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Overseas Environmental Measures of Japanese Companies (Singapore)

Research Report on Trends in
Environmental Considerations related to
Overseas Activities of Japanese Companies
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Preface

Japanese companies operating extensively in Southeast Asian countries are expected to address environmental problems earnestly in their overseas business sites as well as at home. Environmental activities of Japanese companies implementing advanced environmental measures in overseas countries have attracted much attention of the world.

Under these circumstances, since fiscal 1996, the Japanese Ministry of the Environment has commissioned the Global Environmental Forum to conduct a research on trends in environmental considerations related to overseas activities of Japanese companies. The primary purpose of this research is to collect information and model examples that may help Japanese companies making their way to the Southeast Asian region in implementing environmental measures. The research was already conducted in the Philippines, Indonesia, Thailand, Malaysia, and Vietnam in each fiscal year of 1996, 1997, 1998, 1999, and 2001, respectively. The results were compiled as a guidebook on environmental measures for each of the countries. These guidebooks were distributed to a wide variety of relevant entities centering on Japanese companies that have business establishments in these countries for the purpose of providing them with environmental information.

This Report, the sixth in the series, presents the results of the research carried out in Singapore in fiscal 2002 on behalf of the Japanese Ministry of the Environment.

The reasons why Singapore was selected as the subject of the research in fiscal 2002 are multiple. One is the fact that the country is positioned third, after Thailand and Malaysia, among Southeast Asian countries in terms of the number of Japanese companies operating there. Further, in a study conducted by the Ministry of the Environment in fiscal 2000 under the title of the Study on Environment-friendly Corporate Activities, the third-largest number of Japanese companies operating in the Southeast Asian region indicated Singapore, only after China and Vietnam, as a country whose environment-related information needs to be collected and systematized more extensively in the future. Other reasons include the fact that particularly effective environmental measures are being implemented in Singapore in comparison to other countries in the region and that many Japanese companies have established regional headquarters there, which play a central role in the field of environmental management in this region.

In the future, it is expected that many Japanese companies continue to pursue active business operations in Singapore and play an important role as an engine for promoting the economic advancement of the country. We hope that the latest environmental information on Singapore compiled in this Report helps Japanese companies already operating there to implement better environmental measures and also serves as a useful reference material for many of those planning to start new business operations there. We further hope this report is helpful in advancing the policy measures against industrial pollution in the country.

We wish to express our sincere appreciation to the Japanese Chamber of Commerce & Industry, Singapore, and the Singapore Representative Office of Kanagawa Prefecture for their close cooperation extended to us. They kindly introduced us to Japanese companies for on-site surveys. We are grateful to personnel of Japanese companies located in Singapore, the Ministry of the Environment of Singapore, the National Environment Agency of Singapore, the Japan External Trade Organization (JETRO) and its Singapore Center, the Singapore Representative Office of the Development Bank of Japan, and various other organizations for their great assistance and guidance extended to our on-site surveys and information gathering despite their busy schedules.

Global Environmental Forum

Contents

■ How to Use This Book

This book consists of two chapters and appendices. Chapter 1 describes environmental issues the country now faces, and summarizes environmental laws and regulations in Singapore. Chapter 2 introduces examples where Japanese companies operating in Singapore are taking practical environmental measures. The appendices contain reference materials that help the reader to get a deeper understanding of Chapters 1 and 2. The term, Japanese companies, as used in this book refers to member companies of the Japanese Chamber of Commerce & Industry, Singapore, without regard to equity percentage invested from Japan or any other particular conditions. It should also be noted that since many of the Japanese companies who willingly responded to the on-site survey in this research are in the manufacturing sector, this book focuses on environmental measures seen in the manufacturing sector.

This book is so designed that each chapter, as well as each section under a chapter, is independent of the rest so as to allow the reader to access necessary environmental information according to the current state of the environmental measures being taken by the individual company. It should be noted that the names of the laws, regulations, and organizations cited in the text are tentative translations by the Forum.

More specifically, this book is organized as follows.

Chapter 1 provides the latest information on current environmental issues Singapore now faces and trends in its environmental laws and regulations. This chapter is divided into following seven sections.

Section 1: Singapore and Japanese Companies
Section 2: Current Environmental Issues in Singapore
Section 3: Environmental Policies and Legislation in Singapore
Section 4: Water Pollution Management
Section 5: Air Pollution Management
Section 6: Hazardous Industrial Waste Management
Section 7: Other Industrial Environmental Management

Section 1 introduces the relationship between Japan and Singapore and the history of the business activities by Japanese companies in Singapore, while Section 2 summarizes current environmental issues in Singapore in such areas as water pollution, air pollution, and wastes. The part of Section 3 through Section 7 precisely describes Singapore's environmental policies and legislation, administrative organizations, and information about the country's environmental laws and regulations in various fields. These are the information indispensable when Japanese companies are implementing environmental measures in Singapore.

To be more specific, Section 3 introduces the most important points in Singapore's environmental policies, governmental organizations for environmental administration, legislative systems related to industrial pollution, and environment-related procedures necessary for companies to go through when starting businesses in Singapore.

Sections 4 through 6 describe the structures of the laws and regulations and details of control levels in the three areas of water pollution, air pollution, and industrial waste. At the end of Chapter 1, Section 7 devotes pages to introducing other industrial environmental measures unique to Singapore.

The information given in Chapter 1 mainly represents the results of hearings conducted at the Environmental Protection Division of the National Environment Agency (NEA) under the Singaporean Ministry of the Environment (ENV).

In Chapter 2, Section 1 summarizes the features of the environmental measures implemented by Japanese companies operating in Singapore. It is followed by the introduction of 16 examples of pioneering approaches to environmental measures.

Section 2: Case Studies of the Regional Integration Function Manifested in the Environmental Field (3 examples)
Section 3: Case Studies of Voluntary Implementation of Advanced Environmental Measures (4 examples)
Section 4: Case Studies Applying Sophisticated Technology in Reducing Discharge of Pollutants (4 examples)
Section 5: Environmental Measures in New Business Development (5 examples)

As a wide variety of businesses are going on by Japanese companies in Singapore, examples of environmental measures collected during this survey are wide-ranging. In particular, we focused on Japanese companies that allocate their Singaporean operations as regional headquarters for Southeast Asia, and examples of their approaches are put together in Section 2. Examples of approaches taken by manufacturers, which are not limited to the measures for wastewater, waste gas, and other waste materials, but also include other types of positive approaches, are given in Sections 3 and 4. Examples of innovative approaches of those in non-manufacturing sectors and small-to-medium-scale companies for utilizing environmental measures for business expansion are introduced in Section 5.

Appendices at the end of the book carry the reference materials as follows.

Appendix 1: Environmental Pollution Control Act (EPCA)
Revised Edition 2000 (30th December 2000)
Appendix 2: Rg 5 Environmental Pollution Control (Trade Effluent) Regulations
Revised Edition 2001 (31.1.2001)
Appendix 3: Rg 8 Environmental Pollution Control (Air Impurities) Regulations
Revised Edition 2002
Appendix 4: Rg 11 Environmental Public Health (Toxic Industrial Waste) Regulations
Revised Edition 2000 (31.1.2000)
Appendix 5: Sources of Environmental Information in Singapore and Japan

Appendix 1 carries a Japanese translation of the full text (except Schedule) of the Environmental Pollution Control Act in order to help the reader to get a deeper understanding of the Act. Full-text Japanese translations of two regulations under the Act, namely the Environmental Pollution Control (Trade Effluent) Regulations and the Environmental Pollution control (Air Impurities) Regulations appear in Appendices 2 and 3, respectively. Appendix 4 carries a Japanese translation of the full text of the Environmental Public Health (Toxic Industrial Waste) Regulations under the Environmental Public Health Act (EPHA).

The exchange rate used in this book is 70 Japanese yen per Singaporean dollar prevailing as of January 2003.

In this book, names of government agencies, laws, and regulations frequently appearing in connection with environmental problems in Singapore are expressed by their acronyms as needed.

1. Government Agencies

ENV: Ministry of the Environment
NEA: National Environment Agency
MTI: Ministry of Trade and Industry
EDB: Economic Development Board
JTC: Jurong Town Corporation
SPRING: Standards, Productivity and Innovation Board
MND: Ministry of National Development
HDB: Housing & Development Board
URA: Urban Redevelopment Authority

2. Laws

EPCA: Environmental Pollution Control Act
EPHA: Environmental Health Control Act

Chapter 1
Overviews of Environmental Issues and Environmental Conservation Measures in Singapore

This chapter is divided into seven sections and provides basic information necessary for Japanese companies to implement appropriate environmental measures in Singapore.

Section 1 gives an outline of Singapore and a short history of the relationship between Singapore and Japan as well as the activities of Japanese companies in the country. Section 2 introduces current environmental issues facing Singapore. Section 3 gives an outline of Singapore's environmental policies, legislation, and the structure of governmental organizations for environmental administration.

Sections 4 through 6 introduce the structure and content of environmental laws and regulations in the areas of water pollution, air pollution, and industrial wastes, which are key environmental challenges for Singapore and also constitute indispensable factors to be taken into account when Japanese companies are implementing environmental measures. Section 7 provides information on noise and soil contamination control measures, and the regulation on Legionella bacteria in circulating water of cooling towers.

The Environmental Pollution Control Act (implemented in 1999 and last amended in 2000) is the basis for the environmental policy of Singapore. Appendix 1 carries its full text. Appendices 2 through 5 contain necessary portions of four pieces of environmental legislation deeply relevant to Japanese companies operating in Singapore.

Section 1
Singapore and Japanese Companies

1. Close relationship between Japan and Singapore centering on economic areas

Singapore, a Small Island Country the Size of Lake Biwa

The Republic of Singapore (hereinafter, Singapore) consists of a main island situated at the southern tip of the Malay Peninsula, extending 42 km from north to south and 23 km from east to west, and more than 60 islands. Its land area is expanding annually through reclamation of land from the sea, and as of 2001 stood at 682.3 km^2 (compared to 639.1 km^2 in 1991). The population is 4.13 million, including foreigners residing in the country for one or more years, and the ethnic composition is Chinese 76.7%, Malay 13.9%, Indian 7.9% and others 1.5%. Located 137 km from the equator, the country has a tropical maritime climate under the effect of monsoons. The climate is generally hot and humid with the average daytime temperature ranging between 24 to 32℃ and the average relative humidity of 80% throughout the year. There is no clear dividing line between the dry and rainy seasons, but the rainy season lasts approximately from November to February, when it is relatively cool and a little more bearable.

The designated national language is Malay, but as the diverse ethnic composition suggests, Chinese, Malay and Tamil are also used as official languages. Since English remains the main medium for business and public administration, the teaching of English is emphasized, and more than half of the Singaporean speak fluent English.

Since the independence from the Federation of Malaysia in 1965, Singapore has adopted a constitutional republic system of government. The parliament is unicameral with its member’s term of office of five years. The People's Action Party (PAP), formed by the former Prime Minister Lee Kuan Yew, now has 82 out of a total of 84 seats, serving as a ruling party. Hence, the political situation of the country is very stable.

Since 1819, when Thomas Stamford Raffles of the British East India Company landed in Singapore, the country had been under colonial rule by the United Kingdom for a long period of time, except for three years and half during the Second World War, when the country was a colony of Japan. In 1959, when Lee Kuan Yew took office as prime minister, Singapore acquired autonomy from the United Kingdom and became a self-governing state. Thereafter, when the Federation of Malaysia was formed in 1963, Singapore joined it as one of the self-governing states. When friction subsequently developed between Malaysia that gave preferential treatment to the Malaysian and Chinese-dominated Singapore, Singapore declared independence from the Federation on August 9, 1965 as the Republic of Singapore.

Singapore - The First Country With Which Japan Concluded a FTA

On November 30, 2002, a bilateral free trade agreement (FTA) between Japan and Singapore (officially referred to as the Japan-Singapore Economic Agreement for a New Age Partnership) went into effect. The fact that Singapore became the first country with which Japan signed a FTA indicates a close relationship between the two countries, especially in economic areas. This bilateral agreement is comprehensive arrangements for bilateral cooperation in various fields including not only liberalization of trade and investment and their promotion but also financing, information and communications technology, and human resources development in order to further strengthening the cooperation between the two countries in economic activities. Specifically, it calls for, among others, the abolition of customs duties on items accounting for more than 98% (in terms of value as of 2000) of the trade between the two countries; the computerization of trade documents; mutual recognition of occupational skills, including certifications issued in the counterpart country; more active exchanges of people; the liberalization of service trade in a broader range of sectors; the creation of an investment climate that enables investors of both countries to invest mutually more easily (including lifting the control on overseas remittance of funds); the sharing of various types of information, including that on patent examination. This FTA is expected to make the economic relationship between the two countries closer and help vitalize the two economies.

Business Activities of Japanese Companies Contributing to the Economic Development of Singapore

A noteworthy factor behind the establishment of the close economic relationship between the two countries was the business activities of many Japanese companies that started in the 1960s and became full-blown from

the late 1970s to the late 1980s. Particularly in the 1970s, as Japanese assembly manufacturers shifted their manufacturing operations into Singapore in quick succession, their suppliers of materials and parts and logistics-related firms followed suit. Besides the manufacturing sector, various other sectors, including trade, distribution, and commerce, also expanded their business activities in Singapore. These Japanese companies are considered to have made a great contribution to the development of Singapore into an industrially advanced country in the Asian region along with Japan and South Korea.

Singapore is geographically located in a core in the Asian region, and is equipped with advanced infrastructures necessary for business operations, including telecommunications, financial services, and physical distribution. The country also offers various tax benefits to investors. For these reasons, many Japanese companies, as well as multinationals in Europe and the United States, have formed local corporations in Singapore that function as regional headquarters. Most of the Japanese companies operate manufacturing or sales bases alone in other Southeast Asian countries. In contrast, most of the Japanese companies in Singapore are performing the functions of regional headquarters in the Southeast Asian region in varying degrees. Many of them are also playing a role of a model for doing businesses in overseas countries, including approaches to environmental measures.

High Economic Growth of Singapore Through Active Foreign Capital Introduction

The GDP of Singapore, standing at 2.15 million Singaporean dollars in 1960, reached 156 billion Singaporean dollars in 2002, a remarkable 70-fold increase in 40 years. With the GDP per capita reaching 37,400 Singaporean dollars (29,000 US dollars), the country achieved a high economic growth prominent in the Southeast Asian region. The country was suffering from trade deficits and unemployment rates of over 30% at the time of its independence in 1965, and yet achieved such a miraculous growth that is enough to qualify it to join the club of industrially advanced countries. This achievement owes a lot to the economic growth policy vigorously pursued under the leadership of Lee Kuan Yew and the administrative capability of the current prime minister, Goh Chok Tong, who succeed Lee Kuan Yew in 1990.

Under the economic policy, two main pillars of which are the principle of free trade, and the active foreign capital introduction (industrialization based on the introduction of foreign capital), the country opened its domestic market to the world without adopting restrictive trade policies in order to establish itself as an hub of trade ports, and actively invited foreign firms to set up their plants in the country. The national government set up the Economic Development Board (EDB), under which industrial estates were formed one after the other, while social infrastructures such as electricity, city gas, industrial water, and communications were built to ensure smooth operation of seaports, airports, and industrial plants thus attracted.

At the same time, the government endeavored to develop a financial market for promoting more brisk economic activities. In part because Malaysia and Indonesia gave the cold shoulder to people of Chinese origin, Singapore has attracted huge amounts of overseas Chinese capital and come to play a role of a financial center in Asia.

Singapore thus continued to maintain a high GDP growth, average rates of which in real terms were 9.4% in the 1970s, 7.4% in the 1980s, and 7 to 8% even in the 1990s.

Electronics and Chemical Sectors Supporting Singapore's Economy

In 1998, however, Singapore's growth rate in real GDP fell to a negative figure under the influence of decelerated economy within the region due to the Asian currency crisis of 1997. Thereafter, however, the recovery of the Asian economy, worldwide increase in demand for electronic products, and restored domestic consumption helped the country to resume high growth rates: 6.9% in 1999 and 10.3% in 2000.

The manufacturing industry has continued to have the largest influence on Singapore's economic growth. Currently, the electronics and chemical sectors constitute the backbone of the manufacturing industry in Singapore. As of 2002, the electronics sector accounted for 32.3% of the total value added in the manufacturing industry, and the chemical sector 23.8%. These two sectors’ combined share of over 50% in the manufacturing industry indicates their importance. In addition, these sectors accounted for 75% of the total

investment made by the manufacturing industry in 2002. Against this backdrop, almost all of the Japanese companies recently started businesses in Singapore belong to either of these two sectors. The Jurong Island chemical complex area hosts many industrial plants established by leading chemical manufacturers of Japan.

The growth rate in real GDP for 2002 was 2.2%, and its 2003 forecast ranges from 0.5 to 2.5%.

Singapore Aiming at Industrial Restructuring and Enhanced Functions as an Asian Hub Spot

Facing tough international competition with China and other countries, the Singaporean government has recently been introducing a series of new industrial policies for the 21st century, including those aiming at industrial restructuring.

In June 1998, the government of Singapore announced a new basic industrial policy entitled “Industry 21 Program.” This Program aims at turning the country into a place where technology- and information-intensive industries are concentrated and making it an Asian hub by helping businesses to enhance their functions as regional headquarters. Specifically, the Program focuses on six areas: (1) strengthening the foundation of the technology- and information-intensive industries, (2) developing world-class local enterprises, (3) pursuing technological innovation, (4) realizing an international business hub (strategic core), (5) inviting regional headquarters into the country, and (6) developing and accumulating human resources.

In January 1999, the Program’s targets for each industry and each industrial sector were also announced. Nine fields (electronics, petrochemical, life science, engineering, educational services, medical services, physical distribution, information, telecommunications and media, and regional headquarters services) were defined as strategic industries, accompanied by their respective visions and 2010 targets.

In addition, the Singaporean government has come out with the policy of developing industries related with life science (pharmaceuticals, medical equipment, agricultural biotechnology) as priority industrial sectors of the 21st century.

Furthermore, in connection with another plan to be pursued in parallel with the restructuring of the manufacturing industry, that is, to turn the country into an Asian business hub, the government has announced a program named “International Business Hub 2000.” This program is applicable to multiple fields such as regional headquarters operations, financial services, physical distribution, transportation, information and communications, electronic trading, international products trading, international conferences and trade shows, and cultural events and art festivals. The program aims at inviting multinational service enterprises to locate their regional headquarters in the country and building advanced, high-quality infrastructures. In support of the program, the Economic Development Board (EDB) uses its certification system for regional headquarters (RHQ) to offer tax and other benefits to certified firms according to the types of their regional headquarters operations. Three types of RHQ are designated: operational headquarters (OHQ), business headquarters (BHQ), and manufacturing headquarters (MHQ), and their respective requirements for certification and possible incentives are defined.

2. Large-scale entry of Japanese companies, mainly manufacturers, into Vietnam, beginning in 1994

A Large Share of Japanese Investment in Singapore

One of the reasons why Singapore, despite its small land area, small population, and limited natural resources, achieved the economic development prominent in the Asian region is the active introduction of funds and technology from Japan, Europe, and North America. In particular, Japanese companies, mainly those in the manufacturing industry, have played an important role through direct investment in the country, which began in earnest in the late 1970s. In addition, through technology transfer, they also supported Singapore's economic growth when the country was still in the developing stage.

The amount of direct investment by Japanese companies in the manufacturing industry of Singapore was 1,513 million S dollars (approximately 105.9 billion yen) in 2003 according to the Economic Development

Board (EDB) of Singapore.

The largest direct investor in the manufacturing industry of Singapore is the United States, followed by the EU. Japan is the third largest. The amount of direct investment from Japan, after peaking at 20.32 million S dollars in 1997, continued to decline, and it was surpassed by that of the EU in 2000, falling to the third place, due to the stagnation of the Japanese economy and other factors. However, the signing of the FTA between Japan and Singapore, earlier mentioned, is expected to contribute to increasing trade between the two countries. It will also help expand mutual investment between the two countries thanks to deregulation in the service sector such as transportation and physical distribution, so that the direct investment by Japanese firms will no doubt begin to rise again.

In terms of trade value, Japan is an important trade partner of Singapore along with Malaysia and the United States. In 2001, Japan was the fifth largest destination of export from Singapore (7.7% in share), and the third largest origin of import to the country (13.9% in share). Exports to Japan totaled 16.7 billion S dollars and imports from Japan 28.8 billion S dollars, resulting in a trade imbalance with Japan of 12.1 billion S dollars. Anyway, Japan accounts for very large shares in Singapore's international trade values.

Against these marked economic interchanges, Japanese residents living in Singapore as of 2002 numbered approximately 20,000, the majority of which were personnel of Japanese companies and their families. This figure is the second largest in the Southeast Asian region after about 22,000 Japanese residents in Thailand.

Drastic Change in Business Lines of Japanese Companies Operating in Singapore

Japanese companies that have hitherto worked as an engine for promoting the close economic relationship between the two countries totals 763, including representative offices in non-manufacturing sectors, according to the number of members of the Japanese Chamber of Commerce & Industry, Singapore. By line of business, about half of them (52%) are in the manufacturing sector, and the rest are in transportation and service (20%), international trade (13%), finance and insurance (7%), construction (6%). The number of Japanese companies incorporated in Singapore started to increase sharply in the first half of the 1970s and peaked at 173 in the later half of the 1980s. But in the 1990s, they started to decrease gradually. In fact, the number of members of the Chamber, after reaching a high of 833 in 1998, is decreasing, probably because Japanese companies, especially those in the manufacturing sector, are diversifying their operations into neighboring countries such as Malaysia, Thailand, and Indonesia. The shift of new business operations to China would be another reason. However, the number of member companies in Singapore is still the largest in the Southeast Asian region along with the corresponding one in Thailand, indicating brisk business activities of Japanese companies in Singapore.

Representative Japanese manufacturing companies operating in Singapore used to be assemblers of electrical appliances and audio-visual equipment, but because of their operations being relocated to neighboring countries of low labor costs, this position is now taken over by chemical and electronics businesses as mentioned earlier. This remarkable change has occurred in the past ten years or so. A factor especially contributing to the change occurred in 1995 when the Singaporean government, through the Jurong Town Corporation, a government affiliated industrial estate developer, began to claim land from the sea off the Jurong Island in an effort to accumulate petrochemical complexes in the Island and make it a large-scale petrochemical base in the Southeast Asian region. The Jurong Town Corporation actively invited related enterprises to locate themselves in the Island. In response, leading Japanese chemical manufacturers shifted their operations to the Island, and there are many of their plants located there, which started operations in the latter half of the 1990s.

JETRO conducts an annual survey of operations of Japanese manufacturers located in the Asian region. According to the 2001 survey conducted between November and December 2001, 135 Japanese manufacturers operating in Singapore responded. Their lines of business break down into electrical and electronic parts (23.0%), chemical and petrochemical products (17.8%), foodstuffs and processed agricultural and marine products (8.9%), metal products (7.4%), electrical machinery (7.4%), and plastic products (6.7%). The high share of electrical and electronic parts is similar to that in other Southeast Asian countries. Features of Singapore include a relatively high share of chemical and petrochemical products and the absence of fibers,

apparel, other textile goods, cars and motorcycles, reflecting the fact that labor costs in Singapore are too high for labor-intensive industries.

Future Development of Singapore

One fact often cited as the reason for Japanese companies to start businesses in Singapore is its highly developed social infrastructures that make up for rises in manufacturing costs, including wages. In the Asia-Pacific region, however, China (Shanghai and Beijing), Thailand, and Malaysia are rushing to improve the tax systems and infrastructures in order to follow the Singaporean pattern of economic development. These moves on other Asian countries will without doubt place Singapore in a difficult position for it to be selected as a new location of Japanese and other foreign companies. Nevertheless, according to surveys by international think tanks, Singapore ranks fifth in the world in terms of industrial competitiveness (a result announced by IMD, the International Institute for Management Development) and overtook Hong Kong to become the country offering the best business environment in the Asia-Pacific region (Country Forecast announced by EIU, the Economist Intelligence Unit). Doubtless, Singapore is an attractive place to invest in by international standards. The companies interviewed during this on-site survey also cited well-developed infrastructures, quality labor (high levels of technical skills, proficiency in English), the stability of the national government, the flexibility of the administration (bureaucracy) to meet the needs of the private sector as reasons for having selected Singapore as the place to invest in. In the future, Japanese companies will be required to conduct business activities fulfilling the expected functions of the technology- or knowledge-intensive enterprise or an international business hub, in line with the "Industry 21," the new basic industrial policy of the Singaporean government as mentioned earlier. On the other hand, in order to meet the competition with the expanding Chinese market, the Singaporean government will be required to further develop infrastructures in terms of both hardware and software while making the most of its advantages; the central location in the Asian region, and the existence of a huge market where 2.8 billion consumers live within the distance accessible in less than seven hours.

Section 2
Current Environmental Issues in Singapore

1. Successful simultaneous pursuit of economic development and environmental protection in Singapore

Singapore Maintaining Good Living Environment

Singapore has achieved high economic growth through the free trade policy and active introduction of foreign capital while successfully maintaining a favorable living environment. A recent annual report issued by the Ministry of the Environment (ENV) and the National Environment Agency (NEA), the latter being responsible for enforcing environmental legislation under the Ministry, state at its beginning as follows. "Singapore has succeeded in simultaneous pursuit of economic development and environment protection, providing people with a favorable living environment and a high-quality public health by the world's standards." This is a statement that praises oneself on its success in environmental management. Considering the fact that neighboring countries in the Southeast Asian region are suffering from serious environmental pollution caused by economic growth, Singapore is unique in this region in that it is developing the economy while maintaining a favorable living environment.

One reason for this success in environmental management is that Singapore has carried out various environmental policies proactively since the initial stage of rapid economic growth and industrialization. The country's environmental management policy consists of three strategies: pollution prevention, law enforcement, and environmental monitoring. Specifically, the pollution prevention measures include industrial location based on land utilization programs and the building and improvement of environmental infrastructures, including sewer systems and waste disposal facilities. The law enforcement measures include the improvement of environmental administrative organizations, tightening of environmental legislative control and the application of such tightened control to regulate industrial facilities and other sources of environmental pollution. The environmental monitoring measures include the establishment and operation of monitoring systems for air, water, and other environmental qualities. Singapore has implemented these measures in the past 30 years or so. The results of these measures are effectively combined into a comprehensive environmental approach, and this enables Singapore to maintain a favorable living environment.

New Approaches Toward Sustainable Society

Singapore's economic development has increased per capita national income and made mass-production, mass-consumption, and mass-generation of wastes common aspects of the people's lifestyles. These lifestyles, which reflect material affluence, are highly likely to impose environmental risks on Singapore, a small island country with few natural resources. In an effort to avoid these risks, the Singaporean government has started to take a next environmental management step to realize a sustainable society. To this end, the “Singapore Green Plan” was first formulated in 1992, which incorporated various strategies for realizing a sustainable society. The current version of the Green Plan, with 2002 as the target year, calls for further reduction of environmental loads from industry through the utilization of green technology and the development and promotion of environmental technology. The Plan aims at preserving the natural resources by measures such as (1) fresh water generation by desalination of seawater and reclamation of water from sewage with the latest technology, (2) promotion of reduction and recycling of wastes, and (3) the raising of energy efficiencies. Efforts have already been initiated toward these goals. At the same time, the government requires business enterprises to establish management systems that incorporate environmental consideration, and the general public to raise their environmental awareness. In order to help them with these efforts, various incentive programs are being implemented.

Unlike other countries in the Southeast Asian region, Singapore is equipped with necessary funds, technology, and administrative capacity and will continue to maintain a favorable living environment and improve its quality. However, the success so far achieved in environmental management was largely dependent on the strong initiative of the government. In contrast, for example, most of the general public has no practice of separating domestic garbage. Many challenges still remain to be met toward realizing a sustainable society.

The subsequent sections introduce three main environmental problems in Singapore - water pollution, air pollution, and wastes - as they now stand, and present an outline of the measures being taken against those problems.

2. Water pollution

Excellent Water Environment in Each Water Body

Singapore has been a country short of water resources, meeting half of its water demand by purchasing water from neighboring Malaysia, and is much interested in water environment. For this reason, preservation of water quality is given high priority in environmental administration, and active efforts are being made to build sewage facilities as well to implement effective wastewater control.

In order to monitor the water environment in Singapore, bodies of water are divided into three: the water catchment area, where there are rivers and ponds that are used as supply sources of drinking water; the non-water catchment area; and the coastal waters. Many water quality monitoring points are installed at these bodies of water to measure dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS) and the like at regular intervals. The 2001 evaluation of water quality against the water quality control targets in Singapore (for example, 10 mg/liter or less for BOD) produced very good results. 92% of the water samples taken from the water catchment area and 94% of those from the non-water catchment area met the BOD target. The results of measurement on DO, TSS and other items were similar. Seawater from the coastal waters, evaluated in terms of coliform groups, also gave a good result: over 90% of the samples met the target.

Building of Public Sewer systems Contributing to Maintaining Good Water Quality

The largest reason for the maintenance of good water quality is the progress made in the construction of public sewer systems. In Singapore, wastewater, both domestic and industrial, is treated basically in public sewer systems. There are now six sewage treatment plants. Sewage conduits extend over approximately 2,800 km. 489 million m^3 of sewage was treated in 2000. With expansion and improvement of the public sewer systems, and progress in laying sewage conduits, the amount of sewage treated is increasing annually. It increased by as much as 43% in the ten-year period from 1991. For further improvement of public sewer systems, a plan was drawn up to build a new sewage treatment plant in each of the eastern and western parts of the Singapore Island. Construction work of the deep tunnel sewer system, a new sewage conduit network for connecting with the new treatment plants, is already underway.

Industrial wastewater accounts for a large part of the loads contributing to water pollution, and is under thorough control by the Pollution Control Department (PC) of NEA. Industrial plants that may discharge acidic wastewater giving adverse effects on sewage facilities are obligated to install a pH meter at the exit of wastewater and a wastewater shutoff device interlocked with the meter. Plants located in an area where no public sewer system is available are placed under more stringent wastewater control than those discharging wastewater into public sewer systems.

3. Air pollution

Air Quality Management Also Remaining Good

Major sources of air pollutants in Singapore are stationary ones such as industrial plants, and mobile ones such as cars, but like water quality, air quality is also well under control.

In Singapore, a total of 17 air pollution monitoring stations are installed in the general living environment like residential areas and along roads, and air quality is constantly monitored. The 2001 results of measurements by these stations indicate that the concentrations of major air pollutants such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter (PM10) in the general living environment are well below the air environmental standards of the United States Environmental Protection Agency, which are also applied in Singapore. For example, the average annual value of SO_2 is 22 $\mu g/m^3$ compared to the American standard of 80 $\mu g/m^3$, and that of PM10, 20 $\mu g/m^2$ against 50 $\mu g/m^2$.

In order to control lead contained in exhaust gas from cars, measures for reducing it were implemented step by step beginning in 1983. In July 1998, a total ban on leaded gasoline was imposed. Thanks of the effect of this ban, the average annual concentration of lead for 2001 was very low at 0.1 $\mu g/m^3$ both in the general

living environment and along the roads.

The Pollutant Standards Index (PSI), developed by the U.S. Environmental Protection Agency and used by Singapore for the evaluation of air pollution, indicates "GOOD" for 305 days, 83% of the 365 days in 2001.

Unique Air Pollution Control Measures Proving Effective

Singapore has a detailed land utilization program and a unique policy of industrial location under this program. Firms in lines of business that may give large air pollution loads as well as large-scale industrial plants are ordered to locate in the industrial estates at the western edge of the Singapore Island or in the offshore reclaimed land areas to avoid adverse effects on the air quality in residential areas.

Thorough implementation of air pollution control measures at individual plants and obligated use of fuels of small environmental loads are also very effective at stationary sources of air pollutants. Another source of air pollutants, exhaust gas from cars, is dealt with by implementing stringent exhaust gas control on individual cars, modeled after the EU's exhaust gas control. In addition, this pollution source is indirectly dealt with by limiting the total number of cars through limited issuance of the Certificate of Entitlement (COE), a unique car purchase certificate system of Singapore, and also by limiting car traffic through the introduction of a road pricing scheme.

4. Waste

Annually Increasing Wastes

With greater industrial activity and rising national income, the volume of wastes generated in Singapore is annually increasing. Figures compiled by NEA indicate that the total volume of solid wastes generated in 2001 was 5,035,415 tons, of which 44.4% or 2,233,232 tons were recycled in some way. Remaining 2,802,183 tons are disposed of mainly by incineration. 42% of the 2.802,183 tons were industrial wastes, and remaining 58% were domestic wastes including those from commercial establishments.

Most of Wastes Disposed of by Incineration

In Singapore, wastes are disposed of mainly by incineration considering its small land area and economic cost. Four incineration plants, including the up-to-date Tuas South Incinerating Plant, are in operation. An additional one is being planned. At present, about 91% of the wastes incapable of recycling are disposed of by incineration. Final landfill disposal had been conducted at the Lorong Halus site. But since this site became full, a new offshore disposal site (Pulau Semakau Final Landfill Disposal Site) was constructed by means of reclaiming land from the sea between the islands of Pulau Semakau and Pulau Sakeng off the southwestern coast of the Singapore Island. In April 2000, the new site started to accept wastes incapable of incineration and incinerator ash generated at the four incineration plants. These waste treatment and disposal facilities have a treatment capacity exceeding annual 2.80 million tons of wastes generated in the country, and are capable of treating and disposing of all of this volume.

NEA operates and manages these treatment and disposal facilities. Private enterprises licensed by the Singaporean government collect wastes for delivery to these facilities.

In order to reduce, reuse and recycle wastes, the Singaporean government is implementing various incentive programs. In addition, it has begun to direct its efforts to the development of so-called Reverse Logistics industry that recycles wastes back to useful materials. The Singapore Green Plan, mentioned earlier, lists targets to be achieved by around 2012, which include (1) to raise the recycling rate from the present 44% to 60%, (2) to extend the usable years of the final landfill site at Pulau Semakau, now expected to be about 30 years, to 50 years, and (3) to delay the implementation of construction plans for incinerating plants.

Private Sector Responsible for Treating Hazardous Industrial Wastes

Issues related to hazardous industrial wastes can have a great effect on the activity of Japanese companies.

Laws and regulations of Singapore stipulate 26 categories of hazardous industrial wastes. Private enterprises licensed by the Singaporean government are responsible for the collection, transportation, treatment, and disposal of these hazardous industrial wastes. About 120 enterprises have acquired some form of business license for the treatment of hazardous industrial wastes. Some of them are engaged in transportation only, while there are several companies that perform all the operations up to final disposal under contract. All of the licensed enterprises have the capacity to handle hazardous industrial wastes as stipulated by applicable laws and regulations. Under normal circumstances, therefore, hazardous industrial wastes can be disposed of by contracting with these licensed enterprises.

According to data compiled by the government, the licensed enterprises collected and disposed of about 121,500 tons of hazardous industrial wastes in 2000.

Section 3
Environmental Policies and Legislation in Singapore

1. Singapore's environmental policies, and laws and regulations

(1) Development of environmental policies and their features

Land Utilization Program Playing an Important Role in Environmental Control

The rapid economic development and industrialization in the past 30 years or so have enabled Singapore to become one of the world's most advanced countries in economic terms. While doing so, the country was successful in maintaining a favorable living environment known as the "garden city." The successful simultaneous pursuit of economic development and environment protection is attributable to the fact that the country's environmental management policy has ingeniously combined the following three elements indispensable for environmental protection from the early stage of economic development: establishment of pollution prevention measures, enforcement of environmental laws and regulations, and environmental monitoring.

It goes without saying that the simultaneous pursuit has owed much to the enforcement of environmental laws and regulations, including the implementation of highly effective environmental rules as mentioned later, and the efficiency of environmental administrative organizations. The establishment of environmental monitoring systems has also played an important part. But the greatest role has been played by the national land utilization program, which was formulated considering environmental protection and implemented as part of the establishment of pollution prevention measures. This land utilization program zones the national land according to the purpose of utilization and has played the role of preventively eliminating adverse environmental effects of new development projects. The program requires new individual factory construction to undergo environmental investigation in advance. Based on the information thus obtained, locations of factories are thoroughly controlled. This mechanism incorporated in the program has been extremely effective for environmental protection. In addition, the proactive approach to the development of environmental infrastructures indispensable for preventing environmental pollution, including sewage and waste treatment plants, has been very useful in the maintenance of a good living environment.

The land utilization program is supervised by the Ministry of National Development (MND). The first master plan was formulated in the 1950s. The program, reviewed at regular intervals thereafter, precisely zones the national land into nature reserve, green zone, residential area, industrial area, and others according to the purpose of utilization. In each zone, it is prohibited to locate facilities other than those for the purpose specified for that zone. For the industrial area, a detailed location plan is drawn up for each factory according to its line of business, the degree of environmental loading, and the possibility of environmental pollution as determined through a prior environmental investigation. Factories with similar characteristics are located in a specified area. Thus, factories are included in the total picture of national land use, and are constructed in a manner that ensures environmental harmony with neighboring areas. In this way, even if a factory caused environmental pollution, the environmental effect would be limited.

When building a factory in Singapore, a parcel of national land must usually be borrowed from the Jurong Town Corporation (JTC, a government affiliated industrial estate development organization), the Housing and Development Board (HDB), or other agencies. Upon application for a building permit with one of these organizations, an investigation is conducted for possible environmental effects caused by locating the factory at a specific site. This environmental investigation is conducted under the guidance of the National Environment Agency (NEA). Based on the result of the investigation, the location of the factory is determined. For example, assembly or processing factories of small environmental loads are located in an industrial area near a residential area. Industries of large environmental loads such as oil refining and chemical plants are located in a place remote from a residential area, or in some cases, in an island off the mainland such as the Jurong Island. In this process, careful consideration is given to the characteristics of the line of business of a factory in question. For example, foodstuff and asphalt factories are not located next to each other.

Green Plan Giving Future Vision of the Environment

By effectively using these schemes, Singapore had almost completed implementing basic pollution control measures by the late 1980s. But in order to initiate new approaches to environmental problems for securing sustainable development, the country formulated the “Singapore Green Plan 2002” in 1992. This Plan was

triggered by the Earth Summit held by the UN Environmental Development Council in Rio De Janeiro, Brazil. Although it is not a piece of legislation, the Plan was intended to be the basis for environmental action programs to be implemented by Singapore for further improved environmental quality and sustainable development within the next ten years. The Plan gives numerical targets for each area of concern, including the protection of natural resources and the development of environmental technology, to show a future vision of the environment in the country. In 2002, the “Singapore Green Plan 2012” was formulated setting forth targets for the next ten years. The Plan presents a blueprint for environmental policy with 2012 as the target year. It includes numerical targets such as (1) to raise the recycling rate for all wastes from 44% to 60%, (2) to convert 25% of power plant fuels to natural gas, (3) to meet 25% of water demand by desalination and recycling of wastewater, and (4) to introduce advanced environmental technology for the environmental management of industry. In order to achieve these targets, various programs and incentive measures are currently being implemented.

Flexible Environmental Control Considering Effects on Industrial Activity

While implementing the above-mentioned very effective environmental control, Singapore, with economic development as an important national policy, is also taking flexible environmental measures that relax environmental control within certain frameworks, in order to prevent environmental control from stagnating industrial activity. For example, wastewater that does not meet the standard is supposed to require the installation of a wastewater treatment facility. However, for non-hazardous, organically polluted wastewater up to 4,000 mg/liter in biochemical oxygen demand (BOD) concentration, the standard may be exceeded by paying a surcharge according to the concentration exceeding the control limit. A similar economic solution is applied to wastewater exceeding the control limit for total suspended solids (TSS).

Moreover, in order to shorten the period required for the environmental investigation commenced on application for a building permit, it is made possible to obtain a permit to proceed to the design stage in about two weeks if there are no particular problems. The implementation of such environmental policy giving full consideration the effects on the industrial activity as well as those on the environment is a distinguishing feature of Singapore's environmental administration.

Another example of flexible approaches is that, when revising environmental legislation and wastewater standards, the authorities concerned frequently consult with the industry involved from the drafting stage. With the consent of the industry, the authorities proceed with the revision. This also indicates that Singapore attaches importance to the industrial activity in implementing its environmental policy.

Sophisticated Environmental Measures Implemented in Parallel With Economic Development

Singapore has succeeded in maintaining a good environment while steadily achieving environmental management goals and developing economically. This is a feature totally unlike in other Southeast Asian countries, where the priority is placed on economic development and environmental measures tend to be taken belatedly. Singapore has been successful in implementing sophisticated environmental policies. Various environmental measures as mentioned above have been taken in parallel with economic development from its early stage. Singapore's environment administration will continue to implement very effective environment control. At the same time, as described in the Singapore Green Plan 2012, the development and introduction of latest environmental technologies, including the green technology, is listed as one of the priority goals.

Since the latter half of the 1990s, the Singaporean government has been requesting private enterprises to establish environmental management systems such as those certified by ISO 14001, and extending assistance toward this end. This indicates that the government is shifting away from the old industrial environmental policy that aimed at achieving environmental protection through the administrative control to the new policy that intends to realize a sustainable society through voluntary, high-quality environmental action on the part of private enterprises.

(2) Singapore's Environmental Administrative Organization

Start of NEA in July 2002 for Prompt Response to Environment Problems

In Singapore, the Pollution Prevention Agency was formed in 1969, and the Ministry of the Environment (ENV) was established in 1972 for the purpose of providing a clean living environment and high-quality public health. For about 30 years since then, ENV has been in charge of actual operations of environmental policy and environmental control. In July 2002, the National Environment Agency (NEA) was split off from ENV for more stringent environmental control and more effective, prompt environmental management. Taking over part of the responsibility of ENV, NEA is now in charge of daily environmental control over air, water, and other pollution, public health, and waste treatment and disposal.

NEA was formed by merging the Environmental Policy and Management Division and the Public Health Division of ENV, and the Meteorological Division of the Ministry of Transpiration. NEA's operating budget is basically financed by subsidies from ENV and in this sense, it is subordinate to ENV. But NEA is a comparatively independent administrative organization in that it may distribute and execute its budget at its discretion. For this reason, national environmental administration has become more flexible than before when internal organizations of ENV were in charge and the budget was executed within the national framework. NEA is thus more capable of promptly responding to emergencies such as environmental accidents. Since the split-off of NEA, ENV has been in charge of making decisions on national environmental policies, including the formulation of the Green Plan as a national environmental program, and legislation and rules for environmental protection.

The scope of work of NEA is very broad, and includes the monitoring of the general living environment; implementation of various environmental control; management of environmental pollution control measures in the execution of development projects and construction of factories; operation and control of waste treatment facilities (incinerating facilities, landfill sites) and issuance of related permits; control of food sanitation; environmental cooperation with neighboring countries; and weather forecasting added as a new job. NEA consists of seven sub-organizations such as the Environmental Protection Division and the Environmental Public Health Division. NEA's present workforce totals about 3,000, including site workers of waste treatment facilities.

PCD in Charge of Actual Environmental Control

Of various sub-organizations of NEA, the Pollution Control Department (PCD), under the Environmental Protection Division, is influential in implementing industrial environmental measures. With about 130 personnel, PCD is basically the successor to the internal organization with the same name formed in ENV in 1986. Entire staff members of the previous organization were taken over by PCD, along with its scope of work, when NEA was set up. PCD's main jobs include actually implementing environmental control over stationary sources of pollutants, like factories, with regard to air and water pollution, hazardous industrial wastes and the like, and issuing related permits; and environmental assessment of new development projects and factory construction plans. For these jobs, the Inspectorate Unit and the Central Building Plan Unit are established in PCD.

The Inspectorate Unit conducts an on-site inspection of factories for waste gas, wastewater and other wastes discharged from them at regular and irregular intervals, and warns against or points out any violation or problem, instructing the factory in question to take appropriate action. It is also in charge of issuing a business license to firms engaged in collection and transportation of hazardous industrial wastes.

The Central Building Plan Unit investigates the degree of environmental loading of a planned factory and the content of its environmental measures upon application for a building permit for the factory, and determines whether or not to approve the environmental aspects of the construction plan.

The Engineering Service Department, under the Environmental Protection Division, is also in charge of the treatment, disposal, etc. of wastes and is closely related to industrial environmental measures. Its jobs include operation and management of four incinerating facilities for domestic wastes, like the latest Tuas South

Incinerating Facility, and waste treatment and disposal plants, like the final landfill site at Pulau Semakau, constructed off the southwestern coast of the Singapore Island; and issuance of business permits to collectors of domestic wastes. Incidentally, neither NEA nor PCD has their own regional offices or branch offices because of the small national land. Their personnel in the central office, grouped according to geographical areas, visit the factory in question for an on-site inspection or other work.

Figure 1-3-1 Organizational Structure of the National Environment Agency

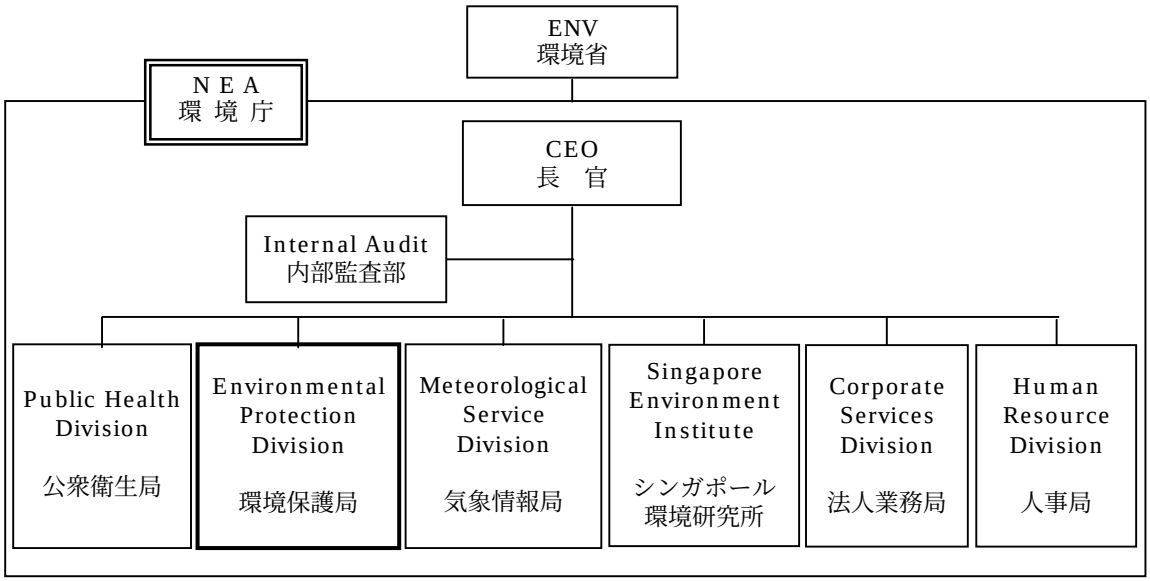


Figure 1-3-2 Organizational Structure of Environmental Protection Division

Environmental Procedure for Factory Construction Through JTC, Etc.

Other government agencies are also involved in environmental policy. In cooperation with the National Environment Agency (NEA), the Economic Development Board (EDB) introduces information on environmental control of Singapore to foreign investors. The Jurong Town Corporation (JTC) and the Housing and Development Board (HDB), both in charge of creating and operating industrial estates, serve as the point of contact through which the environmental aspects of the procedures for application for a building permit for a factory are performed. The Ministry of National Development (MND) and its subordinate

organization, the Urban Redevelopment Authority, formulate long-term land utilization programs and their detailed regional plans. The Public Utilities Board (PUB), under the Ministry of the Environment, is in charge of environmental infrastructures, such as public sewer systems and water supply facilities. The Ministry of Manpower holds jurisdiction over working environment control within factories. The Singapore Standards, Productivity and Innovation Board (SPRING), under the Ministry of Trade and Industry (MTI), provides private enterprises with various incentive programs for establishing environmental management systems.

Thus, in Singapore, NEA, operating mainly through the Pollution Control Department under it, plays the leading role in implementing environmental measures, in cooperation with other government organizations. NEA's administrative ability is so high that Singapore has become the only country in Asia, except for Japan and South Korea, that can ensure effective environmental control comparable to those of Europe and the United States.

(3) Environmental Legislative Control Over Industrial Pollution in Singapore

Environmental Pollution Control Act at the Center of Environmental Legislative Control

Singapore's system of legislation, based on that of its former colonial master country, the United Kingdom, consists basically of two main pillars; acts, formulated in each field as required, and their accompanying regulations, although detailed rules may be issued in the form of orders or notifications. Likewise, the subsystem of environmental legislation is rationally composed of acts and regulations under them. Although there is the Green Plan as mentioned earlier, Singapore has no basic environmental legislation incorporating ideals and overall policy for dealing with environmental problems, like the Basic Environmental Law in Japan or similarly positioned legislation that exists in other Southeast Asian countries.

Environmental control over industrial pollution is basically executed by applying the Environmental Pollution Control Act (EPCA), the Environmental Public Health Act (EPHA), and a number of regulations under them. Of these control measures, those over environmental problems, including air pollution, water pollution, wastes, and noise, are mostly executed by applying regulations based on EPCA. But attention also needs to be paid to the control executed by applying the Sewer and Drainage Act, the Sewerage and Drainage (Trade Effluent) Regulations under the Act, and the Environmental Public Health (Toxic Industrial Waste) Regulations under EPHA.

There is no legislation for environmental impact assessment in Singapore because the master plan for land utilization is drawn up and development work is performed under land utilization programs formulated based on the plan considering environmental balance.

There are no environmental standard indicating desirable levels in the general living environment. For example, in order to evaluate air quality in the general living area, standards of the World Health Organization (WHO) and the US Environmental Protection Agency are applied.

Table 1-3-1 Environmental Legal Documents

Legal Documents on Environmental Pollution Control
Environmental Pollution Control Act (Chapter 94A) (Revised Edition 2000)
Rg 4 Environmental Pollution Control (Hazardous Substances) Regulations
Rg 5 Environmental Pollution Control (Trade Effluent) Regulations
Rg 8 Environmental Pollution Control (Air Impurities) Regulations
Environmental Public Health Act (Chapter 95) (Revised Edition 1999)
Rg 11 Environmental Public Health (Toxic Industrial Waste) Regulations
Sewerage and Drainage Act (Chapter 294) (Revised Edition 2001)
Rg 5 Sewerage and Drainage (Trade Effluent) Regulations

Implementation of EPCA Unifying Environmental Legislation

The Environmental Pollution Control Act (EPCA), the mainstay of environmental control, was enacted in April 1999 to unify environmental legislation established in individual environmental fields in the 1970s, including the Clean Air Act, the Water Pollution Control and Drainage Act, and the Poison Act. EPCA is primarily intended to implement control over air pollution, water pollution, noise, and hazardous chemical substances, and carries penal provisions, and provisions for the issuance of various permits, and scopes of authority of environmental government agencies. Under EPCA, supplemental regulations were established stipulating specific standard control values and the like. There are nine regulations that are deeply related to industrial pollution controls. They include the Environmental Pollution Control (Air Impurities) Regulations, the Environmental Pollution Control (Trade Effluent) Regulations, the Environmental Pollution Control (Hazardous Substances) Regulations, and the Environmental Pollution Control (Boundary Noise Limits for Factory Premises) Regulations.

EPCA also has provisions for so-called “Scheduled Premises” in connection with air pollution prevention. Facilities in fourteen lines of business are designated as scheduled premises, which include cement and asphalt plants of large environmental loads. In order to build such facilities, NEA's permit is required in addition to going through other ordinary environmental procedures. The permit is issued based on detailed information on environmental measures to be taken. In connection with soil pollution, which has recently become an issue in Japan, EPCA also includes one statement that "if a tract of land is polluted or is likely to be polluted, the Minister may formulate a regulation for controlling such pollution." At present, there is no specific regulation that controls soil pollution. But the Code of Practice on Pollution Control, to be described later, carries a requirement for controlling soil pollution in anticipation of future regulations on the matter.

After the implementation of EPCA in 1999, the Environmental Pollution Control (Air Impurities) Regulations were revised in 2001. At present, the Environmental Pollution Control (Trade Effluent) Regulations, which contain standards for wastewater discharged to the environment other than public sewer systems, is under revision.

Sewerage and Drainage Act and Subsequent Drainage Regulations Also Playing Important Roles

Other than the Environmental Pollution Control Act (EPCA), the Sewerage and Drainage Act and the Sewerage and Drainage (Trade Effluent) Regulations under the Act are the most important legislation for industrial pollution control. They give acceptance standards, etc. for wastewater discharged into public sewer systems as mentioned earlier. Public sewer systems are extensively installed all over the country so that almost all industrial wastewater is discharged into public sewer systems. Therefore, in practice, almost all industrial wastewater is controlled by applying the Sewerage and Drainage Act and the Regulations under the Act.

Hazardous industrial wastes are controlled by applying the Environmental Public Health (Toxic Industrial Waste) Regulations formulated under the Environmental Health Control Act (EPHA). This is because wastes and their collection and disposal had long been controlled under the Public Health Act, and hazardous industrial wastes alone remained to be regulated within the framework of the Environmental Health Control Act (EPHA) even after the enactment of EPCA.

While these Acts and Regulations are not under jurisdiction of the Ministry of the Environment (ENV), actual work based on them is conducted by the Pollution Control Department (PCD) of ENV, and the important role played by it in Singapore cannot be ignored.

Control on Legionella bacteria in cooling towers is regarded as an environmental control unique to Singapore. This control has been implemented based on EPHA since 2001, and intends to prevent the multiplication of Legionella bacteria in circulating water of cooling towers commonly used in various factories for air conditioning or in manufacturing processes. Factories are obligated to establish structural and maintenance standards for cooling towers and to measure circulating water of cooling tower for Legionella bacteria at regular intervals. Many of the Japanese companies visited during this survey have complied with this obligation.

Statements in the Code of Practice on Pollution Control That Need Careful Consideration

For the convenience of users of legislation, reference materials named Code of Practice are published in Singapore. These materials summarize and explain various pieces of legislation relevant to a certain field. Its environmental version is the Code of Practice on Pollution Control. These materials are prepared to help the reader to get a better understanding of regulative measures spanning several acts and regulations, and as such they are by no means either an act or regulation itself. It should be noted, however, that certain statements in the Code of Practice may in effect become virtual regulations, obligating factories to comply with such statements as guidelines.

The Code of Practice on Pollution Control explains pollution prevention requirements as well as various pieces of legislation relating to environmental permits and approvals. With regard to wastewater control, for example, it explains various regulations related to wastewater spanning the Environmental Pollution Control Act (EPCA) and the Sewerage and Drainage Act, and makes them easily understandable. But as mentioned above, some of the statements in the Code are applied as virtual regulations.

For example, a PH meter is installed at many factories immediately upstream of the wastewater exit for constant water quality monitoring. However, the obligation to install a PH meter is mentioned only in the Code of Practice on Pollution Control. For soil pollution, on which there exist no legislative regulations, the Code of Practice on Pollution Control has an independent section on soil pollution control where investigation and restoration procedures for soil pollution are described.

(4) Environmental Procedures Required of Companies Starting Businesses in Singapore

Prompt Processing of Environmental Procedures

To go through environmental procedures is necessary when factories or other facilities are to be constructed in Singapore. This section explains the flow of environmental procedures on a representative case in which a factory is going to be constructed on a tract of land borrowed through the Jurong Town Corporation (JTC), the most common government affiliated organization for building and operating industrial estates.

The environmental procedures start with entering basic environmental information in the application form for the construction of a factory, for submission to JTC. Pieces of information required include the manufacturing process of the planned factory, raw materials to be used, and the types and amounts of environmental pollutants and wastes that may be generated. Upon receipt of it, JTC forwards the application form to relevant administrative agencies. The Pollution Control Department (PCD) of the National Environment Agency (NEA) conducts an investigation on the environmental aspects of the construction plan in question on the basis of the information provided in the form. If the information so provided proves to be insufficient, PCD may require the applicant to provide additional information. Based on the results of the environmental investigation, PCD determines in view of the environmental aspects of the plan whether or not to permit the construction of the factory in Singapore. No permit is issued to a planned factory that (1) may discharge a large amount of wastes, (2) may use or discharge a large amount of water, a valuable resource for Singapore, or (3) may discharge harmful wastes incapable of treatment in Singapore.

Once the permission to locate the planned factory in Singapore is given, an examination is conducted to determine the specific location of the factory considering the line of business, the degree of expected environmental loading and other conditions. Normally, light industries with little environmental loads such as software development and assembly of electrical machinery, are located in industrial estates near residential areas; general industries of medium environmental loading such as electric plating in industrial estates away from residential areas; and heavy and chemical industries in places far away from residential areas or in a reclaimed land off the coast.

At the design stage of the planned factory, PCD presents the applicant with various requirements on the environmental aspects of the construction plan, including the installation of pollution control systems, their treatment capacity, and applicable emission and discharge standards. At the same time, if hazardous wastes may be discharged, or hazardous chemical substances may be used, PCD requires the applicant to acquire a

necessary permit for their storage and transportation. If PCD decides that the applicant can built a factory meeting PCD's requirements, PCD asks the applicant to submit a detailed design and construction plan of the factory to check the compliance with PCD's requirements and conditions on the environment aspects. Once approval is given on the environmental aspects by PCD and then on the non-environmental aspects by other relevant government agencies, the applicant is given a building permit for the planned factory.

On completion of the factory, PCD verifies that environmental control equipment and the like are installed as required by PCD, and then issue an operating permit to the applicant. After the start of operation of the factory, PCD conducts an on-site inspection of the factory to check the environmental control equipment and confirm its operating conditions, etc.

The same procedures as described above apply also when the application is made through a government agency other than JTC, namely, the Housing and Development Board (HDB) or the Urban Redevelopment Authority (URA). PCD investigates and determines the environmental aspects of the application in these cases as well. These procedures are processed as promptly as possible. It normally takes about two weeks from the submission of the application to the start of factory construction.

Pollution Control Study Required of Large Factories

Before constructing a large-scale factory, it may be required to conduct a pollution control study or a quantitative risk assessment of chemical substances to be used there, taking more time in the environmental procedures.

In the case of the scheduled promises under the Environmental Pollution Control Act (EPCA) mentioned earlier, the applicant also needs to provide the Ministry of the Environment (NEA) with detailed information such as the manufacturing process, the pollution control equipment to be installed, and the control methods for hazardous chemical substances, and needs to obtain an environmental permit from the Chief Executive Officer (CEO) of NEA.

Section 4
Water Pollution Management

1. Water problems and water pollution management in Singapore

Maintenance of Good Water Quality in Need for Water Supply

The implementation of effective industrial wastewater control, careful water quality monitoring, and progress in building public sewer systems are contributing to maintaining a good water quality in public bodies of water, like rivers and reservoirs, in Singapore, a country with limited land area, where water resources are valuable and of strong concern of the people. Half of the water supplies in Singapore are taken in from reservoirs scattered around the country and several rivers. The remaining half depends on raw water purchased from neighboring Malaysia. With the expiration of part of the long-term water purchase agreement with Malaysia in 2011, negotiations about water price between the two countries are currently encountering difficulties, making it a matter of urgency for Singapore to secure water resources without relying on Malaysia.

Therefore, considering increased water demand attributable to economic development and increased population, the Singaporean government is working on the development of additional water resources toward realizing self-sufficient water supply. Measures to be undertaken include the construction of additional reservoirs and new rainwater storage facilities, introduction of the latest technology for seawater desalination, and recycling of wastewater. As part of these endeavors, in February 2003, the government started to mix tap water with recycled water known as the “NEWater”, water obtained through membrane treatment of processed sewage. Under these circumstances, the maintenance of a good water quality in public bodies of water, including reservoirs as existing valuable water sources, is becoming increasingly important.

Building of Public Sewer Systems as a Main Measure for Controlling Water Pollution

Water quality control in Singapore are mainly based on two measures: (1) the prevention of pollution through building public sewer systems and (2) the strict enforcement of regulations for making industrial wastewater comply with the applicable wastewater standard. Of the two, the building of public sewer systems has become a particularly important. In Singapore, industrial and domestic wastewater basically needs to be discharged into public sewer systems. Aiming at a 100% diffusion rate, their building is well underway. As of 2000, six treatment plants and sewage conduits extending over approximately 2,800 km were completed, where 489 million m^3 of sewage was treated annually. The amount of treated sewage represented a 1.4-fold increase compared to 10 years ago (1991). At present, work is underway to enlarge or remodel existing treatment plants. At the same time, in order to consolidate existing sewage treatment facilities and build more advanced public sewer systems, the deep tunnel public sewer system is being constructed.

In order to avoid the risk of water pollution, restrictions are imposed on the use or storage of large quantities of chemical substances in a water catchment area, where reservoirs or other water resources are located.

A large number of sampling points are installed along reservoirs, rivers, watercourses, and seas to monitor water quality. At sampling points in a water catchment area, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS), etc., are measured at regular intervals. Thus, a system for monitoring water for abnormalities is well established.

Two Sets of Regulations Indicating Wastewater Standards

In the Singaporean legislation relating to water pollution control, there are two sets of regulations. One is the Environmental Pollution Control (Trade Effluent) Regulations, under The Environmental Pollution Control Act (EPCA). The other is the Sewerage and Drainage (Trade Effluent) Regulations, under the Sewerage and Drainage Act.

These two sets of regulations contain wastewater standards that give large effects on the activities of Japanese companies. Of these two, the Environmental Pollution Control (Trade Effluent) Regulations (under the Environmental Pollution Control Act) are applied where wastewater is discharged into watercourses and the like other than public sewer systems. The Sewerage and Drainage (Trade Effluent) Regulations (under the Sewerage and Drainage Act) are applied where wastewater is discharged into public sewer systems. The

Environmental Pollution Control (Trade Effluent) Regulations (under the Environmental Pollution Control Act) contain two levels of wastewater standards. One is for discharging into general watercourses. The other is for discharging into controlled watercourses, from which tap water is taken in. One of these wastewater standards is thus applied to factories depending on where their wastewater is discharged, requiring factories to treat their wastewater to below the applicable control limit before discharging. This in turn requires them to install wastewater pre-treatment equipment within their premises.

Wastewater standards become more stringent when wastewater is discharged into (1) public sewer systems, (2) general watercourses, to which the Environmental Pollution Control (Trade Effluent) Regulations (under the Environmental Pollution Control Act) are applied, and (3) controlled watercourses, to which the Environmental Pollution Control (Trade Effluent) Regulations (the Environmental Pollution Control Act) are applied, in this order. As mentioned earlier, Singapore has a well-developed network of public sewer systems and almost all factories of Japanese companies are located in industrial estates connected with public sewer systems. For this reason, the Sewerage Drainage (Trade Effluent) Regulations (the Sewerage and Drainage Act), containing the most lax wastewater standard among the three, are usually applied to the factories of Japanese companies.

Waste Water Control Under Jurisdiction of the Pollution Control Department (PCD)

In order to ensure that wastewater standards are complied with, the government regulator, or the Pollution Control Department (PCD) of the National Environment Agency (NEA), requires factories to submit reports on water quality measurements at regular intervals, and also conduct an on-site inspection of factories frequently. For factories that may discharge acidic wastewater, or those that are large in scale of operation, it is mandatory to install a pH meter just upstream of the wastewater exit for constant pH monitoring of wastewater. They are also required of installing a device capable of cutting off wastewater discharge when any abnormality is detected. All these steps taken by PCD help ensure the effectiveness of wastewater control.

It should be noted, however, that there is no clear legislative specification as to which of the maximum 36 items covered by the wastewater standards are applicable to a specific factory, or what is the frequency of submission of reports on water quality measurements. Also, the need to install a pH meter is not stipulated anywhere in regulations. All these matters seem to be determined by PCD at its discretion on the basis of the result of the environmental investigation conducted upon application for a building permit.

At present, the work is underway to revise the wastewater standards stipulated under the Environmental Pollution Control (Trade Effluent) Regulations (under the Environmental Pollution Control Act), which are applied when wastewater is discharged into general watercourses or controlled watercourses where tap water intake is.

2. Wastewater control over factories

Different Wastewater Standards Depending On Where It Is Discharged

Table 1-4-1 compares wastewater standards applied to industrial wastewater in Singapore with the uniform wastewater standards applied nationwide in Japan. This table puts together three different sets of wastewater standards applied in Singapore according to where wastewater is discharged, for comparison with Japanese ones. These values are stipulated in the Environmental Pollution Control (Trade Effluent) Regulations, under the Environmental Pollution Control Act, and the Sewerage and Drainage (Trade Effluent) Regulations, under the Sewerage and Drainage Act. These values are upper limits allowable in wastewater. The number of control items differs according to where wastewater is discharged; 36 items for discharging into controlled watercourses from which tap water is taken in, 35 items for general watercourses, and 31 items for public sewer systems.

As used in the regulations, general watercourses refer to those that flow into the sea; controlled watercourses are those used to take in raw water for drinking; and public sewer systems are those into which wastewater is directly discharged. Most of the control items agree with Japanese ones, but include items that are not included in Japan such as chlorine (free), nickel, and tin. Conversely, although not listed in this table, Japanese wastewater standards include more than ten control items that are not included in Singapore such as

organo-chloric compounds. One of the three sets of wastewater standards is applied according to where wastewater is discharged. About 80% of the factories of Japanese companies visited during this survey are subjected to the wastewater standards applied to wastewater discharged into public sewer systems. Part of the factories, namely those facing the sea, are subjected to the wastewater standards applied to wastewater discharged into general watercourses. None of them is subjected to those for wastewater discharged into controlled watercourses.

Table 1-4-1 Industrial effluent standards in Singapore and Japan [1)]

(Unit: mg/liter where not otherwise indicated)

No	Items	Singapore			Japan[3)]
		Types of watercourse for wastewater			
		Public Sewer	General watercourse	Controlled Watercourse[2)]	
1	Temperature (℃)	45	45	45	-
2	Colour/ (Lovibond Units)	-	7	7	-
3	pH Value/pH	6 - 9	6 - 9	6 – 9	5.8 - 8.6 (Other than sea) 5.0 - 9.0 (Sea)
4	BOD_5 (20℃)	400	50	20	160 (Daily average:120)
5	COD (Cr method)	600	100	60	160 (Permanganate method) (Daily average:120)
6	Total Suspended Solids	400	50	30	200 (Daily average:150)
7	Total Dissolved Solids	3,000	2,000	1,000	-
8	Chloride (as chloride ion)	1,000	600	400	-
9	Sulphate (as SO_4)	1,000	500	200	-
10	Sulphide (as sulphur)	1	0.2	0.2	
11	Cyanide (as CN)	2	0.1	0.1	1.0
12	Detergents (linear alkylate sulphonate as methylene blue active substances)	30	15	5	-
13	Grease & Oil Grease & Oil (Hydrocarbon) Grease & Oil (Non-hydrocarbon)	- 60 100	10 - -	5 - -	5
14	Arsenic	5	1	0.05	0.1
15	Barium	10	5	5	-
16	Tin	10	10	5	-
17	Iron (as Fe)	50	20	1	10
18	Beryllium	5	0.5	0.5	-
19	Boron	5	5	0.5	10(Other than sea 230(Sea)
20	Manganese	10	5	0.5	10
21	Phenolic Compounds (expressed as phenol)	0.5	0.2	Nil.	5
22	*Cadmium	1	0.1	0.01	0.1
23	*Chromium (Ⅵ & Ⅲ)	5	1	0.05	Ⅵ: 0.5 Total 2.0
24	*Copper	5	0.1	0.1	3
25	*Lead	5	0.1	0.1	0.1

26	*Mercury	0.5	0.05	0.001	0.005
27	*Nickel	10	1	0.1	-
28	*Selenium	10	0.5	0.01	-
29	*Silver	5	0.1	0.1	-
30	*Zinc	10	1	0.5	5
31	Metals marked with * in total	10	1	0.5	-
32	Chlorine（Free）	-	1	1	-
33	Phosphates (as PO_4)	-	5	2	16 (as P)
34	Calcium (as Ca)	-	200	150	-
35	Magnesium (as Mg)	-	200	150	-
36	Nitrate (as NO_3)	-	-	20	100 [4)]

1) Environmental Pollution Control (Trade Effluent) Regulations, 2001
Analysing methods are defined in accordance with Standard Methods for the Examination of Water and Wastewater, USA.
2) Controlled watercourse means the watercourse within the area of water-intake.
3) Excerpt from the Directive of the Prime Minister's Office for setting effluent standards (1993 Directive No. 54 Table 1, 1993 Directive No. 40 Table 2)
4) (NH_3-N×0.4 + NO_2-N + NO_3-N) ≦ 100 mg/liter

Stringent pH Value Control in Wastewater

Factories discharging wastewater are obligated to control the quality of wastewater by measuring at regular intervals and report the result to the Pollution Control Department (PCD). The items to be measured are designated by PCD according to the manufacturing process of the factory in question, the types and quantities of chemicals used, the amount of wastewater discharged, and others. For the factories visited during this survey, the measuring items range from 9 to 36, the maximum number that may be designated by PCD. The frequency of reporting is also varied from factory to factory, ranging from once a month to once several months. Some small-to-medium-sized factories that discharge only a small amount of wastewater are not required to report at all.

The control limit of pH is 6 to 9 regardless of where wastewater is discharged, but very stringent pH value control is being carried out. Many of the factories visited during this survey are made to install a pH meter and an automatic shutoff valve interlocked with the meter just upstream of the wastewater exit of the factory. PCD explains that this requirement is for preventing acidic wastewater with a substandard pH value from promoting corrosion of the sewer pipe and piercing through it, which results in wastewater leakage and soil contamination. This mechanism is such that when the pH meter senses an abnormal value, the shutoff valve automatically stops the flow of wastewater. The pH meter is sealed by PCD so that other than personnel of PCD may take out the recording chart from the meter. It should be noted, however, that all the factories are not necessarily obligated to install a pH meter and an automatic shutoff valve. PCD determines whether or not they need to be installed on the basis of the types of chemicals used by the factory in question, the characteristics and quantity of wastewater discharged, etc. Some old factories are equipped with a manual shutoff device.

Unique Arrangements under which Paying Trade Effluent Tariff enables the Company to Exceed Wastewater Standards for Public Sewer System

Specific standards for wastewater discharged into public sewer systems, into which Japanese companies commonly discharge their wastewater, are discussed below. Since the wastewater standards for discharging into public sewer systems in Singapore is relatively lax, it is meaningless to compare them with the uniform wastewater standards in Japan that are applied to discharging into public waters. Therefore, control items specified in Singapore but not in Japan are discussed below, pointing out problems with them.

The wastewater standards of Singapore set the control limit for Total Dissolved Solids at 3,000 mg/liter for wastewater discharged into public sewer systems. However, when acidic or alkaline wastewater commonly discharged from factories is neutralized, the salt concentration necessarily increases, and hence the dissolved solid concentration as well, which easily exceeds 3,000 mg/liter. The salt thus formed is sodium chloride (NaCl), sodium sulfate (Na_2SO_4), or other similar substances. These substances are contained in seawater at a

level of some 35,000 mg/liter in total and are not hazardous at all. Some of the factories visited during this survey are not meeting this control limit, but by explaining to PCD the reason why these substances are generated and the fact that they are not hazardous, they are allowed to continue operating. During this survey, we questioned responsible personnel of the National Environment Agency (NEA) about this matter. Already being aware of the unreasonableness of this control limit, they responded that they are going to revise it. For a similar reason, the control limits of 1,000 mg/liter for chloride ion and 1,000 mg/liter for sulphate ion are unreasonable.

A unique feature of the wastewater standards for discharging into public sewer systems is the fact that the control limits for biochemical oxygen demand (BOD) and total suspended solids (TSS) may be exceeded by paying a charge called Trade Effluent Tariff. Table 1-4-2 shows the concentration in wastewater discharged and the corresponding amount of trade effluent tariff to be paid.

Table 1-4-2 Outline of the concentration of wastewater discharged into public sewer systems and the amount of trade effluent tariff

Concentration（mg/liter）	Trade effluent tariff (S dollars/m^3)	
	BOD	TSS
400 – 600	0.21	0.15
601 – 800	0.42	0.3
In between, the trade effluent tariff gradually increases with every increase of 200 mg/liter.		
3,801 – 4,000	3.78	2.7

For example, even when the BOD concentration in wastewater discharged into public sewer systems exceeds the designated control limit of 400 mg/liter, the factory in question can discharge it by paying only 0.21 S dollars per m^3 of wastewater if the BOD concentration is less than 600 mg/liter. This trade effluent tariff scheme is applicable up to 4,000 mg/liter. It is not allowed to exceed this limit under any circumstances. In other words, wastewater exceeding this limit must be treated for reducing the concentration to a level below the limit. The BOD concentration in wastewater from factories may vary in an amplitude greater than 200 mg/liter from day to day. To make the matter more difficult, it takes five days to measure BOD. Therefore, it is difficult to precisely track the variation in the wastewater quality. In practice, it appears that total oxygen demand (TOD) values automatically obtained by a TOD meter are converted to BOD values for controlling BOD. None of the factories of the Japanese companies visited during this survey are using this tariff scheme, and no details are known as to what kind of control is being conducted. Responsible personnel of NEA explained that, while wastewater pre-treatment equipment shall be installed in principle, the tariff scheme is an economic solution that allows factories to discharge wastewater exceeding a control limit into public sewer systems if they pay a trade effluent tariff according to the concentration level. The NEA personnel added that the amount of the trade effluent tariff is based on extra costs incurred for treating such wastewater discharged. A similar trade effluent tariff scheme is also in effect for TSS.

Very Stringent Wastewater Standards for General Watercourses on Some Control Items

Next, wastewater standards for discharging into general watercourses are compared with the uniform standards of Japan, since the purposes of these standards are almost the same in both countries. Generally, the control limits in Singapore are almost at the same levels as those in Japan, but some of the values in Singapore seem to be too stringent and almost unreasonable. Some control items used in Singapore are not adopted in Japan.

The control limit of Chemical Oxygen Demand (COD) is set at 100 mg/liter, more stringent than Japan's 160 mg/liter. This limit is more stringent than it appears because different measurement methods are specified in both countries. In Japan, oxidation reaction with potassium permanganate is used to find the amount of oxygen required for oxidation (COD_{Mn}), while in Singapore, oxidation reaction with potassium dichromate is used for the same purpose (COD_{Cr}). Since potassium dichromate is more oxidative, the Singaporean method

gives a higher analysis value for the same sample. Though varying from sample to sample, the COD_{Cr}-based value is about 2.5 times the COD_{Mn}-based value. This means that the Japanese control limit of 160 mg/liter is equivalent to about 400 mg/liter as determined by the Singaporean method. As a result, wastewater treatment equipment meeting Japan's COD control limit would not work in Singapore if it were brought into the country without modification.

The combined control limit for heavy metals indicated by asterisk at the head of each name in Table 1-4-1 is very stringent at 1 mg/liter. Zinc is included in these heavy metals. It is an amphoteric metal that dissolves not only in an acidic solution but also in a strong alkaline solution. Because of this property, wastewater treatment equipment must be operated while controlling the pH within a very narrow range in order to treat zinc as water-insoluble hydroxide and decrease its concentration to below 1 mg/liter.

Wastewater Standards Determined in a European and American Manner

Countries in Europe and North America set their wastewater standards at concentration levels that can be achieved by the Best Available Technology (BAT). In contrast, Japan first sets environmental standards for the general environment and then, taking into consideration the diluting effect and natural purification, determines the control limits that can meet the environmental standards. For example, in Japan, degradation by microorganisms in nature is taken into consideration before the control limit for total nitrogen is set at 120 mg/liter. In contrast, many Western countries set the corresponding control limit at about 10 mg/liter that can be achieved by using oxidation treatment or other technology.

Singapore sets a stringent control limit of 1 mg/liter for free chlorine in its wastewater standards for general and controlled watercourses, following the examples of Western countries, where chlorine, a very harmful substance, is subjected to stringent control. In Japan, where there are no signs of environmental pollution caused by chlorine, the element is neither an item of control nor that of monitoring. Japanese people, accustomed to the odor of chlorine used to sterilize tap water and swimming-pool water, are puzzled by such stringent limits. As long as Singapore controls wastewater on the basis of the Western thinking, Japanese companies operating in the country must basically meet such limits.

Section 5
Air Pollution Management

1. Air pollution management in Singapore

Control Measures for Pollution Sources Producing Effects

As well as for water pollutant control, Singapore has succeeded in controlling air pollutants. All the concentrations of main air pollutants, such as sulfur dioxide (SO_2), nitrogen oxides (NOx), ozone (O_3), and particulate matter (PM10), are below the corresponding long-term targets of the World Health Organization (WHO) and the control limits of the Air Environmental Standards of the United States Environmental Protection Agency (USEPA). The 2001 evaluation according to the Pollutant Standards Index (PSI), developed by USEPA, gave a "Good" rating to 83%, and an "Average" rating to 17%.

Singapore's air pollution control measures are based on two basic principles: (1) to minimize the generation of air pollutants at their sources, and (2) to minimize the effect of any air pollution arising from industrial location. Possible sources of air pollutants in Singapore include stationary sources, like factories and power plants, and mobile sources, like cars and outdoor incineration of wastes. Measures against the stationary sources include the designation of the site of a plant according to a detailed land utilization program, thorough implementation of air pollution control, and compulsory use of fuels of small environmental loads. Measures against car exhaust gas include control on individual cars and the limitation of total traffic of cars. To verify the effect of these measures against car exhaust gas, air pollution monitoring stations equipped with telemeters are installed at seventeen locations for constant monitoring of air quality in the general environment.

Measures Against Stationary Sources Implemented under the Environmental Pollution Control (Air Impurities) Regulations, Etc.

Specific control measures over stationary sources of air pollutants, like factories, are implemented in accordance with the Environmental Pollution Control Act (EPCA) and the Environmental Pollution Control (Air Impurities) Regulations under the Act. The Regulations contain, among others, emission standards for 23 air pollutants. The predecessor of the Regulations is the Clean Air (Standards) Regulation, in effect since 1978, which was revised as a supplement to EPCA in 2000 when EPCA took effect, to become the Regulations.

These pieces of legislation prohibit factories to emit black smokes (soot and dust) and make it mandatory for them to limit air pollutants below the emission standards. For compliance with these emission standards, factories are required to install, operate, and manage air pollution control equipment in an appropriate manner and to check their exhaust gas at regular intervals. In addition, factories with equipment of a certain size or larger (2,300 kg/hour or more in generated steam in the case of boiler heating equipment) are obligated to make a constant measurement of soot and dust by installing a smoke density meter.

To ensure the implementation of these air pollution measures, the Pollution Control Department (PCD) of the National Environment Agency (NEA) conducts an on-site inspection of factories at regular intervals. Upon receipt of a complaint or the like about air pollution, a surprise on-site inspection is conducted. On the basis of the results of these inspections, the analysis facility of the Ministry of the Environment determines where the factory is in violation of the relevant legislation. In 2001, 28,432 factories were subjected to regular inspections and at 627 factories, the inspectors measured exhaust gas, or soot and dust, or analyzed fuels used.

Obligation to Use Fuels of Low Environmental Loads Playing a Great Role

In reducing the emission of sulfur dioxide, the policy of obligating factories and the like to use fuels of small environmental loads has become a major pillar of the country's air pollution control.

Specifically, factories located in industrial estates are obligated to use fuel oils with a sulfur content of less than 1%. Factories located in the industrial estates of the Jurong Island or the Tuas district, where refineries, chemical plants and other facilities of large environment loads are concentrated, must use clean fuels such as natural gas. Factories near residential areas must use city gas or diesel fuel with a sulfur content of 0.05% or less. Thus fuels to be used are designated in detail.

Industrial facilities of large environmental loads that fall under the category of Scheduled Premises in accordance with the Environmental Pollution Control Act (EPCA) are required to implement more stringent environmental measures. These facilities must obtain environmental permits from the CEO of the National Environment Agency (NEA) prior to the operation of their facilities. An environmental permit generally contains many conditions attached to it such as the installation and operation of pollution control equipment, measurement and recording of waste gas emissions, and use of particular kinds of fuels. They are obligated to meet these conditions.

Control on Car Traffic Volume Producing an Indirect Effect

Another large source of air pollutants is car exhaust gas. Measures for controlling exhaust gas on individual cars have been strengthened in stages. Car owners are required to check exhaust gas from their cars at regular intervals. In January 2001, when the car exhaust gas control was strengthened, the EU's car exhaust gas standards (for gasoline-powered cars, for example, the standards of EC Directive 96/69/EEC) started to be applied to new gasoline- or diesel-powered cars. In July 1998, a total ban on the use of leaded gasoline was imposed. In order to reduce the exhaust gas from diesel cars, starting in March 1999, the permissible sulfur content of diesel fuel was lowered from 0.3 to 0.05 weight percent.

Unique indirect contributors to mitigating air pollution by cars in Singapore are the limitation of the total number of cars owned, and the restriction of traffic volume of cars through the road pricing scheme, under which cars entering urban districts are required to pay a fee.

Originally started as a measure to reduce traffic-jam, these two policies are contributing to air pollution control as well, through reducing the number of traveling cars and thus the amount of car exhaust gas generated. In order to control the total number of cars owned, the issuance of a Certificate of Entitlement (COE) that is necessary for car registration is limited to regulate the number of registered cars in Singapore. This scheme was started in 1990. COE prices are determined by bidding and very high. As a result, the total amount of expenses and various taxes associated with purchasing a new car is several times higher in Singapore than in Japan. Thus, this scheme has an effect of restraining the growth in the number of cars owned.

The road pricing scheme is also known as the Electronic Road Pricing (ERP) system. Cars in Singapore are usually equipped with an on-board device into which a prepaid card is inserted, and each time such car passes through an urban district where ERP is in place, a specified amount of fee is electronically withdrawn from the card.

Outdoor incineration of wastes is prohibited in accordance with the Environmental Pollution Control (Prohibition on the Use of Open Fires) Order under any circumstances.

As of 2001, 17 air pollution monitoring stations were installed across Singapore, of which 14 stations are for monitoring air quality in the general living environment and 3 stations for monitoring air quality along roads. All of them use a telemeter to send measured data to the Strategic Planning and Research Department (SPRD) of the National Environment Agency (NEA).

2. Waste gas emission control on factories

Emission Standards Approximately at the Same Level as in Japan

As mentioned earlier, air pollution control on factories is implemented in accordance with the Environmental Pollution Control Act (EPCA) and the Environmental Pollution Control (Air Impurities) Regulations under the Act. Promulgated in 2000 by revising its predecessor, the Clean Air (Standards) Regulations, the current Environmental Pollution Control (Air Impurities) Regulations were implemented in January 2001. The waste gas emission standards are as listed in Table 1-5-1. The standards started to be applied on new facilities on January 2001. Existing facilities were granted a grace period of 3 years.

The Environmental Pollution Control (Air Impurities) Regulations have more control items than the Japanese

Air Pollution Control Law. Comparison between the same control items indicates that the control limits are almost at the same levels, except for some items. Discussions below focus on the control items not included in the Japanese standards and those on which more stringent standards are imposed than in Japan. Also, actual measures taken by the Japanese companies visited during this survey are introduced.

For benzene, the control limit is set at 5 mg/Nm^3, which is extremely stringent compared with the Japanese limit ranging from 100 to 1,500 mg/Nm^3. To meet this limit, chemical factories handling benzene are taking various measures to prevent its leak. For carbon monoxide (CO), the control limit is set at 625 mg/Nm^3. No such limit is stipulated in Japan, where only a guideline value for ensuring complete combustion at waste incinerators is specified as a part of the measures to reduce dioxins from these facilities. In the factories visited during this survey where CO is necessarily contained in their waste gas emission, combustion equipment for CO is installed at the exit of the smokestack.

Some Difficult Cases in Dioxins Control

For dioxins, the control limit is set at 0.1 ng-TEQ/Nm^3 for all facilities that started operation in January 2001 or later. This limit is also extremely stringent compared with the Japanese control limit ranging from 0.1 to 5 ng/Nm^3 depending on the type and size of the facility. The emissions of dioxins vary according to the type and size of the facility such as an electric furnace or aluminum melting furnace. It would not be easy to meet the control limit of 0.1 ng-TEQ/Nm^3 without fail. Some administrative measures to relax the control limit for dioxins will be desired, especially for a small facility, which is limited in emissions and of small environmental loads.

For nitrogen oxides (NOx), the control limit is set at 700 mg/Nm^3 (about 330 ppm) for all factories, which is very stringent for some factories compared with the Japanese limit ranging from 120 to 1640 mg/Nm^3. To meet this limit, the diesel engine generator, for example, must be equipped with catalytic denitrification equipment or the like, and this is not a realistic solution for small factories. Fortunately, however, because of the stable power supply in Singapore, there are almost no factories visited during this survey where on-site power generation is required.

Particulate Matter Control Through Emission Allowance Trading

For particulate matter, the control limit of 100 mg/Nm^3 is applied under a unique administrative scheme not available in Japan. When there are more than one source of this matter within the same premises, the limit is deemed met so long as the combined amount of particulate matter generated, divided by the number of sources, is not in excess of 100 mg/Nm^3, provided, however, that the amount from the largest source does not exceed 200 mg/Nm^3. This scheme is a kind of emission allowance trading based on the same concept known as the "bubble" policy in the United States. Under this scheme, the factory may use equipment capable of removing dust at high cost only to keep dust concentration just below 200 mg/Nm^3 while using equipment capable of removing dust at low cost to remove a large quantity of dust. In this way, the factory can keep the total dust-removing cost low. Thus, the environmental control cost is reduced by taking advantage of this scheme.

For particulate matter, factories with boiler heating equipment larger than a certain size are also obligated to make a constant measurement of smoke by installing a smoke density meter to monitor the generation of black smoke (soot and dust). For equipment generating 2,300 kg/hour or more of steam, smoke must constantly be monitored to ensure that it passes the Ringelmann No.1 standard. One of the factories visited during this survey has a monitoring television set to visually monitor the smoke from the smokestack 24 hours a day from the control room.

Possible to Meet Sulfur Oxide Control Limit by Using Fuels of Small Environmental Loads

For sulfur oxide, the emission control limit is set at 100 mg/Nm^3 in terms of sulfur trioxide (SO_3), unlike in Japan, where it is set in terms of sulfur dioxide (SO_2). In Singapore, two types of fuel oil are commercially available: one that is desulfurized to a sulfur content of 1% or less, the other to 0.05% or less. The former is

used by factories or the like located in industrial estates, on condition that flue gas desulfurization equipment is installed. General factories near residential districts are obligated to use the latter, which can meet the control limit of 100 mg/Nm^3 when combusted. Natural gas, liquefied petroleum gas, and other fuels of small environmental loads are also becoming widely used in the country, and it is not difficult to meet the emission control limit by using one of these fuels.

Table 1-5-1 Effluent Standard for Industrial Plants

Country / Substance	Singapore [1]		Japan [2]
(a) Ammonia and ammonium compounds	Any trade, industry or process	76mg/Nm^3 expressed as ammonia	-
(b) Antimony and its compounds	Any trade, industry or process	5mg/Nm^3 expressed as antimony	-
(c) Arsenic and its compounds	Any trade, industry or process	1mg/Nm^3 expressed as arsenic	-
(d) Benzene	Any trade, industry or process	5mg/Nm^3	100 - 1,500 mg/Nm^3 [3] [3)]
(e) Cadmium and its compounds	Any trade, industry or process	3mg/Nm^3 expressed as cadmium	1.0mg/Nm^3
(f) Carbon monoxide	Any trade, industry, process or fuel burning equipment	625mg/Nm^3	-
(g) Chlorine	Any trade, industry or process	32mg/Nm^3	30mg/Nm^3
(h) Copper and its compounds	Any trade, industry or process	5mg/Nm^3 expressed as copper	-
(i) Dioxins and furans	Any waste incinerator	(i) 1.0ng TEQ/Nm^3 for waste incinerators commissioned before 1st Jan 2001 (ii) 0.1ng TEQ/Nm^3 for waste incinerators commissioned on or after 1st Jan 2001	0.1 - 5ng TEQ/Nm^3 [3] [3)]
(j) Ethylene oxide	Any trade, industry or process	5mg/Nm^3	-
(k) Fluorine, hydrofluoric acid or inorganic fluorine compounds	Any trade, industry or process	50mg/Nm^3 expressed as hydrofluoric acid	1.0 - 10 mg/Nm^3 [3] [3)]
(l) Formaldehyde	Any trade, industry or process	20mg/Nm^3	-
(m) Hydrogen chloride	Any trade, industry or process	200mg/Nm^3	80,700 mg/Nm^3 [3] [3)]
(n) Hydrogen sulphide	Any trade, industry or process	7.6mg/Nm^3	-
(o) Lead and its compounds	Any trade, industry or process	5mg/Nm^3 expressed as lead	10 - 30mg/Nm^3 [3] [3)]
(p) Mercury and its compounds	Any trade, industry or process	3mg/Nm^3 expressed as mercury	-
(q) Oxides of nitrogen	Any trade, industry, process or fuel burning equipment	700mg/Nm^3 expressed as nitrogen dioxide	120 - 1640 mg/Nm^3 [3] [3)]
(r) Particulate substances including smoke, soot, dust, ash, fly-ash, cinders, cement, lime, alumina, grit and other solid particles of any kind	Any trade, industry, process, fuel burning equipment or industrial plant (except for any cold blast foundry cupolas)	(i) 100mg/Nm^3 ;or (ii) where there is more than one flue, duct or chimney in any scheduled premises, the total mass of the particulate emissions	30 - 250 mg/Nm^3 [3)]

		from all of such flue, duct or chimney divided by the total volume of such emissions shall not exceed 100mg/Nm^3 and the particulate emissions from each of such flue, duct or chimney shall not exceed 200mg/Nm^3 at any point in time (iii) Ringelmann No.1 or equivalent opacity (Not to exceed more than 5 minutes in any period of one hour)	
(s) Styrene monomer	Any trade, industry or process	100mg/Nm^3	-
(t) Sulphur dioxide (non-combustion sources)	Any trade, industry or process	500mg/Nm^3	
(u) Sulphur trioxide and other acid gases	The manufacture of sulphuric acid	500mg/Nm^3 expressed as sulphur trioxide. Effluent gases shall be free from persistent mist.	-
(v) Sulphur trioxide or sulphuric acid mist	Any trade, industry or process, other than any combustion process and any plant involving the manufacture of sulphuric acid	100mg/Nm^3 expressed as sulphur trioxide	Sulphur dioxide ・K value regulation[4)] ・Fuel concentration regulation ・Total emission regulation
(w) Vinyl chloride monomer	Any trade, industry or process	20mg/Nm^3	-

1) The Environmental Pollution Control (Air Impurities) Regulations,
Code of Practice on Pollution Control (2000 Edition) (with amendments in Feb 2001 and Jun 2002)
2) Excerpt from Air Pollution Control Law
3) depending upon type and scale of a facility
4) $q = K \times 10^{-3} He2$ q : permitted SO_2 Nm^3/hr
K-value (= 1.17 at Tokyo area) He: correct height of outlet (m)
He2 = Ho + 0.65 (Hm + Ht) Ho: height of outlet (m)
$Hm = (0.795(Q \cdot V)1/2/(1+2.58/V)$ Q: volume of exhaust gases at 288 k (m^3/sec)
$Ht = 2.01 \times 10^{-3} \cdot Q \cdot (T-288) \cdot (2.30 \log J+1/J-1)$ V: velocity of exhaust gases (m/sec)
$J = 1/(Q/V)1/2 \cdot (1460-296 \times V/(T-288))+1$ T: temperature of exhaust gases (k)

Section 6
Hazardous Industrial Waste Management

1. Hazardous industrial waste management in Singapore

Waste Management Action Required in Singapore

In Singapore, where many petrochemical plants and the like are located, large quantities of hazardous industrial wastes are generated. For this reason, stringent legislative control is imposed on hazardous industrial wastes, and their control measures have become one of the indispensable actions of environmental measures for Japanese companies. Hazardous industrial wastes include sludge generated from wastewater treatment, toxic metals, and rags soaked with hazardous organic solvent. Legislative control on these wastes is implemented in accordance with the Environmental Public Health (Toxic Industrial Wastes) Regulations under the Environmental Public Health Act (EPHA). The Act is under jurisdiction of the Ministry of Health (MOH), but various control measures, issuance of business licenses and other jobs under the Regulations are done by the Pollution Control Department (PCD) of the National Environment Agency (NEA).

26 Categories of Hazardous Industrial Wastes

The Environmental Public Health (Toxic Industrial Wastes) Regulations divide wastes designated as hazardous industrial wastes into 25 categories, as shown in Table 1-6-1. Most of these industrial wastes so stipulated fall under the Japanese category of specially controlled wastes. The Regulations include responsibilities of generators of hazardous industrial wastes, responsibilities of entities collecting, transporting, storing, treating, disposing of, and otherwise dealing with them, application procedures for a business permit required of such entities dealing with them, and precautions to be taken by such entities in transit.

Table 1-6-1 List of hazardous industrial wastes

Acids	1. Spent inorganic acids. Eg. Hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, hydrofluoric acid, boric acid and pickling acid. 2. Spent organic acids. Eg. Acetic acid, formic acid, benzoic acid and sulphonic acid
Alkali	1. Spent alkaline solutions 2. Spent ammoniacal solutions 3. Metal hydroxide sludges and oxide sludges
Antimony and its Compounds	1. Spent antimony potassium tartrate
Arsenic and its Compounds	1. Timber preservative residues containing arsenic 2. Waste containing gallium arsenide
Asbestos	1. Asbestos wastes from asbestos/cement manufacturing processes 2. Empty sacks/bags which have contained loose asbestos fibre
Chromium Compounds	1. Plating effluent and residues containing chromium 2. Timber preservative residues containing chromium 3. Spent and aqueous solutions containing chromic compounds 4. Tannery effluent and residues containing chromium
Copper Compounds	1. Plating effluent and residues containing copper 2. Spent etching solutions containing copper from printed circuit board manufacturing 3. Timber preservative residues containing copper
Cyanides	1. Plating effluent and residues containing cyanides 2. Heat treatment residues containing cyanides 3. Spent quenching oils containing cyanides 4. Spent processing solutions containing cyanides from photographic processing
Cadmium and its Compounds	1. Plating effluent and residues containing cadmium 2. Wastes containing cadmium from Ni/Cd battery manufacturing
Isocynates	1. Spent di-isocyanates. Eg. toluene di-isocyanate (TDI) and methylene di-isocyanate (MDI) from polyurethane foam-making process

Laboratory Wastes	1. Obsolete laboratory chemicals 2. Toxic chemical wastes from chemical analysis
Lead Compounds	1. Sludges containing lead oxide/sulphate 2. Spent organo-lead compounds. Eg. tetraethyllead (TEL) and tetramethyllead (TML) 3. Waste lead-acid batteries, whole or crushed
Mercury and its Compounds	1. Effluent residues or sludges containing mercury from chlor-alkali industry 2. Wastes containing mercury from equipment manufacturing involving the use of metal mercury 3. Spent catalysts from chemical processes containing mercury 4. Spent organo-mercury compounds
Metal Catalysts	1. Spent metal catalysts from chemical processes and petroleum refining. Eg. Catalysts containing chromium cobalt
Nickel Compounds	1. Plating effluent and residues containing nickel
Fluoride Compounds	1. Timber preservative residues containing fluorides 2. Spent ammonium bi-fluoride
Organic Compounds containing Halogen	1. Spent halogenated organic solvents. Eg. trichloroethylene, 111-trichloroethane, perchloroethylene, methylene chloride tetrachloromethane and 112-trichloro-122-trifluoroethane 2. Residues from recovery of halogenated organic solvents 3. Packaging materials or residues containing chlorobenzenes and/or chlorophenols and their salts
Organic Compounds not containing Halogen	1. Spent non-halogenated organic solvents. Eg. benzene, toluene, xylene, turpentine, petroleum, thinner, kerosene, methanol, ethanol, isobutanol, isopropanol, methyl ethyl ketone, methyl isobutyl ketone, isopropyl either, diethyl ether, hexane, dimethyl sulphide and dimethyl sulphoxide 2. Residue from recovery of non-halogenated organic solvents
Pathogenic Wastes	Pathogenic wastes from hospitals
Phenolic Compounds	1. Sludge/residues from paint stripping using chemicals containing phenols 2. Residues containing unreacted phenol and formaldehyde from adhesive industry
Polychlorinated Bi-phenyl (PCB) including Polychlorinated Ter-phenyl (PCT)	1. Spent transformer oil containing PCB and/or PCT 2. Retrofilled transformer contaminated with PCB and/or PCT 3. Electrical equipment and parts containing or contaminated with PCB and/or PCT. Eg. capacitors and transformers 4. Containers and all waste materials contaminated with PCB and/or PCT
Polyvinyl Chloride（PVC）	1. All waste materials containing PVC. Eg. PVC insulated wires, PVC pipes and trunking, PVC parts, PVC upholstery and PVC resins
Silver Compounds	1. Spent processing solutions containing silver from photographic processing
Used, Contaminated Oil	1. Used mineral, lubricating and hydraulic oil from machine cylinders, turbines, switch gears and transformers 2. Spent motor oils from petrol and diesel engines 3. Spent quenching oil from metal hardening 4. Oil recovered from solvent degreasers 5. Spent oil water emulsions. Eg. Spent coolants from metal working industries 6. Oil water mixtures (mainly oil).

	Eg. Oily ballast water from ship tankers 7. Oil and sludge from oil interceptors 8. Tanker sludges and oil sludges/residues from storage tanks 9. Oil sludges containing acid from recovery and recycling of used oil
Zinc Compounds	1. Plating effluent and residues containing zinc
Other Wastes	1. Obsolete/abandoned chemicals and pesticides from storage, manufacturing and trading activities 2. Used containers, bags and process equipment contaminated by chemicals and pesticides from storage, manufacturing and trading activities 3. Wastes/residues containing unreacted monomers. Eg. vinyl chloride and styrene monomers, from polymer manufacturing processes 4. Tar residues from distilling and tarry materials from refining 5. Wastes from toxic waste treatment processes. Eg. wastes and residues from solidification, fixation and incineration processes 6. Wastes from toxic chemical drums and tank cleaning activities 7. Chemical and oil slops from ship tankers 8. Wastes from the production, formulation and use of resins, latex, plasticisers, glues/adhesives containing solvents and other contaminants. 9. Wastes from the production, formulation and use of links, dyes, pigments, paints, lacquers, varnish containing organic solvents, heavy metals or biocides.

Entire Treatment by Private Enterprises

In Singapore, it is basically recommended that hazardous industrial wastes generated in factories be recycled or reused within the factory. Treatment and disposal of those wastes incapable of recycling or reusing are consigned to private enterprises with business licenses to do so. There are no municipal treatment and disposal facilities, and private enterprises with business licenses handle everything from collection and transportation to treatment and disposal. As of 2001, some 120 enterprises were granted business licenses for the treatment and disposal of hazardous industrial wastes. Business licenses are classified by type of operations such as transportation, physicochemical treatment, and incineration, and are issued for each type of waste that may be accepted by the enterprise in question. Some are engaged in collection and transpiration only. Of the total of about 120, five enterprises or so are integrated ones performing all operations up to the final treatment and disposal.

The statistics for 2000 indicate that the licensed enterprises collected about 121,500 tons of hazardous industrial wastes, of which 70% were reused after recycling treatment. Remaining 30% were disposed of at the final landfill site at Pulau Samekau, built off the coast of the Singapore Island. Only those stabilized by physicochemical treatment are disposed of at a landfill site. Ash generated in the incineration process is subjected to leaching tests to check the stability. Unstable ash is mixed with cement, and the mixture is stirred until solidify. Thereafter, its stability is checked again. In a leaching test, the mixture of ash and cement is stirred in water maintained at a weak acidic pH for a fixed time and then the water is analyzed to check the level of leaching. This test is conducted in accordance with the United States standard (Testing Method 1331).

For hazardous industrial wastes discharged by factories or the like, an on-line manifest system is established to monitor them through all the stages from collection to final deposal. All records made under this system are placed under the control of the Pollution Control Department (PCD).

In Singapore, PCBs, chlorobenzene, and other chlorine compounds cannot be treated, and they are collected and transferred to Germany or other countries for treatment.

Necessary Consideration for the Environmental Pollution Control (Hazardous Substances) Regulations

In Singapore, in addition to the above-mentioned control measures on hazardous industrial wastes, control on hazardous chemical substances is implemented in accordance with the Environmental Pollution Control (Hazardous Substances) Regulations under the Environmental Pollution Control Act (EPCA). The Regulations correspond to Japan's Poisonous and Deleterious Substances Control Law, and control the handling of chemical substances, including their manufacturing, importing, storing, transporting, using, and labeling. In operating a factory in Singapore, the Regulations need to be considered.

During this survey, we had an opportunity to visit a representative treatment firm for hazardous industrial wastes in Singapore. Below is an outline of this firm's treatment facility.

2. A representative treatment facility for hazardous industrial wastes in Singapore

(1) Outline of the facility

We visited a treatment facility for hazardous industrial wastes to which many Japanese companies consign the treatment of such wastes. The facility, located in the Tuas district at the western edge of the Singapore Island, started operations in 1997. It is an integrated operator extending from collection and transportation to incineration and disposal of substances discharged from various types of factories that fall under the category of hazardous industrial wastes such as oil-stained rags, waste oils, heavily polluted water, and sludge resulting from wastewater treatment. In Singapore, individual treatment (transportation) firms often performed only a single operation, like treatment of waste oils alone, treatment of wastewater alone, or transportation alone. But the facility was established as an integrated operator capable of all kinds of waste treatment at a single site.

Major equipment includes incinerators, physicochemical treatment equipment, and solvent recovery equipment. These pieces of equipment and the treatment technology used at this facility were imported from an environmental engineering company and a hazardous industrial waste treatment company in Japan. The representatives of this facility toured factories in the same line of business in Europe and the United States prior to constructing their facility, and selected the latest equipment. The total capacity is 500 tons/day. 20 to 30% of the wastes treated at this facility are from Japanese companies operating in the country. Of the total treatment volume, 150 tons/day consist of paper, lumber, glass, aluminum, iron, and other substances of monetary value, and are separated for recycling. The number of personnel is 80, and the lot area is 3.5 hectors.

The treatment volumes by waste type are as shown in Table 1-6-2.

Table 1-6-2 Treatment volumes by waste types

（Unit: t/month unless otherwise indicated）

Waste type	Wastewater	Waste solvent	Waste oil	Heavy metal waste	Acid waste	Alkali waste	Solid waste	Empty containers（pieces）
Amount	2,200	2,700	2,000	120	380	300	7	140,000

The firm operating this facility is affiliated with a recycling firm and an energy recovery firm. These three firms cooperate with each other to do an integrated environmental business. A Japanese engineering company has a stake in the holding company of the three.

(2) Procedure for processing an order for treatment

Upon receipt of an inquiry from a customer, the facility first asks the customer to send samples of the waste in question for chemical analysis. On the basis of the analysis results, it determines the treatment method and cost. When the customer accepts the proposed method and cost, the facility concludes a contract with the customer, and visits the customer to take delivery of the waste. After appropriate treatment, any residual waste that needs to be disposed of by landfill undergoes the final treatment so that it passes leaching tests before being transferred to the final deposal site at Pulau Semakau. The facility also has a license to transport all types of hazardous industrial wastes.

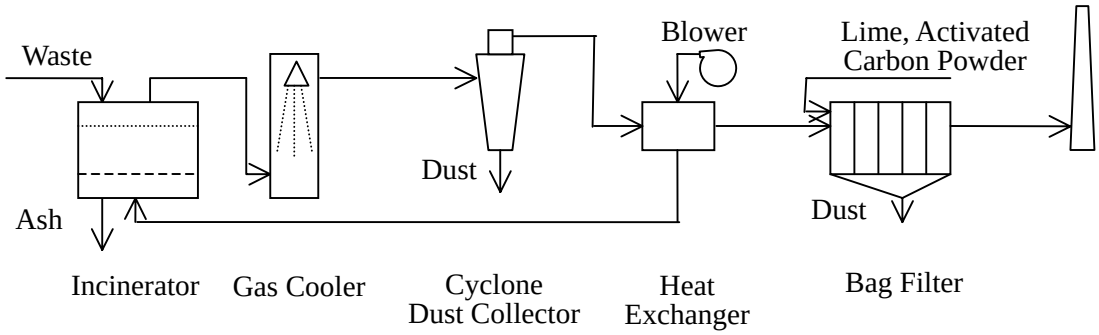
In the entire process from taking delivery of the waste to its final disposal, the facility inputs all relevant data, such as the type of the waste, treatment method, and quantity, into the on-line manifest system being controlled by the Pollution Control Department (PCD). Upon completion of the final disposal, the facility reports the result of disposal to the customer.

(3) Incinerator

The facility is equipped with a fluidized bed incinerator with an incineration capacity of 60 tons/day, incinerating waste oils, waste solvents, sludge, waste organic chemicals, inflammables contaminated with chemicals, wastewater containing organic matter, etc., continuously for 24 hours a day. The incinerator is loaded so as not to exceed 4,000 kcal/kg in calorific value. No auxiliary fuel is used. Liquid wastes are blown into the incinerator by air, solid wastes are carried inside by screw conveyor, and sludge is thrown in by grab. The flow chart for waste gas treatment is as shown in Figure 1-6-1. Waste gas of about 950℃ from the fluidized bed incinerator is rapidly cooled to below 285℃ in the cooling tower in order to inhibit the formation of dioxins. It then passes through the cyclone separator to separate dust with large particle sizes. Thereafter, it flows through the heat exchanger to exchange heat with combustion air, with a result that its temperature drops to about 167℃. Then, lime powder for removing hydrogen chloride, sulfur dioxide, and other acidic gas, and activated carbon powder for removing traces of dioxins are blown in, and the waste gas is lead to the bag filter. Thus, the waste gas discharged from the smokestack meets the standard control limit imposed by the Singaporean government. The dioxins content is below the control limit of 0.1 ng/Nm^3. The analysis values are reported to the Pollution Control Department (PCD) once a year.

The incineration fee charged by this facility is S$330 to 390/ton for wastes containing neither chlorine nor sulfur, and S$600 to 850/ton for those containing either of them.

Figure 1-6-1 Process flow of waste gas from incinerator



(4) Wastewater

Wastewater transferred from a customer’s factory is subjected to a different treatment depending its properties: acidic or alkaline wastewater to neutralization or coagulation sedimentation; wastewater containing cyanide to oxidizing decomposition; and wastewater containing hexavalent chromium to reduction. Part of the treated wastewater is used to cool the waste gas from the incinerator.

The treated wastewater meets the standard control limit for wastewater for discharging into public sewer systems. A pH meter and an automatic shutoff valve interlocked with it are installed just upstream of the discharging exit in accordance with the instructions of the Pollution Control Department (PCD). When the standard control limit for wastewater is exceeded, these devices automatically stop the discharging flow out of the facility. The fee charged for the treatment of wastewater ranges from S$250 to S$350/ton.

(5) Wastes

Some types of wastes contain heavy metals. Those wastes include incinerator ash and dust collected by dust collector, and settled sludge resulting from wastewater treatment. This waste treatment facility accepts wastes from its customers, while at the same time certain amounts of wastes are generated in the facility. Both of these wastes are subjected to leaching tests to verify that they meet the standard control limits prior to

transportation to the final landfill site at Pulau Semakau. Those of the wastes failing to meet the standard control limits undergo solidification mixed with cement and are then checked for compliance with the standard control limits prior to the final disposal. The standard control limits used in the leaching tests are generally more lax than those of Japan. For arsenic, for example, the control limit is set at 5 mg/liter against 0.3 mg/liter in Japan.

The fee charged for the solidification by mixing wastes accepted from the customer with cement ranges from S$400 to S$800/ton. The treatment facility is currently planning to install treatment equipment for waste fluorescent lamps containing mercury and other similar wastes.

(6) Miscellaneous wastes

Used solvents and IPA (isopropyl alcohol) are made reusable by vacuum distillation and purification. Aromatic chlorine compounds (such as chlorobenzene) and PCBs, which cannot be treated by this treatment facility, are transported to a treatment firm in Germany. Personnel of the facility verified in person that these wastes transported to Germany were treated at high temperatures. All these wastes are transported to Germany in accordance with the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal.

This treatment facility is equipped with a laboratory and a R&D center, where samples of wastes received from its customers are analyzed in order to determine the optimal treatment method. Leaching tests of wastes solidified by mixing with cement and the measurement of calorific value produced by incineration are also done there. This treatment facility, accredited by the Singaporean government to analyze wastes, is also consigned to analyze wastes received from other waste treatment firms. However, this facility is not capable of analyzing dioxins. Therefore, sampling of dioxins is consigned to an outside accredited firm, and their analysis is conducted by a laboratory in Japan or Europe. The market for dioxins analysis business in Singapore is not large enough to recover funds invested in the installation of dioxins analysis equipment, and the facility has no plan to analyze dioxins itself. The fee charged by an overseas company for analysis of dioxins is about S$2,500 per sample. The customer of the facility is required to pay this amount plus a sampling fee, or a total of S$5,000 per sample (about 350,000 yen). The analysis result is directly reported by the firm consigned for analysis to the Pollution Control Department (PCD).

This treatment facility also monitors groundwater to determine whether the soil within its premises is polluted. To this end, it compares data collected by it with the standard control limit set by the Danish government for groundwater. It has adopted this control limit because it has been used by the Jurong Town Corporation (JTC), the owner of the tract of land where it is located.

In addition, this treatment facility is also planning to conduct purification treatment of fluoride gas used in the semiconductor manufacturing process for recycling it. It is planned to adopt the dry scrubber treatment method, where activated carbon powder is blown into the gas to adsorb aluminum compounds and other substances contained as impurities. At present, there is no facility in Singapore that can treat this gas, which therefore is transported to Japan for treatment.

This facility, using subsidies from the National Science and Technology Board (NSTB), is engaged in research and development of technologies for detoxification and volume reduction of industrial wastes.

Section 7
Other Industrial Environmental Management

1. Other environmental control measures required for industries in Singapore

The preceding sections have dealt with water pollution management, air pollution management, and hazardous industrial waste management. These are major environmental measures indispensable in carrying out industrial activities in Singapore. Acts and regulations related to these measures are also outlined. Other issues related to environmental management that are necessary for industrial activities in the country include noise control measures, soil pollution control measures, and measures to control Legionella bacteria in circulating water of cooling towers. Below is an introduction of the information necessary in taking these additional measures. Considering the fact that Japanese companies usually commission outside analysis firms to measure wastewater, waste gas, and other environmental items, the system of accrediting environmental analysis firms in the country is also introduced below for informative purposes.

(1) Noise control measures

Factories Adjacent to Residential Districts Need to Consider Noise Control

Since factories in Singapore are located considering the degree of environmental loading, the line of business and others, noise rarely becomes an issue for chemical plants and the like located in large industrial estates away from residential districts. On the other hand, light industries and other similar industries adjacent to residential, commercial, or other districts may face the issue of noise pollution. In 2001, the Pollution Control Department (PCD) of the National Environment Agency (NEA) received 148 complaints about noises from factories, the causes of which included inappropriate installation of equipment and poor maintenance of equipment.

Control on noises from factories in Singapore is implemented in accordance with the Environmental Pollution Control Act (EPCA) and the Environmental Pollution Control (Boundary Noise Limits for Factory Premises) Regulations under the Act. The Regulations divides each day into three time zones: the daytime from 7:00 a.m. to 7:00 p.m., the nighttime from 7:00 p.m. to 11:00 p.m. and the midnight from 11:00 p.m. to 7.00 a.m. of the following day, and specify the upper limit on factory noises according to the characteristics of the adjacent facilities that may be affected by factory noise. The upper limit is specified in two terms: the average noise level for each time zone and the measured level for five minutes in each time zone. The specific upper limits on noise levels are given in Table 1-7-1. For factories adjacent to facilities requiring the highest quietness (including natural parks, hospitals, educational institutions, and libraries), for example, the upper limit for the daytime is 60 decibels (A) in terms of the time-zone average and 65 decibels (A) in terms of the five-minute average. For factories adjacent to other factories requiring the most lax control, the upper limit for the daytime is set at 75 decibels (A) in terms of the five-minute average.

When there are two sources of noise in a single factory, the upper limit applied to the factory is somewhat lowered according the differential in noise levels between the two sources.

Upon receipt of a complaint about noise, PCD measures the noise level. When the factory noise level is found in excess of the applicable upper limit, PCD orders the factory to implement a measure to reduce the noise level or repair or adjust the equipment that generates noise. When the implemented measure fails to reduce the noise level, PCD orders the factory to stop its operation or impose a fine or any other specified penalty. Small-to-medium-sized factories adjacent to residential districts in particular need to consider noise control.

Table 1-7-1 Boundary Noise Limits for Factory Premises

（Unit: dBA）

Type of affected premises	Maximum permitted noise level (reckoned as the equivalent continuous noise level over the specified period)		
	Day 7 am - 7 pm	Evening 7 pm - 11 pm	Night 11 pm – 7 am
Noise Sensitive Premises	60	55	50
Residential Premises	65	60	55
Commercial Premises	70	65	60

Type of affected premises	Maximum permitted noise level (reckoned as the equivalent continuous noise level over 5 minutes)		
	Day 7 am - 7 pm	Evening 7 pm - 11 pm	Night 11 pm – 7 am
Noise Sensitive Premises	60	55	50
Residential Premises	65	60	55
Commercial Premises	70	65	60
Factory Premises	75	70	65

(2) Soil pollution control

No Regulation Exists, but Soil Pollution Control Measures are Required

At present in Singapore, there is a statement concerning the prevention of soil pollution in the Environmental Pollution Control Act (EPCA), but no regulations for specific control. However, the Code of Practice on Pollution Control, issued in June 2002, carries a statement concerning soil pollution control in the form of a guideline, introducing procedures for soil pollution investigation and restoration from pollution.

Basically all tracts of land in industrial estates in Singapore are owned by the government, and may be used under a lease agreement for a fixed term. If soil pollution is found upon returning the possession of the tract of land at completion of the project, it will become a large issue whether it was polluted prior to its use or not. If the soil pollution was evidently occurred during the use, the lessee is required to restore the tract of land. This necessitates any lessee to take appropriate soil pollution control measures in anticipation of such a possible eventuality.

The Code of Practice on Pollution Control refers to soil pollution control roughly as follows:

a) An investigation for soil pollution shall be conducted when any tract of land that was previously used by an industry designated as one that may cause soil pollution is going to be used for any other purposes. If soil pollution is confirmed, the tract of land must be restored to a condition suitable for the new application. Industries designated as ones that may cause soil pollution are as shown in Table 1-7-2.
b) The owner or user of the tract of land in question shall conduct, or consign any entity on behalf of oneself to conduct, such investigation for soil pollution and restoration in a manner acceptable to the Pollution Control Department (PCD).
c) The investigation for soil pollution and restoration must be conducted in accordance with the technical guidelines listed below.
   - The Guidelines for Soil Pollution Control for Netherlands
   - ASTM E 1527-00 Soil Evaluation Standards, Phase I
   - ASTM E 1903-97 Soil Evaluation Standards, Phase II
   - ASTM E 1739-95el Soil Evaluation Standards at Petroleum Release Sites
   - New Zealand's Guidelines for Soil Pollution By Petroleum and Hydrocarbon
   - Other guidelines acceptable to PCD
d) A restored tract of land shall be checked by experts so as to confirm that it is restored as required.

A list of such experts is available at *http://www.env.gov/sg/info/cbpu/main.htm*

Voluntary Investigation on Soil Pollution by Some Japanese Companies

Four of the Japanese companies visited during this survey are voluntarily conducting an investigation on soil pollution on their factory premises. They belong to industries such as semiconductor that are not designated as ones that may cause soil pollution, and least likely to cause it.

At their factories, wells are dug at the edges of the premises and groundwater samples are taken for analysis. Groundwater was monitored at regular intervals prior to the construction of the factory and after the start of operations. Some of them are using groundwater standards of the Netherlands and Denmark. The standard of Denmark is not included in the recommended technical guidelines listed above, but seems to have been accepted by PCD.

Table 1-7-2 Pollutive Activities Subject to Site Assessment

a	Oil installations and other premises storing, handling and using large quantities of oils and similar hydrocfabons products, including the following: Oil refineries; Oil depots; Petrochemical complexes; Petrol stations and refuelling depots; Aircraft manufacture and repair industries; Motor repair workshops.
B	Chemical plants, chemical warehouses or terminals including the following: Chemical warehouses or terminals; Pharmaceutical/biomedical plants; Wood treatment and preservation facilities; Large electroplating works; Factories that use, manufacture or store toxic chemicals.
c	Shipyards and grit blasting works
d	Gas works
e	Power stations
f	Toxic wastes treatment facilities
g	Scrap yards
h	Landfill site for municipal or industrial wastes
i	Facilities for the treatment of sewage.

(3) Measures for controlling legionella bacteria

Legionella Bacteria Control Unique to Singapore

Singapore is implementing a unique control measure for Legionella bacteria that may be detected in the circulating water of cooling towers used by many factories. Infection with Legionella bacteria may affect people who have poor resistance to disease such as the elderly people, infants and convalescent persons, and may result in death if things come to the worst. In the wake of victims of Legionella bacteria appearing in Australia, Singapore started to establish regulations on the bacteria. The resulting regulations, namely, the Environmental Public Health (Cooling Towers and Water Fountains) Regulations under the Environmental Public Health Act (EPHA) started to be applied for control of the bacteria in March 2001. The Regulations consist mainly of structural and maintenance standards for cooling towers, and safety standards for cooling-tower cleaning operators.

The structural standards require the installation of shielding walls preventing splashes on operators, consideration of the location of installation, and the adoption of an easy-to-clean structure.

The maintenance standards stipulates, among others, the stopping and cleaning the cooling tower once every six months to prevent the multiplication of Legionella bacteria; sterilization chemicals and procedures to be used during cleaning; bactericides to be injected into circulating water; periodic monitoring of circulating water; reporting of monitoring results; and steps to be taken in emergency.

The maintenance standards provide that two types of bactericides be used alternately every other week, in order to prevent Legionella bacteria from developing resistance to bactericides. They do not stipulate any specific type of bactericide, but specify that chemicals not prohibited under the Poison Act, chemicals meeting the British Standard 5750, bactericides that do not generate hazardous by-products after use, etc., shall be used.

Sterilization Necessary as Part of Compulsory Steps If Legionella bacteria are Detected

It is made compulsory to measure circulating water for Legionella bacteria at regular intervals. There are two types of measuring methods specified: the Standard Plate Count, to be conducted once every month, and the

Legionella Bacteria Count, to be conducted once every three months. The factory must commission an accredited analysis laboratory to make these measurements. The analysis laboratory reports the analysis results directly to the Quarantine and Epidemiology Department of the National Environment Agency (NEA). If Legionella bacteria are detected, within 24 hours, the Quarantine and Epidemiology Department notifies the factory in question of what steps to be taken. The count of Legionella bacteria detected and the corresponding steps to be take are as shown in Table 1-7-3.

As a part of the compulsory steps to be taken if the evaluation rating is "Dangerous" or higher, a detailed process using sodium hypochlorite that has a strong bactericidal action is stipulated for cleaning and sterilization. Sodium hypochlorite, when dissolved in water, generates free chlorine, which has a strong sterilization effect. However, the Singaporean government sets the control limit for free chlorine in wastewater discharged into public sewer systems at 1 mg/liter, a very stringent value. Wastewater resulting from the sterilization process must be treated to below this control limit prior to discharging it into public sewer systems.

Table 1-7-3 Enforcement action for legionella bacteria

(Unit: cfu/millilitre)

Standard plate count	Interpretation	Action
> 100,000	Potentially hazardous situation	Enforcement action will be taken under the Environmental Public Health (Cooling Towers and Water Fountains) Regulations 2001.

Legionella bacteria count	Interpretation	Action
≦10	Maintenance practices may not be satisfactory	Advisory letter to rectify maintenance programme, monitor and follow-up.
＞10 – 1000＜	Potentially hazardous situation	Enforcement action will be taken under the Environmental Public Health (Cooling Towers and Water Fountains) Regulations 2001.
≧1000	Serious condition	Order under Environmental Public Health (Cooling Towers and Water Fountains) Regulations 2001 to shut down the system immediately, decontaminate, clean and disinfect, monitor and follow-up.

(4) Accreditation system for analysis laboratories

Analysis Values for Submission to a Government Agency Need to Be Those Obtained by an Accredited Laboratory

Many Japanese companies commission an outside analysis laboratory to make various environmental measurements. It should be noted that in Singapore, there is a accreditation system for analysis laboratories that analyze the compositions of wastewater, waste gas, solid wastes, etc., and analysis values for submission to the Pollution Control Department (PCD) must be those obtained by these accredited laboratories. The accreditation body is the Singapore Laboratory Accreditation Scheme (SINGLAS) of the Singapore Accreditation Council (SAC).

In Singapore, manufacturers, consumers, contractors, government officials or others depend on analysis by accredited laboratories for assurance that raw materials, products, services rendered by contractors, or the like have the qualities as required by them. The measurement technology and accuracy control of these accredited analysis laboratories conform to the requirements of the international standard, ISO/IEC 17025. The areas covered by the accredited laboratories include the environment, chemical and biological testing, nondestructive inspection, mechanical testing, electrical testing, medical testing, urban engineering, and accuracy control.

On the basis of the international standard, accredited laboratories maintain and inspect analytical equipment; prepare reagents; take and store samples; take custody of standard substances; conduct accuracy control; process data; and prepare reports.

Highly Capable Analysis Laboratories in Singapore

The Singapore Laboratory Accreditation Scheme of the Singapore Accreditation Council (SAC-SINGLAS) is a member of the Asian-Pacific Laboratory Accreditation Cooperation, an international association of laboratory accreditation organizations. The Singapore Laboratory Accreditation Scheme is affiliated with six international associations of laboratory accreditation organizations. Analysis values obtained by accredited analysis laboratories are mutually checked in order to improve the accuracy in analysis. Supported by these activities, accredited analysis laboratories in Singapore are capable of providing analysis values acceptable by international standards.

In the environmental area, there are two governmental accredited laboratories and eight private ones in Singapore. Their points of contact are listed in Table 1-7-4. They are capable of analyzing almost all items, but analysis for dioxins is not possible in Singapore because there is no analytical equipment for that purpose in the country.

Table 1-7-4 List of Accredited laboratories

Government / Statutory Board Laboratories
PSB Corporation Pte Ltd, Chemical and Material Test Centre 1 Science Park Drive, Singapore 118221 Tel: 6772 9552 Fax: 6778 4301
Health Science Authority - Environmental Laboratory, Center for Analytical Science 11 Outram Road, Singapore 169078 Tel: 6229 0778 Fax: 6229 0749
Private Laboratories Accredited by SAC-SINGLAS
M/s ALS Technichem (S) Pte Ltd 14 Little Road, #07-01 & #08-01, Tropical Industrial Building, Singapore 536987 Tel: 6283 9268 Fax: 6283 9689
M/s Analytical Laboratories (S) Pte Ltd 134 Genting Lane, Singapore 349580 Tel: 6295 4213 Fax: 6297 2589
M/s Chemical Laboratory (S) Pte Ltd 520 Balestier Road, #06-01 Leong On Building, Singapore 329853 Tel: 6253 6122 Fax: 6250 4837
M/s Chemitreat Pte Ltd 28 Tuas Avenue 8, Singapore 639243 Tel: 6861 3630 Fax: 6861 3853
Intertek Testing Services (S) Pte Ltd (Caleb Brett Division) 59 Penjuru Road, GATX Terminals, Singapore 609142 Tel: 6265 5385 Fax: 6265 3716
Setsco Services Pte Ltd 18 Teban Gardens Crescent, Singapore 608925 Tel: 6566 7777 Fax: 6566 7718
SGS Testing & Control Services Singapore Pte Ltd 26 Ayer Rajah Crescent, #03-07, Singapore 139944 Tel: 6775 5625 Fax: 6777 2914
Singapore Test Services Pte Ltd 249 Jalan Boon Lay, Singapore 619523 Tel: 6660 7597 Fax: 6261 2617

Chapter 2
Environmental Conservation by Japanese Companies in Singapore : Case Studies of Corporate Practices and Policies

Chapter 2 presents 16 case studies of implementation of environmental measures by Japanese companies (primarily in the manufacturing sector) resident in Singapore. It is based on a survey conducted during visits to 15 such companies in Singapore. Section 1 presents an outline of the implementation of environmental measures by Japanese companies in Singapore, and is followed by presentation of the 16 case studies in Sections 2, 3, 4, and 5. Section 2 presents three case studies in which a regional integration function is manifested in the environmental field. Section 3 presents four case studies in which companies are voluntarily implementing advanced measures. Section 4 presents four case studies in which the sophisticated technology is employed in the disposal and elimination of pollutants. Section 5 presents five case studies in which environmental measures in playing an active role new business development.

Section 1
Japanese Companies in Singapore and Environmental Measures

The survey was conducted between November and December 2002 during visits to 15 Japanese companies in Singapore. The majority of the companies surveyed were in the manufacturing sector, with the remainder being engaged in trading, transport, and sales of office automation equipment. Factories of companies and the manufacturing sector were visited, and the implementation of environmental measures surveyed at the site of the relevant business activity. Penetration of Japanese companies in Singapore began in the 1960s, and accelerated in the 1970s, with the surveyed companies variously commencing operations between 1970 and 1999.

Chapter 2 introduces 16 case studies of the implementation of environmental measures by Japanese companies in Singapore. A number of Japanese companies in Singapore function to integrate activities throughout the Southeast Asian region, and this survey includes a number of case studies of environmental activities as associated with this integration function, in which support and guidance for environmental measures is provided to companies in a group active in the region. The environmental measures implemented by many of the companies surveyed exceeded the strict environmental regulations of manufacturing-based Singapore, and were of considerable sophistication. Even in the case of soil contamination, a problem for which practical regulations have yet to be implemented in Singapore, a number of case studies showed implementation of measures prior to any legislation as a means of eliminating environmental risk. In non-manufacturing sectors as well, environmental measures were taken in accordance with the characteristics of the particular industry.

In association with the high level of economic growth already achieved in Singapore, its system of environmental administration, and its infrastructure related to environmental measures, are of a similar level to that prevailing in Japan, Europe, and the USA, and there are few points associated with environmental measures requiring attention by Japanese companies. Companies operating in Singapore are fortunate in this respect in comparison to those operating in the less-developed remainder of Southeast Asia.

1. Environmental measures implemented by Japanese companies in Singapore

This survey was conducted during visits to 15 Japanese companies resident in Singapore. The majority of the companies surveyed were in the manufacturing sector, however the nature of Singapore as the primary business hub for Asia ensures that a wide variety of Japanese companies are active, and for this reason the survey also included companies engaged in transport, trading, and marketing for manufacturing industries. The manufacturing industries surveyed cover a wide range of fields, for example chemical, food products, electronic, and electrical. Companies in the motor vehicle manufacturing industry, frequently included in surveys conducted and Southeast Asia, were absent from this survey.

Minimal Risk for Japanese Companies in Implementing Environmental Measures

Singapore's GDP has reached a level of approximately US$20,000, and the nation therefore as the highest standard of living in Southeast Asia. This high standard of living is associated with a system of environmental administration, and infrastructure related to environmental measures (e.g., sewerage systems, waste processing facilities), of a similar level to that prevailing in Japan, Europe, and the USA. While the nation of Singapore focuses on national policy and economic growth, one of its primary targets is the provision of a healthy environment and a high level of public health, and policies for environmental protection are therefore given high priority. Environmental measures in the adjacent Southeast Asian countries have yet to catch up with the high rates of economic growth, and environmental pollution is becoming a serious problem, a situation in direct contrast to that of Singapore. There are therefore very few points requiring particular attention by Japanese companies in Singapore when implementing environmental measures, and provided the appropriate legislation is followed, Japanese companies are free of the risk of causing an environmental problem.

Progressive Implementation of Higher Quality Environmental Measures by Japanese Companies

Companies visited in this survey were found to be not simply adhering strictly to the relevant environmental regulations, but to be progressively engaged in a variety of sophisticated environmental measures.
Many Japanese companies in Singapore fulfill a function of integrating the activities of their associated group companies in Asia and in the Pacific, and these progressive measures consist firstly of support for a variety of environmental measures for group companies in Singapore and the region within the integration of financial and sales activities of the group. Furthermore, environmental measures are not limited to the company itself, but in some cases have also been extended to cover all parties with whom the company conducts its business such as suppliers, customers, and waste disposal operators.
Most of the companies visited were Singaporean branches of major Japanese companies, and certification for the international ISO14001 environmental management system standard is therefore considered a matter of course, however the development of an environmental management system and its implementation in the form of environmental measures is associated with development of a new operation, and in a number of cases this has proved useful in achieving significant cost reductions in terms of energy conservation.
A number of progressive methods of implementing practical environmental measures were noted. The majority of companies visited were in the manufacturing sector, and environmental measures were implemented to a high level in all cases. Even in terms of environmental pollution, an area not covered by Singaporean regulations, a number of companies had implemented measures ahead of any legal requirement. Furthermore, a number of factories visited had expended considerable capital on plant to introduce manufacturing processes with reduced environmental load, and were operating systems to recycle wastewater as a response to the severe shortage of water resources.
While implementation of environmental measures in the non-manufacturing sector presents considerable difficulty, a number of companies in this sector implementing such measures were noted - one transport company had developed a joint freight delivery system which has proven difficult to implement even in Japan.

Minimal Risk for Japanese Companies in Implementing Environmental Measures

Singapore's GDP has reached a level of approximately US$20,000, and the nation therefore as the highest

standard of living in Southeast Asia. This high standard of living is associated with a system of environmental administration, and infrastructure related to environmental measures (e.g., sewerage systems, waste processing facilities), of a similar level to that prevailing in Japan, Europe, and the USA. While the nation of Singapore focuses on national policy and economic growth, one of its primary targets is the provision of a healthy environment and a high level of public health, and policies for environmental protection are therefore given high priority. Environmental measures in the adjacent Southeast Asian countries have yet to catch up with the high rates of economic growth, and environmental pollution is becoming a serious problem, a situation in direct contrast to that of Singapore. There are therefore very few points requiring particular attention by Japanese companies in Singapore when implementing environmental measures, and provided the appropriate legislation is followed, Japanese companies are free of the risk of causing an environmental problem.

Support for Environmental Activities of Regional Group Companies Through Environmental Integration Functions

Singapore's location at the center of Southeast Asia with ready access from the surrounding area, its information and communications, transport and distribution, and financial market infrastructures to support the operations of overseas companies, and its preferential taxation measures, ensure that it hosts many companies which fulfill the function of integrating the Asian and Pacific operations of multinational business groups. A large number of Japanese companies have such companies in Singapore, and this survey found a number companies in which environmental measures were incorporated into this integration function while providing guidance and support for group companies within the region.
One company has established the office of the Regional Environmental Committee in Singapore. This organization exists within the company and is responsible for the environmental committees established in the various companies in the group in each country in the region, the parent company in Japan transmitting its global environmental management policy to each company within the group through this committee. The committee then reports to the parent company on the effects of such activities. Particularly in measures dealing with chemical substances, the committee is involved in the abolition of the use of lead solder, and in guidance and training at each company within the group in relation to management of data on chemical substances for the PRTR (Pollutant Release and Transfer Register). The committee also supports training, auditing, and determination of targets at each company as a means of promoting ISO14001 certification, and persons responsible for environmental matters in the integrating company visit companies in the group to implement training programs for local employees.

Some cases were also noted in which the authority associated with the integration function was employed in a competitive evaluation of environmental matters between companies within the group. As these activities provide a means of numerical evaluation and display of progress in environmental matters, for example recovery and recycling of the products manufactured by the various companies within the group, their reclamation for use as resources, ISO14001 activities, and environmental promotion activities, they clarify the weak points in the environmental responses of each company. This allows for a comparison of the companies in the group so that pressure may be applied to companies under-performing in this area.

A further important point for regional integration in environmental activities is the collection of environmental information relevant to the region and its provision to the companies in the group within that region. In particular, implementation of legal statutes in some of the countries of Asia tends to be lacking, and this fact, together with the existence of areas in which infrastructure such as waste disposal facilities for implementation of environmental measures is undeveloped, mean that there is a possibility of a Japanese company causing an unexpected environmental problem even though environmental regulations have been followed to the letter.

The integrating company therefore collects information on environmental regulations, and case studies of environmental pollution, in each country within the region for distribution to the companies within the group, thus providing support for implementation of environmental measures to eliminate environmental risk.

Extension of Environmental Measures Beyond the Company

A further interesting point relating to implementation of environmental measures by Japanese companies in Singapore is the attempt to extend such measures beyond the company itself to cover all parties with whom the company conducts its business, for example to suppliers and waste disposal operators.
The Environment, Health, and Safety document incorporates such requirements as adherence to the appropriate Singaporean legislation, appropriate reaction to any leakage of chemical substances, and acquisition of the necessary licenses for handling toxic industrial waste, and participation of the factories of subcontracting companies in EHS training. In practice, this training is given to the employees of suppliers annually, and requires cooperation in environmentally friendly production activity. The content of the document is generally of a similar level to the legal requirements, and requires the signature of the representative of the subcontractor as confirmation that the subcontractor will adhere to the legislation.
One case was noted in which a non-manufacturing company produced a questionnaire for its suppliers (e.g., suppliers, companies to whom operations are contracted, warehousing companies) as a means of raising the level of awareness of environmental problems.
The questionnaire required selection of one of the following.

(1) Is your company ISO4001 certified, or does it have a similar environmental management system?
(2) Does your company have a documented environmental policy?
(3) Does your company's environmental management system have a designated person responsible?

While the questionnaire did not require compulsory implementation of environmental measures, it proved difficult to respond repeatedly with negative answers, and had the effect of providing subtle encouragement to suppliers to become engaged in environmental measures. When the questionnaires were returned from the suppliers the company recommended strongly that those without ISO14001 become appropriately certified. Suppliers not returning the questionnaire were followed up until it was returned.

Japanese Companies Engaged in Measures to Eliminate Environmental Risk

Many of the Japanese companies in Singapore are subsidiaries of major international industrial groups, and as such have implemented environmental measures recognized at an international level. In some cases these companies are subject to stringent environmental requirements from European and US customers, so that while strictly adhering to Singaporean environmental regulations, they are also required to implement environmental measures to eliminate environmental risk. Furthermore, the severe shortage of water resources adds a unique characteristic to the consideration of environmental matters in Singapore.
Representative examples of progressive environmental measures are those dealing with soil contamination. Singapore currently has no legislation dealing directly with soil or underground water contamination, however as almost all factories are built on land leased from the government of Singapore, any soil contamination detected when the land is returned will result in the lessee being subjected to considerable expense for clean-up operations. Many of the Japanese companies surveyed therefore expend considerable efforts in preventing soil contamination.
One company surveyed has installed wastewater piping, normally buried, above ground on overhead supports, and wastewater treatment plant is also installed above ground as much as possible, in order to facilitate ready detection of leaks. In addition, double-walled piping is used for high-concentration wastewater as a further means of preventing soil contamination. Other companies, while not taking measures to this extent, have implemented monitoring of underground water as a means of preventing soil contamination. These measures involve the digging of wells at a number of locations within the factory site, and periodic monitoring of the underground water.
When multiple manufacturing processes are able to be selected, some companies surveyed are adopting manufacturing methods with a reduced environmental load, even though plant investment is increased, and installing discharge prevention equipment, for example equipment to remove VOC (Volatile Toxic Compounds) from waste gas, even though such equipment is not required in Singapore, in an increasing comprehensive range of voluntary advanced environmental measures.
The limited land area of Singapore, and its lack of water resources, has resulted in approximately half of the demand for water being satisfied by purchase of water from its neighbor, Malaysia. One Japanese company surveyed using large volumes of water is engaged in positive measures to recycle water which have resulted in a major reduction in water usage. These measures involve the introduction of recycling equipment

incorporating micro-filters and reverse osmosis membrane processing, water used in manufacturing processes being recycled for further use. The measures have been a successful in achieving a major reduction in the volume of water discharged into the sewerage system. Installation of the water recycling equipment has required considerable expense, and has incurred a loss in accounting terms, however the purpose of its introduction was the reduction of environmental load within the unique situation of water resources in Singapore.

ISO14001 Certification has Become Second Nature

The global environmental policy of the Japanese parent company of most Japanese companies incorporates certification under the ISO14001 international standard for environmental management systems, and Japanese companies in Singapore now generally consider this certification to be a matter of course. An ISO14001 certification scheme commenced in 1996 in Singapore, the first certification under the scheme being granted to a Japanese company. The government of Singapore encourages certification as a means of improving adherence to environmental legislation and reducing environmental load, and in promoting environmental accounting by enterprises, and therefore provides considerable support for certification through incentives. These efforts have increased certification significantly from 217 in 2000, to 369 in 2002, the majority of certifications being Japanese companies. Companies visited in the survey were primarily in the manufacturing sector, and almost all were certified, the process of acquiring certification including both development of an environmental management system, and a system for environmental training of employees. Those responsible for environmental measures in the majority of companies visited were Singaporean, and were actively engaged in the implementation of the various environmental measures, operation of environmental management systems, and environmental training of employees.

Cooperation Between Japanese Companies in Environmental Matters

The countries in the area around Singapore often lack facilities for the treatment of toxic industrial waste, and companies must therefore go to considerable expense to implement measures to deal with industrial waste in accordance with legal requirements. Requirements for overseas companies to implement environmental legislation are considerably stronger than those applying to local enterprises, and Japanese companies must consider a wide range of points when implementing environmental measures. On the other hand, the extent of development of the environmental infrastructure in Singapore as noted above ensures that the country of origin of the company is irrelevant, and environmental regulations are applied fairly to all. The situation pertaining to environmental measures of Japanese companies in Singapore is therefore markedly improved in comparison with the other countries of Southeast Asia.

Within this context, the standard of environmental measures is implemented by Japanese companies in Singapore is high, and has progressed beyond simply adhering to local environmental legislation. On the other hand, an impression gained during the survey was that Japanese companies in Singapore lack any means to share environmental information. In Thailand and Malaysia for example, both countries in which large numbers of Japanese companies operate, the local Japanese Chambers of Commerce and Industry have established committees responsible for environmental matters. These committees are engaged in the collection of environmental information, and its dissemination to Japanese companies, and submission of petitions to government in relation to environmental problems. The Japanese Chamber of Commerce and Industry in Singapore provided considerable help and cooperation in introductions to Japanese companies in Singapore for the purposes of this survey, however it is a matter of regret that the Chamber has yet to conduct meetings on environmental concerns, and to establish a committee responsible for environmental matters.

As described above, there are considerable points for concern in relation to implementation of environmental matters in the countries of Southeast Asia other than Singapore, and in many cases these directly affect the economic activity of Japanese companies in terms of implementation of irrational and unfair environmental regulations. From the point of view of Japanese companies intending to develop operations in these countries, it is therefore essential that information relating to environmental problems be collected, and that an organization responsible for environmental problems be established within the local Japanese Chamber of Commerce and Industry.

In contrast, government information on environmental legislation is readily available, and most statutes and procedures are available on the Internet. As this administrative information is in English it is readily understandable by management personnel in Japanese companies, in contrast to the situation in the

surrounding countries. This may be a factor in reducing the perceived necessity for the establishment of an organization for the collection of environmental information by Japanese companies within the Japanese Chamber of Commerce and Industry in Singapore.
On the other hand, while Singapore has succeeded in environmental measures at the level of pollution prevention, there are greater environmental problems requiring resolution. Considerable effort is currently expended in Japan in order to achieve such objectives as a recycling society and sustainable development, and the need for similar efforts is expected to develop in Singapore. It is therefore necessary for Japanese companies to become engaged in more advanced measures such as recycling of resources, clean procurement, environmentally friendly design, the introduction of environmental accounting, issuing of environmental reports, and EPR (Extended Producer Responsibility). These measures require responses to environmental problems from a point of view which differs from that for conventional anti-pollution measures.
While Japanese companies in Singapore are characterized by excellent abilities in terms of environmental measures, progression to the resolution of environmental problems such as those noted above requires consideration of the characteristics of the social system of Singapore. Resolution of such problems by individual enterprises is extremely difficult, and sharing of related information and know-how is necessary for a common approach by Japanese companies to these new environmental problems. At the same time, points related to the social system require submission of proposals to the government of Singapore, and an organization is required for cooperation between Japanese companies on environmental problems, for example within the Japanese Chamber of Commerce and Industry in Singapore.

Contributions to the Environment of Southeast Asia by Japanese Companies in Singapore

Singapore is located in an important position within Southeast Asia, and functions as a center for a number of areas, for example finance and trade. Many Japanese companies in Singapore fulfill an integration function, and many of these companies have incorporated environmental matters within this regional integration function as described previously. Japanese companies in Singapore which incorporate this environmental integration function collect large volumes of practical information relating to environmental problems via their group companies throughout the region, and the question arises as to whether this information could be shared between companies, rather than held by individual companies. To achieve this sharing of information requires the creation of an organization for cooperation between Japanese companies on environmental problems. This organization would manage the information collected by the various individual companies in a systematic manner, providing a single source for the many individuals within companies requiring information on Southeast Asia, for example the most recent information on environmental regulations.

The government of Singapore is engaged in a variety of cooperation in the environmental field with the other countries of Southeast Asia, and cooperation within this framework on the basis of the high level of technology related to environmental measures, and experience acquired in this field, by Japanese companies is desirable as an environmental contribution by the private sector on the part of Japanese companies in Singapore.

Section 2
Case Studies of the Regional Integration Function Manifested in the Environmental Field

Many large enterprises with offices in the countries of Southeast Asia have regional integration companies located in Singapore. The primary purposes of the regional integration function are sales management, marketing and promotion, and personnel management, however recently a number of cases have become apparent in which the integration function includes environmental activities, and fulfils an important role in supporting the environmental measures of group offices throughout the surrounding region.

The function of environmental activities in regional integration companies are (1) to transmit the environmental policies of the Japanese parent company to the group offices within the region, and to collect and summarize the results of environmental activities in reports to the parent company, and (2) to provide guidance and support for environmental activities by the group offices within the region in consideration of regional characteristics.

The case studies introduced in this section all involve a unique method of dealing with environmental matters - the provision of a variety of related information to group offices, and act in support of ISO14001 certification, while at the same time employing the authority associated with the integration function in a competitive numerical evaluation of environmental measures of the group companies.

Case 1 Organic Support for Singaporean Regional Environmental Committees

1) Outline of the company

Company A Details of business: Regional integration company for general electronics business. Number of employees: 50 Commencement of operations: 1994 Location of factory: Central Singapore Japanese equity ratio: 100%

2) Background

Company A is the Asian region integration company for an internationally known general electronics business. The parent company of the business is located in Japan, and is represented in a total of 247 locations throughout the world (86 factories and 161 offices). Its customers are general consumers throughout the world, and further development of its operations naturally requires reliable product quality, and a comprehensive consideration of environmental matters in each of the countries in which it is represented.
An Environmental Conservation Committee has been established at the Japanese parent company of Company A in order to promote an integrated system of environmental management at its various locations throughout the world. The committee has established regional committees for Japan, Europe, the US, China, and Asia, and national committees in each country in which it conducts its business. The office of the Asian Region Environmental Committee is located at Company A and provides support for the Asian Region Environmental Committee and the National Environmental Committees, and promotes environmental measures at the various company locations throughout the entire Asian region.
The Japanese parent company of the company was rated first in environmental measures in the Overseas Environmental Management Evaluation conducted by N Newspapers Limited in 2002.

3) Details of measures implemented

a. Composition and operation of environmental committees

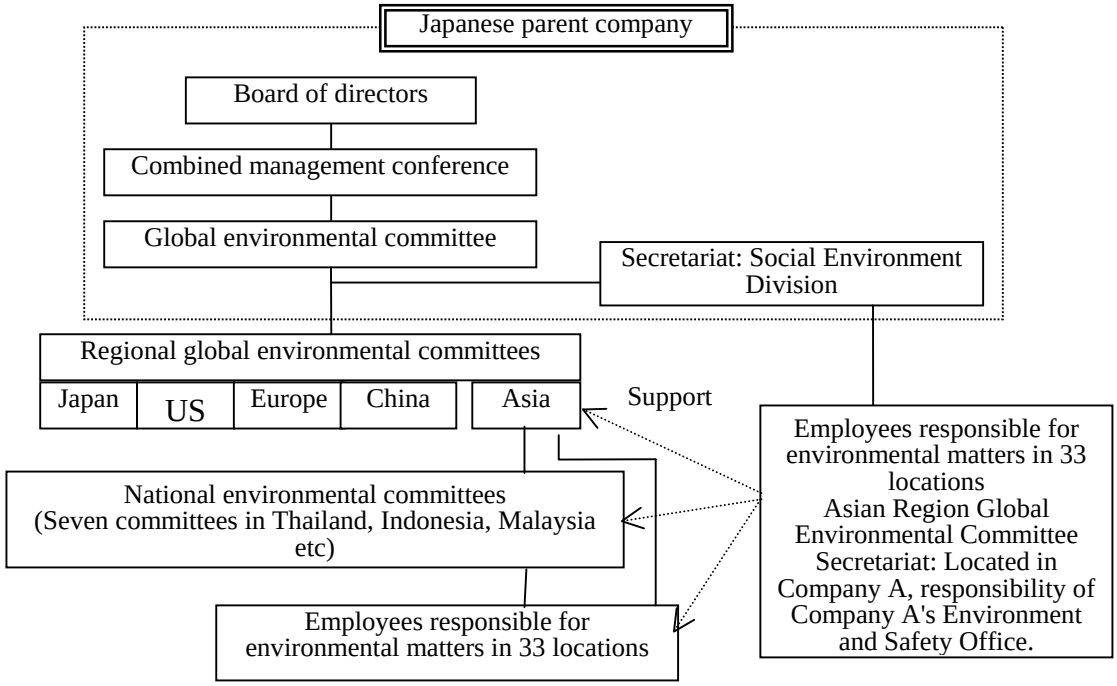
The office of the Asian Region Environmental Committee located at the Asian regional integration Company A is under the jurisdiction of the Social Environment Division at Japanese parent company, and day-to-day office operations are the responsibility of the Environment and Safety Office. The composition of this office consists of two employees responsible for environmental matters, two for occupational safety matters, one for office support, and one manager in charge of environmental and occupational safety matters. The office is responsible for Africa south of the Sahara, Asia except China, and Australia.

The area handled by this office contains 17 factories and 16 offices, at least one person being responsible for environmental matters at each location. An environmental committee is formed by the president of the local company in each country, for example, the company has six locations in Thailand, with the president at each location forming an environmental committee for the exchange of environmental management information within Thailand, and for study of relevant environmental matters. The presidents at each location take it in turns to serve as chairman of the National Environmental Committee. A National Environmental Committee is dispensed with in countries where the company has only one location. A National Environmental Committee has been established in Singapore and the president of Company A serves as the chairman of the Singapore National Environmental Committee.

Global Environmental Committees composed of the executive directors from the countries in each region are established above the National Environmental Committees. The Asian Region Global Environmental Committee is composed of seven members who are engaged in exchange of information relating to environmental activities, recycling, and environmental management etc, and furnishing of information relating to environmental matters in the Asian region to the Japanese parent company.

The committee meets once or twice annually, with the president of the regional integration company, Company A, as chairman. The president of the integration company is also the chairman of the regional global environmental committee, and environmental matters are handled with an importance similar to business development. The role of company A in the global environmental promotion organization centered on the Japanese parent company is shown in Figure 2-2-1.

Figure 2-2-1 Role of Company A in Global Environmental Promotion Organization



b) Role of secretariat

The secretariat of the Asian Region Global Environmental Committee provides the following support for the national environmental committees and the Asian Region Global Environmental Committee.

Sharing of information concerning factory environmental management within the Asian region is considered to be important. For example, legal statutes have been established in the US, and need only be followed consistently, and control of pollutants is important in Europe, however in the Asian region, environmental and other legislation often lack consistency, and systems for implementation of legislation are sometimes underdeveloped. Activities must therefore be based on a best appraisal on how they will develop in future. Even though regulations do not currently exist in a particular country, pollution of the soil will result in future problems, and it is important to avoid environmental risk. The secretariat provides information which is useful in making such decisions, for example, case studies from other countries, and submissions on legislation. Information is obtained from company offices, from magazines, and from the Internet.

While the situation differs between countries, considerable effort has made to ensure that the fundamental environmental policy of the parent company is implemented at all company locations. This policy employs numerical targets for reduction of environmental load in relation to greenhouse gases, resource inputs, resource discharges, water resources, chemical substances, and environmental management. It promotes implementation at each company location, and gathers information on results for transmission to Japanese parent company.

In consideration of the long-term environmental effects of chemical substances, efforts are expended continuously in the search for replacements for substances which affect the environment and the human body, and measures taken to reduce usage and discharge of toxic chemicals at all company locations throughout the world.

Chemical substances are controlled in four categories - Class I (use to be prohibited), Class II (use to be discontinued), Class III (use to be reduced), Class IV (use to be controlled). For example, lead solder is included in Class II, and apart from the small number of applications, its use is to be discontinued at the end

of 2004. Information on the usage of various chemical substances is also received from each company location, and covers most of the chemical substances subject to the requirements of the PRTR (Pollutant Release and Transfer Register). In countries that do not use the PRTR, guidance and training is given in the methodology for collection of such information. The reported information is collected and processed at the Japanese parent company, and published in the form of an environmental report.

In terms of environmental management, the Asian Region Global Environmental Committee promotes ISO14001 certification for each company location. Since 1996, support has been provided for training, internal auditing, and determination of targets, and personnel in Company A responsible for environmental matters have visited group offices to conduct training programs for employees. As a result, within the area covered by the Asian Region Global Environmental Committee, 32 of the 33 company locations (both manufacturing and non-manufacturing) are now certified. The single uncertified company is involved in music-related operations. Committee members of the Asian Region Global Environmental Committee for the relevant country participate in internal auditing of certified locations.

The first company gaining ISO14001 certification in Singapore was a member of the group to which Company A belongs. The certification examination was conducted jointly by the Japanese and Singaporean certification organization. Joint examination by the Japanese certification organization JACO[1] and the Singaporean certification organization certification PSB[2] was aimed at raising the level of examination.

Expenses incurred by the secretariat of the Asian Region Global Environmental Committee are paid by the Japanese parent company.

1 Japan Audit and Certification Organization for Environment and Quality
2 Singapore Productivity and Standards Board, since reorganized as SPRING (Singapore Standards, Productivity and Innovation Board)

Case 2 Fulfilling a Function in Support of Environmental Measures for Offices Within the Region

1) Outline of the company

Company B
Details of business: Sales of electrical appliances.
Number of employees: 474
Commencement of operations: 1989
Location of factory: Industrial area in East of Central Singapore
Japanese equity ratio: 100%

2) Background

The company maintains more than 160 overseas locations and group companies, and has established four regional integration companies to which part of the functions of the parent company have been transferred in order to manage operations effectively. Company B is the integration company for the Asian and Pacific regions, and has jurisdiction over 54 locations in eight countries. The integration companies fulfill three functions - management, integration, and support. Environmental matters are incorporated within the support function. Environmental awareness in the countries of the Asian region has yet to reach the extent prevalent in Europe and the US, and there is always the possibility that simply adhering to the current regulations will result in unexpected problems in future. Overseas companies operating in the region are therefore required to voluntarily implement environmental measures in advance of the current legislation.
The environmental report issued by the Japanese parent company states clearly that the global environmental promotion program will be strengthened by 2010 for all affiliated companies as part of a long-term plan, and the environmental support function is expected to assume a much greater role in future.

3) Details of measures implemented

a. Outline of the environmental support function

The support function of Company B is comprised of six items including distribution operations, strengthening of manufacturing abilities, and implementation of environmental measures. Four employees are responsible for implementation of environmental measures. The number of locations and employees in the Asian and Pacific regions by countries is shown in Table 2-2-1. National environmental committees have been established, with the executive president in each country acting as committee chairman. The Asia and Pacific Environmental Management Committee has been established to coordinate these national environmental committees. Support for both is a major part of the support operations of Company B. Expenses for activities and personnel incurred in support operations are not paid for by the Japanese parent company.

Table 2-2-1 Number of Locations and Employees in Asian and Pacific Regions by Countries

Country	Singapore	Malaysia	Thailand	India	Vietnam	Philippines	Indonesia	Australia
Number of locations	7	14	11	7	1	4	9	1
Number of employees	12,704	30,085	4,782	3,598	231	3,832	23,715	160

Training and raising consciousness of environmental matters in order to protect the 79,107 employees in eight countries from environmental risks is considered an extremely important part of support operations. These operations comprise transmission of the basic policy from Japanese parent company, and its practical implementation as follows.

- Distribution of information related to environmental matters from the Japanese parent company to the national environmental committees.
- Promotion of ISO14001 certification. Personnel are dispatched to locations which are delayed in the certification process to provide motivation. Of 54 companies, two are currently working towards certification. Certification of sales companies will be promoted in future.
- Promotion of use of lead-free solder.
- Promotion of recycling measures (in particular for sales companies).
- Collection of data for Japanese parent company environmental performance reports.

As the support function is not accompanied by any authority, operations must proceed on the basis of persuasion, however as the occurrence of an environmental problem implies responsibility, managerial personnel take these matters seriously. On the other hand, there is a confusion as to the practical measures required and the opinions of the support personnel are regularly sought and accepted. In some cases, compliance is obtained by a reminder of the fact that the policy is from Japanese parent company.
The lack of any authority has never been a problem in day-to-day support operations. Energy conservation was at the center of support operations between two and three years ago, however recently the focus has been on environmental measures. An awareness is developing to the effect that environmental measures for factories are associated with cost reductions.

b. National environmental committees in the Asian region, and the Asian and Pacific environmental management committee

National environmental committees were established in 1998. Committee members consist of managerial personnel from each country, and the committee chairman is a person with leadership ability (e.g., deputy president). Appointment of local employees ensures that the committees have firm roots in the local society and are able to communicate with national governments. The role of the national committees is as follows.

- Transmission of environmental policies from, and response to requests for collection of information from, Japanese parent company.
- Exchange of environmental information (e.g., environmental legislation) within the relevant country.
- Cooperation in volunteer activities, developing awareness of environmental matters, and conducting seminars.
- Reciprocal internal auditing for ISO14001. Two personnel dispatched for each internal audit.
- Reciprocal factory tours, and tours of government facilities. As committee meetings are held in turn, the factory tour is conducted at the location at which the meeting is held. Meetings are held as required on a particular theme.

The national committees are under the umbrella of the Asian and Pacific Environmental Management Committee. This committee fulfils the following role.

- Promoting unification and harmony between continuing environmental activities in the eight countries.
- Promotion of environmental measures in accordance with environmental policy of Japanese parent company, and environmental legislation of the relevant country.
- Development of the most appropriate environmental measures.

The above activities are now not conducted at meetings at which all committee members at present. These activities were previously conducted at these meetings until two years ago, however benefits were minimal and the practice was discontinued.

c) Cases of national environmental committee activities

The Environment Head Office within the Japanese parent company annually holds a Global Environmental Conference at which reports on representative activities of each of the national environmental committees throughout the world are presented. The conference for 2002 was held in October in Osaka. The chairman of the Singapore environment committee, a Singaporean, attended and presented the following three examples committee activities.

(i) Voluntarily social activities: First coastal cleanup by group companies
A total of 400 employees and family members from seven group companies participated in a voluntary rubbish cleanup at the beach of Singapore's East Coast Park on Sunday November 11th, 2001 between 9am and 1:30pm. The activities were conducted in accordance with the Green Plan 2010 policy from Japanese parent company.

(ii) Commencement of reciprocal internal auditing
Exchange of know-how in relation to environmental measures conducted during 1999 was expanded, and a system for reciprocal internal auditing was initiated as a means of improving the skill levels in internal auditing for ISO14001.

(iii) Forestation activities
Group employees and families participated in forestation activities in Bukit Patok Nature Park on February 2nd, 2002.

The Singaporean chairman presented these activities, and was impressed by examples from other countries.

Expenses for seedlings used in forestation activities, and lunches etc were covered by a sum of ¥70,000 from each of the eight companies. The government of Singapore has praised these activities, and they are supported by key executives in the Ministry of the Environment.

Case 3 Numerical Evaluation of Environmental Measures as a Basis for Competition Between Group Companies

1) Outline of the company

Company C Details of business: Sales and service of office equipment (e.g., copiers). Number of employees: 50 Commencement of operations: 1997 Location of factory: Central Singapore Japanese equity ratio: 100%

2) Background

The Japanese parent company of Company C is the technologies to leader in the Japanese copier market with a 40% share, and hold a share of almost 20% in the Asian and Pacific region. The President of the Japanese parent company is aiming for sophisticated environmental measures in the industry, and enthusiastically expounds his views on the need for such measures for overseas operations to be similar to those implemented in Japan.

Company C integrates the operations of seven sales companies and 15 dealerships in 15 countries in the Asian Pacific region, and as such as involved in sales promotion, business management, and technical support. Promotion of environmental measures for the sales companies and dealerships is an important role within the integration function. As the sales companies are fully owned by the Japanese parent company they are currently the target of such promotion, however the President insists that the environmental awareness of local staff is lacking, and as part of its integration function the company is engaged in a range of activities designed to raise environmental awareness.

3) Details of measures implemented

a. Raising awareness of local presidents of sales companies

Two technical support staff are in charge of promoting environmental measures. In practical terms, this involves promoting the following six points to sales companies in the various countries.
- Product recovery: Copiers, faxes, printers, toner cartridges, toner bottles.
- Product recycling and reselling: Copiers
- Recycling: Toner cartridges, toner bottles (cutting and reuse)
- Forest protection: Forestation and support for NGOs in Australia.
- ISO14001 certification: Sales companies in New Zealand, Australia, and Thailand.
- Environmental PR: Web pages, pamphlets, and clocks using defective CDs.

Of the above points, the greatest effort is currently expended in raising the rate of recovery of used products for recycling purposes. Recycling has a considerable history in the Asian region, and a number of companies exist for the purpose of buying up used toner cartridges and repacking with toner. The problem is the disposal of cartridges which are no longer usable, a solution to which is beyond the control of the manufacturer. In the final analysis, the only solution is to implement appropriate processing in order to prevent this buying up of used cartridges and eliminate the associated environmental load.

A variety of measures have been developed for product recovery with the Presidents of the sales companies in mind. One measure is competition between the sales companies on the basis of recovered amount. An environmental conference encompassing the factories and sales companies throughout the world is held annually in Japan, and recovered amounts published during the proceedings. Approximately 80% of the costs of recovery are currently paid by the Japanese parent company. This support is considered to be necessary in the initial stages of implementation of these measures. This support will be withdrawn once these measures take hold and become an integral part of business operations.

Part of the results of environmental measures implemented in the Asia-Pacific region and announced at the environmental conference held in January 2002 are shown in Figure 2-2-2. Amounts recovered vary considerably between sales companies. The Thai sales company (TH) recovered the greatest amount by far at 3850 units, while the Philippine sales company (PH) recovered only an extremely small amount. This data was also announced for toner bottles and faxes as a means of applying pressure to sales companies with

unsatisfactory recovery performance.

There is also a requirement for preparation of national environmental plans as part of the environmental education for Presidents of the sales companies in each country. As an example, a plan has been developed for the Australian company (A) for the period 2002 - 2005.

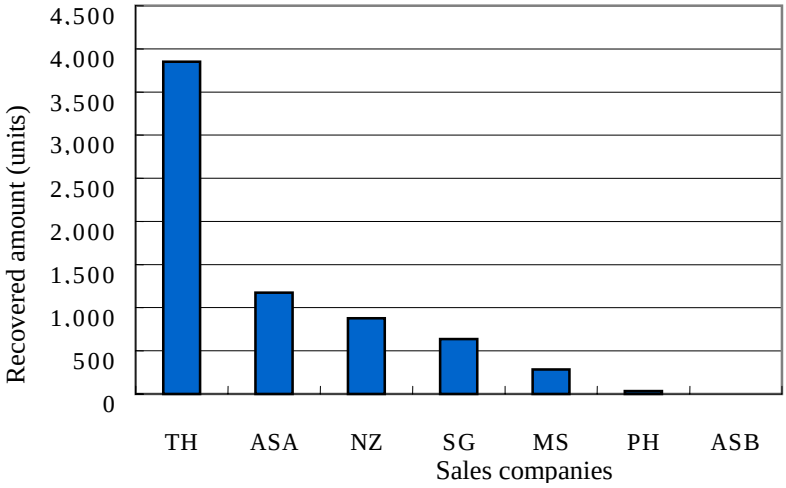
The environmental report is very positive, and includes activities for the development of a climate for environmental measures within the company and cooperation with the local society as the initial stages of the plan, to be followed by promotion to reduce waste products, recycling, and reuse to reduce volume for landfill by 80% by 2004, increased ISO14001 activity, and environmental accounting.

With other companies as well, details are appropriate for the local characteristics of each country. In some countries products are recovered, however no system exists for a selling recycled products.

An overall evaluation of the environmental measures implemented by the sales companies was also announced at the environmental conference. The measures implemented by each company under the environmental plan, product recovery, product recycling, recycling and reselling of second-hand copiers, PR related to environmental activities, and ISO14001 activities were evaluated as 3, 2, 1, or 0. The evaluation for the Australian company (A) the shown in Figure 2-2-3. ISO14001 activities and PR related to environmental activities were evaluated as 3, however recycling and reselling of second-hand copiers was evaluated as 0. The integration office adds comments for improvement on the basis of this evaluation. In this case, the comments were to the effect that product recovery, recycling of plastic components of copiers, and reselling of second-hand equipment should be strengthened in the region under the jurisdiction of the company. These graphs are compared between Presidents so that each becomes aware of his own company's shortcomings, and is thus able to take appropriate action.

Efforts are made to encourage voluntary implementation of environmental measures in order to ensure that they are not forced upon the sales companies. As such measures are not immediately linked to profit, sales companies did not initially warm to the idea, however personnel have recently began to understand their necessity. Dealerships are the next target for expansion of environmental measures.

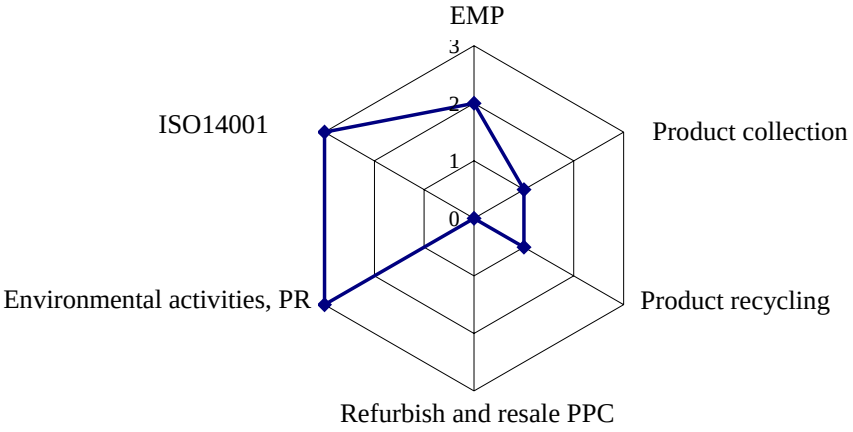
Figure 2-2-2 Recovered Toner Cartridges by Sales Companies



TH: Thai sales company
ASA: Australian sales company (A)
NZ: New Zealand sales company
SG: Singapore sales company
MS: Malaysia sales company
PH: Philippines sales company
ASB: Australian sales company (B)

Figure 2-2-3 Overall Evaluation of Environmental of Measures System of Each Sales Company

Example: Australian sales company



Section 3
Case Studies of Voluntary Implementation of Advanced Environmental Measures

Many companies operating in Singapore are well known internationally and have bases throughout the world. Many of these companies have implemented environmental measures which naturally satisfy the requirements of legislation enacted by the government of Singapore, while at the same time voluntarily implementing advanced measures which go beyond statutory requirements.
Many environmental measures implemented in Singapore by these companies are rarely implemented in Japan, for example, installation of all wastewater piping and treatment equipment above ground to prevent underground seepage in the event of a leak, periodic investigation of underground water to monitor soil contamination, and requirements for suppliers to implement environmental measures.

Case 4 Above-ground Wastewater Piping, and Double-walled Treatment Tanks

1) Outline of the company

Company D Details of business: Color TV manufacturer and sales. Number of employees: 1,049 Commencement of operations: 1992 Location of factory: Industrial area in western Singapore Japanese equity ratio: 100%

2) Background

The Japanese parent company of this company is an internationally known general electronics manufacturer. The company has manufacturing bases for various products located throughout the world, and 69% of the color TVs it manufactures are shipped to the Asian region, and 9% to Europe. Environmental measures undertaken by the company are required to be of a high international standard.

Industrial areas in Singapore are government-owned, tenants being granted leases of a few tens of years. Soil contamination is strictly monitored, and if such contamination is determined when the least expires the tenants is required to restore the land to its original condition. Such restoration work is extremely expensive.

With this in mind, Company D has installed wastewater piping systems above ground and employs a double-walled structure for treatment tanks.

3) Details of measures implemented

a. Above-ground wastewater piping systems

The manufacturing process involves use of acidic wastewater and other types of wastewater containing heavy metals. This wastewater is collected and processed in a treatment plant located at one corner of the factory. As the method of treatment varies with the type of wastewater, a number of wastewater piping systems are used. The factory is of considerable size - 300m in length, and a total of almost 2,000m of wastewater piping is installed between the wastewater sources and the treatment plant. Underground installation of this piping has been completely discontinued, and it is now installed above ground at a few centimeters above head height. Double-walled piping is employed for highly concentrated contaminated water, and drainpipes are installed under both this and other piping to ensure that any leaks do not fall to ground. When walking in the corridors of the factory one is always aware of multiple lengths of suspended wastewater piping.

Wastewater systems require holding tanks for contaminated water between the source and the treatment plant, and if possible, these tanks are always installed a few centimeters above ground so that any leaks are discovered immediately. If installation below ground level cannot be avoided, the tank is of a double-walled construction so that any leak is detected immediately by an alkalinity sensor, and no water leaks from the outer wall of the tank.

In addition to these measures to protect thoroughly against leakage from piping and holding tanks into the soil, wells have being drilled within the factory site for monitoring of underground water.

Case 5 Voluntary Monitoring of Underground Water

1) Outline of the company

Company E Details of business: Manufacture of laminated ceramic condensers. Number of employees: 1,500 Commencement of operations: 1972 Location of factory: Approximately 15km North of the center of Singapore. Japanese equity ratio: 100%

2) Background

Products manufactured by Company E are always used in electronics circuits, and the share of the world market for these condensers held by the Japanese parent company (including this factory) is the largest at 45%. The majority of the products manufactured in this factory are shipped to the major electrical manufacturers in the ASEAN nations, however a portion is also shipped to the US and Europe. The company has an international marketplace, and is expected to implement comprehensive environmental measures.

The manufacturing process consists fundamentally of processing of base materials, with minimal emissions of waste gas and wastewater, and the load on the environment is therefore small. On the other hand, small amounts of toxic chemicals are used within the factory and measures are required to ensure that such chemicals do not contaminate the environment. The factory is leased from the Housing and Development Board and care is required to prevent soil contamination. To satisfy local requirements, and under instruction from the Japanese parent company, underground water is monitored to check for soil contamination.

3) Details of measures implemented

a. Monitoring underground water pollution

Four 6m deep sampling wells have been drilled within the factory site in the vicinity of the chemicals warehouse. When permission to drill the wells was sought from the Housing and Development Board the company was asked why it was prepared to go to this extent. In Singapore, monitoring of soil contamination is recommended for petroleum refineries and chemical plants etc with a high environmental load, however it is not normally required for processing industries. Sampling and analysis has been conducted at six monthly intervals since 2001. Any standard recognized by the Pollution Control Division of Singapore's National Environmental Agency may be used to measure underground water quality. Recognized standards include the Dutch standard, ASTM E 152700, and the Danish standard. In this case the measurements taken are compared against the Dutch standard. No soil contamination has been detected.

Company E has two other factories in Singapore, and underground water is also monitored at these sites in the same manner. Measurements taken are voluntarily submitted to the Housing and Development Board. While the company's factories are not responsible for contamination, it is possible that contaminated underground water may reach the site from another source and it is therefore necessary to clarify this fact.

b. Treatment of wastewater

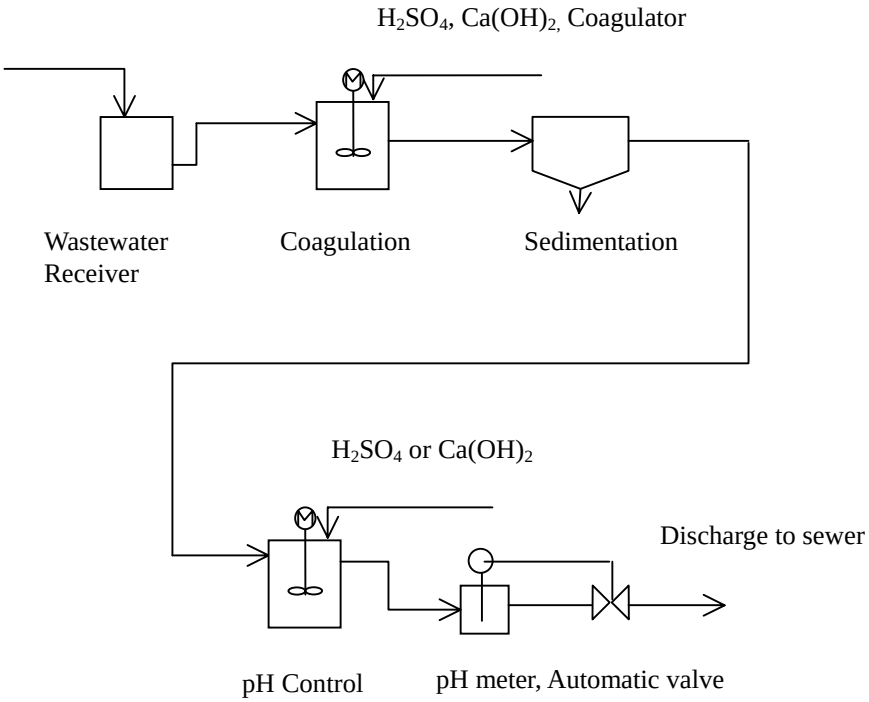
While the level of contamination is low, wastewater is contaminated by dust from the cutting of ceramics, and from chemicals. An outline of the wastewater treatment plant is shown in Figure 2-3-1. Wastewater produced at a number of locations within the factory is collected in a pit, acids and alkalis neutralized, heavy metals and ceramic dust coagulated using a flocculent, and removed in a sedimentation tank.

The pH level of the treated water is finally checked and it is then discharged into the sewerage system. Under the instructions of the Pollution Control Division, a pH meter and a linked automatic shutoff valve are installed at the wastewater outlet to ensure that the wastewater is not discharged if its pH level exceeds the standard. The pH meter and sensor are sealed by the Pollution Control Division and may only be opened by division personnel who visit monthly for inspection purposes.

The Pollution Control Division requires that the quality of wastewater be analyzed on the basis of 36 points in the wastewater standard as specified in the sewerage and wastewater regulations. The analysis is conducted by a certified industrial analysis organization. Each analysis, including analysis of underground water, costs

approximately S$4000.

Figure 2-3-1 Company E Wastewater Treatment Flow



c. ISO14001 certification

The Japanese parent company has provided assistance for ISO14001 certification by 1999, however certification was obtained from the Singapore Productivity and Standards Board (PSB, since reorganized as SPRING) in 1997, and four years of experience has been accumulated since that time. The Environmental Committee, with the president as chairman, has been responsible for promoting ISO14001 certification. The committee is comprised of three sub-groups - Energy Conservation, Reduction of Water Consumption, and Reduction in Waste Products. The leader of each sub-group is a local session manager. An office staffed by three specialists has been established for overall coordination and promotion.

Each sub-group reports annually to management on targets and results. As an example, in 2001 measures implemented in 2001 by the Energy Conservation sub-group to reduce electricity consumption reduced the consumption of electricity required for the production of each 1,000,000 units by 5% in comparison with the 1999 year. Measures implemented by the Reduction of Water Consumption sub-group reduced the consumption of water in air-conditioning and toilet systems by 10% in four years. These measures consisted of installing a fence around the water recirculation section in the air-conditioning cooling tower to prevent dispersal of water droplets. Measures implemented by the Reduction in Waste Products sub-group was successful in reducing waste products by 25% in three years, however reductions in 2001 were small.

All employees are well-informed of ISO14001 targets. Each group holds an annual training course lasting 90 minutes, with participants also including temporary staff (e.g., cleaning personnel, security personnel). The 40-page textbook used in the course has been prepared by employees. Group staff check the level of understanding of the participants three months after completion of the course.

Personnel visit from the Japanese parent company annually for the purposes of environmental audit, and environmental data is reported to the parent company twice yearly. This data is incorporated in the environmental report issued by the parent company.

d. Miscellaneous

Waste products consist of sediment discharged from the wastewater treatment sedimentation tank, and toxic industrial waste (e.g., used toluene). Treatment of these waste products is subcontracted to a certified waste treatment company.

An Improving Suggestion System has been implemented to benefit from the suggestions of employees. Almost 4000 suggestions are submitted annually, and cover proposals for reducing consumption of raw materials and electricity etc, and for improving productivity. For example, improvements in the placing of components on trays entered into ovens has increased production by 25%. The employee responsible for this suggestion was rewarded.

Case 6 A Trading Company Promoting Environmental Measures Among its Suppliers

1) Outline of the company

Company F Details of business: General trading company handling machinery and non-ferrous metals. Number of employees: 47 Commencement of operations: 1991 Location of factory: Central Singapore Japanese equity ratio: 100%

2) Background

The Japanese parent company is a general trading company with operations throughout the world. A clarification of environmental measures is essential in order to do business in Europe and the US. The Japanese parent company acquired ISO14001 certification in 1999, and Company F participated in integrated certification in 2000. Company F has no manufacturing section, and inventive measures were required to reduce environmental load. Its suppliers were therefore incorporated in its environmental activities.

3) Details of measures implemented

a. Environmental evaluation of suppliers

Suppliers cover a wide range, and include vendors, business contactors, and warehousing companies. A questionnaire was submitted to each supplier to gather information on its environmental management system. The questionnaire asked simple multi-choice questions on the following three points.

- Do you have an ISO14001 certified or equivalent environmental management system?
  - (A) Yes
  - (B) Planned for near future (enter name of site).
  - (C) Not yet decided.
- Have you prepared a written environmental policy?
  - (A) Yes (prepared by company)
  - (B) Yes (prepared by office or factory)
  - (C) None at all.
- Do you employ a person responsible for the environmental management system?
  - (A) Yes
  - (B) No

This questionnaire was designed as a means of improving the awareness of suppliers. Dealings with an internationally known company such as Company F are important to the suppliers, and repeated negative replies to the questions inevitably result in application of pressure, thus promoting consideration of the environment. Companies not replying to the questionnaire were followed up by telephone. The questionnaire was not sent to all suppliers, but to the five primary suppliers of each of the three business divisions of Company F - a total of 15 suppliers. Of these, the one company with ISO14001 certification was removed from the list and another added. Companies without ISO14001 certification were recommended to acquire certification.

The Japanese parent company has instructed Company F to head more detail to the questionnaire.

b. Other ISO14001 activities

ISO14001 activities other than environmental evaluation of suppliers are as follows.

(1) Environmental Evaluations

Measures for the treatment of waste products, and prevention of emergency situations. As this is an office site, the environmental impact is not large, however rubbish is divided into the following four classifications and collected in cans of four colors.

- General rubbish (gray): Office rubbish (e.g., paper)
- Environmentally sensitive (black): Copier toner
- Wet items (blue): Kitchen waste

- Solid items (green): Empty cans, bottles etc

The separated items are processed by a waste processing company at the request of the owner of the building. The details of the separation of the rather is explained to the waste processing company, and the rubbish processed accordingly.

(2) Support for Environmental Management of the Business
Improvement of awareness in group companies not yet ISO14001 certified. Introduction of the case of Company F.

(3) Reduction of Environmental Load in Daily Business Operations
- Reduced power consumption: Switch off lights during summer holidays. This resulted in a 5% saving in the first year (2000). A target of 3% was set for the following year, however as the office was renovated in 2000, power consumption actually increased.
- Reduced paper consumption: Double sided copying
- Reduced gasoline consumption: Thorough measures to reduce idling, and checks of distance traveled and gasoline consumed.
- Purchase of green products: Purchase of Eco-marked kitchen detergent (recognized by government of Singapore).

The Japanese parent company acquired ISO14001 certification through a UK certification organization. The Japanese parent company is audited in September of each year prior to auditing of Company F by this organization. As the criteria for Company F are in accordance with those of the Japanese parent company there are no problems.

A conference of personnel responsible for environmental matters in related companies in the Asian region is held annually, and examples of environmental measures, and environmental reports, are presented by each company.

Case 7 Obtaining Promises of Environmental Consideration from Suppliers

1) Outline of the company

Company G Details of business: Manufacture of computer memories and system LSIs. Number of employees: 719 Commencement of operations: 1976 Location of factory: Industrial area in center of Singapore Island. Japanese equity ratio: 100%

2) Background

Company G is well known internationally, and its products are sold throughout the world, notably in the US and Europe. The products manufactured at this factory have an 8% share of the international market, and the environmental measures employed at the factory are in accordance with international standards.
These sophisticated environmental measures are applied not only to the company's factory, but to materials suppliers, and suppliers of services. The environmental report issued by the Japanese parent company clearly states that comprehensive measures to deal with environmental problems must include suppliers at overseas factories.

3) Details of measures implemented

a. Measures including suppliers

Two primary measures are employed, one being the signing of an EHS (Environment, Health, and Safety) document as part of the contract with the supplier, and the second being training of suppliers in environmental matters. Suppliers include suppliers of raw materials, companies collecting waste materials, contactors working within the site, and cleaning contactors.

The EHS document consist of 16 points, and includes consideration of health and safety in addition to environmental matters. This system was commenced in 2000 as part of the ISO14001 environmental management system. The primary points relating to the environment are as follows.

- Adherence to environmental, health, and safety legislation enacted by the government of Singapore.
- Adherence to the regulations, instructions, and hazard signs relating to environmental, health, and safety regulations of Company G.
- Participation of supplier employees in training to handle dangerous situations.
- Implementation of appropriate measures, and immediate reporting of emergency situations (e.g., leakage of chemical substances) to the person in charge of the factory, by suppliers.
- Acquisition of the necessary licenses by suppliers handling toxic waste products. Adherence to the relevant legislation when disposing of such waste products.
- Participation of suppliers of services within the site in EHS training conducted at the factory.

A representative of the supplier is required to sign EHS document. The majority of the items in the document are the same as those in the legislation. Application of the signature to the document is significant in that it strongly implies adherence to the legal requirements.

As noted above, the second measure is the training of suppliers in environmental matters. November has been designated Environment Month, and during this period a variety of environmental activities are conducted, part of which is environmental education for the supplier employees. Company G currently has 35 suppliers, and the employees of all of these suppliers are required to cooperate in environmentally friendly manufacturing. Training includes the necessity of considering the environment, environmental legislation related to manufacturing, environment-related facilities within the factory, methods for controlling toxic waste products, acquisition of the necessary licenses, and emergency measures.

b. Environment month

November has been designated Environment Month to provide an opportunity to increase the awareness of employees in environmental matters. During this period, a variety of events in addition to environmental training are conducted for the benefit of the previously described supplier employees.

The schedule for 2002 was as follows.

October 30th	Environment Month start
October 30th - November 28th	Environmental quizzes
November 2nd	Tour of New Water plant, display of environmental promotion posters.
November 14th	Day for social contributions to improve nature, education, and society.
November 20th	Day for review of environmental management systems (ISO14001). Environmental education, lectures in emergency measures, initiation of Green Partner Program.
November 29th	Practice in emergency measures in front of the executives.

The New Water plant takes water treated at the sewerage treatment plant, and employs sophisticated treatment (e.g., reverse osmosis) to produce water pure enough to drink. The plant was developed as a means of ensuring sufficient drinking water in water-scarce Singapore.

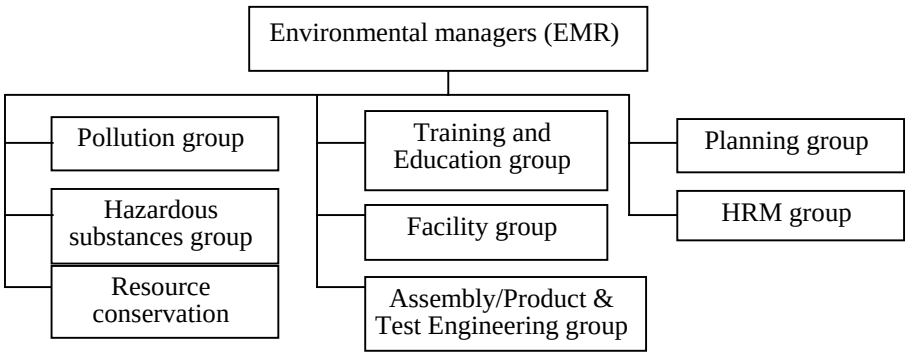
The Green Partner Program is a project designed to promote sorting and collection of waste products.

Practice in emergency measures is designed to handle any leakage of toxic chemicals (e.g., acids, alkalis) used in the factory, to prevent any consequent effects on the environment, and to ensure a safety in the workplace. Supplier employees also participate.

c) ISO14001 certification

Certification was acquired in 2000. The system for promoting such certification is shown in Figure 2-3-2. The system is under the supervision of two local environmental managers (EMR), and is comprised of eight sub-groups.

Figure 2-3-2 System for Promoting ISO14001 Certification



The training education and group is responsible for environmental education for the previously described suppliers. The facility group is engaged in monitoring of wastewater. The HRM group implements training of new employees. New employees in Singapore are not taken on in April of each year as is the case in Japan, but at the irregular intervals, and the training program is therefore implemented throughout the year.

The training material consist of 15 - 20 pages of explanations of environmental policy and related equipment. A target date of 2002 has been set for the implementation of the promotion system, and contents are as follows. All targets have been assigned numerical values.

- Improvements in efficiency of energy usage: An 80% reduction in power consumption by unit test.
- Reduction in water consumption, reuse of water, recycling of water: A 10% reduction in water use by 2002.
- Reduction in use of packing materials, and the paper in offices: A 5% reduction in paper use by 2003.
- Replacement of suppliers wooden palettes by plastic palettes by 2003.
- Reduction in environmental load due to toxic chemicals and toxic waste products: A 10% reduction by December 2002, and introduction of lead-free solder by December 2003.

Individual local staff has been designated as responsible for each of the above items.

d. Waste products

Toxic waste products are classified into three categories - solids, chemicals, and plastic trays. Solids include defective wafers, lead frames, metal sludge, and solder dregs. Disposal of these waste products is contracted to a certified waste processing company. Sludge containing valuable metals is taken by waste processing company and sent to Japan for recycling. Chemicals include solvents, thinners, acids, and fluxes, disposal of which is contracted to a certified waste processing company. Plastic trays are also disposed of by a certified waste processing company, and recycled as crushed pellets.

e. Wastewater

Almost no industrial wastewater is generated during the manufacturing process, the majority being domestic wastewater. Wastewater is therefore disposed of directly into the sewerage system. An oil-water separator has been installed to remove oil and fat in wastewater from the cafeteria. Water disposed of in the sewerage system is in accordance with the applicable standard values. Water quality is voluntarily monitored every two months in accordance with the items in Table 2-3-1.

Table 2-3-1 Wastewater Monitoring

（Items other than pH are in mg/liter）

Item	pH	BOD	COD	TSS	TDS	Cl	CN	SO_4	H_2S	O&G	Phenol	MBAS
Standard value	6-9	400	600	400	3000	1	2	1000	1	60	0.5	30

TSS: Total Suspended Solids, TDS: Total Dissolved Solids, O&G: Oil and Grease, MBAS: Surfactants

Of the 36 regulations enacted by the government of Singapore, all those considered even slightly relevant to operations within the factory are subject to monitoring. For example, CN (cyan) is sometimes used as an analytical reagent in the chemical analysis laboratory, and is therefore subject to monitoring. All standard values are cleared. The Pollution Control Division does not require submission of reports, and it appears that industries with low environmental load are not obligated to submit reports.

d. Progress in measures to reduce environmental load

The factory has been in operation for a period of 26 years, and during that time a number of progressive measures have been taken to reduce environmental load. Representative examples are as follows.

1987	Abolition of trichloroethylene and changes to laser marking.
1994	Abolition of fluorocarbon as detergents and change to cleaning using a surfactant.
1996	Introduction of a solder which does not require cleaning, resulting in a major reduction in usage of flux.
1999	Construction of a factory using an energy-efficient an air-conditioning system and a power supply system.
2000	ISO14001 certification
2003	Plans to introduce lead-free plates in conjunction with customer measures.

Section 4
Case Studies Applying Sophisticated Technology in Reducing Discharge of Pollutants

A number of Japanese companies operating overseas have adopted a strict environmental policy to ensure that their activities do not give rise to any environmental problems in their host nations. The treatment of wastewater to a quality equal to that of drinking water and its subsequent reuse, and the implementation of manufacturing processes with a low environmental load rarely found in Japan, are cases in point. Some of the standard values for waste discharge set by the government of Singapore are more stringent than in Japan, and a level of technology rarely seen in Japan is necessary in order to satisfy these requirements.

Case 8 Sophisticated Treatment of the Factory Wastewater, and its Reuse

1) Outline of the company

Company H (same as Company D in Case 4) Details of business: Manufacture and sales of color TVs. Number of employees: 1049 Commencement of operations: 1992 Location of factory: Industrial area in west Singapore. Japanese equity ratio: 100%

2) Background

The Japanese parent company of Company H is an internationally known general electronics manufacturer. The company has manufacturing plants for various products located throughout the world. 69% of the color TVs it manufactures are shipped to the Asian region, and 9% to Europe. Environmental measures undertaken by the company are required to be of a high international standard.

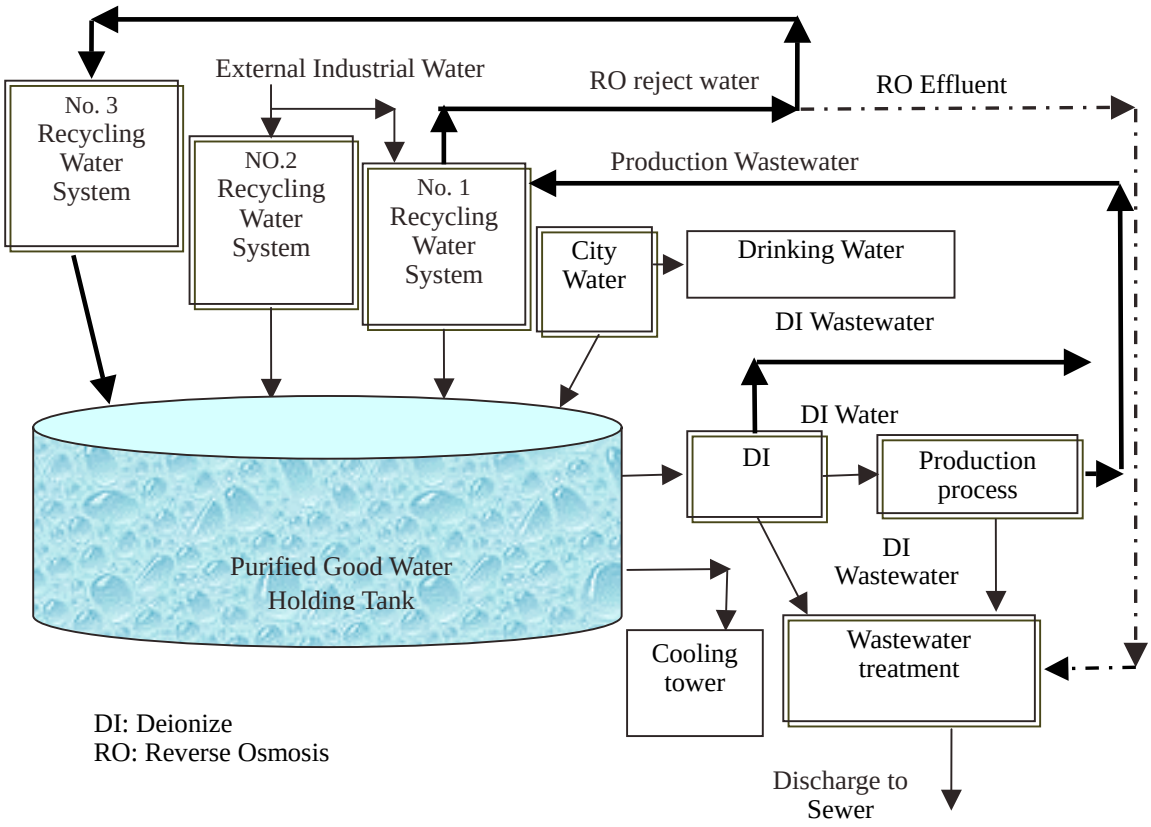
While the lack of water resources in Singapore is satisfied by the supply of water from its neighbor, Malaysia, recent negotiations on water charges between the two countries have proved difficult. As the factory owned by Company H requires supply of good quality water for the manufacturing process, measures have been implemented to ensure that this supply is available in the worst case. Furthermore, as the amount of water discharged is considerable, this water is treated to a high level and recycled in order to reduce environmental load.

3) Details of measures implemented

a. Recycling of wastewater

The recycling flow of wastewater discharged from the factory is shown in Figure 2-4-1. The water discharged from the manufacturing process is piped to the recycling water system (1), treated to produce good quality water, and stored in the purified water holding tank. The purified water is then deionized (DI) to produce water of an even higher quality for use in the manufacturing process. As part of this wastewater must be removed during the recycling process, the purified water tank is replenished from the public water supply. The recycling water system consists of three units, with one unit being owned by Company H, and the other two being released from a vendor. In order to control plant investment, the equipment was manufactured by the vendor at its own expense, and Company H pays expenses including operating costs.

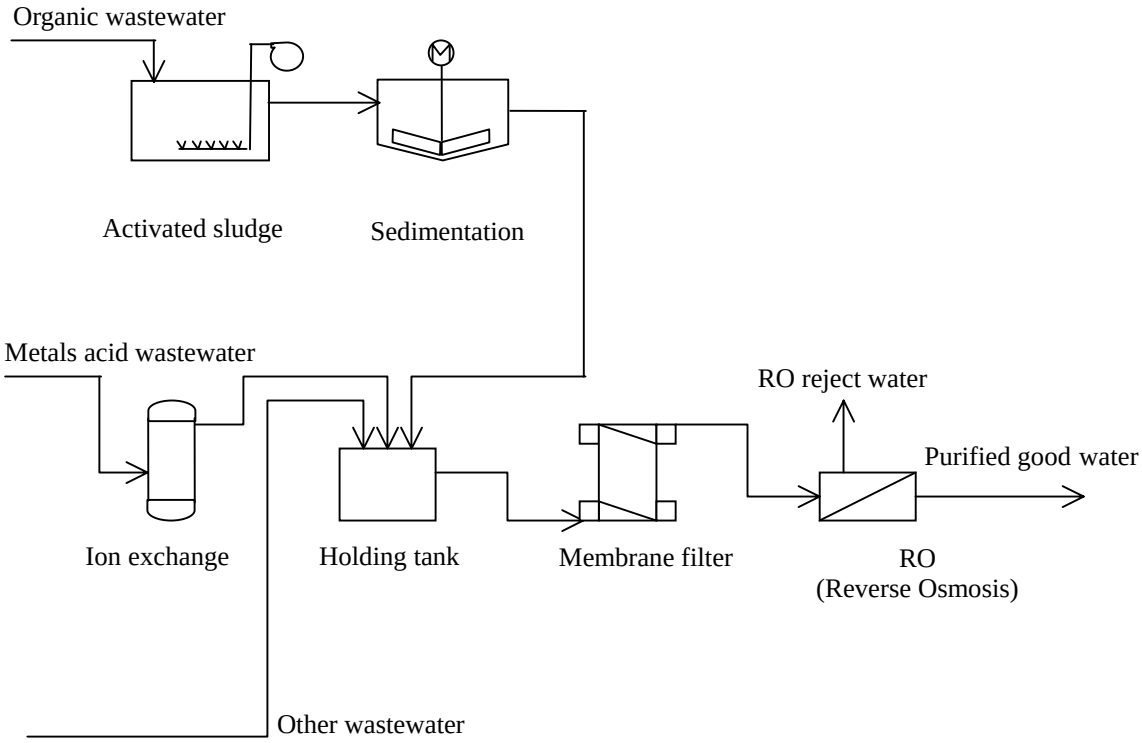
Figure 2-4-1 Recycling Flow of Wastewater



An outline of the recycling water system is shown in Figure 2-4-2. Organic pollutants in wastewater are broken down by treatment using aerated activated sludge, metals in acidic wastewater are removed by ion exchange treatment, and the remaining wastewater, and other wastewater, piped to a holding tank. This water is passed through micro-filters to remove microscopic suspended solids, and then subjected to reverse osmosis. Reverse osmosis involves pressurizing the water so that only water is passed through the osmotic membrane. This method is also used to obtain pure water from seawater.

The recycling rate for treated water was 35% when operations commenced in 1998, and reached 45% in 2001. The recycling of treated water has resulted in a significant reduction in the amount of water purchased from the water supply system, and a significant reduction in wastewater. While the cost of purchasing water from the water supply system has been reduced, recovery of plant investment requires a period of at least seven years. This is therefore not advantageous in management terms, however the primary purpose of the system is to reduce environmental load.

Figure 2-4-2 Outline of Wastewater Recycling Equipment



Case 9 Large Scale Plant Investment for a Manufacturing Process with Low Environmental Load

1) Outline of the company

Company I Details of business: Manufacture and sale of titanium oxide. Number of employees: 240 Commencement of operations: 1989 Location of factory: Industrial area in west of Singapore Island. Japanese equity ratio: 100%

2) Background

Titanium dioxide is important as a white coloring material in paints and plastics, and demand is increasing internationally. It may be produced by either the chlorine method or the sulfuric acid method. The chlorine method has a low environmental load, while the sulfuric acid method has a high environmental load. The chlorine method is therefore in primary use overseas due to its low environmental load.

The basic principle for an environment and safety is stated by the Japanese parent company of Company I as "A harmony of business operations and protection of the global environment, and working to gain the confidence of society". The selection of the chlorine method with its low environmental load for its overseas operations was an important application of this basic principle. In particular, a comparison of the amount of waste products generated by the chlorine and sulfuric acid methods shows that waste products from the chlorine method are much less than for the sulfuric acid method. In light of the increasing costs of treatment of waste products, selection of the chlorine method also became an economic decision. The raw material for the process is imported from Australia, India, and Africa in the form of high purity (93 - 95% titanium) ore. The chlorine gas used in the process is manufactured in the factory.

3) Details of measures implemented

a. Comparison of chlorine and sulfuric acid methods

An outline of the two methods is shown in Figure 2-4-3. The sulfuric acid method involves dissolving all titanium and iron etc in the ore in concentrated sulfuric acid, and hydrolysis of the resultant, titanium oxide sulfate (TiOSO4). The process produces large amounts of waste sulfuric acid of low concentration. This waste sulfuric acid contains impurities and is therefore unsuitable for recycling. Wastewater treatment therefore produces large amounts of wastewater, and dehydrated sludge to be discharged.

The chlorine method involves reaction of the ore with chlorine gas and coke dust at high temperature. Titanium, the primary component of the ore, and small amounts of iron and aluminum, react with the chlorine gas to produce gaseous chlorides. The titanium chloride is separated from the iron and aluminum chlorides using the difference in boiling points.

While the chlorine method is characterized by a low environmental load, the water solubility of the iron and aluminum chlorides allows their neutralization and removal, and wastewater and the reactive gas (CO_2) are discharged from the process. The chlorine gas is recycled and replenished as impurities are removed. The chlorine gas used in the process is manufactured in the factory.

Plant costs associated with the chlorine method are high due to the need for a heat-resistant structure to handle the high temperature reaction, and the variety of safety measures. In particular, comprehensive measures are required to handle chlorine gas, and the need to prevent chlorine gas leaks requires flawless leak detectors and periodic inspections, to the extent that the factory is absolutely free of the smell of chlorine.

b. Wastewater treatment

Wastewater treatment flow is shown in Figure 2-4-4. As the wastewater containing metal chlorides is acidic, it is neutralized by addition of an alkali. The metals are agglomerated as hydroxides and separated in the sedimentation tank, and the pH of the supernatant liquid is checked and discharged into the drainage ditch connected to the sea. A report on all 36 items specified in the factory wastewater standards is submitted to the Pollution Control Division monthly. A pH meter is installed at the wastewater outlet, and the outlet closed automatically if the pH value exceeds the standard value.

c. Waste products

The water in the sediment in the sedimentation tank is removed in a filter press to produce dehydrated sludge. Approximately 20,000 tons of the sludge is produced annually, and is disposed of by a licensed waste processing company.

The waste sulfuric acid produced with the sulfuric acid method is also treated with neutralized sediment, however the amount of solids produced is considerably greater than with the chlorine method.

d. Waste gas

The combustion furnace used in heating the reactor produces waste gas, however as LNG is used as fuel there is no problem with sulfur dioxide or ash. Fuel oil is used to heat the boiler, however conversion to low-sulfur fuel oil or LNG is currently under investigation in order to reduce the ash problem.

A camera linked to the control room is fitted to the smokestack to allow constant monitoring of the discharged gas. The ash concentration may generally be determined from the color of the gas.

e. Water supply

Two types of water - industrial water and water for manufacturing processes, are used. Water for manufacturing processes is taken from the water supply, and industrial water is obtained from sewerage treatment. While industrial water is sterilized, it is of low quality. Industrial water is used for cooling, and care is therefore taken to prevent problems with Legionella.

f. Energy conservation

Power economizers not seen in Japan are fitted to motors. Appendages are fitted to the rear of pumps and compressor motors in order to improve the efficiency of the AC power employed in Singapore by between 8 and 10%. As there is no need to improve the power efficiency in Japan, the benefits of investment in such equipment are low.

Drain water from condensation of steam used in the factory is recycled as boiler water.

Figure 2-4-3 Comparison of Sulfuric Acid and Chlorine Methods in Manufacture of Titanium Oxide

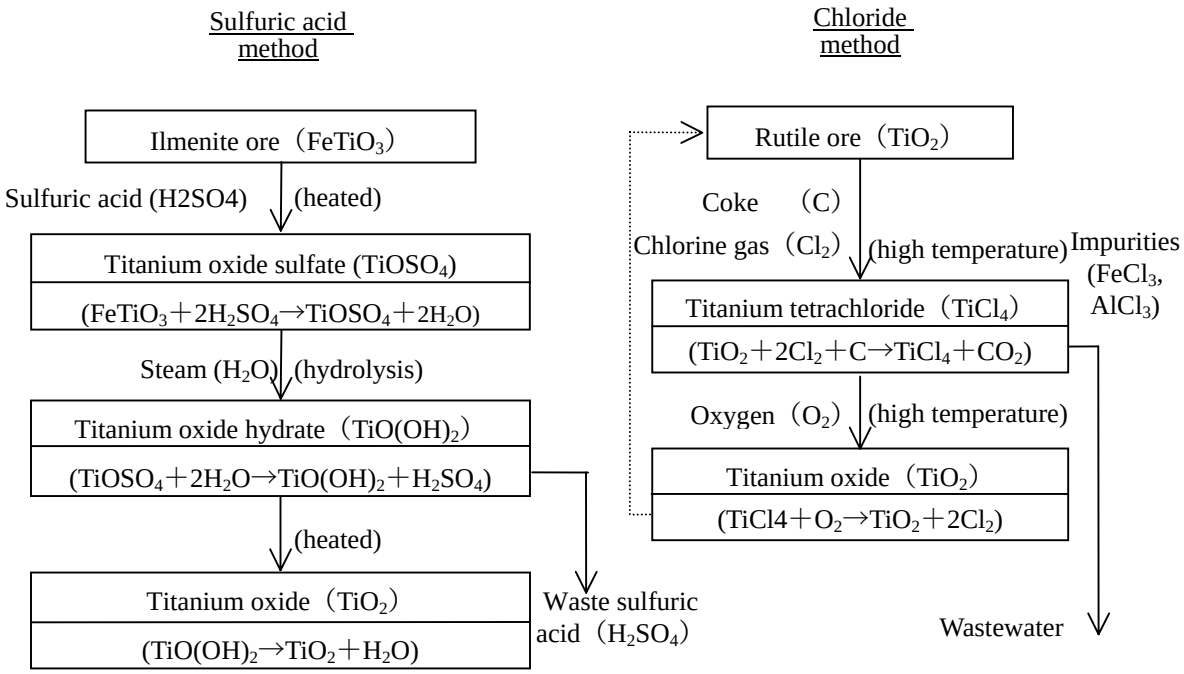
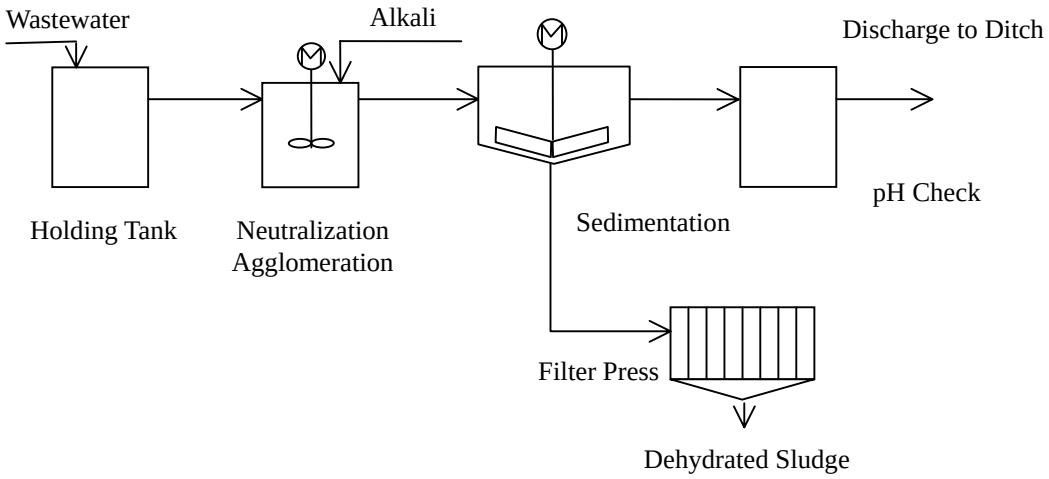


Figure 2-4-4 Wastewater Treatment Flow



Case 10 Dealing With a Large Number of Strict Environmental Regulations

1) Outline of the company

Company J Details of business: Manufacture and sale of phenol and bisphenol A. Number of employees: 139 Commencement of operations: 1997 Location of factory: Industrial area on Jurong Island. Japanese equity ratio: 100%

2) Background

The Japanese parent company considers its phenol and bisphenol A operations as a central part of its business, and is developing these operations focused on the growing market in the Asian region as part of its strategy. It products occupy an overwhelming share of the market in the Asian region. This factory manufactures both phenol and bisphenol A, phenol being the raw material for the manufacture of bisphenol A. Other Japanese chemical companies are located in the immediate area, and the need for a supply of bisphenol A as the raw material for the operations of these factories was the reason for the location of the factory in Singapore. The factories in the adjacent area obtain all raw materials from Company J.

Environmental problems are to be avoided at all costs in order to ensure an uninterrupted supply to customers, and to realize the strategy of the Japanese parent company. The manufacturing processes employed in chemical factories discharge waste products which necessarily result in a load on the environment, and the company is therefore implementing measures to ensure that is adheres to the strict environmental regulations of Singapore.

3) Measures taken by the company

a. Waste

The primary environmentally related process flows for Company J are as shown in Figure 2-4-5. The phenol manufacturing process discharges wastewater containing a high concentration (2%) of organic solids. Treatment of this wastewater to satisfy the wastewater standard values requires considerable equipment and expense, then it was therefore decided to employ a process of incineration in which the wastewater containing the organics is sprayed into a combustion furnace. Fuel oil is used as the heat source for the incinerator, with the heat generated by combustion of the organics being recovered in a waste heat boiler. The wastewater contains dissolved salts which are discharged from the incinerator as fused salts, and the combustion gas dust collector also collects powdered salts. The fused salts and powdered salts are dissolved in the wastewater flowing from the cooling tower and collected in a neutralization tank. As this solution is acidic it is neutralized by addition of an activated soda solution. This solution contains small amounts of heavy metals which are precipitated as hydroxides during neutralization and separated in a settling tank. The pH of the supernatent fluid in the settling tank is checked, and it is then discharged into the drainage ditch connected to the sea. The discharged water has a high concentration of sodium sulfate, a non-toxic salt. The Singaporean standards for wastewater include a TDS (Total Dissolved Solids) value not used in Japan. The standard value for wastewater discharged into the drainage pitch is very strict at 2000mg/liter, a value which is readily exceeded with neutralization of acidic and alkaline wastewater. This requirement was removed when it was explained to the Pollution Control Division and that this level was non-toxic in the factory.

The wastewater generated from the bisphenol A manufacturing process contains low concentrations of organics, and is therefore pumped to a wastewater treatment plant in the industrial area for biological treatment. As the treatment capacity of this plant is approaching its maximum the wastewater it receives is subject to a TOC (Total Organic Carbon) restriction.

A TOC meter is installed in the wastewater pit, and the pumped water is shut off automatically if the limit value is exceeded. As automatic shut off without warning causes problems, the wastewater is controlled at the factory in accordance with the readily measured COD value. The TOC and COD values are interrelated, with the TOC limit being equivalent to a COD value of 2,150mg/liter, and the water is pumped while constantly verifying that this value is not exceeded.

b. Waste gas treatment

The wastewater incinerator used in the phenol manufacturing process is fired with fuel oil. The chlorides in the waste gas, and the heavy metal dust from the fuel oil, are removed with an electric dust precipitator and a bag filter. The standard value for dust when the factory was built was 200mg/Nm^3, a level considerably within the limits of the capacity of the precipitator, however in 2001 the standard value was reduced to 100mg/Nm^3, and a bag filter was fitted in order to satisfy this increased requirement. Ash is measured automatically and a report issued monthly. Reasons are submitted in written form if the limit value is exceeded. This limit is sometimes exceeded when fuel is changed, however it continues for a short time only. This fact is understood by the relevant authorities.

The standard value for sulfur dioxide is cleared with the fuel oil used (sulfur content of 1% or less). The standard value for nitrogen oxide is cleared with combustion control alone. A certified measurement organization is requested to measure ash, NOx, SO_2, and dioxins annually, and a report received. As sampling presents particular difficulties the Pollution Control Division does not undertake this measurement directly.

The waste gas generated by the phenol manufacturing process contains high concentrations of Volatile Organic Carbon (VOC) compounds. This gas is cooled to condense the compounds to a liquid for recovery. These compounds remain at a concentration of approximately 400ppm, and are passed through a catalytic combustor where they are almost completely broken down, to the extent that release into the atmosphere may be practically ignored. The standard value for discharge of benzene, the raw material for the manufacture of phenol, is 5mg/Nm^3, considerably less then the 100 - 1500mg/Nm^3 in Japan. Benzene is recovered and stored in an underground tank, and the level in the tank controlled to ensure that it is not inhaled. Instructions have been received to install combustion equipment as a means of preventing leakage during offloading from tankers.

c. Waste products

Sludge produced from the treatment of wastewater is analyzed by a certified industrial analysis company, and together with the results of the analysis, is passed to a certified waste processing company for disposal in landfill. This sludge amounts to a few tons per month, and it is therefore shipped and analyzed weekly.

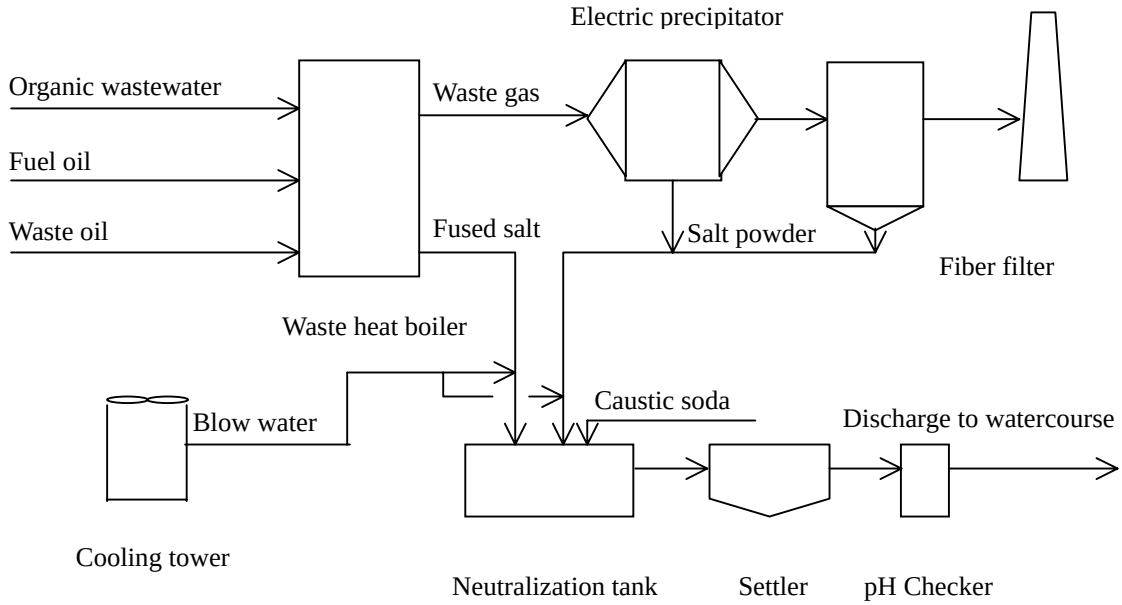
Approximately 400 tons/month of residue is produced from the bisphenol A manufacturing process, the majority of which is non-toxic high polymer organics, however as a very small amount of phenol is included it is handled as a toxic industrial waste product and passed to a certified waste processing company.

d. Miscellaneous

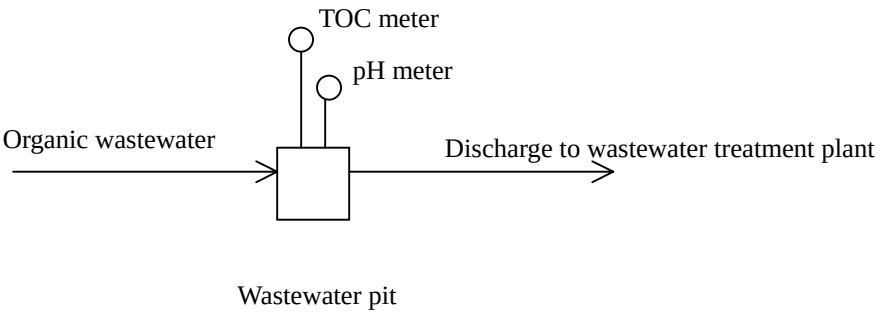
Singapore has implemented regulations for control of Legionella bacteria in the recycled water in cooling towers. Such regulations have not been implemented in Japan. These regulations require that the recycled water be drained completely, and the equipment cleaned, at six-month intervals, however as the factory operates continuously, work cannot be halted for cleaning. After negotiations with the Pollution Control Division, an agreement was reached in which a bactericide is added to the recycled water, and tests for proliferation of Legionella bacteria conducted periodically.

Figure 2-4-5 Primary Environmentally Related Process Flows for Company J

Phenol production



Bisphenol A production



Case 11 Using Sophisticated Treatment Technology to Satisfy Strict Wastewater Standards

1) Outline of the Company

Company K
Details of business: Manufacture of polycarbonate.
Number of employees: 189
Commencement of operations: 1999
Location of factory: Industrial area on Jurong Island.
Japanese equity ratio: 100%

2) Background

Company K receives bisphenol A as the raw material from an adjacent Japanese company and manufactures polycarbonate, a general purpose plastic. In combination with the Japanese parent company's factory, Company K is a leading player in its field, with 12% share of the world market for the product. Increased production is planned. Leading edge environmental measures are required of the company commensurate with its position in its field. The manufacturing process produces large quantities of wastewater which are discharged into the sea. A number of the standard values for discharge of non-sewerage wastewater set by the government of Singapore are extremely strict, and sophisticated technology rarely used in Japan is necessary to satisfy these requirements.

3) Details of measures implemented

a. Wastewater Treatment

The manufacturing process generates large amounts (3,000 tons/day) of wastewater containing unreacted bisphenol A (BPA), methylchloride (MC), and other organics in high concentrations. While this wastewater is discharged into the sea, it is subject to the wastewater standard values for general waterways. These standard values are shown Table 2-4-1. The standard values for COD, TSS, TDS, and phenolic compounds are extremely strict in comparison with the values used in Japan. TDS is unregulated in Japan, and when acidic or alkaline wastewater is neutralized the salt concentration increases and readily exceeds the standard value.

Table 2-4-1 Standard Values for Wastewater Applied in Company K Plant

（Items other than pH are in mg/liter）

Item	COD	TSS[1)]	TDS[2)]	Phenolic compounds	Fats and oils	Phosphate compounds	pH
Standard value	100	50	2,000	0.2	10	5	6-9
Japanese standard values [3)]	160	200	—	5	5	16	5.8-8.6

1) Total Suspended Solids
2) Total Dissolved Solids
3) Ordinance from Prime Minister's office setting wastewater standards (see separate Tables 1 and 2).

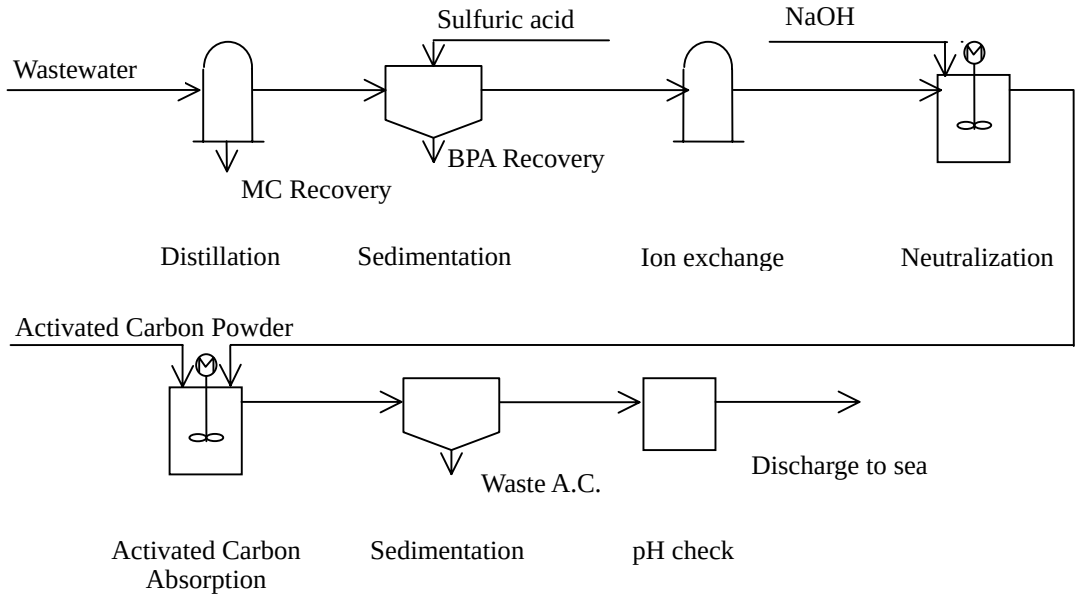
The treatment equipment shown in Figure 2-4-6 has been installed in order to ensure that these standard values are cleared. Wastewater is first evaporated, and the discharged unreacted methylchloride (MC) recovered. Sulfuric acid is then added to precipitate the unreacted bisphenol A, and the precipitate recovered. The remaining trace amounts are then separated and removed with an ion exchange resin. Powdered activated charcoal is added finally to absorb and remove the remaining small amounts of organic compounds. This treatment process is sufficient to clear all requirements, however as acidity or alkalinity is neutralized, the discharged water contains a high concentration of TDS and non-toxic salts such as sodium sulfate.

This situation was explained to the Pollution Control Division and an understanding obtained as to the fact that the standard values are exceeded. The Pollution Control Division visits monthly for random sampling, and the above items are analyzed weekly.

The Singapore government's wastewater regulations cover 36 items including those above. Each of the 36

items is analyzed monthly by a certified industrial analysis company (a group company) at a total cost of S$1,000. The analysis values obtained by the Pollution Control Division and the group company occasionally differ, and in this case the values obtained by the group company are adopted.

Figure 2-4-6 Wastewater Treatment Flow for Company K



b. Waste Products

Approximately 16 tons of industrial waste products such as activated charcoal and methylchloride are generated by the wastewater treatment system every month. Disposal of these waste products is subcontracted to a certified industrial waste treatment company. The plastic-coated cloth bag used for carrying the bisphenol A are also handled as toxic industrial waste, and the total of all waste products generated is therefore between 70 and 80 tons/month. The amount of waste products generated monthly is reported to the Pollution Control Division.

c. Miscellaneous

Occupational safety measures are an important part of company activity. The Ministry of Manpower requires training of employees in occupational safety - persons may only be employed after a training period of four days. This training is at considerable expense to the company, and also applies to short-term employees. A government-certified monitoring organization (NOVO) audits occupational safety measures every two years, and the results of the audit, and the activity plan for the next period, are submitted to the Ministry of Manpower, Pollution Control Division, and the Bureau of Fire Safety and Shelter. ISO14001 certification is planned for 2003.

Section 5
Environmental Measures in New Business Development

The phrase "profit from environmental measures" is sometimes heard in management circles, and the benefits of ISO14001 certification in terms of running a business, and the possibilities of reduced consumption of raw materials through reduction in waste products, are readily understood. Singapore has developed a set of environmental regulations not found in Japan, and in a number of cases the response to the strict demands for environmental measures from European and US customers has lead to the development of new business.

Case 12 Evolution of ISO14001 Activities into New Technological Developments

1) Outline of the company

Company L Details of business: Manufacture of wastewater treatment equipment, and sales of water treatment chemicals. Number of employees: 55 Commencement of operations: 1978 Location of factory: Industrial area on Jurong Island. Japanese equity ratio: 100%

2) Background

Company L has the majority of orders for the construction of wastewater treatment equipment, and related chemicals, for Japanese companies operating in Singapore. The company's operations cover everything from design to construction of the equipment, and manufacture of the chemicals in-house.
It is the largest such operator in Singapore, with a share of 30% of the market. The nature of its business ensures that it is expected to be a model for environmental measures.

In climate in which customers promote ISO14001 certification, the position of Company L in the environmental management business requires that it acquires certification. On the other hand, the small number of employees in the company mitigate against the appointment of a dedicated person in charge of certification, and certification also required development of a bactericide for re-circulated water in cooling towers, an environmental measure not required in Japan. These factors combined to promote the company's ISO14001 activities and development of chemicals in parallel. Cost reductions are often mentioned in connection with environmental measures, however in this case, environmental measures have resulted in development of new products.

3) Details of measures implemented

a. Acquiring ISO14001 certification

The company was among the first in Singapore to be ISO14001 certified, with preparations beginning in 1996 and certification being acquired in 1997. Targets between 1996 and 2002, and the associated dates are as shown in Table 2-5-1. The measures required for Legionella are notable. Regulations to control Legionella bacteria in the re-circulating water in cooling towers used in many factories were introduced in 2001. Chemicals containing hydrazine are conventionally used as a bactericide for re-circulating water, however this chemical has a tendency to induce mutations, and is carcinogenic, and the search for a non-hydrazine based bactericide is continuing. The cost-effectiveness of any replacement for hydrazine is a matter of great importance, and hydrazine is therefore still in use

The company's concern for the effect on the environment has resulted in it taking the lead in setting its own target for a reduction in sales of hydrazine. The targeted reduction in sales of hydrazine was 10% for 1996/1997, 10% for 1998 10%, and 5% for 2000. At the same time, the company employed new technology in the development of a biological treatment method in 2001. This method has been partially implemented. In addition to this technology becoming part of the company's product range, it is widely used in control of Legionella in Singapore. While the company's reduction in sales of hydrazine-based chemicals has a negative effect on its sales figures, it has the significant effect of focusing on environmental measures, and of spurring the development of a replacement chemical. Local staff are engaged in a variety of measures including development of chemicals, reduction in sales, and development of a biological treatment method, and the integrated work of this team has produced excellent results.

The company sets annual targets for reuse of sampling bottles and chemical drums etc, and continues to achieve positive results.

The azole solvent and DMF (dimethylformamide) employed in the manufacture of water treatment chemicals are both recognized as acutely toxic and carcinogenic, and the company has therefore set a target for replacement with DGME (diethylene glycol monomethyl ether) and DMAA (dimethylallyl amine).

Table 2-5-1 ISO14001 Environmental Management System Targets

Year	Target	Period
1996/ 1997	Reduction of 10% in sales of hydrazine used as a bactericide for re-circulated water in cooling towers. April 1997 - December 1997	April 1997 - December 1997
	Recycling of 20% of used sampling bottles.	March 1997 - April 1997
	Reduction of 10% in water for washing mixing tanks employed in manufacture of liquid chemicals.	March 1997 - May 1997
	Recycling of 20% of used chemical drums as chemical containers.	April 1997 - June 1997
	Reduction of 10% in power consumption.	February 1997 - September 1997
	Recycling of 20% of used Jerry cans as chemical containers.	February 1997 - 1997 March 1998
	Use of industrial water as cooling water.	October 1997 - December 1998
	Relocation of wastewater from processes for the manufacture of powder used in preventing chemical leaks and liquid chemicals.	February 1996 - April 1996
	Reduction of BOD and COD for wastewater treatment water to 320mg/liter and 480mg/liter respectively.	August 1996 - April 1997
	Relocation of piping to prevent leakage of chemicals and mixing tanks.	February 1997 - August 1997
	Prevention of water leaks from wastewater treatment equipment used in preventing soil contamination and underground water contamination.	November 1996 - January 1997
1998	Reduction of 10% in sales of hydrazine bactericide.	January 1998 - December 1998
	Reduction of 10% in purchases of Jerry cans and HDPE containers.	January 1998 - January 1999
	Implementation of measures to reduce odors in the workplace by improving exhaust efficiency in chemical mixing process.	October 1998 - March 1999
1999	Development of new chemical to replace hydrazine used as a bactericide for re-circulated water in cooling towers.	June 1999 - December 2000
	Disposal of unnecessary or expired chemicals.	May 1st 1999 - end of December 1999
	Movement of chemicals previously stored outside factory to warehouse.	May 1st 1999 - end of December 1999
	Sorting of waste products prior to disposal.	May 1st 1999 - end of June 1999
2000	Reduction of 5% in sales of hydrazine bactericide.	January 2000 - end of December 2001
	Disposal of unnecessary or expired chemicals.	January 2000 - end of December 2000
	Movement of chemicals previously stored outside factory to warehouse.	January 2000 - end of December 2000
	Discontinued use of azole solvents. Replacement of DMF with DGME and DMAA.	January 2000 - end of December 2000
2001	Development of bacterial treatment method for Legionella bacteria.	January 2000 - end of December 2002
	Recycling of 30% of used plastic containers.	January 2001 - end of December 2001
2002	Reduction of 1% in total materials purchased.	January 2002 - end of December 2002
	Reduction of waste products to maximum of 8% of total materials purchased.	January 2002 - end of December 2002

b) Wastewater treatment

The chemical manufacturing process generates wastewater which is treated with the equipment as shown in Figure 2-5-1 and discharged into the sewerage system. The wastewater is collected in the receiving pit, moved

to the holding tank, and treatment commenced when the tank is full. The small volume of wastewater allows batch processing in this manner.

Chemicals are first added to neutralize and coagulate the solution, and heavy metals and suspended solids removed from the sedimentation tank. Organics are broken down by passing through a bed packed with microorganisms, suspended solids removed by passing through a filter bed, the pH checked, and the water discharged. A pH meter (automatic pH recorder) sealed with tape, and an automatic shutoff valve, are installed immediately before the discharged outlet at the request of the Pollution Control Division. Only Division staff are permitted to remove the recording paper. A Division inspector visits monthly to check the pH value, and an explanation is required if this value exceeds the standard value.

Standard values for wastewater are applicable when the wastewater is discharged into the sewerage system, and analysis values for the 15 items in Table 2-5-2 are submitted to the Pollution Control Division monthly. The analysis is subcontracted to a certified industrial analysis company. Analysis of the 15 items costs approximately S$4000. Items required for checks of water quality are analyzed in the company laboratory if possible (i.e., the 13 items other than BOD and detergents). All items clear the standard values without problems. Items requiring control are determined by the Pollution Control Division on the basis of the type and usage of chemicals originally submitted in the factory planning stage.

Figure 2-5-1 Company L Wastewater Treatment Flow

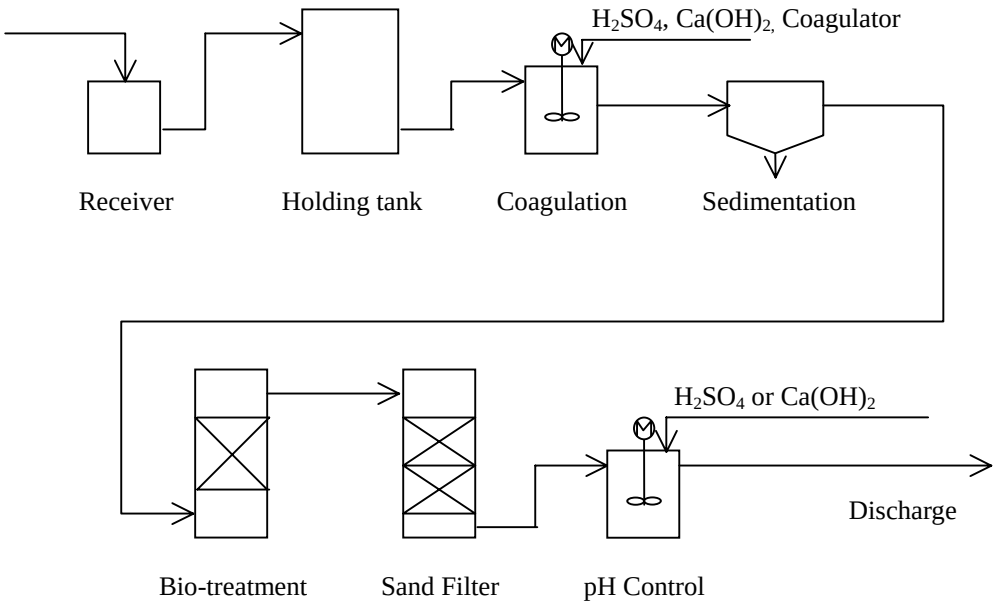


Table 2-5-2 Items Analyzed by Company L, and Standard Values

(Items other than pH are in mg/liter)

Item	pH	BOD	COD	TSS	TDS	SO_4	G&O	Det.	Cl	Fe	Mg	Cr	Hg	Ag	Zn
Standard value	6-9	400	600	400	3000	1000	60	30	1000	50	10	5	0.5	15	10

TSS: Total Suspended Solids
TDS: Total Dissolved Solids
O&G: Oil and Grease
Det.: Detergents

c. Waste products

Empty containers and wooden delivery pallets for stock chemicals formally disposed of are increasingly recycled in accordance with ISO14001 activities. Precipitates generated by the wastewater treatment equipment and dehydrated in a filter press and disposed of as sludge by a certified waste treatment company.

d. Miscellaneous

The operations in which Company L is involved require permission for handling of toxic chemicals. This permission is not granted to the company, but to individuals, and the Singaporean factory manager has therefore received the permission in his personal name.

Case 13 Development of a Non-polluting Cutting Fluid by a Small Business

1) Outline of the company

Company M Details of business: Manufacturing and development of high-grade metal cutting fluids. Number of employees: 6 Commencement of operations: 1988 Location of factory: Industrial area in west of Singapore Island. Japanese equity ratio: 100%

2) Background

Company M's high-grade cutting fluids are used in conjunction with automatic lathes in which precise numerical control is required during the manufacture of small rotating components for hard disk drives, CDs, and printers. The company is an independent small business which has established itself in Singapore in association with the growth of large electronics factories in Southeast Asia. Environmental measures required for cutting fluid for European manufacturing machinery in Singapore are more severe than for Japanese manufacturing machinery, and a non-polluting cutting fluid is required. Development of the product was initiated in-house in response to customer requirements, and the company now has a 70% share of the Singapore market for cutting fluid for automatic lathes. While the scale of operations of the company is small, it has managed to grasp new requirements for environmental measures and employ creativity and determination with excellent results. The adoption of non-polluting cutting fluid for Japanese manufacturing machinery, in addition to its use for European manufacturing machinery, is expected to significantly increase the role of Company M in future.

3 Details of measures implemented

a. Dechlorinated and desulfurized cutting fluid

The EU regulates the use of chloride additives to reduce dioxins when used cutting fluid is incinerated. This specification is also required in high-grade cutting fluid. Cutting fluid is manufactured using a base oil purchased from the major oil companies, to which is added various additives imported from Europe, the US, and Japan. Considerable technical knowledge is required to determine the proportions of the various additives in order to obtain the performance required by the customer. Repeated tests were therefore conducted in which various additives were selected and combined in differing amounts to obtain the optimum conditions.

Dechlorinated additives provide excellent protection from seizing when machine stainless steel, and have therefore being used for a considerable time. A program of new development was required to obtain the same result without the use of dechlorinated additives. Information on dechlorinated additives was collected from European and US reference material, the Internet, and catalogues, samples produced by blending the selected additives, and the samples tested on the company's experimental cutting machinery to verify that seizing did not occur despite rpm being increased. As long-term testing was not possible, customers were approached to participate in the final stage of testing. While the cost of dechlorinated cutting fluids is 3 - 4 times that of other cutting fluids, components in some machines manufactured in Europe and the US may be damaged if chlorinated cutting fluid is used, and the operator therefore has no choice.

The need to use desulfurized cutting fluid in factories using European and US cutting machinery is not directly related to any environmental problem, but is a result of the effect of the mist generated from these fluids on semiconductor chips. The sulfur content of the mist results in defective chips, and the use of desulfurized fluid is therefore a required condition.

A desulfurized cutting fluid was therefore developed by the company in the same way as the dechlorinated product. Sulfur has the property of corroding metals, and its use appears to be prohibited in Europe and the US in connection with precision electronics, however there is no requirement yet for desulfurized cutting fluid in factories using Japanese cutting machinery.

b. Treatment of waste oil

The manufacturing process requires cleaning of the mixing tank each time the mixture is changed, however as the base oils are similar a small amount of base oil is used for cleaning and the cleaning process therefore

does not generate cleaning water. As any oil spilt on the floor is removed with a vacuum cleaner for liquid applications and wiped with a cloth, no oil is released outside the factory. Waste oil stored in drums is disposed of by a certified waste processing company at a cost of S$15/200 liter drum. Cost of disposal of thinners and water-soluble cutting fluid is S$20/200 liter drum.

As customers recycle cutting fluid it is replenished to compensate for the amount adhering to products. A centrifugal separator is used to recover as much as possible of the cutting fluid adhering to products. As recycling continues the additives degrade and cutting performance is reduced, and additives are therefore replenished. While the base oil is recycled, cutting fluid used for long periods is collected by Company M and passed to a waste processing company when a sufficient amount has accumulated. The waste processing company disposes of the waste oil by incineration in a furnace in which the waste gas is held at high temperature for sufficient time to ensure that no dioxins are generated.

Automatic lathes run unattended 24 hours per day. The use of water-soluble cutting fluid is therefore generally increasing as a fire prevention measure, however as there is no danger of a temperature increase with small components, oil-based cutting fluids continue to be used in this application.

The industrial area in which this factory is located contains a number of factories manufacturing small components for industrial applications, a type of industry which was specifically targeted by the Jurong Town Corporation when establishing the area. The land leased is renewed at three-year intervals, and must be eventually returned in its original condition. Particular care is therefore required to prevent oil contamination. There is no legal requirement for measures to prevent explosion, or dedicated staff responsible for control of hazardous goods, as is the case in Japan.

Case 14 Winner of the Responsible Care Award in the Environmental Section

1) Outline of the company

Company M Details of business: Manufacture of basic raw materials for chemical production (e.g., ethylene, propylene). Number of employees: 350 Commencement of operations: 1984 Location of factory: Industrial area on Jurong Island. Japanese equity ratio: 100%

2) Background

Company N manufactures ethylene and propylene, the raw material used for a wide range of petrochemical products manufactured from naptha, LPG, and gasoline. The company supplies these raw materials to 11 companies in a complex in the same industrial area. Any environmental problems would result in a halt to operations and an interference to supply of raw materials, a situation which cannot be allowed to occur under any circumstances.

In addition to the factory being well equipped with environmental equipment, for example wastewater treatment equipment, considerable effort is expended in training and raising environmental awareness of employees. It is considered important that individual employees be concerned about environmental problems, and the Responsible Care Activities (activities related to maintaining autonomous responsibility for environmental, safety, and health measures in all processes in industries handling chemical substances, from product development to disposal) well known in the chemical industry are used effectively in raising the environmental consciousness of employees.

3) Details of measures implemented

a. Responsible care activities

The chemical industries of the primary industrial nations are concerned to establish environmental, safety, and health measures throughout the entire product life cycle, and to raise the confidence of society in the industry through interaction with various groups on the part of operators engaged in the autonomous development of Responsible Care Activities. The Chemical Industry Association in Singapore has a Responsible Care Activities Committee which has established an award system for excellence in environmental, safety, and health activities. Company N has been a member of the committee since 1999, and has received an award for excellence in environmental management. Receipt of an award is also associated with ISO14001 certification, received in January 2002.

Company N announces its Responsible Care Policy in the name of the president. This policy covers basic policy in environmental, safety, and health measures, environmental measures being described as 'Preventing pollution of the environment by minimizing the environmental load of production activities, products, and services, efficient use of raw materials, materials, and energy, and minimizing waste gas, wastewater, and penetration of underground water.'

The policy covers 11 practical activities, the most notable of which are as follows.

- Dissemination of information to employees, supervising agencies, citizens, and customers.
- Management of the environment, safety, and health are the direct responsibility of line managers.
- Demands for strict adherence to Responsible Care Policy by suppliers.

Targets for the environment, safety, and health based on these policies are announced clearly in the name of the president.

Environmental targets are as follows.

- Further implementation of a monitoring system to reduce waste gas pollutants from the factory.
- Wastewater: Prevention of leaks or unexpected discharge of pollutants into wastewater from all facilities.

- Waste products: Improvements in sorting and collection, and sorting system.
- Disposal in landfill: Improvement in management of landfill within complex, and evaluation of effects on underground water.
- Management of raw materials: Reductions in use of toxic substances, and improved efficiency in use of raw materials.

Eleven further targets have been determined for achievement of these targets by 2002. For example, setting of a voluntary waste gas standard to reduce discharge by July 2001, and implementation of underground water monitoring by July 2000.

The Environmental Management Program (EMP) is implemented within ISO14001 activity as a means of achieving these targets. Leaders have been selected for each of the following five activities under EMP, and the program implemented.

- Setting of a voluntary waste gas standard.
- Underground water monitoring.
- Environmental management in accordance with Responsible Care.
- Reduction in discharge of hydrocarbons into the sea.
- Improvements in sorting and management of waste products.

The setting of a voluntary waste gas standard has achieved dramatic results in reducing emissions of volatile organic compounds (VOC). Singaporean regulations do not include standards for VOC emissions. Progress in this activity has been as follows.

- July 2000 Gathering of baseline data for VOC emissions.
- November 2000 Analysis of baseline data and identification of facilities for which reduction is possible.
- June 2001 Feasibility study for facilities for which reduction is possible.
- July 2001 Setting of standard values and proposals for implementation plan.

A standard value of 0.1g/Nm^3 was proposed for VOC emissions for the identified facilities. The emission standard is currently being verified in accordance with the implementation plan, and activities towards achieving the standard value are proceeding. The company received a Responsible Care Award for the implementation of measures for the reduction of a substance for which Singapore has no standards.

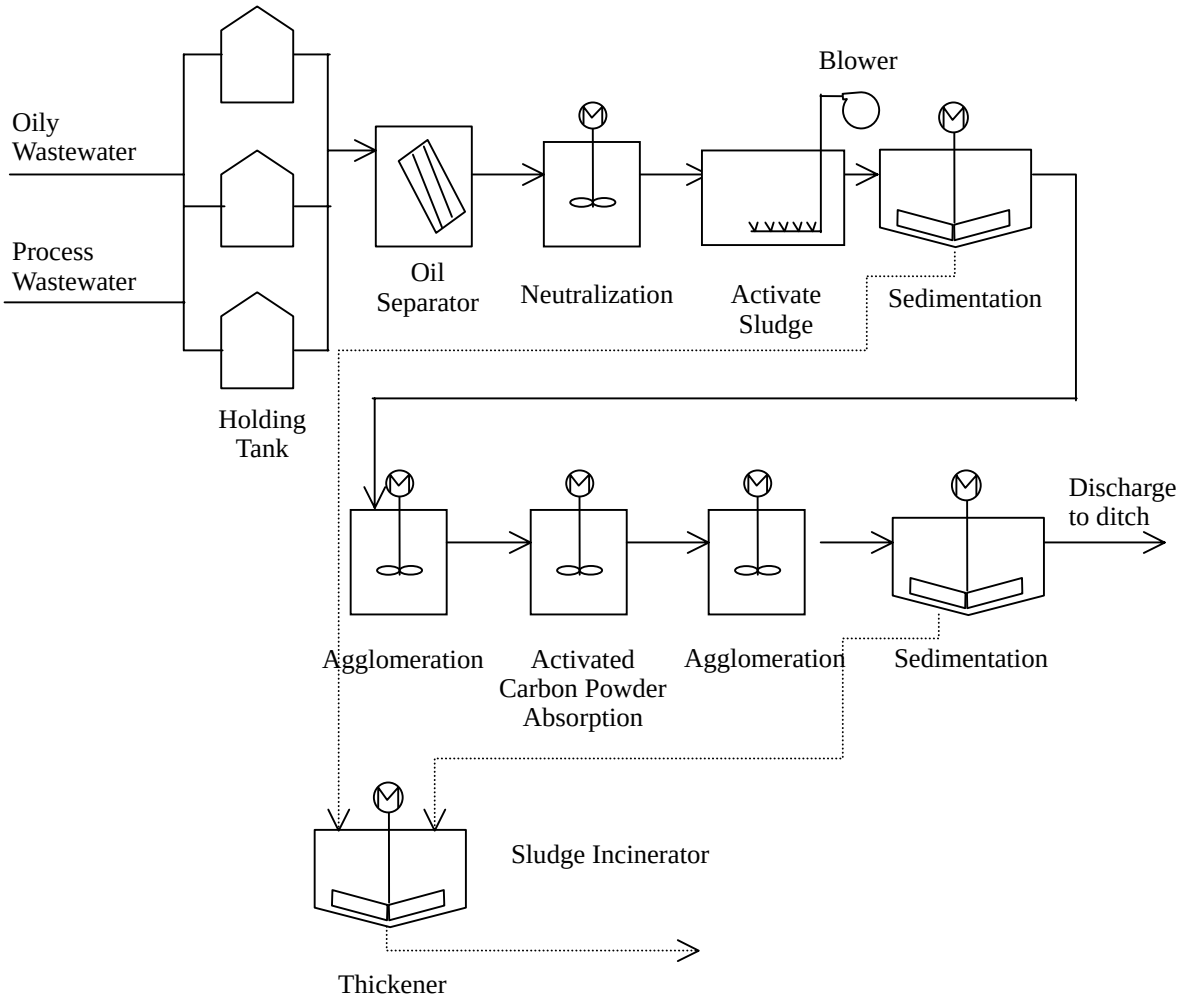
b. Wastewater treatment

The manufacturing process generates two types of wastewater - one containing organics, and the other containing oil. The two types of wastewater are each produced at a rate of 100 tons/hour, and are treated separately into different facilities within the factory, and discharged into the sea. An outline of the wastewater treatment facilities is shown in Figure 2-5-2. The wastewater is generated by a number of different types of equipment, and differs in terms of the organics it contains, and their concentration. COD concentration in wastewater is as high as 2000mg/liter. To ensure stable treatment, three 1000m3 holding tanks have been installed in which wastewater is collected to ensure a uniform water quality before treatment. These tanks are particularly beneficial in ensuring that the water treatment facilities are not subject to an excessive load if water with a high concentration of pollutants is discharged when problems occur in that plant. The wastewater is passed from the holding tanks to an oil separator where the oil is separated on inclined plates, and the water adjusted for pH and pumped to the activated sludge tank in which the organics are broken down by the activated sludge while the mixture is aerated. The activated sludge is separated by sedimentation in the sedimentation tank and the water pumped to the agglomeration additive tank, the activated carbon powder absorption tank, and the sedimentation tank again, and the supernatant liquid discharged into the sea. As the standard value for COD in the discharged water is extremely severe at 100mg/liter, powdered activated carbon is added to the water following activated sludge treatment ensuring that the standard value is cleared without problems. A continuous TOD meter is installed in the discharge outlet to monitor the COD value using an equivalent value. Color, temperature, pH, and suspended solids are measured daily, and a report submitted monthly to the Pollution Control Division. Division personnel also visit for random sampling.

Sludge consisting of activated sludge remaining after it has been treated, and waste activated carbon from the activated carbon additive tank, accumulates in the two sedimentation tanks. The water content of this sludge is removed in the thickening tank, and the sludge is then incinerated in the sludge incinerator using waste oil as

a supplementary fuel.

Figure 2-5-2 Company N Wastewater Treatment Flow



c. Waste gas

Waste gas is generated by the sludge incinerator, and boilers and thermal decomposition furnaces used in the manufacturing process. The sludge incinerator has the capacity of 150 tons/month, and is fired with waste oil from the manufacturing process. Boilers and thermal decomposition furnaces are also fired with waste oil, as well as with fuel gas from the manufacturing process which comprises primarily methane and hydrogen. As the sulfur content of the waste oil and fuel gas is low, emissions clear standard values for sulfur dioxide. As the low sulfur concentration of the fuel is guaranteed, the results of analysis of the waste gas are not required to be reported, and only the dust concentration is reported to the Pollution Control Division. The standard value for dust concentration was set lower in 2003 to 100mg/Nm^3, however a value of 200mg/Nm^3 is applicable during the current transition period. Current treatment of the gas is such that the 100mg/Nm^3 value is cleared. As boilers and thermal decomposition furnaces account for a total of 20 waste gas outlets, measurement of only representative outlets is considered satisfactory.

d. Waste products

Waste products consist of incinerator ash, waste catalysts, and laboratory waste, and are disposed of in a landfill held jointly by the group companies in the complex. This landfill is 3m deep, 50m wide, and 150m long and has been in use for a period of 20 years. It is currently three-quarters full. Underground water sampling wells have been drilled around the periphery of the landfill to monitor water quality as a means of monitoring soil contamination. Currently, no contamination of underground water is apparent, and there is

therefore no danger of soil contamination. On the other hand, if soil contamination does occur in future, not only will major expenses be incurred in cleanup operations, but the image of the company may be irreparably damaged. Furthermore, the land is leased from the government of Singapore and must be returned in its original condition when the lease expires. Plans to close the landfill are therefore underway, and all waste products already buried at the site are scheduled to be removed to a government certified landfill at Plau Semakau. Costs of disposal in this landfill are S$60/ton exclusive of transport costs, however the plan is seen as a means of avoiding future risk. The plan is proceeding under the leadership of Company N, and division of expenses between the companies involved is currently being coordinated.

Case 15 Reduction in Truck Emissions Through Joint Collection and Delivery of Freight

1) Outline of the company

Company O Details of business: Distribution of goods by truck. Number of employees: 250 Commencement of operations: 1970 Location of factory: Dedicated distribution industry area in east of Singapore Island. Japanese equity ratio: 87%

2) Background

The Japanese parent company of Company O is the largest freight forwarder in Japan. Its establishment in Singapore was required in order to take care of the transport and customs requirements of its customers. The company is located at a Jurong Town Corporation site near the airport with convenient access to and from a dedicated freight road. Customs operations are simplified, and access to bonded warehouses is convenient.

The company is engaged in environmental measures appropriate for Japan's leading freight forwarder, and its environmental report introduces a number of activities designed to reduce environmental load in the distribution industry. The activities given primary focus are joint collection and delivery, and joint operations designed to reduce truck emissions and alleviate traffic congestion.

All freight distribution and Singapore is by truck, the size of the country ensures that companies sending and receiving freight are located comparatively close together, and delivery to the large numbers of electronics assembly businesses are in the form of small packages, all factors facilitating the introduction of a joint collection and delivery system. Such a system was introduced as a means of raising the efficiency of collection and distribution.

3) Details of measures implemented

a. Joint collection and distribution

The most important point to be considered in relation to environmental problems in the distribution industry is the shipment of large numbers of small packages. In order to reduce stock in hand, manufacturers wish to make deliveries at specified times, and multiple deliveries of small volumes of freight from a particular sender to a customer are required at specified times. Under these conditions, development of the joint collection and delivery system to reduce the number of trucks required to forward freight from senders located in close proximity to each other to customers receiving freight and located in close proximity to each other both reduces emissions and raises the efficiency of loading of trucks. On the other hand, as delivery time is often specified, the permitted degree of flexibility in timing becomes important.

As a trial, Company O introduced a joint collection and delivery system linking three major Japanese manufacturers of electrical products and 200 component manufacturers. The outline of the system was first explained to the electrical manufacturers who were persuaded of the importance of the project in environmental terms, and who agreed to cooperate. As the components supplied to the electrical manufacturers are often common, it was relatively easy to collect freight from component manufacturers. Furthermore, as the delivery distances are comparatively short, coordination of packing was simplified. Some components are produced in Thailand, Malaysia, and Indonesia, and these are temporarily stored in the Company O's warehouse from where they are subsequently delivered to the electrical manufacturers. As the trial has only recently commenced, sufficient data on benefits has yet to be collected, however it is clear that considerable results have been achieved in terms of reduction in emissions. It is planned to expand the system further.

b. Control of truck emissions

Company O operates 41 trucks and 67 forklifts. New vehicles are purchased in Singapore, however vehicle specifications are the same as for vehicles purchased in Japan. Vehicles are allocated, and as the total number of vehicles is limited, a vehicle purchase certificate (COE) must be purchased by open tender. This raises the

price of vehicles to approximately three times that prevailing in Japan.

The frequency of inspections required depends upon the period for which the vehicle has been in use - one inspection per year if the vehicle has been used for three years or less, and one inspection every six months is the vehicle has been in use for three years or more. The vehicle is a taken to a certified garage where it is expected and maintained, and the Land Transport Authority (LTA) notified of the results. EU, Japanese, and US regulations for exhaust gas and soot are used unchanged.

While not compulsory, drivers are recommended to stop the engine rather than leave it idling. An associated problem is that the high ambient temperature ensures that if the air-conditioning is switched off the temperature in the cab increases to 40'C or more.

c. Waste products

Recycling and reuse of packing used for the personal property of staff of Japanese companies locating to Singapore presents a problem. Recycling of packing material used in protecting personal items is difficult, however the reuse of goods-delivery boxes is recommended to staff.

Case 16 ISO14001 Certification Within a Context of Underdeveloped Environmental Management

1) Outline of the company

Company P Details of business: Manufacture and sale of soy sauce. Number of employees: 58 Commencement of operations: 1984 Location of factory: Industrial area in north-east of Singapore Island. Japanese equity ratio: 100%

2) Background

Company P imports soybeans from the US, Australia, and New Zealand from which it manufactures soy sauce. Its products are sold widely in Southeast Asia, Australia, and New Zealand, and ISO14001 certification is associated with beneficial development of its business operations. The company was requested by its parent company to obtain certification, however it was delayed due to environmental matters such as the lack of monitoring of wastewater and waste gas.

3) Details of measures implemented

a. ISO14001 certification

The company was instructed by the Japanese parent company in 2000 to obtain ISO14001 certification during 2001. Certification was slightly delayed, and was completed in October 2002. This was the second of the overseas factories to obtain certification, the first being the factory in the Netherlands.

As the foundations of environmental management were not fully developed, problems arose in environmental terms. Furthermore, the small number of employees presented a problem in finding enough time for a person in charge of environmental matters.

The first stage involved collection of data on the environmental load of the factory for a period of one year. Based on this data, themes for activities related to reductions in the amounts of water, diesel fuel, and paper used in the factory, and improved management of chemicals in the laboratory, were selected.
Targets of 5% reductions in the amounts of water, diesel fuel, and paper used in the factory were set based on the 2001 year. Efforts were also expended in raising the awareness of employees in ISO14001, and posters to this effect were placed throughout the buildings. These posters focused not only on environmental matters, but also on safety in the workplace, quality control for products, and ensuring product safety. These activities resemble Responsible Clear Activities in the chemical industry, and are worthy of note in a food products factory.

Japanese head office staff visit at three-yearly intervals for environmental audits. Head office staff, and personnel from an auditing company, also visit to collect data for the purposes of environmental accounting, and provide advice on the implementation of environmental policies.

b. Wastewater treatment

Between 150 and 200 tons of wastewater are generated each day in the production process, primarily from the washing of filter cloth and equipment. As the water contains organics which are readily biodegradable, the normal activated sludge treatment is employed. The treated water clears the standard values for search water and is discharged into the sewerage system. COD and suspended solids are monitored to determine the quality of the wastewater. The analysis values from a certified laboratory are reported to the Pollution Control Division annually. Continuous monitoring is not have required. Domestic wastewater is treated separately and discharged into the sewerage system.

c. Waste gas

The exhaust gas from the three steam boilers employed in the production process is subject to regulation. Problems are eliminated by firing the boilers with kerosene having a sulfur content of 1% or less. Dust emissions are subject to regulation, and the data chart from the automatic measuring equipment is submitted to the Pollution Control Division monthly, however the Division makes random inspections once every two

months.

d. Waste products

Approximately 1000 tons of dry drainings are produced monthly as a byproduct of the manufacturing process, and is sold as cattle feed. As this product does not sell in Japan it is currently incinerated, however tests performed at a livestock experimental station showed it to have a considerable fiber content and to be most suitable as stock feed. The drainings are sold packed in the bags and pallets originally used for raw materials, and sold for the cost of the bags and pallets as a means of avoiding financial loss.

Excess bags and pallets are sold to a recycling company. Oil remaining in the dry drainings amounts to approximately 20 tons per year, and is disposed of by a certified waste processing company as waste oil at a cost of S$27/ton.

Cardboard boxes are periodically sold to a paper recycling company.

<Appendices>

Appendix 1
Environmental Pollution Control Act (EPCA)

Revised Edition 2000 (30th December 2000)

THE STATUTES OF THE REPUBLIC OF SINGAPORE

ENVIRONMENTAL POLLUTION CONTROL ACT (CHAPTER 94A)

Act
9 of 1999

REVISED EDITION 2000 (30th December 2000)

ARRANGEMENT OF SECTIONS

PART I
PRELIMINARY

PART II
ADMINISTRATION

PART III
USE OF SCHEDULED PREMISES

PART IV
AIR POLLUTION CONTROL

PART V
WATER POLLUTION CONTROL

PART VI
LAND POLLUTION CONTROL

PART VII
HAZARDOUS SUBSTANCES CONTROL

An Act to consolidate the laws relating to environmental pollution control and for purposes connected therewith.
[1st April 1999]

PART I
PRELIMINARY

Short title

1. This Act may be cited as the Environmental Pollution Control Act.

Interpretation

2. In this Act, unless the context otherwise requires —

"air impurities" includes smoke, cinders, solid particles of any kind, gases, fumes, mists, odours and radioactive substances;

"air pollution" means the emission into the air of any air impurity;

"air pollution control equipment" includes —

(*a*) any apparatus for separating any air impurities from the gas or liquid medium in which they are carried;

(*b*) any automatic device used for securing the more efficient operation of any fuel burning equipment;

(*c*) any device to indicate or record air pollution or give warning of excessive air pollution; and

(*d*) any other device used for the purposes of preventing or limiting air pollution;

"analysis" includes the taking of a sample or any test, measurement, calculation or examination made for the purpose of determining the characteristics of any matter or substance or the effects of any discharge, emission or deposit of trade effluent, air impurity or hazardous substance;

"analyst" means an analyst appointed or approved by the Director;

"authorised officer" means a public officer authorised under section 3 (3) or a person in the employment of a Town Council or statutory corporation authorised under section 4 (1);

"building" includes any house, hut, shed or roofed enclosure, whether used for the purpose of human habitation or otherwise;

"building works" has the same meaning as in the Building Control Act (Cap. 29);

"chimney" includes a structure or opening of any kind from or through which air impurities may be emitted, and any reference to a chimney of or used in connection with any premises includes a reference to a chimney which serves the whole or a part of the premises though structurally separate from such premises;

"construction site" means any premises on or in which the construction, alteration or demolition of any building or structure is carried on and includes —

(*a*) all the land within the vicinity of the work place which are owned by the person for whom the construction works are being carried out and to which the principal contractor has control of access; and

(*b*) any canteen, sleeping quarters, office and other structures or buildings erected on the construction site;

"container" means —

(*a*) any vessel, can, drum, barrel or other receptacle; or

(*b*) where such vessel, can, drum, barrel or other receptacle is contained in another container or is wholly enveloped in a covering or coverings of whatever nature, the outermost container or covering, as the case may be,

but does not include the carrying tank of a road tanker, a tank container or a freight container;

"dark smoke" means smoke which is ascertained by such method as may be prescribed to be dark smoke;

"day" means a period of 24 hours from midnight;

"Director" means the Director of Environmental Pollution Control appointed under section 3 (1);

"export", with its grammatical variations and cognate expression, means to take or cause to be taken out of Singapore by land, water or air and includes the placing of any substances, plant, equipment, machinery or any products in a vessel, conveyance or aircraft for the purposes of the substances, plant, equipment, machinery or any products being taken out of Singapore by water or air but does not include the taking out of Singapore by water or air of any substances, plant, equipment, machinery or any products on the same vessel or aircraft on which they were brought into Singapore unless after being brought into Singapore the substances, plant, equipment, machinery or any products have been landed or transhipped within Singapore;

"fuel burning equipment" means any furnace, boiler, fire place, oven, retort, incinerator, internal combustion engine, vessel or chimney, or any other apparatus, device, mechanism or structure used or to be used in connection with the burning of any combustible material in, or in relation to, any industrial plant;

"hazardous substance" means any of the substances specified in the first column of Part I of the Second Schedule but shall not include —

(*a*) such substance when contained in any substance, preparation or product specified in the second column of Part I corresponding to that substance; or

(*b*) such substance when contained in any substance, preparation or product specified in Part II of that Schedule;

"import", with its grammatical variations and cognate expression, means to bring or cause to be brought into Singapore by land, water or air from any place which is outside Singapore but does not include the bringing into Singapore by water or air of any substances, plant, equipment, machinery or any products which it is proved to be intended to be taken out of Singapore on the same vessel or aircraft on which they were brought into Singapore without any landing or transhipment within Singapore;

"industrial or trade premises" means premises used for any industrial or trade purposes or premises on which matter is burnt in connection with any industrial or trade process, and includes all scheduled premises and construction sites;

"industrial plant" means any plant or equipment used for the generation of power, or for any industrial use, or for the operation of vessels, aircraft, locomotives, cranes, internal combustion engines or other machines using any combustible material for their operation;

"industrial plant works" means any of the following works:

(*a*) the erection or extension of an industrial plant;

(*b*) the alteration or addition of an industrial plant;

(*c*) the erection or extension of a plant for the treatment of trade effluent or toxic substances; and

(*d*) the provision, extension or alteration of any equipment to control pollution from an industrial plant;

"inland waters" means any river, stream, reservoir, lake or pond, whether natural or artificial;

"licensee" means any person licensed under this Act or the regulations;

"occupier", in relation to —

(*a*) any premises, means the person in occupation of the premises or having the charge, management or control thereof; and

(*b*) any part of any premises, different parts of which are occupied by different persons, means the person in occupation or having the charge, management or control of that part;

"owner", in relation to —

(*a*) any premises, includes the person for the time being receiving the rent of the premises, whether on his own account or as agent or trustee or as receiver, or who would receive the rent if the premises were let to a tenant, and the person whose name is entered in the Valuation List authenticated under section 15 of the Property Tax Act (Cap. 254);

(*b*) any premises where building works are carried out, includes the developer and the building contractor; and

(*c*) the common property of any building erected on land comprised in a strata subdivision plan approved by a competent authority, includes the management corporation having control of the building, and a managing agent appointed by a management corporation or by the Commissioner of Buildings under the Land Titles (Strata) Act (Cap. 158) and a liquidator appointed under that Act for the management corporation;

"pollution of the environment" means pollution of the environment due to the release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environment;

"practicable" means reasonably practicable having regard, amongst other things, to local conditions and circumstances and to the current state of technical knowledge, and "best practicable means" includes the provision and the efficient maintenance of plant and the proper use thereof and the supervision by or on behalf of the occupier of any process or operation;

"premises" includes messuages, houses, buildings, lands, tenements, easements and hereditaments of any tenure, whether open or enclosed, whether built on or not, whether public or private, and whether maintained under statutory authority or not;

"process" means any activity carried on in Singapore, whether on premises or by way of plant which is designed to move or to be moved whether on roads or otherwise, which are capable of causing pollution to the environment;

"qualified person", in relation to any industrial plant works, means an appropriate qualified person appointed under section 6 (3) or 9 (1) (*b*) of the Building Control Act (Cap. 29) in respect of building works which include industrial plant works;

"registered inspector" means a person whose name is registered under section 34;

"regulations" means any regulations made under this Act;

"road" has the same meaning as in the Road Traffic Act (Cap. 276);

"road tanker" means a goods vehicle as defined in the Road Traffic Act which has a tank that is structurally attached to or is an integral part of the frame of the vehicle;

"sale" includes barter, exchange, import and export and also includes offering or attempting to sell, or causing or allowing to be sold, or exposing for sale or receiving or sending or delivering for sale and the word "sell" shall be construed accordingly;

"scheduled premises" means any premises for the time being specified in the First Schedule;

"sewage" has the same meaning as in the Sewerage and Drainage Act (Cap. 293A);

"sewerage system" has the same meaning as in the Sewerage and Drainage Act;

"smoke" includes soot, ash, grit and gritty particles emitted in smoke;

"tank" means a container having a total internal capacity exceeding 250 litres for liquids and 500 litres for gases;

"tank container" means a tank with a total liquid capacity of 450 litres or more which is —

(*a*) used for the conveyance of a liquid, gaseous, powdery or granular substance; and

(*b*) constructed for repeated use and to facilitate the carriage of goods by one or more modes of transport without need of removal of its structural equipment or intermediate re-loading of its contents;

"the environment" consists of all or any of the following media, namely, air, water and land;

"Town Council" has the same meaning as in the Town Councils Act (Cap. 329A);

"toxic substance" means any trade effluent, chemical, oil or any other substance which is noxious, injurious or polluting;

"trade effluent" means any liquid, either with or without particles of matter in suspension therein, which is the outflow from any trade, business or manufacture or of any works of engineering or building construction;

"watercourse" includes a reservoir, lake, river, stream, canal, drain, spring or well or a part of the sea abutting on the foreshore and any other natural, artificial or sub-surface body of water;

"work place" means any premises or place used for any industrial, trade, commercial or manufacturing purposes and includes all construction sites, work sites and farms.

PART II
ADMINISTRATION

Appointment of Director and Deputy and Assistant Directors

3.—(1) The Minister may appoint a Director of Environmental Pollution Control and such number of Deputy and Assistant Directors of Environmental Pollution Control and public officers as he may consider necessary for the proper carrying out of the provisions of this Act.

(2) The Director shall have the superintendence of all matters relating to this Act and the regulations subject to the general or special directions of the Minister.

(3) The functions, duties and powers which are imposed or conferred upon the Director under this Act and the regulations may be performed or exercised by any Deputy or Assistant Director of Environmental Pollution Control and by any public officer who is duly authorised in writing by the Director to act on his behalf subject to the direction and control of the Director.

Delegation of Director's function, duties and powers

4.—(1) The Director may, with the approval of the Minister, authorise —

(*a*) any employee or agent of a statutory corporation;

(*b*) any member of a Town Council;

(*c*) any member of any committee of a Town Council; or

(*d*) any employee or agent of a Town Council,

generally or specially authorised by name or office to perform or exercise all or any of the functions, duties or powers which are imposed or conferred by this Act or the regulations upon the Director subject to the direction and control of the Director.

(2) Any person who is generally or specially authorised under subsection (1) to perform or exercise all or any of the functions, duties or powers which are imposed or conferred by this Act or the regulations upon the Director shall be deemed to be —

(*a*) a public officer for the purposes of this Act; and

(*b*) a public servant within the meaning of the Penal Code (Cap. 224).

Protection from personal liability

5.—(1) No liability shall lie against the Government or any authorised officer by reason of the fact that any works are carried out in accordance with the provisions of this Act or the regulations or that such works or plans of the works are subject to inspection, approval or certification by the Director or an authorised officer.

(2) Nothing in this Act or the regulations shall make it obligatory for the Director or any authorised officer to inspect any building or works or the site of any proposed works to ascertain whether the provisions of this Act or the regulations are complied with or whether any plans, certificates, reports, notices or other documents submitted to him are accurate.

(3) No matter or thing done by the Director or by any authorised officer shall, if it were done in good faith for the purpose of carrying out the provisions of this Act or the regulations, subject him or such person personally to any action, liability, claim or demand whatsoever.

(4) Where the Director or any authorised officer provides any information to any person in respect of any building or works by electronic or other means, neither the Government, the Director nor any authorised officer shall be liable for any loss or damage suffered by any person by reason of any error or omission of whatever nature or howsoever caused, including any defect or breakdown in the equipment used for providing the information, if such error or omission is made in good faith and in the ordinary course of duties of the Director or authorised officer.

PART III
USE OF SCHEDULED PREMISES

Licence for use of scheduled premises

6.—(1) No person shall occupy or use any scheduled premises specified in the First Schedule without a licence granted by the Director.

(2) Any person who contravenes subsection (1) shall be guilty of an offence.

(3) Any application for a licence under this section shall be made to the Director giving details of —

(*a*) the trade, industry or process proposed to be carried in or on the premises;

(*b*) the measures the applicant undertakes to adopt to control air, water and noise pollution from the premises; and

(*c*) the measures the applicant undertakes to adopt to manage hazardous substances and to treat and dispose of toxic substances originating from or stored within the premises.

Power of Director to attach conditions to licence

7. Without prejudice to the generality of section 32, the Director may, in granting a licence under section 6, impose conditions to ensure that pollution of the environment, as well as hazardous substances are adequately managed and controlled which may include but not be limited to the following:

(*a*) requiring the owner or occupier —

(i) to install and operate industrial plant, fuel burning equipment, control equipment or treatment plant in or on the scheduled premises;
(ii) to repair, alter or replace any industrial plant, fuel burning equipment, control equipment or treatment plant installed in or on the scheduled premises;
(iii) to erect or alter the height or dimension of any chimney through which air impurities may be emitted from the scheduled premises;
(iv) to alter the method of operation or process used in or on the scheduled premises to prevent or reduce air, water or noise pollution or hazards;
(v) to install and operate instruments and carry out tests and keep records of any such tests and any method of operation or supervision as may be required;
(vi) to use a specified type of fuel to prevent or reduce air pollution; or
(vii) to carry out any of the requirements imposed on him under this paragraph within such period as may be specified;

(*b*) prohibiting the owner or occupier from altering or replacing any control equipment or treatment plant installed in or on the scheduled premises except with the approval of the Director; or

(*c*) prohibiting the owner or occupier from operating any fuel burning equipment or industrial plant installed or altered after the licence has been granted unless approval to do so has been given by the Director.

Permit for certain works on scheduled premises

8.—(1) The owner or occupier of any scheduled premises shall not without the written permission of the Director —

(*a*) alter the method of operation of any trade or industrial process, fuel burning equipment, control equipment, treatment plant or industrial plant in or on the scheduled premises;

(*b*) install, alter or replace any fuel burning equipment, control equipment, treatment plant or industrial plant in or on the scheduled premises;

(*c*) erect or alter the height or dimension of any chimney through which air impurities may be emitted from the scheduled premises; or

(*d*) use any fuel other than the type of fuel specified in writing by the Director.

(2) An application for a permit under subsection (1) shall contain details of the proposed installation, alteration, replacement or erection.

Change of owner or occupier

9. Where there has been any change in the ownership or occupancy of any scheduled premises, the person who becomes the owner or occupier thereof shall notify the Director in writing of such change within 14 days from the date he becomes the owner or occupier of those premises.

PART IV
AIR POLLUTION CONTROL

Occupier to maintain and operate air pollution control equipment

10.—(1) The occupier of any industrial or trade premises shall maintain any fuel burning equipment and any air pollution control equipment installed in or on the premises in an efficient condition.

(2) The occupier of any industrial or trade premises shall ensure that any air pollution control equipment installed in or on the premises is working in a proper and efficient manner whenever the industrial plant or fuel burning equipment is being used.

(3) Any occupier who fails to comply with subsection (1) or (2) shall be guilty of an offence.

Prohibition of dark smoke from chimney

11.—(1) Any owner or occupier of any industrial or trade premises who causes, permits or allows the emission of dark smoke from a chimney of, or used in connection with, those premises shall be guilty of an offence.

(2) This section shall not apply to the emission of dark smoke from any chimney lasting for not longer than such periods as may be prescribed and subject to any prescribed limitations.

Control of air impurities

12.—(1) Any owner or occupier of any industrial or trade premises who conducts any trade or industrial process, or operates any fuel burning equipment or industrial plant in or on the premises in such manner as to cause, permit or allow the emission of air impurities in excess of the standard of concentration or rate of emission prescribed in respect of that industry, process, fuel burning equipment or industrial plant shall be guilty of an offence.

(2) Where any such standard has not been so prescribed, it shall be the duty of the owner or occupier of any industrial or trade premises to conduct any trade or industrial process or operate any fuel burning equipment or industrial plant in or on the premises by the best practicable means available as may be necessary to prevent or minimise air pollution.

(3) If any dispute arises as to the best practicable means available for the purposes of subsection (2), it shall be determined by the Director.

(4) The Director may, in respect of a specified period of time, by notice in writing require the owner or occupier of any

industrial or trade premises to ensure that any air impurity exceeding a specified amount shall not be emitted during that period.

(5) The Minister may by regulations provide for the control or prohibition of the emission of air impurities from any other source.

Power of Director to require work on any premises

13.—(1) Where, in the opinion of the Director, any air impurities are being or are likely to be emitted from any industrial or trade premises, the Director may by notice in writing require the owner or occupier of the premises —

(*a*) to install and operate any industrial plant, air pollution control equipment or additional air pollution control equipment, in or on the premises;

(*b*) to repair, alter or replace any industrial plant, fuel burning equipment or air pollution control equipment installed in or on the premises;

(*c*) to erect or alter the height or dimension of any chimney through which air impurities may be discharged from the premises;

(*d*) to alter the method of operation or process used in or on the premises to prevent or reduce air pollution;

(*e*) to use a specified type of fuel to prevent or reduce air pollution;

(*f*) to dismantle or disconnect any industrial plant, fuel burning equipment, air pollution control equipment or chimney installed in or on the premises; or

(*g*) to install and operate such instruments and carry out such tests and keep records thereof,

within such time and in such manner as may be specified in the notice.

(2) The owner or occupier of any industrial or trade premises to whom any notice in writing is given under this section shall comply with all the requirements set out in the notice.

Power to prohibit use of combustible materials, fuel burning equipment or industrial plants in designated areas

14.—(1) The Minister may, by order published in the *Gazette* —

(*a*) prohibit or restrict the use of any or any class of combustible material, fuel burning equipment or industrial plant as may be specified in the order; or

(*b*) prohibit or restrict the burning of any or any class of material as may be specified in the order,

within such area or premises as may be designated and at such times as may be specified in the order.

(2) Any occupier or owner of any premises or any other person who contravenes an order made under subsection (1) shall be guilty of an offence.

(3) If, in any proceedings for a contravention or non-compliance of an order made under subsection (1), it is shown that any combustible material, fuel burning equipment or industrial plant was found or that the burning of any material was carried out in or on any premises, it shall be presumed, until the contrary is proved, that —

(*a*) the combustible material, fuel burning equipment or industrial plant was used; or

(*b*) the burning of any material was carried out,

by the occupier of such premises, other than a principal contractor to which section 35 applies.

PART V
WATER POLLUTION CONTROL

Licence for the discharge of trade effluent, oil, chemical, sewage or other polluting matters

15.—(1) Any person who discharges or causes or permits to be discharged any trade effluent, oil, chemical, sewage or other polluting matters into any drain or land, without a licence from the Director, shall be guilty of an offence.

(2) Where any trade effluent, oil, chemical, sewage or other polluting matters has been discharged from any premises into any drain or land, it shall be presumed, until the contrary is proved, that the occupier of the premises, other than a principal contractor to which section 35 applies, had discharged or caused or permitted to be discharged the trade effluent, oil, chemical, sewage or other polluting matters in contravention of subsection (1).

(3) Subject to subsection (4), any person who causes or suffers any trade effluent, oil, chemical, sewage or other polluting matters to enter or pass into any drain or land without a licence from the Director (whether wilfully or by accident) shall immediately inform the Director of such occurrence.

(4) The requirements in subsection (3) may be waived by the Director in any case where the amount of trade effluent, oil, chemical, sewage or other polluting matters is, in the opinion of the Director, not of a substantial nature.

(5) Any person who fails to comply with subsection (3) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000.

(6) This section shall not apply to the discharge of a toxic or hazardous substance to which section 17 applies.

Plant for treatment of trade effluent

16.—(1) The occupier of any premises shall treat any trade effluent discharged therefrom in such manner as may be prescribed before such trade effluent is discharged into any drain or land in pursuance of a licence granted under section 15.

(2) A person using, working or operating any plant for the purpose of treating any trade effluent shall use, work or operate

and maintain such plant in such manner as the Director may require.

(3) Any person who fails to comply with subsection (1) or (2) shall be guilty of an offence and shall be liable —

(*a*) on the first conviction to a fine not exceeding $20,000 or to imprisonment for a term not exceeding 3 months or to both and, in the case of a continuing offence, to a further fine not exceeding $1,000 for every day or part thereof during which the offence continues after conviction; and

(*b*) on a second or subsequent conviction to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 3 months or to both and, in the case of a continuing offence, to a further fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

Penalties for discharging toxic substances into inland waters

17.—(1) Any person who discharges or causes or permits to be discharged any toxic substance or hazardous substance into any inland water so as to be likely to cause pollution of the environment shall be guilty of an offence and shall —

(*a*) be liable on the first conviction to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 12 months or to both; and

(*b*) be punished on a second or subsequent conviction with both imprisonment for a term of not less than one month and not more than 12 months and a fine not exceeding $100,000.

(2) Where a person carrying on any trade or business has been convicted of a second or subsequent offence under subsection (1) (*b*) for the discharge of, or for causing or permitting the discharge of, any toxic substance or hazardous substance which is produced by any process or work in connection with that trade or business, the Minister may, by order in writing, direct that person to immediately cease carrying on that process or work either indefinitely or for such period as may be specified in the order.

(3) Any person who fails to comply with an order made under subsection (2) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $100,000 or to imprisonment for a term not exceeding 3 months or to both and, in the case of a continuing offence, to a further fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

(4) If any person fails to comply with an order made under subsection (2), the Director may take such step or measure as is necessary to ensure that the order is complied with and the reasonable costs and expenses incurred by the Director in taking such step or measure shall be recoverable from the person in default as a debt due to the Government.

(5) For the purposes of this section —

(*a*) a person shall be deemed to have discharged a toxic substance or hazardous substance into any inland water if he places the substance or causes it to be placed in a position where it is liable to fall or descend or be washed or to percolate or be blown into the water;

(*b*) the discharge of a toxic substance or hazardous substance shall be deemed to cause pollution of the environment if the substance has been discharged or placed in such a manner or in such quantity (whether by itself or with any other substance) as to subject persons or animals to a material risk of death, injury or impairment of health or as to threaten to pollute (whether on the surface or underground) any inland water;

(*c*) the fact that the toxic substance or hazardous substance is placed in containers shall not of itself be taken to exclude any pollution of the environment which might be expected to be caused if the substance were not in containers; and

(*d*) where the toxic substance or hazardous substance has been discharged from any premises into any inland water, it shall be presumed, until the contrary is proved, that the occupier of the premises, other than a principal contractor to which section 35 applies, had discharged or caused or permitted to be discharged the toxic substance or hazardous substance in contravention of subsection (1).

(6) No prosecution shall be instituted under this section without the written consent of the Public Prosecutor.

Powers of Director to require the removal and cleaning up of toxic substance or trade effluent, oil, chemical, sewage, hazardous substance or other polluting matters

18.—(1) The Director may, by notice in writing, require any person who has discharged or caused or permitted to be discharged or spilled any toxic substance, trade effluent, oil, chemical, sewage, hazardous substance or polluting matters onto any land or into any drain or the sea, to remove and clean up such toxic substance, trade effluent, oil, chemical, sewage, hazardous substance or polluting matters within a specified time to be fixed by the Director as he considers fit.

(2) Any person who fails to comply with a notice issued under subsection (1) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $50,000.

Power of Director to require measures to be taken to prevent water pollution due to storage or transportation of toxic substances or any other polluting matters

19.—(1) The Director may, by notice in writing, require any person who effects, permits or carries out any activity related to the storage or transportation of toxic substance or any other polluting matters —

(*a*) to use a method of storage, operation or process to prevent water pollution;

(*b*) to construct or install spill containment facilities;

(*c*) to use containers, tanks, tank containers or road tankers that are constructed to meet stipulated standards and with approved materials;

(*d*) to install and operate equipment to prevent any leakage or discharge from containers, tanks, tank containers or road

tankers;

(*e*) to install and operate pollution monitoring equipment to prevent and detect any leakage or discharge;

(*f*) to carry out specific tests on equipment, tanks or any other related facilities and to submit the results of these tests;

(*g*) to prepare and submit contingency plan for events of accidental discharge or spillage of oil, chemicals, trade effluent or other polluting matters; and

(*h*) to carry out any works as required by the Director that are necessary to prevent water pollution.

(2) Any person who fails to comply with any requirement in subsection (1) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $20,000.

PART VI
LAND POLLUTION CONTROL

Pollution of land

20.—(1) The Minister may make regulations to control the pollution of land whereby the condition of the land is so changed as to make or be likely to make the land or the produce of the land obnoxious, noxious or poisonous.

PART VII
HAZARDOUS SUBSTANCES CONTROL

Application of this Part to hazardous substances

21. This Part shall apply to the hazardous substances specified in the first column of Part I of the Second Schedule except where —

(*a*) they fall within the exclusion specified in the second column of that Part corresponding to those substances; or

(*b*) they are contained in any substance, preparation or product specified in Part II of that Schedule.

General prohibition with respect to importation and sale of hazardous substances

22.—(1) No person shall import, possess for sale, sell or offer for sale any hazardous substance unless he holds a licence granted by the Director for such purpose.

(2) Every licence granted to any person under this section shall not be transferable to any other person and no licence shall authorise the import, possession for sale, sale or offer for sale of any hazardous substance by any individual other than the individual named therein.

(3) Any person who contravenes subsection (1) or (2) shall be guilty of an offence.

Prohibitions and regulations with respect to sale of hazardous substances

23.—(1) No person shall import, possess for sale, sell or offer for sale any hazardous substance unless —

(*a*) the importation, possession for sale, sale or offer for sale is effected in accordance with the provisions of the licence and with any condition specified therein;

(*b*) the sale is effected by or under the personal supervision of the person named in the licence; and

(*c*) proper records of the sale as required by the Director are kept.

(2) No person shall possess for sale, sell or offer for sale any hazardous substance unless the container of the hazardous substance is labelled in the manner prescribed in regulations made by the Minister.

(3) Any person who contravenes subsection (1) or (2) shall be guilty of an offence.

Storage, use and dealing of hazardous substances

24.—(1) Every person storing, using or otherwise dealing with any hazardous substance and every agent, servant or employee of such person shall do so in such a manner as not to threaten the health or safety of any person, or to cause pollution of the environment.

(2) In any proceedings under this section, if any person is proved to have kept or had in his possession or under his control any hazardous substance, he shall be presumed, until the contrary is proved, to have done so knowingly.

(3) Any person who contravenes subsection (1) shall be guilty of an offence.

Power of Director to require removal of hazardous substances from premises

25.—(1) If, in the opinion of the Director, the hazardous substance stored or kept in any premises is likely to threaten the health or safety of any person or to cause pollution of the environment, he may, by notice in writing, require the owner or occupier of any premises to remove the hazardous substance to a disposal facility.

(2) The Director may, by notice in writing, require the owner or occupier upon whom a notice has been served under subsection (1) to furnish evidence that the hazardous substance stored or kept in the premises has been disposed of at a disposal facility in accordance with the notice.

(3) Any person who fails to comply with a notice made under subsection (1) or (2) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $50,000.

Power to require owner or occupier of hazardous installations to carry out impact analysis studies

26.—(1) The Director may, by notice in writing served on the owner or occupier of any installation, whether fixed or mobile, which is used or intended to be used to carry our activities involving the storage, handling and use of hazardous substances, require the owner or occupier to carry out —

(*a*) identification of all possible potential hazards that may threaten the health or safety of any person, or cause pollution of the environment;

(*b*) estimation of the frequency or probability of occurrence of such potential hazards as identified in paragraph (*a*);

(*c*) quantification of the consequences and risk levels of such potential hazards as identified in paragraph (*a*);

(*d*) evaluation of the effects of potential fires or other disasters including the potential for release of toxic materials or toxic combustion products and the potential for release of contaminated fire-fighting water into the environment; and

(*e*) identification of all necessary preventive measures to avoid and control the hazards identified in paragraph (*a*) and formulation of a programme to implement the measures.

(2) The Director may, by notice in writing, require the owner or occupier —

(*a*) to conduct a review and evaluation of any existing measures for the prevention, reduction or control of any potential hazard that may endanger public health or cause pollution of the environment for the purpose of ascertaining whether such measures are sufficient or effective;

(*b*) to submit for the Director's approval, within such time as may be specified by the Director, a proposal for the implementation of such new or additional measures for the prevention, reduction or control of any potential hazard that may endanger public health or cause pollution of the environment; and

(*c*) to implement such new or additional measures for the prevention, reduction or control of any potential hazard that may endanger public health or cause pollution of the environment as the Director may approve or specify.

(3) The review and evaluation referred to in subsection (2) (*a*) shall be conducted in such manner as the Director may, by notice in writing, require and the Director may issue guidelines for this purpose.

(4) The Director may, by notice in writing, if he considers it necessary —

(*a*) require any modification or addition to be made to the measures proposed by the owner or occupier under subsection (2) (*b*); or

(*b*) require the owner or occupier to conduct a further review and evaluation.

(5) Any person who fails to comply with any notice made under subsection (1), (2) or (4) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $20,000.

Penalty for offences involving hazardous substances

27. Any person who is guilty of an offence under this Part, for which no penalty is expressly provided, shall be liable on conviction to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 2 years or to both and, in the case of a continuing offence, to a further fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

PART VIII
NOISE CONTROL

Control of noise from construction of building and other works

28.—(1) Where it appears to the Director that works of the following description, that is to say —

(*a*) the erection, construction, alteration, repair or maintenance of buildings, structures or roads;

(*b*) the breaking up, opening or boring under any road or adjacent land in connection with the construction, inspection, maintenance or removal of works;

(*c*) piling, demolition or dredging works; or

(*d*) any other work of engineering construction,

are being, or are going to be carried out on any premises, he may, by notice in writing, impose requirements as to the way in which the works are to be carried out on the person who appears to be carrying out, or going to carry out the works or on such other person appearing to the Director to be responsible for or to have control over the carrying out of such works.

(2) The notice may, in particular, specify —

(*a*) the plant or machinery which is, or is not, to be used;

(*b*) the hours during which the works may be carried out; and

(*c*) the level of noise or vibration which may be emitted from the premises referred to in subsection (1) or at any specified part of those premises or which may be so emitted during specified hours.

(3) Where a person who has been served with a notice under subsection (1) —

(*a*) fails to comply with any requirement contained in the notice; or

(*b*) contravenes any regulations in relation to noise emitted from the premises referred to in subsection (1),

the Director may, by notice in writing, order him to stop any work carried out in the premises referred to in subsection (1) until such time as the notice is revoked or until such time as the requirements imposed by the Director have been complied with.

(4) Any person who fails to comply with a notice issued under subsection (3) shall be guilty of an offence and shall be

liable on conviction to a fine not exceeding $10,000 for every day during which the notice is not complied with or to imprisonment for a term not exceeding 3 months or to both.

Control of noise from work place

29.—(1) The Director may, by notice in writing served on the owner or occupier of any work place, prohibit him from causing, permitting or allowing —

(*a*) any specified activity to be carried out in or on those premises; or

(*b*) any specified plant to be used or operated in or on those premises,

in such a manner as to cause the emission from those premises of noise that, when measured at any specified point (whether within or outside those premises), is in excess of the specified level.

(2) Where the Director is satisfied that any noise is being or is likely to be emitted from any work place, the Director may, by a noise control notice in writing served on the owner or occupier, require the owner or occupier —

(*a*) to install, alter, maintain or operate any noise control equipment specified in the notice in or on those premises;

(*b*) to repair, alter or replace any noise control equipment in or on those premises;

(*c*) to erect a noise barrier in or on those premises;

(*d*) to install plant of a specified type, where the Director is satisfied that the use of that plant will result in the prevention or reduction of the emission of noise from those premises; or

(*e*) to carry out repairs or adjustments to specified plant, equipment, apparatus, device, machine or mechanism, where the Director is satisfied that the carrying out of those repairs or adjustments will result in the prevention or reduction of the emission of noise from those premises,

within the time and in the manner specified in the notice.

(3) The Director may, by notice in writing served on the owner or occupier of any work place, require the owner or occupier to operate, in accordance with any directions contained in the notice, any noise control equipment in or on those premises.

(4) Where a person who has been served with a notice under subsection (1), (2) or (3) —

(*a*) fails to comply with any requirement contained in the notice; or

(*b*) contravenes any regulations in relation to noise emitted from any work place,

the Director may, by notice in writing, order that person to stop any work or activity carried out in the work place until the notice is revoked or until such time as the requirements imposed by the Director have been complied with.

(5) Any person who fails to comply with a notice issued under subsection (4) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $10,000 for every day during which the notice is not complied with or to imprisonment for a term not exceeding 3 months or to both.

(6) In this section, “plant” means any plant, equipment, apparatus, device, machine or mechanism.

Director to have regard to certain provisions

30. In acting under section 28 or 29, the Director shall have regard —

(*a*) to the relevant provisions of any code of practice published or referred to in the regulations;

(*b*) before specifying any particular methods or plant or machinery, to the desirability in the interests of any recipient of the notice in question of specifying other methods or plant or machinery which would be substantially as effective in minimising noise and would be more acceptable to him; or

(*c*) to the need to protect any person in the locality in which the premises or work place in question are situated from the effects of noise.

PART IX
LICENCES AND INDUSTRIAL PLANT WORKS

Single licence

31.—(1) Where a person is required by virtue of the provisions of this Act or the regulations to obtain more than one licence, he may apply to the Director for a single licence to carry out the activities specified in his application and the Director may, if he thinks fit, grant or refuse to grant the single licence.

(2) If the holder of the licence is in breach of any restriction or condition subject to which it was granted or is in contravention of such of the provisions of this Act or the regulations as may affect the licence, the Director may instead of suspending, cancelling or revoking the single licence under section 32 (1A) —

(*a*) prohibit the licensee from carrying out one or more activities specified in the single licence; or

(*b*) modify any condition subject to which the licence was gtranted.

General provisions on licences

32.—(1) The grant or renewal of any licence shall be at the discretion of the Director.

(1A) Any licence —

(*a*) may be granted, renewed or refused without giving any reason;

(*b*) may be granted or renewed subject to such restrictions and conditions as the Director may think fit; and

(*c*) shall be subject to suspension, cancellation or revocation at any time without compensation and without notice by the Director upon breach of any restriction or condition subject to which it was granted or to any contravention of

such of the provisions of this Act or the regulations as may affect the licence.

(2) The Director may amend or delete any of the conditions imposed on any licence or impose additional conditions without giving any reasons and at any time during the validity period of the licence.

(3) An application for a licence shall be made in such form and contain such particulars and information as the Director may determine.

(4) The Director may require any applicant for a licence to furnish such information and evidence as he may reasonably require for a full and proper consideration of the application and, in the event of a refusal to furnish the information, shall refuse to grant or renew the licence.

(5) Any person who wilfully furnishes any false information in any application for a licence shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000 and any licence granted shall be void and of no effect.

(6) Subject to the provisions of this Act, any licence may be for such period as the Director thinks fit.

(7) There shall be charged in respect of any application for the grant, amendment or renewal of any licence, such fee, if any, as may be prescribed by the Minister.

(8) Where a licence is granted or renewed for a period of less than 12 months, the Director may charge a proportionate fee therefor; and in so charging any part of a month shall be reckoned as one month.

(9) No licensee shall be entitled to any refund of any fee paid by him in respect of any licence.

(10) No person shall in any manner transfer any licence or permit any licence to be used by any other person without the approval in writing of the Director.

(11) Subject to the provisions of this Act, any person aggrieved by the refusal by the Director to grant, amend or renew a licence or by the suspension or revocation by the Director of any licence may, within 14 days of such refusal, suspension or revocation, appeal to the Minister whose decision shall be final.

(12) For the purpose of this section, "licence" includes any approval, permit, permission, authority or authorisation which may be granted or renewed by the Director in pursuance of this Act or the regulations.

Certificates required for industrial plant works

33.—(1) No person shall commence or carry out, or cause or permit the carrying out of any industrial plant works without the Director certifying that the plans of the industrial plant works comply with such requirements as he may specify for the purposes of this Act (referred to in this section as a clearance certificate).

(2) Every application under this section shall be made by a qualified person or any approved person in such form and manner as the Director may require.

(3) There shall be charged, for the processing of every application under this section, such fees as may be prescribed by the Minister.

(4) Every applicant under this section shall submit to such filing authority as the Director may designate, in such form and manner as the Director may determine, plans of the industrial plant works to which the application relates showing such details or specifications as the Director may require.

(5) The Director may, before issuing a clearance certificate under subsection (1), give a direction in writing to the applicant to comply, within such period as may be specified in the direction, with such requirements as he may specify for the purposes of this Act.

(6) In issuing any clearance certificate under subsection (1), the Director may impose such conditions as he thinks fit.

(7) Any person for whom any industrial pant works, in respect of which a clearance certificate has been issued under subsection (1), had been carried out and completed shall apply to the Director for a further certificate that the industrial plant works have been completed in accordance with the plans submitted under subsection (4) and the conditions imposed by the Director under subsection (6) (referred to in this section as a compliance certificate).

(8) The Director may, on an application under subsection (7), require the appointed qualified person or a registered inspector appointed by such person to inspect the completed industrial plant works and submit a report stating whether the industrial plant works have been completed in accordance with the plans and the conditions imposed by the Director.

(9) The Director may, after considering the report submitted under subsection (8) —

(*a*) issue, subject to such conditions as he thinks fit, a compliance certificate that the industrial plant works have been completed in accordance with the plans submitted under subsection (4) and the conditions imposed by the Director under subsection (6); or

(*b*) give a direction in writing to the applicant to comply within such period as may be specified in the direction, with such requirements as he may specify for the purposes of this Act.

(10) If the person to whom any written direction is given under subsection (9) (*b*) fails to comply with the requirements specified in the direction within the time specified therein, the application under subsection (7) shall be deemed to be withdrawn.

Registration, appointment and duties of registered inspectors

34.—(1) The Director shall keep and maintain a register in which shall be entered the names and prescribed particulars of all persons registered under this section as registered inspectors.

(2) The Minister may by regulations provide for —

(*a*) the manner and form in which the register is to be kept and open for inspection;
(*b*) the manner of making applications by persons to be registered inspectors;
(*c*) the qualifications of registered inspectors and their appointment;
(*d*) the duties and responsibilities of registered inspectors; and
(*e*) the circumstances in which the registration may be cancelled.

PART X
ENVIRONMENTAL POLLUTION CONTROL MEASURES

Principal contractor to prevent pollution from construction site

35.—(1) No principal contractor of a construction site who has control of the construction site shall permit any person to commit an offence specified under section 14, 15 or 17 (referred to in this section as the offence).

(2) Where there is a contravention of section 14, 15 or 17 at any construction site, it shall be presumed, until the contrary is proved, that the principal contractor of the construction site —

(*a*) had control of the construction site;
(*b*) had knowledge of the commission of the offence at the construction site; and
(*c*) had permitted the commission of the offence at the construction site.

(3) The presumptions provided for in subsection (2) (*b*) and (*c*) shall not be rebutted unless the defendant proves that he had exercised due diligence to prevent the commission of the offence at the construction site.

(4) For the purposes of subsection (3), a defendant shall not be presumed to have exercised due diligence unless he had taken all reasonable measures to prevent the offence from being committed at the construction site, including all the measures prescribed under subsection (5) in respect of the construction site.

(5) For the purposes of subsection (4), the Minister may, by notification in the *Gazette*, prescribe the measures that are required to be taken by the principal contractor of the construction site.

(6) Any person who contravenes subsection (1) shall be guilty of an offence and shall be liable on conviction to the same punishment for an offence under section 14, 15 or 17, as the case may be.

(7) In this section, "principal contractor" means a person who has entered into a contract with an owner, a developer or a lessee of a property or his agent for the purpose of carrying out any construction works on the property.

Study on pollution control

36.—(1) The Director may, by notice in writing, require any person intending to carry out any activity that, in the opinion of the Director, is likely to cause substantial pollution of the environment or increase the level of such pollution —

(*a*) to carry out a study on environmental pollution control and related matters;
(*b*) to submit for the Director's approval, within such time as may be specified by the Director, a proposal for the implementation of such measures for the prevention, reduction or control of pollution of the environment; and
(*c*) to implement such measures for the prevention, reduction or control of pollution of the environment as the Director may approve or specify.

(2) The study referred to in subsection (1) shall be conducted in such manner as the Director may, by notice in writing, require, and for this purpose, the Director may issue guidelines for the conduct of such study.

(3) The Director may, by notice in writing, if he considers it necessary —

(*a*) require any modification or addition to be made to the measures proposed by the person under subsection (1) (*b*); or
(*b*) require the person to conduct a further study.

(4) Any person who fails to comply with a notice made under subsection (1) or (3) shall be guilty of an offence.

Self-monitoring and submission of results

37.—(1) The Director may, by notice in writing, require the owner or occupier of any premises from which any air impurity, trade effluent or hazardous substance is generated and emitted into the atmosphere, discharged into the public sewerage system or any land, drain or inland waters to install suitable monitoring equipment or system at any point along the line of discharge, to monitor the quality or quantity of such emission or discharge or both.

(2) The owner or occupier of such premises with monitoring equipment or system installed shall —

(*a*) ensure that such equipment or system is working in a proper and efficient manner;
(*b*) keep a proper record of all monitoring results; and
(*c*) submit the records to the Director as may be required by the Director.

(3) Any monitoring result which shows that any standard prescribed in the regulations has not been complied with shall, until the contrary is proved, be admissible as evidence in any proceedings against the owner or occupier of such premises for

failure to comply with any provision of this Act or the regulations.

(4) Without prejudice to the generality of subsection (3), the Director may, by notice in writing, require the owner or occupier of such premises to install further suitable devices or systems to prevent the emission of air impurities, discharge of trade effluent or emission or discharge of any hazardous substance, if the level of emission or discharge fails to comply with the prescribed standards or requirements.

(5) Any person who, without the written consent of the Director, alters or causes to be altered any monitoring equipment or system referred to in subsection (1) shall be guilty of an offence.

Regulations for mandatory insurance

38.—(1) The Minister may make regulations to require an owner or occupier of industrial or trade premises or a person who handles, stores, transports or uses hazardous substances to take out and maintain policies of insurance in such circumstances and against liabilities for such risks, costs or damages as may be prescribed in the regulations.

(2) Without prejudice to the generality of subsection (1), the regulations may provide for —

(*a*) the terms and conditions including any minimum limit of indemnity of any policy of insurance required to be taken out or maintained under subsection (1);

(*b*) the form of the certificate of insurance; and

(*c*) the different terms and conditions in different circumstances.

Power to prohibit work and processes in certain circumstances

39.—(1) Where the Minister has reason to believe that the emission of air impurities, the discharge of trade effluent or the emission or discharge of any hazardous substance or toxic substance from any premises is likely to cause pollution of the environment or be injurious to public health or safety, the Minister may by order direct the owner or occupier of the premises —

(*a*) to cease forthwith the conduct of any trade or industrial process, or operation of any fuel burning equipment or industrial plant, in or on the premises which produces the air impurities, trade effluent, hazardous substance or toxic substance in or for such period as may be specified in the order;

(*b*) to cease forthwith the emission of air impurities, discharge of trade effluent, emission or discharge of hazardous substance or toxic substance into the atmosphere or any land, drain or inland waters; or

(*c*) to take steps as may be specified in the order to collect, store and treat the trade effluent, hazardous substance or toxic substance either indefinitely or until such steps have been taken as is specified in the order and to treat such trade effluent, hazardous substance or toxic substance before it is discharged into any public sewerage system, drain or inland waters.

(2) The owner or occupier of any premises who fails to comply with an order made under subsection (1) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $100,000 or to imprisonment for a term not exceeding 3 months or to both and, in the case of a continuing offence, to a further fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

(3) Where the owner or occupier of any premises has failed to comply with an order made under subsection (1), the Director may, at all reasonable times, enter upon the premises and take such measures and execute such work as may be necessary to comply with the order.

(4) Any person who is aggrieved by an order made under subsection (1) may, within 30 days from the date of the order, appeal to the High Court which may rescind or vary the order.

(5) Notwithstanding that an appeal has been made under subsection (4), an aggrieved person shall comply with the order pending the outcome of the appeal to the High Court and the Director may exercise the powers conferred under subsection (3).

Advisory and technical committees

40.—(1) The Minister may, from time to time, appoint such advisory or technical committees as he thinks necessary for any of the purposes of this Act or the regulations.

(2) The composition of such committees and the terms of appointment of the members shall be determined by the Minister.

PART XI
ENFORCEMENT

Default in compliance with notice or order

41.—(1) Where a person on whom a notice or order under this Act or the regulations is served fails to comply with the notice or order within the time specified in the notice or order —

(*a*) he shall, unless he satisfies the court that he has used all due diligence to comply with the notice or order, be guilty of an offence and shall, where no penalty is provided for such default, be liable on conviction to a fine not exceeding $20,000; and

(*b*) the Director or any authorised officer may enter the premises under section 47 and execute the works specified in the notice or order.

(2) Any expenses reasonably incurred by the Director under subsection (1) (*b*) may be recovered from the person in default and section 51 and, if that person is the owner of the premises, section 53 shall apply in respect of those expenses.

(3) Nothing in this section shall be construed as prohibiting the Director from carrying out any works specified in any such notice or order at the request of a person who has been served with the notice or order upon an undertaking by that person to pay the costs and expenses in executing the works.

Appeal against notice or order

42.—(1) Where a person on whom a notice or order referred to in section 41 (1) is served is aggrieved by the notice or order —

(*a*) he may, within 14 days from the date of service of the notice or order and in the prescribed form and manner, appeal to the Minister; and

(*b*) no liability to a fine under section 41 (1) (*a*) shall arise nor, except as provided for in this section, shall any proceedings be taken or work done under the notice or order until after the determination or abandonment of the appeal.

(2) Where an appeal is brought under this section, the Minister may dismiss or allow the appeal unconditionally or subject to such conditions as he considers fit, and any decision made by the Minister on the appeal shall be final.

(3) Where an appeal has been brought under this section, and the Minister is of the opinion that —

(*a*) the non-execution of the notice or order will be injurious or dangerous to public health; and

(*b*) the immediate execution of the notice or order will not cause any injury to the person against whom the notice or order was made which cannot be compensated by damages,

the Minister may authorise the Director immediately to execute the work.

(4) The Director shall, if he carries out the work and the appeal is successful, pay the costs and expenses of the work and any damages sustained by the appellant by reason of the work.

(5) The Director may, if he carries out the work and the appeal is dismissed or abandoned, recover the costs and expenses of the work from the appellant and section 51 and, if the appellant is the owner of the premises in respect of which the notice or order was made, section 53 shall apply to any sum recoverable from him hereunder.

Power to demand names and addresses

43.—(1) The Director or any authorised officer may require any owner or occupier of any premises or any principal contractor referred to in section 35 to give his name and address and such other proof of identity, and to furnish such other particulars, as the Director or authorised officer may require for the purposes of this Act.

(2) Any person who, upon being required by the Director or any authorised officer to give his name and address or other proof of identity or to furnish any particulars under subsection (1), refuses to do so or wilfully mis-states his name and address or proof of identity or furnishes false particulars shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000.

(3) The Director may, by notice in writing, require any person to furnish such other information as may be necessary for the purposes of this Act or the regulations.

(4) Any person who fails without reasonable excuse to comply with any requirement of subsection (3) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000.

Powers of Director to examine and secure attendance

44.—(1) The Director or any authorised officer may —

(*a*) examine orally any person supposed to be acquainted with the facts and circumstances of matters under this Act or the regulations, and to reduce to writing any statement made by the person so examined; and

(*b*) require by order in writing the attendance before himself of any person, being within the limits of Singapore, who, from information given or otherwise, appears to be acquainted with the facts and circumstances of matters under this Act or the regulations and that person shall attend as so required.

(2) The person mentioned in subsection (1) (*a*) shall be bound to state truly the facts and circumstances with which he is acquainted concerning matters under this Act or the regulations, except only that he may decline to make with regard to any fact or circumstance, a statement which would have a tendency to expose him to a criminal charge, penalty or forfeiture.

(3) A statement made under this section by any person shall be read over to him and shall, after correction, if necessary, be signed by him.

(4) If any person fails to attend as required by an order under subsection (1) (*b*), the Director may report such failure to a Magistrate who may thereupon issue a warrant to secure the attendance of that person as required by the order.

Powers of arrest

45.—(1) The Director, an authorised officer or a police officer may arrest any person, whom the Director or officer has reason to believe has committed an offence under this Act or the regulations, if the name and address of the person are unknown to him and —

(*a*) the person declines to give his name and address; or

(*b*) there is reason to doubt the accuracy of the name and address, if given.

(2) A person arrested under this section may be detained until his name and address are correctly ascertained.

(3) No person so arrested shall be detained longer than is necessary for bringing him before a court.

Director may act in cases of emergency

46. Where the Director considers it necessary in the case of an emergency, he may direct the immediate execution of any work or the doing of any act being any work or act authorised under this Act or the regulations which is in his opinion necessary to prevent injury or danger to public health or serious pollution of the environment.

Power of entry

47.—(1) The Director or any authorised officer may, for the purposes of this Act or the regulations, enter at all reasonable hours in the day time any premises with such assistants and workmen as are necessary for the purpose of making any survey, inspection or investigation and executing any work authorised by this Act or the regulations.

(2) Unless the consent of the occupier has been obtained therefor, no person shall enter into any dwelling-house in actual occupation under this section without 6 hours' previous notice to the occupier.

(3) For the purposes of this section, the Minister may declare that any class of premises is liable to night inspection, and thereupon the Director or any authorised officer, with such assistants and workmen as are necessary, may, at any time of the day or night and without notice, enter using such force as may be necessary and search or inspect any premises of the class specified in the declaration.

Power to enter on land adjacent to works

48.—(1) The Director or any authorised officer, with such assistants and workmen as are necessary, may enter upon any land, adjoining or being within 100 meters of any works by this Act or the regulations authorised to be executed —

(*a*) for the purpose of depositing upon that land any soil, gravel, sand, lime, brick, stone or other materials; or

(*b*) for any other purposes connected with the formation of those works,

without making any previous payment, tender or deposit and doing as little damage as may be in the exercise of the powers under this subsection.

(2) The Director shall make compensation —

(*a*) to the owner and the occupier for such temporary occupation or temporary damage of the land from time to time and as often as any such temporary occupation is taken or any such temporary damage done; and

(*b*) to the owner for the permanent injury, if any, to the land.

(3) Before the Director makes any use of any land under subsection (1), he shall give 7 days' notice of his intention to the owner and the occupier of the land.

Penalty for obstructing Director in his duty

49. Any person who at any time —

(*a*) hinders or obstructs the Director or any authorised officer in the performance or execution of his duty or of any thing which he is empowered or required to do under this Act or the regulations;

(*b*) interferes with any work authorised to be executed under this Act or the regulations; or

(*c*) fails to facilitate by all reasonable means the entry and inspection of any premises by the Director or any authorised officer or the examination of any equipment, industrial plant, container or the making of any tests which the Director or any authorised officer is empowered under this Act or the regulations to make,

shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $20,000 or to imprisonment for a term not exceeding 3 months or to both and, in the case of a second or subsequent conviction, to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 3 months or to both.

Powers of search and seizure

50. If the Director has reason to believe that any hazardous or toxic substance is being kept, stored, processed, treated, discharged or deposited, or air impurities are being emitted, or any hazardous or toxic substance or trade effluent is being discharged without his consent, the Director or any authorised officer may —

(*a*) search the premises and take possession of any substance found therein and reasonably believed to be or contain hazardous substances;

(*b*) require the production of records, certificates, notices and documents relating or reasonably believed to relate to any dealing in or with hazardous or toxic substances, emission of air impurities or discharge of trade effluent or toxic substance wherever and by whomsoever kept and whether kept under the provisions of this Act or the regulations or otherwise and take extracts therefrom;

(*c*) take samples of any materials whether solid, liquid, gaseous or vapour found in the premises;

(*d*) seal the samples and require the owner of the materials to send the samples to an analyst for analysis and bear any costs and expenses arising therefrom;

(*e*) require the owner or analyst to submit the results of the analysis to the Director;

(*f*) take such photographs as he thinks necessary for the purposes of this Act or the regulations; and

(*g*) require any person whom he finds in the premises to produce his identity card or other identification papers for inspection for the purpose of an investigation or inquiry under this Act or the regulations.

PART XII
COMPENSATION, DAMAGES, FEES, COSTS AND EXPENSES

Compensation, damages, fees, costs and expenses to be determined by Magistrate's Court or District Court

51.—(1) Except as otherwise provided, in all cases where compensation, damages, fees, costs or expenses are provided under this Act or the regulations to be paid, the amount and, if necessary, the apportionment of the amount and any question of liability shall, in case of dispute, or failure to pay, be summarily ascertained and determined by a Magistrate's Court or, if the amount claimed exceeds the Magistrate's Court limit, by a District Court.

(2) In any proceeding under subsection (1), the Magistrate's Court or the District Court may —

(*a*) inquire whether those expenses ought to be borne wholly or in part by some person other than the defendant in the proceedings;

(*b*) make such order concerning the expenses or their apportionment as appears to the Court to be just; and

(*c*) where those expenses were incurred under section 41 (1) (*b*) by the Director in carrying out any works specified in a notice, inquire whether any requirement specified in the notice was reasonable.

(3) The Magistrate's Court or the District Court shall not order the expenses or any part thereof to be borne by any person other than the defendant in the proceedings unless the Court is satisfied that the other person has had due notice of the proceedings and an opportunity of being heard.

(4) If the amount of compensation, damages, fees, costs or expenses is not paid by the party liable to pay it within 7 days after demand, that amount may be reported to a Magistrate's Court or a District Court and recovered in the same way as if it were a fine imposed by a Magistrate's Court or a District Court.

(5) An appeal shall lie to the High Court from any decision of a Magistrate's Court or a District Court under this section, and the provisions of the Criminal Procedure Code (Cap. 68) shall apply, with the necessary modifications, to all such appeals.

Occupier may execute work where owner defaults in execution of work

52.—(1) Whenever default is made by an owner of any premises in the execution of any work required under this Act or the regulations to be executed by him, an occupier of the premises may, with the approval of the Director, cause the work to be executed.

(2) The expense of the work executed under subsection (1) shall be paid to the occupier by the owner of the premises or the amount may be deducted out of the rent from time to time becoming due from him to the owner, and the occupier may, in the absence of any special agreement to the contrary, retain possession until that expense has been fully reimbursed to him.

Recovery of costs and expenses payable by owners

53.—(1) All sums payable by or recoverable from an owner of any premises in respect of costs and expenses incurred by the Government in connection with the execution of any work which are under this Act or the regulations recoverable from an owner of any premises shall, subject and without prejudice to any other rights of the Government, be a first charge on the premises in respect of which the costs and expenses were incurred.

(2) In addition to any other remedies conferred by this Act, any such sum may be recovered in the manner provided in this section, and the person or persons liable to pay it shall be the owner or owners at the time when the work was completed.

(3) If any such sum remains unpaid at the expiration of the prescribed time, a notice shall be served upon the person or any one of the persons, if more than one, liable to pay it, calling on him to pay that sum together with a fee of such amount as may be prescribed for the cost of the notice, within 15 days of the date of service of such notice.

(4) Without prejudice to section 66, if no person liable to pay the sum can be found, such notice shall be deemed to have been duly served by the posting thereof at the office of the Director and by fixing a copy thereof on some conspicuous part of the premises in respect of which the costs and expenses were incurred.

(5) At the expiration of the period of 15 days or such further period as may be allowed by the Director, if any such sum or part thereof remains due and unpaid, it shall be deemed to be arrears and may be recovered as provided in section 55.

(6) The charge mentioned in subsection (1) shall attach, and the powers and remedies conferred by subsections (2) to (5) shall become exercisable, as from the date of completion of the work.

(7) Notwithstanding any change in the ownership or occupation of the premises after the completion of the work, the charge and the powers and remedies referred to in subsection (6) may be exercised against the premises or against any movable property or crops for the time being found thereon.

(8) An occupier who, when requested by or on behalf of the Director to state the name of the owner of the premises, refuses or wilfully omits to disclose or wilfully mis-states the name shall, unless he shows cause to the satisfaction of the court for his refusal or mis-statement, be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000.

Recovery of costs and expenses by instalments

54.—(1) When the Director has incurred costs and expenses in or about the execution of any work, which are, under this Act or the regulations, payable by or recoverable from an owner, the Director may —

(*a*) recover those costs and expenses in the manner provided in section 53; or

(*b*) if he thinks fit, may make an arrangement with the owner for the payment of such instalments as will be sufficient to defray the whole amount of the costs and expenses with interest thereon at the prescribed rate, within a period not exceeding 10 years.

(2) Upon default in payment of any instalment or interest upon the date appointed for payment thereof by any such arrangement, the whole of the balance then outstanding of that amount, together with any interest in arrears, shall immediately become due and payable and, notwithstanding any change in the ownership or occupation of the premises since the date of the arrangement, may be recovered by as provided in section 53.

Proceedings for recovery of arrears

55.—(1) For the recovery of arrears, the Director shall have and may exercise, either successively or concurrently, in addition to any other remedies conferred by this Act the following powers:

(*a*) the Director may issue a warrant of attachment and may seize by virtue thereof any movable property and crops of any person liable to pay the arrears and may also seize any movable property or crops to whomever it belongs which are found on the premises in respect of which the arrears are due and may, after service of the prescribed notice, sell the same by public auction in the prescribed manner;

(*b*) the Director may, by notice of sale to be served or published in the prescribed manner, declare his intention to sell, at the expiration of 3 months from the date of the notice of sale, the premises in respect of which the arrears are due and, if, at the expiration of that period, the arrears have not been paid or satisfied, the Director may sell by public auction, in lots or otherwise, the whole of the premises or such portion thereof or such interest therein as he considers sufficient for the recovery of the arrears and costs.

(2) The Director shall not proceed under subsection (1) (*b*) to sell the premises in respect of which the arrears are due, or any portion thereof or interest therein, where there is or are upon the premises and liable to be seized and sold under subsection (1) (*a*) any movable property or crops belonging to the owner of a value estimated by the Director to be sufficient to realise the sum required to satisfy the arrears and costs.

(3) Any tenant, sub-tenant or occupier who, in order to avoid the seizure or sale of his property for arrears payable by the owner of the premises, pays the arrears and costs may thereafter, in the absence of any written agreement to the contrary, deduct the amount so paid by him from the rent due or to become due by him to his immediate landlord on account of the premises or such part thereof as is held or occupied by him, and may retain possession until that amount has been fully reimbursed to him whether by deduction from the rent or otherwise.

(4) Any tenant or sub-tenant who has reimbursed, whether by allowing a deduction from his rent or otherwise, any sub-tenant or occupier holding or occupying under him the amount so paid by that sub-tenant or occupier shall have a similar right to deduct the amount from the rent due or to become due to his immediate landlord and to retain possession until similarly reimbursed.

(5) The receipt of any public officer duly authorised in writing by the Director in that behalf for any amount so paid by any such tenant, sub-tenant or occupier shall be deemed an acquittance in full for the like amount of rent.

(6) If any premises in respect of which arrears are due, or any such movable property or crops as are mentioned in subsection (1) or the proceeds of sale thereof are already in the custody of the law under any process of execution whereby the Director is unable to exercise the remedies conferred under subsections (1) to (5), the Director —

(*a*) may notify the Sheriff or the bailiff of the court concerned of the amount of the arrears; and

(*b*) shall be entitled without obtaining a judgment to be paid that amount out of the proceeds of sale of the premises or property in priority to the judgment debtor and to the judgment creditor and to any other creditor except the Government.

(7) A certificate from the Director shall, unless it is disputed by the judgment debtor, be conclusive evidence of the amount of such arrears, and, in case of dispute, the amount shall be summarily determined by a Magistrate's Court.

(8) Where any premises which is not registered land is sold under subsection (1) (*b*), the Director shall have the power to execute the conveyance and the purchaser of the premises shall not be concerned to inquire whether the provisions of this Act relating to the sale and the conveyance have been complied with nor otherwise to inquire into the regularity or validity of the sale and conveyance.

(9) Section 144 of the Land Titles Act (Cap. 157) shall apply, with the necessary modifications, to any premises sold under subsection (1) (*b*) which is registered land.

Attachment

56.—(1) The attachment mentioned in section 55 (1) (*a*) may be made by a person appointed for the purpose by the Director who shall give public notice of the attachment in the prescribed manner and shall take an inventory of the property attached.

(2) A person appointed under subsection (1) shall be deemed to be a public servant within the meaning of the Penal Code (Cap. 224).

(3) Such a person may break open in the day time any house or building for the purpose of effecting the attachment.

Application of proceeds of sale

57.—(1) The proceeds of a sale under section 55 (1) and (2) shall be applied in the first place in satisfaction of the arrears together with interest thereon at the prescribed rate and costs.

(2) Where there is any surplus remaining, the Director shall —

(*a*) if satisfied as to the right of any person claiming the surplus, pay the amount thereof to that person; or

(*b*) if not so satisfied, shall hold the amount in trust for the person who may ultimately succeed in due course of law in establishing his title thereto.

(3) If no title is established to the surplus within a period of 5 years from the date of the sale, it shall be paid into the Consolidated Fund.

Title acquired by purchaser at sale by Director

58.—(1) The purchaser at a sale held under section 55 (1) (*b*) shall be deemed to have acquired the right offered for sale free from all encumbrances created over it and from all subordinate interests derived from it except such as are expressly reserved by the Director at the time of sale.

(2) The Director shall notify, by an advertisement published in the *Gazette*, the result of the sale and the conveyance to the purchaser of the property or right offered for sale.

Costs of proceedings for recovery of arrears

59. All costs of any proceedings for the recovery of arrears may be recovered as if they formed part of the arrears.

Power to stop sale

60. If any person having any interest in any property liable to be sold at any time previous to such sale tenders to the Director the arrears with interest and costs, the Director shall thereupon desist from all further proceedings in respect of the sale.

Application to Court

61.—(1) If any person whose movable property, crop or land has been attached or offered for sale disputes the attachment or sale, he may apply to the High Court or, where the arrears do not exceed the District Court's limit, to a District Court for an order to stay the proceedings.

(2) The High Court or District Court, after hearing the Director and making such further inquiry as is necessary, shall make such order as is just.

Security for payment of arrears

62. No application shall be entertained by the High Court or District Court under section 61 unless the applicant has deposited in Court the amount of the arrears and costs or furnished security for them to the satisfaction of the Court.

Liability of transferor who has not given notice

63.—(1) Every person who sells or transfers any property in respect of which costs and expenses have been incurred by the Government in connection with the execution of any work which are, under this Act or the regulations, recoverable from the owner or owners thereof shall continue to be liable for the payment of all the costs and expenses payable in respect of the property and for the performance of all other obligations imposed by this Act or the regulations upon the owner of the property which become payable or are to be preformed at any time before such notice of transfer as is required by section 19 of the Property Tax Act (Cap. 254) has been given.

(2) Nothing in subsection (1) shall affect the liability of the purchaser or transferee to pay such costs and expenses in respect of the property or affect the right of the Director to recover such costs and expenses or to enforce any obligation under this Act or the regulations.

Proceedings where occupier opposes execution of work

64.—(1) If the occupier of any premises prevents the owner thereof from carrying into effect in respect of the premises any of the provisions of this Act or the regulations after notice of his intention to do so has been given by the owner to that occupier, a Magistrate's Court, upon proof thereof and upon application by the owner, may —

(*a*) make an order in writing, requiring the occupier to permit the owner to execute all such works with respect to the premises as are necessary for carrying into effect the provisions of this Act or the regulations; and

(*b*) if it thinks fit, order the occupier to pay to the owner the costs relating to the application or order.

(2) If after the expiration of 8 days from the date of the order the occupier continues to refuse to permit the owner to execute the works, the occupier shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $1,000 for every day or part thereof during which he so continues to refuse.

(3) Every such owner shall, during the continuance of such refusal, be discharged from any penalty to which he might otherwise have become liable by reason of his default in executing the works.

PART XIII
MISCELLANEOUS PROVISIONS

Notices, orders and other documents may be given by authorised officer

65.—(1) All notices, orders, receipts, warrants and other documents of any nature which the Director is empowered to give by this Act or the regulations may, subject to the direction of the Director, be given by any authorised officer on behalf of the Director.

(2) Where any such notice, order, receipt, warrant or document requires authentication, the signature or an official facsimile thereof of the Director or any public officer authorised by the Director affixed thereto shall be sufficient authentication.

Service of notices, etc.

66.—(1) Every notice, order, summons or document required or authorised by this Act or the regulations to be served on any person may be served —

(*a*) by delivering it to that person or by delivering it at the last known place of residence of that person to some adult member of his family or his employee;

(*b*) by leaving it at the usual or last known place of residence or place of business of that person in an envelope addressed to that person; or

(*c*) by forwarding it by post in a prepaid letter addressed to that person at his usual or last known place of residence or place of business.

(2) A notice, order, summons or document required or authorised by this Act or the regulations to be served on the owner or occupier of any premises shall be deemed to be properly addressed if addressed by the description of the "owner" or "occupier" of the premises without further name or description.

(3) A notice, order, summons or document required or authorised by this Act or the regulations to be served on the owner or occupier of any premises may be served by delivering it or a true copy thereof to some adult person on the premises or, if there is no such person on the premises to whom it can with reasonable diligence be delivered, by affixing the notice, order, summons or document to some conspicuous part of the premises.

(4) When a notice, order, summons or document is to be served on any body corporate, it may be served —

(*a*) by delivering it to the secretary or other like officer of the body corporate at its registered office or principal place of business; or

(*b*) by sending it by registered post addressed to the body corporate at its registered office or principal place of business.

General penalties

67.—(1) Any person who is guilty of an offence under this Act (except for an offence under Part VII) for which no penalty is expressly provided shall be liable —

(*a*) on the first conviction to a fine not exceeding $20,000 and, in the case of a continuing offence, to a further fine not exceeding $1,000 for every day or part thereof during which the offence continues after conviction; and

(*b*) on a second or subsequent conviction to a fine not exceeding $50,000 and, in the case of a continuing offence, to a further fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

(2) The court before which such conviction is heard may, in addition to such fine, order the person to pay to the Director the amount of any expense in connection with the execution of any work, together with any interest due thereon or any interest certified by the Director to be due from such person at the date of his conviction.

(3) Such amount may be recovered according to any written law for the time being in force for the recovery of fines.

Furnishing of deposits

68.—(1) Where any permit, consent or approval is given by the Director under this Act or the regulations for the execution of any work, the Director may require a deposit or other security in lieu thereof to be furnished by the person applying for the permit, consent or approval to secure the execution of the work.

(2) Where any such work is not executed to the satisfaction of the Director, he may utilise the deposit or security or any part thereof to make good the defects.

Inaccuracies in document

69.—(1) No misnomer or inaccurate description of any person, premises, building, holding, street or place named or described in any document prepared, issued or served under, by virtue of or for the purposes of this Act or the regulations shall in any way affect the operation of this Act or the regulations as respects that person or place if that person or place is so designated in the document as to be identifiable.

(2) No proceedings taken under or by virtue of this Act or the regulations shall be invalid for want of form.

Evidence of analyst

70.—(1) The Director may, by instrument in writing under his hand, appoint persons who in his opinion are qualified to

be analysts for the purposes of this Act.

(2) Subject to subsection (3), a certificate of an analyst appointed under subsection (1) stating that he has analysed or examined a substance and stating the result of his analysis or examination is admissible in evidence in any proceedings for an offence under this Act or the regulations as prima facie evidence of the facts stated in the certificate and of the correctness of the result of the analysis or examination.

(3) A certificate of an analyst referred to in subsection (2) shall not be received in evidence in pursuance of that subsection unless the person charged has been given a copy of the certificate together with reasonable notice of the intention of the prosecution to produce the certificate as evidence in the proceedings.

(4) Where a certificate of an analyst appointed under subsection (1) is admitted in evidence under subsection (2), the person charged may require the analyst to be called as a witness for the prosecution and the analyst may be cross-examined as if he had given evidence of the matters stated in the certificate.

(5) For the purposes of this section, a document purporting to be a certificate referred to in subsection (2) on its production by the prosecution shall, unless the contrary is proved, be deemed to be such a certificate.

Offence by body corporate

71. Where a body corporate is guilty of an offence under this Act or the regulations, and that offence is proved to have been committed with the consent or connivance of, or to be attributable to any neglect on the part of, any director, manager, secretary or other similar officer of the body corporate, or any person who was purporting to act in any such capacity, he as well as the body corporate shall be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Composition of offences

72.—(1) The Director may, in his discretion, compound any offence under this Act or the regulations which is prescribed to be a compoundable offence by accepting from the person reasonably suspected of having committed the offence a sum not exceeding $5,000.

(2) On payment of such sum of money, no further proceedings shall be taken against that person in respect of the offence except that any compensation, damages, fees, costs or expenses which are provided to be paid under this Act or the regulations shall remain payable.

(3) Nothing in this section shall prevent the Director from issuing any further notice in respect of the same matter to the person who has paid such sum of money.

Jurisdiction of Courts

73. A District Court or a Magistrate's Court shall have jurisdiction to hear and determine all proceedings under this Act or the regulations and shall, notwithstanding anything to the contrary in the Criminal Procedure Code (Cap. 68), have power to impose the full punishment in respect of any such offence.

Saving of prosecutions under other laws

74. Nothing in this Act shall prevent any person from being prosecuted under any other written law for any act or omission which constitutes an offence under this Act or the regulations or from being liable under that other law to any other or higher punishment or penalty than that provided by this Act or the regulations except that no person shall be punished twice for the same offence.

Exemption

75. The Minister may by notification in the *Gazette*, exempt, either generally or for such time as he may specify, any person, thing, premises or works or any class of person, thing, premises or works from any provision of this Act or the regulations.

Amendment of Schedules

76.—(1) The Minister may at any time, by order published in the *Gazette*, amend any Schedule except the Third Schedule.

(2) The Minister may, in any order made under subsection (1), make such incidental, consequential or supplementary provision as may be necessary or expedient.

Regulations

77.—(1) The Minister may make regulations —

(*a*) for or in respect of every purpose which is necessary for carrying out the provisions of this Act;

(*b*) for prescribing any matter which is authorised or required under this Act to be prescribed; and

(*c*) without prejudice to the generality of paragraphs (*a*) and (*b*) for or in respect of the matters specified in the Third Schedule.

(2) The Minister may, in making any regulations, provide that any contravention of or failure to comply with the regulations shall be an offence punishable with a fine not exceeding $50,000 or with imprisonment for a term not exceeding 2 years or with both and, in the case of a continuing offence, with a fine not exceeding $2,000 for every day or part thereof during which the offence continues after conviction.

(3) All such regulations shall be presented to Parliament as soon as possible after publication in the *Gazette*.

Transitional provisions

78.—(1) Any scheme, contract, document, licence, permission or resolution prepared, made, granted or approved under the repealed Clean Air Act (Cap. 45, 1985 Ed.), the repealed Water Pollution Control and Drainage Act (Cap. 348, 1985 Ed.) (repealed by the Sewerage and Drainage Act (Cap. 293A)) or the Poisons Act (Cap. 234, 1989 Ed.) in relation to poisons specified in the repealed Part II of the Poisons List in the Schedule to the Poisons Act shall, so far as it is not inconsistent with the provisions of this Act and except as otherwise expressly provided in this Act or in any other written law, continue and be deemed to have been prepared, made, granted or approved under the corresponding provisions of this Act.

(2) Any subsidiary legislation made under the repealed Clean Air Act and in force immediately before 1st April 1999 shall, so far as it is not inconsistent with the provisions of this Act, continue in force as if made under this Act until it is revoked by subsidiary legislation made under this Act.

(3) The enactments mentioned in the Fourth Schedule shall have effect subject to the amendments to the extent therein specified (being amendments consequential on the preceding provisions of this Act).

(4) The Minister may, by order published in the *Gazette*, repeal or amend any written law which appears to him to be unnecessary having regard to the provisions of this Act or to be inconsistent with any provision of this Act.

Appendix 2
Rg 5 Environmental Pollution Control (Trade Effluent) Regulations

Revised Edition 2001 (31.1.2001)

ENVIRONMENTAL POLLUTION CONTROL ACT (CHAPTER 94A, SECTION 77 (1))

ENVIRONMENTAL POLLUTION CONTROL (TRADE EFFLUENT) REGULATIONS

ARRANGEMENT OF REGULATIONS

[1st April 1999]

Citation

1. These Regulations may be citied as the Environmental Pollution Control (Trade Effluent) Regulations.

Definition

2. In these Regulations, unless the context otherwise requires, "controlled watercourse" means a watercourse from which water supplied by the Public Utilities Board under the Public Utilities Act (Cap.261) is obtained but does not include a watercourse from which water is pumped into a main of the Public Utilities Board.

Particulars to be furnished

3.—(1) An applicant applying for a licence under section 15 of the Act shall furnish the Director —

(*a*) particulars of the trade, manufacture, business or building construction carried on or to be carried on by him and in the course of which the trade effluent is wholly or partly produced or of which the trade effluent is the waste or refuse;

(*b*) details of all the processes or operations employed or to be employed by him, to produce the final products of the trade, manufacture, business or building construction;

(*c*) particulars of all the raw materials and chemicals used or to be used in the processes or operations;

(*d*) details of the layout of all the machinery, plant and equipment used or to be used in the premises in which the trade, manufacture, business or building construction is or shall be carried on, as the case may be;

(*e*) an estimate of the amount of water consumed or used or to be consumed or used in the trade, manufacture, business or building construction;

(*f*) particulars of the physical, organic and chemical nature of the trade effluent; and

(*g*) such other information relating to the discharge of trade effluent as the Director may require.

(2) In his application for a licence, the applicant shall furnish the Director such other information as the applicant considers to be relevant to the consideration of his application.

(3) A licensee shall not discharge trade effluent into any watercourse or land otherwise than in accordance with these Regulations.

(4) A licensee shall, within 14 days of a change in —

(*a*) a process or operation referred to in paragraph (1) (*b*); or

(*b*) the layout of the machinery, plant and equipment referred to in paragraph (1) (*d*),

which affects the amount or the physical, organic or chemical nature of the trade effluent discharged and which has been made after the Director has granted the licence, notify the Director in writing of the change in the process or operation, or the layout of the machinery, plant and equipment, as the case may be.

(5) Any licence granted by the Director to discharge trade effluent into any watercourse or land —

(*a*) shall be subject to such conditions as the Director may impose;

(*b*) may be revoked, or suspended for any period, by the Director without assigning any reason; and
(*c*) shall cease to be valid when the licensee fails to comply with these Regulations or any condition imposed by the Director in granting the licence.

Trade effluent to be treated

4. All trade effluent shall be treated before it is discharged into any watercourse or land, unless an exemption is specifically granted by the Director.

Control mechanism for discharge of trade effluent

5. A person who discharges trade effluent into any watercourse or land shall, in connection with the discharge, install such sampling test points, inspection chambers, flow-meters, and recording and other apparatuses as the Director may, from time to time, require.

Outlet for discharge to require prior approval

6.—(1) A person shall obtain the prior permission in writing of the Director before he makes or causes to be made any drain or other connection to a watercourse for the purpose of discharging trade effluent into the watercourse.

(2) In every such case, the position and design of the outlet for the discharge of the trade effluent into the watercourse shall be approved by the Director and shall not be altered or changed without his prior approval.

Particulars of trade effluent discharge required by Director

7. A person who discharges trade effluent into any watercourse or land shall, at such times as the Director may require, submit particulars of —

(*a*) the amount of water consumed or used for the purposes of a trade, manufacture, business or building construction carried on by him and in the course of which the trade effluent is wholly or partly produced or of which the trade effluent is the waste or refuse;
(*b*) the physical, organic and chemical nature of the trade effluent;
(*c*) the raw materials and chemicals used in the trade, business, manufacture or building construction and the direction of the flow of any liquid or the trade effluent from or produced by the machinery, plant and equipment used in the trade, business, manufacture or building construction; and
(*d*) such other information relating to the discharge of the trade effluent as may be required by the Director.

Nature and type of trade effluent to be discharged

8.—(1) No trade effluent other than that of a nature or type approved by the Director shall be discharged into any watercourse or land.

(2) The temperature of the trade effluent shall not exceed 45 ° Celsius at the point of its entry into any watercourse or land.

(3) The pH value of the trade effluent shall not be less than 6 nor more than 9 at the point of its entry into any watercourse or land.

(4) The caustic alkalinity of the trade effluent shall not be more than 2,000 milligrams of calcium carbonate per litre at the point of its entry into any watercourse or land.

Trade effluent to be free of certain substances

9. The trade effluent discharged into any watercourse or land shall not contain any of the following substances:
(*a*) radioactive material;
(*b*) any pesticide, fungicide, herbicide, insecticide, rodenticide or fumigant;
(*c*) refuse, garbage, sawdust, timber, human or animal waste or solid matter;
(*d*) petroleum or other inflammable solvent; or
(*e*) a substance that either by itself or in combination or by reaction with other waste or refuse may give rise to any gas, fume, or odour or substance which is or is likely to be a hazard to human life, a public nuisance, injurious or otherwise objectionable.

Maximum concentrations of certain substances

10.—(1) The Director may stipulate —

(*a*) the maximum volume and quantity of a substance which may be discharged into a watercourse; and
(*b*) the maximum rate at which the substance may be so discharged.

(2) Subject to paragraph (1), no person who has been informed by the Director by notice in writing of the volume, quantity or rate may discharge the substance into a watercourse in a volume, quantity or at a rate in excess of that so stipulated.

(3) Any trade effluent analysed in accordance with regulation 11 shall not contain the following substances in concentrations greater than those set out below:

Appendix 2

	Limit for discharge into a watercourse other than a controlled watercourse in milligrams per litre of trade effluent	*Limit for discharge into a controlled watercourse in milligrams per litre of trade effluent*
(*a*) Total Suspended Solids	50	30
(*b*) Total Dissolved Solids	2,000	1,000
(*c*) Chloride (as chloride ion)	600	400
(*d*) Sulphate (as SO_4)	500	200
(*e)* Sulphide (as sulphur)	0.2	0.2
(*f*) Cyanide (as CN)	0.1	0.1
(*g*) Detergents (linear alkylate sulphonate as methylene blue active substances)	15	5
(*h*) Grease and Oil	10	5
(*i*) Arsenic	1	0.05
(*j*) Barium	5	5
(*k*) Tin	10	5
(*l*) Iron (as Fe)	20	1
(*m*) Beryllium	0.5	0.5
(*n*) Boron	5	0.5
(*o*) Manganese	5	0.5
(*p*) Phenolic Compounds (expressed as phenol)	0.2	Nil.

(4) The 5-day Biochemical Oxygen Demand at 20 ° Celsius (referred to in this paragraph as BOD) and the Chemical Oxygen Demand (referred to in this paragraph as COD) of any trade effluent analysed in accordance with regulation 11 shall not be in proportions greater than those set out below:

(*a*) 50 milligrams per litre of BOD and 100 milligrams per litre of COD where the trade effluent is discharged into a watercourse other than a controlled watercourse;

(*b*) 20 milligrams per litre of BOD and 60 milligrams per litre of COD, where the trade effluent is discharged into a controlled watercourse.

(5) The concentration of the following metals in the trade effluent shall not exceed those set out below:

	Limit for discharge into a watercourse other than a controlled watercourse in milligrams per litre of trade effluent	*Limit for discharge into a controlled watercourse in milligrams per litre of trade effluent*
(*a*) Cadmium	0.1	0.01
(*b*) Chromium (trivalent and hexavalent)	1	0.05
(*c*) Copper	0.1	0.1
(*d*) Lead	0.1	0.1
(*e*) Mercury	0.05	0.001
(*f*) Nickel	1	0.1
(*g*) Selenium	0.5	0.01
(*h*) Silver	0.1	0.1
(*i*) Zinc	1	0.5.

(6) Where 2 or more of the metals specified in paragraph (5) are present in the trade effluent, the concentration of the metals shall not be more than —

(*a*) 1 milligram per litre where the trade effluent is discharged into a watercourse other than a controlled watercourse; and

(*b*) 0.5 milligram per litre where the trade effluent is discharged into a controlled watercourse.

(7) The concentration of —

(*a*) free chlorine shall not exceed 1 milligram per litre where the trade effluent is discharged into a watercourse;

(*b*) colour shall not exceed 7 Lovibond Units where the trade effluent is discharged into a watercourse;

(*c*) phosphates, expressed as PO_4, shall not exceed 5 milligrams per litre where the trade effluent is discharged into a watercourse other than a controlled watercourse and 2 milligrams per litre where it is discharged into a controlled watercourse;

(*d*) calcium and magnesium, expressed as Ca and Mg respectively, shall not exceed 200 milligrams per litre where the trade effluent is discharged into a watercourse other than a controlled watercourse and 150 milligrams per litre

where it is discharged into a controlled watercourse; and

(*e*) nitrate, expressed as NO_3, shall not exceed 20 milligrams per litre where the trade effluent is discharged into a controlled watercourse.

Method of analysis

11. For the purposes of these Regulations, the trade effluent discharged into any watercourse or land shall be analysed in accordance with the latest edition of "Standard Methods for the Examination of Water und Wastewater" published jointly by the American Public Health Association, the American Water Works Association and the Water Pollution Control Federation of the United States, as amended from time to time, or in accordance with such other method of analysis as the Director thinks fit.

Penalty

12. Any person who contravenes or fails to comply with regulation 3, 4, 5, 6, 7, 8, 9 or 10 shall be guilty of an offence and shall be liable —

(*a*) on the first conviction to a fine not exceeding $10,000 and, in the case of a continuing offence, to a further fine not exceeding $300 for every day or part thereof during which the offence continues after conviction; and

(*b*) on a second or subsequent conviction to a fine not exceeding $20,000 and, in the case of a continuing offence, to a further fine not exceeding $500 for every day or part thereof during which the offence continues after conviction.

Exemption

13. The Director may exempt a person or class of persons from any provision of these Regulations.

Transitional provisions

14.—(1) Any document or written permission prepared, made, granted or approved under the revoked Trade Effluent Regulations (Cap.348, Rg4) in relation to the discharge of trade effluent into a watercourse shall, as far as it is not inconsistent with the provisions of these Regulations, continue and be deemed to have been prepared, made, granted or approved under the corresponding provisions of these Regulations.

(2) A permission granted under regulation 4 (2) of the revoked Trade Effluent Regulations in relation to the discharge of trade effluent into a watercourse shall continue and be deemed to be a licence granted under section 15 of the Act for discharge of trade effluent into a watercourse, until such time when it is revoked by the Director of Environmental Pollution Control.

[G.N. No.S 160/99]

Appendix 3
Rg 8 Environmental Pollution Control (Air Impurities) Regulations

Revised Edition 2002

ENVIRONMENTAL POLLUTION CONTROL ACT (CHAPTER 94A, SECTION 77 (1))

ENVIRONMENTAL POLLUTION CONTROL (AIR IMPURITIES) REGULATIONS

ARRANGEMENT OF REGULATIONS

[1st January 2001]

Citation

1. These Regulations may be cited as the Environmental Pollution Control (Air Impurities) Regulations.

Dark smoke

2.—(1) For the purposes of section 11 of the Act, dark smoke includes smoke of any colour which appears to the Director or any authorised officer —

(*a*) to be darker than shade No.1 on the Ringelmann Chart;

(*b*) when observed or recorded with such instrument or device as the Director may approve, to be darker than shade No.1 on the Ringelmann Chart; or

(*c*) to be of such opacity as to cause obscuration to a degree equivalent to smoke darker than shade No.1 on the Ringelmann Chart.

(2) Section 11 of the Act shall not apply to the emission of dark smoke from any chimney where —

(*a*) the emission of dark smoke is for a duration of less than 5 minutes in any period of one hour in a day; and

(*b*) the total number of emissions of dark smoke from that chimney does not exceed 3 times a day.

Methods of smoke indication

3.—(1) Every occupier of any industrial or trade premises in or on which any industrial plant or fuel burning equipment is situated shall, if required by the Director to do so, provide or install such instrument, equipment or device in or on the premises in accordance with paragraphs (2) and (3).

(2) The instrument, equipment or device referred to in paragraph (1) must be of such type and installed in such manner as will enable any person in charge of the industrial plant or fuel burning equipment to readily ascertain at all times and without leaving the boiler room, furnace room or control room, whether smoke is being discharged from any chimney on the industrial or trade premises.

(3) The instrument, equipment or device may include one or more of the following:

(*a*) a smoke density indicator, recorder and alarm which will provide adequate indication in the boiler room, furnace room or control room of the density of smoke being discharged from the chimney;

(*b*) a closed circuit television installation with the receiver located in the boiler room, furnace room or control room; or

(*c*) any other instrument, equipment or device approved by the Director.

Standards of concentration of air impurities

4.—(1) For the purposes of section 12 of the Act, the standards of concentration of air impurities that must be complied with in the conduct of any trade, industry or process or the operation of any fuel burning equipment or industrial plant shall be those specified in the Schedule.

(2) The concentration of any substance specified in the first column of the Schedule shall be determined in accordance with such method as may be specified by or is acceptable to the Director.

Testing procedures and requirements

5.—(1) For the purposes of section 12 of the Act, the Director may specify in any particular case, the point at which the concentration of air impurities shall be measured.

(2) The point at which the concentration of air impurities shall be measured may be situated at —

(*a*) the fixed point of emission of any air impurities;

(*b*) the final point of emission of any air impurities; or

(*c*) any other point in or along any flue, duct or chimney located at a place in the premises other than the final point of emission of air impurities.

(3) Every owner or occupier of any industrial or trade premises shall —

(*a*) carry out such tests with respect to the emission of air impurities from and the consumption of fuel in or on the premises as may be required by the Director;

(*b*) keep a register of all such tests, specifying the date, nature and results of each test; and

(*c*) ensure that such register is available for inspection by the Director or any authorised officer at all reasonable times.

(4) Subject to paragraph (5), the results of all tests conducted on boilers, furnaces and incinerators with respect to the emission of air impurities shall be expressed on the basis of flue gas containing 12% by volume of carbon dioxide.

(5) The results of all tests conducted on waste incinerators with respect to the emission of dioxins and furans shall be expressed on the basis of flue gas containing 11% by volume of oxygen.

(6) Every owner or occupier of any industrial or trade premises shall, for the purposes of enabling the Director or any authorised officer to exercise his powers under the Act —

(*a*) provide the Director or the authorised officer with access to such premises, any part thereof and any control equipment, fuel burning equipment, industrial plant or chimney on such premises, at all reasonable times and as often as the Director or the authorised officer considers necessary; and

(*b*) provide the Director or the authorised officer with such assistance and facilities as may reasonably be required by the Director or the authorised officer.

(7) The assistance and facilities referred to in paragraph (6) (*b*) shall include, in respect of each chimney serving the premises, the provision of one or more inspection opening or openings and such means of safe and adequate access for the purposes of enabling an authorised officer to inspect and obtain representative samples of any discharge from the chimney.

(8) In this regulation —

"boiler" means any device in which water or other liquid is heated by any combustible material;

"furnace" means any chamber, other than a boiler in which combustion takes place;

"incinerator" means any structure or part of a structure used in any trade, industry or process to dispose of material by burning or heating with any form of energy;

"waste incinerator" means an incinerator which is used for the purposes of disposing of municipal, industrial or hospital waste.

Exemption

6.—(1) Regulation 4 shall not apply to such industrial or trade premises and for such period between 1st January 2001 to 31st December 2003 as the Director may determine.

(2) The Director may —

(*a*) require any industrial or trade premises referred to in paragraph (1) to comply with such other emission standards as he may specify; and

(*b*) if he considers it necessary, extend the period of exemption referred to in paragraph (1), subject to such conditions as he may impose.

Penalties

7.—(1) Any person who contravenes regulation 3 or 5 (3) or (6) shall be guilty of an offence and shall be liable —

(*a*) on the first conviction, to a fine not exceeding $10,000 and, in the case of a continuing offence, to a further fine not exceeding $300 for every day or part thereof during which the offence continues after conviction; and

(*b*) on the second or subsequent conviction to a fine not exceeding $20,000 and, in the case of a continuing offence, to a further fine not exceeding $500 for every day or part thereof during which the offence continues after conviction.

(2) Any offence under these Regulations may be compounded by the Director in accordance with section 72 (1) of the Act.

Appendix 3

THE SCHEDULE

Regulation 4

STANDARDS OF
CONCENTRATION OF AIR IMPURITIES

1. The concentration of any substance specified in the first column emitted from any operation in any trade, industry, process, fuel burning equipment or industrial plant specified in the second column shall not at any point before admixture with air, smoke or other gases, exceed the limits specified in the third column.

Chart — see "chart 1-5-1 " in Chapter 1

2. In this Schedule —

"dioxins and furans" means polychlorinated, dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF), being tricyclic and aromatic compounds formed by 2 benzene rings which are connected by 2 oxygen atoms in PCDD and by one oxygen atom in PCDF and the hydrogen atoms of which may be replaced by up to 8 chlorine atoms;

"mg" means milligram;

"ng" means nanogram;

"Nm^3" means normal cubic metre, being that amount of gas which when dry, occupies a cubic metre at a temperature of 0 degree Centigrade and at an absolute pressure of 760 millimetres of mercury;

"TEF" means Toxic Equivalency Factor;

"TEQ" means Toxic Equivalent, being the sum total of the concentrations of each of the dioxin and furan compounds specified in the first column of the table below multiplied by their corresponding TEF specified in the second column thereof:

Dioxin / Furan	*TEF*
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.01
Octachlorodibenzo-p-dioxin	0.0001
2,3,7,8-Tetrachlorodibenzofuran	0.1
1,2,3,7,8-Pentachlorodibenzofuran	0.05
2,3,4,7,8-Pentachlorodibenzofuran	0.5
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
Octachlorodibenzofuran	0.0001

[G.N. Nos.S 595/2000; S11/2001]

Appendix 4
Rg 11 Environmental Public Health (Toxic Industrial Waste) Regulations

Revised Edition 2000 (31.1.2000)

ENVIRONMENTAL PUBLIC HEALTH ACT
(CHAPTER 95, SECTION 113)

ENVIRONMENTAL PUBLIC HEALTH
(TOXIC INDUSTRIAL WASTE) REGULATIONS

ARRANGEMENT OF REGULATIONS

PART I
PRELIMINARY

PART II
GENERATOR

PART III
TOXIC INDUSTRIAL WASTE COLLECTOR

PART IV
LICENCES

PART V
IMPORT OF TOXIC INDUSTRIAL WASTE

PART VI
TRANSPORT OF TOXIC INDUSTRIAL WASTE

PART VII
MISCELLANEOUS

[6th August 1988]

PART I
PRELIMINARY

Citation

1. These Regulations may be cited as the Environmental Public Health (Toxic Industrial Waste) Regulations.

Definitions

2.—(1) In these Regulations, unless the context otherwise requires —

"carrier" means any person undertaking the transport of toxic industrial waste and includes both carriers for hire or reward and carriers on own account;

"code of practice" means a standard which —

(*a*) sets out the method of installation of equipment and the procedure to be followed for the efficient use and maintenance of such equipment;

(*b*) recommends precautions to be taken in making, using and maintaining such equipment; or

(*c*) specifies the measures or precautions to be taken in designing, planning and constructing such equipment in order to ensure that the requirements laid down in respect of the design, plan and construction of such equipment are complied with;

"consignment" means any load or multi-load of toxic industrial waste presented by a consignor for transport;

"consignor" means any person who presents a consignment of toxic industrial waste for transport or on whose behalf such consignment is presented;

"container" means —

(*a*) any vessel, can, drum, barrel or other receptacle; or

(*b*) where such vessel, can, drum, barrel or other receptacle is contained in another container or is wholly enveloped in a covering or coverings of whatever nature, the outermost container or covering, as the case may be,

but does not include the carrying tank of a road tanker, a tank container or a freight container;

"emergency action plan" means such plan of action to be taken in the event of any emergency situation involving any toxic industrial waste as approved by the Commissioner;

"freight container" means an article of transport equipment designed to facilitate the carriage of goods by one or more modes of transport without intermediate re-loading of the contents;

"generator" includes —

(*a*) any person, whose act or process produces toxic industrial waste or whose act first causes toxic industrial waste to become subject to regulation; or

(*b*) the owner or the person having the charge, management or control of a source of toxic industrial waste;

"import", with its grammatical variations and cognate expressions, means to bring or cause to be brought into Singapore by land, sea or air;

"multi-load" means a load consisting of 2 or more types of toxic industrial waste in separate compartments or containers (whether or not a waste which is not a toxic industrial waste is being conveyed at the same time);

"road" has the same meaning as in the Road Traffic Act (Cap.276);

"road tanker" means a goods vehicle as defined in the Road Traffic Act which has a tank that is structurally attached to, or is an integral part of, the frame of the vehicle;

"tank" means a container having a total internal capacity exceeding 250 litres for liquids and 500 litres for gases;

"tank container" means a tank with a total liquid capacity of 450 litres or more which is —

(*a*) used for the conveyance of a liquid, gaseous, powdery or granular substance; and

(*b*) constructed for repeated use and to facilitate the carriage of goods by one or more modes of transport without need of removal of its structural equipment or intermediate re-loading of its contents;

"toxic industrial waste collector" means any person who receives or accepts any toxic industrial waste for storage, reprocessing, usage, treatment or disposal but does not include the carrier engaged by the generator or the toxic industrial waste collector to transport toxic industrial waste;

"transport" means transport by road and includes any operation incidental to the whole course of carriage, such as loading, unloading and storage in transit;

"vehicle" means any mechanically propelled vehicle or otherwise intended or adapted for use on roads and includes a road tanker and a trailer which does not form part of the vehicle.

(2) For the purposes of these Regulations, a combination of a vehicle and one or more trailers shall be treated as one vehicle for so long as they remain attached.

(3) A vehicle shall be deemed for the purposes of these Regulations to be used for the transport of toxic industrial waste throughout the period —

(*a*) in the case of a road tanker, from the commencement of loading for the purpose of conveying the waste on a road until the tank or compartment of the tank has been cleaned or purged so that any of the waste or its vapour which remains in it is not sufficient to create a risk to the health or safety of any person; or

(*b*) in the case of a vehicle carrying a container, tank container or freight container from either —

(i) the time at which the container, tank container or freight container containing the toxic industrial waste is placed on the vehicle; or

(ii) if the container, tank container or freight container was placed on the vehicle before loading was commenced, from the commencement of loading,

for the purpose of conveying the waste on a road until either —

(A) the container, tank container or freight container is removed from the vehicle; or

(B) the tank container or compartment of the tank container has been cleaned or purged so that any of the waste or its vapour which remains in it is not sufficient to create a risk to the health or safety of any person,

and in either case, whether or not the vehicle is on a road at the material time.

Application

3. These Regulations shall only apply to the toxic industrial wastes which are specified in the Schedule.

PART II
GENERATOR

Commissioner to be notified when toxic industrial waste exceeds permitted level

4. Every generator shall forthwith notify the Commissioner of —

(*a*) any change in the type or nature of toxic industrial waste that is being produced or generated in his premises; and

(*b*) the quantity, volume, concentration or level of any toxic industrial waste that is produced or generated in excess of that prescribed in the second column of the Schedule and the action he intends to take or has taken in respect thereto.

Information to be given to toxic industrial waste collector to enable him to deal with toxic industrial waste properly

5.—(1) Any person who supplies or sells or permits to be supplied or sold toxic industrial waste to any toxic industrial waste collector shall give all such necessary information to the toxic industrial waste collector as will enable him to carry out the storage, treatment, reprocessing or disposal of the toxic industrial waste properly and safely.

(2) Any person who supplies any information relating to toxic industrial waste to a toxic industrial waste collector under paragraph (1) shall ensure that the toxic industrial waste collector is a licensed toxic industrial waste collector and that the information is accurate and sufficient for the purposes of that paragraph.

Generator to keep register

6.—(1) Every generator shall keep a register which shall contain the following particulars in respect of toxic industrial waste:

(*a*) the type and quantity generated;

(*b*) the manner of disposal;

(*c*) the date and the quantity supplied or sold to a toxic industrial waste collector;

(*d*) the name and address of the toxic industrial waste collector; and

(*e*) the quantity held in stock.

(2) The register shall be kept up to date on a weekly basis unless otherwise specified by the Commissioner and shall be kept for such period of time as the Commissioner may direct.

Application

7. Regulations 4, 5 and 6 shall not apply to any generator with on-site disposal facilities established with the permission of the Commissioner for the treatment or recycling of toxic industrial waste produced in the premises whereby no toxic industrial waste need to be transported out of the premises for disposal.

No use or storage of toxic industrial waste except in certain circumstances

8. A generator shall not, on any premises which are used for the purposes of an undertaking carried on by him, keep or use, or cause or permit to be kept or used, toxic industrial waste unless there are on-site disposal facilities established with the permission of the Commissioner or toxic industrial waste collector has been engaged to dispose of the waste.

PART III
TOXIC INDUSTRIAL WASTE COLLECTOR

No person to act as toxic industrial waste collector without licence

9. No person shall —

(*a*) carry on or advertise, notify or state that he carries on or is willing to carry on the business of a toxic industrial waste collector;

(*b*) act as a toxic industrial waste collector; or

(*c*) in any way hold himself out as ready to undertake for payment or other remuneration (whether monetary or otherwise) any of the functions of a toxic industrial waste collector,

unless he is the holder of a toxic industrial waste collector's licence.

Alteration of works or method of operation, etc.

10. The licensed toxic industrial waste collector shall not, without the written permission of the Commissioner —

(*a*) install, construct or alter any works for the reprocessing, treatment, storage or disposal of toxic industrial waste or carry out any works on the premises which is the commencement of or any subsequent steps in relation thereto;

(*b*) alter the method of operation of any waste reprocessing, treatment, storage or disposal process involving toxic industrial waste carried on at his premises; or

(*c*) alter the type of toxic industrial waste being reprocessed, treated, stored or disposed of on the premises,

unless the installation, construction or alteration is done only in the course of and for the purpose of general maintenance.

Toxic industrial waste collector to obtain information on toxic industrial waste

11. A toxic industrial waste collector shall not receive or accept any toxic industrial waste unless he has obtained and verified all relevant information of the waste as will enable him to carry out the storage, treatment, reprocessing or disposal of the toxic industrial waste properly and safely.

Register to be kept by toxic industrial waste collector

12.—(1) A toxic industrial waste collector shall prepare and maintain a register in such form as the Commissioner may require.

(2) The register shall be kept for such period of time as the Commissioner may direct and shall be submitted for inspection by the Commissioner at such times as the Commissioner may require.

PART IV
LICENCES

Application for toxic industrial waste collector's licence

13.—(1) Every application for a toxic industrial waste collector's licence shall be made to the Commissioner in such form as the Commissioner may determine.

(2) Every application shall state the name and address of the applicant.

(3) A toxic industrial waste collector shall receive, accept or deal only in the type of toxic industrial waste for which he is licensed.

(4) A licensed toxic industrial waste collector shall surrender his licence upon its expiry, revocation, cancellation or suspension to a public officer authorised in writing by the Commissioner.

(5) Every licence shall, unless previously revoked, remain in force for such period of time as the Commissioner may specify in the licence.

(6) The fee for the grant or renewal of a licence shall be $125 except that any person who is licensed as a general waste collector under the Environmental Public Health (General Waste Collection) Regulations (Rg12) shall be exempted from payment of the licence fee.

(7) The fee for the amendment of a licence shall be$12 per application.

PART V
IMPORT OF TOXIC INDUSTRIAL WASTE

Import of toxic industrial waste

14.—(1) No person shall, without the written permission of the Commissioner, import or cause any toxic industrial waste to be brought into Singapore.

(2) The Commissioner may, in granting any permission, impose such condition as he thinks fit.

Collection of toxic industrial waste

15. Where any toxic industrial waste is imported and is to be delivered in Singapore, the toxic industrial waste collector or his duly authorised agent shall take delivery of the waste —

(*a*) at the Woodlands Customs Station if the waste is imported into Singapore by road;
(*b*) at a railway station in Singapore if the waste is imported into Singapore by rail;
(*c*) at a wharf in Singapore if the waste is imported into Singapore by sea; or
(*d*) at an air cargo terminal in Singapore if the waste is imported into Singapore by air.

PART VI
TRANSPORT OF TOXIC INDUSTRIAL WASTE

Consignor's responsibility for safe consignment

16. A person shall not consign for transport any toxic industrial waste unless —

(*a*) he has obtained an approval in writing by the Commissioner in regard to the proposed transport of such waste; and

(*b*) the container, tank container, freight container or road tanker to be used for the transportation of the toxic industrial waste is designed, constructed and maintained in accordance with a code of practice approved by the Commissioner.

Consignment note

17. The generator shall —

(*a*) prepare 5 copies of the consignment note in such form as may be prescribed by the Commissioner; and

(*b*) give 3 copies of the consignment note to the consignor before transportation of the toxic industrial waste for transmission to the carrier and one copy to the Commissioner within 3 days of the transportation of the waste.

Driver to deliver consignment note to consignee

18.—(1) The carrier shall give 2 copies of the consignment note referred to in regulation 17 to the driver for delivery to the consignee.

(2) The consignee shall, upon taking delivery of the waste, obtain 2 copies of the consignment note referred to in paragraph (1) from the driver.

Receipt of consignment note

19.—(1) The consignee shall submit one copy of the consignment note referred to in regulation 18 duly completed to the Commissioner within 3 days of the receipt of the toxic industrial waste.

(2) The consignee shall immediately inform the Commissioner of the quantity or type of toxic industrial waste received by or delivered to him if it is different from that shown in the consignment note referred to in regulation 18.

Application

20. Regulation 16 (*a*), 17, 18 and 19 shall apply only to the transport or consigning for transport of any toxic industrial waste in an amount exceeding the quantities as specified in the third column of the Schedule.

Collection from several generators

21.—(1) No person shall transport or collect toxic industrial waste in a vehicle from several generators at any one time unless he is a licensed toxic industrial waste collector or is engaged by a licensed toxic industrial waste collector.

(2) The total cumulated quantity of toxic industrial waste transported or collected per trip shall not exceed the quantities specified in the third column of the Schedule unless the toxic industrial waste collector has obtained an approval in writing by the Commissioner.

Carrier to obtain information on consignment

22.—(1) No carrier shall transport any toxic industrial waste unless he has been given a statement prescribed by regulation 24 (1) as will enable him to comply with the requirements of these Regulations and to be aware of the risks created by the waste to the health or safety of any person.

(2) The statement shall be supplied by the consignor or owner of the consignment of toxic industrial waste to the carrier at the latest when the transport order is given, so as to enable the carrier to take all necessary steps to ensure that the driver of the vehicle used to transport the toxic industrial waste is aware of the instructions therein and is capable of carrying them out effectively.

(3) It shall be the duty of any person who supplies any statement relating to toxic industrial waste to a carrier under paragraph (1) to ensure that the information contained therein is accurate and sufficient for the purposes of that paragraph.

Carrier to be given copy of written approval, etc.

23. Notwithstanding regulation 22, no carrier shall transport any toxic industrial waste exceeding the quantities as specified in the third column of the Schedule unless he has been given a copy of the written approval of the Commissioner as prescribed by regulation 16 and copies of the consignment note referred to in regulation 17.

Transport documents

24.—(1) The consignor or owner of a consignment of toxic industrial waste shall provide in the transport documents a statement regarding the safety requirements and the actions required to be taken by the carrier which shall include the

following:

(*a*) supplementary operational requirements for loading, unloading, transport, storage, handling and stowage or a statement that no supplementary operational requirements are necessary;

(*b*) restrictions, if any, on the mode of transport and any necessary routing instructions;

(*c*) emergency action plans;

(*d*) indication or indications of the general nature of the risk involved and safety precautions when handling the toxic industrial waste; and

(*e*) a declaration that the contents of the consignment are properly described by name and are properly marked, labelled and packaged and are in a proper condition for transport.

(2) The declaration made under paragraph (1) (*e*) shall contain the original or stamped facsimile signature of the consignor or owner of the consignment of toxic industrial waste, as the case may be, together with the date and shall be in such form as may be prescribed by the Commissioner.

Instructions for drivers

25. The carrier shall, before any toxic industrial waste is transported, give the driver of the vehicle used to transport the waste a copy of the statement referred to in regulation 22 (1) and ensure that the driver is adequately trained to carry out the instructions contained in the statement.

Driver's responsibility

26. The driver of a vehicle used for transporting any toxic industrial waste shall —

(*a*) keep in the vehicle a copy of the statement given to him under regulation 25 at all times when the waste is being transported; and

(*b*) comply with all the instructions contained in the copy of the statement given to him under regulation 25.

Transport routes

27. The carrier shall not transport any toxic industrial waste exceeding the quantities as specified in the third column of the Schedule except at such times and along such routes as may be prescribed by the Commissioner.

Hazard warning panels and labels

28.—(1) Where any toxic industrial waste is being transported in a road tanker, a freight container or a tank container or in any other vehicle, the carrier shall ensure that such appropriate hazard warning panel or label as prescribed in the code of labelling specified by the Commissioner is displayed on the road tanker, freight container, tank container or on any other vehicle and such panel or label shall —

(*a*) be weather resistant and indelibly marked;

(*b*) be either rigid or fixed to be rigid;

(*c*) be marked on or securely attached to the vehicle, freight container or tank container in a substantially vertical plane, and if the means of attachment is by a frame, that frame shall carry no other hazard warning panels; and

(*d*) be kept clean and free from obstruction, except that a rear panel or label may be mounted behind a ladder of light construction which does not prevent the information on the panel or label from being easily read.

(2) Where a multi-load is transported in a compartmented tank container or freight container or, if in a road tanker, in separate tanks or compartments of a tank, the carrier shall ensure that each tank or compartment which contains a toxic industrial waste is provided with and displays the appropriate hazard warning panel or label prescribed in the code of labelling specified by the Commissioner and the requirements of paragraph (1) shall apply to such panel or label.

(3) The carrier shall ensure that such hazard warning panel or label is —

(*a*) displayed on the road tanker, freight container, tank container or other vehicle at all times when any toxic industrial waste is being transported; and

(*b*) removed when the road tanker, freight container, tank container or other vehicle is not used for transporting any toxic industrial waste.

Precaution against fire or explosion

29.—(1) Every person engaged in the transport of toxic industrial waste shall —

(*a*) ensure as far as is reasonably possible that none of the waste is spilt or released; and

(*b*) observe all precautions necessary for preventing fire or explosion.

(2) A suitable and efficient fire extinguisher shall be carried in an easily accessible position on any vehicle transporting any toxic industrial waste.

Prohibition against overfill

30. The consignor or owner of a consignment of toxic industrial waste shall ensure that any carrying tank of a road tanker, tank container or freight container in which the toxic industrial waste is transported is not overfilled at the time of consigning for transport.

Prohibition against carriage of multi-loads of toxic industrial waste

31. No person shall transport a multi-load of toxic industrial waste except in accordance with a code approved by the Commissioner.

Supervision of vehicles carrying toxic industrial waste

32.—(1) The driver of a vehicle used to transport any toxic industrial waste shall ensure that the vehicle, when not driven, is —

(*a*) parked in a safe place; or

(*b*) supervised at all times by him or by some other competent person above the age of 21 years.

(2) Paragraph (1) shall not apply where any carrying tank of a road tanker, tank container or compartment thereof, which had contained a toxic industrial waste is nominally empty.

(3) In paragraph (2), "nominally empty" means that as much of the toxic industrial waste as is reasonably practicable has been discharged or unloaded from it and that such waste remaining within the carrying tank, tank container or compartment thereof is not sufficient to create a risk to the health and safety of any person.

PART VII
MISCELLANEOUS

Supply and sale of toxic industrial waste

33.—(1) No person shall supply or sell or permit to be supplied or sold any toxic industrial waste to any unlicensed toxic industrial waste collector.

(2) Paragraph (1) shall not apply to the export of toxic industrial waste from Singapore.

Storage requirements

34. It shall not be lawful to store any toxic industrial waste except in a container —

(*a*) the design, construction and maintenance of which is in accordance with a code of practice approved by the Commissioner;

(*b*) which is in an area to which entry is restricted to authorised personnel; and

(*c*) which is labelled with the appropriate hazard warning sign as prescribed in a code of labelling approved by the Commissioner.

Mixing of toxic industrial waste

35. No person shall mix or permit the mixing of different types of toxic industrial waste or mix or permit the mixing of toxic industrial waste with non-toxic industrial waste unless the mixing is part of a process of treatment, use or disposal approved by the Commissioner.

Safe storage and dealing

36. Every generator or toxic industrial waste collector and every agent or employee of such person shall, when storing, using or otherwise dealing with toxic industrial waste, do so in such a manner as not to threaten the health or safety of any person or to cause pollution to the environment.

Notice requiring removal of toxic industrial waste from premises

37. —(1) If, in the opinion of the Commissioner, the toxic industrial waste stored in any premises is likely to threaten the health or safety of any person or to cause pollution to the environment, the Commissioner may, by notice in writing, require the owner or occupier of the premises to remove the toxic industrial waste to a disposal facility.

(2) The Commissioner may, by notice in writing, require the owner or occupier upon whom a notice has been served under paragraph (1) to furnish evidence that the industrial waste from the premises has been disposed of at a disposal facility in accordance with the notice.

Emergency action plan to be prepared

38.—(1) The generator, toxic industrial waste collector, consignor or owner of any consignment of toxic industrial waste shall —

(*a*) prepare and keep up to date the emergency action plan detailing how spillage, leakage or accidents which may arise from the transportation, storage, reprocessing or treatment of toxic industrial waste will be dealt with; and

(*b*) ensure that his agents or employees have received adequate instruction and training to enable them to implement the emergency action plan in the event of any accident or emergency involving any toxic industrial waste stored, reprocessed, treated or transported.

(2) The Commissioner may by notice in writing require any generator, toxic industrial waste collector, consignor or owner of any consignment of toxic industrial waste to prepare, improve or update the emergency action plan within a reasonable time fixed by him.

Analysis of toxic industrial waste

39.—(1) The Commissioner may, by notice in writing, require any person to submit samples of the toxic industrial waste produced in his premises or collected or received by him to any laboratory approved by the Commissioner for chemical analysis.

(2) All analysis reports shall be kept and shall be made available for inspection by the Commissioner.

Exemption

40. The Commissioner may exempt any person or class of persons from any of the provisions of these Regulations.

Penalty

41. A person who contravenes or fails to comply with any of the provisions of these Regulations shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $2,000 and, in the case of a continuing offence, to a further fine not exceeding $100 for every day or part thereof during which the offence continues after conviction.

THE SCHEDULE

Regulations 3, 4 (*b*), 20, 21 (2), 23 and 27

LIST OF TOXIC INDUSTRIAL WASTES

List of Toxic Industrial Wastes	Prescribed Quantity For Generation Per Year	Prescribed Quantity For Transportation Per Trip
Acids		
1. Spent inorganic acids, e.g. hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, hydrofluoric acid, boric acid and pickling acid	1,000 *l*	250 *l*
2. Spent organic acids, e.g. acetic acid, formic acid, benzoic acid and sulphonic acid	1,000 *l*	250 *l*
Alkalis		
1. Spent alkaline solutions	1,000 *l*	250 *l*
2. Spent ammoniacal solutions	1,000 *l*	250 *l*
3. Metal hydroxide sludges and oxide sludges	1,500 kg	300 kg
Antimony and its Compounds		
Spent antimony potassium tartrate	0 kg	0 kg
Arsenic and its Compounds		
1. Timber preservative residues containing arsenic	0 kg	0 kg
2. Wastes containing gallium arsenide	0 kg	0 kg
Asbestos		
1. Asbestos wastes from asbestos/cement manufacturing processes	1,500 kg	300 kg
2. Empty sacks/bags which have contained loose asbestos fibre	1,500 kg	300 kg
Cadmium and its Compounds		
1. Plating effluents and residues containing cadmium	1,000 *l*	250 *l*
2. Wastes containing cadmium from Ni/Cd battery manufacturing	0 kg	0 kg
Chromium Compounds		
1. Plating effluents and residues containing chromium	1,000 *l*	250 *l*
2. Timber preservative residues containing chromium	0 kg	0 kg
3. Spent and aqueous solutions containing chromic compounds	1,000 *l*	250 *l*
4. Tannery effluents and residues containing chromium	1,000 *l*	250 *l*
Copper Compounds		
1. Plating effluents and residues containing copper	1,000 *l*	250 *l*
2. Spent etching solutions containing copper from printed circuit board manufacturing	1,000 *l*	250 *l*
3. Timber preservative residues containing copper	0 kg	0 kg
Cyanides		
1. Plating effluents and residues containing cyanides	0 kg	0 kg
2. Heat treatment residues containing cyanides	0 kg	0 kg
3. Spent quenching oils containing cyanides	0 kg	0 kg
4. Spent processing solutions containing cyanides from photographic processing	0 kg	0 kg
Fluoride Compounds		
1. Timber preservative residues containing fluorides	0 kg	0 kg
2. Spent ammonium bi-fluoride	1,000 *l*	250 *l*
Isocyanates		
Spent di-isocyanates, e.g. toluene di-isocyanate (TDI) and methylene di-isocyanate (MDI) from polyurethane foam-making process	1,000 *l*	250 *l*
Laboratory Wastes		
1. Obsolete laboratory chemicals	0 kg	0 kg
2. Toxic chemical wastes from chemical analysis	0 kg	0 kg

Appendix 4

Lead Compounds		
1. Sludges containing lead oxide/sulphate	1,500 kg	300 kg
2. Spent organo-lead compounds, e.g. tetraethyllead (TEL) and tetramethyllead(TML)	0 kg	0 kg
3. Waste lead-acid batteries, whole or crushed	10,000 kg	1,000 kg
Mercury and its Compounds		
1. Effluents, residues or sludges containing mercury from chlor-alkali industry	0 kg	0 kg
2. Wastes containing mercury from equipment manufacturing involving the use of metal mercury	0 kg	0 kg
3. Spent catalysts from chemical processes containing mercury	0 kg	0 kg
4. Spent organo-mercury compounds	0 kg	0 kg
Metal Catalysts		
Spent metal catalysts from chemical processes and petroleum refining, e.g. catalysts containing chromium and cobalt	0 kg	0 kg
Nickel Compounds		
Plating effluents and residues containing nickel	1,000 *l*	250 *l*
Organic Compounds containing Halogen		
1. Spent halogenated organic solvents, e.g. trichloroethylene, 111-trichloroethane, perchloroethylene, methylene chloride, tetra-chloromethane and 112-trichloro-122-trifluoroethane	10,000 *l*	1,000 *l*
2. Residues from recovery of halogenated organic solvents	7,500 kg	1,500 kg
3. Packaging materials or residues containing chlorobenzenes and/or chlorophenals and their salts	0 kg	0 kg
Organic Compounds not containing Halogen		
1. Spent non-halogenated organic solvents, e.g. benzene, toluene, xylene, turpentine, petroleum, thinner, kerosene, methanol, ethanol, isobutanol, isopropanol, methyl ethyl ketone, methyl isobutyl ketone, isopropyl ether, diethyl ether, hexane, dimethyl sulphide and dimethyl sulphoxide	10,000 *l*	1,000 *l*
2. Residue from recovery of non-halogenated organic solvents	7,500 kg	1,500 kg
Other Wastes		
1. Obsolete/abandoned chemicals and pesticides from storage, manufacturing and trading activities	0 kg	0 kg
2. Used containers, bags and process equipment contaminated by chemicals and pesticides from storage, manufacturing and trading activities	0 kg	0 kg
3. Wastes/residues containing unreacted monomers, e.g. vinyl chloride and styrene monomers, from polymer manufacturing processes	7,500 kg	1,500 kg
4. Tar residues from distilling and tarry materials from refining	7,500 kg	1,500 kg
5. Wastes from toxic waste treatment processes, e.g. wastes and residues from solidification, fixation and incineration processes	7,500 kg	1,500 kg
6. Wastes from toxic chemical drums and tank cleaning activities	1,000 *l*	250 *l*
7. Chemical and oil slops from ship tankers	10,000 *l*	1,000 *l*
8. Waste from the production, formulation and use of resins, latex, plasticisers, glues/adhesives containing solvents and other contaminants	5,000 *l*	1,000 *l*
9. Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish containing organic solvents, heavy metals or biocides	5,000 *l*	1,000 *l*
Pathogenic Wastes		
Pathogenic wastes from hospitals	0 kg	0 kg
Phenolic Compounds		
1. Sludges/residues from paint stripping using chemicals containing phenols	1,500 kg	300 kg
2. Residues containing unreacted phenol and formaldehyde from adhesive industry	1,500 kg	300 kg
Polychlorinated Bi-phenyl (PCB) Including Poly-chlorinated Ter-phenyl (PCT)		
1. Spent transformer oil containing PCB and/or PCT	0 kg	0 kg
2. Retrofilled transformer contaminated with PCB and/or PCT	0 kg	0 kg
3. Electrical equipment and parts containing or contaminated with PCB and/or PCT, e.g. capacitors and transformers	0 kg	0 kg
4. Containers and all waste materials contaminated with PCB and/or PCT	0 kg	0 kg
Polyvinyl Chloride (PVC)		
All waste materials containing PVC, e.g. PVC insulated wires, PVC pipes and trunking, PVC parts, PVC upholstery and PVC resins	No Requirement	No Requirement
Silver Compounds		
Spent processing solutions containing silver from photographic processing	1,000 *l*	250 *l*

Used, Contaminated Oil		
1. Used material, lubricating and hydraulic oil from machine cylinders, turbines, switch gears and transformers	10,000 *l*	1,000 *l*
2. Spent motor oils from petrol and diesel engines	10,000 *l*	1,000 *l*
3. Spent quenching oil from metal hardening	10,000 *l*	1,000 *l*
4. Oil recovered from solvent degreasers	5,000 *l*	1,000 *l*
5. Spent oil water emulsions, e.g. spent coolants from metal working industries	5,000 *l*	1,000 *l*
6. Oil water mixtures (mainly oil), e.g. oily ballast water from ship tankers	10,000 *l*	1,000 *l*
7. Oil and sludge from oil interceptors	7,500 kg	1,500 kg
8. Tanker sludges and oil sludges/residues from storage tanks	7,500 kg	1,500 kg
9. Oil sludges containing acid from recovery and recycling of used oil	7,500 kg	1,500 kg
Zinc Compounds		
Plating effluents and residues containing zinc	1,000 *l*	250 *l*

Appendix 5
Sources of Environmental Information in Singapore and Japan

1. in Singapore (in no particular order)

(1) Singapore government agencies and other institutions

1) Ministry of the Environment : ENV
40 Scotts Road, Environment Building, Singapore 228231
phone +65-6732-7733
fax +65-6731-9456
URL http://www.env.gov.sg/

2) National Environment Agency : NEA
40 Scotts Road, Environment Building, Singapore 228231
phone 1800-2255 632 / +65-6731-9618 (Pollution Control Department)
fax +65-6235-2611
URL http://app.nea.gov.sg/ E-mail: Contact_NEA@nea.gov.sg

3) Ministry of Trade and Industry : MTI
100 High Street, #09-01 The Treasury, Singapore 179434
phone +65-6225-9911
fax +65-6332-7260
URL http://www.mti.gov.sg/

4) Economic Development Board : EDB
250 North Bridge Road #24-00, Raffles City Tower, Singapore 179101
phone +65-6336-2288
fax +65-6339-6077
URL http://www.sedb.com/

5) Standards, Productivity and Innovation Board : SPRING
2 Bukit Merah Central, Singapore 159835
phone +65-6278-6666
fax +65-6278-6667
URL http://www.spring.gov.sg/

6) Ministry of National Development : MND
5 Maxwell Road, #21-22 Tower Block, MND Complex, Singapore 069110
phone +65-6222-1211
fax +65-6325-7254
URL http://www.mnd.gov.sg/

7) Housing & Development Board : HDB
480 Lorong 6, Toa Payoh, Singapore 310480
phone +65-6490-1111
fax +65-6397-2070 (international) / 6490-1033 (local)
URL http://www.hdb.gov.sg/ E-mail: hdbmailbox@hdb.gov.sg

8) Urban Redevelopment Authority : URA
45 Maxwell Road, The URA Centre, Singapore 069118
phone +65-6221-6666
fax +65-6227-5069
URL http://www.ura.gov.sg/

9) Public Utilities Board : PUB
111 Somerset Road #15-01, Singapore 238164
phone +65-6235-8888
fax +65-6731-3020
URL http://www.pub.gov.sg/mainpage.htm

10) Jurong Town Corporation : JTC
The JTC Summit, 8 Jurong Town Hall Road, Singapore 609434
phone 1800-5687000 / +65-6560-0056
fax +65-6565-5301
URL http://www.jtc.gov.sg/

11) Asia-Pacific Centre for Environmental Law : APCEL
Faculty of Law, 39 Law Link, Singapore 117589
URL http://law.nus.edu.sg/apcel/ E-mail: lawapcel@nus.edu.sg

(2) Japanese government agencies and other institutions

1) Embassy of Japan in Singapore
16 Nassim Road, Singapore 258390
phone +65-6235-8855
fax +65-6733-5612
URL http://www.sg.emb-japan.go.jp/

2) Japanese Chamber of Commerce & Industry, Singapore : JCCI Singapore
10 Shenton Way, #12-04/05/06 MAS Building, Singapore 079117
phone +65-6221-0541
fax +65-6225-6197
URL http://www.jcci.org.sg/ E-mail: info@jcci.org.sg

3) JETRO (Japan External Trade Organization) Singapore
16 Raffles Quay, #38-05, Hong Leong Building, Singapore 048581
phone +65-6221-8174
fax +65-6224-1169
URL http://www.jetro.go.jp/ova/spr/

4) Representative Office of Kanagawa Prefectural Government in Singapore
JETRO, Singapore (Japan trade Center) Kanagawa Section, 16 Raffles Quay, Hong Leong Building #38-05, Singapore 048581
phone +65-6221-8174
fax +65-6224-1169
URL http://www.ktpc.or.jp/report/report-sing.html

5) Development Bank of Japan Representative Office in Singapore
36 Robinson Road, #07-04 City House, Singapore 068877
phone +65-6221-1779
fax +65-6221-1142
URL http://www.dbj.org.sg/

2. in Japan (in no particular order)

(1) Japanese government agencies and other institutions

1) Office of Overseas Environmental Cooperation, Global Environment Bureau, Ministry of the Environment
1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8975 Japan
phone +81-3-3581-3351
fax +81-3-3581-3423
URL http://www.env.go.jp/

2) Japan External Trade Organization: JETRO
2-2-5 Toranomon, Minato-ku, Tokyo 105-8466 Japan
phone +81-3-3582-5511 / +81-3-3582-1775 (library)
URL http://www.jetro.go.jp/top-j/

3) Institute of Developing Economies : IDE
3-2-2 Wakaba, Mihama-ku, Chiba-shi, Chiba 261-8545 Japan
phone +81-43-299-9500
URL http://www.ide.go.jp/Japanese/index4.html

4) Japan Bank for International Cooperation
1-4-1 Otemachi, Chiyoda-ku, Tokyo 100-8144 Japan
phone +81-3-5218-3101
fax +81-3-5218-3955
URL http://www.jbic.go.jp/

5) Development Bank of Japan
1-9-1 Otemachi, Chiyoda-ku, Tokyo 100-0004 Japan
phone +81-3-3244-1900
URL http://www.dbj.go.jp/

6) Nippon Keidanren
1-9-4 Otemachi, Chiyoda-ku, Tokyo 100-8188 Japan
phone +81-3-5204-1500
fax +81-3-5255-6233
URL http://www.keidanren.or.jp/indexj.html

7) Global Environmental Forum
1-9-7 Azabudai, Minato-ku, Tokyo 106-0041 Japan
phone +81-3-5561-9735
fax +81-3-5561-9737
URL http://www.gef.or.jp/

(2) Singapore government agencies and other institutions

1) Embassy of the Republic of Singapore in Japan
5-12-3 Roppongi, Minato-ku, Tokyo 106-0032 Japan
phone +81-3-3586-9111

2) Consulate-General of the Republic of Singapore in Osaka
14F Osaka Kokusai Building 3-13 Azuchi-machi 2-chome, Chuo-ku, Osaka 541-0052 Japan
phone +81-6-6261-5131

3) Honorary Consulate - General of the Republic of Singapore in Nagoya
9F Daiichi Fuji Building 35-16 Daikancho, Higashi-ku, Nagoya 461-0002 Japan
phone +81-52-932-6393

4) EDB Office in Tokyo (Office of the Counsellor (Industry))
8th Floor The Imperial Tower, 1-1 Uchisaiwai-cho 1-chome, Chiyoda-ku, Tokyo 100-0011 Japan
phone +81-3-3501-6041
fax +81-3-3501-6060
E-mail: edbto@edb.gov.sg

5) EDB Office in Osaka
14F Osaka Kokusai Building 3-13 Azuchi-machi 2-chome, Chuo-ku, Osaka 541-0052 Japan
phone +81-6-6261-5131
fax +81-6-6261-0338
E-mail: edbos@edb.gov.sg

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・「進出企業実態調査アジア編～日系製造業の活動状況～2002 年版」（日本貿易振興会、2002 年）
・「海外進出企業総覧＜国別編＞2002 年版」（東洋経済新報社、2002 年）
・「ジェトロ投資白書　2002 年版」（日本貿易振興会、2002 年）
・「シンガポール最新事情」（日本政策投資銀行　シンガポール駐在員事務所、2002 年）
・「DBJ Report　経済成長との調和を図るシンガポールの環境維持政策」（日本政策投資銀行　シンガポール駐在員事務所、2000 年）
・「ジェトロセンサー　2002.12　－東アジアをめぐる FTA の動き－」（日本貿易振興会、2002 年）

(2) in English

・*2001 Pollution Control Report* (Pollution Control Department, Ministry of the Environment, 2000)
・*Annual Report 2000* (Ministry of the Environment, 2000)
・*The Singapore Green Plan 2012* (Ministry of the Environment, 2002)

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・JETRO (Japan External Trade Organization) Singapore
・Development Bank of Japan Representative Office in Singapore
・all the staff of the Japanese companies in Singapore

・Industry and Technology Department, JETRO (Japan External Trade Organization)
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- Research Report on Trends in Environmental Considerations related to Overseas Activities of Japanese Companies FY2002 -

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