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.

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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

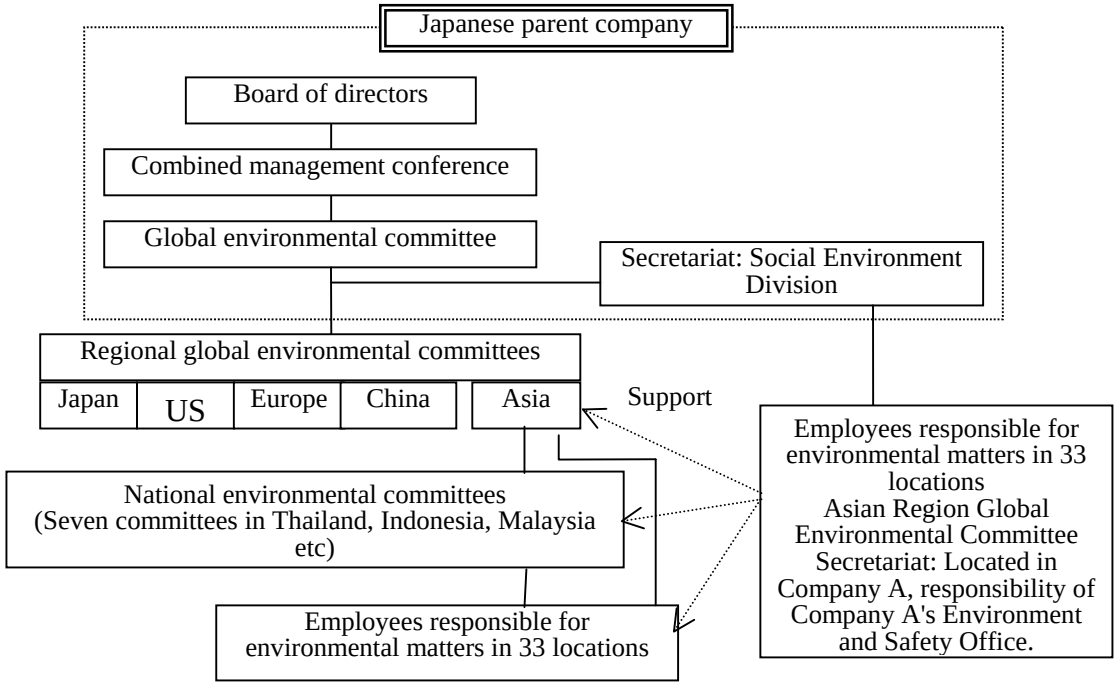
The office of the Asian Region Environmental Committee located at the Asian regional integration Company A is under the jurisdiction of the Social Environment Division at Japanese parent company, and day-to-day office operations are the responsibility of the Environment and Safety Office. The composition 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.

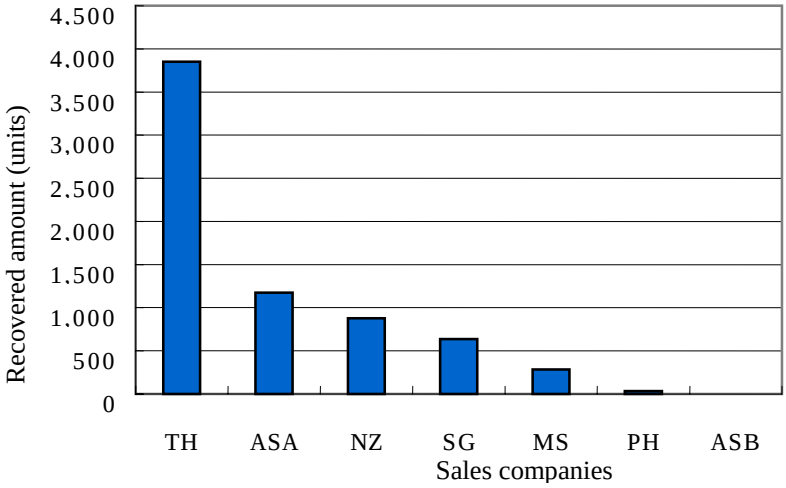
The environmental report is very positive, and includes activities for the development of a climate for environmental measures within the company and cooperation with the local society as the initial stages of the plan, to be followed by promotion to reduce waste products, recycling, and reuse to reduce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

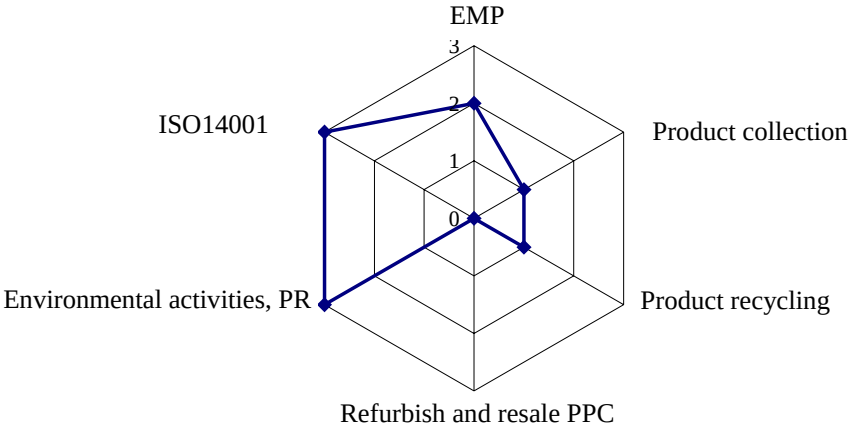
Figure 2-2-2 Recovered Toner Cartridges by Sales Companies



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

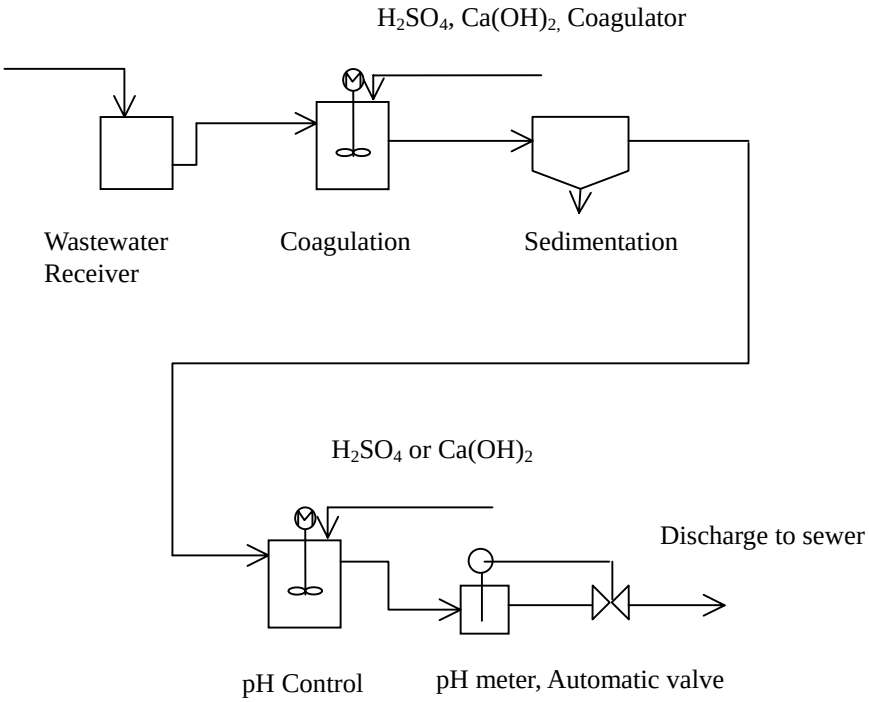
While the level of contamination is low, wastewater is contaminated by dust from the cutting of ceramics, and from chemicals. An outline of the wastewater treatment plant is shown in Figure 2-3-1. Wastewater produced at a number of locations within the factory is collected in a pit, acids and alkalis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

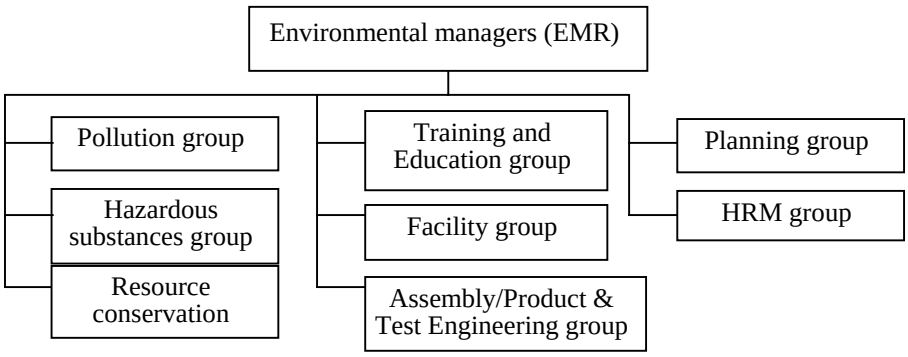
The Green Partner Program is a project designed to promote sorting and collection of waste products.

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.

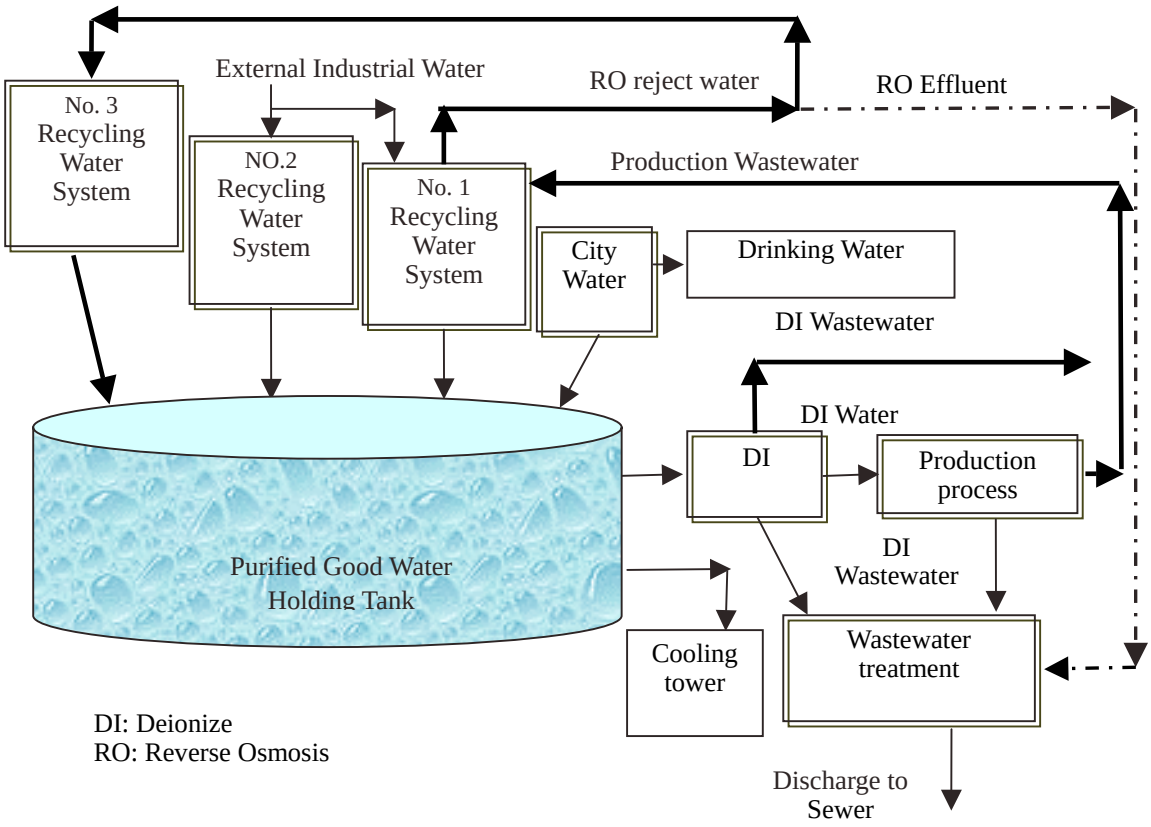
While the lack of water resources in Singapore is satisfied by the supply of water from its neighbor, Malaysia, recent negotiations on water charges between the two countries have proved difficult. As the factory owned by Company H requires supply of good quality water for the manufacturing process, 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.

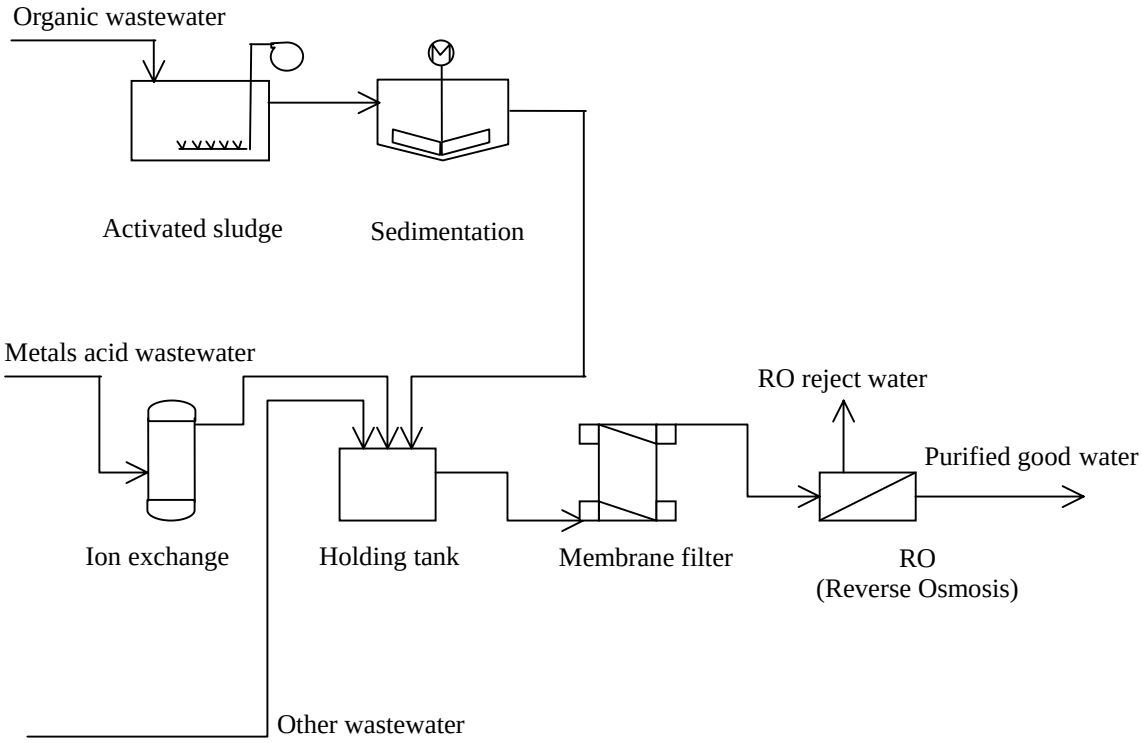
Figure 2-4-1 Recycling Flow of Wastewater



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

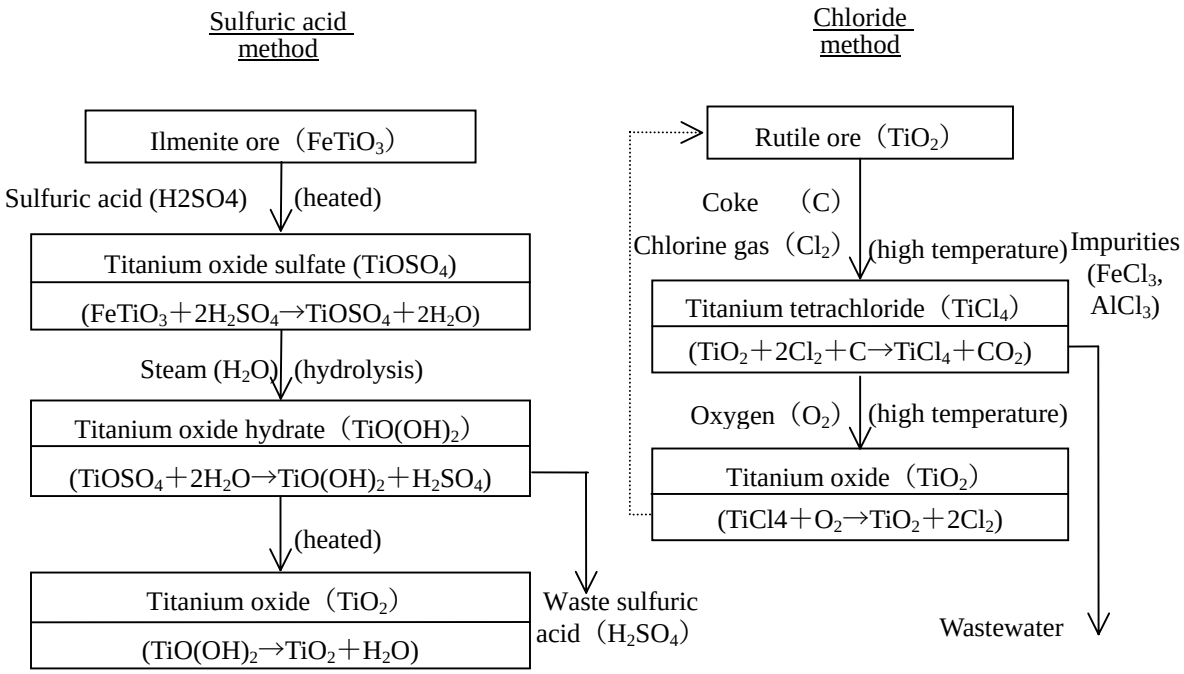
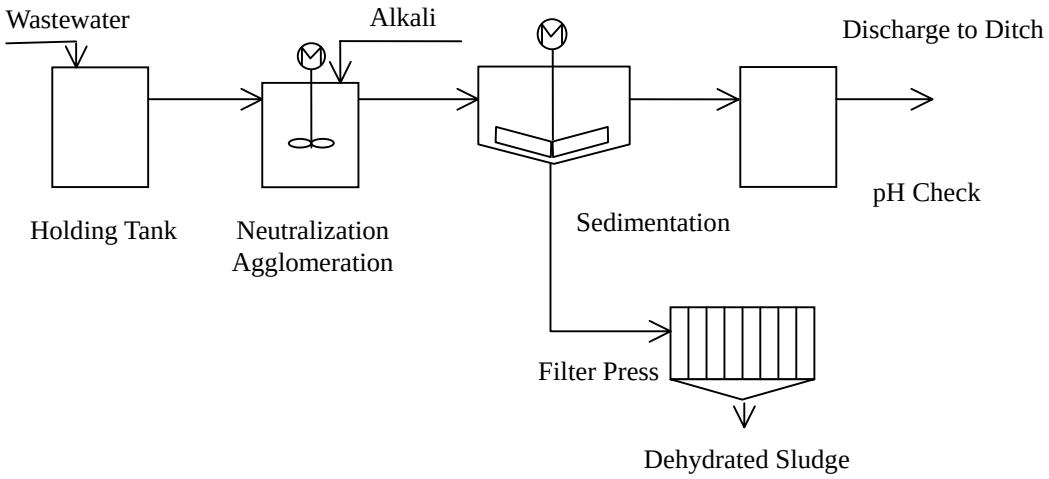


Figure 2-4-4 Wastewater Treatment Flow



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.

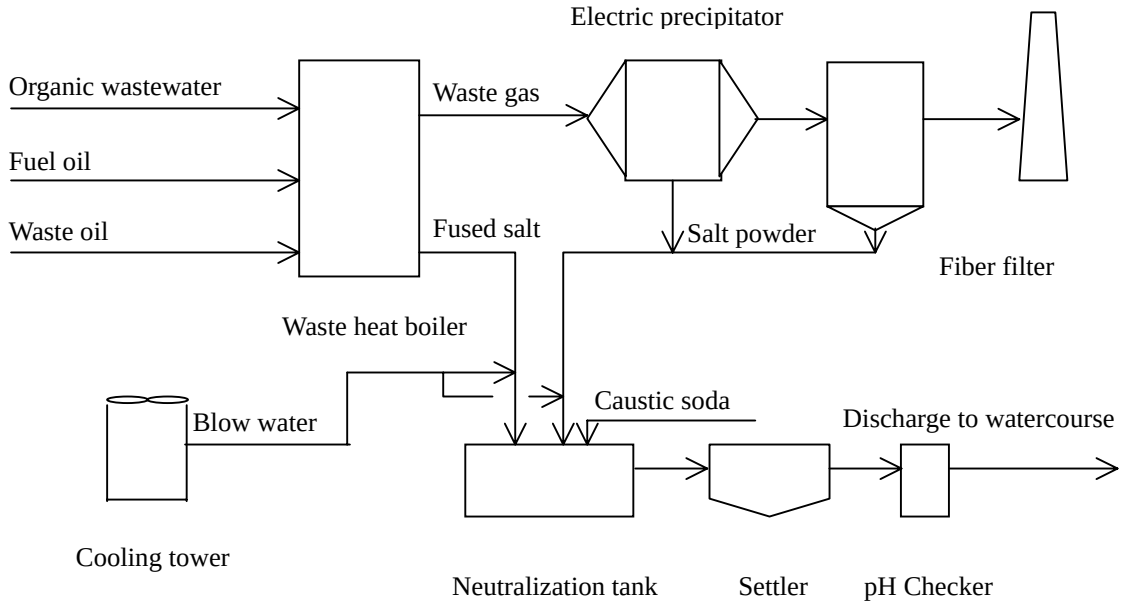
Approximately 400 tons/month of residue is produced from the bisphenol A manufacturing process, the majority of which is non-toxic high polymer organics, however as a very small amount of phenol is included it is handled as a toxic industrial waste product and passed to a certified waste processing company.

d. Miscellaneous

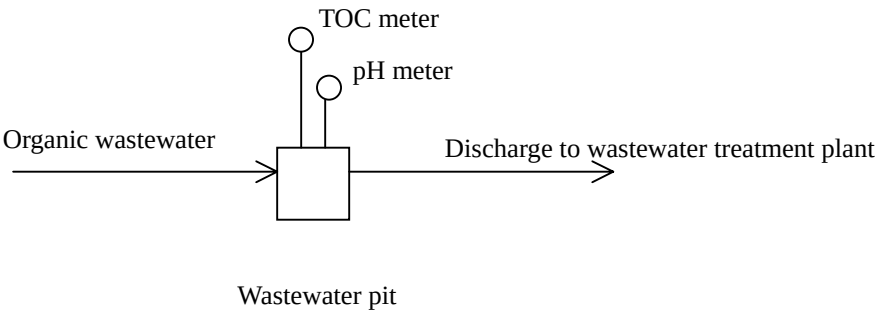
Singapore has implemented regulations for control of Legionella bacteria in the recycled water in cooling towers. Such regulations have not been implemented in Japan. These regulations require that the recycled water be drained completely, and the equipment cleaned, at six-month intervals, however as 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).

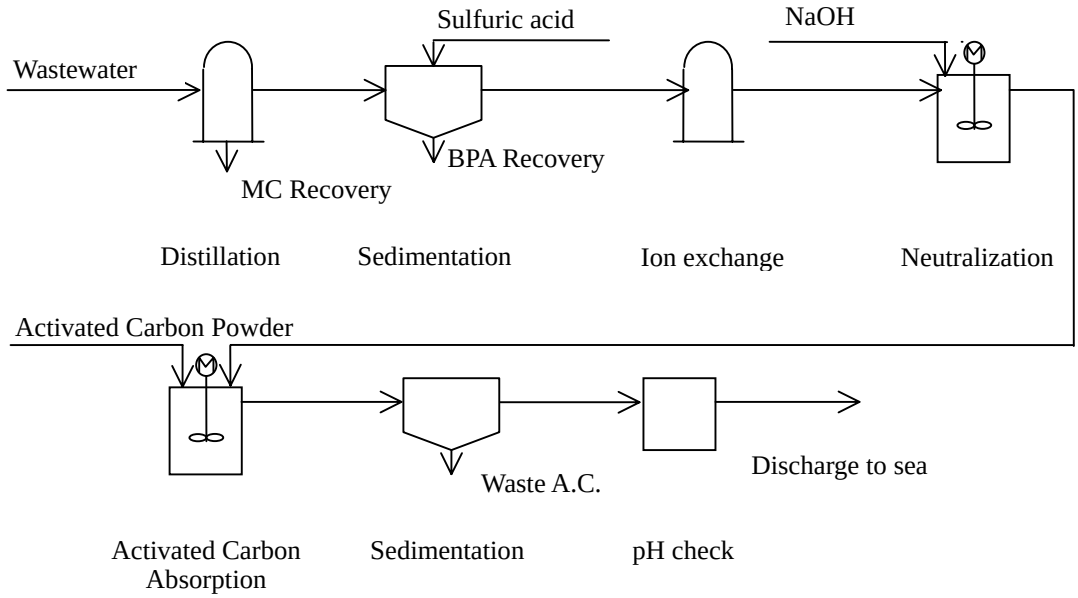
The treatment equipment shown in Figure 2-4-6 has been installed in order to ensure that these standard values are cleared. Wastewater is first evaporated, and the discharged unreacted methylchloride (MC) recovered. Sulfuric acid is then added to precipitate the unreacted bisphenol A, and the precipitate 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

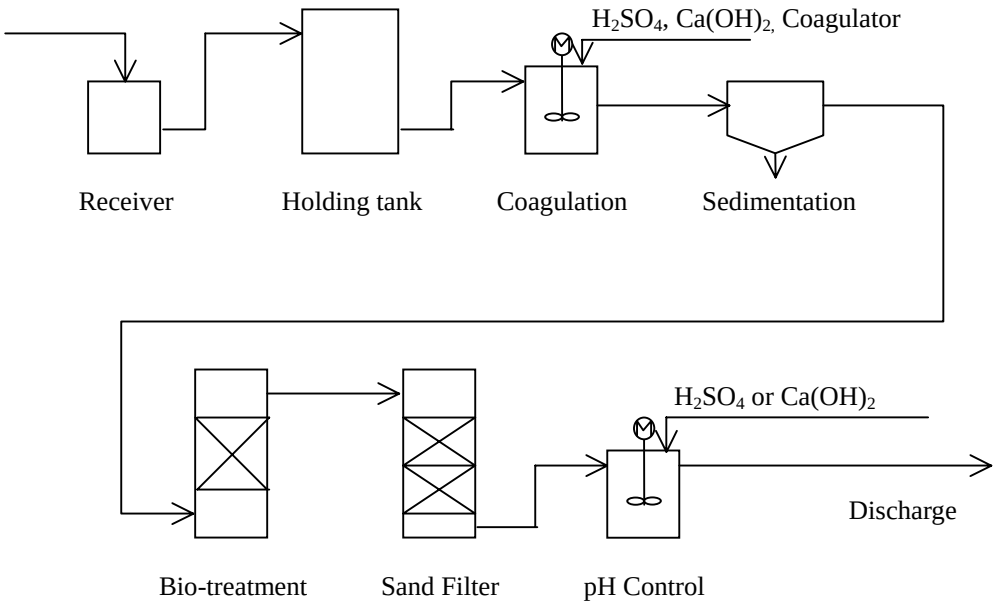


Table 2-5-2 Items Analyzed by Company L, and Standard Values

(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.

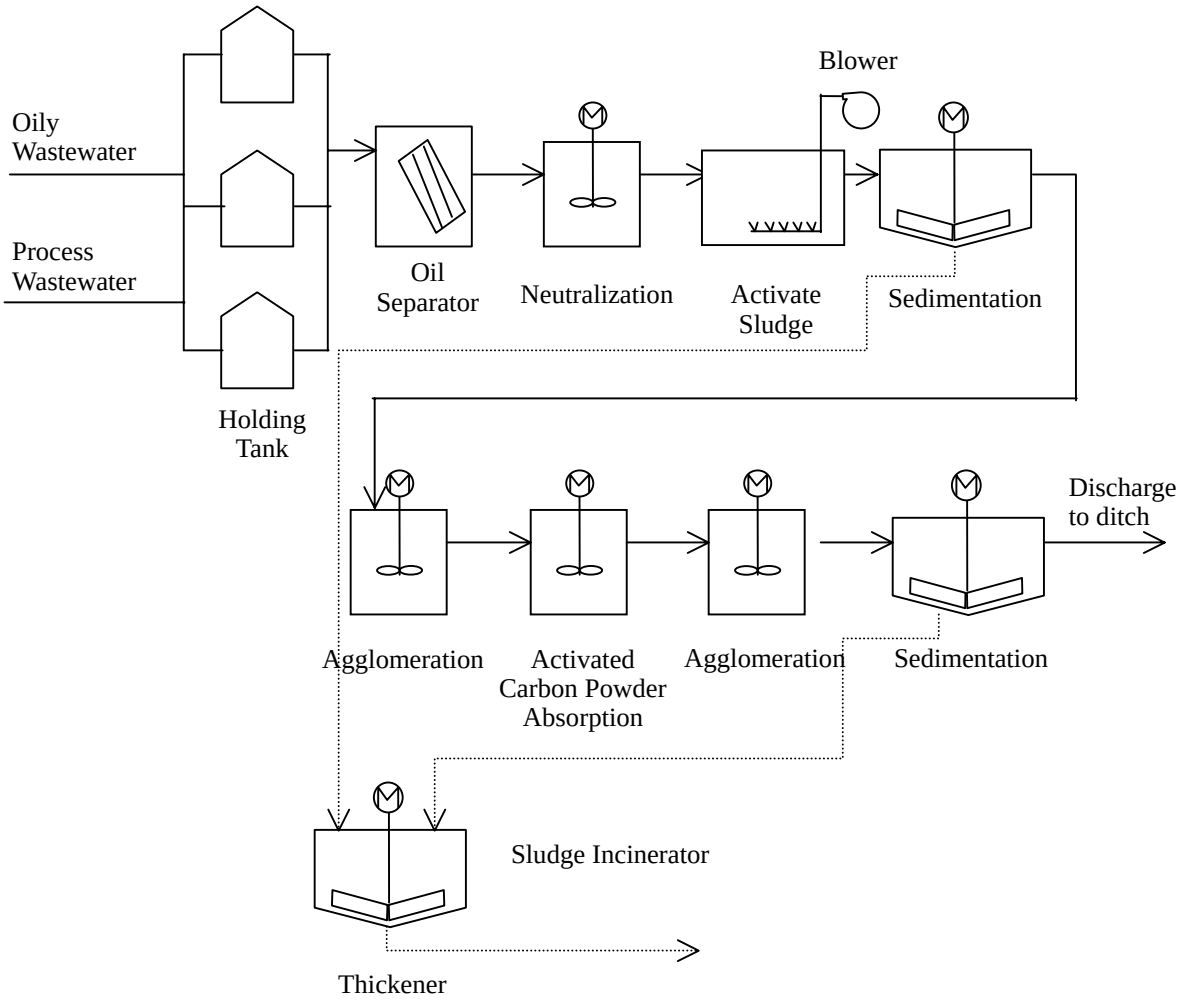
b. Wastewater treatment

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.