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# PRE-INVESTMENT STUDIES

# ON

# PROMOTION OF SUPPORTING INDUSTRIES IN THAILAND

**(US/THA/90/040)**

**Kingdom of Thailand**

## TERMINAL REPORT

**Volume I**

Part I Supporting Industries in Thailand
Part II Pre-investment Studies of Two Sub-sectors

Prepared by the

United Nations Industrial Development Organization

Based on the work of

ENGINEERING CONSULTING FIRMS ASSOCIATION, JAPAN

JAPAN DEVELOPMENT INSTITUTE

FEBRUARY 1993

Backstopping Officer: Michael Davidsen, Feasibility Studies Branch

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# Introduction

Thailand has achieved a rapid economic growth in the 1980s. In the course of development, significant structural change and diversification took place. She has adopted outward-looking strategy for industrialization. Foreign investment has been welcomed to the country and export-oriented industries have played an important role as an engine of growth.

Local supporting industries, such as parts/components manufacturers and sub-contracting firms, assume critical importance in generating self-sustaining industrial development and promoting small and medium enterprise development. UNIDO agreed to provide study fund for promotion of supporting industries under the title 'Promotion of Supporting Industries in Thailand' in 1988 and Engineering Consulting Firms Association of Japan (ECFA) was selected as a consultant for the project. As a continuing effort, 'Pre-Investment Studies on Promotion of Supporting Industries in Thailand' has been conducted by ECFA under the supervision of UNIDO.

In this project, two sub-sector studies have been conducted on aluminum die-casting and surface treatment. The selection of the sub-sectors were determined through the discussions of UNIDO, Ministry of Industry in Thailand, and ECFA during the first visit to Thailand by the ECFA team in January, 1992. Along with the sub-sector study part, the studies on nationwide industrial location and relocation of industries from overconcentrated Bangkok constituted the other important component.

The two sub-sector studies, including macro analysis of supporting industries, are in this volume (**Volume I**). The studies on national industrial location and relocation program in Bangkok are in another volume (**Volume II**).

The members of ECFA team were:

| | |
|---|---|
| Shoichi Kobayashi (team leader) | Economist, Regional Planner |
| Hachiro Ida | Engineering Economist, Regional Development |
| Takafumi Ueda | Industrial Economist, Environmental Management |
| Seth Sulkin | Policy Analyst |
| Myles Elledge | Institutional Development |
| Takenosuke Kuroda | Market Analyst |

During the study, the team conducted extensive interviews with a large number of officials from various offices of the government. Also a survey of enterprises in Bangkok and its vicinity has been conducted with the help of Industrial Development Division, Department of Industrial Promotion, Ministry of Industry.

We would like to express deep appreciation to the following institutions for their kind cooperation and encouragement for our difficult task; UNIDO/Thailand, Department of Industrial Promotion, Department of Industrial Works, Office of Industrial Economics in Ministry of Industry, Industrial Planning Section in National Economic and Social Development Board, Industrial Estate Authority of Thailand, Office of National Environmental Board, Office of the Board of Investment, Department of Treasury in Ministry of Finance, Policy and Planning Division in Bangkok

Metropolitan Administration, Department of Town and Country Planning in Ministry of Interior, Business Promotion Department in the Industrial Finance Corporation of Thailand, the Federation of Thai Industries, Thailand Development Research Institute.

Finally, we appreciate the value comments on the first and second draft provided by the Thai government and UNIDO. We tried our best to include these valuable comments into this final version. We hope all interested parties will be satisfied with the final result and that some of the suggestions in the study will be useful for the Thai government in formulating industrial policy, particularly related to supporting industries and relocation away from Bangkok. Japan's Ministry of International Trade and Industry has just finalized its report on Thai supporting industries, and UNIDO has just agreed to do a feasibility study for Western Seaboard industrial development. Japan's MITI has shown keen interest in carrying out further programs in this field. These projects should help to ensure that the process of policy research contained in this study will be continued for the foreseeable future.

February 1993

Shoichi Kobayashi
Team Leader, ECFA

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## B. Pre-feasibility Study on Aluminum Die Casting

## GLOSSARIES OF ACRONYMS

| | |
|---|---|
| BMA | Bangkok Metropolitan Area |
| | Bangkok Metropolitan Administration |
| BMR | Bangkok Metropolitan Region |
| BOI | Board of Investment |
| CCDP | Clean Center Development Program |
| CMTCDP | Chaing Mai Techno-City Development Program |
| DIP | Department of Industrial Promotion, Ministry of Industry |
| DIW | Department of Industrial Works, Ministry of Industry |
| ESB | Eastern Seaboard |
| ESBDP | Eastern Seaboard Development Program |
| GRP | Gross Regional Product |
| IEAT | Industrial Estate Authority of Thailand |
| IFCT | Industrial Finance Corporation of Thailand |
| MOI | Ministry of Industry |
| NEBCDP | Northeast Border City Development Program |
| NESDB | National Economic and Social Development Board |
| NIEs | Newly Industrialized Economies |
| OECD | Organization of Economic Co-operation and Development |
| ONEB | Office of National Environmental Board |
| PEDC | Provincial Economic Development Corporation |
| REDC | Regional Economic Development Center |
| RUGCDP | Regional Urban Growth Center Development Program |
| SFEZDP | Southern Free Economic Zone Development Program |
| SIFCT | Small Industry Financial Corporation of Thailand |
| SMEs | small and medium enterprises |
| SB | Southern Seaboard |
| TDRI | Thailand Development Research Institute |
| UIMP | Urban Industry Modernization Program |
| UNDP | United Nations Development Programme |
| WSB | Western Seaboard |
| WSBDP | Western Seaboard Development Program |

## Volume I
## Part I Supporting Industries in Thailand

## 1. Supporting Industries in Thailand

(1) Past Performance and Major Problems

Thai industry has grown very rapidly in the past several years led by a high level of export-oriented foreign investment, mainly in manufacturing. In 1990, industry became the largest sector in terms of GDP (23%) and exports (69%), following annual growth of 12-13% since 1987. Although industry had been performing well, Thailand is now facing several obstacles to future sustainable development:

a. shortage of skilled and semi-skilled labor, especially foremen and engineers, causing a slowdown in production and investment, and a rapid increase in wages.
b. overconcentration of industry and population in the Bangkok Metropolitan Area (BMA), resulting in severe traffic congestion.
c. poorly developed raw and semi-raw materials, and supporting industries have caused overdependence on imported materials and goods.
d. insufficient physical infrastructure in areas such as transportation and environmental control.

(2) Major 7th Plan Objectives

In order to cope with existing problems, the government initiated a new-five year plan in 1992. The industry-related objectives of the Seventh Plan can be broadly summarized as follows:

a. sustaining the present high rates of industrial growth and exports
b. reversing the recent trend toward growing regional and income disparities
c. improving industrial competitiveness through greater efficiency and diversification
d. putting an increasing emphasis on qualitative aspects of industrial development, such as urban congestion and environmental issues

(3) Main Strategy of the Seventh Plan

In order to achieve the broad objectives set by the 7th Plan, NESDB and the Ministry of Industry are considering the following three main strategies:

a. in order to reduce the high degree of import dependency, a priority will be placed on developing basic industries (i.e. steel and chemicals) and supporting industries (i.e. electric and transport machinery).
b. in order to reduce the overconcentration of the BMA and income disparities between regions, regional industrial development will be given high priority (NESDB is now formulating detailed action plans known as "Regional Urban Growth Center Development Program (RUGCDP)" in which nine provinces have been selected for priority treatment).
c. more emphasis will be placed on developing low-emission manufacturing and pollution control technology

(4) Role of Supporting Industry in the Seventh Plan

Development of supporting industries is one of the key strategies in the Seventh Plan, given import dependency as high as 85% in newly-established areas such as electronics and transportation machinery. Development of healthy supporting industries will:

a. strengthen competitiveness of Thai industry by producing necessary parts and components domestically, reducing cost and production time;
b. improve the trade balance through reduction of intermediate products imports;
c. strengthen the technology base and worker quality

## 2. PRESENT STATUS OF SUPPORTING INDUSTRIES IN THAILAND

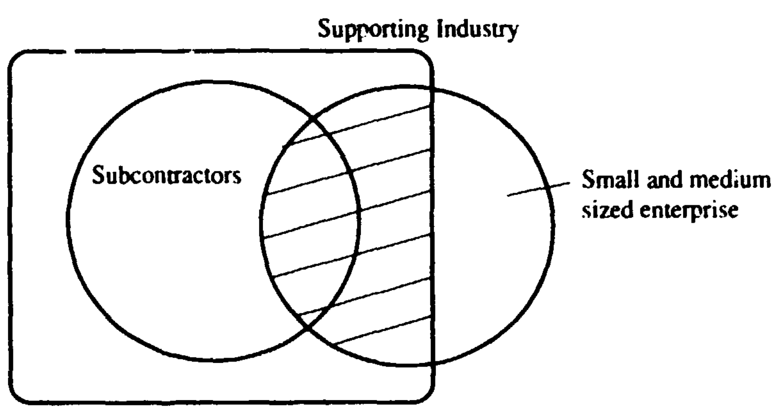
### 2.1 Present Status of Supporting Industries

### 2.1.1 Significance of Supporting Industries in Modern Industry

To transform from a lesser developed country to a newly industrialized economy, traditional small- and medium-sized enterprises (SME) must be drawn into the modern economy, so a clear division of labor is formed with large enterprises.

At present, SME[1] conduct few transactions with large enterprises or subcontractors. The "layer" of supporting industries for modern industrial sectors in Thailand is thin, and foreign-affiliated manufacturers obtain most of their inputs from imports or in-house production. Manufacturers with partial or full Japanese capital, for example, frequently procure from long-time suppliers which they have invited to set up operations in Thailand. Therefore, most Thai supporting industries are actually large enterprises in terms of number of employees. The largest portion of SME in Thailand have 10 of fewer employees. Only a few of the larger ones have sufficient capital and technology to act as supporting industries for larger manufacturers. Thus, Thailand's industrial structure is different than other countries, where supporting industries tend to be SME (See Fig. 2-1.). In this sense, the process of industrialization in Thailand is different from Japan, where programs for promotion of SME were closely related to those for supporting industries and subcontractors.

Figure 2-1. Conceptual Diagram and Definition of the Range of Enterprises Dealt With in This Section




Notes: Hatched portions represent enterprises targeted in this study.
Supporting industries: Supporting industries in this study refer to those producing parts and components for use in the final assembly processes of the automobile, machinery, and electronic manufacturing industries.
Subcontractors: Subcontractors in this study refer to enterprises in supporting industries which have long-term and stable transaction relationships with large enterprises

1 In this study, small- and medium-sized enterprises refers only to those involved in industry

Thailand's Ministry of Industry classifies SME by the following definitions:

| | Employees | Fixed assets |
|---|---|---|
| Household industry: | Less than 10 | less than 1 million Bahts |
| Small enterprise: | 10 to 49 | 1 to <10 million Bahts |
| Medium enterprise: | 50 to 199 | 10 to <50 million Bahts |
| Large enterprise: | 200 or more | 50 million Bahts or more |

This study chose policies which connect promotion of SME with those for supporting industries in modern industrial sectors such as electric, electronics and automobiles. These industries were chosen firstly because they involve a large number of parts and processes, entailing large participation by subcontractors.

Secondly, characteristics of those sectors in Thailand, notably the outsourcing of parts and components, make the Japanese-style industrial structure particularly suitable. Countries such as Japan and Taiwan have acquired their international competitiveness by establishing a division of labor with assembly manufacturers at the top, supported by reliable technology and the flexible production capability of supporting industries which can cope with diverse products. Where the electrical, electronics and automobile industries in Thailand already have Japanese and Taiwanese enterprises as their cores, a step by which Thai enterprises are incorporated in subcontract manufacturing is considered necessary if the industries in Thailand are to gain competitiveness through the most efficient use of foreign capital.

When small and medium enterprises are incorporated efficiently in the modern industrial sectors and function as supporting industries, backward linkages in the industrial sector would be improved. That should lead to a better division of labor and increased competitiveness. Therefore, development of supporting industries will lead to autonomous economic development of Thailand in the future through increased local manufacturing content.

Such development also has a significant social impact through a better distribution of income. In Thailand, where income disparities among different areas and industries is a major problem, development of SME into supporting industries is important not only for improving industrial efficiency, but as a mechanism to relieve social problems.

### 2.1.2 Current Problems Faced by Thai Supporting Industries

This section explores problems created by the rapid industrialization of Thailand in recent years, and the lack of accompanying maturation of SME.

The realignment of major currencies in the wake of the Plaza Accord in September 1985 caused a sharp deprecation of the Baht against the yen. in line with a similar move in the U.S. dollar. This boosted Thai exports, which grew 20.7% in 1986, compared to 10.3% in 1985.

Manufacturers from Japan, the U.S. and Asian countries seeking to maintain their international competitiveness increasingly looked to Thailand, creating a flood of new investment seeking lower-cost land and labor. Applications to the Board of Investment (BOI) of Thailand rose from 431 in 1986 to 1,058 in 1987, and 2,128 in 1988.

Exports grew 12% in the 1980-1985 period, with the benefit of foreign capital and government export promotion measures, while industrial production rose 25% from 1985 to 1989. The 1980s also saw a transition in the nature of exports, from a dependence on primary products to manufactured goods. The share of manufactured goods in Thailand's exports rose from 24% in the 1970s to more than

50% by the mid-1980s, largely due to growth of new products such as electric appliances, machine parts, toys, jewelry, and plastics. However, import dependency intensified as a result, worsening the balance of payments. The current balance deficit increased in 1987 and continued to increase to 1,655 million dollars in 1988 and 2,455 million dollars in 1989, much of which was Japanese goods.

Thailand's industrial trade deficits resulted from structural problems, requiring wide-ranging solutions. Taking advantage of abundant, low-priced labor, Japanese companies took mechanized processes and introduced them to Thailand as labor-intensive ones. These were mainly basic, assembly-type operations, though, and did not contribute to the creation of forward or backward linkages, nor the further development of indigenous Thai industry. If these problems continue, the trade deficit won't be solved and manufacturing will remain underdeveloped. Recent Thai government policy shows strong awareness of these problems and tries to address the problem of lacking industrial linkages.

Overpopulation in the Bangkok Metropolitan Area has been accelerated by the foreign investment boom in recent years, and will be an obstacle to the development of Thai economy unless countermeasures are prepared. In the Seventh 5-year plan, the Government of Thailand places an emphasis on local diversification of industry, and the BOI's promotion of investment in the "Third Zone" outlying areas has led to a shift of Japanese-affiliated electronics manufacturers to local areas in recent years. However, financial incentives for moving to local areas are not favorable compared to export promotion zones such as Laem Chaban, decreasing the effects of the diversification policy.

### 2.1.3 Policies of the Government of Thailand on Supporting Industries

(1) Seventh 5-year Plan

The Seventh 5-year plan places further emphasis on specialization in the industrial sector, following up on the Sixth 5-year plan. In the 7th plan, six industries-- petrochemicals, textile, electronics, agriculture-related industries, metals, and steel--have been selected as target industries. Many of these have a wide range of supporting industries, particularly textiles, electronics and metals. Recently, the Government of Thailand has focused more on long-term strengthening of the overall industrial structure, especially backward linkages.

(2) Tax Reform

The Government recognizes that its previous emphasis on import-substitution is still reflected in the tax system, despite the reorientation toward export promotion. The Ministry of Finance is now reviewing the tax system for each sector, planning to make drastic reforms. In addition, a reform of the corporate tax payment system and marginal rates are under examination. The introduction of a value-added tax (VAT) in January 1992 was one of the measures taken along these lines. A 7% tax is imposed on value-added at every stage from manufacturing to final sale for enterprises with annual revenues of 1.2 million Baht or more. Businesses with annual revenues of less than 600,000 Baht and others from selected sectors are exempt from the tax, while medium-sized firms with sales of 600,000-1.2 million Baht can choose between the VAT and the existing business tax.

(3) Other Policies

Local content regulations

Local content regulations are directly aimed at promoting growth of supporting industries through the imposition of financial incentives for local manufacturing. Practically, however, assemblers have two choices in their countermeasures against local content--in-house production or outside procurement--so such policies are not guaranteed to have the desired effect of fostering growth of supporting industries.

Policy of the Thailand Board of Investment (BOI)

BOI has traditionally adopted policies promoting only export-oriented industries. More recently, however, it has designated supporting industries as well for special treatment.

BUILD (BOI Unit for Industrial Linkage Development)

In order to promote the development of supporting industries, BOI established BUILD in 1990. The purpose of BUILD is to promote development of supporting industries through measures such as technical cooperation, information supply. BOI considers the electrical and electronic industries the most important sectors in promoting development of supporting industries. BUILD aims to achieve progress mainly through the market mechanism, by limiting its policies to existing local content regulations.

Projects now in progress include:

1) a computer data base on companies, including a directory of 800 supporting industries and 100 parts importers.

2) a pilot project producing substitutes for imported parts, in which foreign-affiliated manufacturers are encouraged to try local procurement for a limited time-period through suppliers introduced by BUILD.

## 2.2 Policy on Small and Medium Enterprises in Thailand

(1) Present Status of Small and Medium Enterprises in Thailand

Thailand does not have integrated laws regarding small- and medium-sized enterprises, not is there an independent institution whose central mandate concentrates on promoting small and medium enterprises development including policy coordinations among concerned ministries and agencies regarding this matter. Therefore, the definition of SME is not standardized, and definitions are made by various ministries as needed[1].

When looking at the ratio of SME in overall manufacturing in 1987, micro industries and small enterprises occupy 92%, with medium enterprises occupying slightly more than 7%.

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1 Currently, a new act is being prepared by Ministry of Indutry in order to solve this problem.

Table 2-1 Size Distribution of Thai Industrial Enterprises

| Employment size | By number of factories (%) | | By number of employment (%) | |
|---|---|---|---|---|
| | 1989 | 1987 | 1989 | 1987 |
| 1 - 9 | 64.0 | 64.1 | 10.7 | 12.9 |
| 10 - 49 | 29.0 | 28.1 | 27.9 | 23.5 |
| 50 - 199 | 5.3 | 7.2 | 21.7 | 20.6 |
| 200 - . | 1.7 | 0.6 | 39.7 | 43.0 |
| Total | 100% | 100% | 100% | 100% |

Source: Industrial Structure and Small and Medium Enterprise development in Thailand, Dr. Nattapong Thongpakde, NIDA, 1991

In 1989, there were 51,487 plants registered in Thailand. Only 893, or 1.7% had 200 or more employees, while 47,706, or 93%, had 50 employees or less. The key 50-200 employee group, which have sufficient managerial and technical skills to act as subcontractors for large domestic and foreign assemblers, represent 5.6% of the total, but the ratio varies significantly from industry to industry. While medium-sized firms occupy 18% of the textile and garment industries, the share of plastics is 6.1%, and only about 2% in machinery and metals, key sectors for export-oriented production[1]. Therefore, transforming small enterprises into medium ones is a key to developing supporting industries in modern industrial sectors such as electrical appliances, ]electronics and automobiles. When looking at the rate of increase in the number of enterprises by size, medium enterprises have the slowest growth rate.

Long-term, stable subcontracting transaction relationships are relatively new to Thailand, and are relatively few in number.

Small and medium enterprises are concentrated in the food processing, agricultural machinery, wood processing, printing, plastics, and clothing industries. Thai SME have a poor division of labor, and produce parts with poor quality, low competitiveness, and resulting receive low sales prices. Therefore, most of these cannot be principal parts for large-scale assembly,, and their importance in the industrial sector is not significant despite the large number of plants. This situation is different from Japan, where small and medium enterprises are contributing as subcontractors with specialized technology. This shows the importance of stable, long-term subcontractor relations based on technology, and not simply low-wage labor.

(2) Policies on Small and Medium Enterprises in the 7th 5-year Plan

As described above, improved distribution of income among industries and regions is one of the principal goals carried over from the 6th 5-year plan. Small and medium enterprises are looked upon for generation of employment, regional development, and redistribution of income. Policies from this plan are as follows:

Promotion of small and medium enterprises in this plan is basically characterized as "promotion of small local enterprises", seemingly disregarding the need for medium-sized supporting industries to promote fast-growing industrial sectors.

(3) Policy-making and Implementing Organizations for SME

1 Tetsuo Minato, "Development of Specialized Subcontracting Relations in Thailand," Seasonal Report on Small and Medium Enterprise, 1990, No. 4

The minimum investment amount eligible for privileges from BOI was lowered from 5 million to 1 million Baht to help promote SME. Applications for BOI incentives in this new lower range have been limited, however, because of the complexity of the application and the considerable time required for appraisal and decision.

The Ministry of Industry is the focal point for industrial development in Thailand. But given the role played by BOI and NESDB in the past, MOI's position is still evolving. MOI is empowered to grant factory licenses and restrict construction or expansion of factories, according to the domestic situation and competition.

For purposes of this study, MOI's key function is its responsibility for providing technical and management consultancy services to small and medium-sized firms through its **Department of Industrial Promotion (DIP)**. DIP's activities involve extension and training, and include key groups as follows:

- Industrial services offering technical information, extension, and advisory services in such areas as industrial engineering, industrial design, packaging, furniture, woodworking, ceramics and agro-processing industries.

- Metalworking and Machinery Industries Development Institute (MIDI), upgraded by Japanese assistance, provides support for technology improvement through consultation and courses on casting, welding, heat treatment, electroplating, machining, gear cutting, machine design, engineering and automation technology. UNIDO has provided technical assistance in the area of mold and dies. It also offers services for factory planning and layout.

Before the Anand government came to power, a textile policy committee worked to limit capacity in the textile industry. When Anand became prime minister, this policy was eliminated, and oversight functions shifted to the Textile Industry Division, whose functions include: a) training; b) quality testing of factory products; c) research and development; d) information on general economics applicable to textiles.

- At the regional and provincial level, the DIP is providing information and study reports on investment opportunities, and industry profiles.

- Through its entrepreneurship development program, a "package" of services are provided, including assistance in financial management, marketing, and general business assistance.

- DIP's previously provided financial assistance through the Small Industries Finance Office (SIFO), in the form of low-interest loans and operated a revolving fund scheme for cottage and handicraft industries. This office is being re-formulated into the Small Industries Finance Corporation of Thailand (SIFCT).

The Industrial Development Division (IDD) was established in 1991 by merging the Industrial Development Center, established with assistance from USAID, and the Rural Industry Information Service. However, the number of staff was reduced from 30 to 20 when the two centers were merged and this division is now suffering from a shortage of staff[1].

IDD is performing operations including: information supply to entrepreneurs, F/S service for investments, promotion of joint ventures, organization of seminars (for training of entrepreneurs, management, dispatch of overseas investment missions,). In rural areas, its industrial promotion activities are in cooperation with DIP's IPC.

The Metalworking and Machinery Industries Development Institute (MIDI) is an organization under DIP engaging in the promotion of small and medium enterprises. MIDI is endeavoring to improve metalworking technology through 1) technical training courses, 2) industrial testing service, 3) technical information service, 4) experiment and investigation activities, and 5) support for creation of organization among entrepreneurs.

Currently, there are two organizations which provide finance ("soft loans") to small and medium enterprises in Thailand--Industrial Finance Corporation of Thailand (IFCT) and Small Industries Finance Corporation of Thailand (SIFCT).

The IFCT is a public corporation engaged in general industrial financing and implementing foreign aid for SME. These funds are allocated for investment small and medium enterprises in rural areas under specific conditions attached by donors such as OECF and CIDA.

For enterprises located in northern areas with fixed assets of 200,000 Baht or less, a financing and stock investment project called the Rural Industrial Development Project (RIDP) has been established.

The IFCT is providing credit guarantee operations for small and medium enterprises through the SICGF (Small Industries Credit Guarantee Fund), which was established in 1985 by contributions totaling 2 million Baht from the Thai Bankers' Association, MOF, and IFCT itself. The SICGF will make up the deficiency of collateral when an enterprise applies for financing to a commercial bank or IFCT.

SIFCT has been reorganized and upgraded from Small Industries Finance Office in 1992. Although IFCT was previously sharing responsibility for financing for small and medium enterprises with SIFO (larger size loans), IFCT's role is expected to decrease since SIFCT has been established. In the 7th Five Year Plan, the Government of Thailand stated its intention to improve financing for the promotion of small and medium enterprises. Recently, IFCT has given its branches discretion to provide financing up to a set limit, in view of the Government's rural promotion policy. In addition, it established a Chaing Mai branch in 1991 to undertake banking operations for the northern four provinces.

The steep rise in land prices in the late 1980s has caused severe financing difficulties for SME. As financing amounts to small and medium enterprises have increased along with size of investments, collateral requirements have increased accordingly, causing problems for SME. The price of collateral as evaluated by commercial banks is 50% to 60% of its market price, and 70% by IFCT.

SIFO had been established in 1963 and provided financing for small enterprises under the control of the Industrial Development Division, Ministry of Industry. It defined "small enterprises" as "engaging in manufacturing, handicraft, and service industries with an asset size of less than 10 million Baht". SIFO made priority in financing decisions for improvements in quality and quantity, i.e. upgraded production equipment and new plants enabling mass production techniques. Loans to rural enterprises were particularly promoted.

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1 The number of staff of IDD has been increased to 32 since October 1st, 1992.

In 1990, financing totaled 182.5 million Baht, including both direct loans and those provided jointly with Krung Thai Bank. The loan period ranged from three to seven years, and about 15% of repayments were in arrears. Because of limited staff, consulting services were almost non-existent.

SIFO was positioned under the Industrial Development Division of the Ministry of Industry. Its position as a financial institution was not very clear, as it was neither under the control of the Ministry of Finance (as are ordinary financial institutions), nor had been established by law as a government-affiliated financial institution. Therefore, funds for small enterprises such as the Two-Step-Loan of OECF, which the SIFO should have received in ordinary cases, had flown into IFCT. Legal changes were therefore necessary to allow expansion of SIFO functions. Improvement of SIFO had been discussed for a long time and the establishment of SIFCT was approved for financing small enterprises as declared in the 7th plan. This newly established SIFCT operates under the authorization of both the ministries of finance and industry.

SIFO's greatest problem was a lack of funds to meet rising money demand, given a lack in capital increase since establishment. In 1991, disbursement of more than 60 approved loans was delayed until the new fiscal year.

Upon upgrading to SIFCT, the funds for financing has been increased by 15 million Baht, and the limit per loan has been increased to 2 million Baht.

Recently, the Government of Thailand has been trying to improve cooperation with the private sector through the creation of the "Government Private Cooperation Committee". Federation of Thai Industries (FTI), Chamber of Commerce, and Bankers' Association are the members of the private sector side and the Private Cooperation Division of NESDB is representing the government.

## 3. Supporting Industries in the Electrical, Electronics and Automobile Sectors

The electrical/electronics and automobile industries are expected to be the key sectors for Thailand's industrialization process, but these two sectors have had different histories of development in Thailand. For both industries, foreign capital, mainly from Japan, has played a central role since their emergence in the 1960s. While the electrical/electronics industry began to export at a relatively early stage of development since the early 1970s, the automobile industry has been highly protected, targeted at import substitution. As a result, each sector's supporting industries shows significantly differing development patterns.

For the automobile sector, development of parts industries have been controlled to some extent by the Government through localization policy. In the electrical/electronics industry, however, the top priority was to maintain international competitiveness. This was the only way for Thai policymakers to maintain comparative advantage over other ASEAN countries for attracting foreign-affiliated enterprises.

### 3.1 Present Status of Electrical/Electronics and Its Supporting Industries

#### 3.1.1 Present Status of the Electrical/Electronics Industry

(1) Overview

The share of the electrical/electronics industry in the total value added of manufacturing industries in Thailand was 3.24% in 1989, compared with 1.51% in 1970, 2.52% in 1980 and 4.08% in 1989. With an average growth rate of 28.5% during that period, this sector grew the fastest of all Thai industry.

Since the electrical/electronics industry began exporting in the early 1970s, the growth rate has been quite stable, averaging 48% from 1975 to 1988. In 1989, it ranked among Thailand's top five exporting industries. Since 1985, the share in IC production gradually decreased due to the investment of many foreign-affiliated enterprises and diversification of export items of the electronic industry.

There is no official data available, but based on estimates from BOI statistics, approximately 71,850 were employed in the electrical/electronics industry in 1990, one of the largest employment creators in Thailand.

(2) Industry Development and Change in Policy

Import-substitution Period (1961-1971)

The electrical and electronics industry in Thailand began in the 1960s with production of home electric appliances, following the announcement of BOI's electronics industry promotion policy. Since then, most investment in this industry has been made by Japanese enterprises. Although this industry grew together with the rapid expansion of the domestic market, Japanese-affiliated enterprises in Thailand, which played a key role, imported a large amount of parts and components, resulting in virtually no growth of supporting industries.

First Phase Export Promotion (1972-1981)

The Government's policy began with the Investment Promotion Law of 1972. Investment in export-oriented industries, including electrical and electronics, were actively promoted. IC manufacturers, particularly U.S.-affiliated enterprises, invested in Thailand in pursuit of a low-wage labor force and special tax incentives. The growth of the electric and electronics industry during this period was mainly dependent on mass production and export of ICs. Furthermore, this industry grew by expanding into new fields of assembly and packaging of electronic components. Also in this stage, neither subcontractors nor supporting industries showed any notable development. A large portion of the components of principal export-oriented products, particularly ICs, were dependent on imports.

Second Phase Export Promotion (1982-1985)

During this period, the Government made increasing efforts for export promotion. The total amount of foreign investment approved by BOI in the electric and electronics industry during these 5 years exceeded total foreign investment during the preceding 20 years.

Further, domestic production of many types of electronic components was initiated during this period, mainly through in-house manufacturing. Import of principal components continued.

Recent trends (1986-1990)

Following appreciation of the Japanese yen and Taiwanese dollar in the wake of the Plaza Accord, foreign investment from Japan and Asian NIEs (including Taiwan) significantly increased in Thailand. Major products covered a wide range of export-oriented products, including microwave ovens, VCRs, floppy disks, electronic clocks, printers, computer parts and components. As a result, export of computer-related products increased rapidly from 26.8 billion Baht in 1989 to 38.7 billion Baht in 1990, replacing ICs with the largest share of electric/electronic exports.

As exports increased, Japanese-affiliated assemblers started to outsource some parts formerly produced in-house. In most cases, this shift was achieved by inviting their Japanese subcontractors to setup in Thailand, or by organizing a new group of subcontractors.

But as demand for components outstripped production capacity, the above-mentioned subcontractor groups could not meet all of exporters' needs, and mass production of lower-tech plastic and metal parts has gradually shifted to local Thai enterprises. Among the enterprises of supporting industries formed in this way during this period, many of those affiliated with enterprises of NIEs such as Hong Kong are included as well as those of Japanese-affiliated subcontractor groups.

At the same time, those enterprises which had formerly exported components began to produce for export-oriented final products assembled in Thailand. It is estimated that more than 200 enterprises, ranging from small locally-owned, to large foreign-affiliated firms, are now operating as supporting industries for the electric and electronics industry, producing items such as metal components, plastic components, wire components, PCBs, ICs, and stepping motors.

### 3.1.2 Present Status of and Problems on Local Parts Procurement in Thailand

(1) General Considerations from Investigations

The following is based on interviews by the study team with 25 Japanese-affiliated manufacturers in Thailand (5 assemblers, 20 subcontractors).

a. Summary of interviews with Japanese-affiliated enterprises

1. Reasons that Japanese-affiliated enterprises and local supporting enterprises make transactions with each other are as follows: for assemblers 1) prices are low and 2) stable supply is assured, and for subcontractors 1) amount of orders is stable and 2) technical assistance can be received.

2. In the case of the electric and electronics sector in Japan, not only small and medium enterprises but also large enterprises manufacture and supply parts, functioning as supporting industries. General-use components such as capacitors and chips are mainly produced by large capital-intensive enterprises which benefit from economies of scale. In Thailand, it is difficult to reach sufficient volumes in general-use components, so demand for components depends on imports.

3. Although there is no problem in quality in general on plastic works and press works, etc. as those materials are imported from Japan and produced by Japanese equipment, there are some problems in metal working, etc.

4. Local production is promoted for reasons of 1) reduction of costs, 2) indirect regulations for promoting local production, 3) reduction of lead time

5. Engineers and foreman class personnel are in shortage. Personnel management and skills, development within the organizations is difficult due to constant shortage and frequent job-hopping.

6. Although guidance for subcontractors is provided through the dispatch of engineers from the customer, many cases exist where technical levels decline after the engineers have left. Difficulty in acquiring technologies as well as shortage of managing engineers are serious problems. For those technologies not held by the foreign parent companies, sometimes engineers are dispatched from parts vendors. In addition, engineers tend to keep the technology secret and do not disseminate to their organization in order to maintain value-added.

7. Lack of information about vendors is a serious problem.

b. Summary of surveys on Thai supporting industries through interviews and questionnaires

1. Half of the enterprises surveyed rely on import as sources for 80% or more of their materials and components. However, two enterprises were procuring more than 50% of material from the original contractor in Thailand.

2. Half of the enterprises surveyed were selling 80% or more of their products to foreign-affiliated enterprises and joint ventures with foreign capital in Thailand. Of these enterprises, two were clearly under a subcontractor contract with other enterprises, and both of them were selling products to more than one foreign-affiliated manufacturer, including Japanese-affiliated manufacturers.

3. Merits of having transactions with foreign-affiliated enterprises were stable orders (3 companies) and availability of technical assistance from the customer (2 companies). These enterprises seem to place emphasis on relatively continuous transactions with assemblers. On the other hand, those enterprises which have no such continuous transactions have a problem with unstable orders. Enterprises which already have transactions with foreign-affiliated enterprises are seeking to continue.

4. In terms of the sources of machinery, eight enterprises answered that they rely on import in some form (direct or indirect).

5. With respect to the problem of organization, six enterprises were members of FTI but only one enterprise was a member of an industrial association of electrical and electronic parts manufacturers.

6. Majority of the enterprises surveyed answered that a benefit presently obtained from the association is the information collection function including communications with other enterprises. Some enterprises pointed out the importance of technical instructions (3 companies) and the lobbying functions with government (2 companies).

7. As for sources of finance, a majority of the enterprises surveyed are financed from commercial banks. Some enterprises of relatively large size were procuring funds through capital increases (3 companies). Only one company answered that it is being financed by a company affiliated with Thai capital.

8. As for the present policies of the Government of Thailand for small and medium enterprises that are beneficial, an overwhelming majority of enterprises cited the reduction of import duty on machinery (7 companies) and some companies cited information (3 companies) and training of workers (3 companies).

9. As for present difficulties in performing business, an overwhelming majority of enterprises cited problems of employment of workers from various reasons such as the problems of job-hopping (6 companies), labor-management relationships (3 companies), and the rise in labor cost (3 companies). Further, competition with other companies (4 companies) and problems in acquiring technology (5 companies).

## 3.2 Present Status of the Automobile Sector and its Supporting Industries

### 3.2.1 Present Status of the Automobile Industry

(1) Overview

a. Amount of value added in the whole manufacturing industry

Automobiles have been fostered as a typical import-substitution industry, and more than 20 foreign-affiliated assembly plants have been operating with Government protective policy. Although the number of units sold decreased until 1988 after reaching 110,000 in 1983, 304,000 units mainly consisting of commercial cars were sold in 1990 (with a growth rate of 46% against the previous year) deeply related with economic boom in Thailand from 1988 to 1990. When looking into the breakdown of the vehicles sold, the weight of commercial cars is overwhelmingly high as 80%, while that of passenger cars was only 20%. About 70% of commercial cars were occupied by pickup trucks. The share of Japanese cars sold was overwhelming, at 94.7%, and even higher for commercial vehicles, at 99.4%.

The 13.68% of growth in value- added during from 1970 to 1989 has made automobiles one of Thailand's most important manufacturing sectors. Furthermore, the average annual growth rate for the whole automobile industry, including assembly, manufacture of two-wheel vehicle bodies, and other two-wheel vehicles, was 11.80% during the same 20-year period. That was higher than the transport equipment industry (10.61%), overall manufacturing (9.39%), or the economy as a whole (7.11%).

b. Transition to Export-Orientation

Because of the Government's import-substitution policy for cars, Thai auto exports were negligible until 1987. In 1987, 487 passenger cars worth 69.4 million Baht, and 21 commercial vehicles worth 5.8 million Baht, were exported through export promotion measures. In 1988, exports rose sharply to 15,152 passenger cars valued at 2,006 Baht, and 160 commercial vehicles worth 20.6 million Baht. However, exports decreased in 1989 (passenger cars: 1,330.7 million Baht, commercial 8.55 million Baht).

Export of automotive parts such as safety glass, mirrors, and other accessories, however, showed steady growth in 1989, with growth almost triple the previous year. Total automobile industry exports were 5,381 million Baht in 1988 and 6,342 million Baht in 1989, but that is still extremely low compared to electric and electronics. Despite measures such as local content regulations and prohibitions on imports of complete built units (CBU), Thai's trade deficit in the automobile sector remains.

(2) Development of the Automobile Industry in Thailand

a. Initial development stage: 1961 to 1968

The automobile industry in Thailand emerged with assembly of imported knockdown (CKD) kits, initiated by several joint ventures following tax incentives contained in the , as well as import duties placed in 1962. Production gradually progressed to semi-knockdown parts and components.

In the beginning, supporting industries consisted only of simple metal and non-metalworking. Other enterprises, except the joint ventures, were merely engaged in production of spare parts by "copying", without any appropriate technical guidance or quality control systems.

During that period, the automobile assembling industry developed in connection with the development of highway networks and economic growth in general. Assembly plants continued production activities under careful production measures, such as import duties.

b. Period of active management by the Government: 1969 to 1977

The Automobile Development Committee was established in 1969 and the Government stated positive measures to develop the automobile industry. Regulations on the number of assembly plants, local content, and the number of passenger car models, were enacted under the new policy announced in 1971, and domestic production of 25% of automobiles was imposed in 1972.

Most of the parts assembled domestically during that period were peripheral ones such as starters, alternators, filters, exhaust gas tubes, radiators, and safety glass. During that period, through enforcement of local content regulations, automobile assembly manufacturers in Thailand were urged to raise the domestic procurement ratio of parts, regardless of the growth of local parts manufacturers. There was large demand for metal parts (casting, machining, stamping, welding, plating, and heat treatment), and few casters among Thai enterprises able to produce such parts with sufficient quality control. Therefore, Japanese-affiliated assembly manufacturers took measures which could promote local procurement of parts by imposing conditions on local parts manufacturers in Thailand so they could improve product quality under a licensing agreement with a parts manufacturer from a developed country. Most cases of the establishment of Japanese-affiliated parts manufacturers in Thailand in 1970's took the form of joint venture, while technical cooperation agreements have been dominant since the early 1980s.

c. Period of policies for promoting domestic production: 1978 to 1986

No large effect was expected from the regulation for domestic production enforced in 1972 because they were not accompanied by regulations on imports. Therefore, in the new policy for promoting domestic production enacted in 1978, prohibition of import of complete passenger cars and large buses were imposed first. Further, in addition to the rise in import duties on other complete cars and parts, duties gradually raising local content ratio to 50% over 5 years from 1978 for passenger cars and from 1979 for commercial vehicles, were imposed to promote local production of parts.

In association with the increase in demand for a diversified range of high-quality parts, manufacturers in existing supporting industries achieved major progress in both quality and diversification of product lines. Among others, the technology of casting and machining achieved the largest development.

Owing to the development of supporting industries in the fields of metal, plastic and rubber products, complete production and assembly of several non-core system in Thailand became possible. These systems included exhaust systems, brake systems, fuel systems, suspension systems, lighting systems, stamped parts and their assemblies, and cutting of trims. It is considered that technical cooperation with Japanese-affiliated parts manufacturers which developed in the 1980s played a role for the development of supporting industries.

d. Period of rapid economic growth: 1987 to 1990

During this period, the Government of Thailand exerted efforts for promotion of exports. In 1988, MMC Sittipol, a joint venture with Mitsubishi Motor Co., Ltd., succeeded in exporting to Canada under the brand name of Mitsubishi for the first time

On the other hand, the domestic market was kept carefully protected. The regulations for local content were continuously intensified together with the prohibition of import of passenger cars of 2,300 cc or less and prohibition of the establishment of new assembly plants.

During this period, while existing enterprises mainly consisting of joint ventures between Japanese and Thai enterprises producing principal components continuously grew, there were no new participants in the market. As for those important components such as engines, transmissions, rear axles, and steering systems, imports in the form of CKD kits continued. However, many parts and components started to be manufactured domestically mainly under license.

During this period, Thai enterprises improved their technology of casting and machining, in particular. However, few Thai enterprises have reached a high technical level, and the supply of parts was not able to meet the increasing demand. Therefore, foreign-affiliated enterprises in the field of casting, heat treatment, stamping, casting, machining were established successively.

e. Recent trends

In Thailand, import of complete cars has been virtually forbidden since 1978. The reduction of imported duties as approved by the Cabinet in July 1991 was 180% to 60% for complete cars of less than 2,300 cc and from 300% to 100% for cars of 2,300 cc or more. Further, the import duty for CKD parts was reduced from 112% to 20%.

The automobile assembly industry in Thailand strongly resisted these actions for the reasons that prices of cars produced in Thailand will be kept high as long as the regulations for local content are in place, and the liberalization of import of complete cars will be crucial for the industry.

As can be seen from the above resistance of the automobile industry, local content regulations imposed on automotive parts were an industry protection policy of the Government of Thailand that was functioning in combination with protection of the domestic market. Therefore, it is inevitable that serious problems occur when the government maintains liberalization of import of complete cars on one hand and maintenance of local content regulations on the other hand.

To secure the means for developing parts industries in these circumstances, parts production must be performed in a market large enough to generate economies of scale. Therefore, it is expected that the division of labor within the ASEAN area for each automobile manufacturer will further develop in the future. Movement toward the production of "ASEAN cars" is partly started in accordance with the "Memorandum on automobile industry interpolation plan in the same brand" signed in 1988. The memorandum provides the incorporation of a list of certain parts into the rate of local content and reduction of import duties. Such manufacturers as Mitsubishi Motor Co., Ltd. and Nissan Motor Co., Ltd. have started these diversification within the ASEAN region.

As described above, the development of parts makers in the automobile industry has been promoted by the initiative of assembly manufacturers under local content regulations. However, after the liberalization of import of complete cars, it can be said that the automobile industry in Thailand is standing on a new stage. When considering the relation with the promotion of supporting industries, it is a problem of how to integrate the two policies of local content regulations and abolition of market protection, which go toward opposite directions in principle, including the manufacturing diversification strategy within the ASEAN area.

### 3.2.2 Present Status of Local Parts Procurement in Thailand

(1) General Considerations from Investigations

a. Summary of interviews with Japanese-affiliated enterprises (assemblers), based on 18 companies (3 large assemblers and 15 subcontractors).

1. The reasons for transactions between Japanese-affiliated enterprises and local supporting enterprises are 1) lower price and 2) stable supply for assemblers and 1) stable amount of orders and 2) availability of technical support for subcontractors.

2. Although most subcontractors in Japan are small and medium enterprises, they do not necessarily consist of small and medium enterprises alone in the case of the automobile sector in Thailand. This is because many automotive parts are common to those products of other competitive enterprises and economies of scale exist.

3. There are such enterprises that have become subcontractors for parts manufacturer starting from a small repair shop on the street. Although there are 5 to 6 subcontracting stages in Japan, there are only primary and secondary stages in Thailand.

4. There is no problem in quality in general on plastic working and press work, because they use the imported materials and manufacturing equipment from Japan. However, there is some problem in metal working.

5. Local production is promoted for the reasons of 1) reduction of costs, 2) indirect regulations for promoting local production, 3) reduction of lead time.

6. There is a shortage of engineers and foreman class in personnel. Due to this shortage, enterprises tend to hire these personnel from other companies. However, Japanese-affiliated enterprises in the automobile sector, which have been established in Thailand for a long time, avoid competing against each other for engineers and foremen, even if they are in shortage. There are some cases which the enterprises employ people from Japanese affiliated enterprises of other sectors. There is no shortage of non-skilled workers.

7. The fall in prices of complete cars due to the reduction of import duties on complete cars weakens the competitiveness of locally produced cars. If this situation continues, it is possible that locally produced cars will be wiped out by Japanese cars. Furthermore, parts industries, will be damaged seriously.

8. Although guidance for subcontractors is given by dispatching engineers, there are many cases where the technical level lowers after those engineers have been left. Therefore, the difficulty in rooting and footing technology and shortage of managing engineers are a large problem.

9. There is a problem of insufficient information of vendors; information from Japan as to who are producing what items in what quality is insufficient.

b. Summary of surveys on Thai enterprises of supporting industries (451 questionnaires sent, with 90 replies)

1. About half of the enterprises surveyed relied on import for sources of 80% or more of their material and components.

2. A majority of the enterprises surveyed were selling 50% or more of their products to foreign-affiliated enterprises. About half of the enterprises surveyed cited that in these 2 or 3 years the sales of Japanese-affiliated enterprises to local Thai enterprises have increased.

3. As a merit of transactions with foreign-affiliated enterprises, about 70% of the enterprises surveyed cited stable orders and about 30% of them cited availability of technical assistance from foreign-affiliated enterprises as customers. Although there are some difficulties in transactions with foreign capital such as strict deadlines and a high level of requirement for quality, these do not work as factors to avoid such transactions. On the contrary, positive attitudes can be seen among Thai enterprises of supporting industries that they intend to develop themselves through doing business with foreign-affiliated companies.

4. For the sources of machinery, from the fact that more than 60% of the enterprises surveyed answered that they were relying on either direct or indirect import for 60% or more of their machinery. It can be seen that they are in a state where introduction of imported machinery is necessary to produce such products that can meet the quality requirement level of foreign companies.

5. Association membership is increasing. Sixty percent of the enterprises surveyed were members of the Thai Auto Parts Manufacturers Association or the industrial club of FTI. As for benefits obtained from industrial associations, an overwhelming majority of the enterprises surveyed cited information exchange and communications with other enterprises. It can be seen that they are aware of the importance of updating their information. Further, the expectation on industrial associations is also considerably high in the aspect of technical knowledge provision.

6. As for financing, an overwhelming majority of enterprises surveyed are financed from commercial banks.

7. As for the present policies of the Government of Thailand for small and medium enterprises that are beneficial, 60% of the enterprises cited the reduction of the import duty on machinery and almost 50% of enterprises cited the importance of information.

8. As for problems in performing business, about the same number of enterprises which pointed out the difficulty in the problems of job-hopping pointed out the ambiguity of taxation and policy of the government. Many enterprises had a critical view on the confusion caused by the reduction of import duties in association with the liberalization of import of passenger cars of less than 2,300 cc in 1991. As for "the enforcement of fair taxation systems", many enterprises expressed that the government should take cautious steps for the implementation since the taxation system would determine the future of the automobiles in Thailand.

## 4. PROBLEMS AND RECOMMENDED PROGRAMS AND ACTION PLANS

### 4.1 Problems of Supporting Industries in Thailand

Taking into account interviews, surveys and available reports related to supporting industries the following is a brief summary of problems faced:

1. shortage of supplier

2. quality problems, especially in metal processing and some high-tech components.

3. because of limited demand, economies of scale cannot be achieved in some products.

4. manpower shortages, notably in foreman and engineer class.

5. information shortages for assemblers and suppliers.

6. insufficient technology to produce some products

7. poor financial resources.

8. high land costs and shortage of suitable location for supporting industries

9. inadequate institutional capabilities in private sector and government;

The source of these problems include the following:

1. limited number of supporting industries with technology and quality to work with modern industries.

2. rapid expansion of assembly-type industries during the last several years, requiring large volumes of parts and components

3. large numbers of new products are being exported, requiring stricter quality control and delivery times

4. rapid economic growth created shortages of skilled and semi-skilled labor, especially for supporting industries

5. introduction of new products requiring technology and materials not available or difficult to acquire

6. rapid economic growth and Government industrial location policy have pushed up land prices and decreased supply of suitable land for supporting industries

### 4.2 Urgent Need to Strengthen Supporting Industries

The Thai private sector and government have come to recognize the importance of developing supporting industries, notably for the following: reduction of imports; improved technological base; expansion of skilled labor; and creation of employment. With an overall increase in manufacturing, more and more products will achieve economies of scale to justify domestic production.

Promotion of supporting industries will require a number of well-coordinated programs conducted by various ministries over a long period of time. The programs must include:

institutional building

information services

consulting and training

financial incentives

infrastructural development/environmental protection

### 4.3 Recommended Programs and Action Plans[1]

In order to promote supporting industries in Thailand, the following special programs and actions plans are likely to be required by both the government and the private sector. Foreign technical assistance, bilateral and multilateral, may be justified. To achieve best results, a comprehensive approach directed from a single command is necessary. Specific actions are as follows:

Step 1: Set up special unit for promotion of supporting industries in DIP. This unit should serve as a secretariat for a coordinating committee consisting of concerned agencies such as BOI, IFCT, SIFCT, IEAT, and MIDI[2].

Step 2: Start a comprehensive Supporting Industry Promotion Program under guidance of committee.

Step 3: Carry out action-oriented program study to identify sub-sector products for technical assistance.

Step 4: Action plans in critical areas should be implemented by concerned agencies under guidance of the committee without waiting for results of the overall study.

Key action plans should include:

a. institutional building (i.e. creating industrial clubs for sub-sectors not currently organized by MIDI)

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1 These recommended programs and aciton plans are rough ideas. Final programs and action plans should be further developed by concerned ministries and agencies.

2 Although zero growth policy on staff number exist in Thai Government,, promotion of suppoorting industries is very important and additional staff should be allocated for this task.

b. strengthening of information collection/matching of suppliers, assemblers (Thai-Thai, Thai-foreign)

c. technological upgrading, skill training (skill training at MIDI in such areas as die-casting and electroplating, joint pilot production for new products impossible for a single company, consulting services by MIDI, DIP, technical cooperation by foreign assemblers)

d. financial incentives for supporting industries (entry to BOI promotion scheme, use of SIFCT, IFCT loan programs

e. provision of suitable industrial-use land (IEAT industrial estates designed for supporting industries, relocation programs from BMA to outlying zones)

#### 4.4 Timetable and Necessary Resources

Establishment of the special unit and committee should begin immediately. The study on supporting industries is estimated to require 40-50 man-months, and will likely require foreign technical assistance. Action plans can start along the lines of existing programs, with some additions and/or modifications.

This program should emphasize the use of existing resources to the extent possible, but in addition, will require the following: 1-2 people at DIP to coordinate the program; a small budget for running the committee and coordination activities; 1-2 foreign experts for 2-4 years to advise the program and technical assistance to provide the supporting industries study, plus grant aid for equipment provided to MIDI.

Time Table for Supporting Industry Promotion Program (SIPP)

| | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| 1. Establishment of Special Unit at DIP and Committee for Supporting Industry | ..... | ............... | ............... | ............... | ............... |
| 2. Programme Study | | ............... | ......... | | |
| 3. Action Plan | | | | | |
| 3.1 Institution | | ....... | ............... | ............... | ............... |
| 3.2 Information | | ....... | ............... | ............... | ............... |
| 3.3 Training | | ....... | ............... | ............... | ............... |
| 3.4 BOI Incentive | | ....... | ............... | ............... | ............... |
| 3.5 Industrial Estate for Supporting Industry | | ....... | ............... | ............... | ............... |

# Volume I
# Part II Pre-investment Studies of two Sub-sectors

## INTRODUCTION

Based on the Terms of References (TOR), during the initial inception period, selection of the two sub-sectors to be studied as opportunity and pre-feasibility studies was carried out from the five broad categories which had been agreed upon between UNIDO and the Thai Government. The five broad sectors include;

(1) metal products,
(2) plastic products,
(3) machinery (automobiles and electronics),
(4) textile/garment, and
(5) wood/wood products.

From the five broad categories, the consultants proposed (1) electroplating and (2) pressure die casting for opportunity and pre-feasibility studies. These two sub-sectors were selected based on criteria such as;

(a) supporting high growth manufacturing sectors,
(b) relative size of the companies engaged,
(c) growth potential in the future,
(d) environmental assistance needed,
(e) employment creation, and
(f) foreign currency earning.

Tripartite meeting among the Department of Industrial Promotion, Ministry of Industry, UNIDO and the consultants was held on 29, January 1992. In the meeting, the Department of Industrial Promotion proposed that electroplating sub-sector should be expanded to surface treatment so as to include other process such as metal coating on plastic and ornaments besides the traditional electroplating on metal only. Finally, all of the parties agreed to select (1) surface treatment and electroplating, and (2) aluminum die casting.

Following this introduction section, "Opportunity Study on Surface Treatments and Electroplating" is presented in Chapter A, and "Pre-feasibility Study on Aluminum Die Casting" in Chapter B.

**Volume I**
**Part II Pre-investment Studies of two Sub-sectors**
**A. Opportunity Study on Surface Treatment (Electroplating)**

Table of Contents

## Introduction

Strong economic growth in Thailand has led to a large increase in foreign investment and manufacturing, but supporting industries have not kept up with such a trend. As a result, larger manufacturers, especially those with foreign capital, are forced to conduct certain operations in-house, despite higher costs.

Electroplating is a supporting industry which has wide application in a variety of different manufactured goods, ranging from automobiles to electric and electronic products. Based on a number of interviews with users of electroplated items, demand exists for high-quality, price competitive specialist plating shops in the industrial rim around Bangkok. Stricter environmental protection standards and rising prices in central Bangkok have forced the closure of many electroplating plants, creating additional business opportunities for new entrants.

This section has two parts: an opportunity study outlining the estimated costs and potential revenues from opening a metalplating shop; and an industrial survey discussing the plating sector in general, current conditions in Thailand, and potential applications. The industrial survey was created in response to a request from the Thai counterpart, in discussions with the Study Team and UNIDO.

# Opportunity Study on Surface Treatment (Electroplating)

## 1. Summary

The opportunity study concerns a five-line plating factory with 32 employees, 25 of whom would be directly involved with production. While demand varies for the different types of plating, an integrated approach can offer full-service to customers, which should be an added promotional tool. The five lines include: Cu-Ni-Ni-Cr, zinc, anodizing, hard chrome and ABS plastic.

The suggested location is an industrial estate 30-50 kilometers southeast of Thailand. Initial investment requires 49.134 million baht, including land, buildings, pre- and post-treatment equipment, and the plating lines. Fixed costs total 9.432 million baht per year, while variable costs would total 155.456 million at a 100% operating rate.

Operation would begin after a six-month construction period, starting at 50% capacity and gradually rising to 80% in year 5.

The internal rate of return is 25% based on a 10-year cashflow period.

## 2. Project Background

The idea to prepare an opportunity study for electroplating derived out of the overall program to support supporting industries in Thailand. Electroplating was selected along with diecasting because of its wide applicability in a number of industries. The stimulation of a high-quality, competitive electroplating industry will benefit a variety of upstream industries, and contribute to lower costs at large-scale companies which are now conducting the process in-house.

## 3. Market Analysis

### 3.1 Thai Industrial Growth

Underpinning the demand for supporting industries such as electroplating has been the overall strong growth of the Thai economy for the last several years. According to statistics from NESDB, key sectors such as machinery, electrical machinery and transport equipment posted growth of 14.7%, 18.4% and 26.8%, respectively, in the 1985-1989 period. For the 1992-1996 period covered by the Seventh Five-year Plan, the government forecasts annual industrial growth of 9.5%.

### 3.2 Electroplating

Electroplating is used in a wide variety of industries such as automobiles and electronics, and given the lack of a distinct product, it is difficult to precisely ascertain the size of the market. It is estimated there are some 400 shops engaging in electroplating currently, although only 136 of these are registered as such with the Ministry of Industry. A MOI survey in 1985 found 200 plating shops, although the margin of error was 25-50%.

Based on anecdotal evidence, many plating shops appear to be located inside larger-scale manufacturing enterprises. Because of the low technology of the plating industry in Thailand, many manufacturers say they are forced to conduct the work in-house, despite the higher production and environmental protection costs. If outside alternatives were available, many companies say they would subcontract their plating work.

In addition, stricter environmental protection standards and rising costs have forced many plating shops in the Bangkok Metropolitan Area to close recently, thus creating more opportunities for new businesses outside of the BMA.

Given small local production, demand for ABS plastic plating is expected to be particularly strong.

## 4. Plant Capacity

The plating operation will consist of five lines housed within a plant with floor space of about 550 square meters, on a plot of land of 1,100 square meters:

1. Cu-Ni-Ni-Cr: requires six workers, and produces 150 square decimeters per 30 minute batch.

2. Zinc: requiring six workers, but each 30 minute batch produces 300 square decimeters.

3. Anodizing: five workers, 30 minutes per batch, 300 square decimeters per batch.

4. Hard chrome: three workers, 8 hours per batch, 200 square decimeters per batch.

5. ABS plastic: 10 meters, five workers, 1 hour per batch, 300 square decimeters per batch.

After the six-month construction period, production will rise to 50% of capacity in the second six-months, 80% in the second year, and 85-90% thereafter.

## 5. Materials and Inputs

Production costs for electroplating are roughly split between (chemicals) and electricity and water. Prices in bahts per unit (1 square decimeter) for each line are as follows:

| Line | raw materials | electricity/water |
|---|---|---|
| 1. Cu-Ni-Ni-Cr | 16 | 24 |
| 2. Zinc | 1.6 | 2.4 |
| 3. Anodizing | 14 | 21 |
| 4. Hard chrome | 160 | 240 |
| 5. Abs plastic | 40 | 40 |

## 6. Location

The electroplating factory should be conveniently located near customers, which makes the southeast region of Thailand, within 30-50 kilometers of Bangkok the most appropriate area. In particular, the industrial estates of Lat Krabang, Bang Poo and Bang Natra would provide good locations near many potential customers. Land is estimated to cost 940 baht per square meter, while building construction costs are assumed to be 20,000 per square meter.

## 7. Project Engineering

In general, plating is conducted in three stages:

1. pre-treatment (polishing, rust removal, degreasing, activating
2. plating
3. post-treatment (corrosion-resistance, drying, inspection)

To create nickel-chrome plating on ferrous materials, the following sequence is followed:

1. degreasing
2. washing
3. acid washing
4. washing
5. drying
6. substrate buffing and polishing
7. alkaline degreasing
8. washing
9. electrolytic degreasing
10. washing
11. weak-acid pickling
12. washing
13. neutralizing
14. copper striking
15. washing
16. shiny copper plating
17. washing
18. nickel plating
19. washing
20. washing
21. chrome plating
22. washing
23. drying

In addition to the five plating lines, the list of necessary equipment includes items for pre-treatment and wastewater treatment. The plant operator must abide by the national and local environmental pollution guidelines applicable to the particular location.

## 8. Organizational Structure

The five lines require a total of 25 workers. The management will consist of a president, factory manager, two administrative staff who will handle marketing and quality-control, two clerical workers and a driver/maintenance person.

Maintenance costs are estimated at 10% of equipment investment, while insurance is estimated at 3%. There are no property taxes.

## 9. Manpower

A total of 32 employees will be needed, of which 25 will be production. Annual costs are as follows:

| Category | Number | Monthly Total |
|---|---|---|
| plating lines | 25 | 3,000 |
| factory manager | 1 | 30,000 |
| administrative | 2 | 15,000 |
| clerical | 2 | 5,000 |
| driver/janitor | 1 | 3,000 |
| president | 1 | 60,000 |

## 10. Project Implementation

Before implementation, a more detailed feasibility study will be necessary, to assess costs at the actual site and more specifically determine market rates for plating. Financing for the electroplating operation will be evenly split between local equity and loans. Construction of the plant is expected to take about six months. About one month before expected completion, hiring of workers should take place. Following the completion of construction, will be about one-month of training and trial production. For the next five months, production volume should rise to about 50% of capacity. After that, the operating rate will gradually rise, reaching 80% in year 5.

| Year | Operating Rate( average) |
|---|---|
| 1 | 25% |
| 2 | 50 |
| 3 | 60 |
| 4 | 70 |
| 5 | 80 |
| 6 | 80 |

## 11. Financial Evaluation

### 11.1 Initial Investment Costs

Initial investment costs are estimated at 49.134 million baht (US$1.95 million), including land, buildings, production and treatment equipment and pre-production expenditures. It is assumed that there will be little difficulty in obtaining sufficient land within an attractive industrial estate.

| | Item | unit price | # of units | cost |
|---|---|---|---|---|
| | LAND (m2) | 0.94 | 1,100 | 1,034 |
| | building (m2) | 20.00 | 550 | 11,000 |
| | pre-product | 100.00 | 1 | 100 |
| machinery | cu-ni-ni-cr | 6,600.00 | 1 | 6,600 |
| | zinc | 7,000.00 | 1 | 7,000 |
| | anodizing | 2,000.00 | 1 | 2,000 |
| | hard chrome | 3,000.00 | 1 | 3,000 |
| | abs plastic | 3,000.00 | 1 | 3,000 |
| | pre-treatment | 1,000.00 | 1 | 1,000 |
| | test/quality | 700.00 | 1 | 700 |
| | waste water | 11,200.00 | 1 | 11,200 |
| | testing | 2,500.00 | 1 | 2,500 |
| total | | | | 49,134 |

### 11.2 Working Capital

Working capital consists of three months of fixed costs plus the three months of variable costs multiplied by the operating rate. Working capital will begin at 12.074 million baht and rise to 33.449 million at 80% capacity in year 5.

### 11.3 Production Costs

Full capacity is assumed to consist of five lines operating eight hours per day, 280 days per year, with 25 production workers and seven management/support staff. Under these conditions, variable costs including raw materials, energy and water would total 155.456 million baht, and fixed costs, including salaries, maintenance and insurance will total 9.302 million. Maintenance is estimated at 10% of equipment investment, and insurance is 3% of depreciable fixed assets. Depreciation will run seven years for equipment and 20 years for buildings and is calculated on a straight-line basis. Corporate income tax is 35% of gross profits.

### 11.4 Source of Funds

The initial investment will consist of 50% equity, or 24.57 million baht, with a matching amount to come from a seven-year domestic baht loan carrying a one-year grace period and 13% interest rate.

11.5 Cashflow/Income

As electroplating products do not have standard market prices, an assumption was used to add a margin of 10% above the total of fixed and variable costs, depreciation, and interest payments. Using such assumptions, the project would have a net cash outflow in the first year of 39.984 million baht in the first year, and would turn positive in the second year, at 9.683 million. Net income, however, would be positive from the first year, at 3.314 million baht, then rising to 14,291 million per year in the ninth year.

11.6 Internal Rate of Return

Assuming the entire initial investment as equity, the project would generate an IRR of 25% over a 10-year period.

| cashflow statement | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| time (years) | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| cash inflow | fin resources | 61,208 | 9,716 | 3,886 | | | | | | | |
| | revenue | 56,084 | 109,380 | 126,520 | 143,600 | 160,681 | 160,681 | 160,681 | 160,681 | 160,681 | 160,681 |
| cash outflow | initial invest | 49,134 | 0 | | | | | | | | |
| | operating cos | 43,580 | 87,160 | 102,705 | 118,251 | 133,796 | 133,796 | 133,796 | 133,796 | 133,796 | 133,796 |
| | debt service | 1,570 | 10,467 | 10,503 | 10,485 | 10,467 | 9,943 | 9,420 | 8,897 | 4,348 | 4,348 |
| | income tax | 1,784 | 2,071 | 2,617 | 3,160 | 3,704 | 3,887 | 4,070 | 6,103 | 7,695 | 7,695 |
| net flow | | -39,984 | 9,683 | 10,696 | 11,705 | 12,714 | 13,054 | 13,395 | 11,885 | 14,841 | 14,841 |
| operating rate | | 0.25 | 0.5 | 0.6 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| margin | | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| baht int rate | | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| working cap | | 12,074 | 21,790 | 25,676 | 29,563 | 33,449 | 33,449 | 33,449 | 33,449 | 33,449 | 33,449 |

| net income statement | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | 1.00 | 2 | 3 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 |
| depreciation | 5,835.71 | 5,835.71 | 5,835.71 | 5,835.71 | 5,835.71 | 5,835.71 | 5,835.71 | 550.00 | 550.00 | 550.00 |
| total sales | 56,083.57 | 109,380.47 | 126,520.16 | 143,600.48 | 160,680.81 | 160,681.00 | 160,681.00 | 160,681.00 | 160,681.00 | 160,681.00 |
| prod costs | 50,985.07 | 103,461.92 | 119,043.46 | 134,571.02 | 150,098.59 | 149,575.32 | 149,052.05 | 143,243.07 | 138,694.68 | 138,694.68 |
| gross profit | 5,098.51 | 5,918.55 | 7,476.71 | 9,029.46 | 10,582.22 | 11,105.68 | 11,628.95 | 17,437.93 | 21,986.32 | 21,986.32 |
| tax | 1,784.48 | 2,071.49 | 2,616.85 | 3,160 | 3,704 | 3,887 | 4,070 | 6,103 | 7,695 | 7,695 |
| net income | 3,314.03 | 3,847.06 | 4,859.86 | 5,869.15 | 6,878.44 | 7,218.69 | 7,558.81 | 11,334.65 | 14,291.11 | 14,291.11 |
| | | | | | | | | | | |
| invest loan | 24,567.00 | 24,151 | 20,126 | 16,101 | 12,075 | 8,050 | 4,025 | 0 | | |
| interest | 0.00 | 3,609 | 3,140 | 2,616 | 2,093 | 1,570 | 1,047 | 523 | | |
| principal pay | 0.00 | 4,025 | 4,025 | 4,025 | 4,025 | 4,025 | 4,025 | 4,025 | | |

**Industrial Survey on Surface Treatment (Electroplating)**

## 1. Types of Surface Treatment and Their Characteristics

Generally, industrial materials have a functional value even before any finishing has been carried out. However, since a variety of special functions are required of industrial materials, there are many types of surface treatment, which can produce significant value-added.

Surface treatment has shown remarkable progress in recent years in response to the diversification and specialization of functions required of parts. Traditionally, electroplating was known in connection with rust prevention and its role in improving visual appearance , mechanical criteria (hardness, lubricity, dimensional accuracy), electrical properties (electrical conductivity, magnetic property, electrical resistance), optical properties (anti-reflecting property, etc.), thermal properties (heat resistance, heat conductivity, etc.), physical criteria (properties of soldering and bonding, etc.), and chemical properties (anti corrosion to chemicals, anti pollution properties, etc.). In this way, electroplating has developed into a finishing technology which provides a wide spectrum of industrial properties.

### 1-1 Types of Surface Treatment

The types of surface treatment can be classified as follows according to the type of finishing method employed.

1) Electroplating
2) Electroless Plating (Chemical Plating)
3) Conversion Treatment
4) Vacuum Plating
5) Hot Dipping
6) Impact Plating
7) Anodic Oxidation
8) Painting
9) Thermal Spraying
10) Hard Surfacing
11) Coating
12) Hot Stamp

### 1-2 Characteristics of the Different Types of Surface Treatment

1) Electroplating

The product is suspended in an electrolysis solution and an electric current is passed through the product which acts as a cathode so as to result in the even coating of this with a metal film. This finishing serves as decoration and for rust prevention but also satisfies a wide range of functions relatively cheaply. This process is therefore used in a wide range of applications ranging from large size products such as automobiles, acoustic equipment, aircraft, communications devices, computer related equipment, industrial machinery to accessories and general everyday items.

- Merits

  Finishing can be carried out for both mass produced articles as well as for production of varied small lots. Moreover, the coating of a wide variety of metal films is possible so that metal films of a good fastness using metals with excellent properties can be given to a wide range of industrial materials and non conducting materials.

- Demerits

  There are sometimes irregularities in film thickness depending on the form of the product treated. Moreover, waste water treating facilities are necessary.

2) Electroless Plating

Also known as Chemical Plating. The product is coated with a metal layer making use of a reducing reaction which occurs in solution. With the exception of a certain number of materials, this finishing technique can be used for plating with a wide range of materials both metal and non-metal. The thickness of the resulting plating film is of a high degree of precision, so this finishing is largely used in industrial applications where this is a criteria given emphasis. This finishing process is essential for the substrate of plastic plating.

- Merits

  A very precise, even plating film can be achieved. Moreover this type of plating has a good level of plating fastness even in the case of non conducting materials such as plastics.
- Demerits

  Special complicated preparation before treatment is needed in the case of some materials. Waste water treatment must be carried out.

3) Chemical Conversion Treatment

Using a chemical reaction such as sulphurisation or oxidation a film of either a sulfide or oxide is added to the surface of the finished product.

For applications of coating substrates of iron and steel there are such chromating treatments as parkerizing or zinc plating.

- Merits

  Chromating is effective for zinc plating and for rust prevention of aluminum and magnesium alloys.

- Demerits

  The films are not strong against friction. Waste water treatment is required.

4) Vacuum Plating

In this treatment, a vacuum is produced inside a special container and the metals, oxidizing or nitrodising products are gasified or ionized in order to perform vapor metallizing of the product surface. This processing is essential for the production of semi-conductors.

- Merits
  It is possible to treat the majority of metallic and non-metallic materials using this process.

- Demerits
  In comparison with electro-plating this treatment involves treatment at very high temperatures and is rather costly.

5) Hot Dipping

The finished product is immersed in molten zinc, tin or aluminum, etc. to fasten a coating of these metals. Plating of thick films of this type is often carried out on relatively large structural items or metal sheets. Representative articles produced by this process include steel sheets plated with a film or zinc or aluminum. Hot dip soldering is also widely used with electric sector parts.

- Merits
  This treatment is commonly used for anti-corrosion plating of items with a large surface or which are heavy and bulky. In particular, since the zinc plating of structural items gives a ten year anti-corrosion, the treated materials do not require maintenance.

- Demerits
  Treatment involves very high temperatures (700-720°C). Types of plating are limited with this processing.

6) Impact Plating

The plating solution and finished product are introduced into a special inclined container, and the mechanical impact of the products in the container is employed to effect the deposit the zinc or other metal coating on the surface of products. This treatment is primarily used for rust prevention.

This method is particularly suited to the application of an evenly thick film to small parts such as bolts or nuts, but is not widely employed.

- Merits
  There is no hydrogen embrittlement as a consequence of such treatment. Also the time required for treatment is the same, irrespective of the film thickness required. It is possible to effect the entire treatment with a single treating device.

- Demerits
  There are limits in terms of product form or shape which can be treated (the process is not suited to large items or products which easily entangle). The metal films possible are restricted to soft metals such as zinc, tin, etc.

7) Anodic Oxidation

An electric current is passed through the product acting as an anode in an electrolytic solution (e.g. sulphuric acid or oxalic acid, etc.), therefore this treatment is generally used for aluminum surface treatment. The resulting product is known as almite. This treatment has a wide range of applications including for the various types of sash, doors, writing utensils, name plates, aircraft, precision machinery, measuring devices, etc.

- Merits
  This process has a wide range of applications since it is possible using anodic oxidation to fasten a film with a thickness of between 4 and 10 microns and possible to fasten colors as required for the purposes of decoration or anti-corrosion.

- Demerits
  Since the film is rather secondary processing is rendered difficult.

8) Painting

This can be effected as spray coating, electric spray coating or electrode position coating, etc. each of which has a wide range of applications. A variety of colors can be obtained and this processing is comparatively simple in technical terms.

- Merits
  This is the most commonly applied finishing method used for industrial materials beginning with metal materials. It has the advantage of being a very simple processing method.

- Demerits
  Generally resulting surface hardness is poor, and the volatile nature of the flux presents a pollution problem.

9) Thermal Spraying

A powder made of metal, alloy, etc. is discharged under high pressure from a nozzle and rendered molten in flame or plasma and then coated on the surface of the finished product.

This process is used in the spraying for corrosion prevention which is used for bridges, construction materials, ships and hulls, etc. and also in the plasma spraying given to rolls, machine parts and metal molds.

- Merits
  It is possible to obtain the optimum characteristics required for certain envisaged applications. Moreover the materials for spraying can be freely selected (e.g. lead, aluminum, zinc, ceramics, plastic, etc.).

- Demerits
  Comparatively costly. Since the resulting film is porous it is thin and has poor anti-corrosion properties.

10) Hard Surfacing

Carburizing or nitriding of iron and steel materials, or hardening by high frequency heating are representative types of this processing. The surface of the selected metal materials is modified so as to increase the anti-abrasive hardness or the metal fatigue strength.

- Merits
  This processing is commonly used in surface treatment, particularly of iron and steel materials.

- Demerits
  Since the processing temperatures are generally much higher than those involved in plating there is frequent deformation of materials and dimensional changes so that machining is required after such treatment.

11) Coating

This involves the covering of metals, etc. with organic high molecular materials or inorganic materials such as glass, etc. Methods for such processing include thermal spraying and the electrostatic method. In both the above methods a powder of plastic particles between 10 and 100 microns is fixed using one of the following methods either singly or in combination;

a. rendered to flux after being deposited on the metal selected
b. fixed to the metal by application of heat to render the powder molten
c. applied by coating when in a semi-flux state.

- Merits
  It is easy to effect coating with a thick film of such high molecular materials as vinyl chloride, polyethylene, polypropylene, Teflon, etc. Resistance to chemical corrosion is excellent.

- Demerits
  The selection of forms appropriate for coating and inspection for defects must be carried out. As the surface hardness is generally low, resulting anti-abrasive strength is poor.

12) Hot Stamp

This process is commonly known as stamping leaf, and is widely used for metallic decorative applications.

Aluminum is deposited on a polyester film acting as a base, and the resulting layer is formed into leaf segments. The leaf is placed on a heated relief press and is transferred to the selected finished product under pressure.

- Merits
  Shaped plastic products of a simple form can be easily rendered metallic using this process.

- Demerits

  It is difficult to achieve a strong fastness of adhesion between the leaf and stamped materials. As the metal coat is extremely thin and weak it is necessary to have a protective film for this.

## 2. Outline of Electroplating in Thailand

### 2-1 Electroplating

Electroplating is a finishing method which is used to process a wide variety of industrial component parts and devices.

Of the different processes available for surface treatment, electroplating is the most widely applied for industrial products and so the focus of attention in the present Survey has been given to the electroplating sector.

Table 1 indicates the representative plating functions which are required in relation to the various types of finished product (parts) classified by industrial sector.

In addition to the representative functions shown in Table 1, plating process is also required to provide the following industrial functions:

1) Mechanical functions: hardness, lubricity, dimensional accuracy, easy removal from dies, low abrasion coefficient, etc.

2) Electric functions: electric conductivity, high frequency properties, magnetic properties, low contact resistance, etc.

3) Optical functions: anti-reflecting properties, light reflecting properties, ultraviolet ray screening and blocking properties.

Table 1 Functions Required for Products by Industrial Sector

| Required Functions<br>Industrial Sectors | Representative Functions<br>Decoration | Anti-Rusting | Anti-Abrasive |
|---|---|---|---|
| 1. Automobile, motorcycle | o | o | o |
| 2. Bicycle | o | o | |
| 3. Consumer products | o | o | |
| 4. Audio visual products | o | o | |
| 5. Aerospace industry | | o | o |
| 6. Electronics and semiconductor | | o | o |
| 7. Computer and accessory | | o | |
| 8. Communications equipment | | o | |
| 9. Business machine | o | o | o |
| 10. Precision machinery | o | o | o |
| 11. Industrial machinery | o | o | o |
| 12. Die and molds | | o | o |
| 13. Shipping | | o | o |
| 14. Construction materials | | o | |
| 15. Printing machinery | | o | o |
| 16. Medical appliances | | o | o |
| 17. Glasses | o | o | |
| 18. Sports goods | o | o | |
| 19. Stationery | o | o | |
| 20. Lighting appliances | o | o | |
| 21. House wear | o | o | |
| 22. Clock and watch | o | o | |
| 23. Accessory | o | o | |
| 24. Furniture and interior | o | o | |
| 25. Exterior | o | o | |
| 26. Toys | o | | |
| 27. Gift wear | o | o | |
| 28. General merchandise | o | o | |

## 2-2 Outline of Electroplating in Thailand

It is reported that there are at present some 400 electroplating shops located in Thailand. However, for the present only 136 of these shops are registered with the Thai Ministry of Industry.

Further according to a 1985 Survey carried out by the Thai MOI, there were about 200 plating shops, as shown in Table 2.

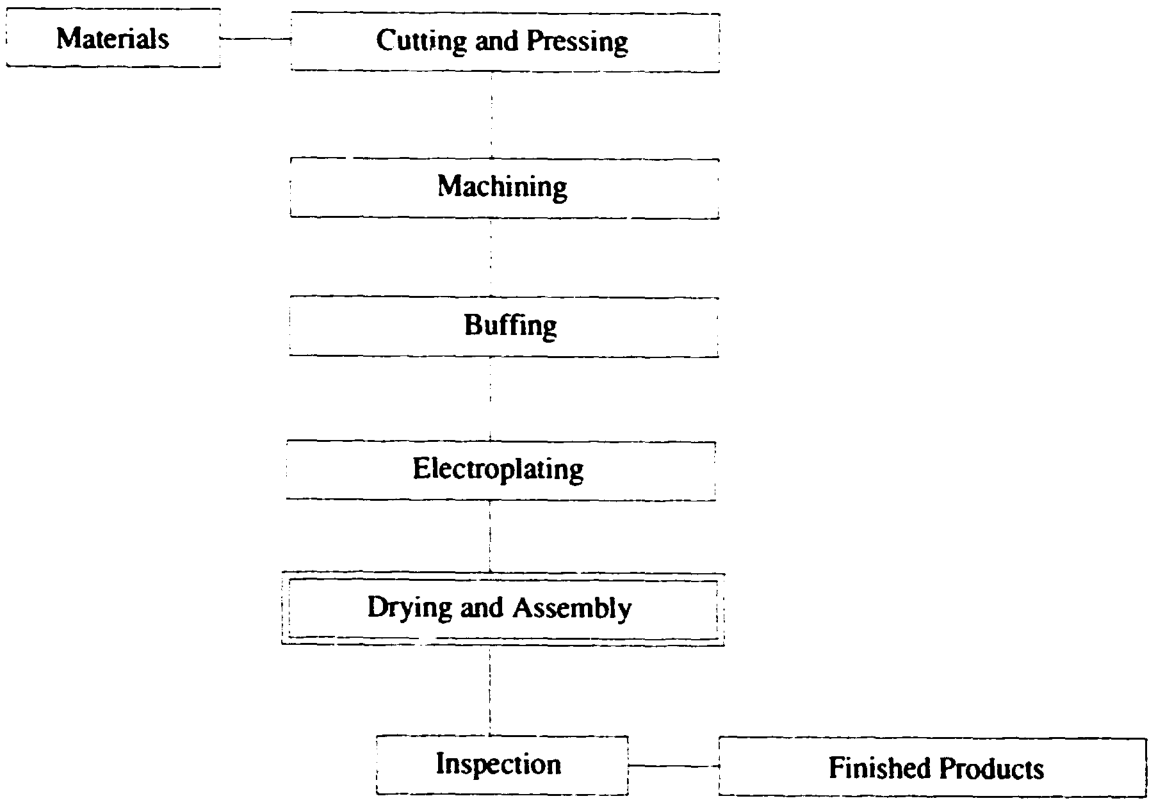
Table 2 Profile of the Metal-coating Industry in Thailand
(from MOI survey, 1985)

| Items | Number of Workshops |
|---|---|
| Total registered plating workshops *1) | 200 |
| | |
| Cr, Ni, Cu and other metal electroplating | 89 |
| Ni electroplating only | 11 |
| Zn and other metal electroplating | 32 |
| Zn electroplating only | 8 |
| Ag and Au electroplating | 8 |
| Al anodizing and metal electroplating | 13 |
| Anodizing only | 9 |
| Sn hot-dip and metal electroplating | 18 |
| Sn and other metal electroplating | 4 |
| Unspecified electroplating practices | 31 |

Note: *1) It was estimated that there are 25% or 50% more workshops which could not be identified, hence the total number could be about 250.
Source: MOI Survey

1) Categories of Thai Electroplating Shops

Thai's electroplating shops can be roughly divided into two categories. The first of these consist of shops where the plating process constitutes one section of the processing of a certain processed product (such as auto parts for example).




Secondly those possessing specialist workshops for the plating process which are specialist plating shops undertaking commissioned processing, by estimating costs according to a unit price for the surface area of products to be treated (either for one product or per kilogram of output). The following is an example of operations involved in the plating process:

Machined Parts and Materials — Surface Preparation
- •Buffing
- •Honing

Degreasing
- •Alkaline cleaning
- •Emulsion cleaning
- •Electrolytic cleaning

— Washing

Acid Cleaning
- •Pickling
- •Acid dipping

— Washing

Activation
- •Acid activation

— Washing

Electroplating

- •Functional cromium plating
- •Gold plating
- •Silver plating
- •Tin plating
- •Lead plating

- •Copper plating
- •Nickel plating
- •Chromium plating
- •Zinic plating
- •Palladium plating
- •Rhodium plating

— Washing

Neutralization

— Washing

Chromating

— Washing

Tarnishing Prevention

— Washing

Drying

— Washing

Inspection, Packaging — Finished Products

In the case of Thailand about 80% of plating is carried out on as in-house production by plating shops of the firm concerned as part of production processing, as illustrated in case 1 above.

Specialist plating shops such as in case 2 above account for only 20% of the total and this share decreases annually.

2) The following are actual examples of Company Profiles for firms which are equipped for the plating process in Thailand.

- Profile of Company D

| | |
|---|---|
| Factory site: | Pathum Thani |
| Employees: | 330 |
| Land area: | 34,660 sq.m. (21 Rai) |
| Capital (Baht): | 240 million Baht |
| Ownership: | 80% Japan, 20% Singapore |
| Products: Pcs/year | Connectors (electric, electronic) 30 million<br>Cable harnesses 1.2 million Baht 90% for export |
| Plating equipment: | functional plating gold<br>gold and silver plating, etc.<br><Investment Value><br>*plating - 12 million Baht<br>*Waste water treatment equipment - 14 million Baht |

- Profile of Company U

| | |
|---|---|
| Factory site: | Samut Prakan |
| Employees: | 700 |
| Land Area: | 15,600 sq.m. (10 Rai) |
| Capital (Baht): | 35 million Baht |
| Ownership: | 51% Thai, 49% Japan |
| Sales (Baht): | 215 million Baht in 1989<br>local 95%, export 5% |
| Main Clients: | Thai Suzuki Motors<br>Thai Honda Mfg.<br>Siam Yamaha<br>Thai Kawasaki Motors |

| | |
|---|---|
| Major Equipment: | Zinc and double nickel chrome<br>Electroplating<br>Buffing machinery<br>Rim forming machines |
| Products: | rim (motorcycle) 100 thousand units/yr.<br>rim (bicycle) 500 thousand units/yr.<br>plating service |

- Profile of Company T

| | |
|---|---|
| Factory site: | Lat Krabang |
| Employees: | 55 |
| Land Area: | 3,700 sq.m. (2.3 Rai) |
| Capital (Baht): | 10 million Baht |
| Ownership: | 20% Thai, 80% Japan |
| Sales (Baht): | 56 million Baht in 1989<br>local 20%, export 80% |
| Major Equipment: | Nickel and gold electroplating, 6 million Baht<br>Waste water treatment system, 6 million Baht<br>Metal pressing machines and buffing shop |

3) Characteristics of Electroplating Shops in Thailand and Current Measures

- The specialist plating shops in Thailand now account for only 20% (approx. 80 shops) of the total industry (400 shops) and the number of specialist shops continues to decrease annually. The main reasons for this decline are the limits on expansion imposed by the location of shops in commercial areas or the over heavy burden of equipment costs entailed by waste water treatment facilities. These factors make relocation of plating shops impossible.

- Moreover, the managerial scale of such firms is small, and they suffer from personnel shortages, high defect rates and low technical levels making it impossible to increase productivity.

- The plating shops which were newly set up in Thailand between 1987 and 1991 were mostly established by foreign investors, and were designed as an integral part of in-house production to carry out finishing of products. These plating shops have a large scale of production and provide the required industrial functions of products by their processing.

The following are the most important aspects requiring attention for the time being in order to upgrade the technology for plating shops in Thailand.

(1) assure the acquisition of basic plating technology in order to reduce defect rates

(2) promote the installation of water treating and purifying facilities to treat the water used in plating flux.

- 99% of the materials used for plating in Thailand are imported.

## 3. Examples of Applications of Electroplating and Market Characteristics

### 3-1 Decorative Plating

(1) Copper, Nickel and Chrome Plating

Copper, nickel and chrome plating of a decorative nature are generally grouped together as decorative chrome plating. A substrate of copper or nickel is used and the finishing plating is chrome. This is the most common type of plating used and applications include for lighting equipment, tableware, metal fittings for toilets, cooking ranges, toasters, etc.

(2) Plastic Plating

Traditionally surface treatment such as plating has been used to give a metallic appearance to plastic and thereby metalize plastic parts to enhance their commercial value and for decorative purposes. At present, the majority of plastic plating shops make use of a decorative plating based on ABS resin. Plastic plating is used for motor parts, for domestic electrical appliance parts, for the printed circuits of electronic devices, for connector hoods, etc.

(3) Full Range of Alloy Plating

Alloy plating embraces a wide range of color tones which have practical applications, from white, black or gold color series. These are used for household articles, handles, switches, auditory equipment, lighting equipment, etc.

(4) Gold, Silver, Rhodium, Paradium, and Platinum Plating

These types of plating are representative varieties of decorative plating. Applications include in lighting equipment, tableware, spectacle frames, and in a wide variety of miscellaneous household articles.

### 3-2 Rust Prevention Plating

(1) Zinc Plating

This is a representative form of rust prevention plating. It is particularly effective for anti-corrosion of ferrous materials. The particularities of zinc plating are:

1) even machined parts of comparatively complicated form can be given a uniform thickness of plating

2) the plating is much cheaper in cost compared to other plating processes

3) the secondary processing properties after plating are excellent

This plating is extensively used for iron products, and common uses include for nuts and bolts used in nuclear power related sectors and for communication parts.

(2) Zinc-Nickel Alloy Plating

As with the zinc plating process various types of chromating are carried out in order to improve the secondary processing properties.

3-3 Industrial Plating

This refers to plating which is undertaken for some industrial function, that is for some industrial application.

(1) Cooper Plating

This is a method of treatment representative of industrial plating, and the process has a wide variety of important functions in a number of industrial sectors.

One typical example is the throng hole plating which is essential for production of multilayered printed circuit boards (PCB).

Also since copper plating results in extremely good heat conductivity such plating is applied to stainless steel pans or the bottom of frying pans.

(2) Nickel Plating and Chemical Nickel Plating

Nickel plating is the most widely used variety of industrial plating for giving a substrate. This is a basic treatment for enhancing the fastness of adhesion with the base and for providing corrosion prevention.

In the case of electronic parts such as connectors, switches and terminals which have been given a plating of gold, tin, rhodium, etc. a 7 micron thickness of nickel plating is applied to these substrates without exception.

Chemical nickel plating serves to increase the fastness of adhesion with the base (plastic) materials of printing type for OA Printers and also improves mechanical strength.

(3) Electroplated Coating of Chromium for Engineering Purposes

This is a typical industrial plating which has a large number of mechanical properties. It is widely applied for motor parts, industrial machinery, aircraft, ship parts, and metal molds and dies, etc.

(4) Gold, Silver, Rhodium, Paradium and Platinum Plating

- The main industrial use of gold plating is for electrical conductive parts, and the plating is of great importance. Other typical industrial applications include plating of lead frames, IC heads, connectors, etc.

- Silver plating like gold plating is an essential plating technology for the electronics industry. Since silver is not as expensive as gold and yet has the best electrical conductivity of metals it is widely used in industry. Typical applications include for connectors, switches, IC lead frames, etc.

- Rhodium plating has a strong hardness and is used in lead switches, etc. of computers.

- Platinum plating is more widely known than rhodium plating but rhodium actually has the greater number of industrial applications. Recently however a plating of platinum over a titanium substrate has come to be used for insoluble electrodes or gas and other sensors.

- Paradium plating is cheaper in cost than rhodium plating. Due to recent improvements made in plating bath technology paradium plating has come to be used as a low contact resistance plating in the place of the more expensive rhodium.

(5) Tin Plating

This has been traditionally used very widely in industrial sectors for the surface treatment of steel sheets. Applications include for steel sheets to be made into tin cans, for tableware, for water heaters, axle shaft parts, etc. Thanks to recent improvements in technology applications for electronic parts have also been developed.

In addition to the typical types of plating outlined above, a number of important industrial plating special plating methods are also employed such as plating of a tin-lead alloy for electronic parts, magnetic plating of magnetic tapes, magnetic drums and the wire memory of computers. In this way plating continues to be developed as a vital technology.

(6) Conversion Treatment

When metal is immersed in a certain bathing solution to effect metallizing by the coating of the surface with a film of a metal salt this is described as conversion treatment.

- Chromating

  This is a representative conversion treatment which is used as a treating process to provide anti-corrosion properties or as a substrate.

- Phosphate treatment

  This is a treating process for steel which is known as parkerizing. A phosphate film is formed on the metal surface which enhances the adhesive property of and gives the treated surface anti-corrosive properties.

## 3-4 Market Characteristics of Electroplating

As shown in Table 1, the characteristics required for each type of product, embrace a wide variety of industrial sectors. Beginning with the contemporary industries leading the way in economic development such as the motor car, domestic electrical appliances and electronics industries almost all metal or plastic products which we encounter today have had some form of plating treatment. Thus plating plays a direct and vital role in our everyday lives. Plating constitutes an important basic industry, supporting development in a wide range of industries, and is essential to the development of new technology.

In view of the above, we can summarize the market characteristics of the plating process as follows.

1) Plating is a finishing process applied to the various types of industrial product which enhances the value added of the product treated by giving this additional functions.

2) The functions for surface treatment which are required of plating processing have becomingly increasingly elaborate and sophisticated recently. Therefore a constant effort to upgrade technical levels and technology is needed meet the requirements of clients.

3) Plating is entirely done on a to order basis so that sector is of a passive nature in market terms, since the market characteristics are determined by the clients and these must constantly be followed.

4) In technical terms, improvements in equipment have tended to promote automation, and these advances together with improvements of the chemicals used mean that much more elaborate operations are required than was previously the case.

5) New technology has been introduced with advances and improvements in the technical aspects of the processing, while there is a trend to automation of the waste water treatment. As a result the outlay needed for waste water equipment is about the same as that for the plating equipment itself, and so there has been a general increase in the cost burden involved.

6) Since elaborate functions have particularly been required in the electronics related industries recently, the market for electroplating has enjoyed a definite expansion. However, this market expansion has occurred within the limits of the in-house production of the large industries and does not represent a market to which the medium and small size industries typical of the specialist plating sector have an access.

## 4. New Developments in Electroplating

### 4-1 Composite Technology of Plating

Development has been concentrated on the development of plating technology to respond to the new blank materials available. The following types of plating processing have been developed.

(1) Methods for Plating of High Performance Glass

This is a new plating method which is applied to make use of the properties of high performance glass materials such as Quartz glass in order to form circuits or electrodes on the surface of the material.

(2) Plating of Textiles

It has become possible to plate textiles such as polyester, acrylic fiber, carbon fiber, etc. Fibers which have been given a nickel plating can be used for warming pads for bodily extremities used in medical treatments or for insulation by passing a low voltage current from dry cells and batteries, solar batteries, etc. through the fibers.

(3) Plating of Powders

Powders (under 10 microns) of alumina ceramics, tungsten or carbon, etc. which undergo the direct plating process can be used as metal powder for screen printing or for IC packages. It is possible to perform copper, nickel or silver plating of this kind.

(4) Ceramic Plating

Together with engineering plastics, the new ceramics represented by alumina ceramics are at the forefront in development of non metal materials, and applications in a wide range of industrial sectors are now being examined.

Thanks to the excellent electrical insulation properties of these ceramics themselves they are provided with exactly the functions needed for electronics parts and semi-conductors. The various types of plating method are rapidly being diffused and this technology is highly valued as an essential technology for applications in high functional devices.

4-2 Printing and Plating

In the decorative field it is possible to combine printing and plating. Using this method screen printing is employed to draw a design on the surface of the blank material (for example brass, stainless steel, aluminum, etc.), then plating is carried out to provide a finish coating which also has resistance to wear. Examples of applications for this method include those for interior design products, stationary items, accessories, and various metal tools.

4-3 Color Plating

This is a method for applying a colored plating film. Typical of this method is the immersion of zinc plated products in a special dyeing liquid to give a bright coating of colors such as blue or red.

Recently, a film is obtained through conversion treatment by giving a bath of a special sulfurizing agent to materials which have been plated with nickel or silver.

4-4 Deposition and Plating

(1) Electrodeposition Coating

In a coating solution which can be electrolysed the product is placed as the anode and a direct voltage current passed between it and the cathode so as to achieve coating by electrophoresis. This method is used for mass produced items such as motor car parts or electronic devices.

(2) Electrodeposition Coating and Plating

In order to reinforce and enhance the anti-corrosive property of plating on the one hand and the coloring property of electrodeposition coating on the other these two methods are combined. This method has begun to be used with miscellaneous household items and decorative items.

## 5. Plating and Waste Water Treatment

There are a large number of process steps involved in the finishing of a product with the overall plating process. Between these process steps washing is carried out without fail. The following shows one example of this.

- Process for giving a shiny decorative nickel chrome plating to ferrous materials.

Degreasing —>**Washing** —> Acid washing —> **Washing** —> Drying —> Substrate buffing and polishing —> Alkaline degreasing —> **Washing** —> Electrolytic degreasing —> **Washing** —> Weak acid pickling —> **Washing** —> Neutralizing —> Copper striking —> **Washing** —> Shiny copper plating —> **Washing** —> Nickel plating —> **Washing** —> Chrome plating —> **Washing** —>Drying

The washing operations determine what amount of water treatment will be needed, and the scale of the waste water treatment equipment depends on the quantity of water used for the washing. In turn the efficiency of the washing process has a large influence on costs.

### 5-1 Cost of Equipment for Waste Water Treatment

As has been noted previously, the waste water treating facilities for plating shops require about an equal outlay of capital as the plating equipment itself. The operation cost of this waste water equipment is also said to represent about 15% of the operation costs of the main plating processing.

### 5-2 Standard Treating Processes of Plating Waste Water Treatment

The standard treating processes are shown in Figure-1.

1) Generally treatment is classified according to the effluent treated into cyanic waste treatment, chromic waste treatment and acid-alkali waste treatment.

2) The average water consumption of a plating shop is about 5 tons per hour. However in the case of large scale plants then up to 15 tons per hour can be consumed.

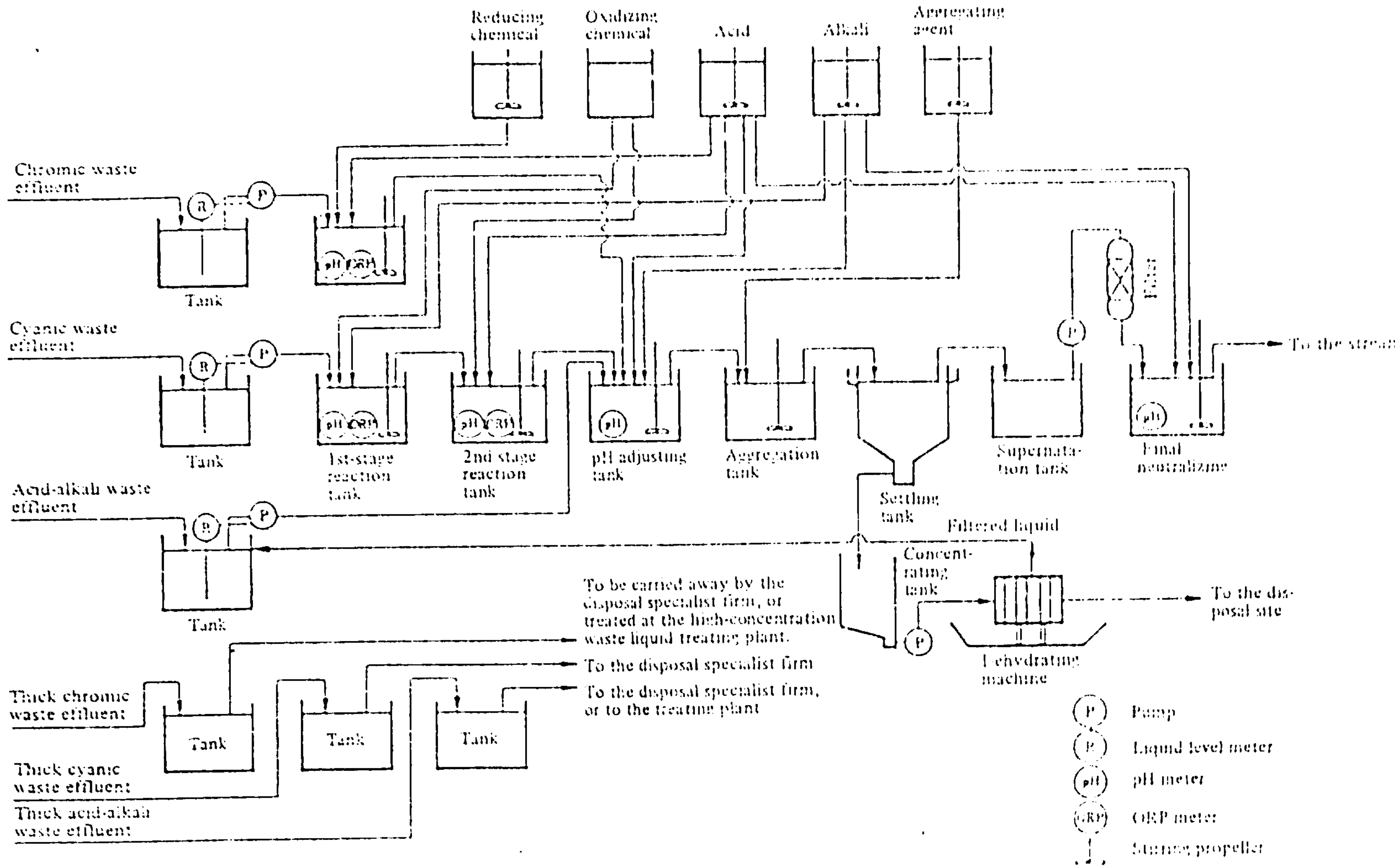



Figure - 1 Standard continuous waste-effluent treating system diagram

Source: THE YOKOHAMA INDUSTRIAL INSTITUTE
Fundamentals of Metal Plating

## 6. Summary and Recommendations

### 6-1 Characteristics of Surface Treatment

To date surface treatment has been concerned with working on the basis of the inherent functions of the materials to be treated so as to add value by upgrading desired functions. In line with social and economic development new industrial functions have continued to arise and these have led to a steady expansion of the markets for surface treatment technology. In particular, the markets for PCB (Printed Circuit Boards) used for electronics parts and semi-conductors have shown a remarkable expansion.

- Characteristics of Electroplating Technology

(1) Plating technology has progressed in strides to embrace a range of typical functions from decoration, rust prevention, to electrical properties and characteristics.

(2) The plating of non metallic materials such as plastics, textiles or glass, etc. is increasingly needed and technology has been developed and applied to meet these growing needs.

(3) The development of semi-automated or fully automated plant has been realized and automated systems covering even waste water treating devices have been put into practice.

(4) In line with the development of technology investment costs for equipment have also increased. However, a reduction of costs can also be expected to arise through the mass production made possible.

(5) For reference, the net total costs (indicating percentage distribution of components costs) of specialist plating firms in Japan have been shown in Annex-A.

- Market Characteristics of Electroplating

(1) As shown in Table 1 on the Characteristics demanded of the various products by industry the market for plating services embraces a wide span of industrial sectors with applications ranging from those in

miscellaneous household items, stationery goods to those in motor cars, domestic electrical appliances, ships, aircraft, etc.

(2) In particular the recent applications of plating technology in the areas of precision machinery, electronic appliances, etc. have realized a great expansion of the market.

(3) In particular future market development can be expected to occur on the basis of functional plating.

(4) The functions which are needed in high tech products are the leading force in further development of plating technology and so will be the main focus for efforts for the time being.

## 6-2 Recommendations

(1) The semi automated equipment already installed in the MIDI (Metal Working and Machinery Industries Development Institute) which was set up in order to establish a solid base for plating technology in Thailand and promote further technical development should be used to carry out basic training in the automating of plating processing.

(2) Also, if small scale plants for plastic plating, chemical plating and through hole plating for PCB applications could be set up these would contribute greatly by providing training in the basic technology needed to meet market trends.

(3) The curriculum of technical training courses and seminars need to be able to provide market information. This will help to establish targets for the development of new plating technology.

Annex-A

## Cost Index of Specialist Plating Firms

- Japanese Example -

1. Production Cost

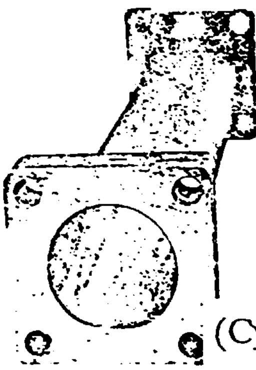
| | (Percentage Distribution) |
|---|---|
| - cost of materials | 22% |
| - labor costs | 27% |
| - depreciation costs | 5% |
| - water, fuel costs | 5% |
| - welfare expenses | 4% |
| - costs for external commissions | 7% |
| - other expenses | 9% |
| | sub-total 79% |

2. Sales and Administrative Expenses

| | |
|---|---|
| - sales expenses | 5% |
| - administrative expenses | 16% |
| | sub-total 21% |

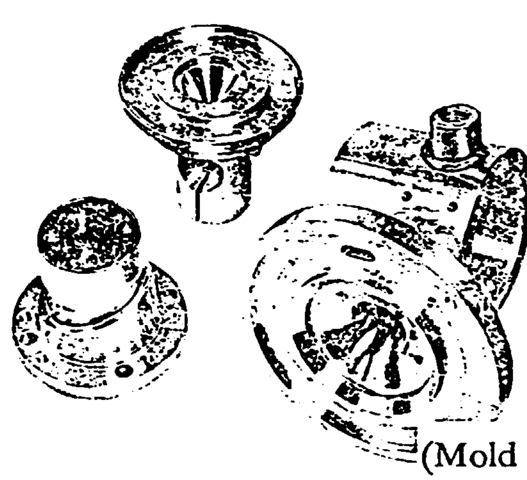
3. Net Total Expenses: 534 million yen (= 106 million Baht)

4. Average Sales: 578 million yen (= 116 million Baht)



(Cylinder)

工業用(硬質)クロムめっき(油圧シリンダ)

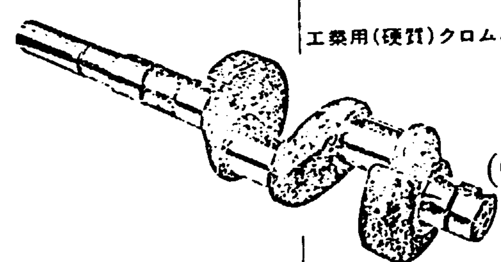


(Mold and die)

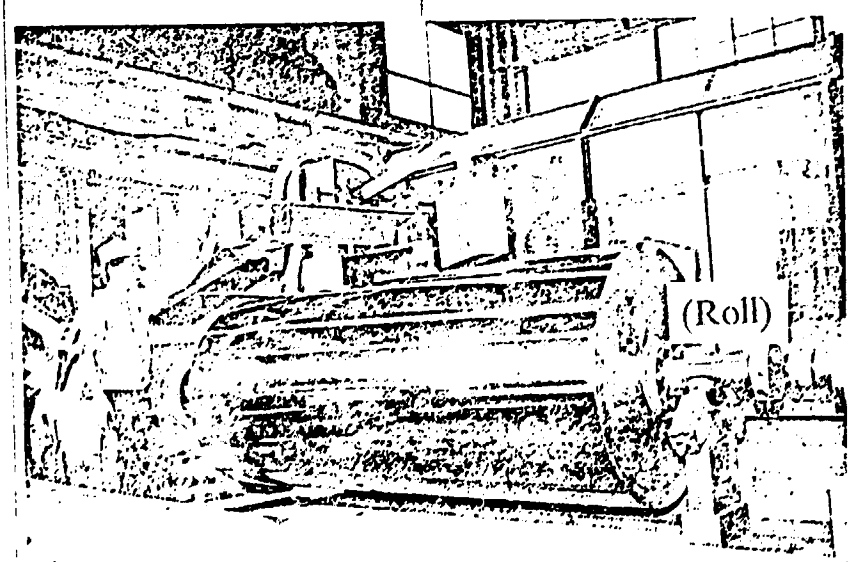
工業用(硬質)クロムめっき(金型)

Electroplated coating of chromium for engineering purpose

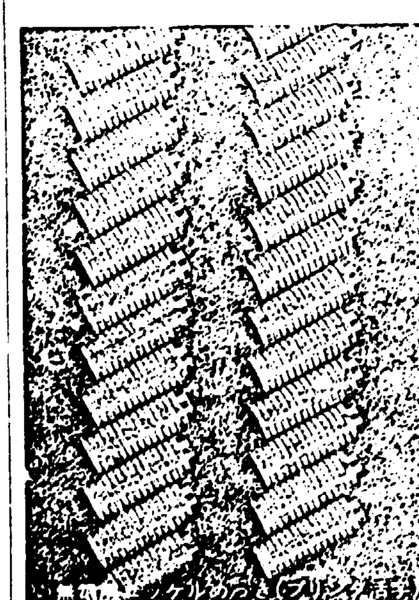
工業用(硬質)クロムめっき(クランクシャフト)



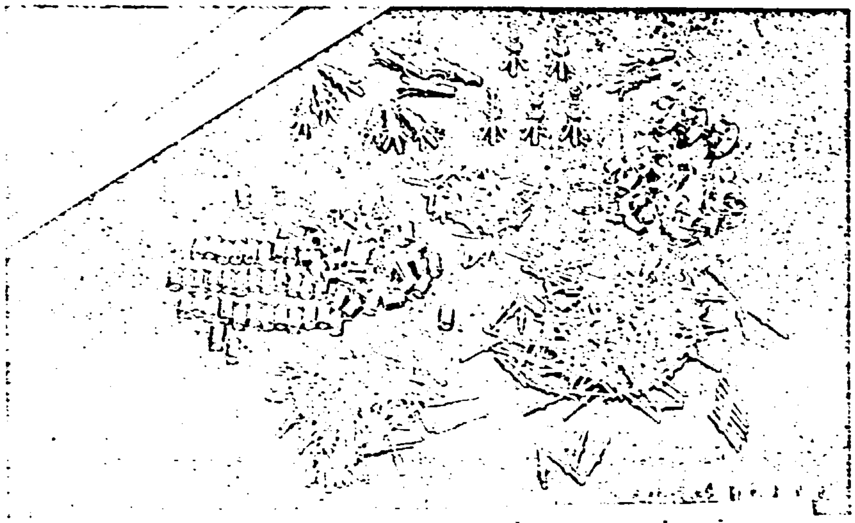
(Crank Shaft)



(Roll)

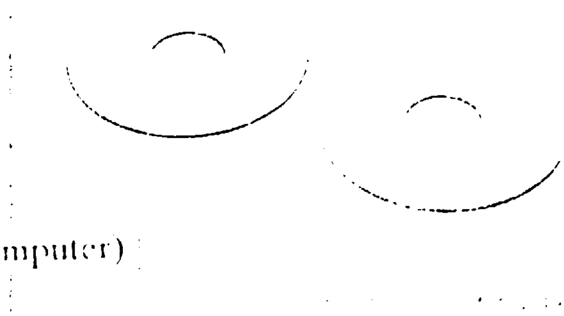


Chemical Nickel-plating (Printing type



Gold-plating (Components of communications)

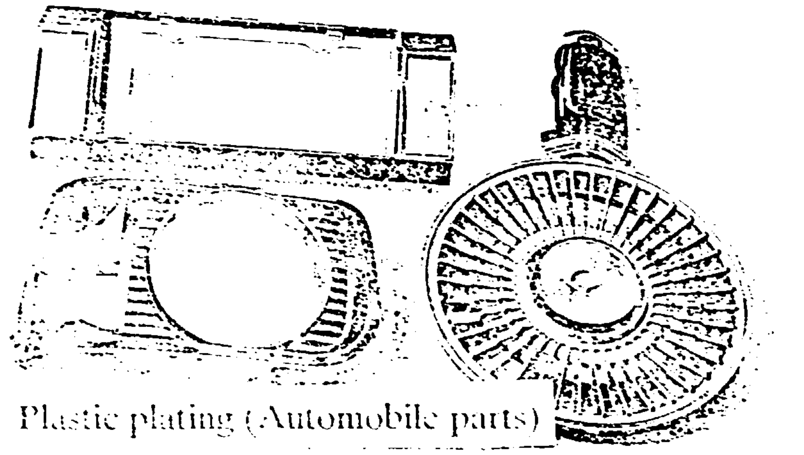
Silver-plating (parts of electronics)



Chemical-plating (Hard disk)

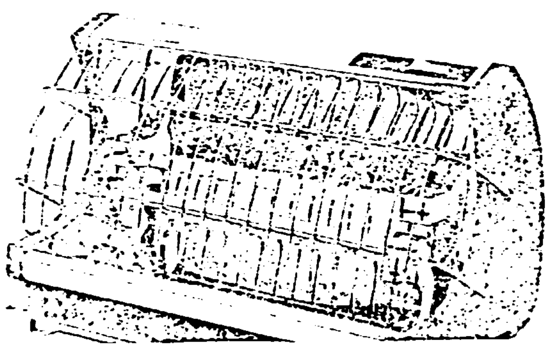
Sealed-plating for magneto electricity (Computer)

3



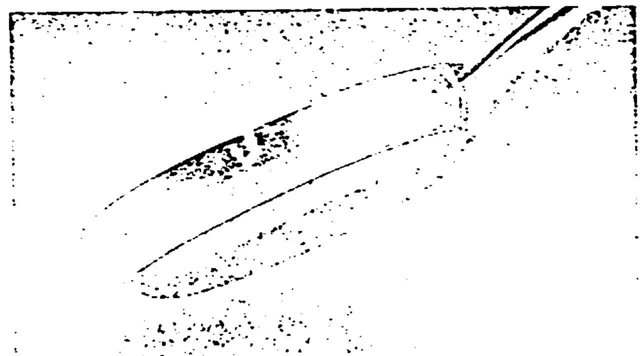
Plastic plating (Automobile parts)

プラスチックめっきされた自動車部品(ノリル、ABS)



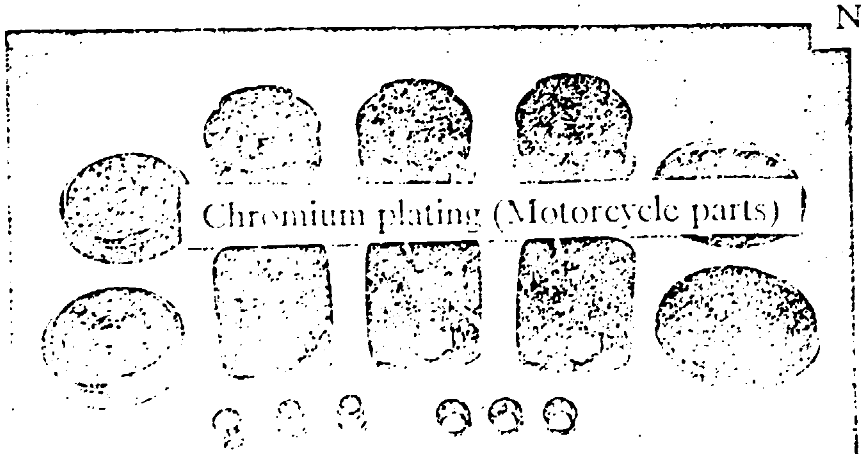
Nickel-chromium plating (Stove)

光沢ニッケル-クロムめっき(ストーブ)



Copper-plating (Frying pan)

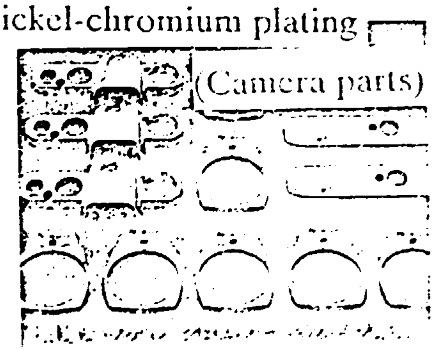
銅厚付けめっき(フライパン)



Chromium plating (Motorcycle parts)

黒色クロムめっき(オートバイ部品)

Nickel-chromium plating (Camera parts)



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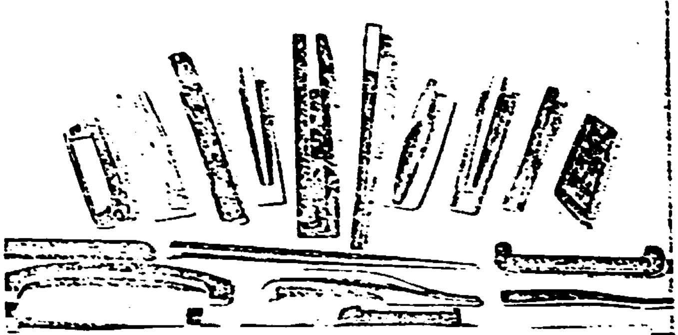
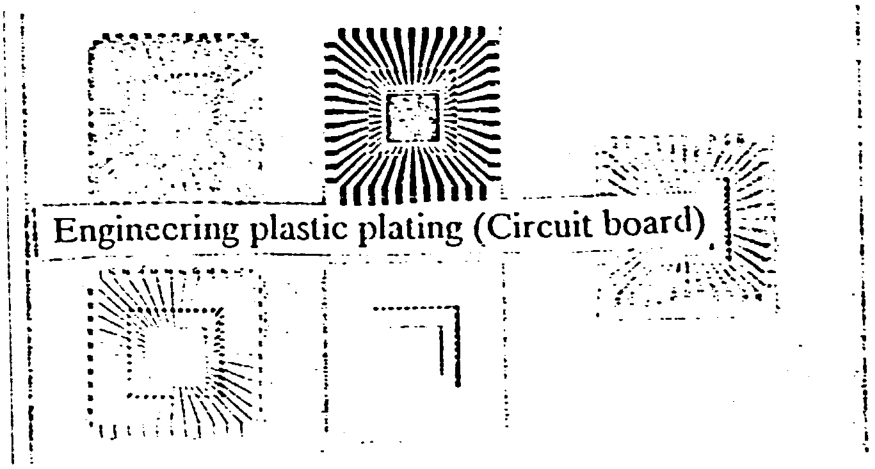


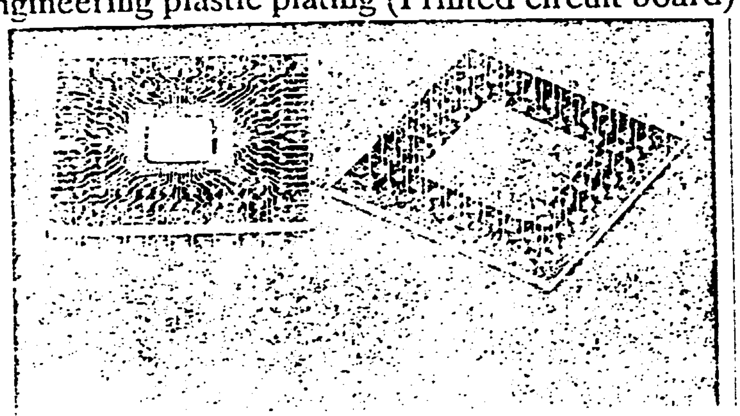
Plastic plating (Electrical appliance parts)

プラスチックめっきされた家電部品(ABS)

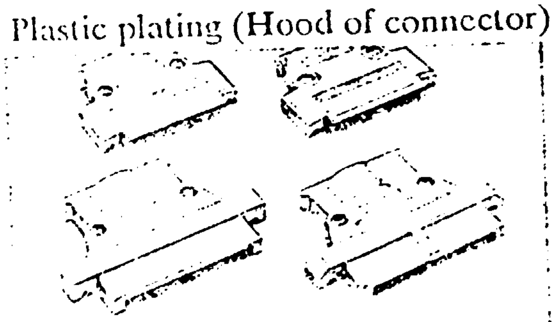


Engineering plastic plating (Circuit board)

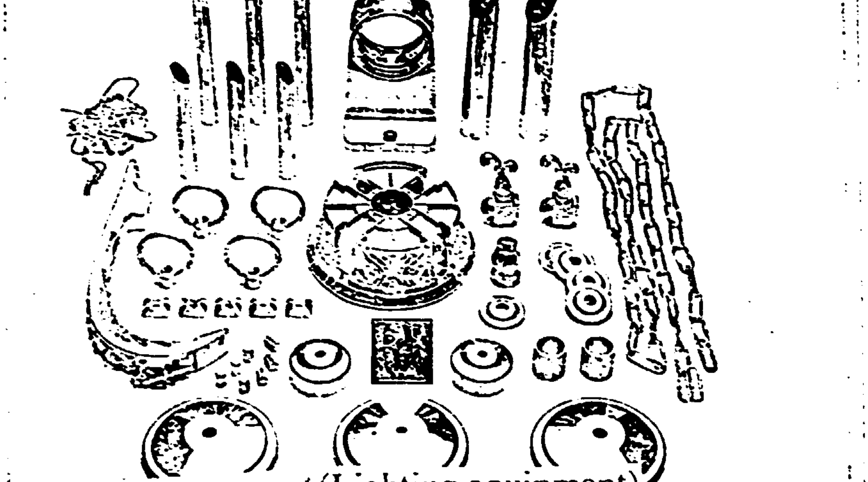
Engineering plastic plating (Printed circuit board)



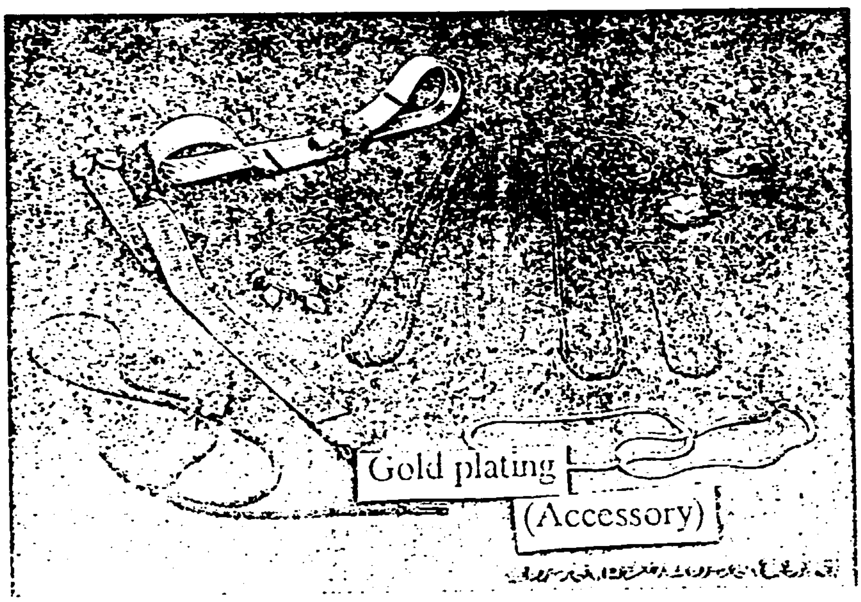
Plastic plating (Hood of connector)



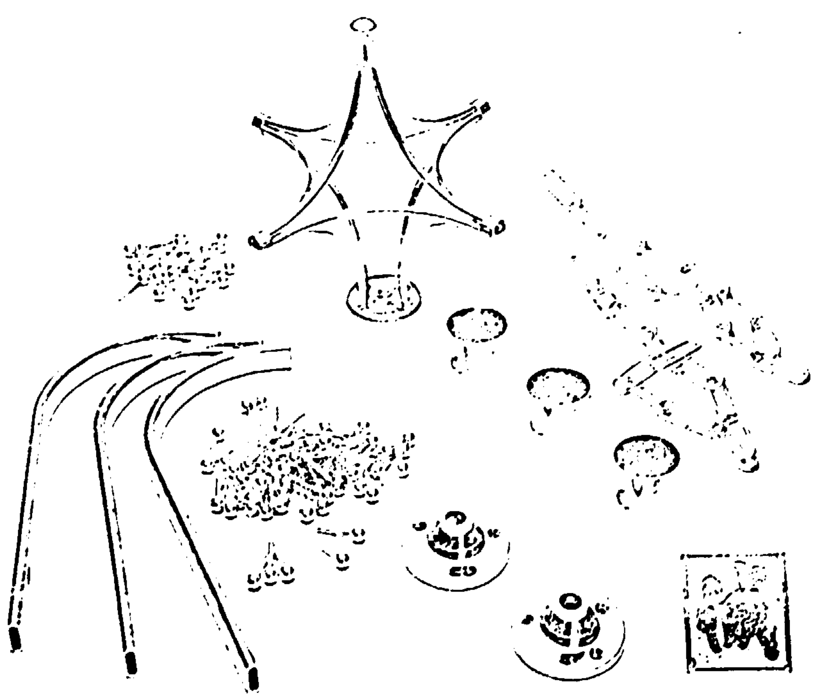
電磁波シールド対策コネクタフード(ABS)



Gold plating (Lighting equipment)

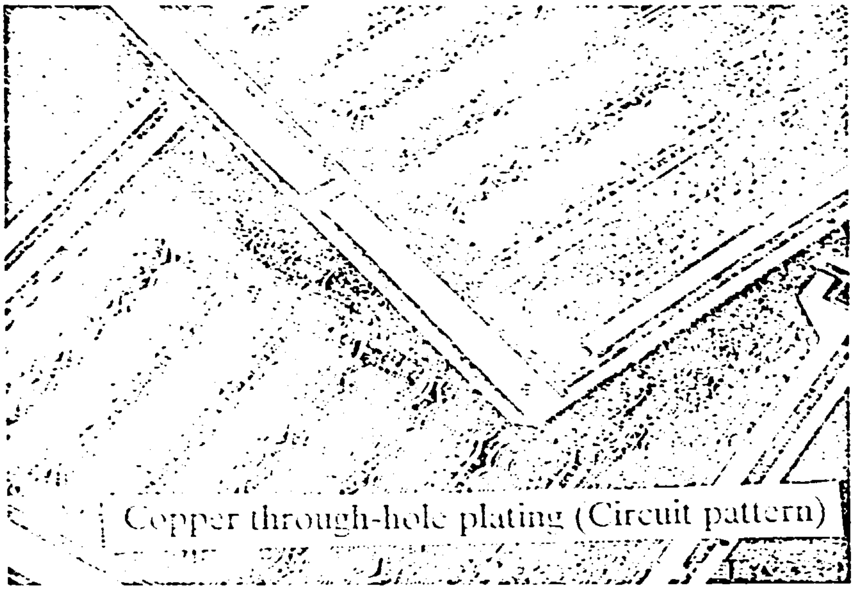


Gold plating (Accessory)

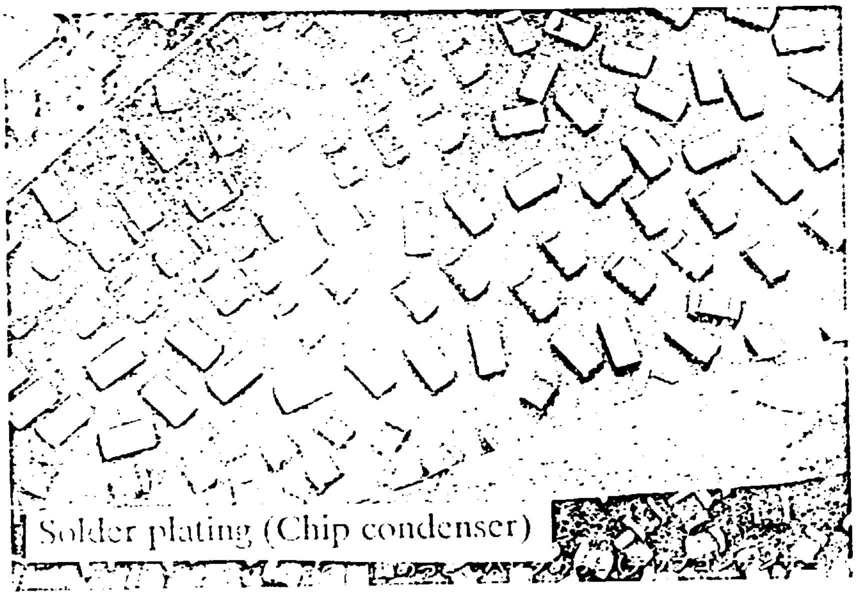


Nickel-chrome plating (Lighting equipment)

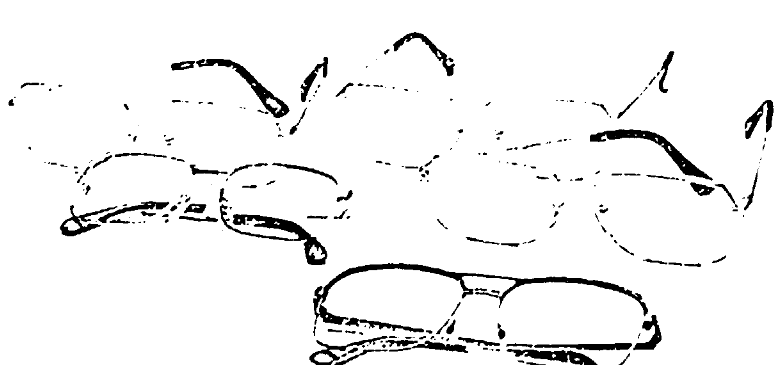
光沢ニッケル-クロムめっき(照明器具)



Copper through-hole plating (Circuit pattern)



Solder plating (Chip condenser)



Gold plating
(Spectacle frames)

**Volume I**
**Part II**

## B. Pre-feasibility Study on Aluminum Die Casting

Table of Contents

**Pre-feasibility Study**

# Pre-Feasibility Study on Aluminum Die Casting

# Chapter 1: Executive Summary

## 1.1 Project Background

The objective of this project is to show the economic and financial viability for the expansion of supporting industries in Thailand. The selection of die-casting as a target sub-sector came as a result of discussions held in January 1992 among UNIDO, the Thai government and the Consultant, and was based on the recent growth and projected rapid increase in assembly production in Thailand, especially in the automobile, electronics and electrics sectors.

## 1.2 Market Analysis

Considering the rapid growth of these three main sectors in the recent past and strong potential, overall annual growth for aluminum die casting is likely to be 10% in 1992-1995 and 8% thereafter. Total production will rise from 26,000 tons per year in 1991 to 42,000 in 1995, 62,000 in 2000 and 91,000 in 2005.

The target of this die casting shop is to produce internationally competitive die cast parts and molds for supply to final assemblers. In the long run, the die casting section is the test-run section and the mold making section is the main business. In the fully developed capacity, the mold making section will command much higher revenue than the die casting section, reflecting the higher value added in mold making. Since mold making is highly sophisticated technology, the expansion of the business must proceed step by step. The size of operations for both die casting and mold making assumed to be the minimum one. However, it has a full line of mold making. Since local heat treatment shops pose some concern for the quality, It is safe to include heat treatment facility as part of mold making section.

SALES SCHEDULE

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Die Casting | | | | | |
| revenue '000 baht | 21,888 | 26,608 | 30.416 | 32,317 | 32,317 |
| Prod. (tons) | 273.6 | 332.6 | 380.2 | 403.9 | 403.9 |
| operating capacity | 50% | 70% | 80% | 85% | 85% |
| Mold Making | | | | | |
| revenue '000 baht | 0 | 0 | 29,200 | 23,035 | 32,639 |
| prod. (units) | 0 | 0 | 24 | 28.8 | 40.8 |
| operating capacity | 0 | 0 | 50% | 60% | 85% |
| total revenue | 21,888 | 26,608 | 49,616 | 55,352 | 64,952 |

## 1.3 Raw Materials and Supplies

The major raw material in manufacturing of aluminum die cast is aluminum allow ingots. Required material for one ton final product is,

44,000 Baht X 1/0.9 = 48,900 Baht

Therefore the annual cost of aluminum ingot is,

48,900 Baht X 404 ton = 19,751,000 Baht

Estimated requirement of steel for a unit mold is 250 Kg. Given 62.5 Baht per Kg as a unit price, cost for a unit mold is,

250 Kg/unit X 62.5 Baht/Kg = 15,625 Baht/unit

Thus annual raw material cost of mold making is,

15,625 Baht X 40.5 unit = 63,280 Baht

Electricity, which is mainly consumed in furnaces, compressors and other machineries, is estimated 2,380Kwh/day assuming three shifts for die casting and one shift for mold making. Thus, annual power consumption is:

2,380 Kwh X 300 days = 714,000 Kwh

To nominalize by a load factorof 0.8 and utilization factor of 0.8,

714,000 Kwh X 0.8 X 0.8 = 456,960 Kwh

Given 1.5 Baht /Kwh as a unit price, the annual cost of power is,

1.5 bahts X 456,960 Kwh= 685,440 Baht

Water is used for cooling and worker amenities. 6,000 l of water is estimated to be consumed every day. Thus annual water consumption will be,

6,000 l X 300 days = 1,800,000 l

Given 7 Baht/Kl as a unit price, the annual cost is,
20 Baht/Kl X 1,800 Kl = 36,000 Baht

Oil is consumed in furnace in order to melt aluminum ingots. The estimated fuel requirement is 100 liter per one ton of aluminum ingots. Annual oil requirement is:

404 ton X 1/0.9(yield rate) X 100 l/ton = 44,900 l

Gieven 10 Baht per liter as a unit price ,the annual cost is,
10 Baht X 44,900 l = 449,000 Baht

## 1.4 Location and Site

Proximity to major clients is the key criteria for locating the die casting factory. Picking a site centrally located to major automobile, motorcycle and electronics assemblers is the top priority. Other key criteria include:

1. distance from Lamechabang Port and Bangkok Port
2. distance from suppliers
3. distance from residential areas
4. availability of utilities
5. land prices
6. locational guidelines and financial incentives provided by the government

Well Grow Industrial Estate is convenient both to Bangkok (35 km) and Lamechabang Port (30 km). Necessary infrastructure, including waste water treatment facilities, are available at the site. This project has relatively minimal physical requirements, so necessary utilities and other facilities such as power, water, waste treatment, and communications could be installed within two to three months.

Environmental Impact

Negative impact on the environment from this project should be extremely limited. Water consumption (about 6 tons/day) will be mainly for toilet, dining facilities and water cooling. All toxic or hazardous wastes will be send to local treatment facilities, along government regulations formulated by IEAT and the Department of Industrial Works. Melting aluminum does not produce air pollution. The main environmental concern will be for plant workers, due to high levels of heat discharged by melting aluminum ingots. This will be alleviated by insulation and ventilation.

## 1.5 Project Engineering

Ingots of different aluminum alloys are mixed and melted down in the furnace to make molted metal of specific alloys required for die casting. Since the nature of casting differs depending on the composition of alloy which is used, selection of alloys is made in accordance with the properties required for the finished casting products and the method of casting to be employed in their production.

Casting

The molten metal is then transfered to the casting machine. It is supplied into the shot sleeves of the machine and injected into a die by the piston so as to form the finished die casting. A cold chamber die casting machine is used for aluminum die casting.

Machining

The die casting products which are extracted from the die casting machines undergo a variety of machining as part of their finishing. The main types of machining are trimming to remove burrs, finishing with a sander, and any necessary heat treatment and plating, etc.

The availability of these machining processes which follow die casting is therefore an important aspect of technology in die casting factories since this processing ensures a higher value added and the upgrading of product quality.

Testing

Rigorous testing and inspection is carried out throughout the process above-mentioned in order to attain stability of product quality. First, selection of blank materials and inspection of molten metal is conducted, during casting operations the operators carry out visual observation checks and sampling inspection of quality and dimensions are carried out. In final inspections CT scanners and other devices are employed to carry out detailed and thorough external inspections. The latest inspection devices and equipment are employed in an effort to improve quality control levels.

B. Mold making

Design

The first step of mold making is design of a mold which requires high level of expertise and technology. Mold design needs to take thorough account of the expansion coefficient of the die material in relation to temperature. A mold is composed of several parts, having different type of steel in order to meet material requirement.

Material selection and measuring

Based on the design appropriate material is selected and is then measured and roughly machined in accordance to the drawinge.

Machining

In machining stage various machine tools such as a machining center, a milling machine, a surface grinder and others are employed to manufacture a mold with a high level precission. Complicated maching technology is required because water cooling system is involved in a mold.

Finishing

After machining heat treatment is carried out to strengthen and improve the material characteristics. Also shot blast is undertaken. Then parts of a mold are set up and final surface finishing is executed.

Test shot and inspection

After installation of a mold in a die cast machine, test shot is undertaken to check a product. Then a mold, having passed the final inspection, is used for the commercial production.

Most machinery is imported except for transport equipment and auxiliarly equipment.

Estimated shipping and installation costs are as follows;

Phase I : 6,999,000 Bahts
Phase II : 4,608,000 Bahts

Plant Layout and Land Requirement

The factory will be located 50km away from the central Bangkok. The total land area is assumed to be twice the size of the building. The factory needs 960 m2 as shown in the below table. The unit cost of the building is rather higher than the local average due to the foundation requirement and air-conditioning for the mold making section.

Land and Building Area

| ITEM | Area (m2) | UNIT PRICE | COST |
|---|---|---|---|
| LAND | 1920 | 0.94 | 1805 |
| SITE PREPARATION | 1920 | 2.08 | 4000 |
| BUILDINGS | 960 | 36.5 | 35000 |

## 1.6 Plant Organization

This project will be organized as a wholly Thai-owned company with no full-time foreign advisors or employees. It is expected, however, that major clients will provide technical cooperation periodically to help raise and maintain quality levels. Short-term technical advisors/trainers will assist during the initial 2-3 years of production.

The firm will consist of three departments, die casting, mold making, and administration, each headed by department manager. Aluminum die casting and mold making department comprise of process, maintenance, and quality control. The mold making section also has a design section. Administration consists of accounting, procurement, sales, delivery, general, and stock control.

Factory Overhead

A property management fee is for locating in an industrial estate is estimated to cost 3.75 baht per square meter for a total of 7,425 baht per year (1.980 m2). Insurance for the factory and machinery is estimated to cost 1% and 2%, respectively.

Administrative Overhead

Administrative costs mainly consist of labor, office supplies, equipment and security, and can be seen in the following table:

| | | | in baht |
|---|---|---|---|
| | Year 1 | Year 2 | Succeeding Years |
| Labor | 1,040,000 | 1,040,000 | 1,235,000 |
| Supplies/Equip. | 190,000 | 190,000 | 500,000 |
| Total | 1,230,000 | 1,230,000 | 1,735,000 |

## 1.7 Human Resources

Requirements by Phase

Phase I will include construction of the factory and introduction of die casting. Phase II will see tne addition of mold making. The first phase will require 48 production workers and five adminstrative staff. In phase II, 29 production workers and 3 administrative staff will be added.

## 1.8 Implementation Schedule

Implementation Schedule (x=months)

| Stage | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| Feasibility Study/Design | xxx | | | |
| Establishment of Company | | x | | |
| Government Registration | | x | | |
| Construction | | xx | xxx | x |
| Training | | | | xx |
| Trial Production | | | | xx |

Pre-production Costs

Following the establishment of the company, the pre-production period will be one year, during which costs will total 2,274,000 baht. The breakdown of costs is as follows:

| | |
|---|---|
| a. feasibility study/detailed design | 800,000 baht |
| b. worker training | 640,000 |
| c. labor | 260,000 |
| d. administration | 520,000 |
| e. property purchase tax (3%) | 54,000 |
| Total | 2,274,000 |

## 1.9 Financial Evaluation

General Assumptions

a. construction period: 1 year
b. production period: 15 years
c. interest rate: baht long-term 15%; short-term 13%
d. grace period 2 years
e. loan term 5 years
f. depreciation: buildings 20 years; machines 10 years straight line
g. insurance: buildings 1% of value; machines 2% of value
h. taxes VAT 7%; income 35%
i. equipment maintenance: die cast 8% of value; mold making 10% of value

Initial Investment Costs

Investment will be divided into two phases: die casting will begin in phase 1 and mold making will commence in stage 2. Investment costs are as follows:

| | cost ('000 baht) |
|---|---|
| Phase 1 | |
| land/buildings | 40805 |
| machinery/equipment | 40889 |
| pre-production capital expenditures | 5315.25 |
| Phase 2 | |
| machinery/equipment | 27648 |
| total | 114657.25 |

Source of Funds

The initial cost will be financed by equity (43.418 million baht), with the rest to come from a long-term loan (40.55 million). The long-term loan will carry an interest rate of 15%, with a two-year grace period and five-year term.

Production Costs

In the fifth year, at the maximum operting rate, production costs will total 40.603 million baht, which will include factory costs of 20.673 million baht, administrative overhead of 2.970 million, depreciation of 8.803 million and financial costs of 8.157 million.

Revenues

Based on current operating practices in the industry, it is assumed that the die casting section will operate on three shifts, with an output cycle time of 60 seconds. The 350-ton, 200-ton and 135-ton machines will produced a final output with a net weight of 0.7 kg, 0.3 kg and 0.2 kg, respectively.

Mold making will operate on one shift, producing four molds per month at full operation. Current prices are 80,000 baht per ton of die casting and 800,000 baht per mold.

Internal Rate of Return

Based on the above assumptions (base case), this project would produce an internal rate of return on investment of 20.5% and 19.17% on equity. The net present value at 15% is 32,014.46.

Economic Analysis

With a rapid increase in production of motorcycles, automobiles and electrics/electronics in Thailand, demand for aluminum die casting and mold making should rise at a rapid rate. The project has a favorable IRR and the creation of a strong supporting industry should have a good impact on Thailand's industrial and economic structure. Therefore, both the Thai government and entrepreneurs should take an aggressive approach to implementing this project. In particular, the combination of die casting and mold making in one factory should make this attractive and profitable. These are key products required for a shift to higher-quality final assembly of high value-added goods.

There is little environmental impact from this project, which will result in direct and indirect employment creation, as well a reduction in parts imports. Over time, the development of healthy supporting industries will be a lure to encourage more final assemblers to create factories in Thailand.

# Chapter 2: Project Background

The objective of this project is to show the economic and financial viability for the expansion of supporting industries in Thailand. The selection of die-casting as a target sub-sector came as a result of discussions held in January 1992 among UNIDO, the Thai government and the Consultant, and was based on the recent growth and projected rapid increase in assembly production in Thailand, especially in the automobile, electronics and electrics sectors. Packaging and forging sectors were also considered, along with electroplating, which was selected for a less detailed opportunity study. Foreign-affiliated large-scale manufacturers and assemblers have been forced to rely heavily on imported parts and inputs, not only hurting the trade balance, but forgoing opportunities for increased value-added to be retained domestically, and for upgrading the technological base. Continued steady increases in large-scale, assembly-type manufacturing are expected in Thailand, which should provide strong demand for die-casting, the building block for a wide variety of manufacturing inputs and finished products.

Die-casting is seen as a key input to several major industrial sectors Thailand is targeting over the near future. Not only will the creation of a high-quality parts industry lead to import substitution, but it will lower costs for final manufacturers, raising their international competitiveness, and boosting Thai exports. Healthy supporting industries will create jobs, raise income levels, and improve industrial linkages.

While this study is not targeted at specific investors, the Consultant has approached several companies to gauge interest and has found strong potential. Further investment promotion, such as seminars by concerned Thai government agencies, will be needed to disseminate the results of this study, and to encourage investors to implement the recommendations contained within.

Field work for this study was carried out by the Consultant between January and June 1992, with additional follow-up research conducted through September.

# Chapter 3: Market Analysis

## 3.1 Current and Future Market Trends

The main clients for die cast products in Thailand are (1) motorbike and car manufacturers; (2) assemblers of domestic electrical appliances and consumer products and (3) computer-related sectors.

For vehicle production, the development of engines which consume less energy has led to a greater demand for light-weight motor parts, increasing the demand for aluminum die casting products.

Since the majority of the main parts used by the motor car industries in the U.S.A., Japan and Germany (such as the engine block, engine main bearing cap, manual transmission case, front gear housing, camshaft case, oil pan, clutch housing, etc.) have complicated structures, aluminum die castings are used .

In Thailand, domestic production of die cast engine parts is minimal, requiring assemblers to import, raising costs and lengthening delivery times. Assemblers interviewed said they would prefer to rely on local suppliers, but that quality and delivery times are not up to required standards.

Clients in the motorbike sector account for 80% of the market of die casting products in Thailand. The main die cast products concerned in this sector are the R/L crank case, the R/L CRK cover, the Hub front wheel, the Hub rear wheel, the Lever brake, etc.

The automobile market in Thailand at present is for about 300,000 cars, and if the export of commodities continues to increase with continuing economic expansion of the country then Thailand is expected to secure a firm position as supplier of automobiles in the markets of the Indochina peninsula (that is Vietnam, Laos, Cambodia and Myanmar). In line with this and with the improvements in technology in Thailand a further increase in the demand and production of die castings is expected to result.

Motorbikes are the basic means of transportation throughout most of Thailand. The market size is estimated at about 700,000 units. Further, it was recently reported in the April 20th, 1992 edition of the Bangkok Post that "Honda will export CKD kits to China". According to the same article Thai Honda Manufacturing Co. is to develop a capacity to export 2,000 CKD sets of the Honda Dream Motorcycle. Exports are scheduled to begin as of July, 1993, and these are to be increased after one year of operation to a level of 50,000 units.

Consequently, as a result of the implementation of the above export projects, the demand for motorcycle parts will increase in 1993 and 1994, expanding the domestic aluminum die casting markets, increasing productivity while also helping to establish higher levels of expertise in die casting technology.

In the domestic electrical appliances sector aluminum die casting parts are used for production of the brackets of electric fan motors, for parts used in rotators, air conditioner, and in refrigerator compressors.

Recently exports of air conditioners and refrigerators have shown an increase. However, at present the aluminum die casting parts of compressors are assembled from imported parts. Since a high level of technical competence is required in processing this represents a challenge to be met by the die casting technology of Thailand. The die castings for the motor parts of electric fans are already built-in to these by the manufacturers of electrical appliances. The annual rate of increase in demand for electric fans is around 30% in the Bangkok Metropolitan area and the market shows a continuing expansion. Therefore a continued increase in the production of die castings for the electric fan market can be expected.

## 3.2 Production Volume of Aluminum Die Cast Products in Thailand

There are two main methods for evaluating the production output of die casting products in Thailand. The first method is to total the reports of daily output which are issued by the die casting manufacturers in accordance with the government directive making such reports compulsory. The second method is to estimate the number of die casting machines installed in factories together with the capacity and actual operating rates of such machinery to produce a model to serve as basis for an overall estimate of production output. For this Report, it was impossible to visit all of the factories where die casting machinery is installed. Therefore, visits were made to representative factories. The main emphasis during such visits was to aim at getting a view of the general situation of production of such factories in Thailand and on establishing the general market characteristics of die casting products in Thailand. Finally, it should be noted that there are 48 die cast factories which are registered with the Ministry of Industry in Thailand.

The number of die casting machines which are currently installed at sites in Thailand was estimated in the present Report by conducting a survey.

a. Number of die casting machines: about 200

b. ratio of imported die casting machines: about 80% of imported die casting machines are of Japanese manufacture while the rest are from Taiwan and other countries.

c. Operating conditions: continuous operation 24 hours a day

d. Operators: 3 shifts, with one operator handling one die casting machine

e. Monthly shots for one die casting machine: 6,000 shots x 90% yield = 5,400 shorts monthly

f. Average weight for individual short: is taken to be 2 kg

g. Monthly output per machine: 5,400 shots x 2 kg = 10,800 kg

h. Monthly output in Thailand assuming 200 die casting machines to be operated: 10,800 kg/month x 200 machines = 2,160 tons/month

i. Yearly Die Casting Output of Thailand and Tonnes: 2,160 tons x 12 months = 25,920 t/y (rounded off to 26,000 t/y)

Estimating the output of die casting products as above on the basis of the number of die casting machines installed in Thailand gives us a figure of between 25,000 and 26,000 tons/year as an estimate for the scale of die casting production in Thailand.

In order to confirm whether such a figure is reasonable as an estimate of the scale of production of die casting products in Thailand and as a comparative reference we have indicated the production figures for aluminum casting products in other countries.

Output of Aluminum Casting Products of Main Manufacturing Countries

(Source: Modern Casting Dec., 1990)

| Country | Aluminum Casting Products in Tons | |
|---|---|---|
| Taiwan | 91,800 | |
| France | 240,090 | |
| West Germany | 475,529 | |
| Italy | 413,000 | |
| Japan | 980,352 | (of which 752,000 t die cast) |
| South Korea | 28,500 | |
| Spain | 90,000 | (of which 63,000 t die cast) |
| U.K. | 121,000 | (including magnesium castings) |
| U.S.A. | 997,940 | (of which 661,839 t die cast) |

3.4 Characteristics of the Aluminum Die Casting Market

- Since the main clients are Automobile and Motorcycle firms market trends in these sectors tend to have a direct influence.

- Die cast production is on a made to order basis and so products are completely custom made. Once manufactured it is impossible to redirect such parts for use as industrial products of a different type from those originally intended.

- The equipment investment required for die casting machines, etc. is of the order of 30 million Baht and this means that the die casting industry enjoys lower costs the higher the output involved as a result of the operation of economies of scale.

- Considerable technical and managerial expertise is required to assure a definite level of production output is achieved.

3.5 Future Market Prospects

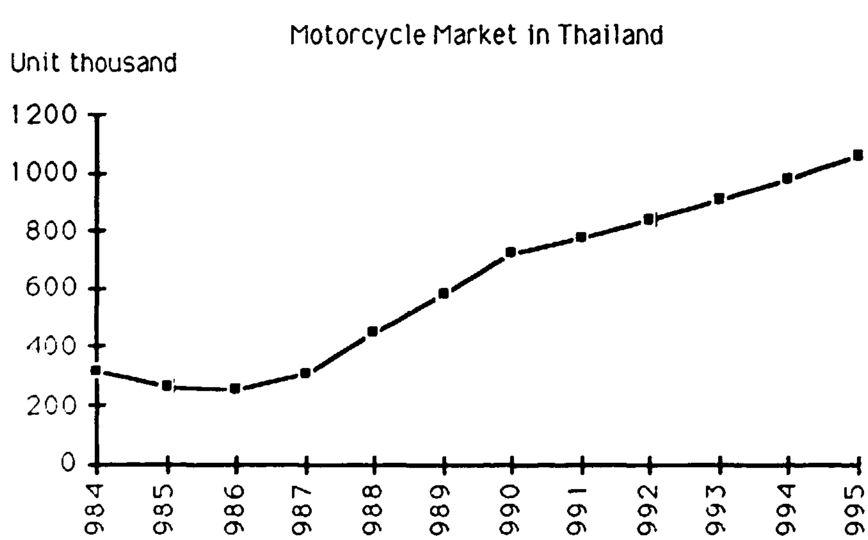
- The decisive factor determining the future of the die casting sector is the development of the Automobile sector.

- Consequently while giving constant attention to the market characteristics and technical developments occurring in the motorcycle and automobile sectors it is necessary to ensure that the die casting sector stays one step ahead of these changes in terms of technology and expertise.

- As a concrete measure to obtain position of superiority in the market it is necessary to undertake the introduction of die casting technology from countries with the most developed automobile industries.

3.6 Motorcycles

The motorcycle is the most common means of transportation for the Thai people. The market of the motorcycle is estimated at 720,000 in 1990. Since 1986 Thai motor cycle market expanded at 30% per year on the average. Fig 1 indicates the market of motorcycles in Thailand. With a moderate projection of 8% annual growth rate, the domestic market alone will reach one million set level by 1995.




In addition, there is a trend that Thailand become the export base of motorcycles for Asian countries. According to Bangkok Post, April 20, 1992, Honda is planning to export the CKD sets of motorcycle "Honda Dream Motorcycle" to the mainland

China. The operation is expected to reach the level of 50,000 per year in 1994. The export opportunities are immeasurable, but enormous.

The motorcycle production has a demand for a substantial amount of aluminum parts. Assuming 9.2 kg of aluminum die casting parts for one motorcycle, and 120, 000 shots per year and 1 kg per shot for one die casting machine, the growth of the local market alone based upon the above forecast will require additional 25 units of die casting machines by 1995.

## 3.7 Automobiles

An automobile demands the largest amount of aluminum die casting parts in terms of one unit of production. Aluminum parts comprise 8-10% of the total weight of an automobile. In other words, one automobile uses 100 -150 kg of aluminum parts. Currently in Thailand, local manufacturers are supplying aluminum oil pans, pistons, etc. Automobile market in Thailand also has shown an impressive growth since 1986. The total volume of sales reached 300,000 in 1990. The market is expected to reach 500,000 in 1993. Although the local production of automobile parts is limited, as the production volume increases and the local content restriction becomes more extensive in automobile industry, this industry as well generate more demand for the local supply of aluminum die casting parts.

## 3.8 Electrics and Electronics

The common use of aluminum die casting parts for electric appliances are the brackets for motors and rotators used for electric fans, air conditioners, and refrigerator compressors. However, currently the aluminum die casting parts for compressors are imported. It is expected that the local supply will replace the importation in the near future. The production of electric appliances in Thailand is expected to increase rapidly in Thailand. For example, the market of electric fans in Thailand is expanding at an annual rate of 30%.

Due to its non magnetic character, aluminum die casting parts are used for computer related products. Among the multi-national corporations that have been transferring their export bases to Thailand, electronics industry is the most aggressive in this respect. Seagate is one such example. Because of its orientation for export this industry will also demand a large volume of aluminum die casting parts. The electronic devices require smaller and thinner aluminum die casting products in general. Thinner aluminum die casting production requires more sophisticated technology in aluminum die casting. It will be necessary to control the temperature of molds and molten aluminum more stringently and scientifically. The molds for thinner products will require more elaborate design and finer finishes. The integrated development of the electronics industry in Thailand depends on whether Thai aluminum die casting industry can meet these technological challenges, or not.

3.9 Future Demand for Aluminum Die Casting

Considering the rapid growth of these three main sectors in the recent past and strong potential, overall annual growth for aluminum die casting is likely to be 10% in 1992-1995 and 8% thereafter. Total production will rise from 26,000 tons per year in 1991 to 42,000 in 1995, 62,000 in 2000 and 91,000 in 2005.

3.10 Bottlenecks for development of the Die Casting Industry

3.10.1. Economy of Scale

Cost is the most decisive factor in determining the extent of the local production of any product. For mass production technology such as die casting, the economy of scale is the key factor of determining the production cost. For die casting, the fixed cost is not the die casting machine only. For each product, die casting requires a mold which by itself costs between US$ 20,000 and over 100,000. The life of one mold ranges from 30,000 to 80,000. Whether the demand for a specific aluminum die casting part amounts to 50,000 or 5000 will critically affect the final production cost. In general, the mold cost comprises 10-20% of the total cost. In the past a small size of local demand for industrial goods always posed a problem in bearing the fixed cost of the mold. However, as the Thai economy has grown and the industry has transformed itself to export based structure, the size of demand no longer poses hindrance for the local production for many products.

3.10.2 Local Mold Making

Since current global manufacturers compete fiercely both in cost and quality, the supply of parts to the global manufacturer means shifting a gear from local to international standards. It is not possible to attain internationally competitive quality level simply by the state-of-art casting technologies alone. Quality assurance lies on the design and manufacturing of molds. There is no mold maker in Thailand which is capable of supplying quality die casting molds. There are some qualified plastic mold makers and press die makers in Thailand. Currently aluminum die casting shops in Thailand source the molds either from Taiwan or Japan. The foreign procurement of molds incurs higher adjustment cost and causes frequent troubles in quality assurance. In order to assure the quality of final products some die casting shops have a mold making section for the internal supply, but the low production volume of molds have entailed higher costs of molds. The local production of quality molds will lower the cost of molds and allows more frequent and closer communication between the mold maker and the manufacturer. The local production of die casting parts may improve both quality and cost to further accelerate Thai economy.

### 3.11 Project Strategy

The target of this die casting shop is to produce internationally competitive die cast parts and molds for supply to final assemblers. In the long run, the die casting section is the test-run section and the mold making section is the main business. In the fully developed capacity, the mold making section will command much higher revenue than the die casting section, reflecting the higher value added in mold making. Since mold making is highly sophisticated technology, the expansion of the business must proceed step by step. The size of operations for both die casting and mold making assumed to be the minimum one. However, it has a full line of mold making. Since local heat treatment shops pose some concern for the quality, It is safe to include heat treatment facility as part of mold making section.

#### 3.11.1 Advantages of Integrated Die Casting Shop

The advantage of an integrated die casting shop is not so much the cost-saving through the vertical integration as the improvement and assurance of quality. The internal procurement of mold for die casting will enable quick delivery and assured quality of final products. Having die casting machines will allow test shots for the molds for outside clients. Both die cast parts and molds will enjoy higher quality. Another advantage is that the die making capability will allow test sample making and will offer better service to the clients.

#### 3.11.2 Technology Development Method

It is impossible to start as an integrated die cast shop with mold making capacity since mold making is highly sophisticated work and requires experience. Therefore, it is natural to conceive of gradual build-up of the technology base. The development of the technology consists of three phases. The initial phase is the mustering of die casting process. The second phase is to attain the capability for the machining of molds. The final phase is the integration of mold design capabilities. Physical expansion should accompany the level of technologies. There are two possible ways to initate an aluminum die casting project:

Joint Venture/Technical Cooperation

There is a great deal of advantage in joint venture in achieving the necessary technological levels in much shorter period of time. The computerization of modern machine tools have made it possible to record machining operations in tape or magnetic device. Electric Discharging Machine (EDM), Wire-cut Machine, and Machining Center all are controlled by a computer. Having a joint venture partner from an industrialized country will dispense with the programming capability in the initial phase. Such arrangement can break the phasing of technology transfer even further.

There are several relatively modern die casting companies in operation. These can be encouraged to expand into new product lines through a technical assistance or equipment from foreign sources.

3.12 Marketing Strategy

Because die casting products are made to order, marketing techniques are different than for standardized goods. Long-term, stable business relationships with final assemblers are necessary, and to do this, the factory must be able to operate under the following conditions: 1) produce consistent, high quality products; 2) meet strict delivery schedules; 3) offer internationally competitive prices. The first two criteria are particularly important to Japanese-affiliated manufacturers. Given that most die cast products are currently imported, or produced internally in an inefficient way, assemblers surveyed indicated they would be happy to switch procurement to local subcontractors. In addition, many of these companies say they will provide technical assistance to raise and maintain quality standards.

3.13 Project Phasing and Production Capacity

The development of the project is phased into two. Initially the aluminum die casting part will be constructed. After two years of the operation of aluminum die casting, mold making capacity will be added. The phasing is based upon the expected built-up of technology through learning.

The die casting section consists of three die casting machines. The mold making section can produce 3-5 molds per month depending on the size and complexity of the mold. Since the development of the shop should follow the phasing of technology development, the factory will build the aluminum die casting section first and mold making second. The scheduled production for each section is shown in Table 1 below:

SALES SCHEDULE

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Die Casting | | | | | |
| revenue '000 baht | 21,888 | 26,608 | 30,416 | 32,317 | 32,317 |
| Prod. (tons) | 273.6 | 332.6 | 360.2 | 403.9 | 403.9 |
| operating capacity | 50% | 70% | 80% | 85% | 85% |
| Mold Making | | | | | |
| revenue '000 baht | 0 | 0 | 29,200 | 23,035 | 32,639 |
| prod. (units) | 0 | 0 | 24 | 28.8 | 40.8 |
| operating capacity | 0 | 0 | 50% | 60% | 85% |
| total revenue | 21,888 | 26,608 | 49,616 | 55,352 | 64,952 |

# Chapter 4: Raw Materials and Supplies

4.1 Raw materials

The major raw material in manufacturing of aluminum die cast is aluminum allow ingots. Although Al-Cu-Si group alloy is mainly used for casting, a couple of alloys will be mixed and melted in order to meet required chracteristics. The average unit price of alloy ingot is 44,000 baht. Unit requirement of material is calculated based on the assumption of 90 % of yield rate (ratio of product weight over melting weight). Required material for one ton final product is,

44,000 Baht X 1/0.9 = 48,900 Baht

Therefore the annual cost of aluminum ingot is,

48,900 Baht X 404 ton = 19,751,000 Baht

For mold making several types of carbon steel are used for different parts of the mold. For the surface part of mold which directly contacts with molten aluminum, SKD-61 (ISO 40CrMoV5) is usually used while other parts are mainly made of S50C (ISO C50). Estimated requirement of steel for a unit mold is 250 Kg. Given 62.5 Baht per Kg as a unit price, cost for a unit mold is,

250 Kg/unit X 62.5 Baht/Kg = 15,625 Baht/unit

Thus annual raw material cost of mold making is,

15,625 Baht X 40.5 unit = 63,280 Baht

4.2 Utility requirement

Electricity, which is mainly consumed in furnaces, compressors and other machineries, is estimated 2,380Kwh/day assuming three shifts for die casting and one shift for mold making. Thus, annual power consumption is:

2,380 Kwh X 300 days = 714,000 Kwh

To nominalize by a load factorof 0.8 and utilization factor of 0.8,

714,000 Kwh X 0.8 X 0.8 = 456,960 Kwh

Given 1.5 Baht /Kwh as a unit price, the annual cost of power is,

1.5 bahts X 456,960 Kwh= 685,440 Baht

Water is used for cooling and worker amenities. 6,000 l of water is estimated to be consumed every day. Thus annual water consumption will be,

6,000 l X 300 days = 1,800,000 l

Given 7 Baht/Kl as a unit price, the annual cost is,

20 Baht/Kl X 1,800 Kl = 36,000 Baht

Oil is consumed in furnace in order to melt aluminum ingots. The estimated fuel requirement is 100 liter per one ton of aluminum ingots. Annual oil requirement is:

404 ton X 1/0.9(yield rate) X 100 l/ton = 44,900 l

Gieven 10 Baht per liter as a unit price ,the annual cost is,

10 Baht X 44,900 l = 449,000 Baht

# Chapter 5: Location and Site

## 5.1 Location Analysis

Proximity to major clients is the key criteria for locating the die casting factory. Picking a site centrally located to major automobile, motorcycle and electronics assemblers is the top priority. Other key criteria include:

1. distance from Lamechabang Port and Bangkok Port
2. distance from suppliers
3. distance from residential areas
4. availability of utilities
5. land prices
6. locational guidelines and financial incentives provided by the government

Taking into account the above factors, the area between the BMA boundary and Lamechabang Port is most favorable. The following industrial estates meet the needs for this project (see map):

1. Gateway Industrial Estate
2. Well Grow Industrial Estate
3. Bongpakong Industrial Estate
4. Bongpoo Industrial Estate

Of these, Well Grow is the most suitable location, due to its proximity to potential clients. Land prices in these areas are about 920 baht per square meter, which would put the cost for this project at 1.804 million bahts (1,920 square meters x 920 baht).

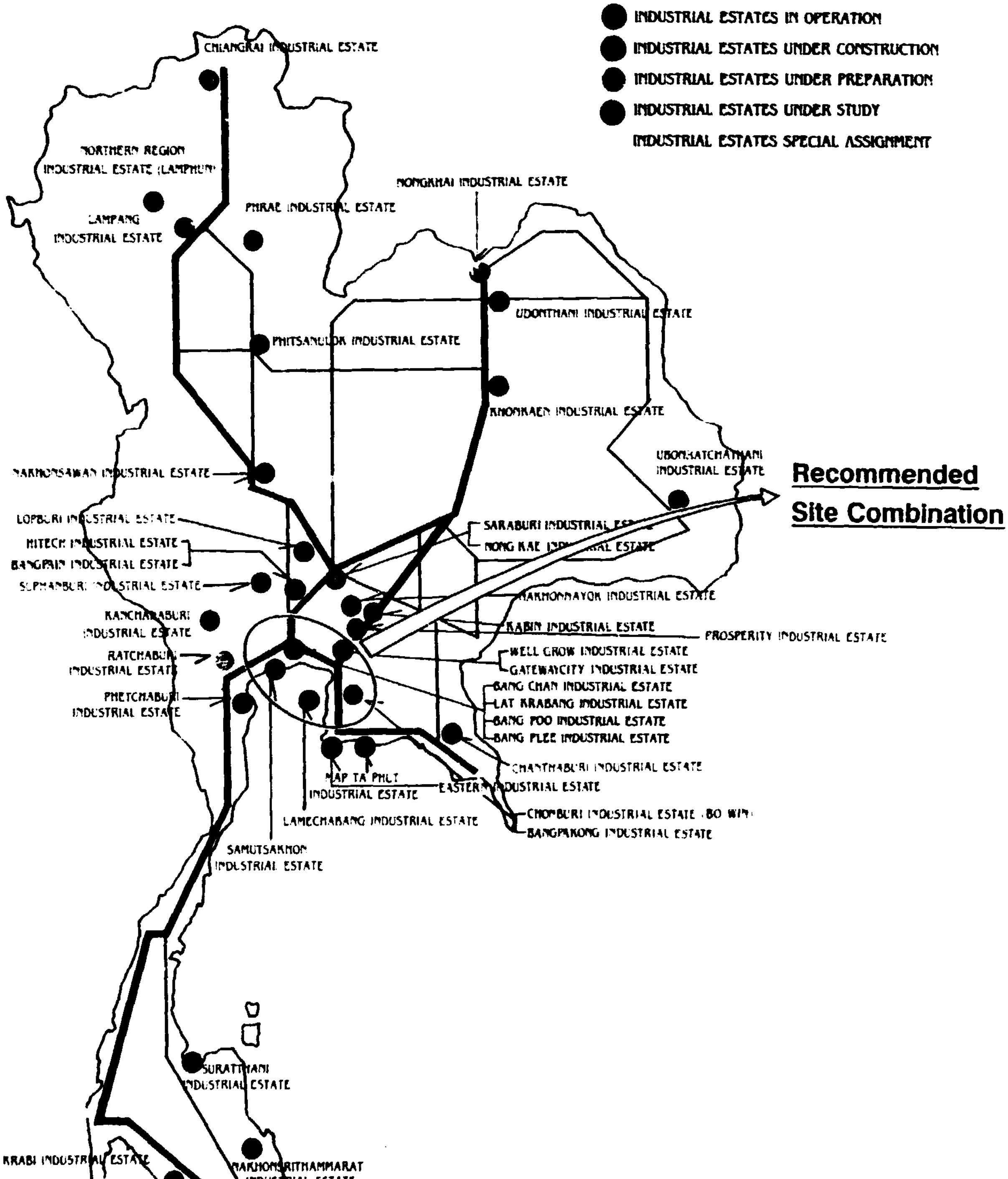
## 5.2 Infrastructure

Well Grow Industrial Estate is convenient both to Bangkok (35 km) and Lamechabang Port (30 km). Necessary infrastructure, including waste water treatment facilities, are available at the site. This project has relatively minimal physical requirements, so necessary utilities and other facilities such as power, water, waste treatment, and communications could be installed within two to three months.

## 5.3 Environmental Impact

Negative impact on the environment from this project should be extremely limited. Water consumption (about 6 tons/day) will be mainly for toilet, dining facilities and water cooling. All toxic or hazardous wastes will be send to local treatment facilities, along government regulations formulated by IEAT and the Department of Industrial Works. Melting aluminum does not produce air pollution. The main environmental concern will be for plant workers, due to high levels of heat discharged by melting aluminum ingots. This will be alleviated by insulation and ventilation.

# INDUSTRIAL ESTATES IN THAILAND




Source : Industrial Estate Authorizing of Thailand (IEAT)

# Chapter 6: Engineering and Technology

6.1 Production technology and requirement

A. Aluminum die casting

The process of aluminum die castiing is as follows;

<u>Melting</u>

Ingots of different aluminum alloys are mixed and melted down in the furnace to make molted metal of specific alloys required for die casting. In general, aluminum base alloys used in die casting can be are divided into the following categories:

- those with excellent liquidity: in the Al-Si group
- those with excellent anti-corrosion: in the Al-Mg group
- those whose strength is increased by heat treatment: in the Al-Cu and Al-Si-Mg groups

Since the nature of casting differs depending on the composition of alloy which is used, selection of alloys is made in accordance with the properties required for the finished casting products and the method of casting to be employed in their production.

One characteristic of the base alloys used for castings in the die casting sector is the greater amount of iron content than is usual with other types of castings. More than 95% of the Aluminum base alloys used in die castings are of the Al-Cu-Si group (ADC 10 or 12). Standard aluminum alloys used in die casting production is shown in appendix. However, in some cases different base alloys are stipulated in the specifications drawn up by clients.

<u>Casting</u>

The molten metal is then transfered to the casting machine. It is supplied into the shot sleeves of the machine and injected into a die by the piston so as to form the finished die casting. A cold chamber die casting machine is used for aluminum die casting. Examples of die casting machinery is attached in the appendix.

Representative Aluminum Alloys used in Die Casting Production

| Code | Alloy Group | Main Constituents (%) | Characteristics | Main Uses |
|---|---|---|---|---|
| Type 1 Die Casting Aluminum | | | | |
| ADC1 | Al-Si | 11.0-13.0 Si | Good casting, excellent anti-corrosion and easily machined | Typewriter, camera, vacuum cleaner, washing machine, measuring devices and airplane parts, etc. |
| Type 3 Die Casting Aluminum Alloy | | | | |
| ADC3 | Al-Si-Mg | 9.0-10.0 Si<br>0.4-0.6 Mg | Good casting, excellent anti-corrosion and easily machined | Clutch covers, mixer of washing machines, oil pump covers, etc. |
| Type 5 Die Casting Aluminum Alloy | | | | |
| ADC5 | Al-Mg | 4.0-11.0 Mg | Extremely good anti-corrosion, but not suited to products of complicated form | Camera body, iron base, mixer, outdoor switch case, pipe joints, etc. |
| Type 6 Die Casting Aluminum Alloy | | | | |
| ADC6 | Al-Mg | 2.5-4.0 Mg | Extremely good anti-corrosion, good resistance to stretching and impacts but poor casting properties | Hand levers, dynamo covers, etc. |
| Type 7 Die Casting Aluminum Alloy | | | | |
| ADC7 | Al-Si | 4.5-6.0 Si | Good casting, anti-corrosion, melting properties | Cooking utensiles, installation tools and materials for construction and shipping, etc. |
| Type 10 Die Casting Aluminum Alloy | | | | |
| ADC10 | Al-Si-Cu | 7.5-9.5 Si<br>2.0-4.0 Cu | Excellent casting and easily machined | Crank case, transmission case, motor cover, domestic utensiles, etc. |
| Type 12 Die Casting Aluminum Alloy | | | | |
| ADC12 | Al-Si-Cu | 10.5-12.0 Si<br>1.5-3.5 Cu | Excellent casting and easily machined | Crank case, gear box case, carburetor body, camera body, base of electric fan, etc. |

A number of technological developments have been accomplished for the improvement of the efficiency of aluminum die casting machinery. The typical development of them are as follows;

(1) The Hot Sleeve Method

This is a new technology currently advocated by the Japan Die Casting Association as of 1983. This method aims at stopping the formation of a solidified layer inside the sleeve since such layering results in disparities of product strength.

(2) The Vertical Cold Chamber Die Casting Machine

A variety of vertical type machines have been developed and these all result in improvements in the strength, porosity, gas content ratio, air tightness, and the heat treatment responsiveness of the Aluminum die castings resulting.

(3) Aluminum Hot Chamber Machine

This was first developed and tried by Toshiba Machine Co. in 1988 and is still in the trial stage. The piston and cylinder coming into direct contact with the molten aluminum is entirely ceramic and this permits the production of a high quality finished product which is superior to the output of a cold chamber in a number of aspects. If this new technology is successfully developed it will revolutionize world technology in this sector.

Machining

The die casting products which are extracted from the die casting machines undergo a variety of machining as part of their finishing. The main types of machining are trimming to remove burrs, finishing with a sander, and any necessary heat treatment and plating, etc.

The availability of these machining processes which follow die casting is therefore an important aspect of technology in die casting factories since this processing ensures a higher value added and the upgrading of product quality.

Testing

Rigorous testing and inspection is carried out throughout the process above-mentioned in order to attain stability of product quality. First, selection of blank materials and inspection of molten metal is conducted, during casting operations the operators carry out visual observation checks and sampling inspection of quality and dimensions are carried out. In final inspections CT scanners and other devices are employed to carry out detailed and thorough external inspections. The latest inspection devices and equipment are employed in an effort to improve quality control levels.

B. Mold making

Design

The first step of mold making is design of a mold which requires high level of expertise and technology. Mold design needs to take thorough account of the expansion coefficient of the die material in relation to temperature. A mold is composed of several parts, having different type of steel in order to meet material requirement.

Material selection and measuring

Based on the design appropriate material is selected and is then measured and roughly machined in accordance to the drawinge.

Machining

In machining stage various machine tools such as a machining center, a milling machine, a surface grinder and others are employed to manufacture a mold with a high level precission. Complicated maching technology is required because water cooling system is involved in a mold.

Finishing

After machining heat treatment is carried out to strengthen and improve the material characteristics. Also shot blast is undertaken. Then parts of a mold are set up and final surface finishing is executed.

Test shot and inspection

After installation of a mold in a die cast machine, test shot is undertaken to check a product. Then a mold, having passed the final inspection, is used for the commercial production.

6.2 Procurement and installation

Major machinery for die casting and mold making is shown in Table 2. Most machinery is imported except for transport equipment and auxiliarly equipment.

Estimated shipping and installation costs are as follows;

Phase I : 6,999,000 Bahts
Phase II : 4,608,000 Bahts

6.3 Plant Layout and Land Requirement

The factory will be located 50km away from the central Bangkok. Fig 2 indicates the building and the layout of the factory. The total land area is assumed to be twice the size of the building. The factory needs 960 m2 as shown in Table 3. The unit cost of the building is rather higher than the local average due to the foundation requirement and air-conditioning for the mold making section.

Table 3 Land and Building Area

| ITEM | Area (m2) | UNIT PRICE | COST |
|---|---|---|---|
| LAND | 1920 | 0.94 | 1805 |
| SITE PREPARATION | 1920 | 2.08 | 4000 |
| BUILDINGS | 960 | 36.5 | 35000 |

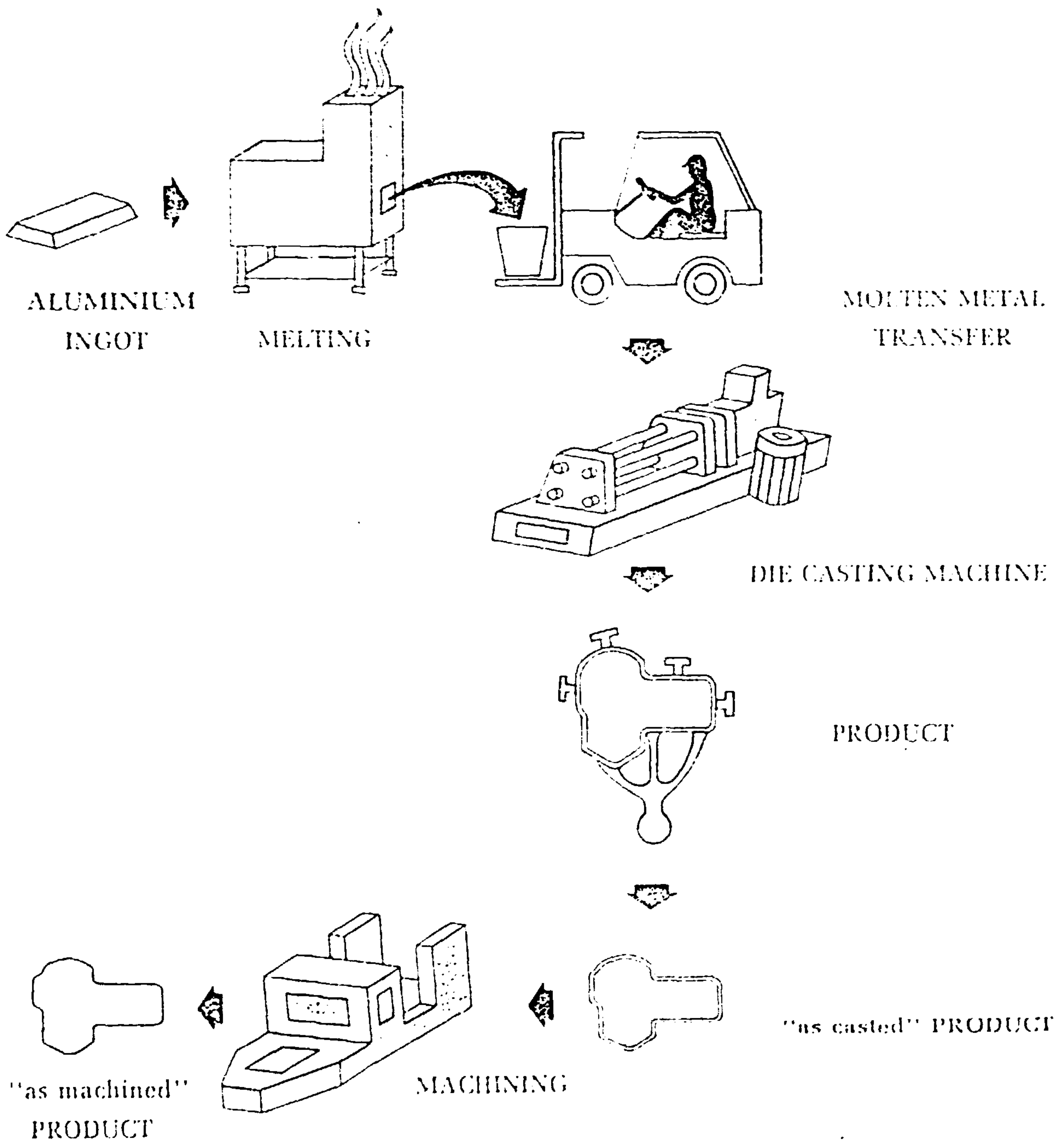
6.4 Die Casting and Engineering

The following table shows the list of machinery necessary for the operations of die casting and die casting mold making. The recent rapid progress in information technologies have brought a drastic change in machining processes. Many machines are equipped with a computer and is capable of repeating the same sequences automatically. It is vital to adopt this state-of-the-art technologies in order to maintain international competitiveness. Therefore, mold-making section includes Machining Center, NC Wire-cut, EDM even though they are costly.

## Machinery Requirements

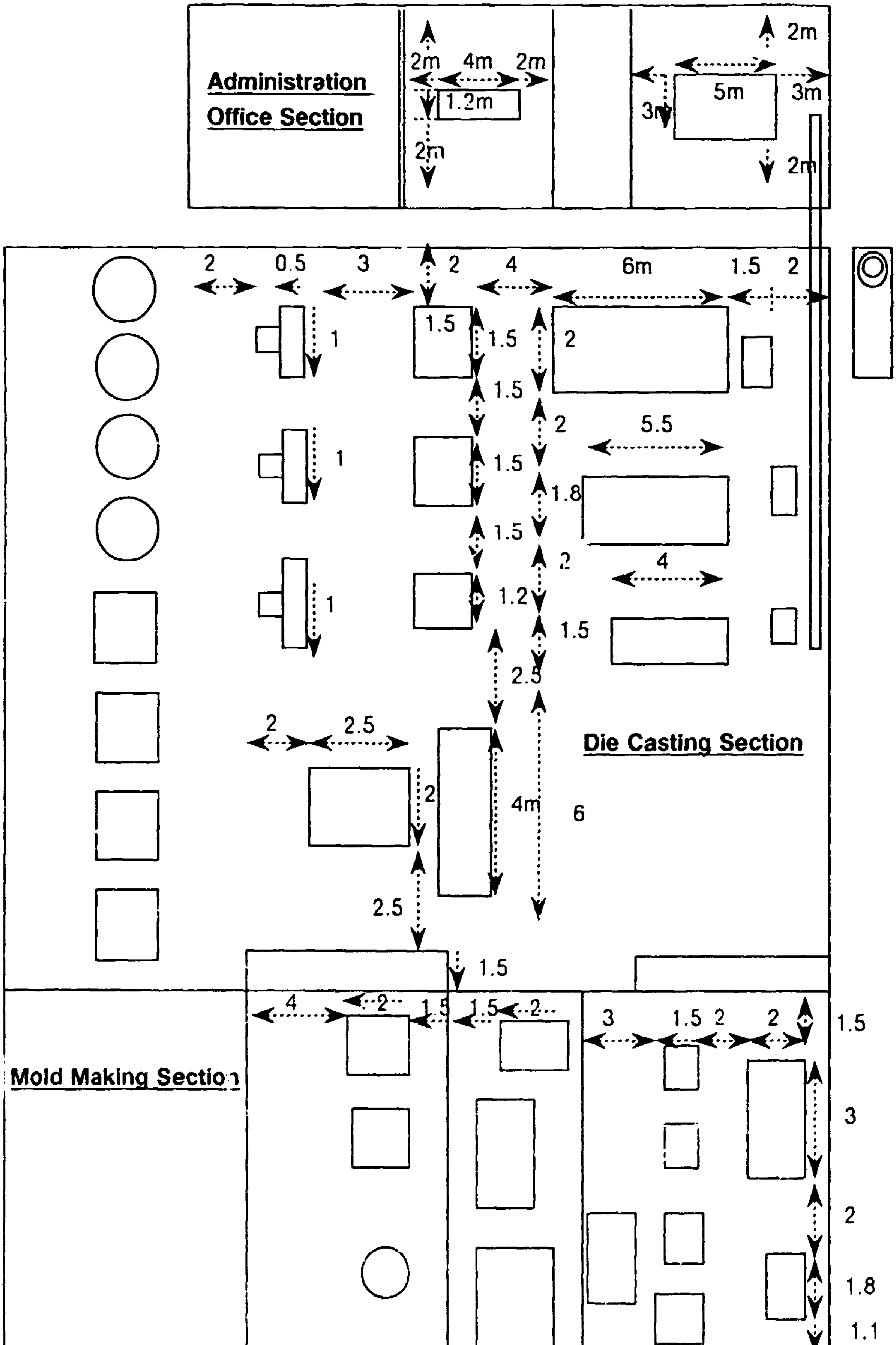
| Type | Specification | Unit Price | No. of Units | Cost |
|---|---|---|---|---|
| **PHASE I** | | | | |
| Die Casting Section | | | | |
| die Casting machine | 350 tons | 7000 | 1 | 7000 |
| | 200 tons | 4400 | 1 | 4400 |
| | 135 tons | 3600 | 1 | 3600 |
| melting furnace | 2 tons | 2400 | 1 | 2400 |
| holding furnace | 500 kg | 240 | 1 | 240 |
| | 300 kg | 200 | 1 | 200 |
| molten metal transport | | 1600 | 1 | 1600 |
| shot blast | rotary | 1200 | 1 | 1200 |
| deburring press | 10 ton | 160 | 2 | 320 |
| | 5 ton | 100 | 1 | 100 |
| belt sander | 50mm width | 30 | 1 | 30 |
| multi-axial drill | | 40 | 4 | 160 |
| automatic lathe | | 120 | 4 | 480 |
| endless paper m/c | 150mm width | 30 | 2 | 60 |
| molten metal tapping mc | | 600 | 3 | 1800 |
| mold relief agent spray | | 600 | 3 | 1800 |
| compressor | 75kwh | 1200 | 1 | 1200 |
| water cooling system | 400 l/min | 600 | 1 | 600 |
| sub-total | | | | 27190 |
| | | | | |
| Testing/Measuring | | | | |
| molten metal thermometer | | 400 | 1 | 400 |
| 3-D meter | | 2000 | 1 | 2000 |
| hardness tester | | 100 | 1 | 100 |
| level plate | | 200 | 1 | 200 |
| measuring device | | 4000 | 1 | 4000 |
| sub-total | | | | 6700 |
| | | | | |
| **PHASE II** | | | | |
| Mold Making | | | | |
| machining center | 500x600mm | 5000 | 1 | 5000 |
| milling machine | 300x400 mm | 1400 | 1 | 1400 |
| surface grinder | 350x500mm | 1000 | 1 | 1000 |
| radial drill | 900mm | 600 | 1 | 600 |
| drill | 30mm | 240 | 1 | 240 |
| lathe | 250mm | 1200 | 1 | 1200 |
| EDM/NC | 500x600mm | 4000 | 1 | 4000 |
| wire-cut | 500x600mm | 4000 | 1 | 4000 |
| shearing m/c | 300mm | 1000 | 1 | 1000 |
| quenching bath | 500x500mm | 1600 | 1 | 1600 |
| tempering furnace | 500x500mm | 2000 | 1 | 2000 |
| shot blast | 500x500mm | 1000 | 1 | 1000 |
| sub-total | | | | 23040 |

# Flow Sheet for Aluminum Die Casting




Source: Thai Engineering Products Co., Ltd.

Fig 2 Plant Layout



# Chapter 7: Organization and Overhead Costs

## 7.1 Plant Organization and Structure

This project will be organized as a wholly Thai-owned company with no full-time foreign advisors or employees. It is expected, however, that major clients will provide technical cooperation periodically to help raise and maintain quality levels. Short-term technical advisors/trainers will assist during the initial 2-3 years of production.

The firm will consist of three departments, die casting, mold making, and administration, each headed by department manager. Aluminum die casting and mold making department comprise of process, maintenance, and quality control. The mold making section also has a design section. Administration consists of accounting, procurement, sales, delivery, general, and stock control.

## 7.2 Factory Overhead

A property management fee is for locating in an industrial estate is estimated to cost 3.75 baht per square meter for a total of 7,425 baht per year (1.980 m2). Insurance for the factory and machinery is estimated to cost 1% and 2%, respectively.

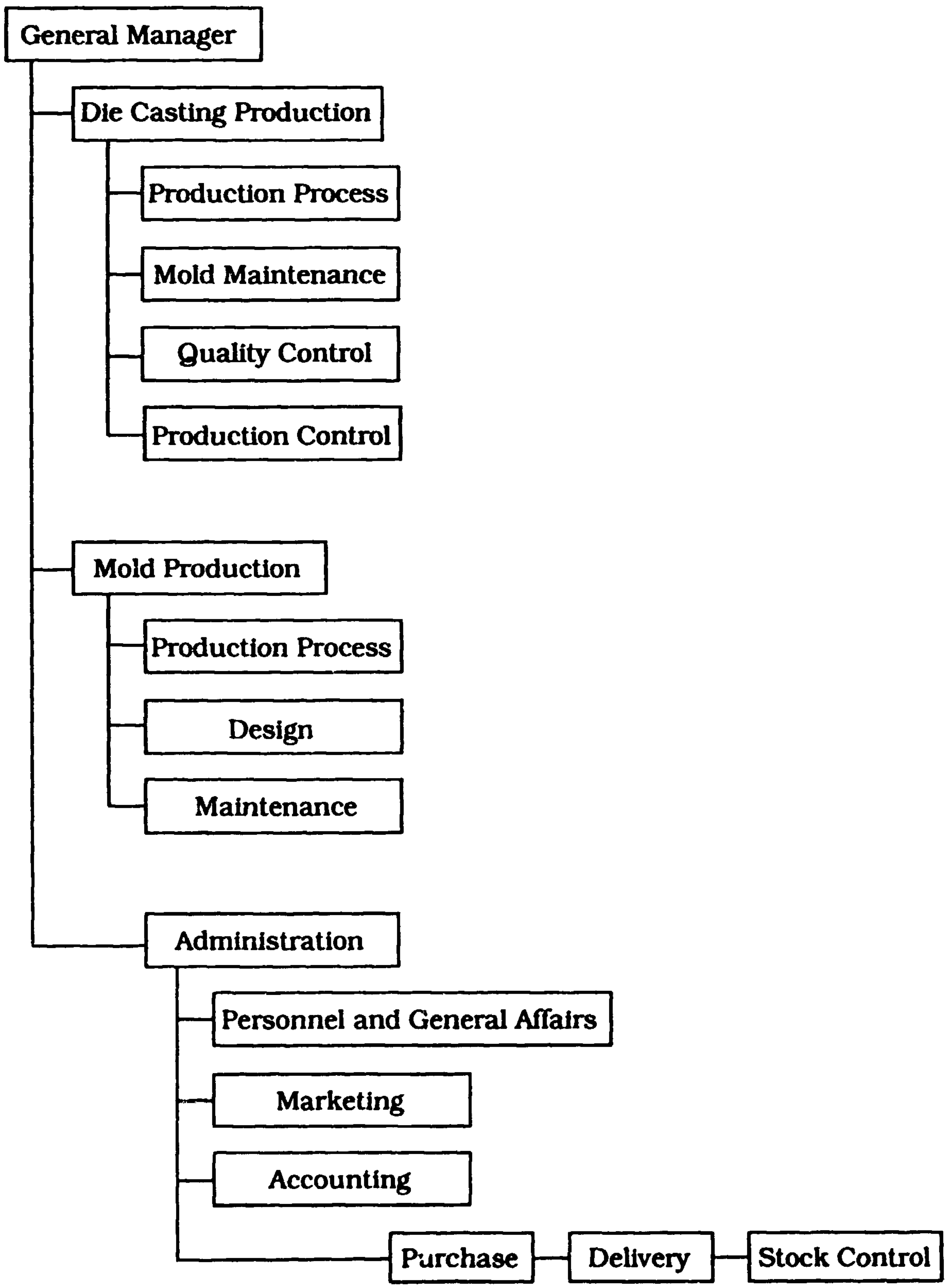
| | | | in baht |
|---|---|---|---|
| | Year 1 | Year 2 | Succeeding Years |
| Property Mgmt Fee | 7,425 | 7,425 | 7,425 |
| Factory Insurance | 384,000 | 384,000 | 384,000 |
| Machinery Insurance | 683,780 | 683,780 | 1,278,580 |
| Total | 1,075,205 | 1,075,205 | 1,670,005 |

## 7.3 Administrative Overhead

Administrative costs mainly consist of labor, office supplies, equipment and security, and can be seen in the following table:

| | | | in baht |
|---|---|---|---|
| | Year 1 | Year 2 | Succeeding Years |
| Labor | 1,040,000 | 1,040,000 | 1,235,000 |
| Supplies/Equip. | 190,000 | 190,000 | 500,000 |
| Total | 1,230,000 | 1,230,000 | 1,735,000 |

# Organizational Structure : Die Cast Plant



# Chapter 8: Human Resources

8.1 Requirements by Phase

Phase I will include construction of the factory and introduction of die casting. Phase II will see the addition of mold making. The first phase will require 48 production workers and five adminstrative staff. In phase II, 29 production workers and 3 administrative staff will be added. The breakdowns for each phase can be seen in the following tables:

Staff Requirements: Phase I

| Production | Salary | No. of Workers | Cost |
|---|---|---|---|
| Line workers | 39,000 | 43 | 1,677,000 |
| Quality control | 156,000 | 2 | 312,000 |
| Production control | 195,000 | 2 | 390,000 |
| Production Manager | 390,000 | 1 | 390,000 |
| Administration | | | |
| General manager | 780,000 | 1 | 780,000 |
| Accountant | 65,000 | 1 | 65,000 |
| Sales | 65,000 | 1 | 65,000 |
| Delivery | 65,000 | 1 | 65,000 |
| Procurement | 65,000 | 1 | 65,000 |
| Total | | 53 | 3,809,000 |

Staff Requirements: Phase II (beginning year 3)

| Production | Salary | No of Workers | Cost |
|---|---|---|---|
| Line workers | 52,000 | 18 | 936,000 |
| Machine center maintenance | 156,000 | 2 | 312,000 |
| Quality control | 156,000 | 2 | 312,000 |
| Mold design | 221,000 | 4 | 884,000 |
| Mold maintenance | 65,000 | 2 | 130,000 |
| Production manager | 390,000 | 1 | 390,000 |
| Administration | | | |
| Stock control | 65,000 | 1 | 65,000 |
| General | 65,000 | 2 | 130,000 |
| Total | | 32 | 3,159,000 |

# Chapter 9: Project Implementation Planning

## 9.1 Pre-production preparations

Assuming the factory locates in an industrial estate, the following steps are necessary:

A. Registration with the Industrial Estate Authority of Thailand, a one-stop service for investors.

B. Land purchase agreement with the industrial estate management company and IEAT.

C. Detailed feasibility study and detailed design of the factory.

D. Employment of factory workers should start 5-6 months before production begins. Standard recruitment practices such as newspaper advertisements should be used. Particular care should be given to the selection of supervisory staff, which must have prior experience in a similar field.

E. Training of production engineers and technicians to ensure high quality products. MIDI can help provide basic training; for more advanced training in mold making. Training by expatriate engineers for a several month period should be considered.

F. Arrangements for utilities, i.e. electricity, water, water treatment, telecommunications, and procurement should be finished before trial production begins. Locating within an industrial estate should make this a simple operation.

G. A two-month trial production should be conducted following the completion of construction to check all equipment and achieve quality control.

Implementation Schedule (x=months)

| Stage | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| Feasibility Study/Design | xxx | | | |
| Establishment of Company | | x | | |
| Government Registration | | x | | |
| Construction | | xx | xxx | x |
| Training | | | xx | xx |
| Trial Production | | | | xx |

9.2 Pre-production Costs

Following the e ablishment of the company, the pre-production period will be one year, during which costs will total 2,274,000 baht. The breakdown of costs is as follows:

| | |
|---|---|
| a. feasibility study/detailed design | 800,000 baht |
| b. worker training | 640,000 |
| c. labor | 260,000 |
| d. administration | 520,000 |
| e. property purchase tax (3%) | 54,000 |
| Total | 2,274,000 |

# Chapter 10. Financial Analysis

10.1 General Assumptions

| | |
|---|---|
| a. construction period: | 1 year |
| b. production period: | 15 years |
| c. interest rate: | baht long-term 15%; short-term 13% |
| d. grace period | 2 years |
| e. loan term | 5 years |
| f. depreciation: | buildings 20 years; machines 10 years straight line |
| g. insurance: | buildings 1% of value; machines 2% of value |
| h. taxes | VAT 7%; income 35% |
| i. equipment maintenance: | die cast 8% of value; mold making 10% of value |

10.2 Initial Investment Costs

Investment will be divided into two phases: die casting will begin in phase 1 and mold making will commence in stage 2. Investment costs are as follows:

| Phase 1 | cost ('000 baht) |
|---|---|
| land/buildings | 40805 |
| machinery/equipment | 40889 |
| pre-production capital expenditures | 5315.25 |
| Phase 2 | |
| machinery/equipment | 27648 |
| total | 114657.25 |

10.3 Source of Funds

The initial cost will be financed by equity (43.418 million baht), with the rest to come from a long-term loan (40.55 million). The long-term loan will carry an interest rate of 15%, with a two-year grace period and five-year term.

10.4 Production Costs

In the fifth year, at the maximum operting rate, production costs will total 40.603 million baht, which will include factory costs of 20.673 million baht, administrative overhead of 2.970 million, depreciation of 8.803 million and financial costs of 8.157 million.

## 10.5 Revenues

Based on current operating practices in the industry, it is assumed that the die casting section will operate on three shifts, with an output cycle time of 60 seconds. The 350-ton, 200-ton and 135-ton machines will produced a final output with a net weight of 0.7 kg, 0.3 kg and 0.2 kg, respectively.

Mold making will operate on one shift, producing four molds per month at full operation. Current prices are 80,000 baht per ton of die casting and 800,000 baht per mold.

## 10.6 Internal Rate of Return

Based on the above assumptions (base case), this project would produce an internal rate of return on investment of 20.5% and 19.17% on equity. The net present value at 15% is 32,014.46.

A simulation analysis has been carried out for cases involving a +/-10% change in revenue and initial investment costs.

Simulation Analysis

| | IRR: investment | IRR: equity |
|---|---|---|
| base case | 20.5 | 19.17 |
| +10% revenue | 23.80 | 23.88 |
| -10% revenue | 17.00 | 14.18 |
| +10% investment | 18.97 | 16.48 |
| -10% investment | 22.27 | 20.68 |

The result of the simulation indicates that this project can be profitably implemented under even severe conditions such as reduced revenue or higher initial investment costs.

10.7 Economic Analysis

With a rapid increase in production of motorcycles, automobiles and electrics/electronics in Thailand, demand for aluminum die casting and mold making should rise at a rapid rate. The project has a favorable IRR and the creation of a strong supporting industry should have a good impact on Thailand's industrial and economic structure. Therefore, both the Thai government and entrepreneurs should take an aggressive approach to implementing this project. In particular, the combination of die casting and mold making in one factory should make this attractive and profitable. These are key products required for a shift to higher-quality final assembly of high value-added goods.

Mold making will provide Thailand with a new technology, and should reduce the burden on the die cast sector. The key to the success of this project is the speed in which workers acquire technological know-how. To reduce risk, it would be better for Thai firms to tie-up with foreign mold making companies in order to acquire advanced equipment and technology.

There is little environmental impact from this project, which will result in direct and indirect employment creation, as well a reduction in parts imports. Over time, the development of healthy supporting industries will be a lure to encourage more final assemblers to create factories in Thailand.

aluminum die casting
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1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: thai baht

## Total initial investment during construction phase

| | | |
|---|---|---|
| fixed assets: | 87009.25 | 46.304 % foreign |
| current assets: | 0.00 | 0.000 % foreign |
| total assets: | 87009.25 | 46.304 % foreign |

## Source of funds during construction phase

| | | |
|---|---|---|
| equity & grants: | 43418.00 | 6.606 % foreign |
| foreign loans : | 0.00 | |
| local loans : | 40550.00 | |
| total funds : | 83968.00 | 3.416 % foreign |

## Cashflow from operations

| Year: | 1 | 2 | 3 |
|---|---|---|---|
| operating costs: | 12542.00 | 15108.00 | 22611.00 |
| depreciation : | 6038.90 | 6038.90 | 6038.90 |
| interest : | 6082.50 | 7119.75 | 8157.00 |
| production costs | 24663.40 | 28266.65 | 36806.90 |
| thereof foreign | 39.61 % | 42.66 % | 41.20 % |
| total sales : | 21888.00 | 26608.00 | 49616.00 |
| gross income : | -2775.54 | -1658.79 | 12808.98 |
| net income : | -2775.54 | -1658.79 | 8325.82 |
| cash balance : | 2993.15 | 31998.88 | -13463.53 |
| net cashflow : | 9075.65 | 11458.63 | -5298.53 |

Net Present Value at: 15.00 % = 32014.46
Internal Rate of Return: 20.50 %
Return on equity1: 19.17 %
Return on equity2: 25.02 %

## Index of Schedules produced by COMFAR

## Cashflow Tables, construction in thai baht

| | |
|---|---|
| Year . . . . . . . . . . | 1994 |
| Total cash inflow . . | 83968.000 |
| Financial resources . | 83968.000 |
| Sales, net of tax . . | 0.000 |
| Total cash outflow . . | 87009.250 |
| Total assets . . . . | 83968.000 |
| Operating costs . . . | 0.000 |
| Cost of finance . . . | 3041.250 |
| Repayment . . . . . | 0.000 |
| Corporate tax . . . | 0.000 |
| Dividends paid . . . | 0.000 |
| Surplus ( deficit ) . | -3041.250 |
| Cumulated cash balance | -3041.250 |
| Inflow, local . . . . | 81100.000 |
| Outflow, local . . . . | 46720.250 |
| Surplus ( deficit ) . | 34379.750 |
| Inflow, foreign . . . | 2868.000 |
| Outflow, foreign . . . | 40289.000 |
| Surplus ( deficit ) . | -37421.000 |
| Net cashflow . . . . . . | -83968.000 |
| Cumulated net cashflow | -83960.000 |

COMFAR 2.1 - ENGINEERING CONSULTING FIRMS ASSOC., TOKYO

## Cashflow tables, production in thai baht

| Year | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| Total cash inflow | 22076.690 | 54279.360 | 49769.860 | 55354.730 | 64951.860 | 64951.860 |
| Financial resources | 188.833 | 27671.500 | 154.000 | 2.875 | 0.000 | 0.000 |
| Sales, net of tax | 21887.860 | 26607.860 | 49615.860 | 55351.860 | 64951.860 | 64951.860 |
| Total cash outflow | 19083.540 | 22280.480 | 63223.390 | 47864.060 | 46564.050 | 46531.510 |
| Total assets | 459.039 | 52.733 | 27972.250 | 26.203 | 32.550 | 0.000 |
| Operating costs | 12542.000 | 15108.000 | 22611.000 | 23643.000 | 24621.000 | 24621.000 |
| Cost of finance | 6082.500 | 7119.750 | 8157.000 | 8157.000 | 0.000 | 0.000 |
| Repayment | 0.000 | 0.000 | 0.000 | 10875.000 | 10876.000 | 10876.000 |
| Corporate tax | 0.000 | 0.000 | 4483.136 | 5161.856 | 11034.510 | 11034.510 |
| Dividends paid | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Surplus ( deficit ) | 2993.154 | 31998.880 | -13453.530 | 7490.678 | 18387.800 | 18420.350 |
| Cumulated cash balance | -48.096 | 31950.780 | 18497.250 | 25987.930 | 44375.730 | 62796.090 |
| Inflow, local | 22076.690 | 54279.360 | 49769.860 | 55354.730 | 64951.860 | 64951.860 |
| Outflow, local | 13247.870 | 14212.320 | 24354.090 | 35741.500 | 33453.510 | 33453.510 |
| Surplus ( deficit ) | 8828.820 | 40067.040 | 25415.770 | 19613.240 | 31498.350 | 31498.350 |
| Inflow, foreign | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Outflow, foreign | 5835.667 | 8068.167 | 38869.300 | 12122.560 | 13110.550 | 13078.000 |
| Surplus ( deficit ) | -5835.667 | -8068.167 | -38869.300 | -12122.560 | -13110.550 | -13078.000 |
| Net cashflow | 9075.653 | 11458.630 | -5298.527 | 28523.680 | 29263.800 | 29298.350 |
| Cumulated net cashflow | -74832.340 | -63433.720 | -68730.240 | -42206.570 | -12942.780 | 16353.590 |

aluminum die casting --- ++++++++++

Cashflow tables, production in thai baht

| Year . . . . . . . . . . | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|
| Total cash inflow . . | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 |
| Financial resources . | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Sales, net of tax . . | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 |
| Total cash outflow . . | 46531.510 | 46531.510 | 35655.510 | 35655.510 | 37086.620 | 37086.620 |
| Total assets . . . . | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Operating costs . . . | 24621.000 | 24621.000 | 24621.000 | 24621.000 | 24621.000 | 24621.000 |
| Cost of finance . . . | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Repayment . . . . . | 10876.000 | 10876.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Corporate tax . . . | 11034.510 | 11034.510 | 11034.510 | 11034.510 | 12465.620 | 12465.620 |
| Dividends paid . . . | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Surplus ( deficit ) . | 18420.350 | 18420.350 | 29296.350 | 29296.350 | 27865.240 | 27865.240 |
| Cumulated cash balance | 81216.440 | 99636.790 | 128933.100 | 158229.500 | 186094.700 | 213960.000 |
| Inflow, local . . . . | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 |
| Outflow, local . . . . | 33453.510 | 33453.510 | 22577.510 | 22577.510 | 24008.620 | 24008.620 |
| Surplus ( deficit ) . | 31498.350 | 31498.350 | 42374.350 | 42374.350 | 40943.240 | 40943.240 |
| Inflow, foreign . . . | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Outflow, foreign . . . | 13078.000 | 13078.000 | 13078.000 | 13078.000 | 13078.000 | 13078.000 |
| Surplus ( deficit ) . | -13078.000 | -13078.000 | -13078.000 | -13078.000 | -13078.000 | -13078.000 |
| Net cashflow . . . . . | 29296.350 | 29296.350 | 29296.350 | 29296.350 | 27865.240 | 27865.240 |
| Cumulated net cashflow | 45649.950 | 74946.300 | 104242.600 | 133539.000 | 161404.200 | 189269.500 |

aluminum die casting --- ++++++++++

Cashflow tables, production in thai baht

| Year . . . . . . . . . . | 2007 | 2008 | 2009 |
|---|---|---|---|
| Total cash inflow . . | 64951.860 | 64951.860 | 64951.860 |
| Financial resources . | 0.000 | 0.000 | 0.000 |
| Sales, net of tax . . | 64951.860 | 64951.860 | 64951.860 |
| Total cash outflow . . | 37086.620 | 38054.300 | 38054.300 |
| Total assets . . . . | 0.000 | 0.000 | 0.000 |
| Operating costs . . . | 24621.000 | 24621.000 | 24621.000 |
| Cost of finance . . . | 0.000 | 0.000 | 0.000 |
| Repayment . . . . . | 0.000 | 0.000 | 0.000 |
| Corporate tax . . . | 12465.620 | 13433.300 | 13433.300 |
| Dividends paid . . . | 0.000 | 0.000 | 0.000 |
| Surplus ( deficit ) . | 27865.240 | 26897.560 | 26897.560 |
| Cumulated cash balance | 241825.200 | 268722.800 | 295620.300 |
| Inflow, local . . . . | 64951.860 | 64951.860 | 64951.860 |
| Outflow, local . . . . | 24008.620 | 24976.300 | 24976.300 |
| Surplus ( deficit ) . | 40943.240 | 39975.560 | 39975.560 |
| Inflow, foreign . . . | 0.000 | 0.000 | 0.000 |
| Outflow, foreign . . . | 13078.000 | 13078.000 | 13078.000 |
| Surplus ( deficit ) . | -13078.000 | -13078.000 | -13078.000 |
| Net cashflow . . . . . | 27865.240 | 26897.560 | 26897.560 |
| Cumulated net cashflow | 217134.700 | 244032.300 | 270929.800 |

COMFAR 2.1 UNIDO

COMFAR 2.1 - ENGINEERING CONSULTING FIRMS ASSOC., TOKYO

## Net Income Statement in thai baht

| Year | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| Total sales, incl. sales tax | 21888.000 | 26608.000 | 49616.000 | 55352.000 | 64952.000 |
| Less: variable costs, incl. sales tax. | 0.141 | 0.141 | 0.141 | 0.141 | 0.141 |
| Variable margin | 21887.860 | 26607.860 | 49615.860 | 55351.860 | 64951.860 |
| As % of total sales | 99.999 | 99.999 | 100.000 | 100.000 | 100.000 |
| Non-variable costs, incl. depreciation | 18580.900 | 21146.900 | 28649.900 | 32446.700 | 33424.700 |
| Operational margin | 3306.961 | 5460.961 | 20965.960 | 22905.160 | 31527.160 |
| As % of total sales | 15.109 | 20.524 | 42.256 | 41.381 | 48.539 |
| Cost of finance | 6082.500 | 7119.750 | 8157.000 | 8157.000 | 0.000 |
| Gross profit | -2775.539 | -1658.789 | 12808.960 | 14748.160 | 31527.160 |
| Allowances | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Taxable profit | -2775.539 | -1658.789 | 12808.960 | 14748.160 | 31527.160 |
| Tax | 0.000 | 0.000 | 4483.136 | 5161.856 | 11034.510 |
| Net profit | -2775.539 | -1658.789 | 8325.824 | 9586.305 | 20492.650 |
| Dividends paid | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Undistributed profit | -2775.539 | -1658.789 | 8325.824 | 9586.305 | 20492.650 |
| Accumulated undistributed profit | -2775.539 | -4434.328 | 3891.496 | 13477.800 | 33970.450 |
| Gross profit, % of total sales | -12.681 | -6.234 | 25.816 | 26.644 | 48.539 |
| Net profit, % of total sales | -12.681 | -6.234 | 16.781 | 17.319 | 31.550 |
| ROE, Net profit, % of equity | -6.393 | -2.898 | 14.543 | 16.745 | 35.796 |
| ROI, Net profit+interest, % of invest. | 3.926 | 6.480 | 14.704 | 15.825 | 18.272 |

aluminum die casting --- ++++++++++

## Net Income Statement in thai baht

| Year | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Total sales, incl. sales tax | 64952.000 | 64952.000 | 64952.000 | 64952.000 | 64952.000 |
| Less: variable costs, incl. sales tax. | 0.141 | 0.141 | 0.141 | 0.141 | 0.141 |
| Variable margin | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 |
| As % of total sales | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 |
| Non-variable costs, incl. depreciation | 33424.700 | 33424.700 | 33424.700 | 33424.700 | 33424.700 |
| Operational margin | 31527.160 | 31527.160 | 31527.160 | 31527.160 | 31527.160 |
| As % of total sales | 48.539 | 48.539 | 48.539 | 48.539 | 48.539 |
| Cost of finance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Gross profit | 31527.160 | 31527.160 | 31527.160 | 31527.160 | 31527.160 |
| Allowances | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Taxable profit | 31527.160 | 31527.160 | 31527.160 | 31527.160 | 31527.160 |
| Tax | 11034.510 | 11034.510 | 11034.510 | 11034.510 | 11034.510 |
| Net profit | 20492.650 | 20492.650 | 20492.650 | 20492.650 | 20492.650 |
| Dividends paid | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Undistributed profit | 20492.650 | 20492.650 | 20492.650 | 20492.650 | 20492.650 |
| Accumulated undistributed profit | 54463.110 | 74955.770 | 95448.420 | 115941.100 | 136433.700 |
| Gross profit, % of total sales | 48.539 | 48.539 | 48.539 | 48.539 | 48.539 |
| Net profit, % of total sales | 31.550 | 31.550 | 31.550 | 31.550 | 31.550 |
| ROE, Net profit, % of equity | 35.796 | 35.796 | 35.796 | 35.796 | 35.796 |
| ROI, Net profit+interest, % of invest. | 18.272 | 18.272 | 18.272 | 18.272 | 18.272 |

COMFAR 2.1 UNIDO

COMFAR 2.1 - ENGINEERING CONSULTING FIRMS ASSOC., TOKYO

## Net Income Statement in thai baht

| Year | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Total sales, incl. sales tax | 64952.000 | 64952.000 | 64952.000 | 64952.000 | 64952.000 |
| Less: variable costs, incl. sales tax | 0.141 | 0.141 | 0.141 | 0.141 | 0.141 |
| Variable margin | 64951.860 | 64951.860 | 64951.860 | 64951.860 | 64951.860 |
| As % of total sales | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 |
| Non-variable costs, incl. depreciation | 29335.800 | 29335.800 | 29335.800 | 26571.000 | 26571.000 |
| Operational margin | 35616.060 | 35616.060 | 35616.060 | 38380.860 | 38380.860 |
| As % of total sales | 54.834 | 54.834 | 54.834 | 59.091 | 59.091 |
| Cost of finance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Gross profit | 35616.060 | 35616.060 | 35616.060 | 38380.860 | 38380.860 |
| Allowances | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Taxable profit | 35616.060 | 35616.060 | 35616.060 | 38380.860 | 38380.860 |
| Tax | 12465.620 | 12465.620 | 12465.620 | 13433.300 | 13433.300 |
| Net profit | 23150.440 | 23150.440 | 23150.440 | 24947.560 | 24947.560 |
| Dividends paid | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Undistributed profit | 23150.440 | 23150.440 | 23150.440 | 24947.560 | 24947.560 |
| Accumulated undistributed profit | 159584.200 | 182734.600 | 205885.000 | 230832.600 | 255780.200 |
| Gross profit, % of total sales | 54.834 | 54.834 | 54.834 | 59.091 | 59.091 |
| Net profit, % of total sales | 35.642 | 35.642 | 35.642 | 38.409 | 38.409 |
| ROE, Net profit, % of equity | 40.439 | 40.439 | 40.439 | 43.578 | 43.578 |
| ROI, Net profit+interest, % of invest. | 20.642 | 20.642 | 20.642 | 22.244 | 22.244 |

aluminum die casting --- ++++++++++

# Appendix

Profiles of Aluminum Die Casting Companies in Thailand

<u>Example of Firm B in Thailand</u>

1) Die Casting Machines: 18 (Made in Japan only)

2) Amount of Aluminum Ingots used Monthly (tonnes/month):

   150 t/month x 12 months = 1,800 t/y or
   100 t/month x 12 months = 1,200 t/y

3) Monthly Input of Aluminum Ingots to One Die Casting Machine:

   150 t/month divided by 18 machines = 8,333 kg/machine

4) Weight per Shot:

   8,333 kg divided by 3,000 shots = 2.78 kg
   8,333 kg divided by 4,000 shots = 2.08 kg

5) Main Clients:

Thai Honda Manufacturing Co.
Thai Suzuki Motor Co.
Asian Auto Parts Co.

6) Profile of Firm B

| | |
|---|---|
| - Factory sites: | Samut Prakan |
| area: | 32,000 sq.m. (20 rai) |
| - No. of employees: | 750 |
| - Capital (Baht): | 100 million Baht |
| - Ownership: | 100% Thai owned |
| - Sales: | 300 million Baht in 1990<br>100% local sales |

- Feb. 1990 Technical Joint Venture with Yanagawa Seiki Co., Ltd. of Japan (to support Die Casting Production Technology)

| | |
|---|---|
| - Breakdown of sales: | Aluminum die casting products = 45%<br>Plastic injection products = 46%<br>Automotive lighting equipment and others = 9% |

Example of Firm K in Thailand

1) Die Casting Machines: 3

2) Amount of Aluminum Ingots used Monthly (tonnes/month):

15 t/month x 12 months = 180 t/y

3) Monthly Input of Aluminum Ingots to One Die Casting Machine:

15 t/month divided by 3 machines = 5,000 kg per machine

4) Weight per Shot:

5,000 kg divided by 3,000 shot = 1.67 kg per shot

5) Main Clients:

Separate Technology (Thailand) Ltd.

- Computer cases

6) Profile of Firm K

| | |
|---|---|
| - Factory sites: | Samut Prakan |
| area: | 1,600 sq.m. (1 rai) |
| - No. of employees: | 220 |
| - Capital (Baht): | 10 million Baht |
| - Ownership: | 100% Thai owned |
| - Sales: | 22 million Baht in 1990<br>90% local sales, 10% export sales |

Example of Firm T in Thailand

1) Die Casting Machines: 14 (all Made in Japan)

2) Amount of Aluminum Ingots used Monthly (tonnes/month):

417 t/month x 12 months = 5,000 t/y or
375 t/month x 12 months = 4,500 t/y

3) Monthly Input of Aluminum Ingots to One Die Casting Machine:

417 t/month divided by 14 machines = 29,785 kg per machine

4) Weight per Shot:

29,785 kg divided by 5,000 shot = 5.96 kg per shot

5) Main Clients:

Isuzu Motors (Thailand) Co.
Siam Nissan Automobile Co.
Siam Yamada Co.
Toyota Motor Thailand Co.
Sukosol & Mazda Motor Industry Co.

6) Profile of Firm T

| | |
|---|---|
| - Factory sites: | Navanakorn Industrial Estate, Pathum Thani |
| area: | 102,400 sq.m. (64 rai) |
| - No. of employees: | 500 |
| - Capital (Baht): | 85 million Baht |
| - Ownership: | 100% Thai owned |
| - Sales: | 855 million Baht in 1989 |

## Aluminium plant

Aluminium ingots are melted in the oil fired furnaces and the molten aluminium temperature is raised and regulated at approximately 700°C before transfering to casting machines.

Casting methods currently employed are:

**1. High Pressure Die Casting.**

By this method, molten aluminium is injected into metal die by high pressure injection machine with pressure range of 500-700 kg/cm.$^2$ Time required for each production cycle is relatively short resulting high production rate with good dimensional accuracy and surface smoothness.

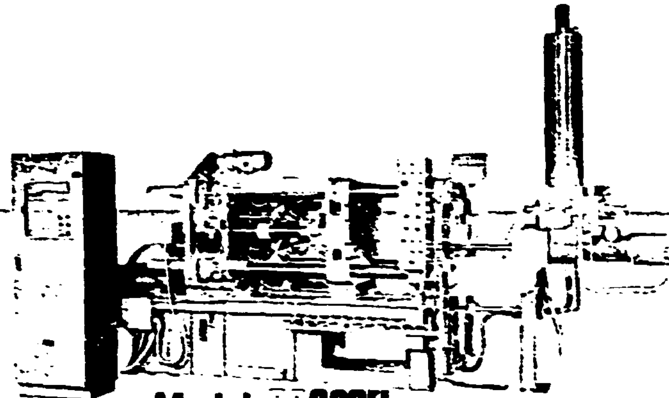
**2. Gravity Die Casting.**

By this method, molten aluminium is poured into metal die by gravity. Time required for each production cycle is relatively long resulting low production rate, however, the work pieces have good dimensional accuracy with acceptable surface roughness.

**Surface Finishing** of die casted aluminium parts are carried out by trimming, buffing, shot blasting and machine finishing.

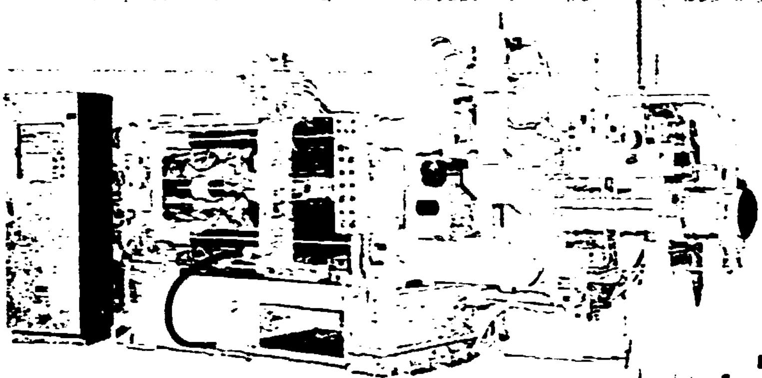
# Representative Models from the Various Series in Production

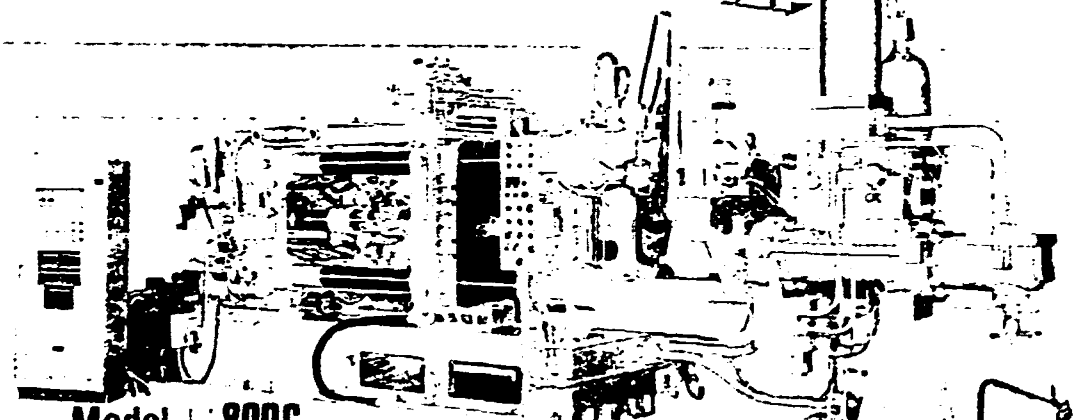
## C-EL series



Model 200EL

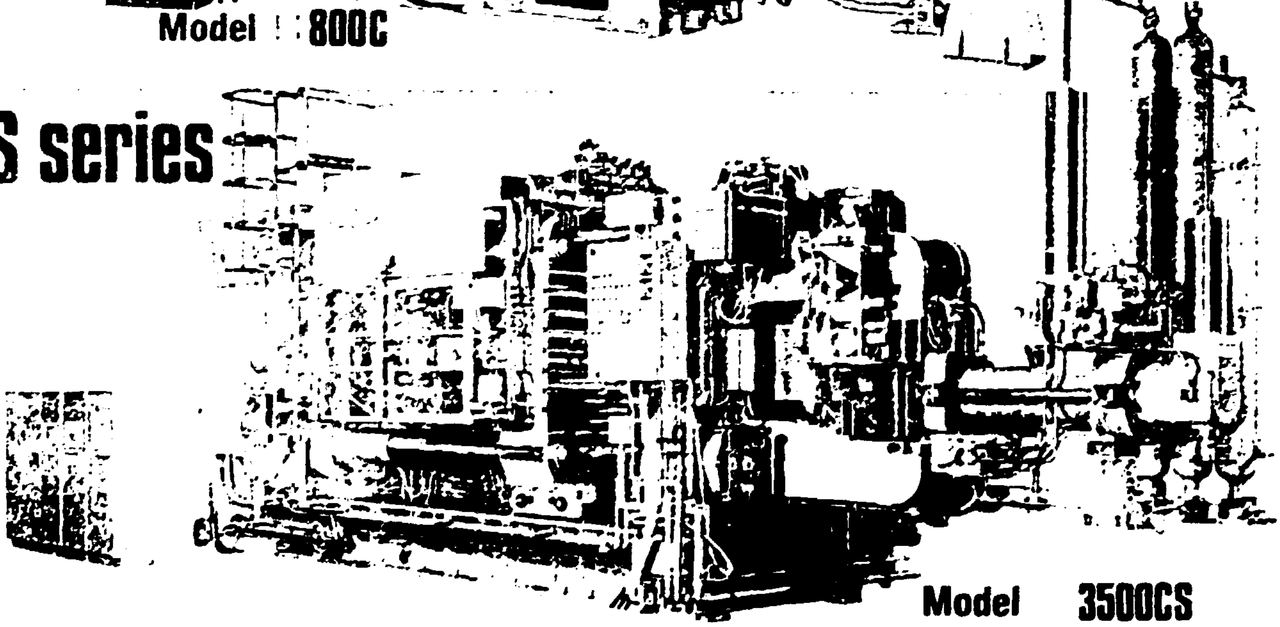
## C-C series





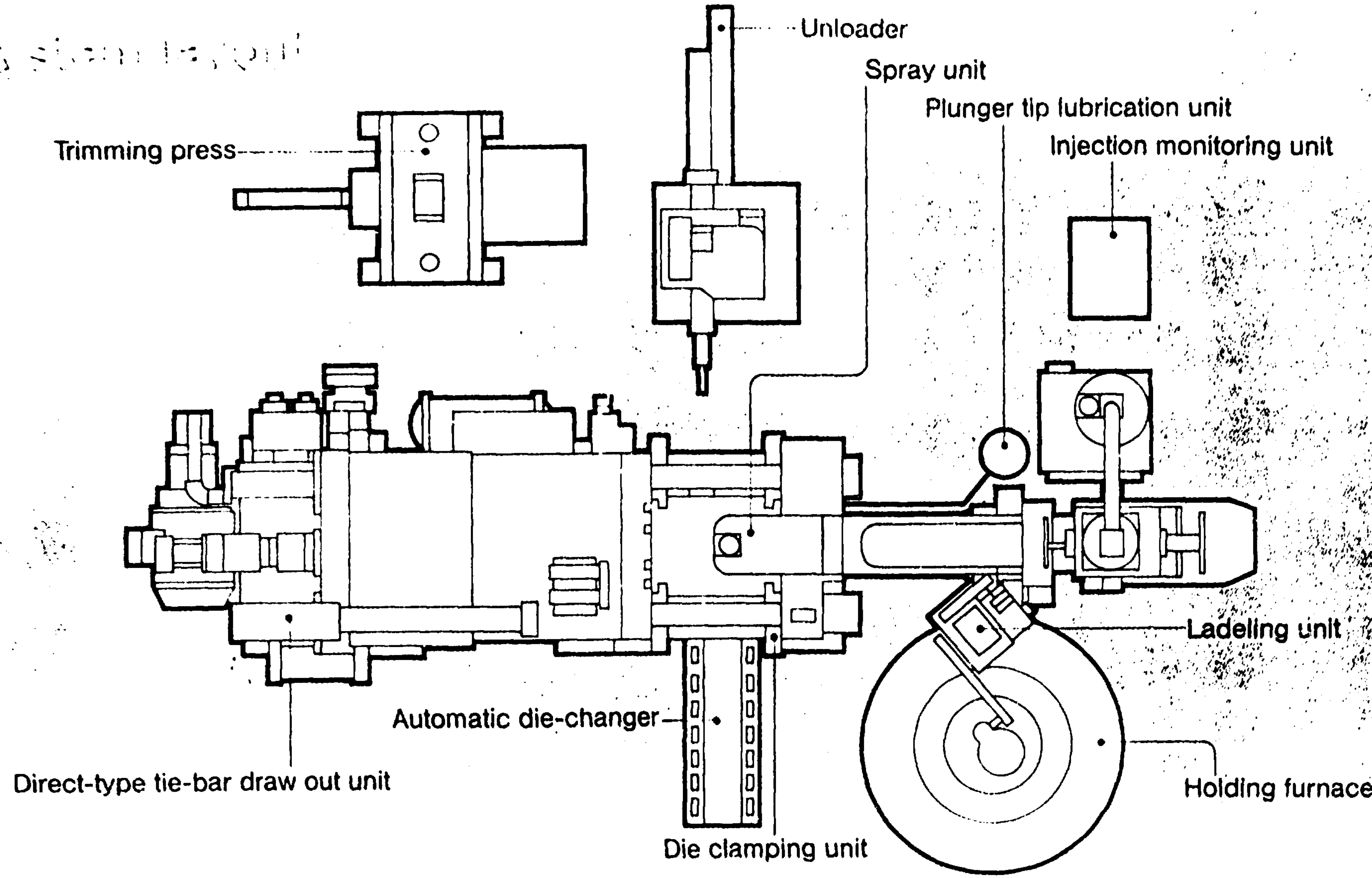
Model 800C

## CS series

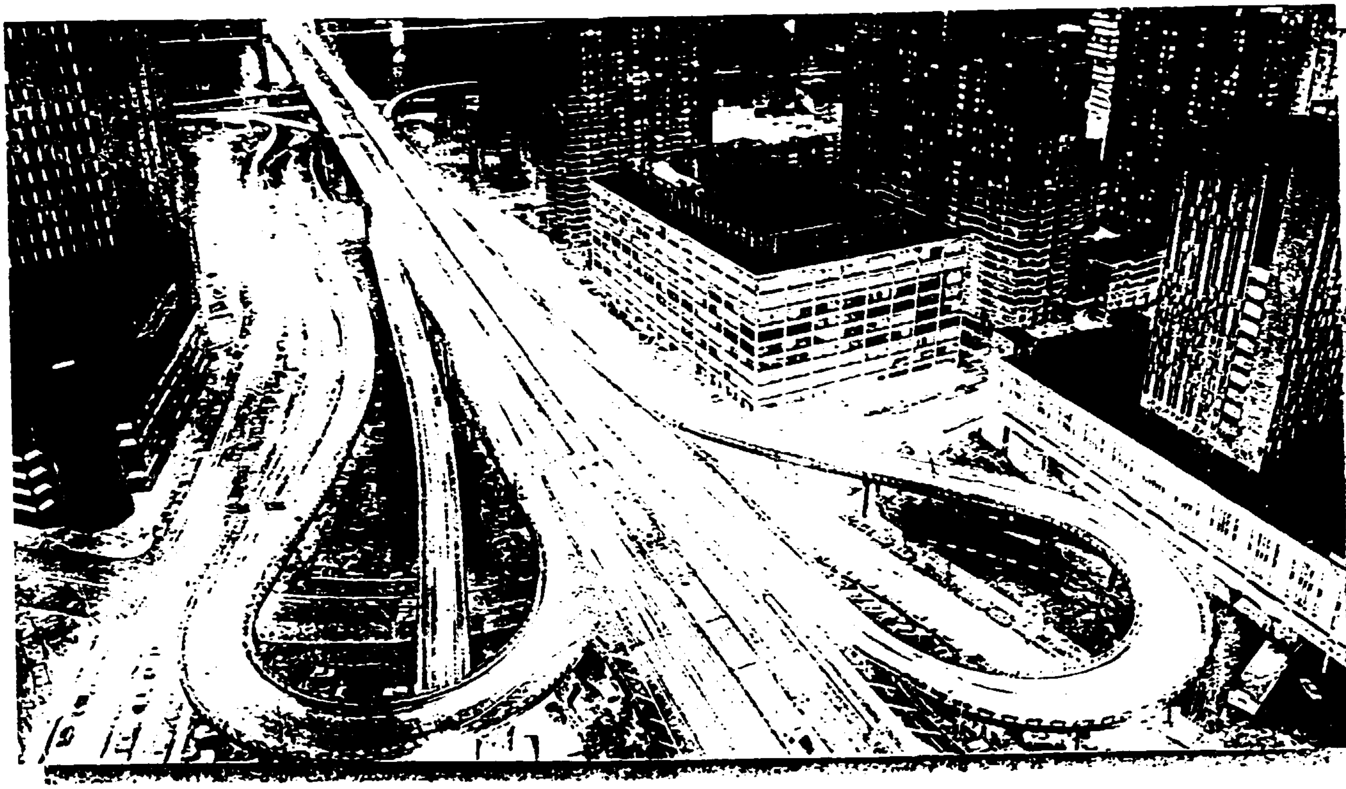


Model 3500CS

# System layout

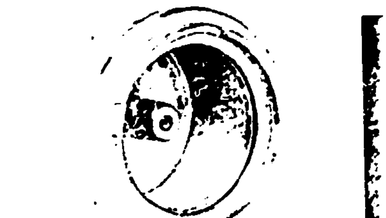


# Die Castings for Vehicles



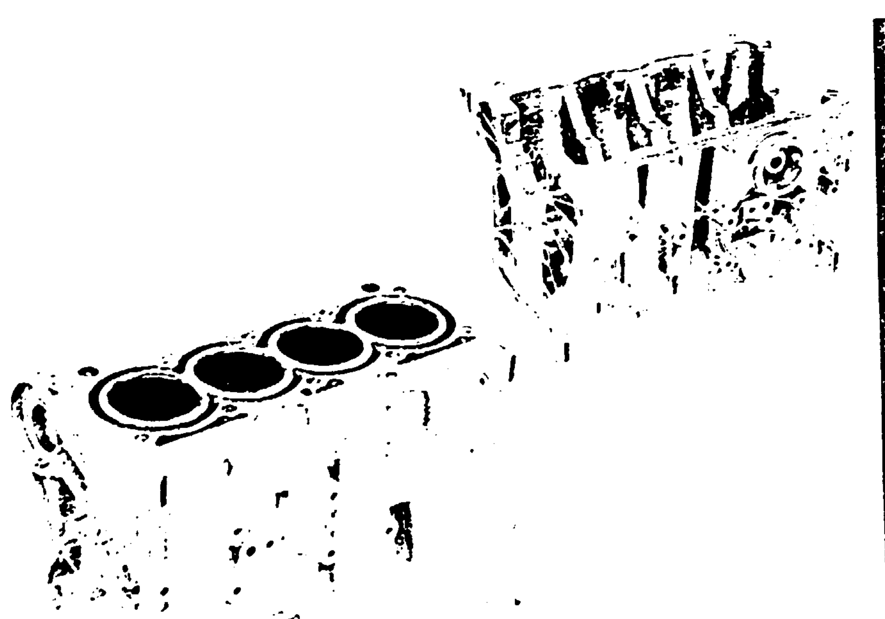
- Engine Main Bearing Cap
- 2.9 kg (6.4 lbs)
- 360 × 130 × 110

Trimmed



- AT Accumulator Piston
- 0.17 kg (0.38 lbs)
- [illegible]30 × 50

Machined



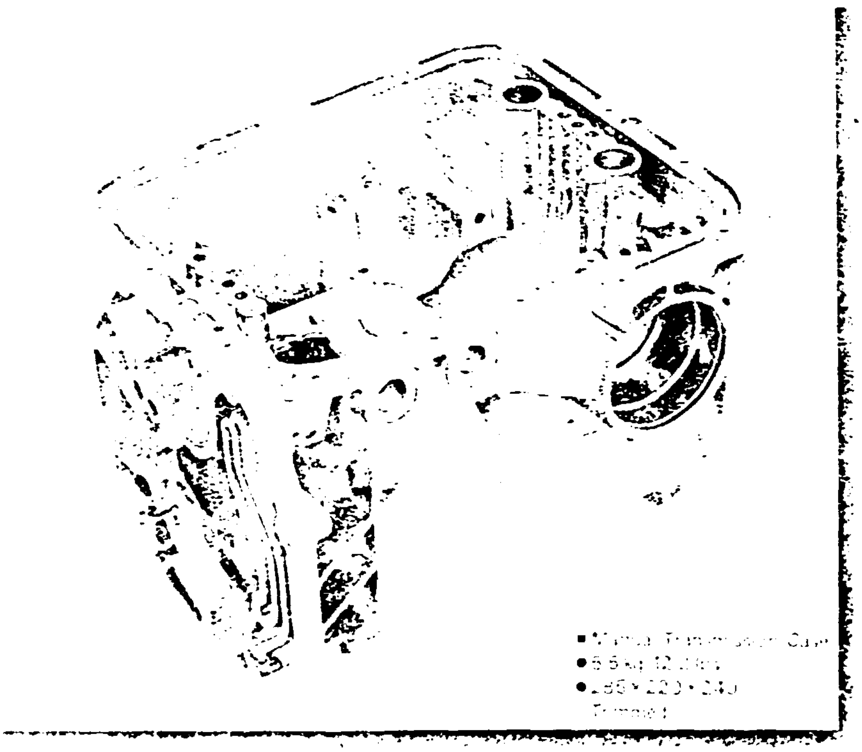
- Engine Block
- 11.6 kg (25.6 lbs)
- 370 × 320 × 240

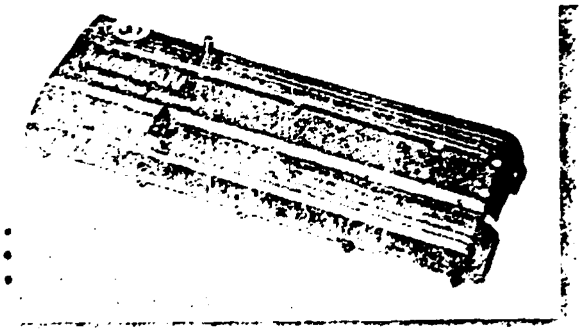
Trimmed



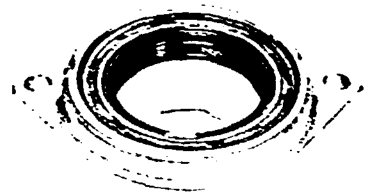
Source: Ahresty Corporation

II-101

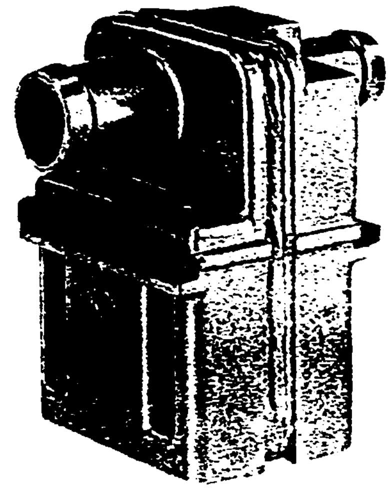




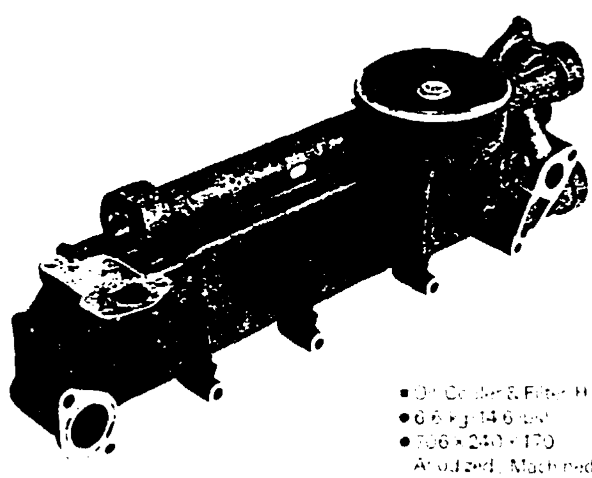
[illegible]



[illegible]



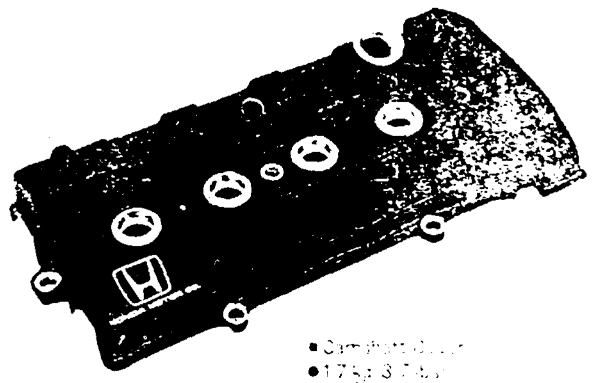
● Oil Separator
● 0.24 kg (0.52 lbs)
● 91 × 91 × 59
[illegible]



● Oil Cooler & Filter Housing
● 6.6 kg (14.6 lbs)
● 706 × 240 × 170
Anodized, Machined & Assembled

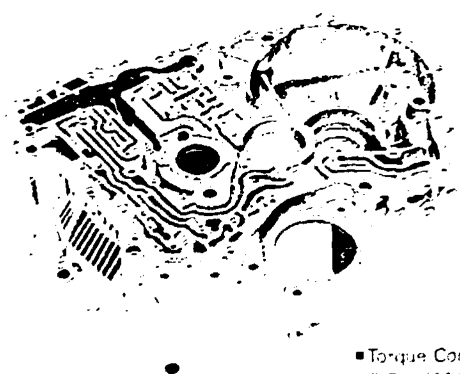
● Clutch Housing
● 6.7 kg (14.8 lbs)
● 450 × 381 × 130
Trimmed

● AT Side Cover
● 2.5 kg (5.6 lbs) ● [illegible]
Assembled



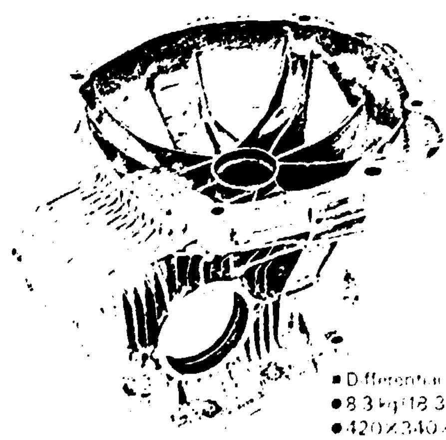
■ Camshaft Cover
● 1.7 kg (3.7 lbs)
● 490×255×60
Machined, Painted & Assembled

■ ADC Case
● 0.32 kg (0.71 lbs)
● 196×185×41, 2mm thick
Machined



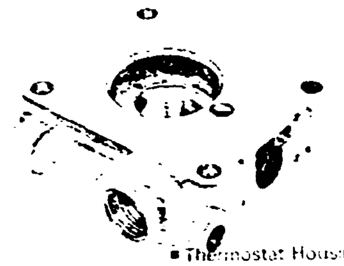
■ Torque Converter Case
● 6.5 kg (14.3 lbs)
● 370×340×46
Trimmed

■ Air Compressor Cylinder
● 0.95 kg (2.1 lbs)
● φ125×61
Trimmed



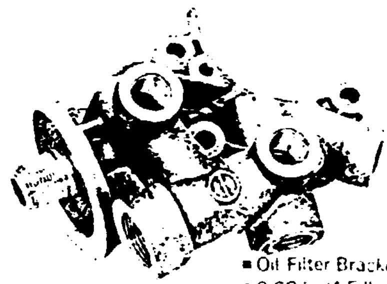
■ Differential Gear Housing
● 8.3 kg (18.3 lbs)
● 420×340×255
Trimmed

■ Electronic Carburetor Housing
● 0.68 kg (1.5 lbs)
● 180 × 140 × 71
Trimmed

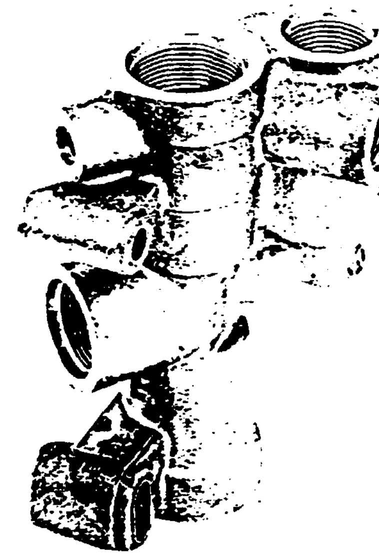


■ Thermostat Housing
● 0.15 kg (0.34 lbs)
● 76 × 79 × 25
Machined

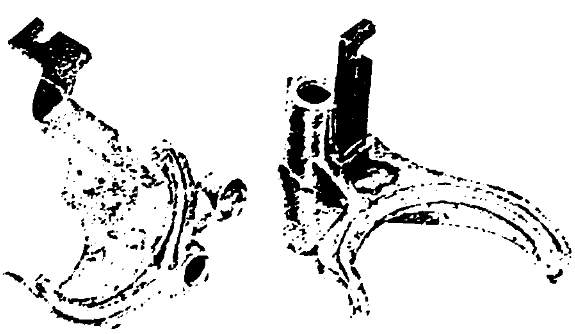
■ ECVT Side Case
● 2.8 kg (6.2 lbs)
● 36 × 220 × 105
Trimmed



■ Oil Filter Bracket
● 0.68 kg (1.5 lbs)
● 160 × 130 × 110
Machined

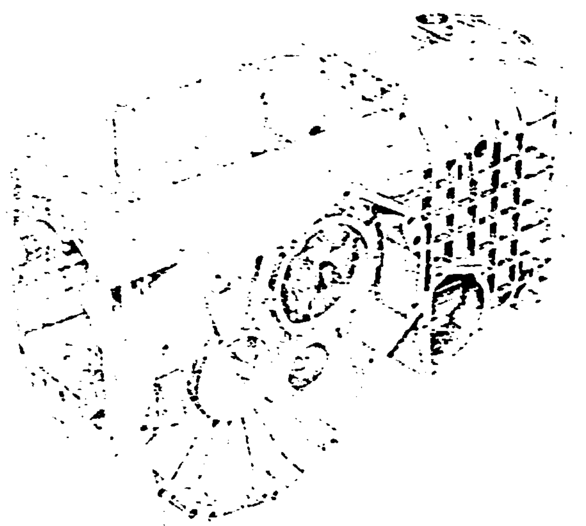


■ Return Oil Manifold Body
● 1.0 kg (2.2 lbs)
● 76 × 127 × 115
Machined



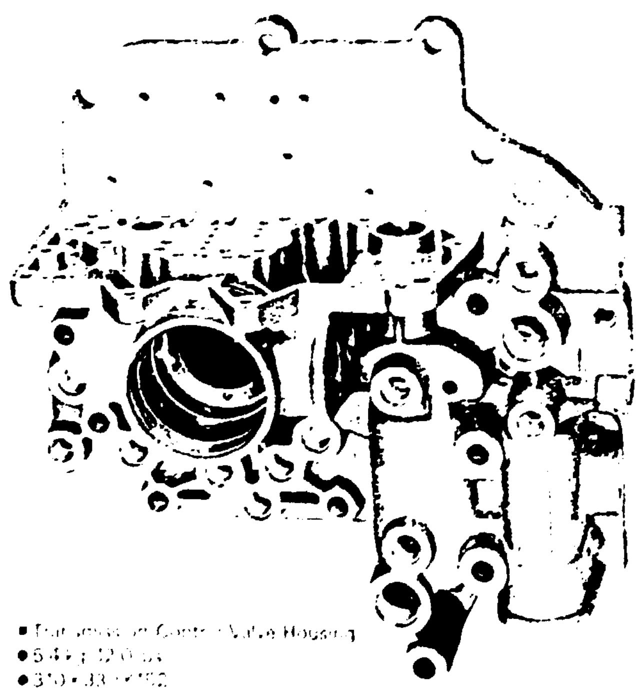
■ Shift Forks
● 0.23 kg (0.50 lbs)
● 0.26 kg (0.58 lbs)
● 130 × 100 × 140
● 170 × 130 × 89
Trimmed
Material 390

■ Fuel Delivery Pipe
● 0.30 kg (0.66 lbs)
● 318 × 25
Machined & Assembled



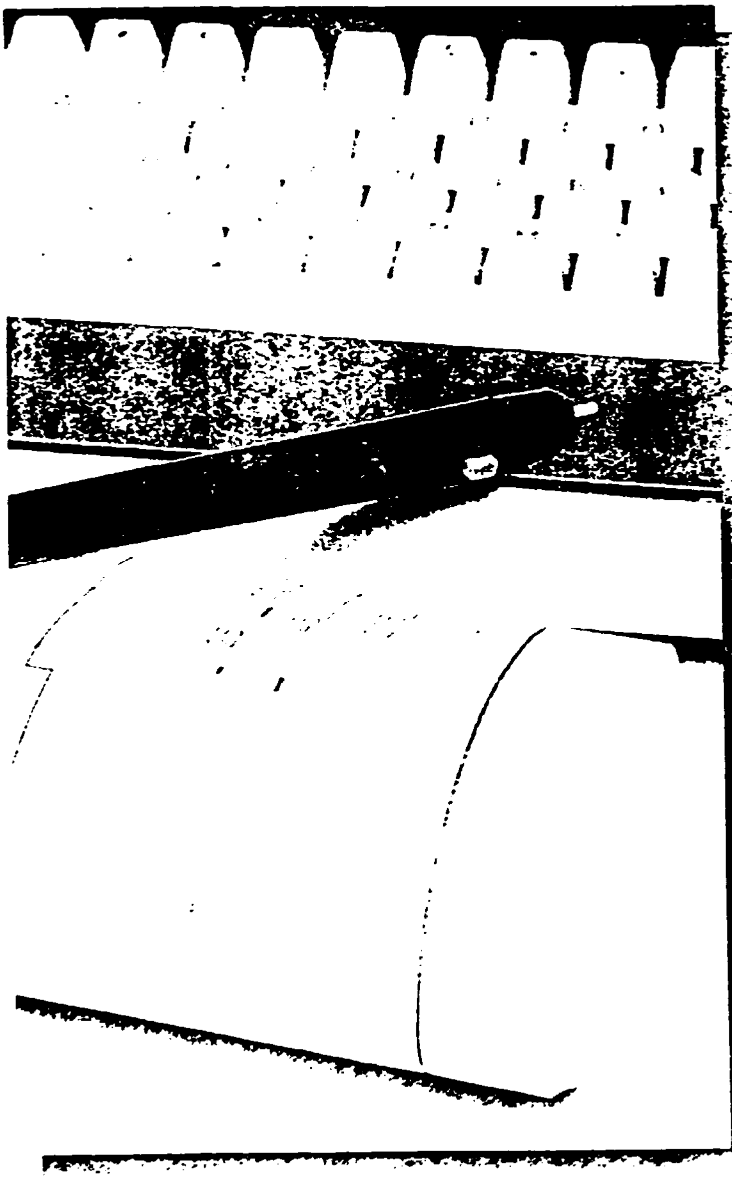
■ Transmission Case
● 16.2 kg (35.6 lbs)
● 550 × 230 × 255
Machined

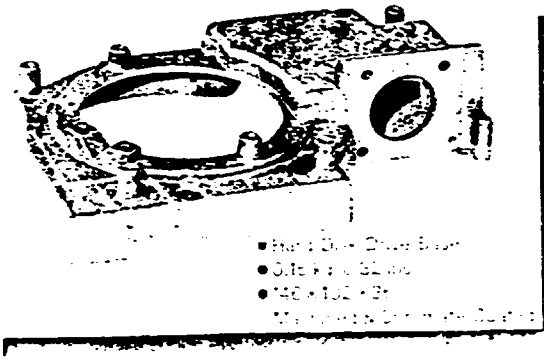
● Shift Valve Housing
● 1.5 kg (3.3 lbs)
● [illegible] × 130 × 33
Machined



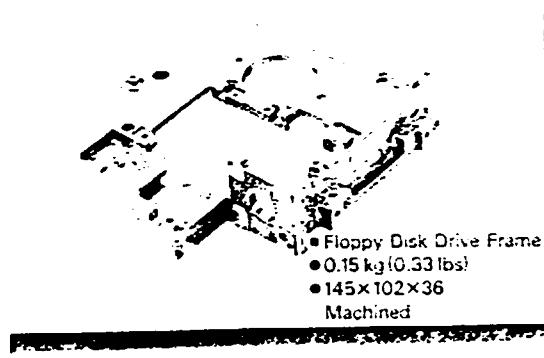
■ Transmission Control Valve Housing
● 5.4 kg (12.0 lbs)
● 310 × 33 × [illegible]
Machined

# Die Castings for Electronic Machines



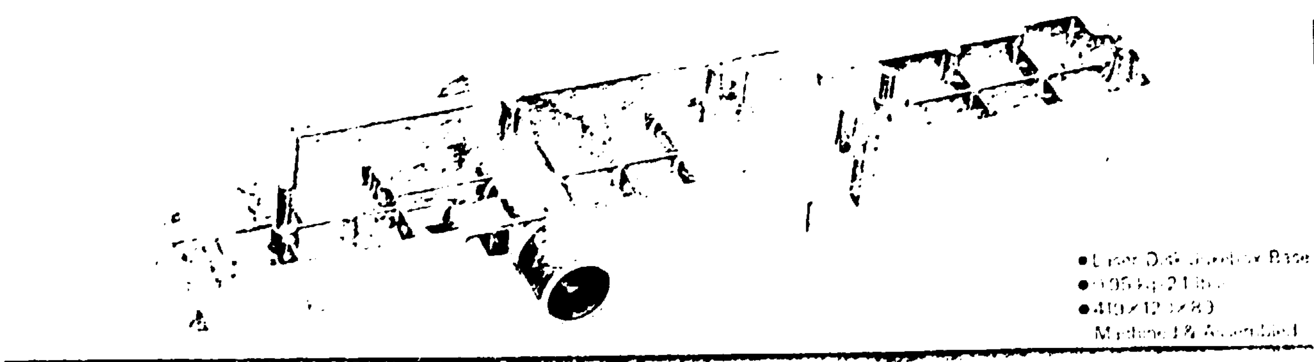


■ Hard Disk Drive Base
● [illegible]
● [illegible]
[illegible]



■ Floppy Disk Drive Frame
● 0.15 kg (0.33 lbs)
● 145×102×36
Machined

■ Printer Lower Case
● [illegible]
● [illegible]
[illegible]

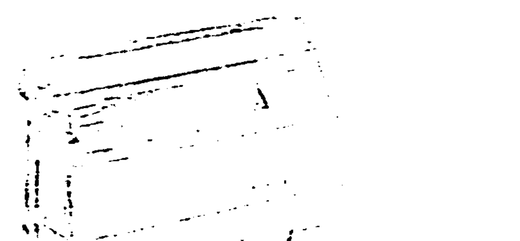


● [illegible] Base
● [illegible]
● [illegible]
Machined & Assembled

# Die Castings for Other Machines

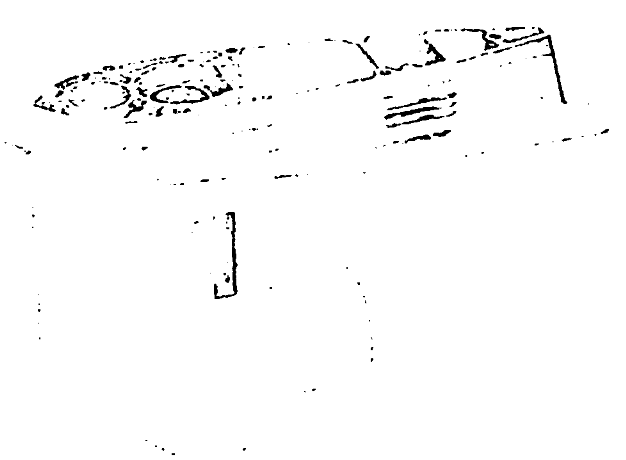
- Outboard Motor Bracket
- 2.8 kg (6.2 lbs)
- 381×250×110
  T7 Heat-treated

- Underwater Camera Body & Lid
- 0.26 kg (0.58 lbs)
- 99×140×48
- 0.11 kg (0.24 lbs)
- 71×140×8
  Trimmed



- Portable Generator Case
- 2.0 kg (4.4 lbs)
- 330×302×152
  Trimmed

- [illegible]
- 2.5 kg (5.5 [illegible])
- [illegible]×185×[illegible]
  Trimmed



- Outboard Motor Lower Case
- 9.3 kg (20.5 lbs)
- 550×650×150
  Trimmed

- [illegible] Bracket
- 4.3 kg (9.5 [illegible])
- [illegible]46×71×[illegible]
  Machined

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