Chapter 5 Final Goals for the Electroplating Units and IDB Electroplating Center

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5.1 Examples in Japan and Other Asian Countries

In order to draw up future figures of electroplating industry in Sri Lanka, histories of technical progress on electroplating in Japan and actual cases in other Asian countries are given below as valuable examples in addition to "Related matters to electroplating technology and waste water treatment" explained in 3.2.3.

5.1.1 Plating technology

(1) Process of advancement of plating technology in Japan

1) Bright plating

Since 1945, the electroplating business in Japan has gone from a small-scale industry to a large-scale one. At first, it was only a repair business. At that time, handlebars, tubes, gears, crank arms, etc. of scrapped bicycles, and in addition household electric irons, etc. were brought into the plating units.

Each of them was put in a circulating box which was placed on the unit floor.

During Japan's postwar economic recovery period, researchers of universities, research institutes and plating industries did their best to acquire the same level of bright plating technique, which did not exist in Japan so far, as in Europe and America. Research circles comprising universities, research institutes and plating industries were established in various districts such as Tokyo, Osaka, and Nagoya, etc. to make bright plating practical. As a result, improvements were made regarding plating agents, electrode plates, and linings of plating tanks. Bright plating, mainly regarding nickel and copper, became rapidly popular together with the development of synthetic resins such as PVC and a hard rubber.

Thereafter, as bright plating became more wide spread and resin materials were consumed in large quantities, most Japanese companies began to use automatic plating machines.

Brightness can not be obtained only in a bright plating bath with brightener added, but plating chemicals and electrode plates need high quality and should not contain any other metallic elements. Both industrial chemical makers and electrode refining companies made great efforts to improve the purity of their products.

For this purpose, filtering of plating solutions was an essential and important process, and filters should have been operated all the time. High-speed, precise, alkali- and acid-

resistant filters are now on the market with exclusive use for plating solutions.

Not only company owners but workers engaged in plating at workshops were thoroughly trained on-the-job. Establishment of organizations for technical ability tests was promoted. Many workers, including new employees every year, were given technical education and encouraged to obtain an official qualification. The method of quality control introduced in Japan in those days was also actively adopted.

All plating techniques were renewed based on experience accumulated through the development of bright nickel plating. Also it was recognized that if bright nickel plating was carried out well other plating techniques could also be obtained.

Nickel plating is such excellent plating that it is no exaggeration that the Japanese plating industry has developed based on the plating and most of industrial products are nickel-plated and there is no alternative excellent for plating to it.(Michio Kobayashi: Metallic allergy and surface treatment, Surface Technology Vol.45, 907 (1994))

2) Quality requirements from the automobile industry

The purpose of plating has been greatly influenced by the requirements of automobile parts. That is, not only a beautiful appearance but corrosion resistance of parts has been given primary importance, consequently requiring accurate plating thickness and proper combination of plating layers and adequate plating methods. In the past, copper plating between iron and nickel has been thought to make them contact closer and to enhance their function as a soft damper.

On the other hand, the evaluation of corrosion resistance of automobile parts has become much more severe, and CASS tests and corrodekote tests have come to be carried out and the results have been compared with the results of outdoor exposure tests. As a result, it was found that the copper layer between iron and nickel increases rusting because copper was electrochemically nobler than iron, nickel and chromium. It follows that copper plating for iron should be omitted.

It is, therefore, recommended also in Sri Lanka that copper plating be omitted in future. Especially, when the basis metal is a special alloy and its surface activation is incomplete, a first copper strike plating is carried out and then nickel or other plating is performed. For zinc die casting, copper plating is performed at about 5 to 7 μm in thickness on copper cyanide strike plating. In copper strike plating, high voltage is given in a very short time and the plating can be applied to a material with a complicated construction like a zinc die casting, even though it is thin.

3) Situations in recent years

Recently, the progress and advancement of production engineering of semiconductors and printed circuit boards and the maturity of the automobile industry have brought significant changes in the plating industry. In the past, about 80% of small- and medium-scale plating units were more or less concerned with plating of automobile parts. Those units were reduced in number and some of them have been transformed into the units handling electronic components. Copper plating, once obsolete in automobile industry, has been adopted again and is attracting attention as functional plating for through-hole plating of printed circuit boards for electronic components. The bright copper sulfate plating bath and bright pyrophosphoric copper bath are now being used again for the plating.

(2) Plating industries in Southeast Asia

According to the investigation of the actual conditions of overseas advances of Japan's plating industry (National Federation of Plating Industries Association, April in 1996), there are 49 companies in Japan's plating industry and its related companies which are advancing overseas, including Singapore, Malaysia and Thailand. All of them are medium or larger scale companies and many of them deal with plating of automobile, communication and electric parts, and plastics.

In Vietnam, there are 18 Japanese companies in industrial parks and processing areas exclusive for export. Company T, an industrial sewing machine manufacturer, manufactures parts in Vietnam and exports them to Japan to plate them there, because plating in Vietnam is inferior in quality.

Company D in an industrial park in Indonesia is favorably located with other Japanese companies in the neighborhood. The company plates speaker frames and electronic parts with zinc, plates bicycle parts with nickel-chromium and processes golden ornaments with "Almite" (aluminum anodizing). Furthermore, it is planning to double the production by introducing an electrodeposition coating line and an electroless nickel-plating line. Most of the overseas advanced companies are willing to contribute to the plating technique improvement in the countries where their companies are located. Although they are looking for subcontractors for plating, there is a problem regarding inferior plating quality.

Companies which have advanced into the Philippines, Thailand, China and Hong Kong are promoting technical exchanges with local companies under the guidance of official institutions, leading to good results. It is a feature common to these local companies that they are steadily absorbing Japan's plating technology and do their best to achieve a clear target of the same quality level as that in Japan and the same price level as that in Taiwan. They can fully control alloy plating bath and have a strong interest in new plating technology. Plating

equipment and plating agent are being more and more produced in their own countries. Dull nickel plating can never be found in these countries and highly corrosive resistant double-layer nickel plating is already being carried out in Thailand and the Philippines.

5.1.2 Waste water treatment

(1) Progress of waste water treatment in the surface treatment industry in Japan

Plating industry in Japan was confronted with many pollution problems in the 1970s. Two basic water quality laws: Water Quality Preservation Act and Unit Waste Water Regulation Act were established by the time Water Pollution Prevention Act was enacted in 1971. Plating industry, most of its member being small-scale companies, had to cope with the laws and regulations changing one after another and mounting public outcry against pollution. The industry has made efforts all together to enhance its consciousness of pollution and develop and spread the treatment technology in the belief that no company can survive without taking measures against pollution. In addition, the industry has improved and developed not only waste water treatment but processes, in-process recovery of materials, water rinsing system, resources recovery, recycling system of resources and plating chemicals taking into consideration the ideas of resource and energy saving. The industry has overcome a lot of difficulties and was doing its best to provide a clean and comfortable living environment under the guidance of related institutions, by a loan from administrative organs and tax support.

1) Waste water treatment technology developed through coping with pollution

Units which discharged waste water into designated zones were regulated regarding waste water by the Unit Waste Water Regulation Act and were obligated to install waste water treatment equipment. Waste water treatment began in surface treatment units around 1963 and the number of waste water treatment equipment has gradually increased. Since the investment for the facilities, however, did not yield any profit and it cost a lot to operate, the installation rate of the equipment was still low and in many cases pollution problems occurred partly because of poor management of equipment. Since there were many small-scale units in the plating industry dealing with poisonous and harmful substances, they could not easily take effective measures and had been regarded as the prime cause of pollution.

Poisonous Substances and Powerful Drug Control Act was revised in 1964 toward pollution prevention and the upper limit of cyanide was determined to be 2ppm by the Act. The upper limit of 2ppm was so severe that the industry was thrown into confusion over the issue, but more and more treatment facilities have been gradually installed.

With regard to the treatment technology, two-stage treatment of cyanide in the designated zones has come to be conducted under the official guidance but the treatment of heavy metals was made only by neutralization and sedimentation. A technical examination was performed of the way and conditions of cyanide treatment. In addition, the research of chemicals collection in the plating process and of water reduction by multi-stage water rinsing system was performed to reduce the waste water treatment cost, which was the transitional treatment technology at that time.

Pollution Countermeasures Basic Law was enacted in 1968 to promote overall pollution countermeasures and the Law was revised drastically to cope with a worsening in the pollution problems. Water Pollution Prevention Act was enacted at the same time to determine the same waste water standards as the social and moral responsibility of the Japanese in all public water areas across Japan based on the philosophy of the Basic Law. Units discharging waste water of $50m^3$/day or less were exempt from observing the standards specified in the Water Pollution Prevention Act except for toxic substances such as cyanide and Cr^{6+} .

The enactment of the Water Pollution Prevention Act forced the conventional treatment techniques to be reexamined thoroughly. Two-stage treatment of cyanide with alkali chlorine, electrolytic oxidation of concentrated cyanide solution, inorganic reduction and sedimentation of chromium, and flocculation and sedimentation of heavy metals were examined and have come into wide use. The Ministry of International Trade and Industry (MITI), the Plating Manufacturers Association and other private groups have prepared the instruction manuals and standards for treatment technology, facilities and maintenance and made efforts for education, dissemination and enlightenment. Coupled with loan of funds for equipment by an administrative organ and special tax measures, this has promoted the self management of the industry and rapidly improved and spread the use of waste water treatment.

Jonan Treatment Center was established as a common treatment facility of the concentrated cyanide solution under the administrative guidance of the Tokyo Metropolitan Government. Acid dissolution combustion and boiled-down high-temperature combustion have been adopted to treat concentrated cyanide solutions which are difficult to be treated.

In Chiba Prefecture, two industrial parks, aiming at jointly treating waste water, were constructed but constituent companies had different management foundations and some of them could not pay the re-location expenses to the parks and retain their customers, resulting in the failure of the joint treatment.

2) Waste water treatment to cope with the demand for resource savings

When prices of water, chemicals and electric power rose rapidly during the oil crisis in 1973, it was realized that true pollution prevention was not for treatment of effluents but to reduce discharge of harmful substances as much as possible. It led to a closed system of waste water treatment process, requiring a reexamination of the processes, location of the source and research of collection technology of valuable substances. To rationalize the use of water, a reduction in drag-out volume, a reduction in rinsing water, multi-stage counter flow rinsing and recycled use of a single application were carried out. Collection of metals from sludge and other utilization of sludge were examined. A variety of concentration methods related to a closed system were published and especially collection of water and metals (particularly chromic acid) using an ion-exchange resin attracted a great deal of attention. On the other hand, development of chemicals containing the least amount of harmful substances or of low-concentration chemicals was conducted and non-use of cyanide in pretreatment and in zinc-plating has rapidly come into use.

3) Future trend

Regulations of environmental preservation will be more and more strengthened in the future along with trends in international environmental protection. Manufacturing plants are required to take full responsibility in processing and disposal of materials used. From now on, we must seriously examine how to deal with trihalomethane caused by organic substances and chlorine, the prohibition of ocean dumping of industrial waste by the London Treaty and the reuse of sludge as resources due to restricted reclamation.

(2) An example in Thailand

1) Installation in individual company (spread through a model unit)

For the in-process improvement and the spread of treatment equipment, Demonstration Unit and Farm Project of the Green Productivity in Electroplating Industries will be useful. That is, after the selection of a model unit, the guidance by experts and the in-process improvement in the unit are performed, a seminar on the in-process improvement in the waste water treatment and on the waste water treatment technology, a case study in a workshop, and a field trip to an improved unit were conducted by the personnel concerned.

Since only with the seminar on waste water treatment technology, it is difficult to understand the actual equipment and its operation, a field trip to a model unit and a case study in a workshop were carried out, leading to a great improvement in waste water treatment technology. The report on the details of the improvement and its merits were presented at the APO World Conference on Green Productivity, in Manila, in December,

1996.

2) An example of centralized treatment

In Thailand, a centralized treatment facility is already in operation. There are about 200 small- and medium-scale plating units in Bangkok. The waste water treatment in the units has the problems regarding the space, no trained personnel and no financial aid for waste water treatment, and no place for disposal of sludge and so on.

To cope with these problems, the Ministry of Industry established a treatment center for harmful waste water 20km east of Bangkok in 1988 and is planning to establish another three facilities north, east and west of Bangkok.

The Center is performing the treatment not only of the plating waste water but of acid cleaning waste water from hot-dip zinc plating, waste water from fluorescent lamp units and waste water from textile dyeing. The sludge containing harmful substances produced in the treatment process is also solidified with concrete there.

The treatment capacity of the Center of plating waste water is $200m^3$/day. As of now, 46 units utilize the Center, the volume of the treated waste water amounts to $100m^3$/day and the mean amount per unit is $2.2m^3$/day. Figure 5-1 shows a flow chart of waste water treatment.

The plating waste water is brought into the Center, separated in cyanide, chromium and other waste water containing heavy metals. The waste water containing cyanide is adjusted to 11 to 11.5 in pH with lime in the conventional alkali-chlorine method and treated with NaClO added. Then, the pH value is decreased and the cyanide is decomposed into $N_2$and CO_2. This treatment is made by a batch and automatically controlled by pH and ORP.

Waste water containing Cr^{6+} is adjusted to 2.0 to 2.5 in pH with H_2SO_4 by the batch system. Then, it is reduced to Cr^{3+} with $NaHSO_3$ added, adjusted to 10 in pH with lime added and precipitated as $Cr(OH)_3$.

Waste water containing other heavy metals such as Ni, Cu and Zn is adjusted to 10 in pH with lime, producing hydroxide deposit and the precipitation is accelerated by using polymer flocculant.

Sludge produced is dried in a sand filtering floor and the dried sludge is used for reclaiming after the stabilization treatment.

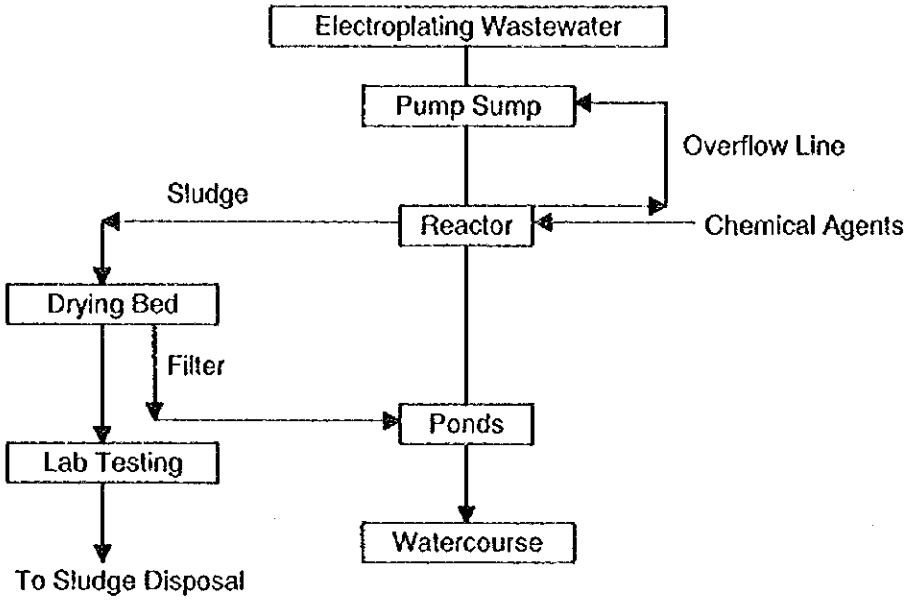

Figure 5-1 FLOW CHART OF TREATMENT OF WASTE WATER FROM PLATING PROCESS

The treatment charge is 120B(530Yen)/m^3 and the transportation fee is 1B/km/m^3. The charge for disposal of sludge amounts to 100B/ton and the transportation fee is 2B/km/m^3.

The construction of the treatment facility was conducted by the Ministry of Industry and the equipment cost amounted to US$ 1.2Mil. The facility is now operated by a private enterprise, which pays all the rental and royalty fees.

In addition, the use of ion-exchange resin is examined to reduce waste water volume to be transported.

5.2 Final Goals for the Electroplating Units

Final goals for electroplating units in Sri Lanka are described as follows, in consideration of the current state of electroplating units and major issues (Chapter 3), future target setting included in recommendations (Chapter 4), and comparable conditions in selected countries, as mentioned in 5.1.1.

5.2.1 Future target setting

In Chapter 4, the primary target that was established is "to help the electroplating industry reduce environmental pollution loads and improve product quality through process improvement." Based on the primary target, future targets have been established to set goals to be achieved in order to fulfill the primary target. Compared to the current state of the industry in the country, they represent fairly ambitious targets which must be accomplished in due course if the primary target is to be achieved.

For electroplating units in Sri Lanka, reduction of environmental pollution loads should be given highest priority. In this conjunction, the improvement of the rinsing process (including recovery of the plating solution) is important as the way to control pollution at source, in addition to changes in the treatment system itself. As for plating technology, process improvement will become an increasingly important issue with growth of the metal finishing industry. Again, special attention should be paid to the pretreatment and rinsing processes in addition to the plating process. To support efforts for upgrading electroplating technology, quality control as well as process control systems need to be introduced and maintained, which in turn requires the upgrading of testing and inspection technology.

(1) Improvement of the rinsing process

Recovery of plating solution, multi-stage rinsing, and process line modification will be major areas of improvement.

(2) Installation of waste water treatment facilities

Self-contained treatment systems will be installed at individual units, while centralized treatment for small units will be initiated through a trade association to be formed for the purpose.

(3) Improvement of pretreatment and plating processes (use of bright nickel plating technology)

To establish work standards and practices on the basis of basic electroplating technology, including dipping and electrolytic degreasing, control of current density, use of plating racks, filtration and air agitation, and proper control of concentration and temperature of plating bath. While efforts should cover all electroplating methods, the shift from currently applied dull nickel plating to bright nickel plating technology is considered as the first step for modernization of electroplating units.

(4) Establishment or improvement of product inspection system

Process control based on proper testing equipment and data will be established to develop the inspection system and assure quality of electroplating products.

5.2.2 Present measures to be taken

The final goals are far from the current situation and require focusing on actual issues to be dealt with in order to identify a set of actions required to accomplish them. Present measures to be taken are therefore established to focus on waste water treatment as well as key electroplating technology which together constitute the first step toward the final goals.

In particular, small units require special attention as they discharge toxic substances such as cyanide and chromium, even though the amount of such discharge is small. At the same time, however, it is unrealistic to install a separate waste treatment system at each unit. The present measures to be taken will focus on work needed at small units for centralized treatment of their waste water.

For medium-sized units

(1) Multi-stage rinsing
(2) Installation of waste water treatment facilities
(3) Use of plating racks
(4) Filtration and air agitation

For small units

(1) Improvement of the rinsing process (installation of rinsing tank)
(2) Fractional storage of waste water (installation of receiving tanks for different types of waste water)

5.3 Final Goals for IDB Electroplating Center

5.3.1 Role of the center

Clearly, it is very difficult for individual plating units in Sri Lanka to make the improvements on their own. The establishment of a joint venture with a foreign partner and obtaining technical assistance from overseas are effective in principle, but they are not practical for a majority of units. Relying on a domestic organization for technical assistance and guidance seems to be the most feasible and logical solution. And IDB can act as such organization, capable of playing a leading role in such efforts, by representing the industry's viewpoint and condition.

IDB Electroplating Center is responsible for providing technical assistance for electroplating units, particularly small- and medium-sized ones, thereby to help raise the quality and productivity of electroplating work in the industry as a whole. To support this, JICA's study related to an industrial sector development promotion plan in the field of the metalworking industry, conducted in 1992～93, recommended an expansion plan for the center. The results of investigation and analysis on electroplating and waste water treatment technologies in the country, as carried out under the present study, have revealed that the country does not now have a full-fledged electroplating industry; electroplating operations are at a primitive level and rely on empirical judgment, rather than understanding of basic technology; waste water treatment is not carried out by most units although the need is felt; and the small scale of operation keeps environmental impacts at a relatively low level without causing a serious problem.

In recognition of these factors, the study team held discussions with IDB and established targets for a promotion and development plan for the electroplating industry (see Chapter 4). In this context, it is believed that the most effective means to foster the industry from the grass roots is to teach engineers and technicians of the center basic electroplating and waste water treatment technologies, including basic and advanced, to enable the center staff to have the ability to introduce and develop new technology, and thereby making it possible for them to disseminate such technology to smaller electroplating units. As a result, the highest priority in the study is given to the upgrading of technology and skills of the center.

The electroplating center serves a variety of industries including the machining industry and the electrical/electronic industry. Thus, the center should play a critical role in establishing and disseminating electroplating technology that can satisfy quality and cost requirements which are demanded by other industries as they develop in future.

Thus, the center's primary role is to foster the electroplating industry. It can also play a meaningful role in performing contract work especially during the period while plating units do not have sufficient technology levels. But once the private sector becomes capable of providing service on its own as a result of the center's efforts, the center should refrain from direct competition with plating units. Such arrangement is seen in many countries. In Japan, South Korea, and Singapore, government or semi-government organizations assuming the similar responsibility conduct research, development and testing on new plating technology by using their own testing equipment, while providing technical assistance for the industry.

5.3.2 Final goals for the center

To fulfill its roles, the center needs to become an organization having the highest technical capabilities in the areas of electroplating and waste water treatment technologies, and to be responsible for research and development, testing and inspection, and promotion and assistance. In particular, its future goals can be described as follows:

(1) To have technology and skills sufficient to play a leadership role in raising levels of electroplating and waste water treatment technologies at electroplating units, and use them effectively.

(2) To have sufficient resources to disseminate electroplating and waste water treatment technologies to electroplating units (ability to provide technical guidance, consultation, testing and inspection, and training).

(3) To have the ability to develop and maintain electroplating technologies which can satisfy quality requirements and methods for plating that change with industrial development (i.e., electroplating technology must not become a bottleneck for development of entire industry).

(4) To maintain close relations with companies and organizations inside and outside the country to collect technical and market information on a worldwide basis and keep abreast of latest technological trends.

Chapter 6 Technology and Skills Improvement Plant for IDB Electroplating Center

Chapter 6 Technology and Skills Improvement Plan for IDB Electroplating Center

6.1 Technology and Skills Improvement Plan for IDB Electroplating Center

The study has formulated technology upgrading plans for the electroplating center under the four categories; the upgrading of electroplating and waste water treatment technologies to prevent pollution which is anticipated to occur in future; the upgrading of electroplating technology in such way to promote growth of the metalworking industry; the strengthening of organization and funds adaptive thereto; and the improvement of day-to-day activities of the center. Table 6-1 summarizes the overview of the plans.

Table 6-1 TECHNOLOGY UPGRADING PLANS FOR IDB ELECTROPLATING CENTER (Waste Water Treatment and Electroplating Technologies)

Dissemination of waste water treatment technology	
Upgrading plan for waste water treatment at the electroplating electroplating center	(1) Learning of basic waste water treatment technology Learning of waste water analysis and measurement techniques (2) Establishment of waste water batch treatment technology
External activities of the center	(3) Promotion and public education on waste water treatment technology (4) Technical assistance and technology transfer (5) Promotion of model plant construction plan (6) Research and study on effluent discharge by the industry and proposal of revised effluent standards (7) Establishment of waste water batch treatment technology training courses
Upgrading of Electroplating Technology	
Upgrading plan for electroplating technology at the center	(8) Upgrading of basic electroplating technology (9) Upgrading of bright nickel plating technology (10) Establishment of electroplating product inspection and measurement technology (11) Learning of maintenance technology
External activities of the center	(12) Reorganization of technology training courses (13) Comparative evaluation of electroplating products made in and outside of the country (14) Technical assistance and technology transfer
The Center's Organization and Function-Strengthening	
Organization and function-strengthening plan	(15) Strengthening of technical staff (16) Additional staffing and function (17) Strengthening of means of communication
Upgrading for day-to-day Activities of the Center	
Day-to-day activity improvement plan	(18) Collection of technical information (19) Continuous training of workers (20) Day-to-day practice of production management and equipment maintenance

6.2 Dissemination of Waste Water Treatment Technology

(1) Learning of basic waste water treatment technology and waste water analysis and measurement techniques

Waste water discharged from the electroplating process must be separated into cyanide, chromium, and acid/alkaline solutions, each of which must be separately treated. Under the plan, a set of laboratory equipment and analytical instruments required to learn the fundamentals of waste water treatment technology will be procured and used to establish technology through experiments.

In the technology upgrading plan for the center, priority should be given to the upgrading of electroplating technology and of skills of the technical staff. For this purpose, it is recommended to install a bench plant, which is capable of electroplating and waste water treatment operations, in an available space in the laboratory or between the electroplating shop and the polishing shop.

Note that the bench plant is not production facilities. Rather it is experimental facilities for learning and technological development purposes. Thus, it will be smaller than the one proposed in "Study on Industrial Sector Development and Promotion Plan" in 1993.

A proposed plan for the bench plant is presented in Appendix 1. Technical staff will be able to have practical experience in electroplating and waste water treatment operations at the bench plant by applying their knowledge learned from overseas training or practical experience. Also, the bench plant can be used to allow students of the training course to have practical experience in both electroplating and waste water treatment.

A treatment tank for waste water from the bench plant's electroplating process may be made of glass beaker or a PVC-made special tank. Equipment to control pH and temperature of the treated solution as well as various measuring instruments are required.

Data obtained from analysis of effluents should be stored and used to help improve the process in such way to reduce the discharge of contaminants.

(2) Establishment of waste water batch treatment technology

It is recommended to treat waste water discharged from the center by separating it into three types; cyanide, chromium, and acid/alkaline. The storage and treatment facilities can be relatively small in size since the current operating conditions require occasional waste water treatment as required. The existing facilities can be used for this purpose, with new capacity to be added. The batching method allows better understanding of the operating principle of the waste water treatment system than automated continuous treatment. Since waste water treatment operations sometimes is accompanied by a certain risk, they must be performed by

workers under specific instruction and supervision of technical staff. Appendix 2 illustrates the batching treatment method. The proposed facilities may be considered as a model plant for batching treatment.

(3) Promotion and public education on waste water treatment technology

Waste water treatment is a cost burden for plating units, while it does not produce any profit. It is required as social duty of plating units that must avoid environmental pollution and human health hazards. It is therefore important to educate and make known to the electroplating industry the importance of waste water treatment as well as proper treatment technology, methods, and costs.

The center, with higher levels of technology than plating units, will be required to teach or transfer waste water treatment technology to small electroplating units, thereby contributing to the upgrading of electroplating technology in the entire country.

(4) Technical assistance and transfer of waste water treatment technology

The most effective way to teach waste water treatment technology to plating units is the workshop using a simulated process (Appendix 1).

Participants will learn the basics of waste water treatment technology through practical experience in treatment of cyanide, chromium, and acid/alkali waste water. The center is required to provide technical guidance and advice customized to individual plating units.

(5) Promotion of model plant construction plan

The model water treatment plant should preferably be installed at a plating unit where plating work is carried out at a continuous pace to produce predictable waste water in terms of quantity and quality, rather than the center where the volume of plating work varies. As a result, construction of the model plant will require cooperation of the plating unit and waste water treatment in a commercial process will have large impact on other units. The center will promote the plan and provide technical support.

(6) Research and study on effluent discharge by the industry and proposal of revised effluent standards

Although CEA has designated the electroplating industry (metal finishing industry) as a high-polluting industry, it does not have reliable data on the electroplating industry, including the number of electroplaters and production figures, not to mention accurate data on wastes discharged by the industry. The trade association will be able to quickly collect basic data

related to environmental impacts of the industry from its members, including the number of enterprises, the type of electroplating operations, production data, effluent volume, the current state of waste water treatment, the type and amount of solid wastes generated. This way, the member of the industry can represent themselves more effectively and cooperate with the government in effective pollution control, contributing greatly to sound development of the industry.

The center should support the formation of the trade association by starting from a real and urgent issue created by the need for waste water treatment, then through the association, data and information on the current state of plating units and their waste water treatment can be collected, based on which discharge standards feasible for the industry comply with can be considered. It is one of important roles of IDB/Electroplating Center to propose to CEA realistic discharge standards which effectively balance dual purposes of pollution control and promotion of the electroplating industry.

The trade association organized by electroplaters would be a useful instrument for promotional activity and dissemination of technology. To ensure healthy growth of the industry as a whole, it is important for individual enterprises to make demands or undertake action collectively through an organization representing their interest. The center seemingly intends to support the establishment of such an organization, and it is desirable to proceed as outlined here.

Finally, the trade association will help create an opportunity for lower-cost acquisition of imported chemicals through collective procurement.

(7) Establishment of waste water treatment technology training courses

Training courses currently offered by the center emphasize electroplating technology. The plan proposes courses focusing on waste water treatment technology. While participants are encouraged to take the both fields, they could also take only the waste water treatment technology courses. The proposed courses are listed in Appendix 3.

6.3 Upgrading of Electroplating Technology

(8) Upgrading of basic electroplating technology

The installation of the bench plant is to be as in (1). It will be used to impact to technical staff basic electroplating technology, to consider various requirements and conditions for electroplating, and to optimize operating conditions. Equipment and instruments to be installed in the bench plant are listed in Appendix 1. As the plant is designed to be capable of performing a variety of experiments with a relatively simple configuration, the technical staff will be able to carry out a wide range of jobs from basic experiments to troubleshooting, development, and prototyping.

(9) Upgrading of bright nickel plating technology

Maintenance of existing facilities and equipment will lead to discovery of components and parts requiring repair and replacement. Major items identified by the study team are listed in Appendix 4; some may require a budget allocation. Note that the list includes the manufacture of plating rack (not practiced in the country), temperature measurement on electroplating bath, and PVC welding, which constitute basic electroplating technology.

Naturally, it is difficult to meet all the requirements at the same time, and the study team proposes to focus on modernization of nickel plating technology which seems to be most widely demanded. Bright nickel plating technology is widely adopted and it is expected to serve as a springboard to proliferate the fundamentals of electroplating technology as a whole. Once it is learned by individual plating units as basic technology, it can be used for plating of other metals and will form the basis for introducing further advanced electroplating technology.

Essential items in facilities and equipment improvement are the installation of filters (used on a permanent basis), the installation of counter flow rinsing tanks, the use of plating racks, and air agitation.

(10) Establishment of electroplating product inspection and measurement technology

It is unavoidable that quality requirements for electroplating will be made increasingly strict in the future. To promote replacement of electroplating parts imported by the country with local products, quality must be improved and inspection equipment becomes an essential tool to achieve that objective. In addition, product quality must be maintained and assured in the electroplating process, while the function of inspection is only to check the results. Since the level of quality control in the electroplating process is reflected in the level of product quality, analytical instruments will play an increasingly important role. In addition, analysis

is essential in checking water quality after waste water treatment. In particular, heavy metals need to be checked by a simple analyzer on a daily basis, while an atomic absorption spectrophotometer will be used for special checks, and the two results will be compared on a periodical basis.

To operate the bench plant and perform control of the bath in the existing electroplating process, the laboratory should be equipped with basic analytical instruments which must be fully utilized. These instruments are listed in Appendices 1, 5 and 6(Note).

Once the technological base for analysis and inspection of the electroplating process, electroplating products, and waste water treatment is established, data need to be collected and analyzed for feedback for process improvement. Analysis and inspection can be handled by existing technical staff, provided that they are additionally provided with a limited number of special equipment, the scanning electron microscope and the atomic absorption spectrophotometer listed in Appendix 6.

(11) Learning of maintenance technology

Daily maintenance of equipment is dealt with in (20), and this segment focuses on the manufacture of plating racks which are an integrated part of the electroplating process and the learning of PVC welding technology. This is an essential technology for improvement of electroplating technology itself, and if the center learns and diffuses this technology to the industry, it will contribute greatly to the upgrading of technology levels in the entire industry.

(12) Reorganization of skill training courses

In addition to the two-day training course currently offered by the center, a training programme to teach advanced skills, including practical training at the bench plant, will be newly established.

The sample curriculum for the comprehensive technical training course is shown in Appendix 3. This is a six-month course designed to train supervisor-class skilled workers. In the curriculum in Appendix 3, course subjects which are considered most important are marked by a circle. These subjects alone amount to 420 hours. Assuming 6 hours of class per day, the course will take 70 days, or nearly three calendar months. The center's skilled worker training programme should be redesigned by selectively reorganizing the curriculum according to an allowable training period, skill levels of prospective students, and expected levels of technology.

(Note) In addition, a standard set of laboratory equipment needs to be provided, including laboratory tables and racks, power units and outlets, water piping and sinks, gas (LPG) supply units, and ventilation.

(13) Comparative evaluation of electroplating products made in and outside of the country

Once the center attains higher levels of electroplating and waste water treatment technologies than small plating units, and the center acquires the necessary analytical instruments, it should collect and evaluate samples of electroplating products from domestic sources as well as other countries in order to make the industry recognize the current levels of electroplating technology in the country on a comparative basis.

The increased awareness of product quality will create demand for the analysis of plating solution, product inspection, and development and prototyping of new products. At this stage, the center will perform analysis, testing, and prototype development services for plating units on a contract basis. This way, the center will be able to secure a new source of income while not competing with small enterprises. Quality evaluation conducted by the center should include plating thickness, anti-corrosiveness, and adhesion.

There are no national standards in Sri Lanka for quality of electroplating. As a higher level of electroplating technology is adopted and quality requirements become stricter, the establishment of quality standards becomes inevitable, because it is impossible to set target levels for quality and technology without quality standards. While industrial standards are developed and established by the Sri Lanka Standards Institute (SLSI), the center should take the lead in developing draft standards for electroplating. In fact, import substitution can become a reality only when national quality standards are established and products begin to comply with them.

Thus, the center is expected to develop draft standards as a guideline for electroplating quality by taking into account quality standards in various countries, current technology levels in Sri Lanka, and market requirements.

(14) Technical assistance and transfer of electroplating technology

Once efficient work applying the basic electroplating theory, process, and equipment is practiced on a daily basis, and production management is formalized at a certain level, introduction and absorption of new electroplating processes become possible. In other words, introduction of new technology prior to the effective implementation of basic electroplating technology would cause poor adaptation of new technology, prevent the manufacture of quality products, and cause trouble within the process.

For instance, IDB is requesting technology transfer in the areas of non-cyanide plating which is non-polluting in nature, plating on plastics, hard chromium plating, and anodizing technology. However, the study team believes that implementation of basic technology and

operations is a prerequisite to transfer of these technologies. These technologies are described in Appendices 7, 8, 9, and 10.

Advanced plating technology to be introduced should be selected on the basis of a demand forecast and strategic focus, rather than an idealistic goal or vision. In particular, what types and quantities of products are produced, and what types of plating they need, should be determined on the basis of research and analysis of market trends. It is important to make decisions based on sound reasoning, otherwise capital expenditures would be wasted.

The result of the second field survey indicates that demand in the area of hard chromium plating exists in repair of hard chromium plated rolls (exfoliation of plate and re-plating) and precision polishing of plated surface can be handled by specialized enterprises. Likewise, introduction of anodizing and plating on plastics needs to be considered and implemented in stages according to actual demand.

To introduce new electroplating technologies (e.g., plating on plastics, hard chromium plating, anodizing), certain laboratory equipment and testing equipment are needed. Such equipment is to be acquired gradually according to the rise in technology levels and any change in products to be plated. Appendix 6 lists instruments and equipment which are generally required.

New technology adopted or implemented by the center will be disseminated widely through extension service for electroplating units, technical consultation, and seminars. The center's technical staff members are expected to provide useful guidance and advice on the basis of practical experience they have gained in the learning process.

In addition, new technology trends and market changes in the world, as obtained by data collection activities, will also be disseminated. This will lead to higher levels of electroplating technology throughout the country to build up the foundation of the electroplating industry.

6.4 Organization and Function-Strengthening Plan for the Center

(15) Strengthening of technical staff

The center is the only technical assistance and training center in the country for people who want to learn about electroplating or who wish to improve their electroplating skills, while serving as an organization active in the introduction, development, and dissemination of electroplating technology. Accordingly, it must have capabilities required for these activities and providing services to accomplish the above objectives.

At present, the center has three technical staff members; their member should be increased if the center is to function more properly. It is recommended to employ at least one chemist with an academic background in chemistry or electrochemistry. In addition, at least one full-time maintenance technician is required to take care of electroplating equipment, waste water treatment equipment, and laboratory equipment. While special maintenance and repair are outsourced, the center should be capable of handling minor repair, production, and work by use of its own staff. The maintenance technician should preferably have basic knowledge of machinery and electricity, with practical experience (a technical high school graduate or higher educational level).

A five-men team led by the superintendent is the minimum required staffing to provide necessary services including external activities. It consists of an superintendent of the electroplating center, two industrial extension officers in charge of electroplating and waste water treatment technologies, a laboratory assistant, and a maintenance technician. It is further recommended that these technical personnel, except for the superintendent and the maintenance technician, should not be given rigidly defined roles but, rather should be capable of performing all the responsibilities of others.

The most important task is to help the center's technical staff to learn about advanced technologies in the fields of electroplating, waste water treatment, production management, and analysis, testing and inspection, while learning practical skills therein. If these technologies and skills are already possessed, they must be applied to actual work. Unworkable knowledge is equivalent to the absence of knowledge. With due respect to work customs and division of responsibilities in Sri Lanka, the study team strongly believes that the technical staff must have practical experience in electroplating and waste water treatment, at least in the laboratory, if it is to provide effective guidance and training. For this reason, all of the technical staff must learn about technology and skills although the extent and magnitude of efforts will vary with each staff's responsibility.

As an effective training method, overseas training of the center's technical staff on a rotation basis is recommended. The minimum training period is considered to be six months,

the duration to depend upon the training programme of the host country. On the other hand, domestic training by inviting expatriate experts is appropriate only after the technical staff has attained a specific level of technology, the bench plant has been installed and specific process lines have been refurbished. In this case, the best result will be obtained by inviting the experts repeatedly for a short period of time (one or two weeks), which allows training to be proceeded while checking the actual rate of progress.

Once basic electroplating technology is mastered, control of the bath becomes a logical step to follow. To keep quality of plated products stable, a series of necessary actions must be established as formal procedures; it will range from periodical analysis and recording of electroplating bath, to the plotting of data on control charts, and the replenishment of chemicals required to maintain the bath in specific conditions.

Only after basic electroplating, waste water treatment and production management technologies are mastered will the center be ready to accept and absorb new technologies, based on which it will be able to develop proprietary technology.

(16) Additional staffing and function

As discussed earlier, the strengthening of technical staff is intended to enable the center to fulfill its mandated roles. Organizationally, this means the creation of a new function responsible for equipment maintenance within the organization.

At present, the center does not have such function, and as a result, the center's equipment is poorly maintained. It is proposed that a full-time maintenance specialist be hired.

As electroplating equipment extensively uses polyvinyl chloride (PVC) materials which are resistant to acid and alkaline substances, the maintenance staff is required to have PVC welding skills for repair.

Finally, the manufacture of plating racks suitable for plating products (including insulation coating) will be an important job for the maintenance staff.

The proposed organization is shown in Figure 6-1.

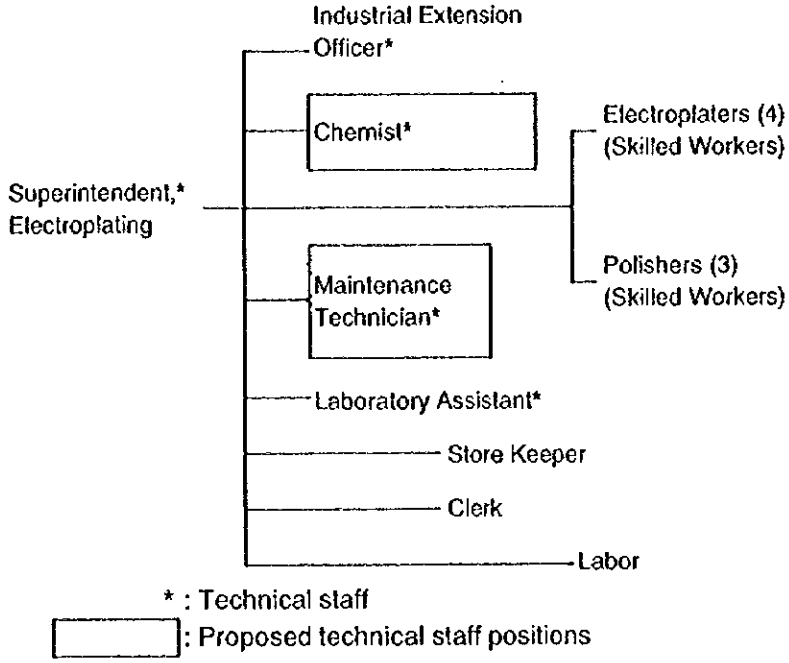

Figure 6-1 ADDITIONAL STAFFING FOR THE ELECTROPLATING CENTER

(17) Strengthening of means of communication

As the center is relatively remote from the IDB headquarters, various devices are required to maintain close communication between them, including an additional telephone line, a facsimile machine, and a motor vehicle.

The vehicle will be stationed at the IDB headquarters or the center and will be used for transportation between the two facilities as well as external activities at present and in future. Closer communication between the IDB headquarters and the electroplating center is expected to positively affect awareness and motivation of the center's employees and help invigorate the center.

6.5 Improvement Plans for Day-to-day Activities of the Center

(18) Collection of technical information

To raise the center's technology levels, it is important to correctly recognize its current capabilities, and identify technology levels and trends inside and outside the country. The first step is to collect relevant data and information through literature and magazines, on the current level of world-class electroplating technology and major issues. Information sources include university libraries, related research institutes, academic societies, and associations. Also, colleagues, peers and counterparts in other companies who have become acquainted with relevant subjects during overseas seminars and workshops as well as engineers of chemical suppliers can be valuable sources.

Attending meetings of societies, discussion groups, and forums, participation in scientific societies and trade associations, and obtaining subscription to in-house publications of manufacturers are other information sources. One company in Sri Lanka participates in seven societies and associations in the U.S. and the U.K.. Gaining access to these information sources allows them to recognize how electroplating technology is closely associated with environmental problems and keep abreast of latest technological trends in the world.

The center cannot solve every problem by itself. It must achieve its objectives by keeping close relations with the IDB headquarters, universities, research institutes, societies, and associations and actively pursuing its own goals under cooperation and support of the counterparts.

(19) Continuous training of workers

Technology and skills obtained by the center's technical staff are first transferred to its workers, which must lead to the upgrading of their skill levels. This is because the center's technology levels must be above those of private electroplating units. There are many items of training for workers, which can be most effectively learned in the form of OJT (on-the-job training) by focusing on practical skills, as selected from the items listed in Appendix 3 (as marked by circle). In particular, since training is conducted for present workers, it is reasonable to add items gradually according to advancement of their current skill level as this procedure will give them a sense of accomplishment.

At the center, polishers and electroplaters perform completely different jobs and are not interchangeable. Whatever the reason is, it is recommended to train them so as to have multiple skills. An important tip for improving labor productivity is to leverage each worker's potential to a maximum extent.

(20) Day-to-day practice of production management and equipment maintenance

In addition to being the leader of electroplating technology, the center must serve as a model for production management and equipment maintenance. When managers and workers of private electroplating units visit the center, it must display these practices as an active model.

The productivity improvement initiative is about to be promoted under the leadership of the IDB headquarters. Concurrently with the move, it is recommended to initiate the 5S movement at the center. 5S stands for five good practices to be followed at any shop floor, namely seiri (arrangement), seiton (housekeeping), seiketsu (hygiene), seiso (cleaning), and shitsuke (discipline). Originated in Japan as the first step toward productivity improvement, the 5S is widely practiced in many countries including the NIEs and ASEAN countries.

The primary goal of industrial production is to minimize variation of product quality, ultimately to approach zero. To achieve this, the quality of raw materials and operating conditions of the manufacturing process involving various processing activities must be kept constant as far as practicable. In the electroplating operation which involves a lot of manual work, standardization of individual tasks and their formalization in manuals are essential to minimize quality variation due to difference in work procedures between individual workers.

In this connection, the use of a work instruction sheet which specifies work procedures is essential in improving the level of quality and ensuring work safety. It is therefore desirable to put the work management system in practice, the proposal for which is now under consideration.

Similarly, the methods for analysis, testing, and inspection need to be standardized. Standardization can be applied to any work or job. For instance, technical staff is required to give work instructions to workers according to product quality required by each customer. The instruction can be accurately transmitted by using a standardized form of document.

Standardization and compilation of manuals must be carried out by technical staff. Then, it is desirable to revise or update them by taking into account the opinions and views of workers. Standards so developed and maintained can be used for technical guidance and training, as well as dissemination of technology.

Equipment maintenance should start from maintenance and repairing of existing polishing, electroplating, and waste water treatment facilities and equipment as well as laboratory equipment, in an attempt to bring them back as close to original conditions as possible. Then, periodical maintenance is formalized on the basis of a plan and budget allocation. The center's equipment reportedly has deteriorated and is in part outdated as ten years have parsed since installation. However, smaller electroplaters in Japan do not always have latest equipment. While having minimum-required capabilities (plating rack, temperature control,

agitation, and circulation/filtering of bath solution), they usually perform daily inspection and maintenance to ensure the maximum use of equipment. What distinguishes them from electroplaters in Sri Lanka are maintenance technology and its effective use.

Since old equipment is not a major issue, the highest priority should be given to the upgrading of electroplating technology and skills and the upgrading/replacement of equipment and devices required for external activity of the center. Existing equipment, on the other hand, should be properly maintained to make up for insufficient efforts in future and make repair as required.

Chapter 7 Policies and Measures to be taken by the Related Authorities and IDB

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7.1 Ministry of Industrial Development (MID)

(1) Policy for fostering the metalworking industry

Electroplating belongs to the final steps of the manufacturing process for metalworking products (some of which do not need electroplating). In fact, many enterprises in Sri Lanka own and operate electroplating lines as part of the process of manufacturing their final products.

This indicates that efforts to foster and promote the electroplating industry will not be rewarded unless diversification, quality, and performance improvements of base materials (metalworking products to be plated) are achieved. While addressing the problems inherent in the electroplating industry, efforts to encourage, foster and promote the metalworking industry should be given first priority. The development of the metalworking industry leads to product diversification and volume production, as well as improvements in quality and performance. It spurs the emergence of the electroplating industry in two ways. First of all, growth of the metalworking industry urges diversification, technological improvement, and quality improvement of electroplating, its supporting industry. At the same time, metalworking enterprises which have previously performed electroplating work internally will look for outside sources as product diversification and volume output make subcontracting economically justifiable. These factors enables dedicated electroplating companies to reach a critical mass and form the electroplating industry.

The metalworking industry supports a wide range of industries and, directly or indirectly, supplies equipment and materials required for the daily life of the population by manufacturing a fairly wide range of products. When we consider the development of the metalworking industry in Sri Lanka, however, the country's current level of industrialization makes it impractical to produce domestically all of the metalworking products within a limited period of time, and improve their quality and performance to world class levels, possibly developing them to export items. Instead, an phased approach that focuses on selected items is a realistic and workable solution. For instance, special promotional measures (in the areas of technology, information, finance, etc.) may be initiated for household goods or textile machinery parts (to support the textile industry which has developed to an export industry). As these products reach target levels of quality, performance and other factors, the next target (items) is to be

selected for high-priority investment and resource allocation.

Promotional measures for the metalworking industry are identified in Part 3 of "Study on Industrial Sector Development " submitted by JICA to the Government of Sri Lanka. These proposals are believed to be very useful for the metalworking industry to develop in the country (if properly implemented).

Proposals in the report (promotional measures for the metalworking industry) are summarized as follows:

1) To recognize the importance of the metalworking industry and make a national commitment to its fostering,
2) To establish a department or section specialized in promotion of metalworking within the MID (then Ministry of Industries, Science and Technology (MIST)) in order to ensure complete implementation of the existing promotion policy, coordinate activities of related ministries, and formulate and implement an additional policy, and
3) To prepare the action programme proposed in the report.

Since two years and six months have passed after the submission of the report, a follow-up survey was conducted to see how it is reflected in the country's industrial sector development and promotion policy. Major findings are as follows. Many policies and measures are found to have been taken and performed, but those for the specific industry like metalworking industry have not been implemented.

1) When the report was submitted to the Government of Sri Lanka (also, during the field survey), MIST was responsible for industrial promotion. After the government reorganization in November 1994, however, MID is currently in charge.

   At present, no department is directly responsible for following up the implementation of the JICA report (it is not certain if the reorganization has something to do with it). Instead, related departments and sections in MID have reviewed and studied the report in their respective responsible fields, and some of proposals have been implemented, although partially, as discussed in 3) below.
2) At the time of the report, IDB, which is primarily responsible for industrial promotion under MID, was under the Ministry of Tourism and Rural Development and was responsible for regional development.
3) The study team asked questions about how issues pointed out in the JICA report - issues

to be generally considered - are dealt with, and obtained the following responses and clarification from the Sri Lanka counterpart (MID).

(a) Recognition of crucial importance of industrial sector development

After the report, industrial sector development has progressed as a consequence of the following measures:

a) Sri Lanka - German Private Sector Promotion Programme was commenced in 1995, to provide assistance for export market promotion, investment promotion skills development in the export sector and productivity improvement.

b) Technology Initiatives for Private Sector (TIPS) is functioning with USAID assistance for promotion of technology and export marketing capabilities of the private sector.

c) A "Project for Development of Agricultural Machinery" has been implemented to provide technical assistance for development and upgrading of agricultural machinery.

d) Programmes have been conducted in order to develop entrepreneurial skills of the SMI sector, at the regional level.

e) A Task Force was set up to advise the Minister on policy and implementation. (It will focus on programmes relating to Implementation of Projects and Programmes).

f) A sub-committee on Industry and Investment has been appointed by the National Steering Committee for the Southern Area Development to prepare a project plan for the development of the southern area.

g) 1996 has been declared the "Year of Productivity". Various productivity programmes have been conducted regarding this.

h) A programme has been commenced to coordinate with Ceylon Institute of Science and Industrial Research (CISIR), National Engineering Research Development (NERD) Center, and Arthur C. Clerk Center to transfer technical know-how available with these institution.

i) To encourage and support enterprises to undertake training, the decision was made to establish a Skills Development Fund.

j) Action has been taken by IDB to identify the problems faced by the foundry industry.

(b) Implementation of industrial development policy

a) A steering Committee has been appointed to study and review industrial policy. The Advisory Council for Industry commenced sectoral studies on the activities and quality of the sectors and these studies are to be completed.

b) As for financial assistance, machinery and equipment purchased to obtain advanced technology is eligible for tax incentives (exemption for five years) for investment

promotion.

(c) Promotion of comprehensive infrastructure development

Infrastructure development projects are to be implemented under the BOT/BOO arrangements (specified in New Industrialization Strategy).

(d) Promotion of environmental protection

a) Relocation of a leather tanning unit is to be carried out under foreign assistance.

b) Research and study on environmental issues related to the textile and rubber sectors has progressed with the cooperation of a private enterprise.

(e) Financial assistance in industrial sector promotion

a) As a loan programme for small and medium scale enterprises, the SMI Loan Scheme was established in 1979 and has been executed in four rounds to this date, contributing greatly to the development of SMIs.

b) A loan programme, the Pollution Control and Abatement Fund, was established under the leadership of the Industrialization Commission to provide funds required for the installation of pollution control equipment and the purchase of technology, and has been operating since April 1996. The programme, established on the basis of the fund provided by Germany Kreditanstalt für Wiederaufbau (KfW), is limited in amount and is not capable of meeting the large demand. It is intended that this sort of loan programme, in consultation with related ministries and agencies, is to be expanded by relying on other financial resources including foreign assistance.

(2) Support for IDB

IDB, as a core organization responsible for implementation of industrial promotion policy, is required to render a wide range of services, some of which cannot be carried out by operational departments on a self-financing basis or can only be implemented by non-operational sectors. If IDB continues to provide these services, it will require large manpower and financial resources, so that it will need committed support of MID even after the establishment of the self-financing capability.

Also, MID is expected to assist IDB in offering its views to government on behalf of the electroplating industry.

7.2 Central Environmental Authority (CEA)

(1) Environmental policy coordinated with industrial development

Environmental policy and standards in Sri Lanka are well planned and prepared, comparable to those in industrialized countries. Environmental administration is highly centralized, and related authority and power are vested in CEA, constituting a simplified yet effective mechanism better than some of industrialized countries. At the same time, environmental standards are very strict and seem to be inconsistent with the actual state of the country's industry.

Clearly, it is admirable that Sri Lanka is attempting to achieve two goals which are sometimes conflicting, "promotion of environmental protection" and "development of industry." Yet, there seem to be cases where industrial development should be given priority over the environment. For instance, to promote a promising industrial sector, temporary exemption from, or easing of, environmental standards may be necessary.

(2) Review of effluent standards and its proper application

Generally, environmental standards in Sri Lanka are stricter than those of most countries. To make environmental standards work effectively, however, they should match the ability of the country's industry to comply with them, i.e., they should be established at a level where most industries can reach with some efforts and should be gradually raised according to the level of compliance. It is important to prevent industrial pollution as it takes a long period of time to clean up contaminated rivers, a few times as long as the period of uncontrolled discharge. Yet, enforcing strict regulations which most units cannot comply with is not a realistic nor effective solution. Review and relaxation on effluent standards related to electroplating industry is taken up below.

Effluent standards of various countries (including Sri Lanka) are excerpted in Table 7-1 for reference.

Table 7-1 STANDARDS FOR DISCHARGE OF EFFLUENT (mg/l) (excerpt)

Component	Sweden	France	Sri Lanka		Japan
			(General)	(Proposed)	(General)
Cr^{6+}	0.1	0.1	-	-	0.5
CN (free)	0.1	0.1	-	-	-
CN (total)	1	1.2	0.2	1.0	1.0
Cr (total)	1	2	0.1	-	2.0
Cr^{3+}	-	-	-	1	-
Ni	-	1	3	1.5	-
Cu	1	2	3	1	3.0
Zn	2	5	5	1.5	5.0
F	15	-	2	-	15

1) Review of general standards

There are several areas which require adjustment to ensure effective environmental protection. For instance, general environmental standards in Sri Lanka set uniform standards for inland water. However, water quality requirements obviously vary according to the intended use, except for toxic substances which affect human health. Different environmental standards may be applied to the upper stream and the lower stream of the same river, and for coastal areas from one location to another. More detailed standards reflecting local conditions need to be established.

In general standards, total Cr is set at a very high level of 0.1ppm, but no standard exists for harmful Cr^{6+}. Both should be controlled as done in most countries.

2) Review of effluent standards for specified industry

Proposed standards for effluents from the metal finishing industry set a CN level lower than general ones, while they are stricter for heavy metals such as Cu, Ni, and Zn. Effluent standards for specified units should be reduced in terms of the number of items as well as target levels. Also, Cr is controlled by Cr^{3+} only, and Cr^{6+} and total Cr should be added.

3) Relaxation of effluent standards for small-sized units

Industrial pollution control guidelines for the metal finishing industry describe pollution sources in each process, effluent reduction measures, and treatment methods in detail. Small units not using Cd, CN or Cr^{6+} (discharging heavy metals of 20kg or less annually) are not subject to effluent regulation, as seen in the Netherlands. Those discharging 20kg or more are required to collect and transport concentrated effluents to a centralized treatment

plant. For large units discharging 250kg or more, up to 50kg are permitted. In Japan, small units discharging $50m^3$ or less per day are not subject to effluent standards, except for toxic substances such as Cd, CN, or Cr^{6+}, and for the purpose of developing the metal finishing industry, less strict control on small enterprises should be considered.

For instance, effluent standards for heavy metals are established for units which do not discharge toxic substances such as CN, Cr^{6+} and Cd, while, as set forth in the Netherlands guidelines, heavy metal standards are not applied to small units discharging 20kg or less annually. Except for new installation and capacity addition, consideration is necessary to existing small units. However, for discharge of toxic substances such as CN and Cr^{6+}, units must be subjected to certain effluent standards.

(3) Reinforcement of the existing loan programme

Introduction of technology and installation of equipment for environmental protection require a large amount of funds for the purchase of pollution control equipment, which do not directly lead to sales growth. As a result, many enterprises are reluctant to make such investment although they realize the need for having the means of preventing their discharge of exhaust gas and wastewater from contaminating the environment.

A loan programme (PCAF) was recently started to provide funds for environmental investment, and 70% of the total fund have been executed during the first six months. While the earmarked fund is very small, the programme's popularity indicates that financial constraints prevent enterprises from taking action while recognizing the need for environmental protection.

Environmental protection and preservation is undoubtedly an urgent task to be undertaken on a global scale, and an area where international financial institutions and industrialized donor countries focus their attention in assistance of developing countries. Given the country's environmental commitment, it will be able to obtain additional funds from these institutions and governments to continue PCAF.(Note)

(Note) Local Newspaper, Daily News, dated on Nov. 15, 1996, during the second field survey reported under the headline of World Bank funded industrial waste plant as follows;

A World Bank - funded US$12 million, industrial waste water treatment plant will be shortly established to treat effluents discharged into waterways. This plant will inter-connect two of the country's most polluted industrial estates at Ja-ela and Ratmalana.

(4) Enforcement of laws and regulations

While the need for environmental protection is widely recognized, individual enterprises are not familiar with procedures and standards they must comply with.

Efforts should be made to make environmental standards known to all the industrial circles, thereby to encourage them to obtain environmental protection licenses. CEA should not allow to make excuses like lack of staff and shortage of budget. CEA is required to tackle with the above tasks, taking into consideration how to perform them under the given conditions.

7.3 Industrial Development Board of Ceylon (IDB)

(1) Need for unleashing its full potential

After its independence, Sri Lanka has been pursuing industrialization policy in an attempt to transform its economic structure that has long been dominated by the colonial rule by encouraging, fostering, and developing various industries. The Industrial Development Act, therefore, was enacted and IDB was set up under this act to encourage, foster, and develop nationwide industry. IDB, as mentioned earlier, has been under control of the Ministry of Tourism and Rural Development from 1986 to 1994 and engaged in industrial development in the specific regions. Rural development is certainly important and one of the duties entrusted to IDB, but it is considered to be one reason Sri Lankan industries having not well developed that IDB has been allowed to engage in only small portion of its duties (nationwide industrial development) under the act for a long time.

The experience suggests the importance of a consistent organizational structure for policy implementation bodies like IDB, which would assure the effective execution of its policy, while drastic organizational changes under the same policy may result in undue restriction on its activities.

(2) Formulation of self-reform programme reflecting SMI's voice

IDB is currently drawing up a self-reform programme to accomplish the objective of self-financing and building a efficient organization.

Under a market economy, an enterprise which cannot meet market needs is forced to go out of business. Government organizations are by no means immune from a risk of extinction. Any government organization loses its raison-de-etre after it has completed its duties. In addition, there have been many cases of government organizations being dissolved or abolished when they are unable to perform their duties in a satisfactory manner, when they fail to attract a sufficient number of users of their services, or when they are criticized by taxpayers by failing to use limited funds in an efficient and effective manner.

On the other hand, IDB is highly valued for its willingness to draw up and implement its own reform plans. Yet, judging from the state of progress in drafting the reform programme, it appears to give high weight to the results of hearings, decisions, and discussions inside IDB (although it is possible that their supervising ministry, MID, may give its opinion or issue instruction). Clearly, IDB needs to listen more to its present and potential users, particularly small and medium scale enterprises, regarding their opinions and views on IDB's service and practice, based on which reform proposals should preferably be developed.

(3) Evasion of competition with private enterprises

To attain the self-finance capability, the operative divisions are requested to promote their productivities and to make money through their operation. This involves significant difficulty and IDB's decisions are critical. In the process, the following view needs to be taken into consideration.

IDB as a government organization which has the sole purpose of promoting industry should not compete with or overwhelm private enterprises even if it has an operational division. It is desirable for IDB's operational division to perform its mandated duty, which may temporarily compete with or overpower private enterprises, rather than give priority to the fulfillment of the self-financing objective.

In other words, IDB needs to go back to its original mission to introduce advanced technology and have it incorporated in new products, which are manufactured and sold by its operational division, thereby to raise awareness on quality and performance in the domestic market. If any domestic enterprise wishes to manufacture and sell the product, IDB will have to support it actively and discontinue the manufacture and sales. Then IDB will move to the next technology and product.

This is believed to be the best approach to ensure the rise in awareness of quality and performance in the domestic market as well as dissemination and transfer of new technologies and products, thereby contributing to the nurturing of the domestic industries, while assisting IDB's self-financing goal.

(4) Discussion with CEA on environmental regulation to be applied to electroplating industry

The industrial pollution control guideline for the metal finishing industry is said, as mentioned earlier, to be not effective so far. As CEA is reported to be waiting for opinions and requests coming from the related authorities and organizations, IDB would do well to discuss with CEA on the step-by-step application and/or mitigation of the proposed standards taking the current state of the electroplating industry into account.

Chapter 8 Proposals and Recommendations

Chapter 8 Proposals and Recommendations

8.1 Promotion Programmes for the Electroplating Industry

Based on the proposed improvement plan for IDB Electroplating Center mentioned in Chapter 6, and recommended measures to be taken by related organizations and IDB, as identified in Chapter 7, proposals and recommendations for promotion of the electroplating industry are described as follows. The present study has revealed that the upgrading of IDB's technology and skill levels as an organization leading the industry is imperative for effective promotion of the industry. It is recommended, therefore, to promote the upgrading of the center's technology and skills, as a formal programme, with cooperation by related authorities and organizations.

(1) Programme to upgrade technology and skills of IDB Electroplating Center

Promotion of the electroplating industry needs to be realized at the initiative of IDB, which must and can play a critical role. While the programme will be planned and implemented under the leadership of the electroplating center, it should preferably be promoted with assistance and collaboration of related authorities and organizations including MID and CEA in order to maximize its effect.

(2) Promotion of the electroplating industry as part of industrial development policy

Promotion of the electroplating industry is closely associated with promotion of the metalworking industry and industrial promotion policy. In this context, MID, which is making efforts to promote the metalworking industry, is expected to support and foster the programme to upgrade IDB Electroplating Center's technology and skills, so as to ensure that the electroplating industry will not become a bottleneck for industrial development as a whole.

(3) Environmental policy in concordance with industrial promotion

While the electroplating industry is still small in size and thus has not become a serious environmental threat, it has high potential to become one, which cannot be underestimated. Development of the electroplating industry hinges upon its ability to treat waste water properly. In this conjunction, CEA must be continually aware of the center's technology upgrading programme and its progress, particularly regarding propagation of waste water treatment technology, and is expected to take flexible policy measures that take into account the realities and growth potential of the industry.

8.2 Upgrading Programme for Technology and Skills of IDB Electroplating Center

"Upgrading programme for technology and skills of IDB Electroplating Center", that is proposed as a core promotion programme for the electroplating industry, is outlined as follows.

8.2.1 Prerequisites for implementation of programme

In proposing the plans to be implemented by IDB, the study assumes the following prerequisites to be fulfilled and considerations to be made.

(1) Use of existing facilities and equipment

Existing facilities and equipment located at IDB Electroplating Center in Peliyagoda will be used for the programme. Before the use, these facilities and equipment will be partially rehabilitated, including the upgrading, repair, addition, and/or layout modification, rather than overall renewal. The process and equipment improvements being contemplated require space for improvement. Therefore it is recommended to reconsider the need for existing equipment, and remove or dispose that which is not needed or is not practical to repair.

(2) Additional staffing and functional strengthening

In consideration of proposed strengthening of technical staff and organizational and functional enhancement in (15) and (16) of 6.4, the minimum additionally required technical staff will be engaged. While electroplating service by the center on a contract basis will bring meaningful benefits through technical improvement and increased revenues, it is recommended to manage the center's service by separating it into technical upgrading/guidance and electroplating work. Under this arrangement, workers will mainly be engaged in the latter. On the other hand, technical staff will be responsible for both jobs, which need to be differentiated clearly. To prevent technical guidance from being neglected, related costs for chemicals, consumables, and maintenance should be recorded separately for each of the two categories as far as is practicable.

8.2.2 Upgrading programme for technology and skills of IDB Electroplating Center

(1) Outline

Tasks and targets for the proposed programme to upgrade waste water treatment and electroplating technology of IDB Electroplating Center and to disseminate them, are shown in Table 8-1.

Table 8-1 UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives		Programme goals
Dissemination of waste water treatment technology	Upgrading plan for waste water treatment technology at the center	To enable the center's technical staff to consider and establish appropriate waste water treatment conditions. To ensure that electroplating is carried out in such method to minimize effluents from the plating process. To ensure that waste water treatment is carried out in compliance with conditions set by technical staff.
	External activity plan for the center (dissemination of waste water treatment technology)	To promote implementation of an optimum waste water treatment plan in the electroplating industry
Upgrading of electroplating technology	Upgrading plan for the center's technical capabilities	To enable the center's technical staff to consider and establish appropriate plating conditions. To ensure that electroplating is carried out in compliance with conditions set by technical staff. To ensure that inspection data on electroplating products are recorded and used for process improvement
	External activity plan for the center (dissemination of electroplating technology)	To promote the upgrading of electroplating technology to meet demand of the metalworking industry.

The action plan of the upgrading programme is shown in Table 8-2. For the content of each project refer to the items in Chapter 6.

Table 8-2 ACTION PLAN FOR UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives		Projects	Equipment upgrading plans	Goals	Remarks
Dissemination of waste water treatment technology	Upgrading plan for waste water treatment technology at the center	Learning of basic waste water treatment technology	Procurement and replacement of laboratory equipment and analytical instruments	Learning of basic technology related to waste water treatment	6.2 (1)
		Learning of waste water analysis and measurement techniques	Procurement and replacement of analytical instruments for effluent	Learning of measuring method for waste water analysis data, and application of accumulated data to process improvement	6.2 (1)
		Establishment of waste water batch treatment technology	Improvement of existing waste water treatment equipment	Implementation of waste water treatment in compliance with effluent standards	6.2 (2)
	External activity plan for the center (dissemination of waste water treatment technology)	Promotion and public education on waste water treatment technology		Education on importance of waste water treatment and knowledge on waste water treatment method to the electroplating industry	6.2 (3)
		Technical assistance and technology transfer	Workshops using model equipment	Teaching of adequate treatment technology to plating shops	6.2 (4)
		Model plant construction plan	Installation of a model waste water treatment plant at a selected plating shop which conducts work on a continuous basis	Teaching of mainstream treatment technology to the electroplating industry	6.2 (5)
		Research and study on effluent discharge by the industry and proposal of revised effluent standards		Research and study on current state of waste water treatment, development of proposed effluent standards which are enforceable, and proposal to CEA	6.2 (6)
		Establishment of waste water treatment technology training courses		Guidance and training on waste water treatment practice	6.2 (7)
Upgrading of electroplating technology	Upgrading plan for the center's technical capabilities	Upgrading of basic electroplating technology	Construction of the bench plant	Understanding of basic electroplating technology and plating conditions	6.3 (8)
		Upgrading of bright nickel plating technology	Upgrading and rehabilitation of existing equipment, Manufacturing of plating racks, Improvement of plating process lines	Learning of adequate plating technology and skills through practical experience in bright nickel plating technology	6.3 (9)
		Establishment of electroplating product inspection and measurement technology	Plating thickness gauge Adhesion testing equipment Corrosion testing equipment	Learning of electroplating product inspection technology, and application of accumulated data to process improvement	6.3 (10)
		Learning of maintenance technology	Plating rack production tools PVC welding equipment	Learning of basic maintenance technology	6.3 (11)
	External activity plan for the center (dissemination of electroplating technology)	Reorganization of technology training courses	Use of the bench plant	Retraining of plating engineers and workers with advanced knowledge and skills	6.3 (12)
		Comparative evaluation of electroplating products made in and outside of the country		Compilation of inspection results on the basis of sampled electroplating products to encourage recognition of current technology levels	6.3 (13)
		Technical assistance and technology transfer		Guidance to plating shops for technological upgrading	6.3 (14)

(2) Implementation schedule for programmes and equipment costs

The above promotion programmes will be implemented within a five year period which is divided into two phases. The first phase (3 years) will focus on upgrading of the center's technology levels and implement priority items. Based on the results of the first phase, the second phase (2 years) will concurrently implement the technology upgrading plan and the technical guidance and dissemination plan. Table 8-3 shows priorities for the programmes, preliminary implementation schedule, and equipment cost estimates.

Table 8-3 PROPOSED IMPLEMENTATION SCHEDULE OF UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives	Projects	Priority	Schedule 0 3 7	Estimated equipment upgrading costs (thousand yen)	Technical support activities
Upgrading plan for waste water treatment technology at the center	Learning of basic waste water treatment technology	AA			Training, consultant
	Learning of waste water analysis and measurement techniques	AA		1) 513	Training, consultant
	Establishment of waste water batch treatment technology	A			(Consultant)
External activity plan for the center (dissemination of waste water treatment technology)	Promotion and public education on waste water treatment technology	A			
	Technical assistance and technology transfer	A			
	Model plant construction plan	B			(Consultant)
	Research and study on effluent discharge by the industry and proposal of revised effluent standards	B			
	Establishment of waste water treatment technology training courses	B			(Consultant)
Upgrading plan for electroplating technology at the center	Upgrading of basic electroplating technology	AA		2) 2,018	Training, consultant
	Upgrading of bright nickel plating technology	AA		3) 3,310	Training, consultant
	Establishment of electroplating product inspection and measurement technology	A			Training, consultant
	Learning of maintenance technology	A			Training, consultant
External activity plan for the center (dissemination of waste water treatment technology)	Reorganization of technology training courses	B			(Consultant)
	Comparative evaluation of electroplating products made in and outside of the country	B			(Consultant)
	Technical assistance and technology transfer	B			
			Total	5,841	

Note 1) Measurement equipment related to Appendix 1 (5), including Appendix 5 (4) ORP mete
2) Equipment related to Appendix 1 (1)～(4)
3) Equipment related to Appendix 4

Training: Overseas training
Consultant: Technical guidance by expert (key items)
(Consultant): Expert advice

(3) Foreign technical assistance

Needless to say, the proposed programmes must be promoted under IDB leadership. In some cases, however, efficient implementation and better results can be expected from foreign technical assistance, such as overseas training and instruction by foreign experts.

1) Overseas training of technical staff

The center's technical staff members have received training in the U.K. or India at the time of employment. Since then, they have had few opportunity to come in contact with new technology. Technologies they have learned are outdated. They need to learn basic plating technology as well as waste water treatment technology. At the same time as new technical staff is added to the center, it is recommendable to provide the existing technical staff with practical training at industrial research institutes in other countries. This will increase the effectiveness of instruction by foreign experts and will accelerate the pace of technological upgrading.

2) Instruction by resident foreign experts

To achieve the primary objective of the programme, i.e., the upgrading of IDB's technical capabilities, in an efficient manner and within a relatively short period of time, instruction by experts from industrialized countries is strongly recommended. Such instruction should cover practical knowledge and know-how with an emphasis on basic technology. It should be noted, however, that training of field workers and external activities need to be carried out under strong leadership of IDB, while foreign experts will only provide advice and suggestion.

Table 8-4 lists items for which foreign technical assistance is desirable.

Table 8-4 RECOMMENDED AREAS OF FOREIGN TECHNICAL ASSISTANCE

Types of technical assistance	Items	Method/period/number of personnel
Overseas training of technical staff	Training items • Learning of basic electroplating and waste water treatment technologies • Including field tour on electroplating and waste water treatment operations at factories	To be conducted at industrial research institutes in industrialized countries, which have similar function to IDB. The training programme will last 3~4 months per person and should preferably cover 2~3 persons over an extended period of time to avoid overlapping.
Instruction by foreign experts	Items • Basic waste water treatment technology • Waste water analysis and measurement techniques • Waste water batch processing technology (design and operation) • Basic electroplating technology • Bright nickel plating technology • Product inspection technology (application to process improvement) • Technology related to plating racks (design and manufacture) Focusing on training of basic technology for technical staff	During the first year, it is recommended to provide two-week instruction at an interval of a few months. Meanwhile, details of facilities and equipment required for instruction (specifications, location to be installed, and actions required by the Sri Lankan counterpart will be studied and prepared for installation). Then, two experts will be assigned for around two years.

(4) Principles of programme implementation

The following principles need to be complied with when implementing the promotion programme:

1) Operating expenses for the center, including chemicals and other consumables, labor, and maintenance, must be specified in a formal budget.
2) The implementation schedule is assumed to take the minimum practical period, which can be extended in keeping with the staff's ability and budget allocation, provided that continuous and sincere efforts are made to accomplish the goal of attaining knowledge of the required technology.
3) As demand for electroplating varies with economic change and technological advancement, the programme should be flexibly implemented by reviewing and revising priorities as required.
4) The programme must be implemented under the leadership of IDB, including technical

assistance where it is expected to involve active participation in and cooperation by foreign experts.

8.2.3 Recommended continuous activities as routine work

The following activities should form the basis of efforts to improve and maintain technology and skills, but are not widely practiced at present. They should be incorporated into the center's day-to-day operation plans and should be conducted on a continuous basis.

(1) Collection of technical information

Developing countries are apt to introduce latest technology, but leave intact existing problems or obstacles. It is critical to keep abreast of world technology trends and evaluate latest technology from its merits to the country and industry.

(2) Training of workers

Since the center is expected to play a leading role in disseminating technology to the industry, work conducted at the center must be at the highest level achievable in the country. The center should also provide a show case of worker training. As will be the case elsewhere as well, although globally applicable training methods are in place, their effect cannot be maximized without due consideration having been given to conditions peculiar to the country and society. Naturally, workers may resist a major change in work procedures and practices to which they are accustomed. Technological upgrading of the center cannot be assured unless there is an environment or mechanism to enable technical staff to provide workers with continuous training on a daily basis, in order to keep pace with technological advancement.

(3) Production management and equipment maintenance

The center must become a model facility for production management and equipment maintenance. In particular, it should develop the ability to provide technical assistance in these areas by making prototypes and performing electroplating work on a contract basis. Also, to increase productivity of the entire industry, it should cooperate with private enterprises that are making innovative efforts in production management. Finally, safety and health of workers are other important aspects to be taken care of on a daily basis.

8.2.4 Plans to be implemented after the programme

To ensure the full-fledged growth of the electroplating industry, the following plans need to be promoted. These plans should be implemented when the proposed programmes have made progress and produced tangible results.

(1) Promotion of centralized waste water treatment plan (support for industry-wide cooperative efforts)

It is very difficult for smaller units to install waste water treatment equipment at their own facilities, and centralized treatment is a realistic and optimum solution. Any such efforts, however, involve various management problems in addition to technical ones. To overcome them, individual enterprises must be organized so as to mobilize collective efforts. In particular, organizational efforts of enterprises that are willing to participate in centralized treatment are a prerequisite to the plan's promotion. In this connection, IDB is expected to provide support for organization of individual plating units in addition to technical aspects of centralized treatment.

(2) Introduction of non-polluting plating technology

Pollution control is not merely treatment of harmful substances. Equally important are efforts to reduce the discharge of effluents by reducing the use of chemicals and recycling plating solution. Furthermore, a new zinc plating bath process using no cyanide or low concentration of cyanide needs to be considered, although the non-cyanide process is difficult to introduce until bright nickel plating technology is fully adopted.

(3) Introduction of advanced plating technologies

The center is contemplating introduction of hard chromium plating and non-electrolytic plating. In fact, demand already exists in the country for these methods of plating. To ensure the high quality required in these advanced plating processes, however, various intricate plating conditions, such as involving plating racks and arrangement of electrodes, must be controlled. They are more complex than those applicable to bright nickel plating technology. This is the reason why this report emphasizes the need for establishing bright nickel plating technology, which is the prerequisite to introduction of advanced plating techniques.

Finally, chromium plating needs to be conducted in a room separated from that for nickel and zinc plating processes, so that it should be introduced in the context of the overall expansion plan for the center.

8.3 Recommendations to MID

Refer to 7.1 for the detail of recommendations to MID.

(1) Support for the technology upgrading programme for IDB Electroplating Center

As the metalworking industry develops, it is important to foster the domestic electroplating industry so as to allow it to keep pace with the metalworking industry and not to become a bottleneck. It is recommended that MID, as IDB's supervising organization, support IDB's operational divisions to implement the technology upgrading programme for IDB Electroplating Center in its manpower and financial aspects, while providing ongoing support for IDB's activity.

(2) Promotion of the metalworking industry

Apart from fostering of the electroplating industry, successful growth hinges upon development of the metalworking industry. Healthy growth of the metalworking industry creates a powerful drive for demand for better electroplating and higher technology levels, which induces modernization of the electroplating industry. Thus, MID needs to focus on promotion of the metalworking industry as part of its ongoing industrial promotion policy, which can be fully justified on the basis of its positive repercussion on the electroplating industry.

8.4 Recommendations to CEA

Refer to 7.2 for the detail of recommendations to CEA.

(1) Environmental policy in concordance with industrial production

While the electroplating industry is still small in size and thus has not become a serious environmental threat, it has high and not-to-be-underestimated potential to become such a threat. Development of the electroplating industry must be accompanied by its ability to treat waste water properly. In this conjunction, CEA must be well aware of the center's technology upgrading programme and its progress, particularly propagation of waste water treatment technology, and is expected to apply regulatory measures by taking into account the objectives of environmental protection and potential contribution of the electroplating industry to industrial promotion, and work with IDB to promote appropriate waste water treatment practice in the industry.

(2) Establishment of viable effluent standards for the metal finishing industry as a whole

Present environmental standards are uniformly applied regardless of chemical consumption or discharge by individual units. To maximize the effect of regulatory measures by setting standards to which units can comply with reasonable efforts, flexible enforcement of environmental standards is recommended, e.g., exemption of enterprises smaller than a certain size. In this context, effluent standards for the metal finishing industry, which is currently being drafted by CEA, seem to contain unduly strict provisions and lack indispensable ones. It is recommended that CEA consults with the industry and/or IDB to establish enforceable standards.

(3) Expansion of the loan programme related to pollution control

The loan programme currently underway, which uses the Pollution Control and Abatement Fund, is small in size and has not been used by the electroplating industry. Once the industry starts to install waste water treatment facilities, an increasing number of units will demand public loans. To accomplish the goal of pollution control initiated by the industry, therefore, the issue cannot be left to the Ministry of Finance and Planning. It is recommended that CEA and MID monitor the development of the loan programme and take steps to achieve a reasonable increase of the budget for the fund, while advising the industry to leverage the programme for quick proliferation of waste water treatment in the industry.

8.5 Recommendations to IDB

Refer to 7.3 for the detail of recommendations to IDB.

(1) Need for coordinated self reform efforts

IDB is now making committed efforts for self reform, which are highly evaluated, provided that the reform plan reflects the needs and wants of small enterprises it serves.

(2) Non-competition with private enterprises

IDB, as a government organization, should not provide service which may compete with or exert undue pressure on private enterprises. Thus, it should confine its activities to those which would serve the interest of helping private enterprises and their development, e.g., introduction and dissemination of advanced technology and products.

(3) Discussion with CEA on environmental regulations to be applied to electroplating industry

IDB should discuss with CEA on the step-by-step application and/or mitigation of the proposed standards, taking the current state of the electroplating industry into account.

Chapter 9 Conclusion

Chapter 9 Conclusion

(1) Current state of the electroplating industry

1) The electroplating industry in Sri Lanka is fairly small and far from reaching a level recognizable as a self-driving industrial sector. The metalworking industry is also underdeveloped and creates minimal plating demand, and the market does not demand high quality from plated products.

2) There is no plating unit that treats its waste water properly by using appropriate treatment facilities. A large number of them do no treatment at all. As a result, effluents discharged from electroplating units contain pollutants above concentration levels permitted by CEA's environmental standards, but they have not caused a serious problem due to the small amount of discharge.

3) Electroplating technology of the industry has lagged behind the world level. Dull nickel plating followed by buffing is the mainstream technology adopted by the industry. The lack of quality awareness in the market discourages aggressive process improvement. There is a lack of knowledge of basic electroplating and waste water treatment technologies.

(2) Major issues facing the electroplating industry

1) Major issues facing the electroplating units are the improvement of the rinsing process, introduction of waste water treatment, the improvement of the plating and pretreatment processes, and product inspection (introduction of quality control practice).

2) Major issues related to IDB Electroplating Center are low technology levels of technical staff, the lack of training for workers, and insufficient ability to provide technical service for the industry.

(3) Final goals

1) In discussion with IDB, it was decided to make the focus of recommendations on two goals, namely reduction of environmental pollution loads through process improvement, and the upgrading of electroplating technology and quality improvement.

2) Future targets for electroplating units are reduction of discharge load, formalization of the waste water treatment process, and the upgrading of electroplating technology.

Reduction of discharge load will be accomplished by improving the rinsing process (control measures at source), while waste water treatment facilities will be installed at individual factories. For small units, centralized treatment should be considered.

The upgrading of electroplating technology, while the plating process plays a central role,

involves the improvement of the entire process including pretreatment and rinsing processes. In particular, introduction and adoption of bright nickel plating technology (serving as key technology for future diversification) is essential.

Present measures to be taken are the improvement of the rinsing process, incorporation of the waste water treatment process, the use of plating racks, and filtration and air agitation, which will constitute the first step toward the future goals.

3) IDB Electroplating Center is mandated to raise technology levels of the entire electroplating industry through technical assistance. To fulfill such a role, the center must develop itself into an organization having highest technical capabilities in the areas of plating and waste water treatment technologies, and assume responsiblity for research and development, testing and inspection, and promotion and assistance.

(4) Upgrading programme for technology and skills of IDB Electroplating Center

1) For the industry to attain the prescribed future goals, it is imperative that IDB Electroplating Center, as the leader and propagator of industrial technology in the country, must improve its own technological capabilities. For this purpose, the programme to upgrade technology and skills of IDB Electroplating Center is proposed.

2) The programme must be promoted under the leadership of IDB, the efforts of which can be significantly enhanced by technical assistance from industrialized countries.

(5) Recommendations to related authorities

1) MID is recommended to step up efforts to promote the metalworking industry, and support IDB itself and the programme to upgrade technology and skills of IDB Electroplating Center.

2) It is recommended that CEA pursue environmental regulation in concordance with industrial development, optimized application of regulatory measures, and effective dissemination and enforcement of environmental standards. In addition, CEA should work with the Ministry of Finance and Planning and other competent ministries to expand the loan programme for pollution control-related investment.

3) Recommendations to IDB include efforts to maintain consistency of IDB's service, the development of the self-reform plan in consideration of the needs of its users, and self-restraint to avoid undue competition with private enterprises.