Zinc industry.

to all types of industries in all areas. The notification specifies the quality of the water to be discharged, the discharge rate and procedures, and the installation of observation wells. Parameters involved include colour, pH, turbidity, total solids, BOD, oil and grease, free chlorine and heavy metals.

Furthermore, there are ministerial regulations and notifications which set special limits for certain areas. MOSTE has issued several ministerial notifications to protect some areas which are crucial for the water supply of the Bangkok Metropolitan Region. An area of about 50 square kilometers in Patumthani was designated in B.E. 2522 (1979), and expanded to 200 square kilometers in B.E. 2531 (1988). In B.E. 2534 (1991) a further area of 458 square kilometers on the west bank of the Chao Phraya River was specially protected. These notifications usually involve restrictions on the expansion of industrial or/and agricultural activities, but a range of economic activities may even be prohibited.

In order not to endanger coastal zones (and thus income from tourism), NEQA also foresees that the Government, more precisely the Office of Environmental Policy and Planning (OEPP) and Department of Pollution Control (DPC), both working under MOSTE[7], can designate "control areas" in Coastal Zones as well as for some islands surrounding Phuket Island. Provincial authorities and local officials in designated areas have the responsibility for the formulation of environmental quality management plans and action plans. The DPC, can intervene if the responsible agencies fail to do so and they can be brought to court. The notifications normally include prohibition of activities such as manufacturing.

Areas so far designated include islands such as Phi Phi Le and Phi Phi Don in Krabi Province as well as the coastal area at Pattaya and some of its off-shore islands such as Lan, Sark and Krok. On the latter, similar activities are prohibited as on Phuket Island and some types of activities (such as the construction of jetties and thermal power stations) are subject to special environmental impact assessment requirements.

Air Standards

Existing Thai air quality standards only cover CO, NO_2, SO_2, SPM, O_3 and lead. Industrial emission standards only concern the smoke intensity at the mouth of the stack. There are no further industrial emissions standards at present. Thus, there are still major differences in ambient air quality standards between Thailand and OECD countries. Emission guidelines covering 31 substances applying to all new industries are in the process of being adopted by the MOI. The NEB has also drafted specific standards for oil refineries, cement, and iron smelting and rolling plants which should become legally binding in the foreseeable future.

Standards for solid and hazardous wastes

Toxic substances standards are contained in the MOI list of 41 types of chemical wastes, a list of toxic substances and a list of banned and restricted chemicals under the Hazardous Substances Act. Factory licensees are responsible for the separation and management of wastes and must provide information regarding type, quantity, characteristics, storage, location, method of collection, treatment, transportation and disposal of these wastes. Regulations include conditions for the location of disposal sites, criteria for landfill design, disposal operations and monitoring. There are toxic substance limits for food, atmospheric chemical standards for the workplace, regulations for industrial toxic substances (MOI, 1971), and regulation for the manufacturing, use, transport, storage and disposal of toxic substances (MOI, 1981).

Hazardous waste standards often tend to be rather general, i.e. not sufficiently industry-specific. So far, the concentration of substances such as pesticides in public water bodies has not been regulated.

2.1.3 Institutional framework - responsible agencies

The two main Government agencies directly responsible for controlling industrial pollution are the National Environment Board (NEB) under the Ministry of Science and Technology and Environment (MOSTE) and the Department of Industrial Works (DIW) under the Ministry of Industry (MOI). Enterprises basically deal with DIW. Other institutions which are involved in environmental issues include the Industrial Finance Corporation of Thailand (IFCT), the Board of Investment (BOI) and the Industrial Estate Authority of Thailand (IEAT). Finally, the National Economic and Social Development Board (NESDB) is at least indirectly involved as its Technology & Environment Planning Division has been established to incorporate ecological considerations in the overall economic planning process.

A major problem of the various agencies is the lack of qualified personnel for the implementation, monitoring and enforcement of environmental legislation and regulations. The private sector has drawn many qualified people away from the public sector in recent years. An alternative to the (costly) expansion of personnel in the various agencies would be to provide stronger incentives for environmental self-policing in the private sector - directly by the enterprises, by the FTI or by independent environmental auditing firms. NEQA provides a basis for such a development, but the provisions on third-party auditing remain to be tested in practice.

2.1.3.1 National Environment Board

The NEB, operating under MOSTE, is responsible for formulating Government environmental protection policies, for supervising private industries in pollution control, for co-ordinating pollution prevention efforts with other Government agencies, and plays a leading role in ensuring that other government agencies adopt and follow appropriate environmental standards.

It was indicate above that the 1992 NEQA significantly strengthened the mandate and especially the enforcement powers of the NEB, particularly with respect to defining and enforcing standards. This of course increases demands on NEB. The Office of the National Environment Board (ONEB), NEB's secretariat, had an environmental management budget of around Bt 50 million in the late 1980s (around US$ 400,000). This was increased to Bt 184 million in 1991 (US$ 7.2 million) before being cut to Bt 134 million (US$ 5.4 million) in 1992. Despite massive increases compared to the mid 1980s levels, only some $54 has on average been available for each factory check, which of course limits the effectiveness of the ONEB.

With the new legislation, three separate agencies replaced the ONEB in 1992: the Office of Environmental Policy and Planning (OEPP), the Pollution Control Department (PCD) and the Environmental Quality Promotion Department (EQPD). The duties and powers of the three new agencies are summarized in Boxes 2-1 to 2-3.

The OEPP acts as the Secretariat of the NEB and the Secretariat of the Environment Fund Committee, and it is responsible for the administration of the EIA system. It is also empowered by NEQA to designate areas for environmental conservation. The DPC is responsible for formulating pollution control strategies and establishing standards which, in the absence of other standards, automatically become minimum standards for ambient quality and limits for emissions and effluents. It has the power to designate pollution control areas, to monitor pollution, to take remedial action where the responsible organizations fail to do so, and to initiate court cases against offenders. The EQPD deals with the dissemination of environmental information, public campaigns and education. Promotion of environmental quality through various activities of NGOs also comes under its jurisdiction.

Box 2-1: The Pollution Control Department (PCD).

The Department, inter alia, has the following mandate and tasks:

- Recommendations for the formulation of policies and plans on pollution control.
- Recommendations on the establishment of environmental quality standards, and standards for the control of pollution at sources.
- Preparation of environmental quality management plans and measures for the control and abatement of pollution.
- Monitoring and inspection and preparation of pollution status report.
- Development of systems and models including appropriate methodologies for application in the management of water and air qualities, noise levels, hazardous substances and solid wastes.
- Taking action concerning complaints with respect to pollution.

Box 2-2: The Environmental Quality Promotion Department (EQPD)

The Department, inter alia, has the following mandate and tasks:

- Promotion and distribution of information concerning the environment.
- Collection, preparation and provision of services concerning environmental data, making the EQPD an information centre on the environment.
- Transferring environmental knowledge to both government and private agencies.

Box 2-3: The Office of Environmental Policies and Planning (OEPP)

The Department, inter alia, has the following mandate and tasks:

- Preparation of policies and plans to enhance and protect national environmental quality "in harmony" with other national policies.
- Co-ordination of the preparation of the Environmental Quality Management Plan.
- Co-ordination of natural resources management following the policies and Plan for the Enhancement and Protection of National Environmental Quality, the National Economic and Social Development Plan, and the Environmental Quality Management Plan.
- Taking action concerning an evaluation of impacts on the environment arising from projects or activities of the government or the private sector.
- Establishment of positions and guidelines and co-ordination of international activities and commitments concerning the environment.
- Recommendations on policies and guidelines and coordination of the administration and management of the Environmental Fund including fund raising.
- Co-ordination of matters concerning the environment at the provincial level.

2.1.3.2 The Department of Industrial Works (DIW)

So far, the establishment, monitoring and enforcement of industrial pollution regulations and environmental quality standards has largely rested with the DIW. The DIW controls industrial operations mainly through mandatory factory licensing in three-year intervals. Licenses can be revoked if factories violate standards. DIW is required to co-ordinate its environmental activities with the DPC and with other agencies.

DIW units involved in the enforcement process are the Factory Inspection Division, the Industrial Environment Division, the Factory Control Division and the Environmental Quality Standards Division. Their task is to test and control factories for noise, air and water pollution and to check the adequacy of waste treatment facilities. Private sector entrepreneurs have to submit wastewater treatment masterplans to DIW. Table 2-2 summarizes the industrial wastewater standards.

Despite their impressive range, the impact of DIW's environmental protection activities is limited.

First of all, about 40 per cent of all new investment is approved by either the Board of Investment (BOI) or the Industrial Estates Agency (IEAT). In these cases DIW factory licensing is automatic, and the DIW has no authority to monitor or enforce environmental standards of factories on industrial estates - this is the responsibility of the IEAT (see below). More importantly, the three-year period for the renewal of factory licences leaves the DIW in a relatively weak position for enforcing pollution standards on a day to day basis. DIW is empowered to check compliance periodically, but does not have powers to punish factories 'on the spot' for non-adherence.

The ratio of staff to the number of registered factories moreover is too low. Already as low as 1:100 in the late 1980s, it has deteriorated further as the number of new factories grew, which makes efficient monitoring and enforcement impossible. DIW's budget is also insufficient: it was Bt 93.6 million (US$ 3.6 million) in 1989 and only increased to Bt 106.5 million (US$ 4.2 million) in 1992. In real terms, the increase is even smaller, and the average amount available per factory is only $42.

Furthermore, DIW measures to keep hazardous waste under control are often ineffective[8]. Certain hazardous wastes - including those from estates - are transported to DIW's treatment facility at Bangkhuntien (Thonburi). This plant, established 1988 by the Ministry of Industry but operated by a private firm, deals with wastewater contaminated with heavy metals from electroplating and textile factories in the Bangkok region. Such common facilities are a practical solution for enterprises which are too small to install their own equipment. But with a capacity of 120,000 tonnes/year, Bangkhuntien only covers 6 per cent of all hazardous waste which is produced in Thailand.[9] According to some reports, some three-fourths of all hazardous waste is discharged illicitly into rivers and landfills. The construction of additional plants at Ratchaburi, Saraburi, Chonburi and possibly Rayon has been planned; the critical issue will be how to devise a charge system that allows cost recovery while discouraging illegal dumping.

2.1.3.3 Industrial Finance Corporation of Thailand (IFCT)

The IFCT, established in 1960, has only recently become involved in attempts to positively influence the ecological orientation of Thai industry through subsidized loans. The principal purpose of the IFCT is to provide investment capital for the establishment, expansion and modernization of industries in Thailand. It provides a variety of loan types including low-interest long-term loans of five to fifteen years, with grace periods on principal ranging from one to three years. Loan financing is available up to 50 per cent of project cost.

The IFCT plays a role in environmental management in two ways. First, one of the two general managers of the new Environment Fund is nominated by the IFCT, with the understanding that the IFCT thus de facto acts as fund manager for the portion reserved for the private sector[10]. It has however been pointed out before that, as yet, the Fund is only marginally involved in the private sector.

At present, special incentives for investment in pollution control may be more important. The IFCT has established a special new credit line for pollution control and energy saving ("loan service for environmental protection") to encourage private enterprises to make such investments. It is supported by a loan from the Japanese Overseas Economic Co-operation Fund; once enterprises start repaying loans, the scheme could become self-financing. Although this credit line is rather modest, it is likely to increase in the years to come; on the other hand it might be merged with the Environment Fund. In 1991 the IFCT granted low-interest loans to four projects involving the installation of water treatment facilities with a total project cost of Bt 34.0 million (US$ 1.4 million). Total loans in that year amounted to Bt 4,450 million (US$ 180 million) for 177 projects. Such

low-interest loans could be a way of initiating pollution control in small and medium-scale plants, which often cannot afford environmental consultants and/or the purchase of the equipment they recommend.

Another scheme to provide financial assistance to industry for environmental purposes was initiated by the Government. This Bt 1,200 million scheme has been included in IFCT normal project lending, in which loans are evaluated on commercial grounds. To date, 28 projects have been funded; 75 per cent of the funds went to water treatment systems and the rest to air pollution equipment (see Table 2-3).

The IFCT has also started to collect environmentally relevant data and information including standards and regulations concerning industrial wastes. Moreover, it has held a series of ecological awareness building seminars[11].

Table 2-3: Statistics on IFCT Environmental Credit Programme (1992)

Type of Industry	Number of Loans	Credit Amount (Million baht)
Pulp and paper	3	400.00
Construction material	5	240.00
Steel	3	215.00
Electronic	3	132.50
Food processing	6	119.00
Chemical	7	95.85
Garment	1	10.00
Total	28	1,212.35
Type of Pollution		
Water pollution	21	697.35
Air pollution	7	515.00
Total	28	1,212.35
Size of Loans, million baht		
0-20	15	154.85
21-50	5	217.00
51 or more	8	840.50
Total	28	1,212.35
Location of Projects		
Bangkok and Vicinity	12	360.85
Other Provinces	16	851.50
Total	28	1,212.35

2.1.3.4 Board of Investment (BOI)

With the Prime Minister as its Chairman, the BOI is evidently considered a very important organization by the Government. The Office of the Board of Investment acts as Secretariat of the Board. It has been given wide powers to promote investment and provide incentives, and it has established investment service centres, provincial offices in Chiang Mai, Nakorn Rachasima and Surat Thani, and economic adviser offices in New York, Frankfurt, Sydney and Tokyo.

While it is thus well-placed to inform potential foreign (and local) investors about environmental issues, "ecological services" have only been of secondary importance so far. Despite some legal provisions which call for an ecological orientation of activities of the BOI (Section 19 of the Investment Promotion Act), the actual policies of the BOI were - in the past - directed towards attracting a maximum number of enterprises. Privileges and incentive packages normally did not use criteria such as pollution intensity per unit of MVA produced or the outcome of Environmental Impact Assessments (EIAs) to target certain industries for special incentives.

Furthermore, the BOI has been rather weak in evaluating and monitoring investment projects in environmental terms. The BOI has therefore been criticized for de facto contributing to the promotion of increasingly polluting industries in Thailand.[12] Since the early 1990s, however, the BOI has begun to take the ecological challenge more seriously, as will be shown in Chapter 3 of this report on Environmental Issues of Foreign Direct Investment.

2.1.3.5 Industrial estates

To keep industrial pollution under control while pursuing a policy of decentralization the Government encourages location of new enterprises outside Bangkok in designated Industrial Estates. Implementation of this policy is in the hands of the Industrial Estates Authority (IEAT) and the BOI. The IEAT, established in 1972, is responsible for the operations of industrial estates which are managed by the Government or by joint ventures, while the BOI promotes private industrial compounds. The IEAT has a small Environmental Control and Safety Unit, whose responsibilities are outlined in Box 2-4.

According to recent statistics of BOI, the number of private industrial parks (zones) in Thailand was 19 in 1993, which will increase to 21 (23, according to other sources), by 1995/96.[13] Under the Industrial Estate Authority Act, there are two different types of industrial estates, namely General Industrial Zones (GIZ) and Export Processing Zones (EPZs). The IEAT is empowered to grant privileges to enterprises which are located in industrial estates. Enterprises located in industrial estates can also apply for BOI privileges.

Although progress has been made, the ambitious plans for relocation have not yet been fulfilled. Two-thirds of the estates are still found in the Bangkok area. Only half of the 1,700 factories expected to be operating in General Industry Zones in 1991 were actually located in such zones per year later (see Tables 1-10 and 2-4), representing only 0.8 per cent of all industrial establishments in Thailand, or about one per cent if enterprises in EPZs are included. But as some large-scale industries are concentrated on the estates, the actual importance of industrial zones for both production and the environment is greater than the mere number of establishments might suggest.

Including EPZs, 16 per cent of all establishments are companies operating in the field of machinery & electrical machinery (including electronics), 10 per cent produce chemicals, 9 per cent are in petroleum refining and oil related products, 9 per cent in textiles and clothing, 8 per cent in food processing and 7 per cent in transport equipment. The share of hazardous waste producing industries is significantly higher than in the overall industrial structure in Thailand and clearly shows the importance of the estates as designated areas where facilities exist to monitor, control and finally reduce industrial pollution.

Land cost in the estates ranges from Bt 750,000 to Bt 3.2 million per rai (6.25 rais = 1 ha), depending on the location and the facilities offered. One of the latter is wastewater treatment. Better wastewater treatment facilities were, for instance, a reason for the Japanese Canon group to shift a Bt 4,000 million manufacturing project from Kuala Lumpur to the Thai Bang Pa-in Industrial Estate in the early 1990s.[14]

In general, only basic water pollution control systems have been provided so far. Recently, however, this has changed. The Samut Sakorn Industrial Estate for instance has been planned specially for textile companies and offers special wastewater treatment facilities for the industry. Within this estate, the land cost for the textile zone (one-fourth of the total surface) is higher (Bt 3.2 million/rai) than in the general industrial zone (Bt 2.4 million/rai). As of 1992, no textile company had actually taken advantage of the special services. This might change soon as environmental law enforcement gains in importance; but it shows clearly how difficult it is for industrial estate authorities to plan ahead and provide companies with specialized environment-friendly sewage

systems without exactly knowing in advance which type of companies will eventually be making use of the system.

For industrial estates with various types of industry an extended aeration-activated sludge process is employed which under proper operating conditions should remove more than 90 per cent of potential BOD load.

Box 2-4: Responsibilities of the Environmental Control and Safety Unit (IEAT)

1) Environmental Impact Assessment

Co-ordinating environmental impact assessments of factories located within an industrial estate, including giving advice concerning planning, management and providing data and information.

2) Environmental Control

Establishing environment standards within an industrial estate; preparing guidelines and measures to control and abate pollution.

3) Monitoring and Evaluation

This includes pollution control monitoring and evaluation of the effectiveness of measures used in pollution control and environmental protection in both areas within and areas surrounding an industrial estate. Furthermore, study and research is done concerning testing methodology and analysis for planning purposes and investigations of complaints.

4) Safety Control

This includes surveillance of the impact on health and industrial safety of factories located in industrial estates.

Table 2-4: Number of factories in industrial estates (1992)

Major Industry Group	Bang chang	Bang Poo		Lat Krabang		Northern Region		Bang Phlee	Map ta Phut	Laem Chabang		Bo-Win		Hi-Tech		Samut Sakhon	Banpain		Well Grow	Bang pakong
		GIZ	EPZ	GIZ	EPZ	GIZ	EPZ			GIZ	EPZ	GIZ	EPZ	GIZ	EPZ		GIZ	EPZ	GIZ	EPZ
Food	9	16	-	12	4	12	-	10	-	1	-	1	-	1	-	2	-	-	1	-
Beverages	1	-	-	-	-	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Textiles	-	20	-	-	2	1	3	1	2	-	1	-	-	-	-	2	1	-	1	-
Wearing apparel	3	1	15	2	22	2	6	10	-	-	-	-	1	-	-	-	-	-	-	-
Leather products & footwear	-	5	8	-	8	1	8	5	-	-	-	-	-	-	-	-	-	1	-	-
Wood and cork	7	3	1	1	2	2	4	6	-	2	-	-	-	-	-	1	-	-	-	-
Paper and paper products	1	8	-	3	1	2	1	6	-	1	-	-	-	-	1	-	-	-	2	-
Printing, publishing & allied	9	7	-	5	-	-	-	11	-	-	-	-	-	-	-	3	5	-	-	-
Chemical products	7	57	1	10	4	1	-	8	13	1	-	-	-	-	-	-	-	-	1	1
Petroleum products	7	14	3	6	8	1	2	16	13	6	-	-	-	-	-	1	2	-	6	-
Rubber and rubber products	1	5	-	6	6	-	-	3	2	2	-	-	-	-	-	-	-	-	-	-
Non-metallic mineral products	6	4	2	3	2	7	3	1	1	1	-	-	-	-	-	-	1	-	1	-
Basic metal industries	1	4	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1
Febricated products	6	39	4	6	4	1	3	18	4	3	3	1	1	-	3	-	1	-	4	11
Machinery and electrical machinery	17	27	10	15	12	3	22	18	-	8	2	4	1	3	-	1	3	-	9	5
Transport equipment	7	14	-	12	2	3	-	13	-	12	-	-	-	1	-	1	-	-	2	3
Miscellaneous	3	19	4	5	18	8	8	8	4	2	-	-	-	-	-	-	2	1	2	3
Total	85	243	48	86	95	45	65	136	40	40	6	6	3	5	4	11	15	2	29	24

Notes: GIZ denotes General Industrial Zone; EPZ denotes Export Processing Zone

Table 2-5: Wastewater treatment plants and their capacities in industrial estates

Industrial Estate	Loading m^3/day	BOD (mg/L)	Treatment Plant
1) Bang Chan	-	-	-
2) Bang Poo	23,000	1,000	A.L./R.B.C.
3) Lat Krabang	15,800	1,000	A.S.
4) Northern Region	5,600	750	O.P.
5) Bang Phlee	5,000	500	A.S.
6) Map Ta Phut	8,000	500	A.S.
7) Laem Chabang	30,700	500	A.S.
8) Bo-Win	13,460	750	A.S.
9) Hi-Tech	16,800	500	A.S.
10) Samut Sakhon	21,000	500	A.S.
11) Ban pa-in	13,000	500	A.S.
12) Well Grow	14,400	500	A.L.
13) Bang pa Kong	11,500	500	A.L.
14) Saharattananakorn	6,400	500	A.S.
15) Kong Kae	14,400	500	A.S.
16) Kangkhoi	8,800	500	A.S.
17) Gate way city	37,229	500	A.S.
18) Eastern	12,000	750	A.S.
19) Anyathani	11,200	250	A.S.

Notes: A.L.: Aerated Lagoon Process; A.S.: Activated Sludge Process; O.P.: Oxidation Pond Process; R.B.C.: Rotating Biological contact process.

Table 2-6 : Solid waste disposal facilities in industrial estates

Industrial Estate	Sanitary Landfill m^3/day	Incinerator kg/hour	Incinerator Tonne/day	Dumping Site m^2	Hazardous Waste
1) Bang Chan					
2) Bang Poo		200		32	
3) Lat Krabang			3	832	
4) Northern Region			0.23	9,000	
5) Bang Phlee					
6) Map Ta Phut	12.8				
7) Laem Chabang				4,000	
8) Bo-Win		1,000			DIW
9) Hi-Tech			25		DIW
10) Samut Sakhon		1,250			DIW
11) Ban pa-in		500			DIW
12) Well Grow		750			DIW
13) Bang pa Kong		3,000			DIW
14) Saharattananakorn					DIW
15) Kong Kae			25		DIW
16) Kangkhoi			21		DIW
17) Gate way city			360		DIW
18) Eastern			12		DIW
19) Anyathani					DIW

For solid waste disposal, each industrial estate is supposed to have its own facilities including:

- Sanitary landfills
- Incinerators
- Dumps
- Hazardous waste treatment facilities

Table 2-5 presents types and capacities of wastewater treatment plant employed on industrial estates; Table 2-6 presents solid waste disposal facilities in industrial estates.

All industries are obliged to treat their wastewater before discharging them into receiving water. Given the fact that organic matter is a major constituent of most of the industrial wastewater, the presently used wastewater treatment facilities are largely based on biological treatment processes including:

- Stabilization ponds;
- Aerated lagoons;
- Activated sludge processes;
- Rotating biological disc contactors.

Physico-chemical treatment processes are employed to a lesser extent.

2.1.3.6 The Office of the National Economic and Social Development Board (NESDB).

The NESDB is at least indirectly important for the improvement of the environment as it is ultimately responsible for the country's economic and social development planning. Only recently it has been equipped with a Technology and Environment Planning Division in order to better incorporate ecological considerations from the very start into the overall economic planning process.

The Office of the NESDB carries out a wide range of activities, including studies of social and economic conditions to recommend goals and policies of national economic and social development. These increasingly include ecological considerations, which are the responsibility of the Social, Human Resources, Quality of Life and Environment Group within NESDB. Plans and projects proposed by ministries and department are scrutinized for incorporation into the National Plan. Monitoring and evaluation of Plan implementation are also responsibilities of the Office.

2.2 Incentives Aimed at Reducing Industrial Pollution

Incentives to reduce industrial pollution in Thailand primarily aim at prevention, improved control of industrial operations and improvements in the selection of locations. Large and medium-size industries in Thailand are established on a formal basis, and are thus easily targeted by incentives, and comparatively easy to control.

But Thailand has a large and fast growing number of small-scale industries in the informal sector. They are characterized by being family-owned and having limited technological, financial and human resources, which makes it rather difficult for them to introduce new environment-friendly technologies which often demand a high initial outlay, and whose operation requires sufficient technological capabilities as well as qualified human resources. Furthermore, these small scale factories often have to cope with limited areas of land which for example limits their use of land-consuming water treatment systems.

An additional problem is that the majority of these small-scale industries tend to be located in and around Bangkok and its vicinities, thus significantly contributing to that congested area's environmental problems. It has so far proved very difficult to enforce land use laws and regulations.

2.2.1 Pollution control equipment incentives

As an incentive to accelerate the purchase of pollution control equipment, a first Notification on the Reduction of Import Duty was issued by the Ministry of Finance in 1983. Box 2-5 gives examples of the types of imported machinery, materials and equipment for energy saving and environmental conservation in industrial plants which qualify for import duty reduction.

Pollution control equipment with an annual average value of some Bt 3C million baht (US$ 1.2 million) was submitted for tax reduction in the first five years of the scheme. In 1989 alone some Bt 180 million (US$ 7.2 million) worth of environmental technology (ET) equipment (63 items) was imported under the preferential scheme. (See Table 2-7). Since 1991, the rate of import duty under the scheme is the lower of half the normal rate or 10 per cent[15], respectively 5 per cent.

Equipment under this regulation should be primarily intended for pollution control and pollution abatement. In practice, this regulation thus concerns only end-of-pipe technologies and further contributes to the bias of Thai enterprises to end-of-pipe solutions instead of the introduction of cleaner production technologies.

Further rules limit the purchase of equipment. Thus, imported second-hand equipment does not qualify for reductions, and replacements of old equipment are not allowed. Finally, the equipment shall not be of the same type as equipment which can be locally produced or be barred from reduction of import duty for other reasons, as laid down in the notification issued by the Director-General of the Customs and Duty Department.

These restrictions show that the Government has adopted a long-term approach to fighting pollution by building up a strong domestic base for the production of pollution abating equipment, protecting it from imports even at the cost of lower reductions in environmental damage in the initial phase. Supported by this policy, the Thai ET industry managed to gain a market share of around 20 per cent in the early 1990s.

Second-hand ET equipment was excluded from the import reduction scheme because of the likelihood that it would not meet medium and long- term criteria; but increasing the incentives for local production and the limited pollution control facilities of the Government may also have played a role. Effective pollution control by the Government is still largely limited to checks during the process of granting operating permits. As long as the possibilities of control are limited, it certainly makes sense to concentrate promotion on new equipment, as the likelihood of failure in the three-year interval which is common for checks made by DIW is smaller than for second-hand equipment.

2.2.2. Incentives for operating residual disposal and wastewater treatment services

The BOI has issued a list of activities which are particularly promoted, including residual disposal and wastewater treatment services. To be eligible for BOI privileges and support the service must involve an investment not less than Bt 20 million (US$ 0.8 million) in addition to the cost of land and operating costs. Conditions include that the promoters of the project must have Thai nationality or that Thai interests hold at least 60 per cent of the shares of the registered capital. In addition, the project must have been approved by one of the ministries concerned.

Box 2-5 : Examples of pollution control equipment and materials entitled to import duty reduction:

1. Wastewater Treatment

Wastewater treatment package plant; aerator; air difuser; pH Controller; D.O. controller; cominutor; barminator; shredder; grinder; sludge and scum scraper; automatic screen; non-clog or semi-non-clog sewage pump; trickling filter media; flow meter; air compressor or blower, filter press; vacuum filter; chlorinator; chemical feeder; sludge pump; resin; hydro-cyclone separator; etc.

2. Air Pollution Control

Wet scrubber; electrostatic precipitator rectifier; flu gas desulfurizator; bag filter; filter bag; fan and blower; absorption column; vapour condenser etc.

3. Residues and Solid Waste Disposal

Incinerator.

4. Research, analyzing and Monitoring Equipment

Samplers; incubators; pollutant analyzer; lab-analysis equipment (BOD analyzer, DO meter), monitoring equipment; combustible gas indicator, oxygen deficiency indicator; hazardous gas indicator etc.

2.2.3. The Environment Fund

The Environment Fund, briefly referred to in the discussion of NEQA, is one of the two main loan facilities with low interest rates and grace periods. The other is the Loan Service for Environmental Protection, operated by IFCT since 1991, and discussed in some detail in Section 2.1.2.6.

The Environment Fund is intended to support industries investing in pollution control facilities or relocating to industrial estates, industrial zones or other suitable locations where pollution control facilities have been provided. In practice, as indicated, there has been a strong bias in favor of allocations made to government agencies.

The Environment Fund Committee (EFC) is made up of high-level officials: the Permanent Secretary of MOSTE is Chairman and the Secretary General of OEPP is Secretary and Committee Member. Private industry is not directly represented on the Committee. The EFC specifies criteria, conditions, rules and procedures concerning the allocation and loan applications and is charges with other matters concerning the administration of the Fund.

Table 2-7: Imported merchandise for environmental control during 1984-1989

Year	Total		Waste Water Treatment Utilities		Air Pollution Control apparatus and sampling		Analytical equipment	
	Items	Amount (Baht)	Items	Amount (Baht)	Items	Amount (Baht)	Items	Amount (Baht)
1984	19	22,433,421	10	18,935,980	4	2,794,361	5	703,080
1985	17	51,822,843	10	44,979,715	5	6,498,159	2	344,969
1986	20	19,998,815	2	3,848,147	14	13,069,825	4	832,516
1987	26	16,771,574	10	2,720,984	12	13,362,747	4	687,843
1988	58	50,403,684	43	33,382,259	13	15,718,041	2	1,303,384
1989	63	176,526,250	20	27,054,944	40	147,822,110	2	1,429,000

Source: Charuratana, U., Imported Merchandise for Environmental control during 1983-1989; paper presented on 2nd National Seminar on Water and Wastewater Technology, Chulalongkorn University, Bangkok, Thailand, 15-16 March 1990, p. 335.
Note: During the first 5 years (B.E. 1984-88) requests worth 30 million baht per year of pollution control equipments were submitted for tax reduction.

The following activities are eligible for support:

1. Activities entitled to request grants:

- Central wastewater treatment plants or central waste disposal systems belonging to the government or local administration. This includes support for capital investment as well as operational and maintenance costs;

- Activities of registered NGOs;

- Activities directed primarily towards environmental enhancement or conservation.

2. Activities entitled to request loans:

- Local administration projects concerning central wastewater treatment or waste disposal systems;

- Local administration or public enterprise projects with respect to air pollution control;

- Private enterprises which are required by law to install pollution control facilities;

- Transfer costs incurred due to relocation of private enterprises to industrial estates, industrial zones or other suitable areas where pollution control (water and wastes) facilities have been provided;

- Private enterprises which have a licence to provide central wastewater treatment or central solid waste disposal systems.

For the private sector the Fund is limited to 20 per cent of total capital investment in fixed property. It furthermore must not exceed the investment in pollution control facilities for the business concerned, or exceed the relocation cost, or exceed 60 per cent of the fixed property investment of a central pollution control facility.

Procedures for applying for support from the Environment Fund have also been laid down. Article 21 specifies that a Government finance institution must be the Fund Manager for funds earmarked for local administration and public enterprises. The IFCT is the Fund Manager for the private sector portion.

At present, a sum of Bt 4,500 million has been allocated to the Environmental Fund from the Oil Fund and Bt 500 million from the annual budget of the Government. It is hoped to add more money to the Environment Fund from other sources, including from loans granted by external donors. The funds available at present have been allocated to four projects involving the construction of central wastewater treatment:

- Phuket Project Bt 1,100 million
- Pattaya Bt 1,700 million
- Hat Yai Bt 1,000 million
- Songkhla Bt 700 million

To be entitled to receive support, a project does not need to be located within a designated area for pollution control or environmental protection. The EFC is supposed to base its decisions on the merits and needs of the project itself.

2.2.4 Research and development subsidies

Universities and Government agencies can request financial assistance to conduct research from several sources, such as the National Research Council (NRC), the Scientific and Technological Development Board (STDB), from their respective ministries as well as from some bilateral agencies such as IDRC of Canada.

For industry, R&D subsidies from government sources did not exist in the past. Although co-operation with government agencies in some research projects was possible, industries were usually expected to bear the cost themselves. When the STDB was established in 1985, support for the private sector in the form of company-directed research and diagnostic/research design services began to be available.

STDB, in collaboration with the IFCT, the Bangkok Bank Ltd, and Thai Military Bank Ltd, now provides low-interest loans, on a cost sharing basis, of up to 50 per cent of project cost to firms for R&D activities and engineering projects. These also cover activities and projects aimed at finding solutions to ecological problems. It is expected that STDB will support 23 such projects with preference to small and medium-sized firms. So far, STDB has supported among others three projects in biotechnology which concern the treatment of tapioca wastewater by stabilization contact processes with the production of algae. (Table 2-8).

What is still needed in Thailand are increased R&D efforts to adapt internationally available ET products to the local environment[16]. This should also help Thai manufacturers to export such "adapted" technology to other developing countries, in particular to neighbouring Southeast Asian countries.

Table 2-8: Support of research and development projects in biotechnology

Project	STDB	NCGEB	ATT	CDR	PSTC	Total
Agriculture	40	50	34	8	26	158
Public Health	4	9	-	6	20	39
Environment	3	7	2	4	1	17
Energy	-	2	-	-	1	3
Others	-	12	2	1	-	15
Total	47	80	38	19	48	232
Budget	198.6	108.9	200.0	37.5	163.6	709.3

Source: STDB Annual Conference '91, Office of the Science and Technology Development Board, p.37.

2.2.5 Decentralization incentives

In 1988, the Government expressed its commitment to relocate factories to provincial areas to improve income distribution, alleviate rural unemployment and reduce the problems of congestion and pollution in urban areas, notably Bangkok.

2.2.5.1. Industrial decentralization incentives granted by the BOI

The BOI already had powers under the Investment Promotion Act to designate areas as "industrial promotion areas". Criticism was raised, however, that such areas were not necessarily selected according to environmental criteria, and that this applied even more strongly to the actual enterprises promoted or projects approved. While such criticism may be valid, it should be recognized that most attempts to redistribute factories away from Bangkok are likely to have a positive effect on the local environment. In that sense, the policy has played a useful role - irrespective of whether this was intentional or unintentional.

Recently the BOI has created a separate environmental unit so that in the future environmental considerations are likely to be an explicit part of the project approval process and the selection process concerning industrial promotion areas.

The BOI has classified its promotion activities according to the location of enterprises into three major zones:

Zone I: Bangkok Metropolitan Region including Nakorn, Pathom, Nontaburi, Patumthani, Samutprakarn, and Samutsakorn.

Zone II: Provinces surrour ling Zone I - Kanchanaburi, Rachaburi, Samutsongkram, Saraburi, Supanburi and Angthong.

Zone III: The remaining provinces

Privileges which can be granted by the BOI are as follows:

Zone I:

- Import duty reduction up to one-half for some types of machinery;
- Business tax exemption for machinery if more than 80 per cent of products are exported or if the plant is located on an industrial estate;
- Income tax exemption for a period of 3 years if more than 80 per cent of production is exported and the factory is located on an estate or in an industrial zone with a BOI promotion certificate.

Zone II:

- Import duty reduction for certain types of machinery by one-half and business tax exemption for machinery;
- Income tax relief for a period of 3 years which is increased to 5 years if the factory is located on an industrial estate or in an industrial zone with a BOI promotion certificate. (Negotiations are under way between industrial enterprises and the MOI to extend income tax exemption from 5 to 8 years. The MOI has in principle already indicated its willingness to accept such a proposal).

Zone III:

- Business tax exemption for machinery and import duty reduction by one-half for certain types of machinery;

- Income tax relief for a period of 6 years which is increased to 8 years if the factory is located on an industrial estate or in an industrial zone with a BOI promotion certificate.

The BOI incentives for the provinces have been continuously raised; the previously stringent "export-only" rule has been relaxed in 1990 and tax privileges and further privileges were being considered in 1993 to attract more investment to remote areas of the country[17]; these will be discussed in Chapter 3.

2.2.5.2. Incentives granted by the Industrial Estates Authority of Thailand (IEAT)

The IEAT's general role has been discussed above. It remains to be pointed out that the Governor of the IEAT has announced plans to draw on the Environment Fund to finance pollution control; to lobby for a further reduction of concessional rates for loans from the Fund granted to factories located in estates; and to have utility rates reduced.

The IEAT, being a Government agency as well as a representative of a significant number of private industrial establishments in the industrial estates, has significant advantages in getting direct access to the Environment Fund. Thus, industries in the estates will not have to apply for subsidized loans individually, which is a time-consuming activity with small chances of success.

If private enterprises can get indirect access to relatively cheap loans via the IEAT, this may act as a further incentive for them to relocate and take advantage of the creation of industrial estates which, in the future will presumably be increasingly established outside the Metropolitan Bangkok area for ecological reasons.

2.3 Private Industry Response to Environmental Challenges

Most industries have so far only paid lip service to environmental protection. Only a few, mostly foreign firms from the OECD area have publicly stated environmental protection as a corporate goal, partly as a response to pressure in their countries of origin. As a consequence, the ET industry and environmental consultancy are still at the infant stage. But progress is being made, in particular as a result of efforts of the Federation of Thai Industries (FTI).

2.3.1 The Industrial Environment Management Program of the Federation of Thai Industries (FTI)

At present, the FTI has more than 2,000 members from large, medium and small-scale industries. FTI is the only official representative of Thai industry as a whole. One of FTI's new roles is to co-ordinate private industrial development with national economic development and to protect national interests in the international economy. Within this context, one of FTI's tasks is to find economically feasible solutions for environmental problems caused by industry. FTI is also actively engaged in contributing to solutions of problems at the enterprise level.

The Industrial Environmental Management Program (IEMP) was conceived in 1990 as part of the USAID-sponsored MANRES programme to improve the capacity of Thai governmental and non-governmental agencies for dealing effectively with natural resource and environmental problems. The FTI is the implementing agency.

The objectives of the IEMP are:

- To build consensus and capacity among Thai industrialists for addressing fundamental environmental and workers' health and safety issues; and

- To promote private and public sector investment in environmental protection and to demonstrate means of improving industrial environmental management.

The main activities of the IEMP comprise:

- Creation of environmental awareness;
- International exchanges;
- Staff development;
- Co-operative technical assistance;
- Creation of an industrial environmental database.

The activities of the IEMP are clearly focussed on industrialists. In the early phase the activities were concentrated on environmental awareness raising. Current activities are now more focused on specific issues. The current program covers four main industries: textiles, pulp and paper, food processing and metals.

Textiles: The emphasis is on the use of clean technology in the dyeing and finishing processes, in addition to the promotion of good housekeeping practices to reduce material use and waste. The programme has cooperated with a plant in Samutprakarn to install vacuum technology which can achieve a 40 per cent reduction in material use. The use of computerized colour matching in dyeing puts an end to trial and error methods and thus reduces the use of dyes. The program also experiments with technologies to remove colour from wastewater.

Pulp and Paper: The project has assessed the status of the industry and is planning demonstration facilities. It has also become involved in a pulp mill which was ordered to suspend operations for non-compliance with environmental standards.

Food processing: Plans were being drawn up to assess the status of the industry in 1993. The emphasis here is on waste recycling.

Metals: In this sector, hazardous waste has been identified as the main problem.

The programme is also assessing the petrochemical industry and is looking into the feasibility of establishing a central hazardous waste treatment plants in industrial estates.

The dyeing and finishing project is a good example of the range of activities involved. These included advice from international experts on pollution reduction while keeping cost low, observation tours for Thai industrialists to see low-waste technologies and wastewater treatment plants in operation in the USA, Brazil and Switzerland, and discussions with industrial managers from these countries on the practical problems of introducing clean technologies. Seminars and workshops on computer colour matching including demonstrations of the use of vacuum technology were also held.

Although it is still too early to assess the success of these activities, the active involvement of the FTI in examining practical solutions for environmental problems arising from the operations of industry is a good start, and should help to convince private industry that sustained economic success will only be possible if environmental regulations are adhered to. The projects and activities accomplished so far have centered on the argument that reduction of pollution can go hand in hand with increased levels of efficiency and thus makes sense from an ecological as well as from an economic point of view.

2.3.2 Environmental auditing and consultancy

There are as yet no Thai firms offering environmental auditing services. There are only laboratories conducting emission tests. Although a few private firms are involved, much of the work is still done directly by government agencies as part of their monitoring work. NEQA (1992) provides for the licensing of "monitoring" and "contract service" agencies, to carry out waste treatment processes and environmental quality monitoring. Such agencies are also eligible for financial support from the Environmental Fund. The procedures for licensing have not been officially announced yet. However, in anticipation of the regulations, a group of private firms has formed an Independent Laboratories Association to establish a common code of conduct and standards.

More progress has been made in consultancy, where a market has been created by the requirement of an EIA for large-scale projects. For major projects, such as large power stations and dams, local consultancy firms normally join forces with foreign firms for the necessary expertise. The present OEPP (as well as the previous ONEB) requires consultants to be authorized. At present (1993) there are 32 organizations authorized to conduct EIAs. Most of these are Bangkok-based and are also involved in other engineering consultancy tasks. The major universities are represented in this field as well, two of them in Bangkok and one each in the North, the Northeast and the South. One publicly-funded scientific and technological research agency is also represented. Licences are valid for a period of 3-5 years (Table 2-9).

The weakest link is in air pollution control engineering and consultancy. Only a limited number of university professors and private sector consultants undertake consulting in this field and the quality of services varies significantly. Given the fact that both supply of and demand for consultancy services is limited, the pollution control equipment which is installed is often inappropriate.

2.3.3 Manufacturing of pollution prevention/control equipment

About 20 per cent of the Thai ET market is supplied with locally manufactured or assembled goods. So far, Thai manufacturers have specialized in the low technology/high turnover market segment. Local firms offer poor after-sales services and maintenance support. Another major problem is related to licensing. A number of manufacturers hold licences from overseas manufacturers and hence are usually supported technically by these; but much of the low-technology equipment is copied from foreign equipment because patent laws are not enforced.[18] This has boosted the production of these items but it has also made foreign suppliers very reluctant to co-operate with Thai companies in the manufacturing of high-tech ET equipment. Only recently the Thai Government - after severe pressure from the US - announced plans to improve its legislation and enforcement practices[19], which may strengther. the role of the Thai manufacturing sector in the more sophisticated ET equipment market.

In general, the advantage of domestically produced ET equipment is the low initial capital outlay. However, operating costs and in particular maintenance costs tend to be rather high and overall performance rather low. This makes domestically produced ET equipment adequate and competitive only for simple problems. More sophisticated requirements, which are characteristic for industrial operations, cannot yet be met by Thai industry.

Equipment for water pollution control

Most of the water pollution control equipment used in industry is imported and assembled for use at specific sites. Water treatment systems for domestic waste water however are locally produced and both mechanical and biological systems are being offered.

Table 2-9: List of licensed firms/organizations for conducting environmental impact assessments

No.	Name	Location	Date of start	validity expiry
1	Aggie Consult Co. Ltd.	Bangkok	1988	1993
2	Consultant of Technology Co. Ltd.	Bangkok	1988	1993
3	TESCO Co. Ltd.	Bangkok	1988	1993
4	Southeast Asia Technology Co. Ltd.	Bangkok	1998	1993
5	Chulalongkorn University	Bangkok	1988	1993
6	Toranee Tech Co. Ltd.	Bangkok	1988	1993
7	TEAM Consulting Engineer Co. Ltd.	Bangkok	1988	1993
8	Chiangmai University	Chiangmai	1988	1993
9	Mahidol University	Bangkok	1988	1993
10	STS Engineering Co. Ltd.	Bangkok	1988	1993
11	System Engineering Co. Ltd.	Bangkok	1989	1994
12	Songkhla University	Songhkla	1989	1994
13	SPS Consulting Service Co. Ltd.	Bangkok	1989	1994
14	Paul Consultant Co. Ltd.	Bangkok	1990	1995
15	Universal Engineering Consultants Co. Ltd.	Bangkok	1990	1995
16	Thailand Institute of Scientific and Technological Research	Bangkok	1991	1996
17	NS Consultant Co.Ltd.	Bangkok	1991	1996
18	Thai-Thai Visakakorn Co. Ltd.	Bangkok	1991	1996
19	Kaserart University	Bangkok	1992	1997
20	TIPCO Consultant Co.Ltd.	Bangkok	1992	1997
21	SGS Environmental Services Co.Ltd.	Bangkok	1990	1993
22	Water and Environment Consultant Co.Ltd.	Bangkok	1992	1995
23	Khonkaen University	Khonkaen	1990	1995
24	Macro Consultant Co. Ltd.	Bangkok	1990	1993
25	SDCON Corporation Co. Ltd.	Bangkok	1990	1993
26	International Testing Co.Ltd.	Bangkok	1991	1994
27	Siam DHV Co.Ltd.	Bangkok	1991	1994
28	Pree Development Consultant Co.Ltd.	Bangkok	1992	1995
29	ENVITECH Consultant Co.Ltd.	Bangkok	1992	1995
30	Metric Co. Ltd.	Bangkok	1992	1997
31	L and A Visavakorn Co. Ltd.	Nontaburi	1993	1996
32	Life and Environment Co.Ltd.	Bangkok	1993	1996

Thailand mainly manufactures low technology/high turnover equipment such as:

- Filtration equipment;
- Clarifiers and associated equipment;
- Mechanical screens;
- Surface aerators.

The share of domestic products in the domestic market for water purification equipment is some 30 per cent for coagulation and flocculation clarifiers as well as filtration equipment. This is above average (20 per cent). It is still well below average for pumps and disinfection equipment and to a lesser degree also for control equipment and fitting valves. On the other hand, the domestic production of surface aerators and screen filters has a rather strong market position, with a share of 30-40 per cent. The share of submerged aerators, pumps, disinfection equipment and in general for any kind of equipment for specialized treatment processes is extremely low.

Equipment for solid waste disposal

Here, industry still mainly relies on imported incinerators though the basic engineering designs of the various systems may be locally provided. Locally produced incinerators are relatively inexpensive and thus popular for housing estates, hospitals, universities etc. However, the domestically produced incinerators are generally not equipped with air pollution control systems.

Equipment for hazardous waste disposal

Local capacity for this type of equipment is virtually non-existent, mainly as a result of the lack of demand. But this is likely to change soon. So far, there was only one industrial waste treatment plant at Bangkhuntian, built by the MOI and leased to a private operator under a 5-year concession from 1988-1992. The concession has now expired and a new bid is being called. Also, industrial estates are now required to provide solutions for the disposal of hazardous waste. Finally, there is the possibility of individual firms constructing such waste disposal systems to provide a service to other factories. A recent example is found on the industrial estate in the eastern seaboard region designed for chemical plants. One of those plants has announced plans to construct its own hazardous waste treatment facility, also accepting, against a fee, chemical waste from other plants on the estate.

Equipment to control air pollution

This industry is still weak. While there are numerous Thai manufacturers of air pollution control equipment, this equipment is usually based on copied systems. As indicated before, this has made foreign equipment distributors and manufacturers reluctant to provide details of their equipment, and this has delayed technological progress and the emergence of local design capabilities for up-to-date equipment.

Dry mechanical dust collectors, primarily cyclones, are used extensively throughout Thailand, both as a process unit and for air pollution control. The demand for high-performance equipment is still limited to a few large industries and is mainly covered by imports.

The main types of air pollution control equipment produced in Thailand include:

1) Dust control equipment:

   - Cyclones of all size;
   - Ventilation equipment;
   - Small bag filters;
   - Small scrubbers.

2) Gas emission control equipment:

- Small scrubbers;
- Small afterburners.

There is a market for, e.g., electrostatic precipitators to control dust, but these cannot be manufactured locally yet; and gas emission absorption units cannot be marketed, mainly due to the lack of carbon regeneration facilities.

Limitations of locally produced ET equipment have led to inappropriate applications, such as removing dust with scrubbers instead of with dry collection processes which would prevent subsequent water pollution. Another example is the widespread use of cyclones which are not effective for small particles because they are cheap and widely available, being produced in Thailand.

2.3.4 Private industry R&D efforts

Lax enforcement of environmental laws in the past has not stimulated interest of private industry in both prevention and control of pollution - in spite of the efforts made, for example, by the IEMP (see above). This has resulted in a low level of relevant R&D efforts by private industry. Most efforts, as indicated before, concern end-of-pipe technologies. Under the present conditions industrialists do not have enough incentives to undertake R&D activities relating to pollution prevention and control in the early phases of production.

The lack of environment-oriented R&D must also be seen against the background of an overall lack of genuine R&D efforts in Thailand, for which there are several reasons:

- Firms operate in an expanding market, and the priority is thus meeting demand rather than innovation;
- There are obstacles to foreign competition in some markets, reducing the pressure for R&D;
- Import taxes on equipment and taxes on license fees increase costs of foreign technology which would be required for R&D;
- Severe shortages of technically-qualified manpower are common; normal production activities have priority over R&D;
- Firms generally have to finance technology acquisition from internal funds only;

Focussing on pollution reduction, several pre-conditions would have to be satisfied in order to stimulate interest in R&D, including:

- Certainty that environmental standards, especially for emissions, will be rigorously enforced;
- Increasing awareness of financial benefits from pollution reduction;
- Greater consumer demand for environmentally friendly products.

Progress towards meeting these conditions is at present only made with regard to the enforcement of standards. Improved production processes would require additional investment, but despite the FTI's efforts financial returns are still perceived to be larger in other areas. Finally, the Thai consumer has so far remained sensitive to low prices rather than to quality and environmental issues. However, with rising levels of income in Thailand, this should start to change as well.

One way to spur R&D activities would be to introduce market-based mechanisms whereby environmental costs are ultimately borne by the consumers of the particular goods and services in question, making it attractive for private firms to investigate ways of reducing pollution in order to reduce costs and thus prices, increasing competitiveness. This would involve arrangements similar to the carbon tax imposed on users of fossil fuels which is under discussion in industrialized countries. The range of pollutants on which the tax is levied, should of course be adjusted to suit local conditions. This approach could complement the polluter-pays-principle embodied in NEQA, which forces enterprises to take account (literally) of the environmental damage they cause. Prime candidates in Thailand would be the amount of waste water released from factories and the amount of sulphur dioxide emissions from lignite-using industries. (See also Chapter 5).

Endnotes for Chapter 2

1. Deutsche Investitions- und Entwicklungsgesellschaft - Commission of the European Communities, Thailand - Environmental Technology Study, Vol. 1, Cologne, May 1993, p. 69.

2. Dhira Phantumvanit, Phanu Kritiporn, Teerapon Soponkanaporn, Business and Environment in Thailand, March 1990, p. 5.

3. TDRI, The Greening of Thai Industry: Producing More and Polluting Less, Research Report No. 5, Bangkok 1990, p. 85.

4. Dhira Phantumvanit, Phanu Kritiporn, Teerapon Soponkanaportn, Business and Environment in Thailand, March 1990, p. 6.

5. Deutsche Investitions und Entwicklungsgesellschaft, Commission of the European Communities, Thailand - Environmental Technology Study, Vol. 1, Cologne, May 1993, p. 73.

6. The following discussion draws heavily on DEG, Commission of the European Communities, Thailand - Environmental Technology Study, Vol. 1, 1993, pp. 83-86.

7. While the OEPP is responsible for designating "areas for environmental conservation", the DPC is responsible for designating "pollution control areas".

8. DEG, Commission of the European Communities, Thailand Environmental Technology Study, Cologne 1993, Vol. I, p. 91.

9. Deutsche Investitions- und Entwicklungsgesellschaft, Commission of the European Communities, Thailand - Environmental Technology Study, Vol. 1, May 1993, p. 62.

10. The other Fund Manager comes from the Krung Thai Bank and is in charge of administering grants, aids and loans to government agencies, local administration and public enterprises.

11. Thus, in 1991 the IFCT in collaboration with NEB organized a seminar on "Control of Water Pollution from Industries"; with ASEAN a seminar was organized on "Environmental Conservation and National Development"; and with the Samut Prakarn Province a seminar was held on "Control and Abatement of Water Pollution in Samut Prakarn Area".

12. DEG, Commission of the European Communities, Thailand - Environmental Technology Study, Cologne, May 1993, Vol. 1, p. 88.

13. Martin Venzky Stalling, "Industrial Estates and Regional Industrialization in Thailand", Department of Geography, School of Oriental & African Studies, 19 March 1993, Table 15.

14. "Hi Tech Estate closes door to basic, polluting industries - Japanese camera firm Canon has bought a 100 rai plot of land for 200 million baht at the Hi-Tech Industrial Estate in Bang Pa-in", Bangkok Post, April 2, 1990.

15. Dhira Phantumvanit, Phanu Kritiporn, Teerapon Soponkanaporn, Business and Environment in Thailand, March 1990, p. 7.

16. Dhira Phantumvanit, Phanu Kritiporn, Teerapon Soponkanaporn, Business and Environment in Thailand, March 1990, p. 16.

17. See Financial Times, 20 January 1993; and Bangkok Post Weekly, 19 February 1993, p. 15.

18. DEG, Commission of the European Communities, Thailand - Environmental Technology Study, Vol. 2, Market Study, Cologne May 1993, p. 113.

19. "Thailand gets three months to satisfy US on patents", The Sunday Post, May 2, 1993, p. 3.

CHAPTER 3

ENVIRONMENTAL ISSUES OF FOREIGN DIRECT INVESTMENT

Thailand has increasingly received FDI in the secondary (i.e. manufacturing) sector (Table 3-3), while the share of total FDI to the primary (agriculture and extractive industries such as oil and mining) and tertiary (construction, trade, transport, real estate, etc.) sectors has decreased. Generally, the secondary sector is considered as having greater environmental impacts than the primary or tertiary sectors. It is essential, therefore, to review the major environmental issues stemming from the prominent role played by FDI and to identify action requirements and related capabilities of the BOI, the leading agency for attracting FDI.

This chapter is partly based on extensive interviews with major TNCs in branches generally considered to be potentially highly polluting. While the case study conclusions are summarized in section 3.4.3 below, the reader interested in individual interviews is referred to Annex B.

3.1 Recent Trends in FDI Inflows: Magnitudes and Determinants

In Thailand's Third Plan (1972-76), the promotion of manufactured exports and import substitution of intermediate goods and raw materials was adopted as a key theme of national economic policy. With subsequent developments in the Thai economy, this policy stimulated increasing inflows of FDI, particularly from 1987 onwards (See Table 3-1; for detailed statistics see Appendix - Tables A-9 to A-16).

The five years following 1987 were characterized by the steadily increasing pace of FDI as Thailand continued its drive towards export-oriented manufacturing. It is estimated[1] that in 1990, FDI directly accounted for between 30 to 40 per cent of Thailand's manufactured exports, which, in turn, made up the majority of the country's exports, valued at US$ 22.79 billion for that year. In the same year, FDI was equivalent to 8.3 per cent of Gross Domestic Investment (GDI) and 10.5 per cent of Gross Private Business Investment (GPBI), up from 2.9 per cent and 4.5 per cent, respectively, in 1986.

The post-1987 surge in FDI was triggered by two principal factors: first, the increasing absorptive capacity of the Thai economy for capital inflows in terms of natural resources, infrastructure, low cost labour and a Government policy which encouraged foreign involvement. Second, the appreciation of the Japanese yen and increasing labour costs, particularly in Taiwan Province of China, Hong Kong and the Republic of Korea, made Thailand an increasingly attractive location for relocating manufacturing facilities.

An indication of the impact on the Thai economy and its industrial make-up of the FDI surge can be gained from comparing total BOI-approved projects before and after 1987. By September 1991, BOI-approved projects for the period since 1987 stood at 3,614. This was almost triple the number of projects approved in the 25-year period prior to 1987 (See Annex Table A-10). A 1992 study[2] states that for the 1987 to September 1991 period: "The NICs and Japan are the major sources of FDI, together accounting for 66 per cent of joint-ventures and 78 per cent of foreign subsidiaries..... It should be noted that the share of NIC investors among export oriented foreign subsidiaries, especially from Taiwan, rose markedly from 4 per cent to 44 per cent over the same period."

The post-1987 FDI surge was marked by two notable trends. First, the level of foreign involvement in promoted projects increased from less than 50 per cent to more than 80 per cent by 1991, with 20.8 per cent of the total accounted for by foreign subsidiaries and 56.7 per cent as joint ventures. While BOI-promoted joint-venture (JV) export projects are very diversified, foreign subsidiaries are concentrated in such industries as fabricated metal products, electrical machinery and appliances as well as electronic products.

Table 3-1 : Net Inflows of Foreign Direct Investment by Country Group - 1970-1990

	1970-1979	1980-1984	1985	1986	1987	1988	1989	1990	Cumulative FDI Inflows
Net FDI Inflows (billion baht)									
North America	5.76	9.13	2.42	1.33	1.83	3.24	5.39	5.94	35.04
Japan	4.97	8.37	1.53	3.05	3.27	14.61	18.76	27.82	82.38
Europe	3.08	6.10	0.43	0.93	1.75	2.85	5.16	5.20	25.49
Newly Industrialing Countries	1.43	3.38	0.82	1.09	1.51	6.24	11.03	15.15	40.64
ASEAN Countries	1.09	2.99	-1.09	0.36	0.53	1.65	2.81	6.44	14.78
of which: Singapore	0.90	1.18	-1.12	0.40	0.54	1.57	2.75	5.91	12.12
Other Countries	-0.09	2.53	0.33	0.15	0.16	-0.62	2.55	1.97	6.96
Total FDI Inflows	16.23	32.49	4.44	6.91	9.04	27.96	45.70	62.52	205.29
Country Group Shares in Total (percentages)									
North America	35.5	28.1	54.6	19.3	20.2	11.6	11.8	9.5	17.1
Japan	30.6	25.8	34.5	44.1	36.1	52.2	41.1	44.5	40.1
Europe	19.0	18.8	9.6	13.5	19.4	10.2	11.3	8.3	12.4
Newly Industrializing Countries	8.8	10.4	18.4	15.8	16.7	22.3	24.1	24.2	19.8
ASEAN Countries	6.7	9.2	-24.4	5.2	5.9	5.9	6.2	10.3	7.2
of which: Singapore	5.5	3.6	-25.3	5.8	5.9	5.6	6.0	9.5	5.9
Other Countries	-0.6	7.8	7.4	2.1	1.7	-2.2	5.6	3.1	3.4

Source: Bank of Thailand.
Note: Equity and loans from parent or related companies including capital funds of foreign commercial bank.

The second distinct trend is the dramatic increase in export orientation of BOI-promoted projects: "The number of approved projects with export requirements (generally at least 80 per cent of total annual sales) increased from 437 to 3,165 with their share in total project approvals growing from 31 per cent to nearly 90 per cent.... . By 1991, virtually all foreign subsidiaries and almost 90 per cent of joint ventures projects receiving promotion were export oriented. This clearly reflects the BOI policy to allow projects which export 100 per cent of total sales to have 100 per cent foreign equity ownership."[3]

For BOI-promoted joint ventures and foreign subsidiaries established in the 1987-1992 period, there has generally been a pronounced shift away from traditional labour-intensive activities such as food, garments, and plastic products, to more sophisticated sectors such as fabricated metals, chemicals, electronics and electrical machinery (Table 3-2). In 1991-92, FDI in chemicals, metal processing and electronics/electrical industries ranked second, third and fourth, respectively, in value terms (surpassed only by FDI in services). The environmental significance of these structural shifts will be discussed below.

Table 3-2: FDI in three environmentally-significant industrial sectors (1991 & 1992)

INDUSTRY	1991		1992	
	Projects	Investment	Projects	Investment
Chemicals	39	US$1,395m	22	US$3,659m
Metal Processing	61	US$1,098m	46	US$1,016m
Electronics and Electrical	105	US$ 941m	84	US$ 696m

Source: EBG extract from BOI data (See Annex A-16 for the complete table).

3.2 Environmental impact of FDI in Thailand: A Broad Assessment

3.2.1 Introduction

It seems that so far no comprehensive field studies have assessed the general environmental impact of the industries that have been brought to Thailand with the increased inflows of FDI. Analysis of the direct environmental impacts of FDI is made difficult by the limited systematic scientific data describing industrial waste streams, including hazardous waste, and emissions from plants established as a result of FDI. This reflects the limited amount of centralised data on the volume and nature of waste streams from Thai industry in general. No government agency routinely collates statistics describing FDI activities generating hazardous waste at present. Furthermore, the complexity of the issue makes interpretations of the existing data tentative at best. Partial evidence is (or will be) available from the following exercises:

- In 1988-1989, Engineering Science Inc. of the USA, together with two Thai engineering firms, made projections of the country's hazardous waste streams while preparing the National Hazardous Waste Management Plan;[4]

- For its conference at the end of 1990,[5] the Thailand Development Research Institute (TDRI) analyzed BOI-promoted industries and concluded that the proportion of hazardous-waste generating industries among approved investment projects increased from 25 per cent in 1987 to 55 per cent in 1989;

- A study has been initiated by the BOI to investigate the waste streams of the factories it promotes. In October 1992, a research team from the Sanitary Engineering and Hygiene Department of Mahidol University, Bangkok, was commissioned by the Office of the Board of Investment (OBOI) to investigate and classify companies having the most serious impact on the environment and to make recommendations for environmental management. This study should be completed within 1993;

- Another initiative, funded by the Asian Development Bank (ADB) and launched in late 1992, is a study managed by a US consultancy, Plant Pacific Inc., to analyze the industrial waste stream for the heavily industrialised Samut Prakan area, south of Bangkok. Samut Prakan, a province with more than 4,000 factories, has been a favoured location for operations promoted by BOI (See Annex Tables A-14 and A-15);

When completed, these studies should provide the basis for a more thorough assessment of the direct environmental impact of industrial FDI. A full assessment of the environmental impact would have to cover not only the environmental degradation directly caused by the operation of foreign subsidiaries and affiliated companies in Thailand, but also the many linkage effects with the Thai economy and environment at large.

Table 3-3 : Net inflows of inward Foreign Direct Investment by sector, 1970-1990

	1970-1979	1980-1984	1985	1986	1987	1988	1989	1990	Cumulative FDI Inflows 1970-1980
Net FDI Inflows (billion baht)	16.23	32.49	4.44	6.91	9.04	27.96	45.70	62.52	205.29
Primary Sector	1.94	7.64	0.59	0.44	0.48	0.79	1.18	1.90	14.96
Agriculture	0.01	0.35	0.08	0.20	0.29	0.32	0.60	0.76	2.61
Mining and Quarrying	1.93	7.29	0.52	0.24	0.19	0.47	0.58	1.14	12.35
Secondary Sector	5.39	10.51	1.36	2.12	4.75	16.16	21.87	29.07	91.23
Food	0.57	0.31	0.39	0.29	0.44	1.06	1.96	1.95	6.98
Textiles	2.05	0.85	0.06	0.09	1.00	1.11	0.69	1.76	7.60
Metal and Non-metallic	0.25	1.42	-0.13	-0.02	0.37	2.11	2.76	2.84	9.60
Electrical Appliances	1.15	3.18	0.28	0.62	1.14	6.32	8.87	10.83	32.37
Machinery and Transport Equip.	0.33	0.99	0.03	-0.01	0.16	0.63	1.10	2.42	5.65
Chemicals	0.65	1.13	0.49	0.48	0.87	1.06	2.82	4.29	11.79
Petroleum Products	0.22	2.05	0.00	0.01	-0.02	0.77	-1.19	0.89	2.74
Construction Materials	-0.07	0.05	0.04	0.01	0.01	0.03	0.09	0.01	0.15
Others	0.26	0.52	0.19	0.67	0.80	3.07	4.77	4.08	14.35
Tertiary Sector	8.89	14.35	2.49	4.34	3.82	11.01	22.65	31.54	99.10
Financial Institutions	2.22	1.17	-1.24	0.51	0.44	2.58	2.84	3.83	12.36
Trade	3.51	5.52	1.08	1.78	0.85	3.88	6.82	13.00	36.46
Construction	1.89	4.60	1.59	1.23	1.35	1.84	3.93	3.29	19.73
Services	1.26	3.05	1.06	0.81	1.17	2.53	8.70	10.94	29.53
Others	0.00	0.00	0.00	0.00	0.00	0.19	0.36	0.47	1.02
Sector Shares in Total									
Primary	12.0%	23.5%	13.3%	6.4%	5.3%	2.8%	2.6%	3.0%	7.3%
Secondary	33.2%	32.3%	30.6%	30.7%	52.5%	57.8%	47.8%	46.5%	44.4%
Food	3.5%	1.0%	8.9%	4.2%	4.8%	3.8%	4.3%	3.1%	3.4%
Textiles	12.6%	2.6%	1.3%	1.2%	11.0%	4.0%	1.5%	2.8%	3.7%
Metal and Non-metallic	1.5%	4.4%	-2.8%	-0.3%	4.0%	7.6%	6.0%	4.5%	4.7%
Electrical Appliances	7.1%	9.8%	6.3%	8.9%	12.6%	22.6%	19.4%	17.3%	15.8%
Machinery and Transport Equip.	2.0%	3.0%	0.7%	-0.2%	1.8%	2.3%	2.4%	3.9%	2.8%
Chemicals	4.0%	3.5%	11.0%	7.0%	9.6%	3.8%	6.2%	6.9%	5.7%
Petroleum Products	1.3%	6.3%	0.0%	0.1%	-0.2%	2.8%	-2.6%	1.4%	1.3%
Construction Materials	-0.4%	0.1%	0.9%	0.1%	0.1%	0.1%	0.2%	0.0%	0.1%
Tertiary	54.8%	44.2%	56.1%	62.9%	42.2%	39.4%	49.6%	50.5%	48.3%

Source: Bank of Thailand.

Note: Equity and loans from parent or related companies including capital funds of foreign commercial banks.

3.2.2 FDI in pollution-intensive industries

To gauge the full environmental significance of FDI for Thailand, it would be necessary to identify the industries to which FDI is directed and to analyze the pollution-intensity of those industrial processes, the actual make up and control of their waste streams, emissions and other environmentally significant factors, which might include: the environmental management performance of domestic suppliers and sub-contractors; product distribution and stewardship; and product life-cycle monitoring. While these issues cannot be dealt with in detail, they are touched upon in the case studies of TNCs. Certain transnational corporations (TNCs), for example, conceded to the research team during field interviews that some categories of their toxic waste are collected by industrial cleaning services and that they have no idea of how this waste, or their sub-contractors waste, is disposed of, and that it might be openly dumped (see Annex B).

The overall environmental impact of FDI is nevertheless clear. The number of registered hazardous waste-generating factories has increased from 6,600 in 1979 to 16,000 in 1989[6], indicating the structural change taking place in the manufacturing sector, a process in which FDI plays a prominent role. Moreover, "the volume of hazardous waste generated in Thailand is expected to grow at a rate of 8.6 per cent per annum, in response to continuing growth in the metals industry, transport equipment and machinery manufacture, and the chemicals, textiles, rubber and pulp and paper industries."[7] Statistics from a variety of sources show that the majority of these branches have a high level of foreign investment. There are recent indications that FDI is on a downward trend[8], but foreign investment in large-scale chemical projects has nearly tripled during 1992 (up to US$ 3,659 million, from US$ 1,395 million in 1991). This is an industry with a potentially very significant environmental impact, which demonstrates that it is the pattern and not just the scale of investment which determines pollution intensity.

3.2.3 Inorganic waste and FDI

While inorganic waste still makes a small contribution (in volume terms) to pollution in Thailand, the rapid growth in the volume of hazardous waste causes growing concern. Effects such as widespread contamination of water resources may not be noticed immediately, taking years to surface and to be appropriately documented. FDI, as indicated, is concentrated in highly hazardous-waste generating industries such as chemicals, minerals, metals and ceramics. Chemical and chemical product industries accounted for more than 23 per cent of total FDI in firms promoted by the BOI in the period 1960-1985. The corresponding figure for the mineral, metal and ceramics industries was 22 per cent and for mechanical and electrical equipment 12.4 per cent[9].

BOI data reveal that the chemical industry and the metal processing industry accounted for over 60 per cent of the registered capital value of BOI-promoted companies in 1992. The capital intensity of foreign projects in these sectors is above average. It should be remembered that not all BOI-promoted companies are foreign-owned and that much FDI to Thailand does not pass through BOI.But data from the Bank of Thailand confirm the picture that BOI figures suggest: FDI in hazardous-waste generating industries has risen sharply in the last few years, 85 per cent of the Bt 15,666 million net flow of FDI to the chemical industry during 1970-1991 being invested during the last five years of the period.

Table 3-4: Net flow of FDI
to a selection of environmentally significant sectors
(Million Baht)

INDUSTRY	1970-79	1980-85	1986-1991
Chemical	647.8	1,619.4	13,398.8
Metal and Non-Metallic	247.1	1,295.0	10,309.9
Electrical Appliances	1,148.1	3,458.5	36,593.8

Source: Bank of Thailand.

3.3 The Role of Environmental Objectives in FDI Promotion

3.3.1 Recent changes in BOI regulations

The 1977 Investment Promotion Act, which defines the role of BOI, also takes environmental implications of investment into consideration. Section 19 states that BOI shall promote projects which incorporate "appropriate measures for the prevention and control of harmful effects to the quality of the environment in the interest of the common good of the general living of the public and for the perpetuation of mankind and nature." The Act also states that BOI may include "prevention and control of damaging elements to the quality of the environment," in the promotion certificate.

A number of new regulations and incentives related to the environment have been introduced by the BOI in recent years:

- In 1991, BOI declared that pollution control and energy saving machinery and equipment would be eligible for exemption from or the reduction of taxes and import duties.

- In the same year, BOI also announced that it would require that all projects with investment capital exceeding Bt 500 million submit a feasibility study which takes environmental issues into consideration. Prior to issuing a promotional certificate, BOI requires information on raw materials, products and production processes which may cause environmental problems as well as on investment in pollution control machinery and the cost of implementing a pollution control plan.

- In 1992, environmental requirements and incentives were further strengthened. To be eligible, projects, must not only be "important and beneficial to the country's, economic and social development, and to national security," but also "economically and technologically appropriate, and have adequate preventive measures against damage to the environment."

- In 1992, it was also announced that projects which preserve, protect, restore or rehabilitate the environment and conserve energy are given a privileged promotional status. The exact form and implementation of this privileged status remains to be determined.

3.3.2 BOI's implementation of environmental provisions

The BOI requires promoted factories to meet the environmental standards of the government's key enforcement agencies (the DIW and the three new environmental departments of MOSTE operating under the jurisdiction of the NEB). Certification that the environmental requirements of these agencies have been met must be submitted during the application process for promotional status. In addition, the BOI can include special environmental requirements in any Promotional Certificate if this is deemed necessary.

Cross-jurisdiction between various government agencies on different aspects of environmental management of industrial plants may complicate BOI's environmental role. While DIW is primarily responsible for factory inspection and control, pollution control officers of MOSTE's Department of Pollution Control have monitoring and reporting responsibilities. Furthermore, NEQA contains a provision that MOSTE's environmental department can request a third agency in the public or private sector to monitor and report on a factory if DIW fails to do so. To date, MOSTE has not applied this provision. BOI usually leaves technical monitoring and enforcement of environmental management standards to these MOSTE departments.

BOI's method for monitoring and enforcing environmental regulations and standards could not be determined. It appears that it is confident that any investor who meets the requirements of the NEB when an EIA is required, and obtains a factory operating license from the DIW, has satisfied the legal environmental requirements. No independent monitoring or checking by the BOI appears to take place, a task for which the agency lacks the resources anyway.

Prior to the introduction of the updated Factories Act, two factory licenses, a factory set-up license and an operational license, were required by promoted factories. The updated act streamlines the procedure. For a Promotional Certificate from the BOI the investor now only needs a Factory Operations License, supplied by the DIW after inspection prior to production. Alternately, the BOI can supply such a license and it is then the duty of the company to inform the DIW and request a check before operations commence.

3.3.3 EIAs and special promotion certificate conditions

As discussed in Chapter 2, EIAs are mandatory for certain industrial projects. Promotional privileges from the BOI require an NEB-approved EIA. In addition, the BOI requires that all factories applying for promotion have appropriate waste treatment systems, the ability to monitor and control their waste streams, and a factory license granted by the DIW. Again, the BOI apparently assumes that firms which apply for promotion and meet the standards of the government agencies named above also fulfill BOI conditions. The BOI's authority to include special environmental conditions in its Promotional Certificates (see above) has primarily been applied to chemical projects.

These special conditions are drafted on a project by project basis by the relevant division supervising the promotion application. There are no set BOI standards, only very general environmental conditions which must be met. A discussion is taking place within the BOI about dropping the system of special environmental conditions altogether as these may cause delay and deter investors from proceeding with their applications.

3.3.4 Locational preferences

In spite of policies favouring decentralization (see Chapter 2), a significant number of investors continue to locate in Bangkok, Samut Prakan and the adjoining provinces (See Annex Table A-15). In January 1993, BOI announced a series of measures to further encourage investment in other areas, reducing pollution and congestion problems in the Bangkok area:

- Activities which were previously promoted if they met export requirements will now be eligible for promotion if they are located in Zone 3 without export conditions[10]. Additionally, the locational condition "will be waived for export-oriented projects located in industrial estates in Zone 2"[11].

- Projects locating in Zone 3 will be granted increased tax benefits which include an exemption of duty on imported machinery which is currently subject to 5 per cent tax; extended income tax holidays from 6 to 8 years; and a reduction of import duty on raw materials used in production for domestic sales.[12] Also, for projects locating on industrial estates in Zone 3, income tax holidays are lengthened by two years from 5 to 7 years.

- Finally, factories which relocate to Zones 2 or 3 will be eligible for BOI promotional status if the following conditions are met: the activity must be included in the revised eligibility list; polluting factories which are obliged to relocate by MOI must move to an industrial estate; non-polluting factories must

employ at least 100 people in the existing plant and are required to move major items of machinery to the new location; and the new factory must be operating within 2 years of receiving the Promotion Certificate.

Factories relocating to Zone 2 will receive an extended income tax holiday of 3 years, increased to 7 years if they locate on an industrial estate. "Factories which move into Zone 3 will receive income tax holidays for 8 years and 50 per cent income tax reduction for a further 5 years. They will also be granted double deductions from taxable income of water, electricity, and transport costs; and a deduction from their net profit of 25 per cent of the costs of installation or construction of infrastructure facilities."[13]

3.3.5 Branch preferences

Until recently there was little evidence that BOI actively sought to promote particular industries or product groups. Also, like most investment promotion authorities in the region, BOI has not been seeking to attract "green" FDI as a matter of priority. In early 1993, it announced plans to try to actively attract selected industries to specific provincial areas: the North, for example has been targeted as a base for electronics manufacturing; automobile manufacturers will be encouraged to locate in Nakhon Ratchasima, Khon Kaen and Saraburi; petrochemical investors will be targeted for investment on the Eastern Seaboard, etc. No obvious environmental objectives seem to have been incorporated in this new policy initiative, although negative environmental consequences for the regions in question must be expected.

3.4 Selected case study evidence

3.4.1 Samut Prakan Province

Industrial pollution problems in Thailand may very well be worst in the province of Samut Prakan, south of Bangkok. A paper being prepared by the TDRI[14] investigating waste streams in Samut Prakan names the following five industries which are top BOD-polluters: food processing; textiles; chemicals; paper and paper products; and transport equipment. The five greatest hazardous waste producing industries are: fabricated metal products; electrical machinery; industrial chemicals; transport equipment; and textiles. The most serious hazardous wastes are heavy metals, acids and oil.

Samut Prakan is part of the increasingly industrialized suburban zone surrounding the BMA. It is host to the operations of many TNC subsidiaries and affiliates engaged in manufacturing. BOI has promoted - and continues to promote - FDI here, in spite of the fact that the province is considered to be one of the most heavily polluted areas in the country.

The governor of the province is lobbying, unsuccessfully so far, for the province to be declared a pollution control zone, like Pattaya and Phuket. According to him, there are 4,000 factories in the province, of which more than half affect people living nearby. Over 30 factories cause severe pollution problems, and should be shut down immediately, according to the governor[15]. Some observers see Samut Prakan as Thailand's foremost "pollution haven". Industrialists in the area acknowledge that environmental regulations are not enforced, and that release of untreated industrial wastewater is the norm, even in Bangpoo, the province's major industrial estate[16].

In 1991, 85 BOI-promoted companies started operations in Samut Prakan, and BOI approved 53 new applications for projects in the province. A year later, 55 BOI-promoted firms started operations in the province, and 24 new projects received the BOI go-ahead. On March 30 1993, the BOI granted investment privileges to Yamato International (Thailand) Co. Ltd. The wholly Japanese-owned company plans to establish a Bt 2.4 million plant to produce 690 tons of liquid glue a year, all for export. These projects are likely to increase the burden on the environment considerably.

The continued promotion of industrial investment in the province takes place despite the fact that the industrial areas of Samut Prakan have been earmarked as a prime target for the MOI's policy to relocate polluting industries to industrial estates outside the Greater BMA. The recent decrease in the number of projects

starting operations in Samut Prakan (see Table 3-5) reflects the overall reduction in applications; it is not due to any BOI policy to deter investors.

Table 3-5: BOI-promoted firms in selected industries starting operation in Samut Prakan Province

Industry	1991	1992
Chemical products	9	1
Processing metal	12	12
Electronic products	10	8
Plastic products	8	4
Spinning, weaving, dyeing, printing and knitting	7	5
Others	39	25
Total	85	55

Source: EBG Co., Ltd extract from BOI database.

3.4.2 The pesticide industry

The pesticide industry is considered highly pollution intensive[17]. In 1992, there were 65 registered pesticide producers in Thailand: 28 formulating plants, 38 repackaging plants, and one plant manufacturing pesticides from intermediate products. The involvement of TNCs in the country's pesticide industry increased during the 1980s, the total market held by TNCs increasing from 47.0 per cent in 1984 to 71.8 per cent in 1987. Only 25 per cent of the 30 TNCs surveyed had adopted global environmental standards. Close to 60 per cent acknowledged that they had adopted local standards for environmental management although a majority of TNCs were "greatly influenced by the parent companies' policies on standard, process, procedures and equipment used in pesticide processing."

The many local small and medium-sized companies in the Thai pesticide industry are generally felt to pose a greater environmental and public health risk than the larger foreign-owned companies, due to their often lax environmental management and safety procedures. This is also confirmed by a TDRI survey of three transnationals and three local firms.

Thus, the increased involvement of foreign companies in the market could potentially improve the safety and environmental performance of the industry. Local operators could learn from TNCs how to upgrade their technologies and management; industry associations could help to initiate such a transfer of know-how.

But environmental issues can lead to serious conflicts within industry associations. When toxic safety management and environmental technologies were put on the agenda of the Thai Pesticide Association this resulted in a split of the organization in 1986, a number of local firms breaking away to form the Local Thai Agro-Chem Business Society. The local firms accused the TNCs of trying to dominate the association and the industry. More specifically, the TNCs were accused of lobbying to strengthen legislation concerning

environmental safety. Stricter standards, local industry felt, would only serve the interests of the TNCs. The potential for such conflicts should be taken into account when assessing the potential for industry organizations - formal or informal - as vehicles for environmental technology transfer and safety management techniques from TNCs to local operators.

3.4.3 Evidence from company interviews

A number of interviews were carried out for the present study with leading TNCs. These may be found in Annex B. While they do not cover a representative sample of foreign companies,[18] these interviews have come up with interesting results which are summarized below.

The interviews established that Thailand's comparatively low environmental standards and enforcement levels (in international terms) were not a prominent motive for investment. The Thai and regional economies, political stability, easy profit repatriation, low labour costs and the nature of incentives were far more relevant. The track record of environmental management in TNCs is in most cases better than that of local companies. This can be attributed to factors such as the former's high visibility and exposure; the emerging role of environmentally-friendly production in competitivity; access to modern pollution control and prevention technology; availability of financial resources; and experience in managing the environment at the plant level.

The majority of companies sought to comply with environmental regulations in their home countries and/or had their own corporate policy and standards concerning the environmental aspects of operations in a developing country. They felt that their own corporate environmental standards protected them from liability under Thai law. However, the recent overhaul of environmental legislation and signs that compliance standards will become tougher over the next decade have made these TNCs keener on tracking developments in Thailand's environmental management framework and on monitoring the development of environmental awareness among the Thai population. The marketing implications of such a development (e.g. green labelling, green packaging), were specifically mentioned by a number of interviewees.

The conclusion of other empirical studies on the subject "that environmental cost differences have not been a major determinant of FDI, and that major shifts through FDI have not occurred because of differences in national standards"[19] is confirmed by the interviews. This implies that stricter environmental legislation is not likely to deter foreign investors. On the contrary, the latter often prefer restrictive to lax regulations if the former are transparent and follow predictable enforcement patterns. Research shows no evidence "that an industrializing country intent on attracting multinational corporations will lose any business by maintaining environmental codes that require incoming companies to make adaptations similar to those they have been required to make back home"[20].

Indeed, one very large TNC which was interviewed mentioned that, despite a corporate and market preference to establish operations in Thailand, a large investment had actually taken place in Singapore recently. The fact that the Singapore authorities would assist the company in establishing strict environmental management practices was an important reason for doing so.

The interviews showed that many TNCs insist on extending their environmental management principles to their sub-contractors. There is obviously a great readiness to provide technical and managerial assistance to sub-contractors; this constitutes a significant source of environmental expertise for local companies, the potential of which has not been fully utilized so far.

The following specific aspects of the interviews should be mentioned here:

- A number of companies admit that elements of their environmental management practice in Thailand would not be considered adequate in their home country. The way in which industrial cleaning services or "scrap dealers" dispose of waste collected from the TNC, for example, is not always known; the environmental management methods of sub-contractors, including disposal of hazardous and toxic wastes, is often not checked; and the companies have difficulties in maintaining product stewardship and monitoring product use and disposal because local customer networks are highly

fragmented. A number of TNCs indicated their lack of leverage with local suppliers when it comes to environmental performance, because these are not dependent on them.

- TNCs seeking to address environmental concerns in the production and distribution processes (e.g. packaging), are frustrated by limited market information and support industry services (see e.g. the Stanley Tools Ltd case study).

- TNC executives find that an appropriate cultural approach is needed at their plants if environmental management and responsibility principles are to be adopted and implemented successfully by local employees (see e.g. the 3M case study).

- There are practical difficulties in co-operating with local companies, and vice-versa, on improved environmental management (see e.g. the case study on the pesticides industry): different traditions of environmental management and awareness result in a different approach to environmental issues; local companies may feel suspicious of the motives of TNCs when these call for higher environmental and safety standards; and they are primarily interested in the financial aspects of improved environmental management.

3.5 Conclusions

Obviously, the speed of industrialisation in general and FDI in particular has far outpaced the development of environmental government enforcement agencies. In a number of cases, TNCs have taken the initiative to establish and enforce their own standards in order to avoid future liability and cleaning operations; and because high standards already exist (and are expected) in their home countries.

Without extensive interviews with the staff of BOI-promoted companies, it is hard to quantify or qualify to what extent BOI has used the legal provisions of the 1977 IPA. A general impression gained by the research team in field interviews however was that environmental issues have had a rather low priority. Moreover, the 1981 regulations for EIAs show wide gaps. No EIA, for example, is required for setting up a pesticide plant.

In general, the effectiveness of the EIA process has been questionable so far: "EIAs have become a formality which are routinely approved by NEB and are kept semi-confidential and away from the public eye and meaningful debate. Few, if any, projects have ever been rejected on environmental grounds. BOI has clearly not used EIAs and section 19 of the Investment Promotion Act as tools for selecting environmentally sound projects"[21]. A survey[22] of 33 TNCs, representing a cross-section of industries, found that about 40 per cent of the respondents prepared EIAs for internal use. Around 20 per cent prepared EIAs only when required by authorities. "More strikingly," the report states, "most industrial chemical and pesticide factories which were environmentally sensitive did not prepare EIAs for internal use."

It has been pointed out before that the BOI relies on other government agencies for the enforcement of environmental standards. Communication between the agencies however leaves much to be desired and the other agencies, moreover, also lack sufficient resources and expertise for effective enforcement. BOI-promoted companies may thus have been routinely able to by-pass the provisions of Section 19 of the IPA.

It appears that, at a time when FDI inflows are slowing down and the BOI is searching for a new direction and role, environmental issues are not given enough attention by most senior officers of the organisation. Whether this is due to uncertainty about the BOI's environmental role vis-à-vis other government agencies, to a lack of institutional will or concern about the environment remains to be seen.

As to the BOI's recent locational preferences, it may be questioned whether industrial dispersal will not have the effect of scattering pollution all over the country. This could be avoided if a sound environmental management framework and enforcement procedure were already in place in both the Bangkok region and the outlying provinces. Most observers agree however that in spite of improvements in the country's environmental management structures, a sound nation-wide enforcement system is still some years away.

Whatever the BOI initiatives in support of industrial decentralisation, rising costs - for labour and land - in the industrial heartland and other market forces are already pushing and attracting certain types of industries to outlying areas. Two questions arise in this context:

- Will the environmental laws and regulations that are so poorly enforced today be adequately enforced in the provinces in the future?

- To what extent will an increase in industrial pollution in the rural areas endanger existing manufacturing industries, such as the food-processing industries, which are based on local crops and fish catches?

Heavier FDI in chemical, metal processing and electronics projects are part of a trend towards industries with greater potential environmental damage. Pollution prevention and control activities therefore need to be more rigorously adhered to and monitored in the future. The experience of Taiwan Province of China could serve as a warning to Thailand's policy makers. While Taiwan Province has succeeded in achieving a relatively equitable income distribution through decentralized rural industrialization, this was clearly won at the expense of the environment. The high costs of repairing environmental damage resulting from past neglect are only now becoming apparent in Taiwan Province.

Endnotes for Chapter 3

1. Brimble P.; Sibunruang A.; 1992: "Export Oriented Industrial Collaboration. A Case Study of Thailand." (mimeo), May 1992, page 56.

2. Ibid.

3. Ibid. page 24.

4. Engineering Science Inc.; Thai DCI Co., Ltd.; Systems Engineering Co., Ltd; "Final Report. National Hazardous Waste Management Plan", March 1989.

5. TDRI Year-End Conference, 1990,"Industrializing Thailand and Its Impact on The Environment."

6. Thailand Country Report to the United Nations Conference on Environment and Development (UNCED), June 1992.

7. Ibid.

8. See BOI Investment Review, February 1, 1993, Volume 2, No. 1, page 8.

9. ESCAP/UNCTC. Transnational Corporations and Environmental Management in Selected Asian and Pacific Developing countries ESCAP/UNCTC Publication Series B, No. 13, Bangkok, 1988.

10. BOI Investment Review; February 1, 1993, Vol., 2 No. 1: BOI Lures Investors to Regional Areas, p. 13.

11. Ibid.

12. Ibid.

13. Ibid.

14. In March 1993, Owanruedee Limuorapitak, a Research Fellow at the TDRI Natural Resources and Environment Programme, was preparing papers on waste streams in Samut Prakan and Eco-business in Thailand.

15. March 25, 1993; "Out of the Wasteland", in The Nation.

16. Representative of a TNC chemical manufacturer with two plants in Samut Prakan. Requested anonymity for this reference.

17. The following information is derived from: ESCAP/UNCTC, Environmental Aspects of Transnational Corporation Activities in Pollution-intensive Industries in Selected Asian and Pacific Developing Countries, New York 1990, and TDRI, Reducing Pesticides Hazards in Formulating/Repackaging Plants in Thailand, Bangkok 1992.

18. Some 20 TNCs were approached and in 9 cases in-depth interviews were actually carried out. The results may be biased in the sense that apparently the most environmentally conscious companies have positively responded to the requests. Yet at the same time this leads to significant conclusions on the potential role of TNCs as catalysts for environmentally sound industrial development.

19. Cf. UNCTC, World Investment Report 1992. Transnational Corporations as Engines of Growth, New York 1992, p. 233; for some of the arguments put forward in this section cf. also op. cit, chapter IX.

20. Leonard, Jeffrey H.; Pollution and the Struggle for the World Product. Multi-national Corporations, Environment and International Competitive Advantage, Cambridge 1988.

21. Panayotou T.; "Promoting Sustainable Development: A New Role for the BOI," (Draft paper). 1989.

22. See ESCAP/UNCTC Publication Series B. No. 13, 1988.

CHAPTER 4

ENVIRONMENTAL ISSUES IN THE THAI ELECTRONICS INDUSTRY

4.1 Characteristics of the Industry

4.1.1 Contribution to MVA and pollution

The electronics industry in Thailand has grown very rapidly over the last decade. In real terms, value added in the electrical/electronics machinery sector[1] rose an average 17 per cent per annum from 1980-90, at a time when overall manufacturing value added (MVA) was growing by 10 per cent per annum. The contribution of electronics/electrical machinery to MVA rose from 3.2 per cent to 6.0 per cent over the period, while its contribution to hazardous waste output increased to 4.5 per cent of manufacturing.[2] The bulk of hazardous waste was acid waste (42 per cent), heavy metal sludge (41 per cent), alkaline waste (11 per cent) and inorganic sludge (4 per cent). The rest are oils and solvents (about 1 per cent each). The electronics/electrical machinery industry is responsible for nearly 30 per cent of acid waste, more than 1/4 of alkaline waste and about 1/6 of inorganic sludge produced in Thailand.

4.1.2 Growth and markets

The electronics industry in Thailand has its beginnings in the 1960s. Initially, production was largely for the local market. During the 1970s, TNCs acquired a strong position in the industry. Major Japanese producers like Sanyo, National, Hitachi, Mitsubishi and Toshiba formed joint ventures with local firms. Major US manufacturers of integrated circuits (ICs), such as National Semiconductor and Data General established plants serving export markets. By 1980, however, electronics products still accounted for only 5.1 per cent of total exports. The rapid expansion of electronics only occurred during the 1980s, with the expansion of the production of ICs, computer components and printed circuit boards (PCBs). ChinTek Electronic Industries, a fully Thai-owned firm managed became the largest domestic producer after the international giants by the mid-1980s.

The appreciation of the Japanese yen has caused a further surge of the Thai electronics industry since 1987. In 1987 alone the Board of Investment promoted 53 projects, which was more than the total of the 1960-1986 combined. In 1988 another 55 projects were approved in the first six months. The slowdown of the global economy in the early 1990s reduced the pace of expansion of the electronics industry in Thailand, but did not halt it. By 1993, the number of purely electronic industrial operations in Thailand was above 170. If classified by the number of employees, there are 20 plants employing more than 1000 each. More than 50 plants employ less than 100 employees.

If one uses a broad definition of the electronics sector, the number of electronics/electrical machinery sector enterprises (with over 7 employees or 2 hp of machinery) registered with the DIW almost trebled between 1979 and 1989 -- from 409 to 1,121.

While the expansion of the electronics industry before 1980 was mainly directed towards the domestic market, the rapid expansion of the industry during the 1980s was largely geared towards export production, with the result that by 1990 electronics accounted for roughly 8 per cent of total exports,[3] higher than the MVA share of about 6 per cent. This strong export orientation poses challenges: with Thai electronic enterprises still mainly working in price sensitive fields, price competitiveness may be reduced if ecological standards are improved and enforced.

4.1.3 Firm size

The 1980s were not only characterized by a strong expansion of exports but also by a tendency towards smaller firms in electronics. The number of small and medium sized firms has grown rapidly as can be clearly seen from the following figures: during 1980-84 the average number of workers employed per project was

roughly 440; during 1987-90 the average was only 230. Likewise, the average capital investment per project decreased from Bt 324 million to Bt 225 million.

Table 4-1: Profile of Electronic Industry in Thailand

Products	Number of Plants	
	Outside Estates	Inside Estates
1. Computers	6	5
2. Electronic parts	58	28
3. PCBs	16	3
4. ICs	5	-
5. Consumer electronic parts	2	-
6. Consumer electronics	26	14
7. Ceramic capacitors	1	1
8. Transformers	1	1
9. Satellite equipment	1	-
10. Watches	1	-
11. Switchboards	-	2

The growing number of smaller size firms in the electronics industry poses new challenges for environmental management. Previously, the relatively few large firms could not always be trusted to adopt sound environmental management practices on their own; but at least they could be monitored fairly easily for compliance with environmental regulations. The larger number of firms now operating has made monitoring and enforcement far more complicated.

4.1.4 Employment

Actual employment figures for electronics are difficult to obtain and depend upon the definition used. Figures on the estimated numbers of workers employed by electronics projects approved by the BOI may give some indication of the sector's importance. Between 1962 and 1990, the cumulative total of workers in BOI-approved electronics projects was 216,700. Of those, roughly 170,000 were employed in projects approved after 1987. Another estimate of electronics employment puts the figure at roughly 144,000 workers at the end of 1990, 4.8 per cent of the total manufacturing labour force, compared with a share of 6 per cent in MVA.

4.1.5 Location and ownership patterns

The majority of the electronic firms are located in and to the north of Bangkok, as well as in Samut Prakarn. New electronic firms are usually located on industrial estates north of Bangkok. This has been the result of the creation of "high-technology" industrial estates at Navanakorn and Bang Pa-In, which are within a 50 km distance from Bangkok. Only a few electronics firms are found in other parts of the country.

It has already been noted that the industry is rather heavily foreign-owned. A 1988 survey indicated the following ownership pattern: 21 per cent of the industry is foreign owned, joint ventures account for 28 per cent and in 51 per cent the Thai share is more than 90 per cent. Locally-owned assembly operations act as subcontractors or original equipment manufacturers (OEMs) for multinationals or overseas customers. These include a few semiconductor assembly plants and a large disk drive facility. Some of the major Thai industrial groups -- e.g., Siam Cement and Saha Union -- have diversified into electronics during recent years. With the influx of Japanese, and to a lesser degree Korean investment, the consumer electronics industry has expanded

rapidly to serve both a growing domestic market and the international market. Telecommunications equipment (mostly but not only subscriber equipment) has also become a growing area of investment. This is partly the result of the major expansion of Thailand's telecommunications network.

4.1.6 The transformation of Thailand's electronics industry

Initially the Thai electronics industry was a producer of consumer electronics and some telecommunications equipment. The 1970s saw the rise of semiconductor production (chip assembly). This industry continued to grow as chip plants were joined by a new generation of investments in disk drive production and a variety of other computer peripherals in the early 1980s. Since the mid-1980s, electronics production has expanded in almost all areas, driven by a new wave of foreign direct investment originating from Japan and to a lesser extent the 'four dragons' (Taiwan Province, the Republic of Korea, Singapore, and Hong Kong).

The changing structure of the industry is visible in exports: in 1980, the active components sector (overwhelmingly semiconductor assembly) accounted for 93 per cent of total electronics exports. By 1990, that share had fallen to 22 per cent. The office automation (mostly computers and peripherals) equipment share of electronics exports rose from less than 1 per cent to 38 per cent, a growth that was attributable largely to the rapid expansion of computer disk drive production. Production of computer keyboards and other peripherals also grew rapidly, but in value terms it is still a small fraction of disk drive production. Consumer electronics exports increased from 2.3 per cent of total electronics exports in 1987 to 22 per cent in 1990.

4.2 The Major Environmental Impacts of the Electronics Industry

The electronics industry generates a variety of wastes, many of them toxic and hazardous. Moreover, it has strong links to suppliers and supporting industries that are significantly more polluting than electronics itself - notably chemicals, plastics, metalplating and finishing.

There are certain common types of environmental problems affecting most if not all electronics operations. Localised air pollution is not a major concern in the electronics industry, though air quality inside the workplace can be an important occupational health issue. Lead emissions have caught the headlines in Thailand in recent years. Lead is a component of the flux used for PCB production. However, it is used at low temperature so that emissions are low at worst. Since control of lead emissions is rather simple, most plants have introduced special controls. In the case of water, BOD discharges are not a major problem but discharges of acidic waste can be.

World Bank economists have mapped pollution intensities per unit of output for the manufacturing industry, broken down by 4-digit ISIC classifications.[4] The ISIC numbers that encompass the bulk of the electronics industry are 3825 (office machines and computers) and 3832 (radios, televisions, telecommunications equipment, and active components). According to these findings, toxic chemicals and bio-accumulative metals are released in considerable quantities by the electronics industry, although many industries in, among others, the chemicals sub-sector are far greater polluters in this respect.

We will now look in turn at localised pollution of water and soil caused by the industry, principally from releases of inadequately treated waste water and unsafe disposal of toxic sludges; and its contribution to global problems like ozone depletion and climate change.

4.2.1 Local pollution problems

Toxic chemicals and heavy metals in waste streams are largely the result of cleaning/degreasing operations and electroplating. The former makes use of a variety of industrial solvents (chlorinated and non-chlorinated), many of which are toxic and some of which are carcinogenic. The materials removed from the electronic components or assemblies during cleaning/degreasing include oils and solder residues, notably lead. Electroplating also makes use of certain toxic chemicals but its main by-products are metals.

Both types of operation generate waste streams which need to be managed carefully. In some cases, this calls for heavy metals removal and wastewater treatment; in others, the safe disposal of waste sludges; in still others, the recovery and recycling of waste products. In addition, in the numerous operations requiring handling of toxic or carcinogenic chemicals, adequate environmental health and safety procedures are needed at the workplace to minimize worker exposure. One area of concern is the continued use by some electronics plants of suspected carcinogens (such as 1,1,1 trichloroethylene) that have been banned in the USA and certain other OECD countries and for which there are readily available, safer substitutes.

Below, a process-specific review is undertaken of the most significant environmental problems associated with the electronics industry per se and with its most important supplier and supporting industries.

Semiconductors

Tin dip/plate

This area uses a number of potentially hazardous substances, including several metals (lead, tin, copper, zinc) and acids (hydrochloric, sulphuric). Wastewater needs to be tested for metal content. If it exceeds acceptable levels (by Thai or international standards), precipitation/removal is required. Wastewater may also need to undergo pH neutralisation if acid content is high.

Environmental tests

This process refers to the testing of electronic components for their reliability in harsh environments, e.g. temperature extremes and fluctuations, moisture, radiation, physical stress, etc. It is a particularly crucial procedure in the case of components destined for military or other high-reliability applications. Radioactive gases (e.g. Krypton-85) are sometimes used for leak testing. Very strict safeguards are needed to prevent worker exposure.

Printed circuit board production

In PCB production, there are two techniques of printing circuitry on the substrate, additive and subtractive. The former is used principally in commercial production and the latter in R&D. In the subtractive method, part of the copper cladding on the base plate (or laminate) is etched away with chemicals so that only the desired circuit pattern remains. In the etching process, residues containing copper and toxic chemicals are generated; these should be recovered and either recycled or disposed of properly.

Printed circuit board assembly

Soldering

If not protected by masks and adequate ventilation, workers in the soldering area risk inhalation of solder fumes which contain high concentrations of lead. Proper ventilation systems are therefore crucial in this area. The blood lead level of workers should be tested periodically. If the fumes are not to become a source of air pollution outside the factory, (packed water) scrubbers need to be installed. Scrubber discharge can then be routed to a heavy metals recovery (and pH neutralisation) system.

Post-solder defluxing

This process removes flux and solder residue from the PCBs. The chemical composition of the flux determines the degree of toxicity of the residue. In the event that a zinc chloride flux is used, then the zinc in the residue needs to be recovered. Also, the solder dross normally contains lead which should be recovered. Since the defluxing process utilises solvents, these also need to be managed properly. Commonly, azeotropes of CFC-113 and 1,1,1-trichloroethane (methyl chloroform) are used as defluxing agents; these are not toxic but ozone-depleting; their proper management is discussed in the section on global environmental problems.

Metalworking

Metal cleaning

Electronic equipment contains a variety of metal parts including: mechanical components and metal casings for computer disk drives, micromotors, lead frames for integrated circuits, parts for electron guns used in cathode ray tubes (CRTs), connectors, power supplies, fans, casings for computers, keyboards and other peripherals. Depending on the particular product and process, the wastes generated differ somewhat, but there are a few fairly common wastes which need to be managed. These include metal scrap, lubricating oils, and degreasing solvents. Recovery and recycling should be feasible for solvents. Depending on the metal and the quantities, recovery and recycling may also be feasible. For small sub-contractors, however, there is probably not enough waste volume to justify in-house recycling, so a common recycling facility may be needed.

Electroplating

Metal plating and finishing are sometimes performed within electronics plants and sometimes by outside contractors. In the electronics industry, tin, aluminium, nickel and copper plating are employed. By-products of the plating process can include solvents (e.g. toluene), acidic and alkaline wastes, waste oil, salts, chromium and cyanide, in addition to trace metals. These should be properly disposed of, or recycled, if feasible.

On-site chemical storage

There are two areas where chemical management is needed: storage in stocks and in-process use. The former is the least difficult problem; the main concerns are to prevent leakage from storage tanks/drums, to ensure against explosions and to prevent fires in the case of inflammable substances (e.g. solvents like alcohol and acetone). In-process chemical control involves not only containment of leaks and precautions against fire/explosion but also minimisation of worker exposure to toxics and carcinogens. As a rule, secondary containment is needed in chemical storage and use areas to guard against contamination of soil or ground water. Ventilation is also essential, to reduce health risks as well as the risk of explosion. Another concern is the compatibility of chemicals stored together. Corrosives, e.g., should not be stored close to inflammables.

Control technologies and procedures

While much of the pollution control effort in the electronics and related industries relies on end-of-pipe treatment, the reliance on closed loop systems in which waste products are recovered, recycled, and reused - including wastewater - is increasing. This waste minimisation approach can also be economically attractive.

Common waste disposal facilities

The Bang Khuntien hazardous waste treatment facility, briefly referred to before, is the only common waste disposal facility for the electronics industry so far. One of the principal industries served by the facility is electroplating. A firm wishing to have its effluents from electroplating treated normally has to sign a one-year contract which covers the collection of the waste and transportation to the treatment plant. The client has to provide the initial storage at his plant. The service fee for the service is calculated in advance on the basis of the volume and characteristics of the waste, and the distance of client's factory to the treatment plant. Electroplating wastewater is treated chemically, and the remaining inorganic sludges are stabilized and later on transported to a security landfill in Ratchaburi, about 120 km from Bangkok.

So far, a total of 123 electroplating plants are using the central treatment plant service, with contracts totalling some 6,000 tonnes of wastewater per month. Only 12 electronic firms have a contract with the central wastewater plant, for a total amount of some 100 tonnes a year, less than 0.2 per cent of all electroplating wastewater. This is very low even when taking into account that electroplating is not necessarily a main activity of electronic companies. Interviews with MOI officials revealed that the highly polluting electroplating activities of the electronic industry therefore frequently go unreported and thus remain undetected. Although the MOI is increasingly clamping down on the illegal disposal of wastewater, it has proven to be difficult for the

authorities to keep track of electroplating and other kinds of surface treatment activities. Most hazardous wastewater, as pointed out before, is dumped illegally.

New technologies to remove heavy metals from wastewater at the factories have so far not fulfilled the initial expectations. The ion-exchange process, for example, has been introduced by some firms and aroused great interest because of low initial costs. However, the resins used in the process must be regenerated to prevent heavy metals from being released into water bodies. The MOI has so far been reluctant to approve this technology for small and medium-sized enterprises. This means however that Thailand's electronic industry, and more precisely the enterprises engaged in electroplating, will remain dependent on the existence of central waste treatment plants for cost reasons.

It has already been mentioned that the MOI intends to establish additional hazardous waste treatment facilities; progress however has been slow. Meanwhile, wastewater from the electronics and electroplating plants can also be treated at the Suksawat and Rangsit industrial wastewater treatment plants, provided it is not too toxic. The new Ratchaburi site will, in addition to other facilities, also have a hazardous waste incinerator (rotary or rocking kiln type, possibly) by 1994. Security landfills will be made available at Chon Buri, Ratchaburi and probably at Rayong. In the future, common facilities will also be needed to recycle waste products from electronic firms, in particular CFC-113, until firms will be able to convert their operations to non-CFC technologies.

4.2.2 Global environmental problems

The main damage done by the industry to the global environment comes from chemicals used for cleaning and degreasing, which are ozone-depleting substances (ODS), now controlled under the Montreal Protocol. Solvent cleaners constituted about 43 per cent of total ODS (ODP-weighted[5]) in 1991; of that, 34 per cent consisted of chlorofluorocarbon (CFC)-113 and 9 per cent of 1,1,1-trichloroethane (or methyl chloroform - MC)[6]. Some of these chemicals as well as others used in the industry also contribute to global warming.

Thailand has signed the Montreal Protocol, and electronics firms must therefore find ways of rapidly phasing out the use of such ozone-depleting chemicals. There is a strong fear - in particular in the integrated circuit industry - that special levies could be raised by importing countries, notably the USA, in the case of products manufactured with CFCs; this has prompted industry to give up its resistance against a phaseout.

The ODS most commonly used in electronics production are CFC-113 and MC. Both are chlorinated solvents and their chlorine atoms react with stratospheric ice and dust particles to break down ozone (O_3) molecules, thinning the ozone layer. CFC-113 is mainly used as a cleaning agent for integrated circuits, PCBs and computer components, in particular computer disc drives.

4.2.2.1. Status of phase out of CFC-113 and methyl chloroform

While Thailand does not produce ozone-depleting substances, a recent study by the MOI, the Chulalongkorn University and the United Nations Environment Programme (UNEP), based on a sample of 20 electronic firms, shows that the consumption of CFC-113 quadrupled between 1986 and 1990 and then decreased slowly after the Montreal Protocol had become effective.

However, this survey seems to portray an overly optimistic picture. For industry as a whole, consumption does not yet seem to decline but to grow, although at a lower pace than in previous years. Only preliminary figures for 1992 indicate a stabilization or perhaps even a small decline over the previous year. In 1991 the import of CFC-113 still rose by some 14 per cent from 2,800 to 3,200 tonnes - in previous years the growth rate was at about 30 per cent per annum. Out of those 3,200 tonnes of CFC-113, nearly 60 per cent were used for the electronics industry. According to other sources, the 1991 imports of CFC-113 even reached 3,500 metric tonnes, two-and-a-half times more than in 1986, the base year for control purposes in the Montreal Protocol. Imports of MC doubled over the same period, reaching nearly 8,000 tonnes in 1992.

Consumption of CFC-113 was divided roughly evenly between electronics cleaning and metal/precision equipment cleaning. In the case of MC, electronics cleaning accounted for about 58 per cent of consumption and metal/precision instrument cleaning for the remainder.

A few large foreign electronics and metal products firms account for most of the use of these substances in Thailand. In 1991, a single Japanese company - which manufactures miniature ball bearings, micromotors, and computer peripherals for export -- is estimated to have consumed roughly half of all ODS used as solvents (on an unweighted basis). The second largest ODS user in solvent cleaning is the leading US hard disk drive manufacturer. So far, control efforts in Thailand have been directed at those large foreign-owned firms.

4.2.2.2 Policy response to the ozone depletion problem

Thailand ratified the Montreal Protocol in 1989. The government has also adopted the London Amendments which call for an accelerated phase-out of ODS, with most controlled substances phased out by the developed countries by the year 2000. Because Thailand's annual consumption of Annex A substances (which includes the major CFCs and halons) is less than 0.3 kg per capita, the country has a 10-year grace period under the Protocol to accomplish its ODS phase-out. However, Thailand has meanwhile initiated a strategy to accelerate the phase-out of the banned substances.

To monitor and control the consumption of ODS, Thailand has classified substances which come under the MP as hazardous, thereby allowing for their regulation under the Toxic Substances Act. Thailand relies entirely on imports for these chemicals. Prior permission is now required before a company can import any ODS. Once the shipment has landed, the importer must file a declaration stating the exact quantity imported. The DIW has adopted a policy of not allowing new companies to import ODS unless they have a factory operating license, in which case the imports are tied to factory capacity. Moreover, the MOI has urged the BOI to end promotional privileges to firms using ODS.[7]

Government action to phase out ODS has thus centred so far on restricting the use of the substances by new industrial firms while existing industries who wish to reduce the use of the substances are encouraged by tax incentives (e.g. reduced import taxes on recycling equipment) and promotion as well as access to cheap finance. On 23 March 1993 the Policy Committee on Montreal Protocol Action decided to entrust the IFCT with the management of the multilateral fund to assist industry in reducing the use of CFCs.

One important component of the efforts to phase out CFCs in Thailand has been a tripartite agreement involving Thailand, Japan, and the United States. Under the non-binding agreement, Japanese and US electronics firms operating in Thailand are supposed to phase out their CFC use on the same schedule as in their home countries.

If the tripartite agreement is implemented as foreseen, it would initially reduce the demand for ODS in Thailand quite substantially. Whether that reduction will continue, however, depends on the effectiveness of the Government's efforts to control growth in demand from other ODS users - notably firms from Hong Kong, the Republic of Korea, Singapore and Taiwan Province. Depending on how rapidly their operations in Thailand grow, they could cause the consumption of ODS to rise again. Moreover, there are a growing number of Thai electronics firms in the subcontracting and OEM business whose ODS consumption is not governed by the tripartite agreement either. Thus, the government needs to regulate the growth in their demand for ODS. It may also be necessary to offer certain Thai firms and the smaller foreign-invested firms financial assistance to undertake the conversion to ODS alternatives. The incremental costs of conversion should in theory be reimbursable from the Multilateral Fund established under the Montreal Protocol (MP).

There is however a major incentive for phasing out CFCs: because the electronics industry is overwhelmingly geared towards export markets, Thai enterprises must phase out CFCs as soon as possible to prevent retaliatory measures by the main importing countries. These could easily use the environmental argument as a pretext to protect their domestic markets from successful Thai competitors, or even ban products produced with ODS completely.

In the longer run, CFCs are likely to be phased out completely. Not only because the electronics industry, which is among the leading foreign currency earners for Thailand, accounts for about 80 per cent of exports which are produced with the help of CFCs, but also because the technology of CFC-based manufacturing is becoming obsolete rapidly. Finally, the availability of CFCs will certainly be limited in the future. This will increase their price, especially given the fact that Thailand does itself not produce the substances.

4.2.2.3 The industry response

TNCs such as Minibea of Japan have already begun to eliminate CFCs from all processes. AT&T of Thailand, Northern Telecom and 3 M discontinued the use of CFC-113 in 1992 and have been instructed by their head offices to phase out other ODS, in particular MC, by the end of 1993. The list could be easily complemented by other firms. The problems are mainly with smaller Thai-owned firms which still need time and finance to pay for the technology transfer which will allow them to switch to other substances or production processes. Thus, Thai-owned firms are generally at a clear disadvantage, at the moment.

Alternatives to CFCs are controlled-atmosphere soldering, no-clean flux, aqueous or semi aqueous cleaning, HCFC and alcohol-based cleaning. Other alternatives (trichloroethylene, perchloroethylene and methylene chloride) raise health questions and must be handled with care in order to protect workers. Recycling and re-use of CFCs is an alternative for the short term but no long term goal as industry aims at total elimination of CFCs.

The phase-out cost has been estimated at about Bt 100 million for the domestic sector and Bt 225 million for the export sector.

Phasing-out issues in individual industries

The following paragraphs contain a short summary of responses to the need for phasing out ODS by Thai enterprises visited in the context of the present report. The companies investigated remain anonymous.

The integrated circuit industry

Integrated circuit production processes usually involve joining the IC to the frame (wire bonding), moulding or encapsulation, and testing. Two factories were visited and surveyed.

The first factory used MC as a solvent to clean the IC. The consumption was small (200 l/year). Nevertheless, the company decided to have the substance replaced by isopropanol. The necessary technology and know-how was transferred from the parent company in the USA.

The second firm used CFC-113 for degreasing of frames, IC leak checking, and for general purposes. This factory was in the process of replacing CFC-113 by a new closed system using fluorinert (FC, consisting of fluorine and carbon) with FC detectors to check any leaks. This had the additional advantage of improved overall efficiency. In the old process, workers checked for leaks by looking for CFC-113 bubbles as ICs were soaked in a hot water bath. The new process, relying on detectors, eliminates human errors and costs for the enterprise. As fluorinert costs 10 times as much as CFC-113, the enterprise has a strong self-interest in eliminating leakages. For the degreasing process the company has switched to roasting the frames instead. The results were satisfactory in spite of the need for increased ventilation. CFC-113 consumption altogether went down from 16 to about 4 tonnes per year. The cost of the FC detector was Bt 6 million and of the roaster Bt 3 million, which however should be recovered within a two-year period due to efficiency gains.

The printed circuit board assembly industry

PCB manufacturing involves the following processes: auto insertion, manual pick and place, wave soldering and paste soldering, defluxing and testing. Products are either "surface mounted" or of "through-hole type". Four factories were visited. Cleaning was primarily done with solvents, mainly CFC-113. The following alternative technologies were being used and tested to replace CFC-113:

- Using isopropanol (IPA) as cleaning solvent for disc drive heads of computers. This process, however, is not as efficient and satisfactory as traditional CFC-113 cleaning and in addition proved to be a special fire hazard. Nevertheless, the Japanese parent company promoted the use of that technology in order to fulfil the (moral) obligations of the tripartite agreement.

- A new soldering method ("non-clean method", or "no need for flux cleaning"), promoted by a firm manufacturing telephone switching instruments which can use the PCBs produced by this method.

- Using de-ionized water for cleaning by means of "through hole assembly". One company has used this method since 1989 and another since 1991. For "surface mounted assembly" this method cannot be used. The capital cost of manufacturing deionized water was about Bt 1 million and the operating costs were at about Bt 80,000 per year plus costs on the water treatment plant. In one plant which used this method, the investment was recovered in only one year as chips used on water-cleaned boards are cheaper than the ones previously used. The method cannot be used with epoxy-based chips. In this case rubber-based chips can be used. For "surface mounted assembly" the firms visited expressed the opinion that "low-solid flux" might be the answer.

In-house recycling of CFCs

A significant reduction of environmental damage cannot only be achieved by replacing but also by recycling CFCs. Six firms in a 1992 survey successfully used the condensing method to recover 70-95 per cent of CFC-113 which would otherwise have evaporated. The cost of a recycling unit was about Bt 300,000 and investment was amortized within a year. Contaminated CFC-113 from the cleaning process can be sold back to the supplier, who can redistill and resell it.

4.2.2.4 The role of TNCs

Although an increasing number of local subcontractors and original equipment manufacturers supplying the world market are active in the electronics industry, TNCs still to a large degree determine its development. These often use state-of-the-art pollution control methods and surveys have shown that the control technology is - on the whole - effective. This is the result of environmentally effective process designs rather than of end-of-pipe treatment.

International corporate policy may in some cases dictate a common set of environmental standards worldwide and this may explain the high standards (see also chapter 3). Nevertheless, there are also cases of companies which are inclined to tailor their practices to the environmental standards and law enforcement practices in the host country. This implies that the host country government's environmental policy regime, the stringency of its standards, and the rigour with which they are enforced are important influences on firm behaviour. On average, multinational firms are more likely to comply with environmental standards than local firms, because they stand to lose more from being tagged environmental 'outlaws'. Still, if standards are lax, even compliance will yield few environmental benefits.

Endnotes for Chapter 4

1. Data on manufacturing value added by sector do not disaggregate electronics from electrical machinery. Apart from domestic electrical appliances, however, the electrical machinery sector is relatively slow-growing as compared with electronics.

2. NESDB, National Income of Thailand, Rebase Series 1980-1991, Bangkok 1992; TDRI, the Greening of Thai Industry, op. cit., Bangkok 1990.

3. BOI, Investment Opportunity Study: Electronics Industries in Thailand, Bangkok 1991.

4. Wheeler, David et al., Sectoral Pollution Intensity Estimates, World Bank Industrial Pollution Projections Project, Washington 1993.

5. ODP = ozone depletion potential, which is a factor comparing a chemical's potency with respect to ozone destruction to that of CFC-11, which is assigned an ODP = 1. The estimated ODP of CFC-113 = 0.8 and that of MC = 0.1.

6. On an unweighted basis, methyl chloroform consumption was more than twice as large as CFC-113 consumption in 1991.

7. ICF/SIAMTECH/TDRI, Country Study: Phaseout of Ozone Depleting Substances in Thailand. Final Report submitted to DIW, Bangkok, 10 September 1992.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the main issues emerging from the analysis in the preceding chapters are pulled together to serve as a basis for action recommendations related to future policy and technical cooperation requirements in Thailand. Section 5.1 deals with the need for a stronger environmental orientation of industrial policies. It introduces an economic perspective of the issue of environmental pollution, discusses the potential to introduce environmental dimensions into a number of specific policy areas and outlines required institutional capabilities. Section 5.2 presents selected proposals for future technical cooperation aimed at strengthening industrial pollution prevention and control efforts in Thailand.

5.1 Environmental Orientation of Industrial Policy

5.1.1 An economic perspective on the environment[1]

It has become clear that nature is a scarce resource, not only in developed but increasingly also in developing countries, in particular in economically successful developing countries such as Thailand. There are therefore good reasons to consider its use from an economic angle, i.e. in terms of competing demands on the production factor "environment" which has limited absorptive capacities to deal with the problems of pollution. The scarcity of the resources not only implies that different uses of the environment are competing at any given point in time: the issue is complicated by the problem of inter-generational distribution, i.e. the fact that present use increasingly precludes future use of the environment.

What, then, are the main uses or functions of the environment in an economic perspective? Four different functions can be distinguished:

- *Location function*: The environment provides the space for locating economic activities, infrastructure and residential as well as recreational areas;

- *Resource provision function*: The various natural resources (air, water, energy, minerals, etc.) are used as inputs for the production system;

- *Absorption function*: The environment must ultimately absorb all unutilized by-products and pollutants from production and consumption activities;

- *Public good function*: The environment offers a number of public goods (e.g. air to breathe, or the recreational value of an intact ecosystem) from the use of which no individual can or should be excluded.

If the environment is to continue fulfilling these functions, its degradation must be kept under control. If not, ecological systems may collapse. Even if the causes of degradation are removed it may take a long time and great efforts and costs to restore the environment - if this is possible at all. Thus, the exploitation of the ecosystem for short-term benefits may turn out to be extremely expensive in both monetary and non-monetary terms (e.g. health) in the long run. All of this calls for a very cautious approach to the use of the environment and the need for early measures when the absorptive limits of the environment are not yet reached.

There are not only good ecological but also economic arguments for such a strategy of pollution reduction - to focus the discussion on the subject of the present report - is more expensive at later stages. In the early phase modest efforts can be extremely effective. A developing country such as Thailand can thus achieve great reductions

in (industrial) pollution at relatively low cost, unlike the OECD countries. Moreover, an early ecological re-orientation of industry should enable Thai industry to develop an efficient domestic ET industry; this should put Thailand at a comparative advantage in the medium term, once (industrial) pollution abatement has become a major issue in neighbouring countries as well. Japan provides a good example.[2]

To protect the environment, the Government has a choice between direct regulations on the one hand and the use of economic instruments on the other hand. Furthermore, it has to decide whether the polluter or society at large should pay for a reduction in the level of pollution, or whether a combination of these possibilities is most appropriate. As will be argued, from a theoretical point of view the use of economic instruments and the incorporation of the polluter-pays-principle are the most efficient ways to achieve a reduction in pollution. At the same time, there will often be a need for a flexible approach and combinations of measures. The various policy options are briefly discussed now.

While, direct regulations continue to be the most commonly used environmental policy instrument, economic instruments are in many cases more (cost)-efficient for controlling and reducing pollution. They are an attempt to introduce quasi-prices to certain uses of the environment and/or to create artificial markets for the use of the environment as production factor. The common characteristic of economic instruments is their "indirect nature". By increasing the costs of pollution and/or reducing the costs of pollution abatement, economic instruments utilize the profit motive to reach socially desirable results.

Among the major advantages of economic instruments are their flexibility and cost effectiveness. Pollution reduction by regulations which lower maximum emissions may put a tremendous financial burden on some heavy polluters without touching other polluters. Economic instruments favour pollution reduction in fields where costs for doing so are low compared to the benefits. In contrast to regulatory instruments, they leave the choice of compliance to the polluter who can be expected to select the least costly option. Economic instruments may thus be as effective as direct regulation in reducing pollution, at a lower cost for society. Moreover, the existence of economic instruments, if properly applied, provides permanent incentives to make industrial products and processes less polluting, not only through end-of-pipe control measures but also by giving incentives to move towards cleaner production technologies.

Economic instruments can only be effective in a well-functioning market system. Such a system, has inherent characteristics which can contribute to limiting pollution: it will tend to minimize demand for inputs for a given level of output (indirectly contributing to a reduction of unwanted outputs) and to accelerate the introduction and diffusion of more efficient new technologies (which would also reduce the ecological burden). But ecological efficiency gains can only be guaranteed on the input side, not on the output side. The increased production and use of (often unrecyclable) packaging material is a good example and a proof that the market system is not working efficiently once the price mechanism fails to indicate shortages. This is often the case on the output side (emissions) where the burden can be easily shifted onto the environment and thus onto society at large. Nevertheless, strengthening the market system, with accelerated diffusion of new technologies and with a removal of price distortions - in particular the abolishment of directly or indirectly subsidized inputs (e.g. energy prices) - should result in improvements in ecological terms.

In the case of Thailand, the artificially low price of lignite and the tendency of enterprises to shift production to the use of this low-cost energy input has led to increased air pollution. Another example is the artificially low price of water for industry (and other users) which supports the practice of simply diluting wastewater instead of properly treating it. In a country with frequent droughts and water shortages, water (and energy) prices have been frozen in nominal terms in recent years while inflation on average reached some 6 per cent annually.

However, even strengthened markets, which in the case of Thailand would not require major policy changes, provide only part of the answer. The various functions of the environment are a classic case where the unfettered operation of market forces tends to fail to deliver acceptable results. In economic terms: the existence

of widespread externalities leads to a divergence between private and social costs and benefits. External costs are not reflected in the equilibrium price charged. Government intervention is thus required to avoid excessive demand on the environment, which may cause irreversible damage. Major ecological problems due to market failure, i.e. due to excessive use of the environment, can also be interpreted as a result of lack of property rights for air, water etc. which may call for government intervention to create appropriate substitutes (e.g. tradeable emission rights - see below). Whatever the economic explanation for excessive use of the environment, it is clear that government intervention based on economic instruments should go beyond mere strengthening of the market system.

In the case of Thailand, the most appropriate economic instruments would seem to include charges (e.g. effluent charges, user charges, product charges, administrative charges for registering potentially hazardous products, etc.)[3], environmental taxes, deposit refund schemes, the use of ecological liability insurance and tradeable emission rights.

Environmental charges and taxes are intended to integrate external costs into the pricing mechanism, thus removing distortions due to wrong price signals[4]. As pollution is reduced, the taxes or charges should go down. A gradual introduction of these instruments, with predictable increases in the future is essential to give enterprises sufficient time to reorganize their production process. In Thailand, it would appear appropriate to phase them in over a 7 to 10 year period, the normal time period for an investment in equipment.

The introduction of the concept of strict liability in NEQA as well as in the amended Factory Act has boosted the use of ecological liability insurance. However, it is not yet clear whether it will be sufficient to invite the private sector to offer and make use of such insurance schemes, or whether such insurance should be compulsory for all companies dealing with potentially hazardous materials or waste. Especially small industrial companies - the fastest rising segment in Thailand - will find it difficult to pay for ecological damage unless covered by such insurance schemes. Their advantage is to put pressure on individual enterprises to minimize risks in order to minimize insurance rates.

A deposit refund system can be a good instrument to reduce solid waste and some types of hazardous waste. Such a system, which may include cans, bottles and other packaging material but also tyres, refrigerators, TVs, cars, etc., can be an incentive for reconsidering the whole production process in order to minimize waste. Such system can help to reduce the negative environmental effects in the market system, as the price mechanism fails to deliver the correct signals. Moreover, without a system guaranteeing correct pricing of (solid) waste, a shift towards clean production technologies - preventing waste and pollution rather than reducing them - remains very unlikely. Deposit refund systems can be an efficient instrument in this respect. However, such systems have to be carefully designed in order to avoid illegal dumping.

In this context, a proposal by TDRI which should be seriously considered concerns the creation of a special hazardous waste refund scheme. Under the scheme, central treatment and disposal facilities for hazardous wastes would be established, financed by waste charges. The operation of the treatment and disposal facilities would be contracted out to private waste management firms through competitive bidding. It was calculated that a charge of Bt 1,000/tonne on the 600,000 tonnes of industrial hazardous wastes projected for 1991 would raise Bt 600 million. This would be equivalent to 0.3 per cent of GDP or 1.5 per cent of net profits of the 17,000 industrial plants generating hazardous wastes. Factories would deposit their waste charges in advance for the entire year on the basis of an estimate of the amount of waste to be delivered. In addition, companies would pay about the same amount as their waste charges into an escrow account as a bond ensuring the delivery of waste[5]. The latter amount would be returned to the producer, with interest, after delivery of the waste. Factories which manage to lower waste per unit of output (as verified by accredited private environmental auditing firms) would be eligible for rebates[6].

This scheme contrasts with the current system in operation at Thailand's only hazardous waste treatment center at Bangkhuntian, which does not offer incentives for firms to reduce waste since the contract amount is specified in advance and no rebates are granted for reduced deliveries. The intention may be to discourage illegal disposal in view of the weak state of Thailand's environmental audit system.

Finally, tradeable emission rights are a way of compensating for the lack of property rights in the field of the environment. For such a system to succeed, efficient monitoring is a sine qua non, and its introduction will therefore depend on improvements in the institutional infrastructure.

Economic instruments which only apply to end-of-pipe technology, such as import duty reduction on pollution control equipment in Thailand, have a delaying effect on the introduction of integrated processes of clean technology and strengthen the general tendency of enterprises in Thailand to choose end-of-pipe technologies added to existing facilities. Thus, the structure of the customs duties reductions scheme should be analyzed and redesigned from this perspective. As most of the machinery and equipment is still imported, the authorities could reduce the attractiveness of polluting technologies by levying import duties based on the likely amount of emissions during the expected lifetime of a piece of equipment. From an economic point of view, such an import tariff would be nothing more than an emission charge that is shifted forward to the time and point of importation in order to minimize administration and transaction costs. (In order not to infringe on GATT rules, a similar cost burden could be imposed as well on potential domestic suppliers).

The polluter-pays-principle (PPP), as endorsed by NEQA 1992, is well-suited to the conditions of a market economy, as it creates an incentive structure in the economy which will prompt enterprises to adopt production processes - and consumers to buy goods - which cause less environmental damage. Even if the cost for PPP may be ultimately shifted to the consumer, it does make a significant difference whether a person pays as consumer or as a taxpayer. In the first case, the spur of the market system can be maintained while in the second case it is lost. What may be equally important is that only PPP provides a lasting incentive for more environmentally-friendly production systems.

Limits to the practical application of PPP may arise for social reasons as well as due to foreign competition ("competitiveness imperative"). In both cases the increased burden can be offset by appropriate adaptations of the tax system. In order to remain competitive, for instance, Thai enterprises might be compensated for additional expenses due to PPP by tax reductions. This should result - at least at the subsectoral level - in no significant changes in the overall cost burden, but enterprises would still have an incentive to shift towards cleaner production processes.

The general superiority of economic instruments does not imply however that they are preferable to direct regulations under all circumstances. Many hazardous and toxic substances have irreversible adverse effects on human health and the environment if surpassing certain critical limits. This necessitates compulsory preventive measures rather than reliance on the likely responses of polluters to indirect incentives. The question of enforcement capabilities is also critical, in particular in a developing country such as Thailand where institutional and administrative capacities are already over-strained. This may call for economic instruments in some cases, and direct regulation in others. While direct regulations are needed to set upper limits for pollution and to prevent the collapse of the ecological system, economic instruments would present the most efficient way to actually lower the level of pollution. Attention should be given to innovative ways of combining both approaches, providing incentives for polluters to comply with regulations. The deposit refund scheme proposed by TDRI for hazardous waste management is a case in point.

Given the limited human, technical, and financial resources in dealing with ecological problems, the Thai Government will have to establish priorities in dealing with these. This requires evaluation of relative environmental risks. A good example of the results of environmental risk assessment is a 1990 USAID study, which determined that lead exposure - principally from the burning of leaded petrol - was among the most serious urban environmental problems in Thailand. Reduction in IQ levels of children raised in Bangkok was estimated to be a major social cost associated with high ambient lead levels. Soon after this study was published, the Thai Government introduced measures to speed up the phase-in of unleaded petrol. Such assessments can thus be a powerful influence on government priorities and policies. Since the environmental situation changes very rapidly in Thailand, with the growth of new industries and new types of environmental risk, it may be worthwhile to consider preparing updated

environmental risk assessments at frequent intervals - perhaps every 3-4 years - to help the authorities to establish clear priorities.

5.1.2 Selected economic policies with strong environmental impact

5.1.2.1 Investment promotion policies

Although the investment promotion policy of BOI is said to have become stronger ecologically oriented, it is difficult to identify specific measures - except the establishment of industrial estates outside Bangkok - which would substantiate such a statement. The attraction of new enterprises still has clear priority over ecological considerations. The following recommendations are based on the analysis in Chapter 3 of this report and aim at helping BOI to ensure that investment, and in particular foreign investment, is promoted with due consideration of its environmental impact.

Development of operational environmental guidelines

Standardized operational guidelines, including questionnaires relating to process control, would be required to alert BOI staff working in the various Investment Promotion Divisions, but particularly those dealing with pollution-intensive industries, to the environmental implications of the industries they are promoting. Such guidelines would have to be integrated in the BOI's investment promotion procedure from the very beginning, if the requirements of Section 19 of the 1977 IPA are to be met. Carefully designed environmental questionnaires relating to the environmental provisions of the IPA, completed by investors as a standard part of the investment promotion procedure, need not complicate the procedures unduly.

Ultimately, the guidelines and standardized questionnaires would allow the BOI to develop its own internal, environmental profiles of the projects it is promoting. Such profiles could be shared with other agencies, notably DIW and MOSTE's Pollution Control Department, to enable monitoring of compliance with the environmental provisions of the IPA.

To develop these guidelines for each industrial sector, a true assessment of the environmental impact of various FDI categories must be made. The studies by Mahidol University and the ADB-funded Samut Prakhan industrial waste stream studies could provide a starting point. Such guidelines could be developed in conjunction with and tailored to the joint operating needs of environmental specialists at DIW and MOSTE. This would stimulate a higher degree of inter-agency communication between BOI, DIW and MOSTE, which is the key to ensuring that the environmental provisions of the IPA are complied with. To facilitate this process, a series of joint BOI, DIW and MOSTE seminars could be held to investigate where duplication of environmental management roles can be eradicated and complementary functions strengthened for more effective control of BOI-promoted industries.

Industrial decentralization monitoring programme

The BOI-promoted process of encouraging industrial decentralization and creating a manufacturing base outside BMR and the surrounding provinces has significant environmental implications. It appears essential, therefore, to set up a monitoring programme aimed at tracking the operations of companies - both new investors and relocation cases - taking advantage of the new Zone 2 and Zone 3 incentives. This is another case which would require BOI to liaise with DIW and MOSTE, but above all with the provincial authorities concerned, to ensure that the decentralization process does not lead to a spreading of industrial pollution from BMR to outlying provinces. A properly organized monitoring programme could be an effective instrument for guiding the process of decentralizing environmental management which is an integral element of the 1992 Environment Act.

Creation of "Green Promotion Zones"

The possibility of BOI pro-actively targeting environmental equipment and product manufacturers to set up in specially created "Green Promotion Zones" should be investigated. Such industries could serve the (emerging) environmental markets both in Thailand and in the region. Thailand appears to possess the required engineering and manufacturing expertise to establish a cost-effective and competitive environmental equipment industry. By adopting a forward-looking approach, BOI would be facilitating the development of a much-needed environmental product manufacturing and support service industry. As part of this process, the waiving of local content requirements for proprietary environmental technologies (See the Volvo case study and the delays in introducing the clean air-conditioning system) could be investigated.

Manufacturing of pollution control equipment as BOI "promoted activities"

The manufacturing of pollution control equipment is not yet eligible for special investment incentives. It might make economic and ecological sense for the BOI to declare the manufacturing of pollution control equipment and processes a "promoted activity". Producers of pollution control equipment would then become eligible for the full range of investment incentives - essentially tax exemptions on profits and customs duties exemptions. This would strengthen the position of domestic producers vis-à-vis ET imports, which to a large degree are subject to lower import duties than the equipment needed by Thai manufacturers to produce ET goods.

Ecological labelling

Special recognition or special incentives for firms using adequate environmental control equipment are not yet institutionalized in Thailand. Special labelling - controlled by the BOI or other institutions such as MOI or FTI - could serve as a first step to recognize environmental efforts undertaken by enterprises in Thailand. Thus, demand for ET equipment could be further raised.

Comparative regional study of environmental approaches of investment promotion agencies

A study should be launched on the policies, approaches and instruments applied by other investment promotion agencies in the region (e.g. Malaysia, Singapore) in addressing environmental issues of FDI. This study should put special emphasis on the concrete assistance provided by such agencies to investors pursuing ambitious environmental management programmes as part of their corporate strategy. The objective of the study would be to identify approaches applicable to Thailand and to suggest methods to integrate them into an enhanced environmental function of the BOI.

Study of the environmental performance of NIC-based TNCs

A significant share of total FDI inflows now originates in Asian NICs. Compared to OECD-based TNCs, the companies in question are exposed to relatively little pressure at home to adopt environmentally sound practices in their overseas operations. They also tend to be technologically less well endowed and thus less capable to transfer low-pollution or clean technology. It is proposed, therefore, to undertake an in-depth empirical study of their environmental performance and to establish an information base for appropriate action by BOI.

5.1.2.2 Locational policies

The success of various locational policies in reducing pollution problems has been limited so far. Although a number of industrial estates with adequate waste treatment systems exist the large majority of existing plants is still located outside estates and a majority of industrial establishments is still located in and around Bangkok. Thus, practical experience with the ecological impact of industrial estates is limited. The estates are generally

well-equipped for handling wastewater. For solid waste, there are already limitations with regard to space for landfills, leading to increased use of incinerators. For hazardous wastes, the estates tend to rely on DIW facilities which however are insufficient. The reliance on public facilities may thus need to be reconsidered, although there are good reasons to have more common facilities - for example for small industries - to alleviate the problem.

The usefulness of the BOI investment promotion zones concept is limited because incentives are only available to BOI-promoted firms. Moreover, the incentives granted for location in Zone 1, the most congested and polluted zone, remain rather generous, which indirectly weakens the incentives granted for Zones 2 and 3.

Experience with industrial firms located or relocated to rural areas outside industrial estates has been rather mixed, from an ecological point of view. Non-compliance with environmental regulations often cannot be controlled. Such industrial establishments have tended to become a target for popular complaints and attracted "unwanted" publicity. It can be expected that NGO-based monitoring activities will increase after having been legally sanctioned by NEQA. This is likely to put increasing pressure on firms to (re-)locate to IEAT and BOI estates.

The DIW has attempted to locate industries generating similar waste in a common area so that waste treatment facilities could be established. The concentration of sugar refineries or tanneries are good examples in this context. In fact, industrial zoning has long been incorporated into the law governing the issue of factory licenses, with permits to be issued in line with officially adopted land use plans. But the adoption of land use plans has been slow: in an important industrial area like Samutprakarn, south of Bangkok, such a plan has only recently been adopted.

One instrument for reducing the concentration of polluters in and around Bangkok would be to differentiate the ambient and emission standards for different localities in Thailand, depending, among other things, on the existence of other polluting sources and the exact type of those polluting sources in the area. Thus, one could imagine - depending on the location - different combinations of air and water pollution standards for industrial enterprises. This would be an incentive for firms to look for sites where ambient standards may be still less strict, thus reducing the burden on locations which are already close to environmental collapse, giving them the opportunity to recover. The proposed system in fact functions indirectly because environmental standards are hardly enforced outside the Bangkok area, but this of course is no solution.

5.1.2.3 Environmental pricing and pollution prevention incentives

At present there is no system of environmental pricing in Thailand. As in most other countries, regulations and permits are the main means of fighting pollution. While the polluter-pays-principle has in principle been accepted in Government policies there are no incentives for firms to improve on official standards.

Environmental pricing could be introduced via the tax system. While overall taxes for enterprises could be reduced, taxes could be levied on various toxic emissions, providing strong incentives to reduce emissions. Environmental auditing is needed for this system to work. Such a change in the taxation system should be introduced gradually and should not cause disruptions in production, discourage expansion or discriminate against industry or individual subsectors.

Another approach is the scheme proposed by TDRI to levy pollution charges from industry to finance the construction of waste treatment facilities, with refunds for enterprises which reduce their waste output (see above). Again, the key element in such a scheme is an efficient environmental audit system to make sure that firms do not dispose of the waste by other means. One medium-term aim should thus be to improve Thailand's environmental audit system. While the TRDI system is likely to work well in the medium term with established medium and large scale firms, which have a functioning accounting system and a public reputation to defend, it would provide no encouragement to small firms, particularly because it involves audits and pre-payment. Neither is likely to be

popular, and the latter could be a problem. Monitoring small firms is perhaps only possible if it involves the public or NGOs in a watchdog role, for which NEQA provides the legal basis.

5.1.2.4 Technology policies

Central to the long-term success or failure of environmental policies in Thailand is the creation of an economic environment which allows for fast adaptation of new technologies to the special needs of Thailand. In this context, the main priority is to achieve accelerated introduction of clean technologies, including low-waste and non-waste technologies. The same applies to recycling technologies as well as technologies which reduce the input of raw materials.

Both the Factories Act and the IPA empower the MOI and the BOI to specify measures for the selection of clean technologies and to give incentives for their use. But in practice the choice of technologies has rested with the industries who have in most cases decided on production technologies and processes before applying for a permit to establish a plant. Experience has shown that even if there is an explicit demand by Thai industries to support them in the selection process of clean technologies (as was the case with some chemical producers), the actual quality of advice given by Government agencies tended to be rather poor as they lack the latest detailed technological information.

The best way of promoting new technologies would be to revise all policies and regulations which still hamper their introduction, such as the current practice of customs duties reductions which are de facto limited to end-of-pipe technologies and thus act as a bias in favour of these.

Another way would be to provide better access to cheap finance for the purchase of clean technology. The recently established Environment Fund is one initiative in this respect. However, the demands of the public sector on that fund are so large that disbursements of the fund to the private sector are very limited. Thus, there is an argument in favour of increasing that fund and to make it self-financing by means of pollution charges. Another financing scheme is the environmental lending facility created by IFCT. Once loan repayments commence, the IFCT facility will presumably become self-financing. Special attention, however, needs to be given to ensuring that financing is made available on favourable terms to small- and medium-scale enterprises, since they will often have difficulties in financing pollution control investments.

Small and medium-scale enterprises may also need technical assistance in the selection of appropriate pollution control technologies; therefore, financing should be made available for the costs of hiring environmental consultants and not solely for the purchase of plant and equipment. An environmental consultant may be able to recommend ways to achieve significant pollution reductions with only modest fixed investments, through improvements in engineering and management practices. It should be emphasized again that assistance should be clearly focussed on waste-reduction and pollution prevention rather than on end-of-pipe treatment, as the gains for the enterprise and society are potentially larger.

One way of strengthening plant-level environmental management would be to set up an industrial environmental audit programme.[7] Firms which agree to participate in the programme could be eligible for low-interest loans to finance waste minimization investments. Specialists familiar with the industry would conduct environmental audits or pollution reduction appraisals. Among the variables to be examined during the audit are: the materials used in production, the manner in which they are handled, energy use, standard housekeeping practices, engineering controls, ventilation and exhaust systems, waste handling, treatment and disposal. Records of levels of hazardous substances in wastewater (pre- and post-treatment) and in air would be examined and compliance with existing operating permits and performance standards ascertained.

Following the audit, the auditor would submit to the firm as well as to the government a report containing his assessment of existing practice and a series of specific recommendations for improving environmental performance. The recommendations would emphasize process and equipment changes which can reduce material and energy requirements and waste. Where waste cannot be eliminated, consideration should be given to recovery and recycling. If the firm accepts the audit results and agrees to adopt the measures recommended, it would become eligible for financial assistance; the degree of conditionality of any loans would depend on the expected financial rate of return from any required investments. A follow-up audit could be conducted after one year. This would provide the basis for determining the effectiveness of the measures proposed both in environmental and in economic terms.

Finally, the process of introduction of "clean technologies" can be accelerated with pilot plants and better information, showing industrialists the likely costs and benefits involved. Seminars and study tours may further contribute to the information dissemination process. This approach was used by FTI to foster the introduction of clean technologies, especially in the dyeing and printing industries and in the pulp and paper industry. Other industries where clean technologies would lead to major benefits include electronics, metal working and finishing, tanning etc.. A number of pilot projects have been established for these industries. Information and pilot plants however do not yet deal with re-cycling or re-use technologies very often. Several industrialized countries have made considerable progress in this respect. Thus, this is an area where international co-operation could be explored. Positive experience with international co-operation programmes exists, and future transfer of know-how and technology to Thailand should build on this experience. TNCs located in Thailand which use advanced ET (see the case studies in Annex B) could also be involved in such transfer programmes, although these might primarily benefit the larger Thai companies.

5.1.2.5 Provision of common environmental facilities

Firms with low turnovers are most likely to find in-house treatment facilities unaffordable. For these, common waste treatment facilities are a solution. This approach is practiced at the Bang Khuntien hazardous waste treatment facility, which serves a number of small electronics firms. The government is planning construction of several more such treatment plants at Ratchaburi, Chonburi, Saraburi, and possibly Rayong. However, progress in the implementation of these projects is rather slow, partly because of increased resistance by local communities and NGOs. A stronger involvement of NGOs in the early stages of the planning process and giving them more responsibility in presenting alternative solutions might help to solve that impasse. The formulation of a charge system which allows cost recovery while discouraging illegal dumping, as mentioned before, is one of the difficult issues facing the government as well as the managers of those facilities.

Common recycling facilities may also be needed for a number of waste products. In the case of the electronics industry, for instance, solvent recovery/recycling is one area which could benefit from such facilities. This is particularly important as the government seeks to encourage reduced consumption of chlorinated solvents that are controlled under the Montreal Protocol (see Chapter 4 on the electronics industry). If recycling is found to be viable, an important consideration will be certification of the quality of the recycled product, since e.g. electronics firms require solvents of a very high degree of purity. Without such guarantees, customers are unlikely to purchase the recycled product.

5.1.3 Strengthening of institutional capabilities

Pollution control in Thailand still largely relies on regulation rather than on economic incentives. Although the regulatory and institutional framework to control pollution is impressive, there is a general problem of lack of manpower, of finance and equipment as well as of coordination, although the latter is improving. As a consequence, the quality of the environment is worsening through rapid industrial growth.

One problem is the strong competition for skilled labour by the rapidly expanding private sector, which has drawn many qualified people away from government service in recent years. This is difficult to remedy via a realignment of public/private sector pay scales since the necessary adjustments would place unacceptable strains on public finance. As discussed, the government may need to devise measures which provide stronger incentives to self-policing by polluters - either individually or collectively, e.g. through industry associations, NGOs, etc. Another possibility is to stimulate the role of independent environmental auditing firms to monitor and report on the environmental performance of enterprises.

5.1.3.1 Regulating and controlling institutions

The main agencies responsible for regulation and control of industrial pollution are DIW and to a limited extent MOSTE. DIW has direct authority to inspect and control industries' compliance with the regulations while MOSTE has responsibility in setting overall guidelines. However, given its increased powers, MOSTE is likely to play an increasingly important role in the field of industrial pollution monitoring and control as well. Other agencies, such as the Ministry of Health and local administrations (in particular the Bangkok Metropolitan Administration) and a large number of specialized agencies with very specific tasks also fulfill some monitoring and controlling activities. The shortage of manpower is illustrated by the fact that DIW currently has about 200 inspectors for all factories in Thailand (some 100,000), and only one laboratory to check the quality of effluents and emissions.

Under the circumstances, the only feasible way to have a country-wide system of pollution control are controls at the planning stage, and in particular at the time when operating licenses (in which pollution control measures are described in detail) are issued. In this context it is proposed that Government agencies study the concept of Best Available Control Technology (BACT). Using BACT means that the industries are responsible for incorporating the best available technologies in the plant design; the controlling agencies only have to check and approve the design. The advantage of such a scheme is that it allows a relatively small workforce to handle the task. The drawback is that factories often do not use the equipment efficiently, partly as a result of lack of subsequent inspections by the authorities. A significant increase in the number of inspectors would therefore be required also within this approach.

Apart from inadequate staffing, there is the problem of lack of co-ordination of activities among monitoring agencies. There is a need to standardize analytical procedures as well as to harmonize monitoring policies and objectives in order to make results complementary and thus save time, costs and efforts while making monitoring of the industrial sector more effective. The very rapid growth of the informal sector, which shows an even stronger tendency towards violation of environmental standards, makes it even more important that monitoring capabilities and activities of individual Government agencies are harmonized and made more efficient.

Better training for pollution control officers is also needed. Foreign technical cooperation could play an important role here. In accordance with efforts to decentralize the monitoring and enforcement effort, it will be necessary to decentralize the training effort as well. Thus, it may be useful to consider a series of training workshops located in the major areas of concentration of polluting enterprises. Besides Government officers, it may also be worthwhile to invite participants from industry and from local community organizations and non-governmental organizations (NGOs). Unfortunately, there are few appropriate training facilities. So far, only four institutions in Thailand offer undergraduate degrees in environmental engineering (Chulalongkorn, Khon Kaen, Chieng Mai, and Kasetsart Universities). MOI has sent 280 staff members to Chulalongkorn University for a four-day course in environmental engineering. While not sufficient, this programme has already produced positive results. There are now more environmental officers in the provinces who can deal immediately with problems without having to wait for instructions from Bangkok.

5.1.3.2 Policy and planning institutions

The control agencies basically also act as planning agencies. However, while in monitoring and controlling most of the power is with DIW, environmental policy and planning is mainly done by MOSTE's Office of Environmental Policy and Planning (OEPP). The Department of Pollution Control (DPC) in that ministry also plays a role. Environmental policies and planning are formulated within the policy framework set by NESDB.

Like other Government agencies in the field of the environment, DPC and OEEP lack a sufficient number of qualified human resources. However, in this case the effects may be even more serious as policy and planning requires not only academic experience but also understanding of related problems at the grass root level, i.e. in enterprises and among various groups of society affected by pollution. Shortage of qualified personnel at the provincial level is also an obstacle to the decentralization of policy and planning activities required by NEQA.

Despite the fact that there are strong linkages between environmental quality and sectoral development issues, there appears to be a lack of policy integration: the ecological implications of the promotion of various industrial subsectors do not seem to be always clear to the various agencies. It seems that the existing co-ordinating committees have not always brought about actual co-ordination, because central and local Government have conflicting policies regarding control over wastewater and wastewater treatment plants, land reclamation in coastal areas, etc. Thus, there is a need to investigate ways of strengthening co-ordination within the existing institutional structure.

5.1.3.3 Financing institutions

The financing schemes for environmental investments initiated in recent years (the Environment Fund, the environmental facility of IFCT) also suffer from a lack of experienced administrators who can properly evaluate the feasibility of proposed investments in pollution control or cleaner process technologies. There is therefore a need to provide at least basic training to loan officers on environmental technology evaluation. As pollution control investments become more widespread, loans for that purpose are likely to become a more important part of the portfolios of other financial institutions as well. It may, therefore, be appropriate to consider offering short courses on environmental loan evaluation for the interested personnel of financial institutions as a group - perhaps in co-operation with a banking trade association.

5.1.3.4 Academic institutions and consultants

There are good capabilities in this field although the actual number of institutions in Thailand that offer undergraduate degrees in Environmental Engineering (Chulalongkorn, Khon Kaen, Chiang Mai, and Kasetsart University) is rather limited. Know-how transfer has slowed down in recent years due to lack of new students and trainees. This is the result of limited student enrolments despite the fact that graduates find themselves in high demand, in particular for consultancy work.

Although the human resource base in academic institutions as well as in the consultancy sector is good, this cannot be said about the equipment available, which is far from being state-of-the-art technology. This sector urgently needs support in acquiring new technology, which - given the existing good human resource base - could be readily absorbed and the know-how transferred to industry.

5.2 Selected Proposals for Technical Cooperation

In this section, a number of concrete proposals are put forth in terms of technical cooperation requirements. The first of these calls for a high-level meeting to be convened to address strategic policy and institutional issues raised by this report, which clearly revealed a need for greater co-ordination of industrial pollution control efforts in Thailand. The rest of the proposals highlight a number of programmes or programme areas for potential technical co-operation by the international community. Drawn from information presented in previous chapters, they are intended to assist the Thai authorities and Thai industry in combatting industrial pollution more effectively.

As has been amply illustrated, the basis already exists in Thailand for most of these activities. Significant progress has been made in recent years, through, inter alia, stronger legislation and greater empowerment of enforcing bodies, and economic incentives for enterprises. However, some gaps and duplication still exist. The proposals in the following pages would further develop and refine the capacity for industrial pollution control through a combination of measures aimed at three levels:

- Government (strengthening its ability to set policy and provide the requisite legislative and enforcement framework, including a combination of regulations and economic incentives to encourage investment and enforce the polluter-pays-principle).

- Institutions (helping build up capacities to analyze and apply technological options).

- Enterprises (ensuring adoption and application of cleaner production or pollution abatement technologies at the plant level).

The optimal solution to pollution is prevention at source, through cleaner production. End-of-pipe treatment, the norm today, should be viewed as the last resort and should be employed only to treat final, unavoidable wastes or when for other reasons no other economic alternative exists. The aim is to save material, financial and human resources - and therewith also the environment - by preventing as far as possible the generation of pollution. This effort must be broad-based and integrated, requiring inter alia raising awareness of the causes and effects of industrial pollution; enabling full access to information on environmental technologies; promotion of cleaner production programmes in the various sectors; strengthening of the system of both private and government institutions to monitor and enforce standards; improving the ability of enterprises to take advantage of economic benefits of cleaner production; increasing the participation of women and NGOs; building up the capacity for local development of new environmental technologies and equipment manufacture rather than continued exclusive reliance on imported technology and equipment.

As pointed out in Chapter 40 of UNCED's Agenda 21,

> "Developing countries face a dual challenge: on the one hand, they have to develop their industrial sectors, often from a very low base; and on the other hand, they have to adjust constantly to rapid advances in technology, changes in world markets and market access, international price structures and other trends and policy factors that affect international comparative advantage. This challenge is all the more daunting as developing countries have to face it despite a serious shortage of qualified and experienced manpower in all fields of industry and industrial development."

5.2.1 High-level meeting on strategic policy and institutional issues for co-ordination of Thailand's industrial pollution control programme

The present report was drawn up using many sources and in its draft form was discussed with numerous officials, both Governmental and non-Governmental. All made valuable contributions, but it was striking how little overview there was on the issues discussed and how little clarity concerning the measures taken thus far by the Government of Thailand. This was confirmed by the report itself. In fact, in spite of the many legislative measures

there are still many operational details to be worked out concerning the mechanics of monitoring industrial pollution and enforcing industrial pollution control measures. Also, although MOSTE has been given significant responsibility, in the absence of a designated "Environmental Protection Agency", the exact responsibilities of various parts of MOSTE, MOI, NESDB, etc. must be ascertained, as well as the modes of co-operation necessary to avoid duplication and waste. The role of the industrial private sector as well as that of FDI should also be examined.

The idea for such a meeting was raised at all meetings held during a mission from UNIDO Headquarters in late July 1993. The idea received unanimous support from all parties. Therefore, it is recommended that a high-level meeting be convened under the auspices of UNIDO and UNDP to bring together top Governmental and non-Governmental decision-makers with a view to elaborating specific measures to operationalize industrial pollution control policies in Thailand. The said meeting would be held in Thai and English, and take place for 1-3 days at a venue outside of Bangkok. The meeting could also review the specific proposals for technical co-operation outlined below.

5.2.2 Establishment of an energy and environment information system for small- and medium-scale enterprises

"Information within many countries is not adequately managed, because of shortage of financial resources and trained manpower, lack of awareness of the value and availability of such information and other immediate or pressing problems, especially in developing countries. Even where such information is available, it may not be easily accessible, either because of the lack of technology for effective access or because of associated costs, especially for information held outside the countries and available commercially" (UNIDO Medium-term Plan 1992-1997).

Previous chapters of this report have shown that it is often the myriad small- and medium-scale enterprises, which are not in compliance with Government pollution-control regulations. Very often such enterprises see compliance as not economic or viable for their limited operations, or assume that the pollution they create is too small to be of significance. However, with the sheer number of small- and medium-scale enterprises operating in many polluting sectors, the cumulative effect of the pollution they generate is overwhelming.

On the Government's side, public awareness about pollution will have to be raised and greater enforcement measures sought to bring these small-scale polluters in line with official targets. For the enterprises themselves, access to specific technological information is crucial. A study conducted for UNIDO in Thailand in April 1993 found that many local enterprises collect economic and trade information, but few were knowledgeable about actual technological information sources. They rely on overseas distributors for information about standards, specification and other regulations concerning their products, to which they then react. This puts them at a disadvantage to enterprises involved in joint ventures or which are foreign-owned, whose foreign partner or parent company often provided up-to-date technological information which not only facilitates compliance but also provides a potential competitive edge to those enterprises. The study suggests setting up an Energy and Environment Information System (EEIS) for small- and medium-scale enterprises, with the aim of providing 'ready-to-use' information.

To make use of such information attractive, not only must a system of incentives exist to promote alternative production processes which are energy-efficient, recycle or re-use waste, encourage substitution of raw materials or otherwise change production processes to be more environment-friendly, but the information must be easily accessible and relatively inexpensive, and perceived to offer value for the money expended.

The report identified several important considerations, namely that the client be willing to pay for the EEIS information to be supplied, that it be well-targeted and that the technical staff capable of providing the service be provided. The main thrust of the EEIS proposal is to locate a Primary Contact Point in Thailand to act as the main repository of energy and environment technological information, supported by a network of Secondary Contact Points. The Primary Contact Point recommended in the study is the Library and Regional Documentation Center

of the Asian Institute of Technology, while the list of Secondary Contact Points included such organizations as the Federation of Thai Industries, MOI/DIW, IEAT, TDRI, and others. This network of primary and secondary contacts would play an important part in getting the EEIS project operational.

The entire project foresees support through, inter alia training, computer software tools, data delivery and support documentation/reference material on environmental issues. This system could also be the basis for Thailand's industrial sector component of the UNDP Sustainable Development Network.

5.2.3 Enhancement of national consultancy capabilities

The new basic environmental law (NEQA/92) provides the mandate for initiating a third-party environmental monitoring/auditing programme. Technical and financial assistance from international organizations could help bolster that initiative. Technical cooperation could be provided to help create a proper accreditation system to determine the eligibility of consulting firms/individuals for certification. Training programmes could upgrade their capacities in a number of areas: to act as auditors (energy, environmental and/or waste audits); to conduct environment impact assessments, to consult on selection of appropriate technologies, etc. The trained consultants would therefore serve not only to verify compliance with Government standards and regulations, but would also be engaged to advise enterprises on using environmental technologies to improve their overall environmental performance and competitive position.

The existing institutional framework should be used as much as possible. In particular, staff resources and training facilities at the joint Japanese/Thai Environment Research and Training Center operated within the Office of the National Environment Board could be drawn upon.

5.2.4 Compliance with the Montreal Protocol on Substances which Deplete the Ozone Layer

Under the Multilateral Fund of the Montreal Protocol, Article 5 countries, of which Thailand is one, are entitled to technical assistance to help cover the incremental costs of converting to industrial processes that do not utilize CFCs and other ozone-depleting substances (ODSs).

As noted in Chapter 4 above, nearly half the CFC use in Thailand is in the electronics sector, for chlorinated solvent cleaners needed for cleaning and degreasing. During the phase-out period, this sector would require a system of collection and recycling of these chemicals. Such a transitional measure may be useful, in particular for those enterprises which, for financial or technical reasons, are unable to convert quickly to alternative cleaning systems. The same applies to the other sectors which together account for the remainder of CFC use in Thailand: refrigeration, foams and air-conditioning.

UNIDO is one of the four implementing agencies of the Multilateral Fund of the Montreal Protocol, and the only one conducting plant-level work to reduce the actual amount of ODSs used in industrial applications. A seminar took place in late August 1993 in Bangkok on "Feasibility study on recycling of CFCs from automobile air conditioners and other systems in Bangkok". The Multilateral Fund had already decided in an earlier meeting that UNIDO would implement this project for the World Bank, and at the seminar the Thai Government focal point for Montreal Protocol projects expressed a wish to co-operate with UNIDO in all mobile air-conditioning projects in Thailand.

CFC recycling should become economically attractive as the price of CFCs can be expected to rise as world production is phased out. If not, the Government could offer subsidies to encourage investment in such common recycling facilities. In any case, care should be taken that supporting CFC recycling will not delay their phasing out, which in the long run could negatively affect the competitiveness of Thai industry.

5.2.5 National Cleaner Production Centers (NCPCs)

Cleaner production, also called pollution prevention and waste minimization, eliminates waste at source, thereby improving environmental quality and often enhancing profitability. Cleaner production requires the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment. Sample activities include environmental-, waste- and energy audits, demonstration projects, sector-specific training and information dissemination.

UNIDO in co-operation with the United Nations Environment Programme (UNDP) are jointly launching a new programme on a pilot basis to promote cleaner production. The programme will support national cleaner production centers (NCPCs) in approximately 20 countries for a five-year period;. Under phase I of the programme, two to five centers will be funded for an initial three-year period. Selection of host countries will be completed during the winter of 1993/1994.

UNIDO and UNEP anticipate that the centers will play a co-ordinating and catalytic role in cleaner production by providing technical information and advice, stimulating demonstrations of cleaner production techniques and technologies, and training industry and government professionals in this new area of industrial environmental management. They will be managed by experienced nationals of the countries concerned and hosted preferably in existing institutions. The NCPCs could, for instance, be located in industrial trade associations, chambers of commerce, industrial productivity centers, research and development centers, universities or other industry-oriented organizations.

UNIDO, with the co-operation of its field offices and UNEP's regional offices, will be responsible for monitoring the establishment of the NCPCs, and will provide long-term supervision of the engineering aspects of the centers in their demonstration projects, their audits of production processes and their life-cycle analyses of products. The UNIDO Country Directors will be able to draw on UNIDO engineering experience and expertise in advising industrial managers and plant operation staff on improving procedures, operational efficiency and product yield, while also reducing pollutant discharge. UNIDO will also provide information on cleaner production techniques and technologies through the Environment and Energy Information System (EEIS), part of the UNIDO INTIB programme.

UNIDO, in co-operation with UNEP, will also be responsible for assisting the centers in formulating training programme. UNEP will provide information on cleaner production techniques and technologies through its International Cleaner Production Information Clearinghouse (ICPIC), working groups, technical documents and the Cleaner Production newsletter.

Individual NCPCs will develop five-year and annual work plans and implement the activities described in the plans. Both the five-year and annual work plans will be reviewed by their advisory boards, representatives from Government and industry and a technical panel of UNIDO and UNEP advisors for the programmes. Thailand has applied and is under consideration to host an NCPC.

5.2.6 Waste minimization and sampling and evaluation of waste streams of SMIs in the electronics sector

A technical cooperation programme could be designed with the purpose of providing technical assistance to small- and medium-scale electronics enterprises, for reducing waste generation through process innovation and the installation of closed-loop recycling systems. Improved engineering and management practices are likely to be central to the effort; investments in plant and equipment and thus overall financing requirements would be small. Recovery of heavy metals and recycling of waste water as well as of industrial solvents would be priority areas for technical assistance. Foreign specialists may need to be hired initially for short periods to provide training to local consultants in industrial environmental auditing techniques, with specific reference to the electronics industry.

Small- and medium-scale industries in the electronics sector must have a method for sampling and analyzing their waste properly. This requires equipment which not many small enterprises can afford, and technical expertise which not many have. It is important, therefore, that they can use public or private laboratories for such evaluation at modest cost.

As a first step, it would be useful to conduct an inventory of the existing environmental laboratory facilities in Thailand, their equipment, and their testing/analytical capabilities. There are a few private laboratories serving the electronics and other industries in Thailand which have state-of-the-art equipment. In addition, there are laboratories at a few universities, and the Environmental Research and Training Center may also have the necessary equipment to conduct evaluation/analysis of waste streams.

An arrangement could then be made between the Government and the relevant laboratories for the latter to perform contract analytical services on behalf of small electronics enterprises. These enterprises would be expected to shoulder part of the cost, since participation in the evaluation programme could yield certain benefits. If enterprises are found, for example, to have waste streams containing pollutant levels well within Government standards, they could qualify for a refund (perhaps with a small incentive bonus). If they are in violation, the Government would offer them the option of technical assistance and low-cost financing to ensure compliance with standards. The alternative would be to pay a fine, in addition to which they would be expected to reduce their pollution loadings at their own expense. Those not agreeing to the 'voluntary monitoring and evaluation' programme would still be subject to periodic monitoring by the DIW and would face even stiffer penalties if found to be in violation of standards.

5.2.7 Assistance to the textiles dyeing and finishing industries

The textile industry is one of Thailand's most important manufacturing industries, employing over 600,000 workers (including the wearing apparel industry). The industry has emerged as a top foreign exchange earner and efforts are being made to maintain this export drive. However, there are severe constraints in terms of quotas placed on the wearing apparel sector. Hence, in order to fully develop this sector, one solution would be to increase the domestic value added of the products concerned by utilizing as much of the local raw materials as possible. To achieve this, it is necessary that mid-stream sectors, namely the weaving, knitting and finishing sectors, be developed to meet the demands of the garment industry both in terms of quality and quantity.

Efforts to do so have been hampered in part by the industry's contribution to industrial pollution, in particular the colour and chemical effluents discharged into local waters. Assistance to this sector would therefore have to focus on pollution reduction, which has the added benefit of conserving raw materials and improving profitability. This could be achieved through the following measures: Assistance would aim at reduction of dyestuff and chemicals consumption, and decrease the level of effluents produced with their colourant load, by using optimized recipes; decreasing the percentage of reprocessing through instrumental colour controls, recycling, and where possible, of wash-off liquors from bleaching, mercerizing, scouring and afterwashing of dyed/printed materials, together with using print-fast remnants in re-formulated recipes.

Endnotes for Chapter 5

1. Much of the following discussion is based on: Peter Michaelis, Environmental Policy in OECD Countries, Lessons for ASEAN, ASEAN Economic Bulletin, Vol.9 No.2, November 1992; OECD, Economic Instruments for Environmental Protection, Paris 1989; Theodore Panayotou, Economic Incentives in Environmental Management and their Relevance to Developing Countries, in OECD, Environmental Management in Developing Countries, Paris 1991; and David Wheeler, The Economics of Industrial Pollution Control, An International Perspective, 26 July 1991.

2. See Ministry of Industry: Industrial Waste Management Study: Problems and Measures (prepared by Engineering Consulting Firms Association, Japan), December 1990, pp. 38 ff.

3. Jean-Philippe Barde, "The Economic Approach to the Environment", OECD Observer, June/July 1989, pp. 13 ff.

4. Don Wusingh, J.J. Bouma, "Achieving 'win-win' through economic incentives", in Cleaner Production - How to Make It Work for You, Melbourne 1992, p. 162.

5. This instrument is also called a "performance bond". Performance bonds are payments to authorities in expectation of compliance with imposed regulations. Refunding takes place when compliance has been achieved.

6. TDRI, The Greening of Thai Industry: Producing More and Polluting Less, Bangkok, December 1990.

7. USAID/Philippines (1991), Industrial Environmental Management Project (492-0465): Project Paper, September, Manila.

ANNEX A

STATISTICAL TABLES

ANNEX A

ANNEX - Table 1 : SO_2 Emission by Sector

SO_2 Emission by Sector										
	1981		1991 estimate					1996 forecast		
	Tonnes	Share 1981	Tonnes	Share 1991	Growth of SO_2 pollution	Economic Growth (MVA, GDP)	SO_2 elasticity of MVA	Tonnes	Share 1996	Growth of SO_2
					1981=100					1991=100
Industry (excl. energy)	99,901	27.6	208,548	21.5	209	247	0.85	279,736	21.6	134
Power generation	212,205	58.6	547,877	56.4	258	348	0.74	815,637	62.9	149
Refineries	9,894	2.7	13,791	1.4	139	..	..	31,483	2.4	228
Subtotal[a] (Industry)	322,000	89.0	770,216	79.3	239	256	0.93	1,126,856	86.9	146
Agriculture	18,379	5.1	31,509	3.3	171	..	..	..	0.0	0
Res. & comm.	7,007	1.9	5,435	0.6	78	..	..	5,213	0.4	96
Transportation	14,475	4.0	163,834	16.9	1,132	..	..	146,774	11.3	90
Total (incl. other sectors)	361,861	100.0	970,994	100.0	268	214	1.25	1,297,121	100.0	134

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

a/ The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A-2 : NO_2 Emission by Sector

	1981		1991 estimate					1996 forecast		
	Tonnes	Share 1981	Tonnes	Share 1991	Growth of NO_2 pollution	Economic Growth (MVA, GDP)	NO_2 elasticity of MVA	Tonnes	Share 1996	Growth of NO_2
					1981=100					1991=100
Industry (excl. energy)	25,463	11.8	70,429	13.1	277	247	1.12	98,372	12.3	140
Power generation	29,704	13.8	86,818	16.1	292	348	0.84	129,396	16.2	149
Refineries	1,470	0.7	2,048	0.4	139	284	0.49	4,676	0.6	228
Subtotal[a] (Industry)	56,637	26.2	159,295	29.6	281	256	1.10	232,444	29.1	146
Agriculture	5,028	2.3	8,885	1.7	177	..	..	10,182	1.3	115
Res. & comm.	36,250	16.8	26,375	4.9	73	..	..	23,171	2.9	88
Transportation	118,135	54.7	344,328	63.9	291	..	..	532,186	66.7	155
Total (incl. other sectors)	216,050	100.0	538,884	100.0	249	214	1.16	797,983	100.0	148

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

[a] The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A-3 : CO_2 Emission by Sector

	1981		1991 estimate					1996 forecast		
	Thousand tonnes	Share 1981	Thousand tonnes	Share 1991	Growth of CO_2 pollution	Economic Growth (MVA, GDP)	CO_2 elasticity of MVA	Thousand tonnes	Share 1996	Growth of CO_2
					1981=100					1991=100
Industry (excl. energy)	13,458	22.7	25,282	22.7	188	247	0.76	33,897	22.3	134.1
Power generation	9,923	16.8	28,780	25.9	290	348	0.83	43,293	28.4	150.4
Refineries	973	1.6	1,356	1.2	139	..	..	3,095	2.0	228.2
Subtotal[a] (Industry)	24,354	41.1	55,418	49.9	228	256	0.89	80,285	52.7	144.9
Agriculture	2,983	5.0	5,026	4.5	168	..	..	5,579	3.7	111.0
Res. & comm.	19,183	32.4	15,496	13.9	81	..	..	14,803	9.7	95.5
Transportation	12,705	21.5	35,224	31.7	277	..	..	51,372	33.8	145.8
Total (incl. other sectors)	59,225	100.0	111,163	100.0	188	214	0.88	152,219	100.0	136.9

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

a/ The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A-4 : Total Suspended Matter (SPM) Emission by Sector

	1981		1991 estimate					1996 forecast		
	Tonnes	Share 1981	Tonnes	Share 1991	Growth of SPM pollution	Economic Growth (MVA, GDP)	SPM elasticity of MVA	Tonnes	Share 1996	Growth of SPM
					1981=100					1991=100
Industry (excl. energy)	90,624	19.8	351,451	56.6	388	247	1.57	473,907	60.6	134.8
Power generation	11,578	2.5	16,757	2.7	145	348	0.42	28,842	3.7	172.1
Refineries	532	0.1	742	0.1	139	284	0.49	1,694	0.2	228.3
Subtotal[a] (Industry)	102,734	22.4	368,950	59.5	359	256	1.40	504,443	64.5	136.7
Agriculture	1,577	0.3	3,341	0.5	212	..	..	3,828	0.5	114.6
Res. & comm.	189,717	41.4	128,067	20.6	68	..	..	99,076	12.7	77.4
Transportation	49,029	10.7	120,174	19.4	245	..	..	175,284	22.4	145.9
Total (incl. other sectors)	458,478	100.0	620,532	100.0	135	214	0.63	782,630	100.0	126.1

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

a/ The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A-5 : SO_2 Emission by industrial subsector

	1986		1991 estimate					1996 forecast		
	Tonnes	Share 1986	Tonnes	Share 1991	Growth of SO_2 pollution	Economic Growth (MVA, GDP)	SO_2 elas-ticity of MVA	Tonnes	Share 1996	Grow th of SO_2
					1986=100					1991 =100
Mining	1,797	0.4	2,211	0.2	123	..	..	2,176	0.2	98
Manu-facturing	101,678	22.9	201,681	20.8	198	176	1.13	272,023	21.0	135
- Food	23,614	5.3	34,741	3.6	147	160	0.92	46,431	3.6	134
- Textile	15,612	3.5	30,225	3.1	194	200	0.97	48,931	3.8	162
- Wood	997	0.2	2,249	0.2	226	160	1.41	3,477	0.3	155
- Paper	8,551	1.9	17,123	1.8	200	145	1.38	25,211	1.9	147
- Chemicals (excl. oil refining)	3,246	0.7	7,049	0.7	217	141	1.54	4,059	0.3	58
- Non-metal	38,098	8.6	85,024	8.8	223	186	1.20	103,249	8.0	121
- Basic metal	5,547	1.3	8,640	0.9	156	165	0.95	12,018	0.9	139
- other	6,014	1.4	16,630	1.7	277	..	??	28,647	2.2	172
Construc-tion	3,169	0.7	4,656	0.5	147	204	0.72	5,538	0.4	119
Industry (excl. energy)	106,644	24.0	208,548	21.5	196	247	0.79	279,736	21.6	134
Power generation	206,816	46.6	547,877	56.4	265	348	0.76	815,637	62.9	149
Refineries	10,502	2.4	13,791	1.4	131	..	..	31,483	2.4	228
Subtotal[a] (Industry)	323,962	73.0	770,216	79.3	238	256	0.93	1,126,856	86.9	146
Total (incl. other sectors)	443,805	100.0	970,994	100.0	219	214	1.02	1,297,121	100.0	134

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

[a] The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A - 6 : NO_x Emission by industrial subsector

	1986		1991 estimate					1996 forecast		
	Tonnes	Share 1986	Tonnes	Share 1991	Growth of NO_x pollution	Economic Growth (MVA, GDP)	NO_x elas-ticity of MVA	Tonnes	Share 1996	Growth of NO_2
					1986=100					1991=100
Mining	1,246	0.4	2,102	0.4	169	..	..	2,647	0.3	126
Manu-facturing	28,618	9.2	63,435	11.8	222	176	1.26	88,022	11.0	139
- Food	10,725	3.5	15,045	2.8	140	160	0.88	19,295	2.4	128
- Textile	1,902	0.6	3,818	0.7	201	200	1.01	6,201	0.8	162
- Wood	188	0.1	355	0.1	189	160	1.18	535	0.1	151
- Paper	1,541	0.5	5,446	1.0	353	145	2.43	8,067	1.0	148
- Chemicals (excl. oil refining)	900	0.3	1,886	0.4	210	141	1.49	2,511	0.3	133
- Non-metal	11,595	3.7	33,216	6.2	286	186	1.54	45,467	5.7	137
- Basic metal	855	0.3	1,495	0.3	175	165	1.06	2,117	0.3	142
- other	912	0.3	2,173	0.4	238	..	..	3,829	0.5	176
Construction	3,510	1.1	4,656	0.9	133	204	0.65	7,702	1.0	165
Industry (excl. energy)	33,373	10.7	70,429	13.1	211	247	0.85	98,372	12.3	140
Power generation	34,543	11.1	86,818	16.1	251	348	0.72	129,396	16.2	149
Refineries	1,560	0.5	2,048	0.4	131	..	..	4,676	0.6	228
Subtotal[a] (Industry)	69,476	22.4	159,295	29.6	229	256	0.89	232,444	29.1	146
Total (incl. other sectors)	310,893	100.0	538,884	100.0	173	214	0.81	797,983	100.0	148

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17. UNIDO, Global Econometric Database 1993.

[a] The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A - 7 : Carbon Dioxide (CO_2) emission by industrial subsector

	1986		1991 estimate					1996 forecast		
	Tonnes thousands	Share 1986	Tonnes	Share 1991	Growth of CO_2 pollution	Economic Growth (MVA, GDP)	CO_2 elas-ticity of MVA	Tonnes thousand	Share 1996	Growth of CO_2
					1986=100					1991=100
Mining	158	0.2	232	0.2	147	..	..	292	0.2	126
Manu-facturing	15,841	21.8	24,529	22.1	155	176	0.88	32,785	21.5	134
- Food	9,860	13.6	12,722	11.4	129	160	0.81	15,694	10.3	123
- Textile	809	1.1	1,553	1.4	192	200	0.96	2,522	1.7	162
- Wood	143	0.2	233	0.2	163	160	1.02	339	0.2	145
- Paper	439	0.6	997	0.9	227	145	1.57	1,477	1.0	148
- Chemicals (excl. oil refining)	573	0.8	1,095	1.0	191	141	1.35	1,534	1.0	140
- Non-metal	3,211	4.4	6,349	5.7	198	186	1.06	8,639	5.7	136
- Basic metal	343	0.5	587	0.5	171	165	1.04	832	0.6	142
- other	462	0.6	992	0.9	215	..	..	1,748	1.2	176
Construction	366	0.5	520	0.5	142	204	0.70	819	0.5	158
Industry (excl. energy)	16,365	22.5	25,282	22.7	154	247	0.62	33,897	22.3	134
Power generation	11,481	15.8	28,780	25.9	251	348	0.72	43,293	28.4	150
Refineries	1,032	1.4	1,356	1.2	131	..	..	3,095	2.0	228
Subtotal[a] (Industry)	28,878	39.7	55,418	49.9	192	256	0.75	80,285	52.7	145
Total (incl. other sectors)	72,783	100.0	111,163	100.0	153	214	0.72	152,219	100.0	137

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17.
UNIDO, Global Econometric Database 1993.

[a] The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A - 8 : Suspended particulate matter (SPM) emission by industrial subsector

	1986		1991 estimate					1996 forecast		
	Tonnes	Share 1986	Tonnes	Share 1991	Growth of SPM pollution	Economic Growth (MVA, GDP)	SPM elas-ticity of MVA	Tonnes	Share 1996	Growth of SPM
					1986=100					1991=100
Mining	310	0.0	498	0.1	161	..	..	628	0.1	126
Manu-facturing	157,653	22.5	349,807	56.4	222	176	1.26	471,475	60.2	135
- Food	93,573	13.4	127,353	20.5	136	160	0.85	157,627	20.1	124
- Textile	1,316	0.2	3,780	0.6	287	200	1.44	6,140	0.8	162
- Wood	283	0.0	430	0.1	152	160	0.95	603	0.1	140
- Paper	4,877	0.7	28,294	4.6	580	145	4.00	41,914	5.4	148
- Chemicals (excl. oil refining)	2,463	0.4	3,691	0.6	150	141	1.06	5,238	0.7	142
- Non-metal	25,732	3.7	181,402	29.2	705	186	3.79	252,488	32.3	139
- Basic metal	1,447	0.2	3,153	0.5	218	165	1.32	4,465	0.6	142
- other	961	0.1	1,703	0.3	177	..	..	3,000	0.4	176
Construction	817	0.1	1,146	0.2	140	204	0.69	1,804	0.2	157
Industry (excl. energy)	158,780	22.7	351,451	56.6	221	247	0.89	473,907	60.6	135
Power generation	19,961	2.9	16,757	2.7	84	348	0.24	28,842	3.7	172
Refineries	565	0.1	742	0.1	131	..	..	1,694	0.2	228
Subtotal[a] (Industry)	179,306	25.6	368,950	59.5	206	256	0.80	504,443	64.5	137
Total (incl. other sectors)	699,718	100.0	620,532	100.0	89	214	0.42	782,630	100.0	126

Sources: TDRI, The Greening of Thai Industry: Producing more and polluting less, Bangkok 1990, p. 17.
UNIDO, Global Econometric Database 1993.

[a] The calculation of economic growth rates was based on time series of MVA expressed in deflated 1990 US-dollar.

ANNEX Table A-9: Distribution of BOI-Approved Projects by Ownership
(investment of value projects in the manufacturing sector, million baht)

	Before 1987	1987	1988	1989	1990	1991	1987-1991
Total Project Approvals	258,822	63,695	182,266	163,037	169,340	88,125	666,463
Thai-owned	112,448	21,702	56,574	56,852	60,059	9,491	204,679
(share in total)	43.4%	34.1%	31.0%	34.9%	35.5%	10.8%	30.7%
Joint Ventures	121,464	30,429	104,626	80,027	86,492	63,438	365,012
(share in total)	46.9%	47.8%	57.4%	49.1%	51.1%	72.0%	54.8%
Foreign Subsidiaries	24,910	11,564	21,066	26,158	22,789	15,196	96,773
(share in total)	9.6%	18.2%	11.6%	16.0%	13.5%	17.2%	14.5%
Export Projects	46,686	54,178	131,601	98,296	106,373	57,451	447,899
(share in total)	18.0%	85.1%	72.2%	60.3%	62.8%	65.2%	67.2%
Thai-owned	12,695	19,620	39,894	24,571	32,919	4,268	121,271
(share in total)	4.9%	30.8%	21.9%	15.1%	19.4%	4.8%	18.2%
(share in export firms)	27.2%	36.2%	30.3%	25.0%	30.9%	7.4%	27.1%
Joint Ventures	15,810	23,163	70,652	48,003	50,873	38,259	230,951
(share in total)	6.1%	36.4%	38.8%	29.4%	30.0%	43.4%	34.7%
(share in export firms)	33.9%	42.8%	53.7%	48.8%	47.8%	66.6%	51.6%
Foreign Subsidiaries	18,181	11,395	21,055	25,722	22,581	14,924	95,677
(share in total)	7.0%	17.9%	11.6%	15.8%	13.3%	16.9%	14.4%
(share in export firms)	38.9%	21.0%	16.0%	26.2%	21.2%	26.0%	21.4%

Notes: Export projects are those with an explicit export requirement specified in the condition of promotion

Source: Extracted from the Board of Investment Main database

ANNEX Table A-10: Distribution of BOI-Approved Projects by Ownership
(numbers of projects in the manufacturing sector)

	Before 1987	1987	1988	1989	1990	1991	1987-1991
Total Project Approvals	1,403	500	1,245	935	622	312	3,614
Thai-owned	722	196	497	310	165	70	1,238
(share in total)	51.5%	39.2%	39.9%	33.2%	26.5%	22.4%	34.3%
Joint Ventures	599	216	560	479	321	177	1,753
(share in total)	42.7%	43.2%	45.0%	51.2%	51.6%	56.7%	48.5%
Foreign Subsidiaries	82	88	188	146	136	65	623
(share in total)	5.8%	17.6%	15.1%	15.6%	21.9%	20.8%	17.2%
Export Projects	437	450	1,110	804	538	263	3,165
(share in total)	31.1%	90.0%	89.2%	86.0%	86.5%	84.3%	87.6%
Thai-owned	204	175	419	245	131	49	1,019
(share in total)	14.5%	35.0%	33.7%	26.2%	21.1%	15.7%	28.2%
(share in export firms)	46.7%	38.9%	37.7%	30.5%	24.3%	18.6%	32.2%
Joint Ventures	185	188	504	415	273	150	1,530
(share in total)	13.2%	37.6%	40.5%	44.4%	43.9%	48.1%	42.3%
(share in export firms)	42.3%	41.8%	45.4%	51.6%	50.7%	57.0%	48.3%
Foreign Subsidiaries	48	87	187	144	134	64	616
(share in total)	3.4%	17.4%	15.0%	15.4%	21.5%	20.5%	17.0%
(share in export firms)	11.0%	19.3%	16.8%	17.9%	24.9%	24.3%	19.5%

Notes: Export projects are those with an explicit export requirement specified in the condition of promotion.

Source: Extracted from the Board of Investment Main Database

ANNEX Table A-11 : Net Inward FDI and Gross Domestic Investment 1970-1990
(million baht)

Year	Foreign Direct Investment Inflows	Gross Domestic Investment	FDI as % of Gross Domestic Investment	Gross Private Business Investment	FDI as % of Gross Private Business Investment
1970	891	37,731	2.36%	24,566	3.62%
1971	808	37,136	2.18%	25,482	3.17%
1972	1,427	36,872	3.87%	27,216	5.24%
1973	1,605	59,958	2.68%	38,526	4.17%
1974	3,836	74,365	5.16%	54,628	7.02%
1975	1,745	81,134	2.15%	53,676	3.25%
1976	1,614	83,109	1.94%	55,848	2.89%
1977	2,164	108,480	1.99%	74,870	2.89%
1978	1,011	137,496	0.74%	85,891	1.18%
1979	1,128	152,050	0.74%	100,434	1.12%
1980	3,878	174,045	2.23%	107,104	3.62%
1981	6,414	199,723	3.21%	120,059	5.34%
1982	4,331	189,577	2.28%	125,793	3.44%
1983	8,225	236,090	3.48%	144,808	5.68%
1984	9,644	242,506	3.98%	156,546	6.16%
1985	4,442	243,949	1.82%	148,363	2.99%
1986	6,908	238,643	2.89%	155,087	4.45%
1987	9,044	299,790	3.02%	218,868	4.13%
1988	27,964	434,546	6.44%	329,614	8.48%
1989	45,698	559,707	8.16%	457,891	9.98%
1990	62,516	753,952	8.29%	597,328	10.47%

Source: Bank of Thailand,
National Economic and Social Development Board

ANNEX Table A-12 : Manufactured Export Contributions of Surveyed BOI-Promoted Firms (million baht)

Sector	Thai (>90%)	Joint Venture	Foreign (100%)	Total	Total Exports	Thai (>90%)	Joint Venture	Foreign (100%)	Total
Food, Beverages, & Tobacco	17,487	13,661	862	32,010	141,522	12.4%	9.7%	0.6%	22.6%
Textiles	3,722	4,236	325	8,284	19,844	18.8%	21.3%	1.6%	41.7%
Wearing Apparel, Leather Products, Footwear	2,188	3,830	112	6,130	106,943	2.0%	3.6%	0.1%	5.7%
Wood Products & Furniture	464	574	0	1,038	5,112	9.1%	11.2%	0.0%	20.3%
Paper, Paper Products & Printing	566	127	17	710	1,560	36.3%	8.1%	1.1%	45.5%
Chemicals, Chemical & Petroleum Products	1,056	3,918	2,355	7,329	16,009	6.6%	24.5%	14.7%	45.8%
Rubber Products	3,885	1,953	1,224	7,062	30,160	12.9%	6.5%	4.1%	23.4%
Plastic Products	1,783	1,688	151	3,622	7,421	24.0%	22.8%	2.0%	48.8%
Non-Metallic Mineral Products	1,385	739	31	2,155	7,278	19.0%	10.2%	0.4%	29.6%
Basic Metal Products	109	225	9	343	3,600	3.0%	6.2%	0.3%	9.5%
Fabricated Metal Products	675	2,859	3,432	6,966	10,381	6.5%	27.5%	33.1%	67.1%
Non-Electrical Machinery	942	3,016	11,253	15,211	56,049	1.7%	5.4%	20.1%	27.1%
Electrical Machinery & Appliances	153	8,299	2,622	11,073	60,325	0.2%	22.1%	64.1%	86.5%
Electronic Products (TVs, Radios, etc.)	15	6,821	41,182	48,017					
Transport Equipment	174	1,266	281	1,722	5,715	3.0%	22.2%	4.9%	30.1%
Professional & Scientific Equipment	304	833	2,091	3,228	7,878	3.9%	10.6%	26.5%	41.0%
Other Manufacturing Industries	3,859	3,592	2,842	10,292	38,203	10.1%	9.4%	7.4%	26.9%
Total	38,768	57,635	68,789	165,192	526,002	7.4%	11.0%	13.1%	31.4%

Notes: - comprises manufactured exports broadly defined.
Sources: Extracted from the Board of Investment Survey database.
- compiled from Trade Statistics of the Customs Department.

ANNEX Table A-13: Distribution of BOI-Approved Export Projects by Nationality Group

(numbers of projects in the manufacturing sector)

	Before 1987	1987	1988	1989	1990	1991	1987-1991
Joint Ventures	185	188	504	415	273	150	1,530
North America	15	10	32	27	14	12	95
(share in joint ventures)	8.1%	5.3%	6.3%	6.5%	5.1%	8.0%	6.2%
Japan	39	72	145	110	72	49	448
(share in joint ventures)	21.1%	38.3%	28.8%	26.5%	26.4%	32.7%	29.3%
Europe and Other DCS	40	25	56	61	45	21	208
(share in joint ventures)	21.6%	13.3%	11.1%	14.7%	16.5%	14.0%	13.6%
NIC Countries	57	51	195	160	101	48	555
(share in joint ventures)	30.8%	27.1%	38.7%	38.6%	37.0%	32.0%	36.3%
ASEAN	14	6	32	22	13	9	82
(share in joint ventures)	7.6%	3.2%	6.3%	5.3%	4.8%	6.0%	5.4%
Other LDC Countries	20	24	44	35	28	11	142
(share in joint ventures)	10.8%	12.8%	8.7%	8.4%	10.3%	7.3%	9.3%
Foreign subsidiaries	48	87	187	144	134	64	616
North America	16	6	12	5	11	2	36
(share in subsidiaries)	33.3%	6.9%	6.4%	3.5%	8.2%	3.1%	5.8%
Japan	16	34	57	47	42	33	213
(share in subsidiaries)	33.3%	39.1%	30.5%	32.6%	31.3%	51.6%	34.6%
Europe and Other DCS	10	6	16	22	8	5	57
(share in subsidiaries)	20.8%	6.9%	8.6%	15.3%	6.0%	7.8%	9.3%
NIC Countries	2	36	95	52	67	19	269
(share in subsidiaries)	4.2%	41.4%	50.8%	36.1%	50.0%	29.7%	43.7%
ASEAN	1	3	5	7	1	2	18
(share in subsidiaries)	2.1%	3.4%	2.7%	4.9%	0.7%	3.1%	2.9%
Other LDC Countries	3	2	2	11	5	3	23
(share in subsidiaries)	6.3%	2.3%	1.1%	7.6%	3.7%	4.7%	3.7%

Notes: - Export projects are those with an explicit export requirement specified in the condition of promotion.
Source: Extracted from the Board of Investment database

ANNEX Table A -14: BOI Investment/Project Statistics Jan-Dec. 1992

Product	Total	Bangkok	Samut Prakarn	Perimeter	Eastern
Proposed Sites	445	59	34	63	91
Investment (B.mn)	213,065.8	55,489.2	22,695.6	9,881.7	75,160.6
Approved Sites	371	61	24	53	98
Approved Investment (B.mn)	275,389.8	14,819.3	24,036.1	6,270.4	198,858.3
Proposed Sites, Promotion Certificate Issued	385	69	28	55	78
Investment, Promotion Certificate Issued (B.mn)	457,234.8	291,895.9	4,651.7	9,169.2	113,447.9
Proposed Sites, Operation has begun.	456	63	55	81	82
Investment, operation has begun (B.mn)	95,609.9	12,329.5	10,828.3	14,227.9	26,550.9
Foreign Registered Capital, by product/region (B.mn)	12,244.3	1,447.6	2,763.8	589.3	2,605.4
Foreign Registered Capital, application approved (B.mn)	18,556.2	1,010.7	3,293.8	1,387.9	10,900.6
Foreign Registered Capital, Promotion Certificate Issued (B.mn)	14,366.4	7,276.8	585.2	1,008.2	3,159.9
Foreign Registered Capital, Operation has begun (B.mn)	16,506.2	834.5	1,928.6	5,110.7	3,417.9

* TOTAL COVERS 53 SECTORS AND 10 REGION

* All proposed sites and investment are classified by product and region.

SOURCE: EBG CO., LTD. EXTRACTION FROM BOI DATA BASE (MARCH, 1993)

ANNEX Table A-15: BOI INVESTMENT/PROJECT STATISTICS JAN-DEC, 1991

PRODUCT	TOTAL	BANGKOK	SAMUT PRAKARN	PERIMETER	EASTERN
Proposed Sites	632	86	47	68	148
Investment (B.mn)	8281,994.5	32,307.9	6,282.6	10,495.3	159,027.0
Proposed Sites Application Approved	606	78	53	61	129
Investment, Application Approved (B.mn)	277,107.0	135,367.8	8,200.2	9,506.4	60,584.0
Proposed Sites, Promotion Certificate Issued	563	76	61	83	129
Investment, Promotion Certificate Issued (B.mn)	180,620.7	35,647.6	11,957.4	18,473.6	76,268.1
Proposed Sites, Project has begun.	447	56	85	91	99
Investment, Project has begun (B.mn)	74,754.2	2,765.2	10,693.8	9,469.8	33,854.9
Foreign Registered Capital (B.mn)	26,768.4	1,082.5	1,077.0	1,874.5	13,061.8
Foreign Registered Capital, Application Approved (B.mn)	82,633.1	39,738.0	3,129.6	2,620.9	17,103.0
Foreign Registered Capital, Promotion Certificate Issued (B.mn)	15,269.9	2,157.2	1,287.3	1,347.0	5,381.9
Registered Capital, Operation has begun (B.mn)	37,692.4	2,225.3	3,485.1	4,432.7	16,720.6

SOURCE: EBG CO., LTD. EXTRACTION FROM BOI MAIN DATA BASE

ANNEX Table 16: BOARD OF INVESTMENT ACTIVITIES

PROJECTS RECEIVING PROMOTION CERTIFICATES - 1990 TO 1992

	1990		1991		1992	
	Number of Projects	Value of Investments (Mil. US$)	Number of Projects	Value of Investment (Mil. US$)	Number of Projects	Value of Investment (Mil. US$)
Total	730	7,562	534	7,141	378	18,001
By Sector						
Agricultural Products	98	566	77	381	48	178
Minerals & Ceramics	19	78	18	171	12	82
Garments & Textiles	46	323	32	385	13	204
Other Light Industry	174	573	82	457	64	324
Chemicals	49	1,329	39	1,395	22	3,659
Metal Processing	103	1,374	61	1,098	46	1,016
Electronics & Electrical	95	835	105	941	84	696
Services	146	2,484	120	2,313	89	11,842
By Country						
Japan	137	1,540	134	1,673	90	1,256
United States	42	555	34	553	29	3,236
East Asian NICs						
Taiwan	113	353	53	218	39	549
Hong Kong	44	901	32	443	16	6,340
Korea	16	69	16	169	14	394
Singapore	27	263	30	586	20	324
Europe						
United Kingdom	30	809	15	359	19	601
Germany	10	30	3	377	9	72
Switzerland	14	150	6	31	5	39
France	16	83	7	164	6	38
Netherlands	9	260	7	42	1	49

* Projects receiving promotion certificates must have already registered a company and paid up a percentage of registered capital.
* The data in the section classified by country does not add to the total as projects with more than one foreign shareholder are double counted.

Source: EBG Co., Ltd. Extraction from BOI main data base.

ANNEX Table A-17 : Flow of Wastewater from Various Types of Agro-Processing Activities in Thailand

Type of Activity	Number of Plants	Outflow m3/day	BOD mg/litre
Distillery	17	20 - 1,500	35,000 - 40,000
Alcohol-producing	2	120	35,000
Sugar	35	200 - 2,000	200 - 3,000
Palm-oil	11	25 - 140	6,700 - 27,700
Vegetable-oil	4	20 - 60	2,000 - 14,000
Natural rubber	68	20 - 200	240 - 5,800
MSG	1	120	100,000
Pickle & sauce	25	1 - 50	270 - 9,050
Cannery	18	20 - 2,000	560 - 3,500
Steamed fish	25	2 - 5	730 - 1,000
Ice cream	23	1 - 10	220 - 2,000
Frozen-seafood	5	30 - 1,200	430 - 2,100
Slaughterhouse & frozen meat	4	3 - 1,500	450 - 900
Meat-processing	9	0.5 - 30	350 - 4,600
Noodle	169	1 - 80	500 - 5,500
Transparent noodle	12	20 - 250	480 - 19,800
Pulp & paper mill	3	2 - 80	400 - 10,000
Parboiled rice	53	15 - 300	600 - 3,000
Lac	7	n/a	950 - 3,000
TAPIOCA STARCH	58	20 - 3,200	6,400 - 7,650
Glucose syrup	8	2 - 80	370 - 10,000

Source: Chavadej, Sumaeth. "Application of Anaerobic Treatment for Agro-Industrial Wastes in Thailand", 1990

ANNEX B

COMPANY INTERVIEWS

ANNEX B

CASE STUDY 1: NESTLE (THAILAND) LTD

Date: 25 March 1993
Interview: Salvador Pigem, Technical Director
Marco Bernasconi, Group Engineering Manager

Contact: Tel: 256-9119
Fax: 256-9156

Background

Much of the discussion revolved around a new, BOI-promoted instant coffee plant in Chachoengsao province, which was opened in 1992. The plant was established as a relocation of an old plant located on Bangna-Trat Road in Samut Prakan Province. The old plant had the following disadvantages: it was too small; not based on the latest technology; located in a residential area; and there was a limited possibility to extend operations there. In contrast, the new plant is state of the art equipped and is considered to be the most advanced instant coffee plant in Nestle's world-wide operations.

Production Process

Instant coffee is produced from green coffee beans, grown in Thailand. Some chemicals are used in the plant but only in small amounts: hydrochloric acid; sodium hydroxide; and cleaning agents. Salt is also used in the process.

The new plant incorporates an incinerator which also generates 70% of the power required to generate steam which is used in the production process. The incinerator, which cost Baht 100 million, allows for maximum heat recuperation and is also considered state of the art by Nestle. A wet scrubber catches the ashes from the incinerator. Management considers that the incinerator saves money and reduces waste volumes. The level of savings depend, to some extent, on the price of oil. Spent coffee ground, a waste from the production process, is also used as fuel.

In the Samut Prakan plant, spent coffee was dumped by the truckload every day. In the new plant only one truck of ashes per week needs to be disposed off in the city dump. Other power requirements are met by burning the highest domestic grade, low sulphur, fuel oil.

The plant's activated sludge waste water treatment system meets European standards. The color of the effluent from the coffee production process is black and is considered the plants most serious waste stream challenge. Water is drawn from deep wells on site. The water is brackish, and has to be treated before it can be used. Saltwater and fresh water is separated by electrodialysis. The salt water is then evaporated in a US$1.4 million titanium evaporator. Nestle is now in discussions with the Thai fisheries authority, to sell the remaining salt - two trucks per day - to shrimp farmers in the area. At present these farmers truck in seawater from the coast for their needs.

General observations

Nestle has a global policy to abide by local environmental regulations, in the first instance. If local laws are deemed inadequate, company standards come into force.

An environmental coordinator sits at Head Office in Switzerland. So far he has never visited Thailand. Summaries of locally conducted environmental surveys are sent to the environmental coordinator. Every Nestle factory in Thailand has an environmental committee which draws up environmental action plans for its facility. Bangkok head office makes environmental surveys of each factory on an annual basis.

Nestle has a global policy to phase out the use of CFCs. A Nestle plant in Malaysia has shifted to ammonia-based air-conditioning. This might be introduced to Thailand if it works well in Malaysia. Nestle (Thailand) tries to cut down on water usage in all of its plants. In consideration of the current water crisis in the country the company expects water prices to increase in future. The company operates an extensive recycling programme. A separation system for tin cans, steel, glass, paper, etc. is employed at its plants. The waste minimization program ties in with product and packaging design.

Nestle (Thailand) has three plants located in industrial estates, and these facilities are connected to the Industrial Estates' centralized waste water treatment system. They therefore have no waste water treatment of their own for these plants. The waste water treatment systems of the IE are said to be frequently out of order, due to bad maintenance standards by IE staff. As a result, untreated waste waters from the Nestle plants are released to the surrounding area.

The company feels it has little clout with which to pressure local subcontractors to improve their environmental performance.

CASE STUDY 2: STANLEY TOOLS LTD

Date: March 19, 1993
Interview: Edward Rubesch, Engineering Project Manager

Contact: Tel: 316-3249/316-6071/316-3629
Fax: 316-8655

Background

Stanley Tools Ltd is a 100 percent, US owned, BOI-promoted company, mostly assembling hand tools. It was first established in Thailand in 1989-90, with a factory in Samutprakan Province, employing 80. The company primarily produces tape rules, with both metal and fiberglass blades, as well as the assembling work for a variety of other tool product lines. Stanley is in a growth stage in Thailand and plans to continually add capabilities to its operation. This will allow the company to perform in Thailand more of the processing steps involved in manufacturing its products.

Stanley are now looking to expand their operations and want to set up a new and larger factory within 1993. They are investigating various options, building a greenfield plant or identifying suitable premises already built, for this purpose.

Production Process

Waste from the present plant is mostly in solid form such as plastic scraps and is taken care of by the public garbage collection system. The current production process produces no waste water, and therefore no treatment system exists.

At the moment, the bulk of the Samut Prakan plant's pollution is in the form of industrial solvents which are disposed of through an industrial waste service. Paints used are water-based. Small amounts of lacquer is used for coating the hand tools. Admittedly, this is not handled in the best of ways and would not be considered up to US standards. The lacquer is picked up by the professional waste disposal service ,mentioned above. The engineer did not know where the waste finally ends up. As Stanley's capabilities increase, the company anticipates the need to install their own waste-water treatment facility for the new plant.

The company is currently using a local subcontractor for small volumes of electroplating. They have not checked his environmental record or his environmental management performance. The company feels that it is such a small customer for the electroplator, that it has no leverage over the subcontractor to improve his environmental standards.

US head office will soon conduct an environmental audit of the Thai plant. It is felt that the Thai plant's environmental performance will be determined more by head office's comments after this check - rather than by Thai or US environmental legal regimes.

The planned expansion and relocation is seen as a chance to improve environmental performance. In future, electro-plating will be done in-house. It is likely that the entire plating process, including a waste water treatment system, will be bought second-hand from an existing plant in the United States.

General observations

Stanley Works, the parent company, has a very rigorous environmental policy for all of its companies worldwide, which is usually more stringent than local environmental laws. The reasons for this are twofold. Firstly, the company has a history of being a "good-neighbor" and is intent on maintaining this position in each of the communities in which its companies are located. Second, the headquarters and many of its operations are located in the Northeast United States, which because of its industrial heritage, is now saddled with a

number of heavily polluted and environmentally-damaged areas, even where factories no longer exist. No company in this area (or the whole of the U.S.) is unaware of the potential environmental liabilities. At the corporate level, Stanley Works has an environmental department which is responsible for implementing the company's policies. Every manufacturing site is required to undergo regular environmental audits.

At the moment, Stanley in Thailand does not utilize "green" or "environment-friendly" promotional strategies. However, in Europe, Stanley divisions in the U.K. and France have taken the lead with green packaging and use this as a promotional advantage. The U.S. is also following suit. Once their campaigns are implemented, it will not take long for the methods to be incorporated into the Thai operations, the engineer maintains, especially with the wave of environmental concern in Thailand.

Stanley environmental corporate policy seems to be above the compliance level of Thailand. The operation in Thailand is working to adhere to its corporate standards and believes this will satisfy any regulations in Thailand.

In general, environmental incentives make a positive impact on manufacturing because they require greater control of the entire process. This results in more forethought in the design of the product, the layout of the manufacturing operation, and tighter control of the day-to-day running of the plant. More advantages result than just a cleaner environment. Indeed, this may be seen this as an opportunity to provide a better overall product to the customer, rather than a restriction. It is from this perspective that some Japanese companies see this as a competitive advantage for them and are even ahead of legislation in implementing changes.

Of course, if environmental incentives have advantages in all aspects of a manufacturing operation, the flip side is that Thailand (especially its vendors) must be able to support these advantages. It must be able to provide the skilled people to support a design effort in both packaging and products. (Right now, it seems most mechanical engineers are construction and structural engineers, rather than design engineers.) It must be able to provide the right materials. (The wide-range of plastics, including some more-environmentally-friendly ones, are not as available in Thailand as in the West, and heavy duties will tend to prevent them from being available until they are made locally.) And it needs to have a packaging industry which is willing to benefit from finding a creative solution rather than re-producing the same old packaging.

If the vendors exist which provide the services that referred to above, they are not easy to find. Perhaps, what is needed is a reliable source of industrial product/service information (like the Thomas Register in the U.S.)

CASE STUDY 3: VOLVO (THAILAND)
THAI-SWEDISH ASSEMBLY (TSA) CO., LTD.

Date: March 26, 1993
Interview: Interview 1: Volvo Thailand
Mr Bo Gaden, Business Development Manager,

Interview 2: Thai-Swedish Assembly (TSA) Co., Ltd
Mr Ingvar F. Muhl, General Plant Manager
Khun Naurepont Pongcharoen,
Maintenance and Personnel Manager

Contact: Tel: 316-2577-80
Fax: 316-2582

Background

Thai-Swedish Assembly Co., Ltd, manufactures Volvo and Renault cars in Thailand (only the Volvo production process and marketing policies is considered in this Case Study). It was established in 1976 and does not have BOI promotion.

The company considers itself and is viewed by many in Thailand, and internationally, as highly environmentally aware. For example, its European parent company is leading the way to develop schemes for recycling of cars. This initiative would be premature in Thailand primarily because the country lacks the supporting industries to service such a recycling initiative. However, in principle, if such a support industry were to develop here, recycling options may be introduced in the future in Thailand. "Green" sales arguments are used in Volvo's Thailand marketing programme.

The Thai operations follows Volvo's corporate environmental standards, which, in many instances, are above the compliance with Thai regulations. The Thai plant has been subject to a recent environmental revision (from Sweden). The respondent does not believe the revision extended to include local suppliers.

In 1993 the company is introducing a new car air conditioning system which does not use ozone-depleting CFCs. It is introducing a substance called R 134, which required new air-conditioning technology, that does not-exist in Thailand. As local-contents requirements forced the company to use locally-made products, importing the technology was not an option. This had the effect that the technology's introduction to Thailand was delayed while the local subcontractor, Nippondenso, was assisted in developing capabilities to produce the modified air-conditioning system.

This shift to "green" air-conditioning will be mentioned in the marketing of the new Volvo 960 models that are coming on the market. The new technology was introduced in August 1992.

Production Process

At the Thai assembly plant, the painting of cars is done in a solvent-based process. Solvent gases in the air are burned in an incinerator, before the air is released to the outside. One plant in Sweden has introduced a water-base paint, but this is not used in Thailand. Instead of spraying by hand, TSA has changed to "dipping" the car frames into chemical baths. The same method is used in the parent company's plants in Sweden.

In a connected waste generating activity, TSA has recently cut down drastically on chemical consumption in the plant, just by changing behavior. Staff used to wash their overalls in solvents. When finished, they would pour the used solvent into the drainage system. Now, staff overalls are sent out for washing with a professional washing service. Also in an effort to reduce chemical consumption, the company has stopped painting some covered areas on the cars.

Solvent emissions have been cut down from 32 liters per manufactured car to 12-13 liters/car in just one year. The improvement has come about because of better handling and control of chemicals. Usage records have been kept since 1992.

TSA has recently upgraded its waste water treatment system - investing 10 million Baht for a what is considered a state of the art plant. TSA has cut down on its consumption of raw water, from 10,500 cubic meters per month in January 1992 to 5,700 cubic meters/month in February 1992. This was achieved just by mending leaks in the piping system, and monitoring of real water usage by installing flow meters at various points. In December 1992, usage had fallen to 3,600 cubic meters/month. Water is drawn from a well on site. TSA pays 1 Baht per cubic meter for the water it draws. Thus, in monetary terms, the saving is rather insignificant. On the other hand, the plant site in Samut Prakan province has suffered significant land subsidence in the 17 years since TSA was established. The company believes however that water fees may rise in future and this will increase the financial motivation for the efficient use of water in the plant.

Since 1991, TSA has been running an energy savings program, basically as a cost-saving measure. The company bought two capacitors for its plant at 300,000 Baht per piece from ABB.

Waste sludge is taken care of by a professional waste service, SGS Environmental, which for a fee, transports solid sludge to its centralized treatment facility at Bang Khuntien.

Hazardous waste is "taken care of" by a scrap dealer. TSA does not know where it ends up. In future, the company will probably store hazardous waste on site. If a private company could handle, treat and dispose of the hazardous waste properly, TSA would be very much willing to pay for the service, just like it does with SGS.

Recycled paper, wood and plastic scrap,is sold to a scrap dealer. Suppliers ICI and DuPont take some of TSA's used chemicals back. Paint is also returned to the supplier. The respondents felt that oils and solvents, which TSA pays the scrap dealer to take care of, might also be recycled.

In 1991, TSA installed an incinerator to burn fumes from solvents, on order from Sweden. The incinerator was in operation in early 1992. A second incinerator is being installed in a new expansion. The total cost to install them is 100 million Baht. It is believed that TSA is the first car manufacturer in Thailand to use incinerators. Competitors are known to just release the fumes to the air. The incinerators are also used for energy generation.

Thai law does not cover air pollution such as solvents released to the air. But it is believed that a new law to regulate this type of air pollution will be promulgated in the near future.

General observations

A main reason why the company is trying to improve its environmental management is that its global marketing is strongly revolving around the themes of safety and the environment. This is also the case for Volvo's marketing campaigns in Thailand.

The company is also keen that its own corporate performance should be ahead of tougher environmental compliance standards developing around the world. TSA strives to comply with Thai law. If there is no covering Thai Law, the company will go by Swedish law. An environmental committee will be set up shortly at TSA which will follow direct orders from Sweden. The respondents stated that all environmental improvement activities so far, have actually saved money.

In the past, the company has been lobbying the Thai government to require catalytic converters on all cars or set emission standards that in effect force car manufacturers to fit all cars with catalytic converters. The reason: the company wanted to stop having to update an increasingly "obsolete" series of engines still using leaded gasoline for small markets such as Thailand, while the rest of the world is shifting to unleaded gasoline. Today, all Thailand-manufactured TSA cars are fitted with catalytic converters, as required by Thai law from January 1993 - and comply with EC emission standards.

As there is often only one supplier in Thailand producing a certain automotive part, and the volumes ordered are quite small, it would be difficult for Volvo to pressure suppliers to improve their environmental performance.

The Thai Maintenance and Personnel Manager is responsible for environmental management at the plant. Sweden has expressed that a Swede should have the responsibility, but TSA feels that it is better if the knowledge is transferred to a local, so that there will be continuity at the plant, considering that foreign staff are rotated regularly.

CASE STUDY 4: OCCIDENTAL CHEMICALS (OXYCHEM) FAR EAST LTD.

Date: March 19, 1993
Interview: Kevin F. Smith, Representative Director

Contact: Tel: 253-8733-4, 252-5595
Fax: 255-7773

Background

Occidental Chemicals Far East Ltd is the mother company of three joint-venture firms in Thailand. Two of the JVs are manufacturing plants and are located in Bangpoo Industrial Estate, Samut Prakan Province.

The three JVs are:

a. Siam Occidental Electrochemical Co., Ltd. established in 1990 and a producer of chemicals for general industrial use, such as caustic soda, chlorine and hydrochloric acid, 90% of which is sold locally.

b. Thai Occidental Chemical Ltd., established in 1985 and a producer of chrome sulphate, 60% of output is exported, the balance being sold locally, primarily to the leather industry.

c. Chemtrans (Thailand) Ltd. Safe Delivery, is a JV with Australian company Insitec The specialist firm provides safe transportation of hazardous chemicals and was registered in March 1993.

Oxychem received BOI promotion and were granted reduced import duties on machinery and raw materials (toxic chemicals). Oxychem companies are required by their own corporate regulations to use the higher of US or local environmental standards. Roughly 20% of total capital cost is devoted to pollution control technologies.

Production Process

The Thai chrome plant is using a closed system where everything involved in the process is recycled. Oxychem considers its processes in Thailand state of the art. The Thai chrome sulphate plant will be the most advanced of all plants in the company's global operations.

One waste effluent, that for solid particles dissolved in the waste water, constantly exceeds Thai standards. The solid matter, however, is a small amount of salt but Thai standards don't differentiate between salt and heavy metals. The problem will be solved by May.

Three environmental engineers are working at Siam Occidental, one at Thai Occidental. Daily measurements are taken in two surrounding khlongs and in soil, to monitor that no chemical leaks occur. Analysis is done in-house.

In Thailand, the company is training customers in the safe use of chemicals. The sales system is being computerized in order for the company to be able to keep track of where its products are going. There are problems with some customers of chrome sulphate. The customer base is a high number of small clients, such as tanneries. It is so fragmented that it is impossible for the company to ensure that all customers are handling the chemicals in a safe manner (as it is in the United States, under Responsible Care). Improved government enforcement is perceived by Oxychem as the only way to solve the problem.

No Thai government agency has ever visited the plants to monitor or inspect its environmental performance. But EIAs were required by the Ministry of Industry before starting up the factories.

Thai Occidental is operating a salt mining operation in Korat, which supplies the single most important raw material for its production process - salt. The company is considering to stop running the mine, as it would require huge investments on environmental upgrading. Other mining operations in the Northeast are known to have caused economic damage to farmers, as fields have become salinated after leakage of water from the salt mining operations. A decision on the mines future is to be made by June 1993.

General observations

The reasons for the company's pro-active stance on environmental management are: to avoid liability for clean-up costs in the future; pressure from the US market to perform at home and in the Third World; and in the US, the company is having to spend substantial amounts on clean up operations of its older plants and it wants to avoid having to do the same elsewhere in future.

The company is running "the works" of corporate environmentalism: Responsible Care, Environmental Audits, Waste Minimization and Energy Efficiency Programmes, etc.

However, environmental regulations are said not to be enforced within the Bangpoo Industrial Estate.

The company is part of the Energy and Chemical Manufacturing Committee within the American Chamber of Commerce in Thailand, a grouping that is said to account for 70% of total US direct investment to Thailand. The group has issued a position paper which provides a code of conduct on environmental issues. The group is working closely with - and in support of - the Chemical Club of the Federation of Thai Industries, which is seen as a key to affecting the development of government standards and policies in Thailand.

Staff are following strict safety procedures at the plants but safety thinking and awareness is at a low level for all staff categories. Management believe a long process is required before Thai employees internalize safety thinking. Strict safety measures implemented - wearing of gas masks at all times etc - have also caused fear among employees. There are right-to-know stations, with information on all chemicals, placed in several spots around the plants. Workers do not use them very much, however.

Oxychem is planning to start a dialogue with the communities surrounding the site of its plants at Bangpoo, for example, by inviting school children to familiarize themselves with the industry.

CASE STUDY 5: 3M THAILAND

Date: April 1, 1993
Interview: Thomas F. Beddow, Managing Director
Stephen E. Stolberg, Senior Manager, Manufacturing, Engineering & Technical Service

Contact: Tel: 326-0780,326-0095
Fax: 326-0017

Background

3M has been in Thailand 25 years and is registered as 100% foreign owned under the Treaty of Amity between Thailand and the US.

Planning for the Lat Krabang factory started 5-years ago and production of box-sealing tape, abrasive belts and decorative graphics, started in October 1992. The Thailand subsidiary of 3M has 296 employees working in the Lat Krabang factory; 18 trained engineers and 278 unskilled laborers. 3M Thailand receives direction on 3M environmental policy from 3M's Headquarters in St. Paul, Minnesota. As 3M has only recently begun manufacturing in Thailand, they do not, as yet, use many local suppliers, except for packaging supplies and film, but this may change in the near future with the on-going development of the Lat Krabang facility.

Production Process

The 3M Lat Krabang plant manufactures packaging tapes, such as industrial box tapes, which require a lot of coating. Coating requires the use of solvents. Solvents are potentially a key source of soil and groundwater contamination.

At the 3M Lat Krabang plant, 3M began using a water-based solvent to coat the tapes, therefore significantly reducing factory generation of possible contaminants. 3M Thailand is therefore not considered a serious polluter, compared to older 3M plants in other countries.

3M's hard (equipment) investment in industrial environmental management in Thailand exceeds US $750,000 for the Lat Krabang Factory. This has been invested on an air handling system; catch basin in the spill containment building (to prevent seepage and resulting soil/groundwater contamination) and in investment in solid waste management for factory outflow.

In the factory, a Hazard Control Program is in place which includes implementing hazard control standards and procedures at the initial training level for both skilled and unskilled workers. The use of safety control equipment, including gloves, boots, glasses, air filters, etc., is mandatory. 3M in Thailand utilizes the Japanese 5-S System used to sort out unnecessary production processes, develop good work habits and safety habits. Namely: 5-S; Sort, Situate, Scrub, Stay Clean, Study.

CHALLENGE '95 is a waste minimization program which emphasizes efficiency at every task level (employee, professional, management, senior management). It includes efficiency in the areas of: waste, energy, cycle-time, and unit cost. As part of this initiative, there is an emphasis on reduction of solid waste in the factory. For example, incineration is to be scrapped during Challenge '95 because it results in heavy residual sludge disposal.

Recycling is a branch program of Challenge '95. 3M sells excess plastics, papers, cardboards to Thai recycling companies. No names were given. Profits from recycling are put back into the 3M environment and social programs.

3M soft (social programs, assistance, training) environmental investment has not been measured because it is ongoing and involves various sources of 3M funding.

General observations

3M has a global environmental policy, named 3P Plus (Pollution Prevention Pays Plus). Emphasis is on manufacturing development by coming up with waste-minimising production methods, from the start. The 3M environmental goal is to be pollution free, world wide, by the year 2000. 85 per cent of 3M factories world wide are now ISO 9000 certified. 3M Thailand has begun certification procedures this year.

3M Environmental Audit is controlled from headquarters in St. Paul. It is used to ensure that all subsidiaries are following 3M corporate environmental standards. In the last one (1992), the environmental audit exposed that not all of 3M Thailand's leased or owned buildings and supplier's buildings were asbestos-free. As a result, 3M Thailand will ensure that the asbestos regulation is followed more strictly.

Regarding hiring an on-site, factory environmental engineer in Thailand the respondent made the following comment: "At 3M, caring for the environment is everybody's responsibility. If we designate a Thai to do something, he will only do the job he is designated to do and nothing beyond that. The other employees will do only their jobs and will pass off anything to do with environmental management to the man hired to do that job. It just doesn't work in Thailand to designate only 1 environment officer. Group work, group pressure and group responsibility are important cultural considerations."

In Thailand, 3M is active on the Energy and Chemical Manufacturers Committee of AmCham (American Chambers of Commerce) 3M contributes to the committee by bringing in ideas based on the company's worldwide experience in energy efficiency, hazardous waste management and environmental quality control.

In Thailand, the company has two Environmental Publications. Internally, the magazine "Sawaddee" is distributed to all employees and an external publication: "Kob Khun". Both internal and external environmental programs emphasize the following: waste minimization; waste treatment; social assistance and education; occupational health and safety; global assistance to environmental concerns; and assistance to domestic environmental concerns.

For 3M internal programmes in Thailand, it must be noted that at this point the company primarily uses foreign suppliers. To local suppliers the company distributes information on environmental standards and 3M expectations. Recently, this has included sending all suppliers information on the use of CFC's and standards in production processes. 20% of the suppliers contacted responded "yes, we are following these standards". The rest, management believe, did not understand, or did not want to understand, the initiative.

3M sends out invitation letters to all its suppliers to attend its environmental and safety seminars and conferences. However,3M has not yet extended its 3P Plus programme to its supplier networks in Thailand.

3M External Programs in Thailand are mostly related to environmental and social development. The promotional benefit for 3M is goodwill, as well as a cleaner environment in the factory, etc. The external programmes are based on the belief that in order for Thailand to have balanced growth, opportunities must be created up North. The people and businessmen up North must understand the environmental and developmental concepts. The programmes stress that Bangkok is not Thailand's only key to development.

Initiatives include: financial assistance to the NGO Magic Eyes, for creation of village environmental education programmes; assistance has been offered to the Population Development Association (PDA) for a water tank project in a village in Northern Thailand; and 3M are involved in "TBIRD" (Thai Business In Rural Development) which is a program for offering soft loans to villages in Thailand to specialise in one specific industry.

In the TBIRD pilot project, Klong Muang Village, has been offered assistance to establish a silkworm raising business. The next project will specialise a village in silk spinning.

CASE STUDY 6: DUPONT THAILAND

Date: March 17 , 1993
Interview: Khun Thirachai Ongmahutmongkol
Managing Director
Contact: Tel: 236-0026, 238-4361
Fax: 238-4396

Background

Du Pont employs 130,000 people worldwide, with its own operations in more than 70 countries and involvement in 120 countries. Core business areas include: agricultural and industrial chemicals; medical technologies; electronics and aerospace; and energy, coal and gasoline.

Du Pont has had an office in Thailand since 1971. Not including its joint-venture partners in the country, the company employs 110 people directly. Originally, the company was BOI promoted but only in terms of the land it bought. That category was later abandoned by the BOI. A manufacturing plant at Bang Poo produces agricultural chemicals and a joint-venture plant with TOA at Bagna Trad produces automative paint. Du Pont is looking for different types of joint-venture partnerships for future expansion.

Production process

Du Pont's environmental and safety standards are far higher than those presently required by the Thai government. The Responsible Care programme is followed in all manufacturing plants. Products stewardship and training customers in the use of products is also viewed as an important element of assisting Thailand improve its environmental management track record.

In Du Pont's two plants in Thailand pollution control costs account for between 5 and 25 percent of total investment. In the agricultural chemicals plant, where wastewater is the major concern, a US5 million wastewater collection and flood protection system was introduced in 1982. In the automative plant, spray booths and protective equipment increased overall investment costs by 10 percent.

Du Pont has established a training centre for appropriate use and safety techniques related to the use of automative paint. Educational and training literature is distributed to employees and customers to inform them of safe handling techniques for Du Pont products.

General observations

The Energy and Chemical Manufacturers Committee at AmCham, of which Du Pont is a member, is currently discussing the appropriate form under which Responsible Care (RC) can be introduced into Thailand. RC has not yet officially been adopted. This committee has also acted as unofficial advisor to the Thai government on its various new environmental and industrial laws. It works in close collaboration with the Chemical and Petro-chemical Committees of the Federation of Thai Industries (FTI).

In 1992 Du Pont co-sponsored a report: " Asia Pacific and the Environment: Investing in the Future", which surveyed environmental issues in 12 regional countries. The report, which retails for US$400, has been distributed to a select group of government, industry, NGO and academic figures in Thailand.

CASE STUDY 7: CIBA GEIGY (THAILAND) LTD.

Date: March 22, 1993
Interview: Ronald W. Goodey, Managing Director
Norbert Straub, Financial Affairs Director
Songsri Vongphantuset, Executive Director,
Legal Affairs and Human Resources

Contact: Tel: 551-1046
Fax: 552-1539

Background

Ciba-Geigy have been represented in Thailand for 30-years. In 1971-72 a pharmaceutical division called Ciba-Geigy (Thailand) Ltd was created and the distribution of pharmaceutical products began. The large Thai trading and distributing company, Diethelm, now distributes Ciba-Geigy pharmaceutical products in the country.

Formulating of the products began in the early 1980s after a company with a factory unit at Ramkhaenheng, Bangkok, was purchased. Manufacturing of pharmaceuticals and formulation of agricultural products in association with 3rd parties commenced in 1984. Re-formulation of chemicals products commenced in 1986 when the company's Lat Krabang plant came on stream. The company also produces dyes and pigments at its Thai operations.

The company is not BOI-promoted as a deliberate corporate preference, it prefers to stand alone in the country. When it views some of the difficulties and delays for companies who deal with the BOI it is glad that it chose this course.

In 1985/86 the companies administrative and sales operations were relocated to the present Ciba-Geigy building on the highway to the international airport.

The group of companies worldwide underwent a major re-organization in 1990 with its 6 divisions split further to 14 divisions. 11 of these divisions are represented in Thailand, the major ones being pharmaceuticals, agricultural products and the dyes and chemicals divisions.

Ciba-Geigy management feels that it is one of the fore-runners on corporate environmental practice and sets high standards for itself. In part, this relates to the high environmental standards set in the home country, Switzerland, of the parent company.

The 1986 fire at the plant belonging to Sandoz, the second largest Swiss chemical manufacturer, which resulted in contaminated water spilling into the Rhine, means that Swiss companies were subject to stringent monitoring of their environmental performance by the home government and this has resulted in their having exported high environmental standards to operations around the world.

Production process

In-plant environmental management at Ciba-Geigy's factories in Thailand meets with the highest government standards around the world.

When Ciba-Geigy works with local third parties in Thailand, for example to reformulate agricultural chemicals, they monitor the performance of the domestic operator. Although their standards are unlikely to meet those of Ciba-Geigy plants, the company works with local manufacturers and reformulators to improve their environmental management practices and to help them upgrade their related capabilities. If a local third party consistently fails to perform according to a certain level of standards Ciba-Geigy will drop them.

However, in some cases where Ciba-Geigy has started with a formulator and there are a very limited number of other producers to make an agreement with, the economics sometimes over-rule the environmental considerations.

Safe manufacturing and product stewardship are to the fore in Ciba-Geigy's corporate policy in Thailand. When chemicals are delivered to third party operators, such as formulators, Ciba-Geigy takes back the empty drums or if they are unusable makes holes in them and ensures they cannot be used for other purposes such as storing water. Containers for the company's pesticides are dissolvable. Safety Data Sheets, translated into Thai, are used as a matter of routine when dangerous products or raw materials are handled in the course of production. Emphasis is placed on appropriate product usage and Ciba-Geigy staff work with client groups to educate them on safe handling practices. For pharmaceutical, agricultural and dye stuff products distributed by the distributing company, Diethelm, it is possible to track the products by use of serial batch numbers. It would be possible to recall any product in a short period of time.

General observations

Ciba-Geigy considers itself a ground-breaker on the environment. They were one of the first European corporations to set up an Issue Management Team on environment and if not the first, one of the very earliest to start direct negotiations with the environmental NGO community.

The company initiated a no-smoking rule in all its buildings from 1.1.93 and its fleet of 12 trucks have been fitted with an exhaust emission control device at a cost of Baht 150,000. Its fleet also uses Unleaded Gasoline (ULG), which has been on sale in Thailand since May 1991.

Profile: The Energy and Chemical Manufacturing Committee (ECMC) of the American Chambers of Commerce in Thailand

A number of TNC executives interviewed referred to the work of the ECMC of AmCham as the most effective and pro-active TNC initiative on the environment underway in Thailand. Members of the committee are reported to represent US companies accounting for between 60 and 70 percent of total US FDI in Thailand.

At the 19th meeting of the committee on January 7,1993, a position paper on Health, Safety and the Environment, was presented. The paper states that: "Member companies are committed to develop and support initiatives in Thailand in the areas of health, safety and the environment consistent with these principles."

The committee, with both senior Thai and foreign executives as representatives, has strong political, business and industrial connections which cover the entire spectrum of Thai society. For that reason the ECMC, which has impressive technical support and access to world leading expertise on health, safety and environment, must be viewed as a key vehicle for initiating and implementing environmental improvement programmes for Thai industry.

The ECMC also has sound contacts with the Federation of Thai Industries various industry' committees. In many ways, the make up of the ECMC, and its economic influence and bearing on various key market sectors, places it in a strong position to work directly with Thai industry possibly also in co-operation with international aid agencies, attempting to implement environmental improvement projects.