THE STUDY ON SELECTED INDUSTRIAL PRODUCT DEVELOPMENT IN MALAYSIA

THIRD YEAR FINAL REPORT

(SUMMARY B)

NOVEMBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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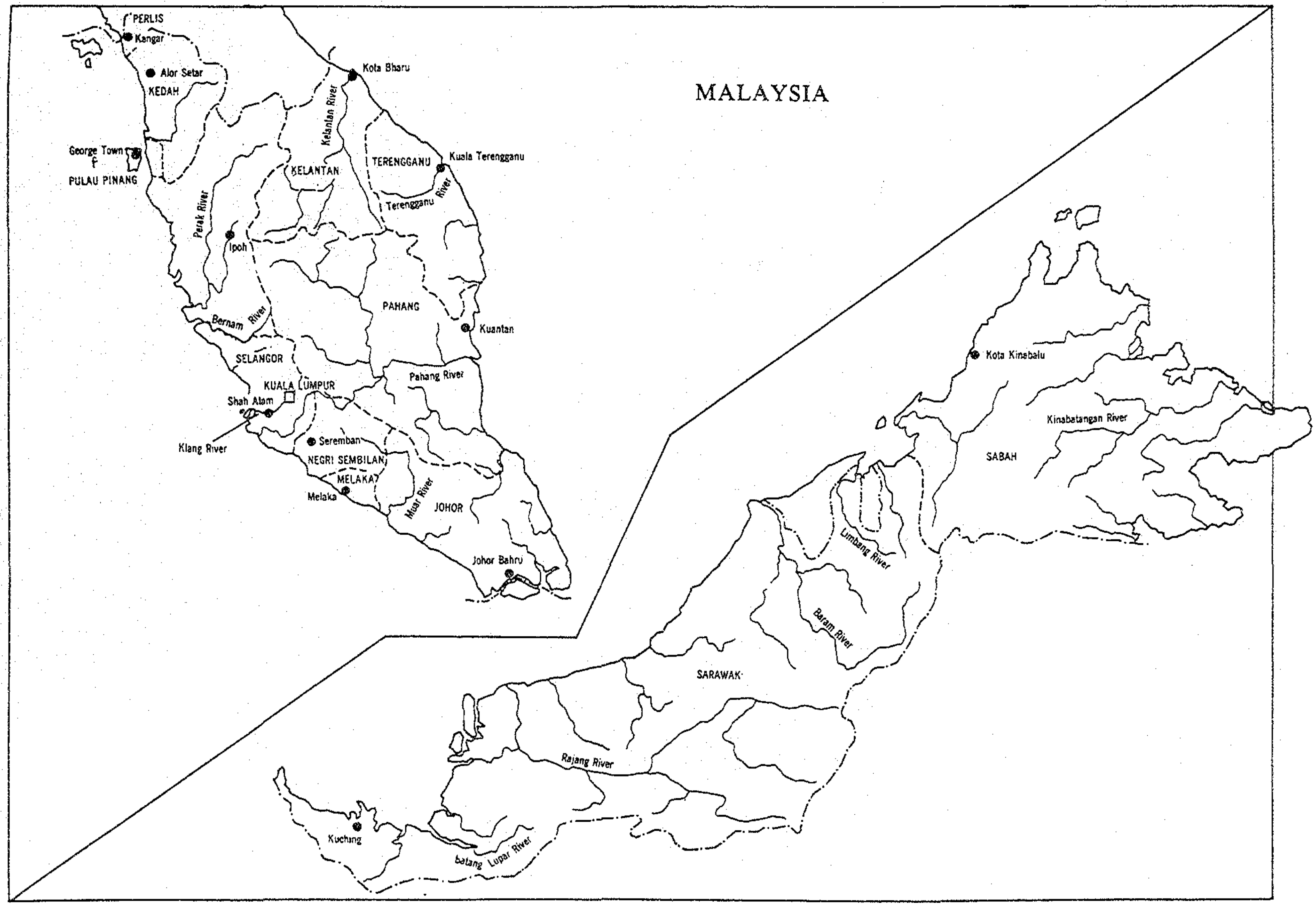
MALAYSIA
PERLIS
Kangar
Alor Setar
KEDAH
George Town
PULAU PINANG
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Ipoh
PAHANG
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SELANGOR
KUALA LUMPUR
Shah Alam
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NEGRI SEMBILAN
MELAKA
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Johor Bahru
Kota Kinabalu
Kinabatangan River
SABAH
Limbang River
Baram River
SARAWAK
Rajang River
Kuching
batang Lupar River

CONTENTS

Summary B was compiled from necessary portions of the original report for the reference of those concerned.

I. Castings

I-1. Outline of the Casting Industry

I-1-1. Development of the Casting Industry

The Malaysian casting industry has grown together with the tin industry. The former industry began its existence relying on orders from the latter for repairs, parts, maintenance, machining, and welding, and the relationship has continued throughout the past 70 years.

The following diagram shows the relationship between tin production and the number of foundries in Malaysia against the backdrop of the international tin market environment. It can be seen how the ups and downs experienced by the tin industry during the ten years leading up to 1986 affected casting companies. For example, 1985 saw the collapse of the international tin accord, and in 1986 tin prices dropped more than 26%. During this year, 38 foundries ceased production.

International Market Environment		Tin production (1,000 tons)	No. of foundries
• Long-term supply shortage —> Rising tin prices			
	1975	64.4	220*
• Global economic recession			
• Rising tin prices —> Efforts by major buyers to develop substitutes			
• Increased production and new development by Brazil, Bolvia, and China			
• Release of tin inventory by the U.S.			
—> Collapse of world supply-demand balance	1984	41.3	120
—> Collapse of international accord and plummeting prices	1985	36.9	114
• Seven-country agreement to restrict production and limit exports	1986	29.1	76
• Economic recovery			
	1989	30.0	121

Source: Economic Report 1988/89, Survey on Malaysian Foundry Industry
* 1976 figures

As will be shown in the analysis of cast metal demand that will follow, the tin mining industry provided the largest single source of demand for Malaysia's casting industry in 1988, with other traditional industries such as palm oil, rubber, and timber also accounting for large shares.

Since 1987, however, despite only slight growth in tin production, the number of foundries in Malaysia has increased markedly. This is indication of the rapid deversification being undergone by the industry as a result of increased demand from new, modern industries.

I-1-2. Distribution and Scale of Production

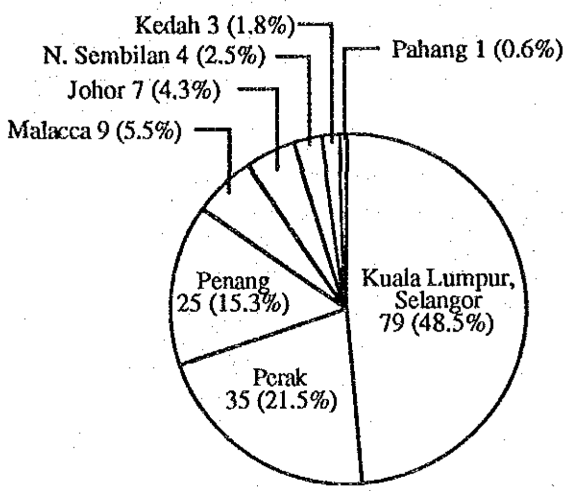
(1) Distribution of production

At the end of 1989, 121 foundries belonged to the Federation of Malaysian Foundry & Engineering Industries Association (FOMFEIA). There are no official figures as to the total number of foundries in Malaysia, including non-FOMFEIA facilities, but based on information gained from local industry sources during the present survey the figure is thought to number 163. In the current interviews and questionnaires, responses concerning production volume were obtained from 112 factories, 68.7% of the total. The distribution of production was determined based on these figures, and the total production volume in Malaysia was also measured.

1) Distribution of foundries by region

Of the 163 foundries, 48.5% were concentrated in Kuala Lumpur and Selangor. When added to the 21.5% found in Perak and the 15.3% in Penang, it can be seen that facilities in these three areas account for more than 85% of all Malaysian foundries.

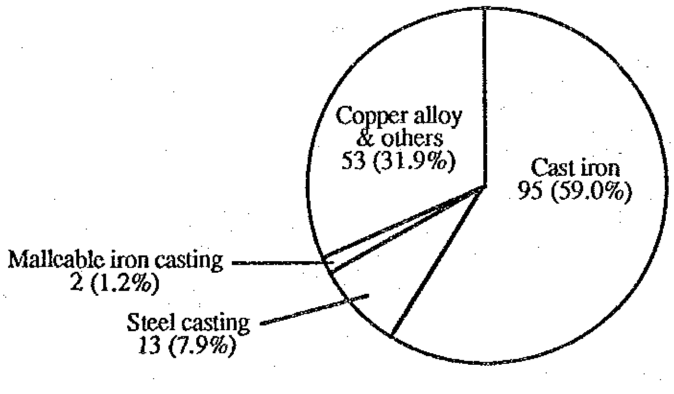
Fig. I.1-1 Distribution of Foundries by Region



2) Distribution of foundries by material

95 of the facilities were cast iron foundries, and 13 cast steel foundries, these two groups accounting for 66% of all plants. A breakdown of production by material is provided in the following section (2) Production scale.

Fig. I.1-2 Distribution of Foundries by Material



(2) Production scale

Malaysian production of castings in 1988 was estimated at 55,884 tons. The three most common materials were cast iron, steel casting, and malleable iron casting, their respective shares being 59.8%, 24.7%, and 7.1%.

Production value for the same year totaled an estimated M$187.7 million. The breakdown by material is as shown in the Table below.

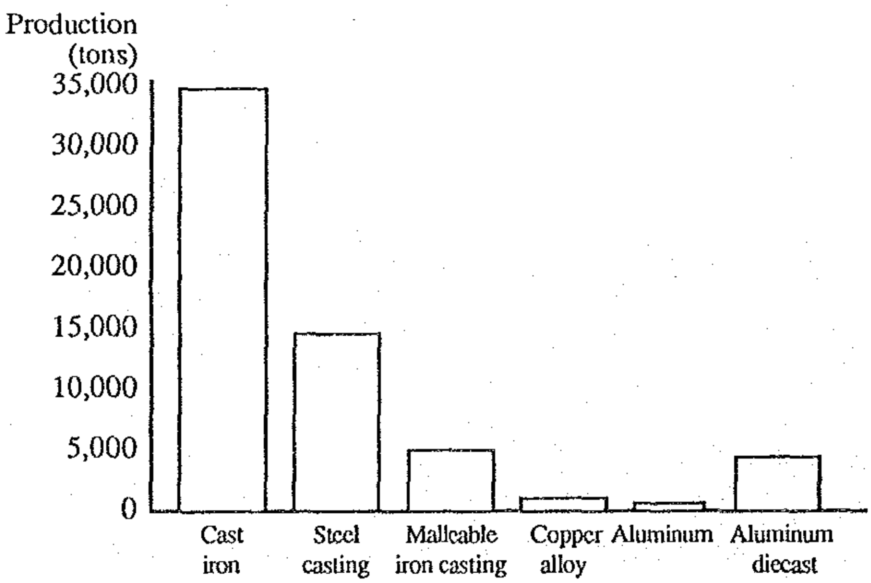
Table I.1-1 Estimated Production of Castings in Malaysia (1988)

Material	No. of foundries: No. interviewed or responding to questionnaire	No. of foundries: Estimated total no.*	Production (tons): No. interviewed or responding to questionnaire	Production (tons): Estimated total production	Unit price (M$/kg)	Sales (M$1,000)
Cast iron	75 (53.6)	95 (59.0)	26,385 (58.9)	33,421 (59.8)	2.3	76,868
Steel casting	12 (8.6)	13 (7.9)	9,902 (22.1)	13,802 (24.7)	3.6	49,687
Malleable iron casting	2 (1.4)	2 (1.2)	3,960 (8.9)	3,960 (7.1)	4.3	17,028
Copper alloy	21	8	1,029 (2.3)	1,070 (1.9)	12.2	13,054
Aluminum	14 - 51	20 - 53	432 (1.0)	449 (0.8)	9.6	4,310
Aluminum diecast	16 (36.4)	25 (31.9)	3,060 (6.8)	3,182 (5.7)	8.4	26,729
Total	140 (100.0)	163 (100.0)	44,768 (100.0)	55,884 (100.0)	—	187,676

Source: JICA Study Team estimates
Figures in parentheses indicate percentage share of total.
*Estimates for the total number of foundries were provided by industry sources.

(Method of calculation)
Cast iron: 26,385 ton/year x 95/75 = 33,421
Steel casting: 3,900 tons/year (annual production at one large factory) added to the survey statistics
Copper, aluminum, diecast: 4% added to the survey statistics in each of these categories

Fig. I.1-3 Malaysian Production of Castings by Material (1988)



I-1-3. Export-import and Local Sales

(1) Export and Import

According to trade statistics, Malaysia exported M$1.27 million of casting products in 1987 while importing M$2.83 million of the same.

It is considered that there is a high ratio of indirect trade, indicating cases in which castings are used as components in automobiles or machinery. Taking the indirect trade into consideration, indirect imports appear to outpace direct import considerably in Malaysia. Because of the high transportation costs required for these products, however, direct export ratios of casting products are usually low in any country in comparison with those of other products.

Table I.1-2 Exports of Casting Products

(Unit: M$)

		1985	1986	1987
679,411.00	Manhole covers, gratings & frames thereof cast iron	95,270 (93,605)	214,332 (211,824)	307,146 (290,451)
679,419.00	Other iron castings in the rough state	491,542 (482,463)	515,913 (471,957)	427,880 (316,684)
679,420.00	Manhole covers, gratings & frames thereof cast steel	20,612 (20,612)	—	20,136 (11,413)
679,429.00	Other steel casting in the rough state	2,045,050 (1,744,012)	770,021 (671,544)	515,383 (339,703)
	Total	2,652,480	1,500,266	1,270,725

Source: Malaysia External Trade Statistics
( ): Export to Singapore

Imports for the three years totaled M$2,549,194, M$2,921,748, and M$2,825,775, respectively.

The following report on export was drawn up based on the results of the questionnaire survey.

1) Export

28 firms responded to the question concerning export ratios. These 28 firms account for 27.2% of all the firms responding to the questionnaire, and roughly half indicated export ratios of 10-29%.

was destined for overseas markets. Some of the firms with high export ratios, however, pointed out that the fierce competition in foreign markets made it dangerous to depend too heavily on exports.

2) Products for export

Products for export indicated by the 28 firms above are listed below.

- Rubber processing machinery
- Gas stoves, gas stove burner heads
- Gas heating systems
- Sterilizers
- Firefighting equipment
- Gear box water pumps
- Gravel pump covers
- Piano frames
- Mine pumps
- Hard pumps
- LPG burners
- Pipe fittings
- Water gravel pumps
- Parts for mining equipment
- Ductile iron pipes and fittings
- Gray cast iron pipe fittings
- Worm screws for palm oil

3) Export markets

The following responses were obtained concerning export destinations (numbers indicate the number of companies).

Singapore	14
Indonesia	8
Thailand	6
U.S., Europe, Australia, Japan	2
Kuwait, Africa, Hong Kong, Netherlands, Papua New Guinea	1

4) Export initiative

A great deal of interest is being shown in exports. 50 firms, including 18 firms which had visited foreign buyers, reported that they were engaged in some type of export promotion activity.

However, there remains a shortage of information concerning overseas markets, and many firms indicated their dissatisfaction with the information currently available from government bodies and industry associations.

(2) Local Sales

Most of the foundries did business with customers in the traditional industries of tin, palm oil, rubber, and timber, and most buyers were private companies. In a questionnaire survey, 99 out of 123 firms (80.5%) indicated that most of their business was done with private-sector firms, while 22 (17.9%) did more business with the public sector. Two firms did business with others. In business with the traditional industries described above, direct sale is the most common type of transaction regardless of whether the customer is publicly or privately-owned, but vendor markets exist for motorcycle parts, daily goods, hardware, and some mechanical components. Concerning the sales organizations at these companies, 40 of the 73 responding firms (71.3%) answered that they employed one person as sales staff; 10 (17.9%), two people; 3:, three people and 3 four or five people.

I-1-4. Recent Industry Trends

The IMP (Industrial Master Plan) marked the first time that the casting industry had been designated as one of the key industries by the Malaysian government. Cast metal products were classified under the "Machinery & Engineering" heading, one of the 12 in the IMP, a task force was established to conduct surveys of cast metal products, and working committees and subcommittees were created to work with the private sector on studying the establishment of the Foundry and Engineering Park described below. There have been other projects as well, including HICOM, which will manufacture components for motorcycles and automobiles, and a machinery manufacture and training project currently under negotiation with India. Although details on these projects have yet to be announced, they would seem to represent new sources of demand for cast metal goods and hence are being watched with considerable interest.

1) Foundry and Engineering Park

The development of Malaysia's tin industry brought about a rapid rise in the number of small-scale plants located on TOL (Temporary Occupied Land) in the Klang and Ipoh regions. Small land plots and a high concentration of foundries in a limited area, however, generated fears of pollution, and the government ultimately forced these operations to move in a project to promote "green cities." Before the project in Selangor, Ipoh secured 150 acres of land in Pengkalan, of which 115 acres was allotted to firms in the foundry and engineering sector. In addition to a Common Facility Centre offering a showroom, laboratory, and an information center, this spacious Park serves to promote linkages between companies with common interests. Further cooperation between the private and public sectors will be needed to support the development of the industry.

MIDA gave the following concept of a foundry and engineering park in "*Proposal Paper for the Establishment of a Foundry and Engineering Park in Selangor and Perak* (September 1988)". The concept is considered to be capable of responding to the individual needs of the tenant firms.

<u>Concept of a Foundry and Engineering Park</u>

The proposed foundry and engineering park would accommodate foundry operators and others related to the foundry trade such as pattern makers, mould and die makers, foundry machinery and equipment suppliers and suppliers of foundry raw materials and additives. The set-up would also include the establishment of common facilities such as those for research and development, testing, heat treatment, etc. It is proposed that the following buildings, trades and amenities be accommodated in the foundry park:-

(a) Foundries with office stores, laboratories, etc. built to individual design on individual lots.
(b) Cheaper standardised units built for smaller size foundry/die casting operators.
(c) Offices with showrooms and stores and dealers in foundry machinery and equipment.
(d) Offices with stores for foundry/die casting material suppliers.
(e) Workshops with offices and stores for foundry pattern makers.
(f) Workshops with offices and stores for mould and die makers.
(g) Administrative office with store for the foundry park management company to deal with general administrative work.
(h) Multi purpose block with:-
    [1] Cast products display area
    [2] Library and information centre with advisory service
    [3] Lecture rooms for talks and short courses
    [4] Foundry technology testing facilities
    [5] CAD/CAM facilities
    [6] R&D facilities
    [7] Meeting rooms
    [8] Administration office
    [9] Canteen
(i) Fabrication and welding workshops
(j) Machine shops, assembly, repairs
(k) Workshops for heat-treatment, shot-blasting, chrome plating, etc.
(l) LLN sub-station
(m) Hawker centre
(n) Playing fields

(o) Community hall

The multi-purpose block is to be run and managed by a group comprising representatives in foundry industry. Buildings may be built by owner/operators themselves/or by a development company or financial institution for sale or rental to other operators.

It is essential that the foundry complex should have access to good roads, good drainage system, adequate public utilities, pollution control and waste disposal systems, fire fighting and security systems.

Source: MIDA "Proposal paper for the establishment of a foundry and engineering park in Selangor and Perak"

2) HICOM Engineering Sdn. Bhd.

HICOM Engineering Sdn. Bhd.owned entirely by HICOM is the manufacturer of cast metal parts for automobiles. The industry is very interested to find out when and how this firm, whose factory is currently under construction, will break into the precision casting market. [See Note (1)]

3) HICOM Diecastings Sdn. Bhd.

This company will begin production of motorcycle parts in September 1990. It also has plans to move into the heavy industry sector in the future. [See Note (2)]

4) Advanced Training Centre, Engineering Industries Complex

This project, currently under negotiation between the Ministry of Youth and Sports and HMT (International) Ltd. of India, aims at both the on-the-job training of workers and the production of machine tools and would be the first of its kind for Malaysia. [See Note (3)]

Notes:

(1) Commercial production is scheduled to begin in February 1991, with an expected payroll of 130 employees. Initially, production will centre around automotive components such as brake discs and drums, rear hubs, brake calipers, steering knuckles, exhaust manifolds, engine brackets, pulleys, water pumps, and flywheels, with plans to manufacture heavy equipment, compressors, and munitions in the future.

(2) Commercial production is scheduled to begin in October 1990 with a staff of 65. Main production items will include motorcycle engine parts (crankcases, crankcase covers, etc.) and alternators and housings for automobiles.
(3) Still in the process of negotiation at the time of the local survey, this project is slated for commencement on May 10, 1990 as the Advanced Training Centre (ATC). The training programmes, designed to improve the standards of production technology for metal machining, will target technicians, craftsmen, and machine operators. A single training course will be capable of accommodating 204 trainees for the training period of 1-2 years. Short courses lasting 3-12 weeks will also be available.

I-1-5. Industry Promotion Policies

(1) Industrial Master Plan

The IMP has designated machinery and engineering (subdivided into the foundry, mould and die, machinery, and fabrication sectors) as a key industry and provides direction for the industry and potential investors. Directions for the industry are explained in Volume II, part 10, MACHINERY AND ENGINEERING."

(2) Product strategy

The IMP has made two proposals concerning the priority and scheduling of products for domestic production in its product strategy for the machinery and engineering industry. One gives 57 products as "examples of products classified according to various levels of technology requirements," ranking these in the order A, B, C from the lowest technical level up. The IMP has as one of its goal the upgrading of production technology levels from A to B and finally to C by the year 1995.

The other proposal classifies machinery and machinery components and specifies a time schedule for the crossover to domestic production which is divided into three phases: 1986-1990, 1991-1995, and post-1995. These products are listed in the Appendix "Products to be considered for local production."

(3) Incentive measures (Pioneer Status)

Casting has been designated by the Minister of Trade and Industry as an industry for promotion, and as such it is eligible to apply for Pioneer Status.

I-1-6. Supporting Service Facilities

With the objective of contributing to the development of Malaysian industry, Malaysian government bodies have been the focus of efforts to provide education and training as well as a variety of services such as technical guidance and testing and inspection. The following section will discuss the activities being undertaken by major related bodies with a focus on foundry industry.

(1) MARA Vocational Training Schools

The MARA vocational training schools form one of MARA agencies under the authority of the Ministry of National and Rural Development. They have been engaged in vocational training since 1966 with the objective of producing Bumiputra technicians. There are nine schools at present, with plans in the Fifth MP for an additional three. Vocational training is currently being conducted for 39 trades, of which three are related to electronics technology: electronic instrumentation, industrial electronics, and radio and television repair. The training centers around repair and maintenance techniques.

Applicants are required to have completed secondary schooling (i.e., 11 years of schooling and an M.C.E.). Classes are held 36 hours a week, with one semester consisting of 17 to 20 per semester and a total of 120. Annual numbers of intakes/graduates of the casting course are as follows.

1977	1978	1979	1980	1981	1982	1983
14/1	14/3	23/12	28/29	21/19	81/84	78/69

1984	1985	1986	1987	1988	1989	1990	Total
22/23	21/41	20/17	21/13	33/22	28/5	0/28	404/366

Source: IKM

(2) Centre for Instructor and Advanced Skill Training (CIAST)

The Centre for Instructor and Advanced Skill Training (CIAST) was founded in Shah Alam, Selangor in 1984 with Japanese assistance and technical cooperation. CIAST was established to train and re-train technical instructors at public training facilities and plant managers at private corporations, and it is considered the summit of public training facilities in Malaysia. More than 2,000 individuals have received training at CIAST since its establishment, and in March 1988 a regional training program targeting rural areas was begun. CIAST also functions as a regional training center for ASEAN, and in 1988 a regional training program was held for ASEAN member nations.

CIAST training courses can be broadly divided into those offering (1) instructor and manager training and (2) advanced skills training. Since attendance requires the NITTCB Intermediate Certification, most of the attendants are instructors at vocational training institutes or plant managers at private companies. As a result, the courses are divided into two- to four-week modules to allow free selection. Trainees receive a "module certificate" upon completion of a module, while a "proficiency certificate" is presented to those who complete all of the modules in a given course.

The instructor training course consists of a six-month course in methods of instruction and nine one- to two-week modules in basic training techniques, skills analysis, audiovisual teaching materials, etc. The manager training course consists of seven one- to two-week modules covering quality control, safety management, and production planning and management.

Course names, module numbers, and course periods for the casting course are shown below.

Casting course: Gating and Risering System

Module number. H.2 1

09/01/87	09/18/87
01/09/89	01/27/89
07/17/89	07/24/89

Casting course: Gating and Risering System

Module number. H2.1.84

08/19/85	09/06/85
10/06/86	10/24/86

Casting course: CAD Gating and Risering System

Module number. H2.2

04/17/89 04/21/89

Casting course: Steel Casting

Module number. H2.2.84

09/02/86 09/23/86

06/87/87 06/26/87

Casting course: Casting

Module number. H2.3

01/18/88 02/05/88

06/27/88 07/15/88

Casting course: Non-iron Casting

Module number. H2.3.84

07/14/86 08/01/86

Casting course: Cupola Melting

Module number. H2.4

05/15/89 05/19/89

07/03/89 07/17/89

Casting course: Analysis of Casting Defects in Die Casting

Module number. H2.5

12/07/87 12/11/87

10/31/88 11/04/88

Source: CIAST

(3) Foundry Technology Unit (FTU)

[One of the units of Metal Industry Development Centre (MIDEC) in Standards and Industrial Research Institute of Malaysia (SIRIM)]

FTU started out as one of the units of MIDEC but has grown to become Malaysia's sole facility engaged in casting technology R&D. Today it boasts facilities and personnel on a par with those of MIDEC at the time of its establishment.

FTU was founded via the following process. In July 1986 the Malaysian government requested the cooperation of Japan, which then dispatched a fact-finding mission in September-October 1987 and in the following April-May conducted a survey concerning the possibility of cooperation and types of assistance. In October 1988 a team was dispatched to discuss concrete details of the project, and on October 12 the Record of Discussions was signed by both sides, with the cooperative project beginning on this day.

This section will first discuss FTU activities and then provide a summary of Japanese cooperation.

1) FTU activities

[1] Location and size

Standards and Industrial Research Institute of Malaysia
P.O. Box 35, 40700 Shah Alam, Selangor Darul Ehsan
Location (Block N, SIRIM headquarters)
Office 145.3 m^2 Conference room, computer room, etc. 102.3 m^2
Experimental plant 10,549 m^2 137.5 m^2

[2] FTU role and activities

At present, SIRIM is trying to shed its traditional emphasis on testing operations and become an R&D organization capable of leading efforts to achieve advanced industrialization under the motto, "A Friend and Partner of Industry." It is hoped that the role of the FTU will change from one of simply supporting related industries to one involving leadership through R&D.

R&D and services constitute the two major aspects of FTU activities. SIRIM also has a standards division responsible for the handling of industrial standards, and offering assistance to this division is one of the main services provided by FTU.

Following is a list of the activities currently being pursued by FTU.

(a) R&D

1) To carry out R&D on advanced utilization technologies for locally-available raw materials with the objectives of improving local casting technology and product quality and reducing manufacturing costs.

2) To promote product diversification and thereby expand the market for local industry. Also, to contribute to the localization of production of items which are currently imported.

3) To pursue manufacturing technologies for large-scale and high-quality castings.

(b) Services

i) To offer technical consultation and guidance in order to improve the quality of local cast metal products.

ii) To achieve the dissemination of casting technologies through the sponsoring of seminars, workshops, and training programs.

iii) To assist the standards division of SIRIM in drawing up casting-related industrial standards.

2) Technical cooperation

[1] Project name

Japanese Technical Cooperation for the Project on Foundry Technology Unit in the Standards and Industrial Research Institute of Malaysia

[2] Project duration

5 years (October 12, 1988 - October 11, 1993)

[3] Objectives

This project has as its objective the training of personnel capable of transferring technology to local companies (and hence the technological development of the Malaysian casting industry) through technical guidance, testing and inspection services, information services, and training programs in the field of casting technology.

In order to achieve these goals, the Japanese side will, throughout the duration of the project, provide technical guidance and advice in the following fields for the training of its Malaysian counterparts.

(1) Model fabrication

(2) Melting

(3) Mould fabrication

(4) Quality control

(5) Testing and inspection

(6) Finishing

(7) Product development

[4] Dispatch of experts

Long-term (4) (chief advisor, coordinator, melting expert, mold-making expert)

Short-term (as needed) (15 had been dispatched as of the end of May 1990)

[5] Acceptance of trainees

Nine had been accepted as of the end of May 1990.

[6] Provision of equipment and materials

The main equipment and materials to be provided are as follows.

(a) Model fabrication		
Set of materials for wooden mould fabrication		1
(b) Melting		
High-frequency induction furnace; 500, 100, and 80-kg crucibles		1 of each
(c) Models		
Joint squeeze moulding machine	650 x 575mm	2
Core blowing machine	310(W) x 400(L) x 340(H) mm	1
Shell core machine	300(W) x (70/70) x 300(H) mm	1
Sand processing system for CO2 and furan moulds		1
Sand processing system for green sand moulds		1
Sand drying system		1
Sand testing system		1
(d) Testing and inspection		
Fluorescent X-ray spectroscopy system		1
CS analysis system		1
(e) Finishing		
Shot blasting machine		1
Double-headed grinder		1
(f) Other		
Personal computers		6
Video equipment		1
Microbus		1
Land Cruiser		1
Casting-related reference materials		

Source: FTU

I-2. Present Status of Production

I-2-1. Production of Castings by Demand Industry and Material

Table I.2-1 shows a breakdown of production by demand industry and material as calculated from the questionnaire results. As is clear from the Table, demand for cast iron and steel casting is centered in the rubber, tin, and palm oil industries; for copper alloy casting, in the rubber, tin, and shipbuilding industries; for die casting aluminum casting, in the rubber, tin, and construction industries; for aluminum, in the construction and motorcycle industries; and for malleable iron casting, in construction.

Table I.2-1 Breakdown of Production of Castings by Demand Industry and Material (1988)

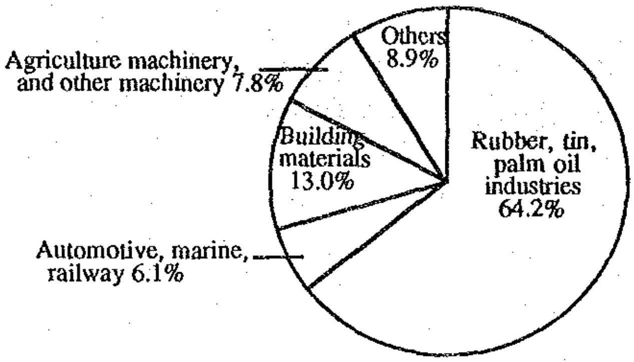
(Unit: %)

Demand industry	Cast iron	Malleable iron casting	Steel casting	Copper alloy casting	Alu-minum	Die casting
1. Rubber	13.0	—	9.5	24.0	20.0	0
2. Tin	24.3	—	33.3	20.0	30.0	0
3. Palm oil	13.9	—	28.6	12.0	0	0
4. Timber	13.0	—	4.8	0	0	0
5. Building material	13.0	100	4.8	8.0	20.0	19.0
6. Automotive	2.6	—	0	4.0	0	4.8
7. Motorcycle	0.9	—	4.8	4.0	0	14.3
8. Railway	0.9	—	0	0	0	0
9. Agriculture machinery	2.6	—	0	0	10.0	0
10. Marine	1.7	—	0	20.0	0	9.5
11. Electrical equipment	0	—	0	0	20.0	38.1
12. Other machinery	5.2	—	9.5	4.0	0	0
13. Others	8.9	—	4.7	4.0	0	14.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Questionnaires

In other words, the Malaysian foundry industry is still highly dependent on traditional industries. As for copper alloy casting, aluminum casting or die casting, however, they have recently found application in the marine, electrical and motorcycle industries.

Fig. I. 2-1 Production of Cast Iron by Demand Industry



I-2-2. Production by Material

Table I.2-2 shows a breakdown of Malaysian production by material. As is clear from the Table, the scale of production at most plants in the Malaysian casting industry, with the sole exception of malleable cast iron, is very small.

Table I. 2-2 Number of Foundries by Material

Material	Production scale (tons/year)							
	100>	300>	500>	1,000>	2,000>	3,000>	3,000<	Total
Cast iron	11	27	20	11	3	1	0	73
Malleable iron casting	0	0	0	0	1	1	0	2
Steel casting	3	1	1	3	3	0	1	12
Copper alloy	16	5	0	0	0	0	0	21
Aluminum	14	0	0	0	0	0	0	14
Die cast	7	4	3	2	0	0	0	16

Source: Questionnaires

In the case of cast iron, 14.7% of all plants (11) had an annual production capacity of less than 100 tons (approx. 8.5 tons/month); 36.0% (27), annual capacity of 100-300 tons; and 27.4% (20), annual capacity of 300-500 tons. These plants accounted for 77.3% of the total (58), thus indicating the small-scale nature of cast iron production in Malaysia.

The only two plants engaged in the production of malleable iron casting were large-scale facilities, one with annual production of 1,000-2,000 tons and one with capacity of 2,000-3,000 tons.

Only five factories out of 12 which are engaged in the production of steel casting showed annual production of less than 500 tons per year (approx. 42 tons/month), indicating the slightly larger scale of steel casting operations.

In the field of non-ferrous metals, 16 out of 21 coper alloy foundries, or 76.2% of the total, were small facilities with annual production of less than 100 tons. All of the factories engaged in the production of aluminum casting also fell into this category. Seven out of the 16 die casting factories, or 43.8%, reported annual production of less than 100 tons, but two of the facilities also fell into the 500-1,000 ton category.

I-2-3. Manufacturing Methods

(1) Furnaces

Table I.2-3 shows a breakdown of the types of furnaces used in the Malaysian casting industry by material.

Table I.2-3 Number of Foundries by Material and Furnace Type

Material	Furnace type				
	Cupola	Low-frequency induction furnace	High-frequency induction furnace	Arc furnace	Crucible furnace
Cast iron	69	2	4	0	0
Malleable iron casting	1	1	0	0	0
Steel casting	0	2	9	1	0
Copper alloy casting	0	0	0	0	21
Aluminum casting	0	0	0	0	14
Die casting	0	0	0	0	16

Source: Questionnaires and factory visits

In the case of cast iron, virtually all of the facilities used cupola, with just six found to be using induction furnaces. Three of these factories were engaged primarily in the production of steel casting and were making ductile cast iron. The other three were relatively large factories engaged solely in the production of cast iron products such as automobile components, valves, piano frames, centrifugal cast iron pipes, liners and valves for diesel engines, and metal moulds for glassmaking.

Only two Malaysian firms are involved in the manufacture of malleable iron casting. One uses a cupola furnace, while the other depends on a low-frequency induction furnace. In terms of the strength of the cast iron which can be obtained, the latter method is somewhat superior because of the lower resulting carbon content (2.6-2.8% vs. approx. 3%).

In the industrialized nations arc furnaces are generally used for melting during the production of steel casting because of their low power consumption and their tolerance for low-grade scrap metal. In Malaysia, however, high-frequency induction furnaces are the most commonly used. Given the views on the cost savings of electrical power and the scarcity of steel scrap in this country, however, arc furnaces would be more appropriate. As is seen in Table I.2-3, only one Malaysian factory uses an arc furnace. Due to the large (8-ton) capacity of the model in use, moreover, it is used primarily for the production of steel bars rather than steel casting, for which a high-frequency induction furnace is used. Two companies use low-frequency induction furnaces, which are seldom used in the industrialized nations because of long melting times and the difficulty of bringing up the furnace temperature. Reasons why arc furnaces are not used at Malaysian steel casting foundries include a lack of the technical expertise required to operate this type of furnace combined with the ease of operation offered by high-frequency induction models.

In Malaysia, crucible furnaces are used during the casting of non-ferrous metals such as copper alloy and aluminum as well as in die casting. A similar situation can be found in the industrialized nations. Petroleum, gas, and coke are used as heat sources.

Regardless of the type of metal, the following characteristics are required of a melting furnace:

(1) No oxidation of or gas absorption by the molten metal

(2) Ability to reach the desired melting temperature

(3) Ability to provide a molten metal with the desired physical properties

(4) Ability to provide a molten metal with the desired chemical composition

In order for a melting furnace to provide the desired properties, operators must have a thorough knowledge of the primary and subsidiary materials used in melting, of the physical structure of furnace refractories, and of the operation of the furnace. At the factories visited during the survey, the ample room for improvement was recognized in this area.

In the case of the primary material, for example, an excess of rust or oil or the introduction of different types of metal were found to lead to casting defects. It would be necessary to remove any rust and oil using a tumbler or shot blasting machine and eliminate any foreign substances.

(2) Moulding sand and sand reclamation

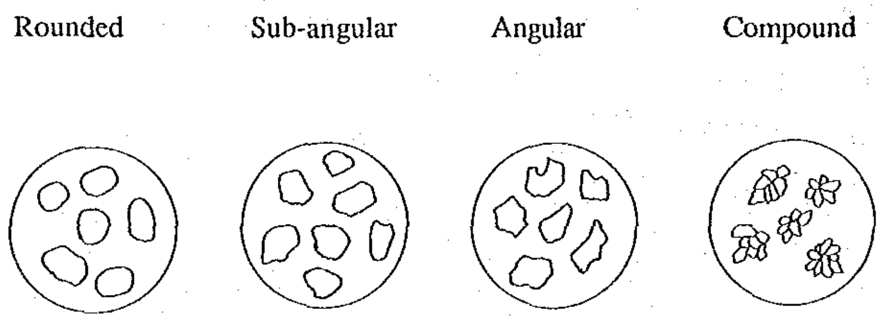
1) Moulding sand

The leading types of moulding sand used in Malaysian casting factories are as follows: high-quality Johor sand, named for the Johor district from which it is taken; the tin mining sand produced in the tin mines of Kuala Lumpur and the Ipoh district; river sand; and soil sand. Johor sand has a silica content exceeding 98% and a round grain shape, but since grains are often smaller than 70 mesh the sand must be screened to 35-60 mesh. This naturally increases costs. As a result, Johor sand is often used in shell moulds but is generally held to be too fine for use in general casting applications.

Tin mining sand has a sub-angular grain shape that results in poor fluidity during moulding and often leads to moulding defects. It is therefore suggested that a conical machine be used to round out the grains. In Japan, this technique is used by sand suppliers in order to provide their customers with rounded sand.

Of the varieties of moulding sand recognized by the American Foundrymen Society (AFS) and shown in Fig. I.2-2, rounded sand is held to be the most desirable. Photograph 1 shows the grain shape of tin mining sand taken from the Selangor Rawang district, and Table I.2-4 shows grain size distributions for three types of sand obtained from the same location. For reference, Japan Industrial Standards (JIS) for moulding sand are shown together with examples of Japanese silica sand.

Fig. I.2-2 Grain Size Distribution of AFS



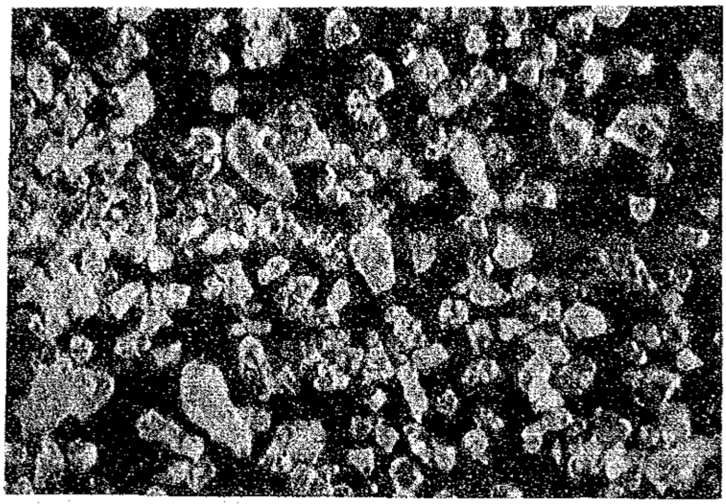


Photo
(Sand grain shape in tin mining in Rawang region, Selangor state)

Fig. I. 2-3 Degree of Purity of Silica Sand for Die Casting

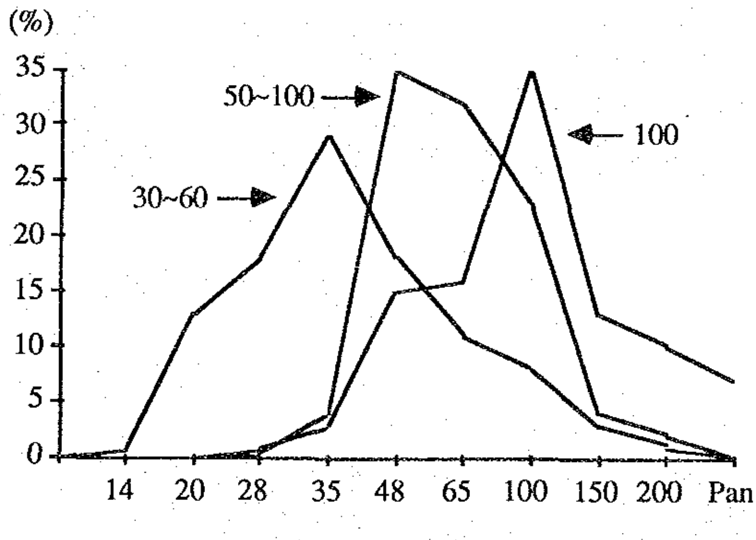


Table I.2-4 Grain Size Distribution of Malaysian Silica Sand

Type	14	20	28	35	48	65	100	150	200	270	Pan	Total	Clay content
30~60	0.1	0.8	12.3	18.3	28.4	18.3	11.1	7.4	1.8	0.6	0.2	99.3	0.7
50~100	tr	tr	0.2	0.5	4.1	35.3	31.3	21.4	4.7	1.7	0.2	99.4	0.6
100	0	tr	0.2	0.8	2.8	15.0	16.2	34.8	13.2	9.7	6.1	98.8	1.2

Note: Sand was taken from the Rawang region of Malaysia and tested by Saitama Casting Equipment Industires.

Table I.2-5 Purity Grades of Molding Silica Sand (JIS G5601)

(Unit: %)

Grade	Purity SiO_2	Impurities Fe_2O_3	Impurities Al_2O_3	Impurities CaO+MgO
1st	More than 98.1	Less than 0.5	Less than 1.0	Less than 1.0
2nd	96-98	Less than 1.0	Less than 2.0	Less than 1.5
3rd	93-96	Less than 1.5	Less than 4.5	Less than 2.0
4th	90-93	Less than 2.0	Less than 6.0	Less than 2.5
5th	85-90	Less than 3.0	Less than 8.0	Less than 3.0
6th	70-85	Less than 5.0	Less than 15.0	Less than 5.0

JIS of foundry sands
Moulding silica sand JIS G 5601 (1974)

As can be seen in Table I.2-4, clay content is less than 2% and Table I.2-5 shows that purity is divided into six grades, Grade 1 having a SiO_2 content exceeding 98%. This is used primarily for steel casting. Grade 4 and above are used for cast iron, while Grades 5 and 6 are used for casting of non-ferrous metals.

Table I.2-6 shows JIS grain size numbers for silica sand. As can be seen from the Table, since the peak sand wt% for the 10-35 mesh sand is at least 40% and that of the >48 mesh sand at least 30%, the peak sand wt% of any sieve and its two neighbors will always be at least 70%.

Table I.2-6 Grain Size of Silica Sand (JIS)

(Unit: %)

Size No.	Nominal Dimension of Sieve μ			Peak	Wt% of peak	Wt% of 3 sieves
10 Mesh	2,380 (8)	1,680 (10)	1,190 (14)	1,680 (10)		
14 Mesh	1,680 (10)	1,190 (14)	840 (20)	1,190 (14)		
20 Mesh	1,190 (14)	840 (20)	590 (28)	840 (20)	>40	
28 Mesh	840 (20)	590 (28)	420 (35)	590 (28)		
35 Mesh	590 (28)	420 (35)	297 (48)	420 (35)		>70
48 Mesh	420 (35)	297 (48)	210 (65)	297 (48)		
65 Mesh	297 (48)	210 (65)	149 (100)	210 (65)		
100 Mesh	210 (65)	149 (100)	105 (150)	149 (100)	>30	
150 Mesh	149 (100)	105 (150)	74 (200)	105 (150)		
200 Mesh	105 (150)	74 (200)	53 (270)	74 (200)		

Note: 1. ( ) means mesh. Wt% of 3 sieves if peak size and neighbors.
2. JIS 5601

This has a favorable impact on the permeability, mouldability, and strength of the moulding sand. The grain size numbers shown in the Table are actually the mesh of the peak sand.

Table I.2-7 Typical Japanese Moulding Sand

	20	28	35	48	65	100	150	200	270	Pan	AFS (Finess No)
A sand	1.6	16.2	38.2	28.1	12.0	3.0	0.6	0.1	0.1	0.1	35.4
B sand	tr	1.0	4.1	16.2	34.0	31.8	12.3	0.2	0.1	tr	53.9
C sand	0.2	0.4	3.0	13.4	39.6	17.8	8.6	1.6	0.8	1.7	51.3

Based on the Tables and Figures shown above, it was judged that the silica moulding sand used in Malaysia has too loose a grain size distribution and requires improvement.

2) Sand reclamation

When moulding sand is used repeatedly, the concentration of mixed and added substances (clay, coal dust, starch, etc.) increases, and the silica sand itself can be crushed by the tremendous heat load, thereby impairing its properties as a moulding sand. The sand must therefore be monitored to keep additive content at a constant level.

Fig. I.2-4 Grain Size Distribution of Japanese Silica Sand

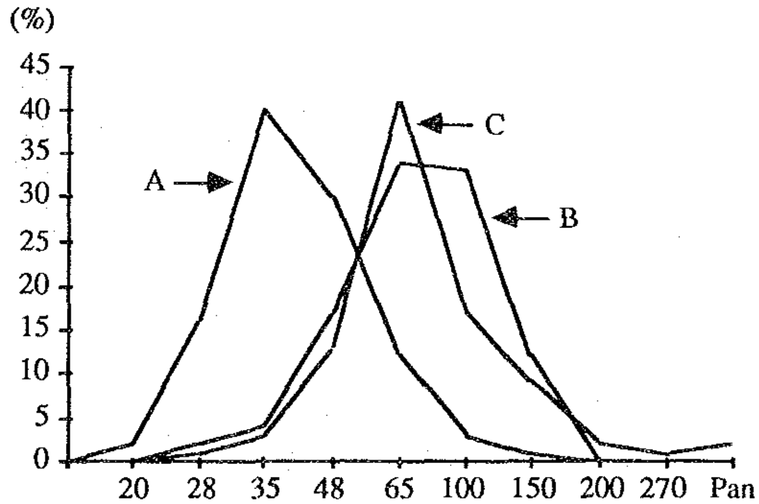


Table I.2-8 shows data obtained from the questionnaires concerning the reclamation of moulding sand at Malaysian cast iron foundries. It can be seen from the Table that small-scale factories are not very active in sand reclamation. This results in more casting defects due to deterioration of the moulding sand.

Table I.2-8 Reclamation of Moulding Sand at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	No. of factories engaged in reclamation
<100	11	0
<300	27	6
<500	20	3
<1,000	11	2
<2,000	3 (1)	3 (1)
<3,000	1 (1)	0 (1)
>3,000	0	0
Total	73 (2)	14 (2)

Source: Questionnaires
Figures in parentheses indicate malleable cast iron foundries.

Table I.2-9 shows moulding sand reclamation at steel casting foundries. The facing sand is generally new sand, while reclaimed sand is used the back sand. It was noted in Table I.2-11 that most steel casting foundries use CO_2 moulds. Use of reclaimed sand for the back sand in these moulds would be effective.

Table I.2-9 Reclamation of Moulding Sand at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	No. of factories engaged in reclamation
<100	3	0
<300	1	1
<500	1	0
<1,000	3	0
<2,000	3	1
<3,000	0	0
>3,000	1	1
Total	12	3

Source: Questionnaires

Three of the steel casting factories surveyed were engaged in the reclamation of moulding sand. Of these, those with annual production capacities in the range 1,000-2,000 tons and >3,000 tons use pepset moulds, and all of the sand used in these moulds is reclaimed.

In the case of non-ferrous alloys, green sand moulds are most common. It is suggested that the sand used in these moulds be reclaimed and occasionally mixed with new sand to prevent aging.

(3) Moulding Process

1) Types of moulds

a) Cast iron

Table I.2-10 shows that green sand moulds, CO_2 moulds, and cement moulds are most commonly used in the production of cast iron. Specifically, 24 out of 75 factories (32.0%) used green sand moulds, while 23 (30.7%) used CO_2 moulds and 46 (61.3%) cement moulds.

Table I.2-10 Types of Moulds Used in Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	11	5	6	7	3	0
<300	27	7	7	22	2	0
<500	20	5	6	8	3	1
<1,000	11	3	3	9	2	0
<2,000	3 (1)	2 (1)	0	1	3	1
<3,000	1 (1)	(1)	1	0	0	0
>3,000	0	0	0	0	0	0
Total	73 (2)	22 (2)	23	47	13	2

Source: Questionnaires and factory visits
Figures in parentheses indicate malleable cast iron plants

Semi-synthetic skin dry moulds are generally used for products used in local tin mines; green sand moulds, for burners and valves in autmobiles, agricultural equipment, and kitchen appliances as well as piano frames and other mass-production items; and cement sand moulds, for the production of low-volume items such as mechanical components. Organic chemical resin binder ("no-bake") moulds were used at two factories. Shell moulds were used for the cores of small mass-produced items.

In Japan and other industrialized nations as well as NIEs such as Korea and Taiwan, CO_2 moulds are used only for cores, while cement sand moulds have been completely replaced by the organic no-bake moulds. Use of this type of mould is expected to increase in Malaysia as well in the future.

b) Steel casting

Table I.2-11 shows the types of moulds used at steel casting factories in Malaysia. As can be seen from the Table, CO_2 moulds are used by virtually all of the facilities. Green sand moulds and cement moulds were both used by three relatively small plants, while larger firms used pepset moulds (the organic no-bake variety described above).

In the industrialized nations, CO_2 and pepset moulds are the most commonly used for the production of cast steel. The former are used especially as alloy and cast steel moulds, while the latter are commonly used in the molding of carbon steel.

Table I.2-11 Types of Moulds Used in Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	3	1	3	1	1	0
<300	1	1	2	1	0	0
<500	1	0	1	1	0	0
<1,000	3	1	2	0	0	0
<2,000	3	0	1 (1)	0	0	1
<3,000	0	0	0	0	0	0
>3,000	1	0	1	0	1	1
Total	12	3	10 (1)	3	2	2

Source: Questionnaires and factory visits
Figures in parentheses indicate the number of ester moulds and CO_2 cast moulds

c) Non-ferrous casting

Table I.2-12 shows the types of moulds used at copper alloy foundries in Malaysia. As can be seen from the Table, all of the 21 plants surveyed used green sand moulds, while three used CO_2 moulds and three cement moulds as well. The CO_2 moulds are used mainly for cores, while the cement moulds are used for the casting of propellors.

As is seen from the Table, copper alloy foundries are generally small in scale, with annual production at 18 of the factories totaling 419 tons, resulting in an average annual capacity of 23.3 tons per factory (roughly 2 tons/month). Production at the remaining three plants totaled 610 tons/year, averaging out to 203 tons/year (equivalent to 16.9 tons/month) at each factory.

Table I.2-12 Types of Moulds Used in Malaysian Copper Alloy Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	18	18	3	3	0	0
<300	3	3	3	3	0	0
<500	0	0	0	0	0	0
<1,000	0	0	0	0	0	0
<2,000	0	0	0	0	0	0
<3,000	0	0	0	0	0	0
>3,000	0	0	0	0	0	0
Total	21	2	6	6	0	0

Source: Questionnaires and factory visits

Table I.2-13 shows the types of moulds used at aluminum foundries in Malaysia. It can be seen from the Table that the 14 aluminum foundries in Malaysia have a combined annual production capacity of 432 tons, averaging out to approximately 30 tons/year or 2.5 tons/month for each factory and indicating the extremely small-scale nature of this sector. In addition, virtually all of these factories were part of copper alloy, die casting, or iron and steel-related foundries.

Virtually all of Malaysia's aluminum casting factories use green sand moulds. Three factories do use CO_2 moulds, but these are used for cores.

Table I.2-13 Types of Moulds Used in Malaysian Aluminum Casting Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	14	14	3	0	0	0
<300	0	0	0	0	0	0
<500	0	0	0	0	0	0
<1,000	0	0	0	0	0	0
<2,000	0	0	0	0	0	0
<3,000	0	0	0	0	0	0
>3,000	0	0	0	0	0	0
Total	14	14	3	0	0	0

Source: Questionnaires and factory visits

(3) Moulding methods

1) Cast iron

Table I.2-14 shows a breakdown of moulding methods used at Malaysian cast iron foundries. As can be seen from the Table, 60 out of the 75 factories, or 80%, used hand moulding, while the remaining 15 used machine moulding. Those foundries with annual production capacities exceeding 1,000 tons all used machine moulding. When classified by the use of moulding flasks, those facilities engaged in flask moulding outnumbered those not using flasks.

Table I.2-14 Moulding Methods at Malaysian Cast Iron Foundries

		Hand moulding	Machine moulding	Flask moulding	Flaskless moulding	Pit moulding
<100	11	9	2	5	3	2
<300	27	24	3	19	16	20
<500	20	18	2	5	1	6
<1,000	11	9	2	9	8	5
<2,000	3 (1)	0	3 (1)	4 (1)	0	0
<3,000	1 (1)	0	1 (1)	1	(1)	0
>3,000	0	0	0	0	0	0
Total	73 (2)	60	13 (2)	43 (1)	28 (1)	33

Source: Questionnaires and factory visits
Note: Figures in parentheses indicate malleable cast iron foundries

With the exception of the flaskless high-speed, high-pressure moulding system being used by one malleable cast iron foundry, all of the moulding machines used at Malaysian cast iron foundries were of the prototype jolt or jolt squeeze variety. Centrifugal casting machines were in use at two factories, one producing centrifugal cast iron pipe and the other small engine liners and related components. It was already pointed out in Table I.2-10 that the shell mould method is used for cores at 13 companies. According to the questionnaire results, these 13 factories possess a total of 37 shell machines, but virtually all of this equipment is concentrated at those facilities with annual production of at least 1,000 tons.

2) Steel casting

As shown in Table I.2-11, CO_2 moulds are the most commonly used for the moulding of steel casting. In Japan, no-bake moulding using organic chemical binders is the most often used method due to considerations of pollution and productivity. Only two Malaysian firms use no-bake moulds. Since the cement moulds and CO_2 moulds used at casting factories both require highly alkaline moulding sand with pH values in the range 10-11, they would pollute rivers and lakes, and this has been the reason for their gradual disappearance from Japanese foundries.

3) Non-ferrous metals

Tables I.2-12 and I.2-13 above show that green sand moulds are the most common varieties used in the moulding of non-ferrous metals in Malaysia. Large ship propellors and similar pieces are the exceptional products which are generally moulded using cement moulds or CO_2 moulds.

Low-refractoriness naturally-bonded sand, rather than the silica sand used in the casting of ferrous metals, is used as the moulding sand for the casting of non-ferrous alloys. Naturally-bonded sand is characterized by a fine grain (<100 mesh) and high clay content (20% - 25%), and is often called as mountain sand or soil sand
Because of the extremely small market, Malaysia's non-ferrous metal foundries have small production capacities and are usually either part of a larger corporation or engaged in the casting of copper alloy or aluminum or die casting on the side.

Die casting is the technique in which molten metal is mechanically forced into a metal die. Table I.2-15 shows the number and size of die casting machines at Malaysian die casting plants. The Table shows that most of the machines in use at these facilities have capacities of at least 100 tons.

Table I.2-15 Number of Die Casting Machines at Malaysian Die Casting Foundries

Production /year (tons)	No. of factories	30t	31~50t	51~100t	101~300t	301t~
<100	7	0	0	2	11	2
<300	4	0	0	1	2	5
<500	3	1	0	3	3	3
<1,000	2	0	0	0	4	5
<2,000	0	0	0	0	0	0
Total	16	1	0	6	20	15

Source: Questionnaires and factory visits

Table I.2-16 provides a summary of the moulding methods used for each material. The Table shows that 106 out of 122 foundries (86.9%) use hand moulding, while 25, or 20.5%, are engaged in machine moulding. The total exceeds 100% because some of the hand-moulding plants have also introduced machine moulding facilities. In the future, it will be necessary for Malaysian foundries to introduce automated high-speed, high-pressure moulding machines.

Table I.2-16 Breakdown of Moulding Methods at Malaysian Foundries by Material

Units: Number of factories/% of total

Material	No. of factories	Hand moulding	Machine moulding	Flask moulding	Flaskless moulding	Pit moulding
Cast iron	73 (2)/100	60/80.0	13 (2)/20.0	43/57.3	42 (2)/60.0	33/44.0
Steel casting	12/100	11/91.7	4/33.3	10/83.3	8/66.7	3/25.0
Copper alloy	21/100	21/100	3/14.3	13/61.9	8/38.1	12/100
Aluminum	14/100	14/100	4/28.6	14/100	10/71.4	10/71.4
Total	122/100	106/86.9	25/20.5	80/65.6	71/58.2	58/47.5

Source: Calculated based on questionnaires and factory visits

Flask moulding is somewhat more common than flaskless moulding. Although both of these methods have their respective advantages, flask moulding is able to offer slightly higher dimensional precision.

58 of the 122 foundries (47.5%) responding to the questionnaire answered that they used pit moulding. In contrast to the 44.0% of cast iron foundries and 25.0% of steel casting foundries using this technique, fully 100% of the copper alloy foundries and 71.4% of all aluminum foundries employed pit moulding.

Pit moulding is the technique in which a pit is dug in the floor to perform moulding. During the factory visits, this type of operation could be seen only at cast iron plants. The high percentages of this application indicated by the questionnaire results would be due to a confusion of this technique with floor moulding.

(4) Finishing Process

After the molten metal is poured into the mould, allowed to harden and removed from the mould, attached moulding sand is shaken out. Such unneccessary portion as the gate, sprue runner and bar are removed, and deburring is performed. The surface is then ready for finishing.

Cast metal pieces produced in Malaysia's larger foundries, as well as non-ferrous metal pieces, have a relatively good external appearance, but other varieties cannot be so favorably evaluated. This is due to a lack of understanding concerning moulding sand characteristics and insufficient knowledge and know-how concerning the use of this sand.

In the finishing process, all of the unnecessary portions are removed from the surface of the cast piece. The manufacturer has a responsibility to provide the customer with a product that adequately fulfills his needs.

Numerous machines are used in finishing cast metal: shake-out machines, used to shake out moulding sand; and turn blast machines, shot blast machines, grinders, and swing grinders, used to remove sand attached to the surface and for polishing.

As can be seen in Table I.2-17, five foundries (6.7% of the total) had a total of six shake-out machines; 13 factories (17.3%), a total of 21 turn blast machines; 10 factories (13.3%), a total of 25 shot blast machines; and 47 (62.7%), a total of 168 hand grinders and table grinders. No firms used swing grinders.

Table I.2-17 Finishing Facilities at Malaysian Cast Iron Foundries

Production /month (tons)	No. of factories	Shakeout machine	Turn blast	Shot blast	Swing grinder	Grinder
<100	11	0	1/1	1/1	0	13/6
<300	27	1/1	5/5	4/2	0	54/19
<500	20	1/1	4/4	4/2	0	26/11
<1,000	11	3/2	3/1	8/2	0	58/7
<2,000	3 (1)	1/(1)	3/(1)	3/2	0	12/3
<3,000	1 (1)	0	5/(1)	5/1	0	5/1
>3,000	0	0	0	0	0	0
Total	73 (2)	6/4 (1)	21/13	25/10	0	168/47

Source: Questionnaires and factory visits
Units: No. of machines/no. of factories

The number of firms conducting sand shake-out (5) was very low, even when the high-variety and low-volume nature of the products is taken into consideration.

Only 13 of the factories (17.3%) had turn blast machines. These machines are relatively small for finishing machines and are reasonably priced as well, and it is suggested that all plants producing smaller items have at least one on hand.

Ten factories (13.3%) had a total of 25 shot blast machines. That there were more of these than the smaller turn blast machines was probably due to the large size of the pieces handled by the casting industry.

Swing grinders are both powerful and efficient, but as yet they have seen no application in Malaysian cast iron foundries.

There are two types of grinders — table and portable — but they were lumped together for the current survey. 47 of the factories in the present survey (42.7%) possessed a total of 168 grinders. When viewed by annual production, these numbers can be broken down as follows. <100 tons: six factories, 13 units; 100-300 tons: 19 factories, 54 units; 300-500 tons: 11 factories, 26 units; 500-1,000 tons: 7 factories, 58 units; 1,000-2,000 tons: 3 factories, 12 units; and 2,000-3,000 tons: 1 factory, 5 units.

The average of more than eight units per factory for facilities in the 500-1,000 ton range is abnormally high, but this is due to two factories in the group which possessed 30 and 10 units, respectively, and is not characteristic of the group as a whole. In the 300-500 ton class, the average was 2.3 units per factory. At factories with annual production of more than 100 tons, the number of grinders increased together with plant size, but there was no direct relationship between tonnage and the number of units.

Further expansion of exports will require a more complete lineup of finishing machinery and equipment in order to meet the customers' requirement.

(5) Raw materials

The supply of raw materials to Malaysian foundries is unstable in terms of quality, quantity, and price.

According to the results of the questionnaires and factory visits, some very low-grade materials were being delivered to the foundries. Specifically, many pieces were too large, contained too much rust, or contained foreign substances and could therefore not be used. On the cost front as well, many interviewed were troubled by the increase in prices that has come about partially in response to rapidly increasing demand. As a result of this situation and the resulting uncertainty as to when ordered materials would arrive, practices such as early ordering and stockpiling have appeared on the steel scrap scene and are sources of concern to those in the business. Some companies have been forced to resort to surplus storage.

On the positive side, however, limestone, used to melt metals, is inexpensive and of good quality. In addition, high-quality silica moulding sand can be obtained from the Johor district, and recently high-silica sand with a silica content of at least 95% is being produced from the residual sand at tin mines. At present, tin mining sand has poor shape and grain size distribution, but it could become a rich resource if suppliers made the effort to bring it up to the quality standards of the industrialized nations.

Of the energy sources used for melting metals, only coke, used in cupola, is imported. The electrical power used by electric furnaces and the petroluem consumed by non-ferrous metal furnaces are provided locally. Electrical power in particular is relatively inexpensive: with the basic rate of M$12/kw plus the usage fee of 16 cents/kwh in the daytime and half that at night minus the 20% discount offered to industry, the final cost of electricity is 13-14 cents per kilowatt-hour (equivalent to about 7 yen), far less than the 18-22 yen rate typical in Japan.

Many factories used oil-powered generator motors to compensate for the lack of electrical power available for cast steel melting. Assuming a figure of M$0.5 per liter of petroleum and consumption of 58 l/hour for a 150-kw generator, petroleum consumption would amount to M$29 per hour. Electrical power would therefore cost M$29/150 = M$0.193/kwh (roughly 10 yen/kwh), roughly half the figure for Japan. (Note: These calculations were made based on data provided by the foundries visited.)

The conditions of the major raw materials are as follows.

1) Pig iron

Some of the foundries visited kept stocks of pig iron, but in fact it was seldom used at any of the facilities. This is due to a lack of basic knowledge of why pig iron is required in the manufacture of cast metal. More specifically, both buyers and producers were unaware that cast mechanical components must be capable of providing certain chemical, physical, and mechanical properties.

In Japan, for example, the mechanical and physical properties of cast (pig iron) mechanical components are specified by JIS. These have symbols such as FC 15, FC 20, and FC 30. Table I.2-20 shows the Japan Industrial Standards for gray cast iron. These figures are used in material tests, in which the dimensions of the test piece are specified by the material grade and wall thickness of the product. The foundry must produce products capable of fulfilling the needs laid out in the plans or specifications provided by the customer.

In order to produce gray cast iron meeting these material specifications, the Japan Foundrymen Society provides those in the industry with a list of target values for chemical composition. These values are shown in Table I.2-18.

Table I.2-18 Target Composition of Gray Cast Iron

Grade	T.C.	Si	Mn	P	S
FC 15	3.5~3.8	2.8~3.1	0.5~0.8	<0.25	<0.1
FC 20	3.3~3.6	2.3~1.8	0.6~0.9	<0.20	<0.1
FC 25	3.2~3.5	2.2~1.7	0.6~0.9	<0.15	<0.1
FC 30	3.1~3.3	2.1~1.6	0.6~0.9	<0.12	<0.1
FC 35	2.9~3.2	2.0~1.5	0.7~1.0	<0.10	<0.1

Source: Hand book, Japan Foundrymen Society

In Japan, the foundry decides upon a specific chemical composition based on the plans or specifications provided by the customer and then proceeds to calculate the necessary blend ratio of new pig iron, cast iron scrap, and steel scrap. The new pig iron content is generally similar to the one shown in Table I.2-19.

In contrast, chemical analysis of pig iron during the visits to Malaysian foundries indicated 3.3-3.5 total carbon and 1.4-1.6 Si contents, both of which are quite low. In addition, many products had non-uniform compositions and were therefore unusable.

Table I.2-19 Recommended Chemical Composition for Pig Iron

T.C.	Si	Mn	P	S
3.8~4.1	2.0~2.2	0.6~0.8	<0.15	<0.06

2) Cast iron scrap

Automobile engines appeared to be the most common source of cast iron scrap. This was followed by scrap from various types of light machinery. In general, these types of scrap are favorable because of their small wall thickness, which facilitates melting in a cupola or electric furnace. On the other hand, they tend to be plagued by an abundance of rust and the presence of impurities. When using this type of scrap, therefore, it is important to remove rust with a shot blasting machine and eliminate any foreign substances.

Table I.2-20 Japan Industrial Standard (JIS) for Gray Cast Iron

C.2.2 Cast iron products

a. JIS G 5501-1976 Gray cast iron

				Tension test	Breakage tests		Hardness test
Grade	Symbol	Common thicknesses mm	Diameter of test piece mm	Tensile strength kgf/mm^2 (N/mm^2)	Maximum load kgf(kN)	Flexure mm	Brinell hardness Hp
1	FC 10	4~50	30	10~ (98.1~)	700~ (6,860~)	3.5~	~201
2	FC 15	4~8	13	19~ (186~)	180~ (1,770~)	2.0~	~241
	9~15	20	17~	400~ (167~)	2.5~ (3,920~)	~223	
	16~30	30	15~	800~ (147~)	4.0~ (7,850~)	~212	
	30~50	45	13~	1,700~ (127~)	6.0~ (16,670~)	~201	
3	FC 20	4~8	13	24~ (235~)	200~ (1,960~)	2.0~	~255
	9~15	20	22~	450~ (216~)	3.0~ (4,410~)	~205	
	16~30	30	20~	900~ (196~)	4.5~ (8,830~)	~223	
	30~50	45	17~	2,000~ (167~)	6.5~ (19,610~)	~217	
4	FC 25	4~8	13	28~ (275~)	220~ (2,160~)	2.0~	~269
	9~15	20	26~	500~ (255~)	3.0~ (4,900~)	~248	
	16~30	30	25~	1,000 (245~)	5.0~ (9,810)	~241	
	30~50	45	22~	2,300~ (216~)	7.0~ (22,550~)	~229	
5	FC 30	8~15	20	31~ (304~)	550~ (5,394~)	3.5~	~269
	16~30	30	30~	1,100~ (291~)	5.5~ (10,790~)	~262	
	30~50	45	27~	2,600~ (265~)	7.5~ (25,500~)	~218	
6	FC 35	15~30	30	35~ (343~)	1,200~ (11,770~)	5.5~	~277
	30~50	45	32~	2,900~ (314~)	7.5~ (28,440~)	~269	

Notes
(1) Units and figures in parentheses are based on the International System of Units (SI) and are provided as reference. Note that 1 N/mm2 = 1 Mpa.
(2) Hardness tests are not performed unless there is a specific request from the purchaser. Mechanical tests are normally not performed on Grade 1 gray cast iron.
(3) Unless otherwise noted, the mechanical properties indicted are for a test piece ihanashi diameter of 30 mm.
(4) Common thicknesses and the mechanical properties of pieces with common thicknesses of less than 4 mm or more than 50 mm are determined based on agreements between purchaser and manufacturer.

3) Steel scrap

Virtually none of the cast iron foundries visited during the survey used steel scrap. Naturally, this was the main material used at cast steel foundries. Unfortunately, it often comes in shapes that are not suited to the size (inner diameter) of the melting furnace -- long, thin steel wire and excessively thick or thin plates, for example --resulting in thermal energy waste. It is common practice for scrap to be cut into pieces roughly one-third to one-fifth the inner diameter of the melting furnace.

4) Ferro-alloys

In order to allow ferro-alloys such as FeSi and FeMn to pass the material standards (e.g., JIS, BS, DIN, ASTM), a pretense is often made of calculating and adding the appropriate elements to the melting material. In fact, however, both buyers and producers pay relatively little consideration to this point, and as a result ferro-alloys are not being used meaningfully.

5) Silica moulding sand and additives

When correct knowledge and technical know-how are not applied during the use of moulding sand, there is the danger that numerous defects will be generated in the resulting product. In many of the operations visited there appeared to be no recognition of this very basic fact. Particularly in the case of green sand moulding, very few foundries performed reclamation of the moulding sand, and even at those that did insufficient control over the process negated any possible benefits. Ordinarily, bentonite, starch (dextrin or a heat-treated starch), or coal dust is added to the green mould sand, but at virtually all of the facilities visited operations were being conducted without knowledge of how much should be added. A lack of understanding of these additives and the objective behind them results in significant material waste.

Overall, the following conclusions can be drawn concerning materials. First, it is difficult to obtain new iron and steel scrap from key industries such as machinery, shipbuilding, iron and steel, and automobiles as well as cast iron and steel scrap from the market. Second, there is a dearth of material suppliers possessing any degree of expertise in the field. Finally, the foundries themselves lack accurate information concerning materials, and when they make uninformed material purchases they are, in a way, condemning the quality of their products. Particularly in the area of pricing, the practice of determining the quality grade of the material in question and then basing the price on this determination needs to be established.

(6) Standards

The MS standards are being drawn up through the deliberations of committees comprising representatives from related government bodies, academic organizations, commerce and industry organizations, and consumers. Standards for castings have also been determined by SIRIM as shown in the following list.

These deliberations will be continued in pursuit of improved quality.

Standards for the Casting Industry

Cast Iron Product				
[1]	CI Spigot Soil Pipes	MS 624	:	1980 (P)
[2]	Sluice Valves	MS 626	:	1980 (P)
[3]	Malleable C.I. Screwed Pipe Fittings for Steam, Air, Water an Oil	MS 638	:	1980 (P)
[4]	Grey Iron Pipes & Fittings	MS 708	:	1981
[5]	C.I. Non-pressure Pipes and Fittings	MS 709	:	1981
[6]	Double Flanged C.I. Wedge Gate (Sluice) Valves for Waterworks Purposes	MS 1049	:	1986
[7]	Cast Iron Fittings for Asbestos Cement Pressure Pipe	MS 1094	:	1987
Zinc Product				
[1]	Zinc Alloy Die Casting	MS 638	:	1980 (P)

Source: SIRIM

The main standards in use in Malaysia appear to be MS, BS, JIS, DIN, and ASTM. JIS is often used in day-to-day business. In fact, however, these standards are only being used for appearance's sake; it is hard to believe that they are actually being applied in any meaningful way. Tables I.2-21 through I.2-23 show the results of an investigation conducted to determine to what extent these standards were being applied.

Table I.2-21 Testing and Inspection at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement	CE measurement
<100	11	0	1	0	0	0
<300	27	0	0	1	0	0
<500	20	1	0	1	2	2
<1,000	11	0	0	0	2	2
<2,000	3 (1)	0	1	0	2	2
<3,000	1 (1)	1	2	1	2	2
>3,000	0	0	0	0	0	0
Total	73 (2)	2	4	3	8	8

Source: Questionnaires and factory visits

Table I.2-22 Testing and Inspection at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement	CE measurement
<100	3	0	0	0	0	0
<300	1	1	1	1	1	1
<500	1	1	0	1	1	1
<1,000	3	1	0	1	3	2
<2,000	3	3	2	3	3	3
<3,000	0	0	0	0	0	0
>3,000	1	1	1	1	1	1
Total	12	7	4	7	9	8

Source: Questionnaires and factory visits

Table I.2-23 Testing and Inspection at Malaysian Non-ferrous Metal Casting Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement
<100	37	0	0	0	0
<300	9	0	0	0	1
<500	3	0	0	0	0
<1,000	2	0	0	0	0
Total	51	0	0	0	1

Source: Questionnaires and factory visits

One of the properties referred to in the standards is tensile strength. In the case of cast iron foundries, only four out of 75 factories (5.3%) performed tests for tensile strength on a daily basis. Three of these four were factories with annual production exceeding 1,000 tons. In the case of steel casting foundries, four out of 12, or 33.3%, performed such tests. None of the non-ferrous metal foundries engaged in this type of testing.

Chemical analysis is a common topic for all the materials used in cast metal and is absolutely necessary if products are to meet the standards for tensile stength described above. Despite this, virtually no such analysis is being performed except at steel casting foundries. Although pre-cast ingots with chemical compositions already meeting standards are sometimes used at non-ferrous metal foundries, this is no excuse for the lack of testing. During the manufacture of a manganese bronze ship propellor, for example, it is necessary to form a test piece from the test block attached to the propellor body and carry out tests for tensile strength, elongation, and hardness. In the present questionnaire, however, no mention of such tests was made by the respondents.

When firms were asked to evaluate how "standards" were being understood and implemented in the factory, one malleable cast iron foundry reported that Malaysian pipe fitting standards were vague and that it was having difficulty obtaining certification from the JKR. At other factories as well standards were being implemented less than thoroughly, and customers were being supplied with goods of inferior quality.

SIRIM should consult with buyers, manufacturers, and third-sector parties alike and work towards the development of MS as fast as possible.

I-2-4. Technical Standards

(1) Technical Management

As described in Table I.2-1 above, the main customers of Malaysian cast iron foundries are firms in the tin mining, palm oil, rubber, timber, and building materials fields, while there is relatively little demand from the automotive, agriculture, and marine fields. The same is true of cast steel foundries. The leading customers at copper alloy foundries are companies in the rubber, tin, marine, and building material industries, while for aluminum foundries tin, rubber, electrical equipment, building, and motorcycle-related firms are the greatest buyers. In other words, with the exception of die casting plants Malaysia's casting industry still remains dependent on traditional local industries. This situation is often reported to have hindered the development of the nation's casting industry.

This limitation of the market for cast metal has effectively delayed the modernization and mechanization of the industry. As described in the section on the moulding process, however, cement moulding has been adopted by cast iron foundries, CO_2 moulding and pepset moulding by cast steel foundries, and both types of processes at non-ferrous metal foundries. Thus the efforts of those in the industry, who have struggled to compensate for the technical disadvantage caused by a lack of demand, should not be overlooked.

One common method of evaluating technical standards is to determine at what level these technical standards are determined and implemented, i.e., by the workers themselves, by experienced foremen, or by engineers and management, and then to categorize and evaluate the casting operation.

In Japan, the days in which these decisions were made based on the experience and intuition of laborers under the guidance of a foreman and the support of engineers who had graduated from uiversity or technical schools are long gone. Since around 1935 Japanese industry has worked to change its management structure from a worker-guided model based on experience and "feel" to an engineer-guided model based on scientific plant management and theory complemented by the introduction of key technologies. This type of management system expanded throughout Japanese society and was supplemented and improvemed as necessary to vitalize the nation as a whole. Practices such as SQC, TQC were introduced in all factories and have been extremely effective.

Table I.2-24 shows the results of an investigation to determine who decides melting ratios and casting plans in Malaysian cast iron foundries. The Table shows, blend ratios for the melting melting materials were decided by engineers, managers, and owners 7.6% of the time, followed by the workers thesmelves (22.7%), and finally foremen (6.7%). Casting plans were most often decided by engineers, managers, and owners (41.0%), followed by workers (38.7%) and pattern makers (21.3%).

Table I.2-24 Engineering Decision Makers in Malaysian Cast Iron Foundries

	Melting material				Casting plan			
Production /year (tons)	No. of factories	Opera- tors	Fore- man	Engineer manager	Opera- tors	Fore- man	Engineer manager	Pattern maker
<100	11	4	0	7	9	0	1	1
<300	27	7	0	20	10	0	10	7
<500	20	3	4	13	7	0	8	5
<1,000	11	3	1	7	3	0	6	2
<2,000	3 (1)	0	0	3 (1)	0	0	3 (1)	0
<3,000	1 (1)	0	0	1 (1)	0	0	(1)	1
>3,000	0	0	0	0	0	0	0	0
Total	73 (2)	17	5	51 (2)	29	0	28 (2)	16

Source: Questionnaires and factory visits

Table I.2-25 shows the results of a similar survey taken concerning technical management in Malaysian steel casting foundries. As can be seen from the Table, aside from one small facility with annual production of less than 100 tons, all decisions concerning melting material blend ratios were made by engineers, managers, and owners. Identical results were obtained for casting plans, although six firms did respond that they relied on pattern makers as well.

Table I.2-25 Engineering Decision Makers in Malaysian Steel Casting Foundries

	Melting material				Casting plan			
Production /year (tons)	No. of factories	Workers	Fore-man	Engineer manager	Workers	Fore-man	Engineer manager	Pattern maker
<100	3	1	0	2	1	0	2	0
<300	1	0	0	1	0	0	1	0
<500	1	0	0	1	0	0	1	1
<1,000	3	0	0	3	0	0	3	3
<2,000	2	0	0	3	0	0	3	1
<3,000	0	0	0	0	0	0	0	0
>3,000	1	0	0	1	0	0	1	1
Total	11	1	0	11	1	0	11	6

Source: Questionnaires and factory visits

Results of similar surveys conducted for copper alloy foundries, aluminum foundries, and die casting plants are shown in Tables I.2-26, I.2-27, and I.2-28, respectively.

Table I.2-26 Engineering Decision Makers in Malaysian Copper Alloy Casting Foundries

	Melting material			Casting plan		
Production /year (tons)	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	16	1	15	5	11	1
<300	5	1	4	1	4	0
<500	0	0	0	0	0	0
Total	21	2	19	6	15	1

Source: Questionnaires and factory visits

Table I.2-27 Engineering Decision Makers in Malaysian Aluminum Casting Foundries

Production /year (tons)	Melting material			Casting plan		
	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	14	3	11	3	11	1
<300	0	0	0	0	0	0
Total	14	3	11	3	11	1

Source: Questionnaires and factory visits

Table I.2-28 Engineering Decision Makers in Malaysian Die Casting Foundries

Production /year (tons)	Melting material			Casting plan		
	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	7	1	6	1	6	—
<300	4	1	3	1	3	—
<500	3	0	3	0	3	—
<1,000	2	0	2	0	2	—
Total	16	2	14	2	14	—

Source: Questionnaires and factory visits

At copper alloy foundries, blend ratios were determined by engineers, managers, and owners at 19 plants and by the workers at two. At aluminum foundries and die casting factories, the two figures were 11 versus three and 14 versus two. In any case, it is clear that engineers, managers, and owners are generally responsible for determining melting material blend ratios.

In casting plans, these plans are determined by engineers, managers, and owners at 15 out of 21 copper alloy foundries versus the workers at six. For aluminum foundries and die casting factories the figures were 11 versus three and 14 versus two.

These Tables show that technical management over the melting and moulding processes is performed by the workers more often in cast iron foundries than in other types of foudries. From the viewpoint of technical standards, this is one of the factors delaying the rationalization, mechanization, and modernization of the industry.

It was often found during the plant visits that those actually in charge of production were not the managers and engineers but rather the workers themselves. To take an example, cupola furnace melting uses a low melting temperature of about 1430°C, and because this can lead to the generation of blow holes, sand inclusions and other defects in the products, it is necessary to increase the coke ratio from 10-11% to 13-14% and to use an appropriate amount of the base metal. Virtually all of the plants relying on the experience of factory workers were unaware of this, and not attempting to make any improvements. In many other cases management was seen to be hindering the solution of problems, such as the case in which cast good defects were clearly resulting from poor casting plans and yet the resolution of these defects was still entrusted to the workers at site.

The very basic understanding on the role of management would have to be established in Malaysia.

(2) Quality Standards

Although it is difficult to make precise evaluation on the quality standards of Malaysian cast metal, some judgements were made from these aspects of external appearance, materials, and defects.

1) External Appearance

For cast metals, a favorable external appearance constitutes a smooth surface and freedom from harmful defects. A surface inspection should be made before products are delivered to the customer.

During the course of the foundry visits, it was found that while products at two or three of the larger companies were acceptable, those at most of the cast iron foundries were unacceptable. This is due to the fact that the shot blast and turn blast machines were unable to remove baked-on sand, indicating a lack of basic knowledge and know-how concerning moulding sand and also suggesting that the vocational training institutions and schools in Malaysia are not putting efficient emphasis on this respect.

Steel casting foundries in Malaysia are generally of a larger scale than their cast iron counterparts. At these factories there appears to be adequate knowledge and know-how conerning materials and operations, and appropriate technologies are being introduced. In this sense, factory management is better than at the cast iron foundries. Malaysia's non-ferrous metal foundries generally have small production capacities, and few quality-related problems have appeared as yet.

2) Materials

Materials are another important factor in determining product quality. It is common practice for desired quality standards to be provided by the customer in the form of plans or specifications.

Malaysian foundries, and cast iron foundries in particular, appear to be unconcerned about material specifications. As described in Table I.2-23 above, virtually no product testing or inspection is carried out. This type of situation cannot help but breed distrust and insecurity on local casting products among customers.

3) Defects

a) Types of defects

The results of an investigation into defects at Malaysian foundries and countermeasures being taken in response will be described below. Table I.2-29 shows the frequency of defects at cast iron foundries.

As is seen from the Table, the most common defect at the 75 factories was blow holes, reported at 60 factories (80.0%), followed by sand inclusions, reported at 42 factories (56.0%), shrinkage, at 42 factories (56.0%), pin holes, at 38 factories (50.7%), slag inclusions, at 37 factories (49.3%), chill, at 34 factories (45.3%), misruns, at 31 factories (41.3%), and cracks, at 13 factories (17.3%).

The causes of these defects should be investigated using scientific quality statistics, but the following probable causes could be suggested:

[1] Molten metal-related
    Melting temperature too low: blow holes, pin holes, misruns
    Inappropriate materials: shrinkage, chill
[2] Moulding sand-related
    Excess sand moisture: blow holes, pin holes, misruns, chill
    Low strength: sand inclusions, blow holes
[3] Casting plan-related
    Gating system defects: sand inclusions, blow holes, shrinkage, slag inclusions
[4] Operation-related
    Poor mould pouring: sand inclusions, shrinkage

Table I.2-29 Defects at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack	Chill
<100	11	6	6	7	6	5	5	1	2
<300	27	27	12	14	12	10	15	5	13
<500	20	17	8	8	9	7	15	5	12
<1,000	11	8	10	9	9	6	4	1	7
<2,000	3 (1)	1	1	3	1	3	3	1	0
<3,000	1 (1)	1	1	1	0	0	0	0	0
>3,000	0	0	0	0	0	0	0	0	0
Total	73 (2)	60	38	42	37	31	42	13	34

Source: Questionnaires and factory visits

The knowledge for improved melting process, sand, and moulding techniques should be mastered as soon as possible in order to resolve these problems.

Table I.2-30 shows the frequency of defects at steel casting factories. Shirnkage was the most common defect, found at nine of the 12 factories, followed by blow holes, slag holes, and slag inclusions, at seven factories, and pin holes, sand inclusions, and misruns, at six.

Table I.2-30 Defects at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shri-nkage	Crack	Chill	Blister
<100	3	2	3	2	1	1	2	0	—	0
<300	1	1	0	1	1	1	1	0	—	0
<500	1	0	0	0	1	0	1	0	—	0
<1,000	3	2	2	2	3	3	3	2	—	1
<2,000	3	2	1	1	1	1	2	0	—	0
<3,000	0	0	0	0	0	0	0	0	—	0
>3,000	1	0	0	0	0	0	0	0	—	0
Total	12	7	6	6	7	6	9	2	—	1

Source: Questionnaires and factory visits

These defects are believed to stem either from inappropriate moulding sand, casting plans, and materials or from a lack of skills or laziness on the part of operators. SQC should be implemented in order to resolve these problems.

Defects at copper alloy foundries, aluminum foundries, and die casting foundries are shown in Tables I.2-31, I.2-32, and I.2-33, respectively. The most common defects at copper alloy foundries were blow holes, found at 17 of the 21 factories, and shrinkage, found at 16. The former is due to improper deoxidation or excess moisture in the moulding sand; the latter, to excessively high casting temperatures or improper feeder head design.

Table I.2-31 Defects at Malaysian Copper Alloy Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	16	12	7	6	4	4	11	2
<300	5	5	4	4	2	2	5	2
Total	21	17	11	10	6	6	16	4

Source: Questionnaires and factory visits

Table I.2-32 shows defects at aluminum foundries. Common defects at these facilities included blow holes, pin holes, shrinkage, and misruns. These are due mainly to improper degassing and excessively high melting temperatures. Greater mastery is needed in this areas.

Table I.2-32 Defects at Malaysian Aluminum Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	14	11	10	8	6	9	11	1
<300	0	0	0	0	0	0	0	0
Total	14	11	10	8	6	9	11	1

Source: Questionnaires and plant visits

Aluminum die casting plants suffer from fewer defects than those using sand moulds because the moulds are metal and the die temperature is maintained at about 300°C. Defects at these plants are shown in Table I.2-33.

Table I.2-33 Defects at Malaysian Die Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	7	4	2	0	0	1	2	0
<300	4	1	1	0	0	0	1	2
<500	3	0	0	0	0	0	0	0
<1,000	2	0	0	0	0	0	0	0
Total	16	5	3	0	0	1	3	2

Source: Questionnaires and factory visits

b) Percentage of defective products

As described above, defects are generated during the manufacturing process and sometimes render the product unfit for use. It is the responsibility of the manufacturer to keep these to an absolute minimum. The percentage of defective products, or rejects, was investigated for each of the materials.

Table I.2-34 shows the average percentage of rejects for cast iron goods. Because of the significant variations according to plant size, the averages were taken separately for each category. When broken down by type of mould, green sand moulds were found to produce the highest average percentage of defective products (8.1%). They were followed by cement moulds, with an average rate of 5.5%, and CO_2 moulds, with a rate of 3.0%.

When broken down according to plant size, those foundries with annual production falling in the ranges 500-1,000 tons and 1,000-2,000 tons had high percentages of rejects. This was due, however, to factories which had just started operation and as a result had reject rates as high as 30%.

Table I.2-34 Rate of Defects at Malaysian Cast Iron Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds	Pepset moulds	Centrifugal
<100	11	8.3/5	3.3/6	3.1/7	—	—	—
<300	27	3.5/7	4.2/7	6.1/22	—	—	—
<500	20	7.3/5	3.8/6	6.0/8	—	—	—
<1,000	11	13.0/3	—/3	5.7/9	—	—	—
<2,000	3 (1)	17.0/2 (1)	—/0	4.5/1	—	—	—
<3,000	1 (1)	3/ (1)	—/1	—/0	—	—	—
>3,000	0	0	0	0	—	—	—
Total	73 (2)	8.1/24	3.0/23	5.5/47	—	—	—

Source: Questionnaires and factory visits

Overall, these figures are quite acceptable. Unfortunately, however, products are sometimes passed through the inspections and sent to the customer despite numerous defects. When viewed by international standards, the percentage of defective products would probably be much higher.

Production of cast iron goods in 1988 totaled approximately 3,500 tons. If exports are to be expanded in the future, quality should be brought up to international levels as soon as possible.

When taken out of the moulds, steel casting goods actually contain more defects than cast iron, but since repair welding is accepted on an international basis the percentage of defective products is relatively low. Table I.2-35 shows the rate of defective products at Malaysian cast steel foundries.

Those factories with annual production in the range 500-1,000 tons have the highest reject rate, at 20%. The most common defects at this facility were blow holes and shrinkage. These defects are thought to be due to inappropriate casting plans and a high moisture content (6-7%) in the moulding sand. Possible solutions would be to limit the moisture content to 4% by adding 0.2% - 0.5% dextrine to the moulding sand and to improve the gating system.

The factory with the lowest percentage of rejects had annual production exceeding 3,000 tons. Products from this foundry were of excellent quality.

Tables I.2-36 through I.2-38 show the percentage of rejects at non-ferrous metal foundries. Rates of defective products at these foundries ranged from 1% to 20% with no relation to the size of the plant.

Table I.2-35 Reject Rate at Malaysian Steel Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Pepset
<100	3	—/1	4/3	5/1	/0
<300	1	—/1	5/2	—/1	/0
<500	1	—/0	2.5/1	—/1	/0
<1,000	3	20/1	6.1/2	—/0	/0
<2,000	3	—/0	3.1/1 (1)	—/0	—/1
<3,000	0	—/0	—/0	—/0	0
>3,000	1	—/0	0.1/1	—/0	0.1/1
Total	12	6.7/3	3.3/10	5/3	—/2

Source: Questionnaires and factory visits

Table I.2-36 Reject Rate at Malaysian Copper Alloy Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds
<100	16	4.2/16	9/3	6.8/3	—
<300	5	3.1/5	4.3/3	4.1/3	—
Total	21	3.9/21	6.7/6	5.5/6	—

Source: Questionnaires and factory visits
Units: Reject rate/no. of factories

Table I.2-37 Reject Rate at Malaysian Aluminum Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds
<100	14	4.3/14	7.5/3	/0	—
<300	0	—	—	—	—
Total	14	4.3/14	7.5/3	—/0	—

Source: Questionnaires and factory visits

Table I.2-38 Reject Rate at Malaysian Die Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production/year (tons)	No. of factories	Metal dies
<100	7	4.1/7
<300	4	7.0/4
<500	3	6.5/3
<1,000	2	5.3/2
Total	16	5.4/16

Source: Questionnaires and factory visits

(3) Testing and Inspection

Quality improvement at Malaysian foundries will require standardization of materials and operations, the preparation of manuals for machinery, and thorough in-process checks. In other words, constant and thoroughgoing quality control activities are needed.

An investigation was made to what extent and in what ways the items critical to product quality -- molten metal temperature and composition, moulding sand, mechanical characteristics of the cast metal, etc. -- were being tested and inspected.

Table I.2-39 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Cast Iron Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Pressure resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	11	1	2	1	1
<300	27	5	7	2	5
<500	20	2	5	3	8
<1,000	11	2	2	1	4
<2,000	3 (1)	2 (1)	3 (1)	3 (1)	3 (1)
<3,000	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
>3,000	0	0	0	0	0
Total	73 (2)	13 (2)	19 (2)	11 (2)	22 (2)

Source: Questionnaires and factory visits

Table I.2-39 shows that only about 20% of all cast iron foundries were engaged in the testing of moulding sand pressure resistance and ventilation. 21 factories (28.0%) checked molten metal temperature; 13 factories (17.3%), molten metal composition; and 22 (32.0%), mechanical properties of the materials used. The frequency with which these checks are performed is unclear, but during the factory visits it appeared to be quite low.

Table I.2-40 shows the frequency of testing at steel casting foundries in Malaysia. Three out of the 12 facilities (25%) test moulding sand; 10 (83.3%), molten metal temperature; eight (66.7%), molten metal composition; and 10 (83.3%), the mechanical properties of the materials used. These figures are significantly higher than those obtained at cast iron foundries.

Testing and inspection at non-ferrous metal foundries is summarized in Tables I.2-41 through I.2-43. The Tables show that inspection of material properties is most common at these plants, followed by measurement of molten metal temperature. Those firms not checking the temperature are thought to control temperature based on experience, but the use of measuring instruments would allow reduction of metal oxidation and hydrogen gas absorption as well as energy savings.

Table I.2-40 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Steel Casting Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Tensile resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	3	0	1	0	1
<300	1	0	1	1	1
<500	1	1	1	1	1
<1,000	3	0	3	3	3
<2,000	3	1	3	2	3
<3,000	0	0	0	0	0
>3,000	1	1	1	1	1
Total	12	3	10	8	10

Source: Questionnaires and factory visits

Table I.2-41 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Copper Alloy Casting Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Tensile resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	16	2	7	1	10
<300	5	0	2	0	0
Total	21	2	9	1	10

Source: Questionnaires and factory visits

Table I.2-42 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Aluminum Casting Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Tensile resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	14	2	6	0	7
<300	0	0	0	0	0
Total	14	2	6	0	7

Source: Questionnaires and factory visits

Table I.2-43 Testing and Inspection of Molten Metal and Materials at Malaysian Die Casting Foundries

(Unit: No. of factories testing)

		Molten metal		Materials
Production /year (tons)	No. of factories	Temperature	Composition	Mechanical tests
<100	7	4	0	3
<300	4	2	0	1
<500	3	2	0	1
<1,000	2	2	0	1
Total	16	10	0	6

Source: Questionnaires and factory visits

I-2-5. Business Administration

(1) Corporate Structure and Size

1) Corpoate structure

Of the 110 factories which answered questionnaires or were interviewed in the current survey, more than half were joint-stock companies whose names were followed by either SDN BHD ("Sendrian Berhad" -- private company) or BHD (public company). The remainder included limited partnerships and privately-owned companies.

Table I.2-44 Breakdown of Companies by Corporate Structure

Capital structure	No. of factories	Percentage of total (%)
Joint-stock company	57 (54 private companies) (3 public-companies)	52 (49 private companies) (3 public-stock companies)
Other	53	48
Total	110	100

Source: Questionnaire and interviews

2) Capitalization

Table I.2-45 shows a breakdown of the plants surveyed according to capitalization.

Table I.2-45 Capitalization

Paid-in capital (M$1,000)	No. of factories	No. of factories receiving foreign assistance
5,001~10,000	3	2
1,001~5,000	10	6
50~1,000	8	—
~500	86	2
Total	107	10

Source: Questionnaires and interviews
Note: *These figures exclude HICOM Diecastings Sdn. Bhd. together with two firms* whose main area of business is not casting.

As the Table shows, fully 80% of the companies surveyed are concentrated in the under-M$500,000 range. In contrast, 12 firms, representing 12% of the total, had paid-in capital exceeding M$1 million. The three firms capitalized at more than M$5 million. They consist of a firm which manufactures pipe fittings, a firm which engaged in steel rolling as well as castings, and a company which belongs to a group consisting of firms in a variety of industries.

The study on the extent of foreign-capital assistance shows that only two of the small-scale companies had received such assistance, while many factories capitalized at M$1-5 million had received infusions of foreign capital. Major sources of such assistance included companies in Japan, Singapore, Taiwan, and Indonesia, with firms in Singapore and Taiwan providing the greatest amounts.

3) Number of employees

Table I.2-46 shows a breakdown of companies according to the number of employees. As can be seen from the Table, 77 of the factories, or 70% of the total, had fewer than 30 employees, with only six facilities having more than 100 workers.

Table I.2-46 Breakdown of Factories by Number of Employees

No. of employees	No. of factories		Percentage of total (%)
2~10	38	77	70
11~20	26		
21~30	13		
31~40	6	33	30
41~50	7		
51~100	14		
101~235	6		

Source: Questionnaire and interviews

Joint-stock companies on the average had about 3.5 times as many employees as other companies. The average number of employees for both types is shown in Table I.2-47.

Table I.2-47 Average Number of Employees

Corporate structure	Average no. of employees
Joint-stock	48
Other	14
Average	32

Source: Questionnaire and interviews

Note: The number of employees includes those in both casting and machining. Rolling and other processes not directly related are not included.

4) Breakdown of factory size by material

The six large factories having at least 100 employees included two manufacturer of cast iron, two of steel casting, one mass-producer of pipe fittings and one die casting firm. In contrast, cast iron and alloy foundries were usually smaller operations, nearly half being privately owned and managed.

5) Factory size (floor space)

77 foundries had floor space of less than 2,000 m^2. The 77 facilities had a combined floor space of 61,513 m^2, resulting in an average of approximately 800 m^2.

6) Reliance on casting production

One of the characteristics of foundries in Malaysia is the fact that they are mostly exclusive manufacturers of casting products. Of the factories interviewed in the current survey, however, one was engaged in the manufacture of bar steel using steel rolling, and another was producing castings for use as electrical appliance components together with the manufacture of casting products.

7) Machining

Ordinarily, castings are shipped after being machined, with no pieces being shipped "as cast." All but one of the facilities visited had machining facilities. The one exception relied on outside firms for its machining.

In addition, some companies possessed a variety of machine tools and used them in processing their own castings and assembling simple pieces of equipment, such as rubber creaping machines. In general, however, these machine tools were not of high precision. At present, the cost of such precision machine tools are too high for most companies to modernize them.

In the future, however, high-performance machine tools would become indispensable if companies are to supply parts to modern industries such as the automobile and machinery sectors.

8) Melting frequency

Most companies surveyed carried out the melting operation once or twice a month. Table I.2-48 summarizes interview results concerning cupola furnace melting frequency.

Foundries with a high melting frequency are often those engaged in mass production of pipe fittings, etc., while those with a low melting frequency are usually engaged in job-based manufacture.

Table I.2-48 Cupola Furnace Melting Frequency (monthly)

<table>
<tr><td>Melting frequency</td><td>Daily</td><td>8 times</td><td>3 times</td><td>2 times</td><td>1 times</td><td>0.5 times</td><td>Total</td></tr>
<tr><td>No. of factories</td><td>3</td><td>1</td><td>1</td><td>5</td><td>2</td><td>1</td><td rowspan="2">13</td></tr>
<tr><td>Total</td><td colspan="2">4</td><td colspan="4">9</td></tr>
</table>

Source: Interviews

(2) Factory Location

Malaysian foundries are concentrated around Ipoh in the Perak district and around Kuala Lumpur. Both areas are important tin-producing districts, indicating the historical dependence of the casting industry on work from the tin industry.

There is not casting company in Eastern Malaysia. With the exception of small-scale operations producing souveniors using the lost-wax technique in Trengganu province along the eastern coast, there are no foundries engaged in casting production in Western Malaysia either.

Many of the small foundries concentrated around Ipoh and Kuala Lumpur remain dependent on traditional industries such as tin and palm oil.

In contrast, the larger factories, such as one in Ipoh employing 235 people and one in Selangor employing 90, tend to be located in Malacca and Johor . Foundries in both areas are often found on TOL (Temporary Occupied Land), and studies on a proposal to establish foundry engineering parks for the casting industry are steadily proceeding.

The following is a summary of answers from each casting firm to questions concerning attitudes on moving their operations to the proposed foundry parks, the reasons therefor, and additional comments and suggestions.

Table I.2-49 Desire to Move to the Foundry Parks

	No. of factories	Current location					
		Kuala Lumpur	Selangor	Perak	Malacca	Johor	Penang
Yes	77	44	15	18			
No	11	2	2	3	2	2	
Other	2				1		1
Total	90	46	17	21	3	2	1

Source: Questionnaires (103 respondents with 90 valid responses)

Table I.2-49 shows that an overwhelming majority of the firms surveyed expressed a desire to move their operations to the new foundry parks. Those not interested were currently located in Malacca, Johor, and areas distant from urban centres.

Table I.2-50 tabulates the reasons offered for wanting to move.

Table I.2-50 Reasons for Moving to the Parks

Reasons	No. of firms	Subtotals
Land/building-related		
Current lot is TOL	20	38
Current lot is too small	13	
Current building is too small	5	
Production-related		
To expand production	12	20
Deterioration of current facilities	8	
Environment-related		
Unreliable or insufficient supply of water and electricity	8	23
Pollution-related complaints	6	
Poor road access	6	
Poor water treatment facilities	3	
Other		
Company policy, etc.	6	6
Total		87

Source: Questionnaires (Answers from the 77 firms expressing the desire for relocation. Multiple responses were permitted.)

As can be seen from Table I.2-50, the most frequently given reason was that the present factory is located on TOL. Another common reason, however, was the desire to expand production. Since reasons such as small lot size, insufficient floor space, and other production-related factors can also be taken as a desire to expand existing operations, a total of 38 firms expressed the desire to expand current operations as their reason for moving to the parks, far more than those indicating TOL as their reason.

A total of 23 firms expressed dissatisfaction with the surrounding infrastructure of their present locations.

Table I.2-51 provides a summary of suggestions and requests made by the companies with respect to the new foundry parks.

Table I.2-51 Suggestions and Requests Concerning the Parks

Reasons	No. of firms	Subtotals
Land/building site-related		
That the park be located near Kuala Lumpur	58	75
That the park be located near Ipoh	17	
Production-related		
That the park provide a variety of functions	20	28
	4	
That transportation convenience be improved	2	
That facilities for joint use be made available	2	
Purchasing conditions-related		
That land prices be kept down	68	107
That installment payments be allowed for lots in the parks	29	
That payments for the lots be spread over three years	10	
Other		
Desire to receive public financing	7	7
Total		217

Source: Questionnaires (Answers from the 77 firms expressing the desire for relocation. Multiple responses were allowed.)

(3) Fund Raising

Virtually all of these foundries are locally-capitalized small businesses. The great majority of factories have used funds raised during the past two years as operating capital. In addition, most of these funds have been raised from individuals, with only one factory receiving foreign capital assistance during the same period. A large number of factories plan to use funds raised during the next two years as operating capital, with equipment expansion being the most common destination.

It is clear that factories are looking to public financial institutions as suppliers of funds for the construction of new plants. This can be seen from Table I.2-52.

Table I.2-52 Intended Uses and Prospective Suppliers of Funding

	Past 2 years	Plans for the next 2 years	Increase in (2) over (1)
Intended use			
Operating capital for increased sales	18	61	3 times
Expansion/renovation of equipment and facilities	16	65	4
New plant construction	6	52	8.6
New product development	7	21	3
Other	7	4	
Prospective supplier			
Domestic			
Public financial institutions	7	52	7.4
Private financial institutions	1	4	
Private companies or individuals	12	4	
Other	2	3	
Overseas	1	2	

Source: Questionnaires (103 respondents)

Many factories reported great difficulty in raising funds. It was repeatedly expressed during the interviews that the relocation of operations to the industrial parks will generate the need for further funds, and it was hoped that something be done about this. The main problems associated with fund-raising, as shown in Table I.2-53, were high interest rates and excessive collateral requirements.

Table I.2-53 Reasons for Difficulty in Raising Funds

Reasons	No. of firms
Conditions of borrowing	
High interest rates	83
Collateral requirements	83
Loan requirements	44
Limitations on amount	35
Guarantee from a parent company required	32
Procedures	
Long time required for consideration	78
Complicated procedures	78
Lack of knowledge concerning loans	43
No access to the international credit market	17
Other	4

Source: Questionnaires (103 respondents).

(4) Manpower Training

Tables I.2-54 and I.2-55 show the composition of the workforce at Malaysian foundries.

Table I.2-54 Employee Age and Years of Service

		Factory workers	
	Staff	Skilled	Unskilled
Average age	34	36	28
Average years employed	11	9	5

Source: Questionnaires (averages taken from valid responses)

Table I.2-55 Educational Background of Employees

Education	Staff	Factory workers: Skilled	Factory workers: Unskilled
Primary School	11%	44%	53%
Lower Secondary School	17	43	46
Upper Secondary School	65	13	1
University/College	7	0	0
Total	100%	100%	100%

Source: Questionnaires (calculated from valid responses)

While a comparison of staff and skilled workers shows no significant difference in the average age and length of service of white-collar staff and skilled workers, a major break could be viewed in the area of education: while 65% of all white-collar staff had finished upper secondary school, only 13% of the skilled workers and 1% of the non-skilled workers had done the same.

As shown in Table I.2-56, in-house training is by far the most common type of training offered to employees, with few companies providing workers with opportunities for outside training.

Table I.2-56 Employee Training

	In-house training	Outside training
Offered	90	14
Not offered	13	89

Source: Questionnaires

On-the-job training was the most frequent type of in-house training, and only two large companies carried out any sort of systematic training. In addition, only large firms responded that they provided training "when necessary." Concerning on-the-job training, many felt that since there are few company employees capable of serving as instructors not much could be expected from them.

Table I.2-57 Current and Scheduled In-house Training

	No. of firms
On-the-job training	86
Provided when necessary	10
Provided systematically	2

Source: Questionnaires

Compared with in-house training, far fewer firms provided employees with outside training. As can be seen from Table I.2-58, only four companies offered employees opportunities for overseas training in 1988.

Table I.2-58 Outside Training Destinations (in 1988)

Destination	No. of firms	Remarks
Public institution		
CIAST	7	Centre for Instructor and Advanced Skill Training
SIRIM	2	Standard and Industrial Research Institute of Malaysia
ITI	1	Industrial Training Institute
Overseas, etc.	5	Four foreign firms

Source: Questionnaires (responses from 14 firms providing outside training)

In addition to those listed in Table I.2-58, there are such other educational and training institutes as IKM (Institut Kemahiran MARA) and TAR College (Tunku Abdul Rahman College), in Malaysia.

It was informed that ITI is not providing training courses of casting at present, although programmes are scheduled to resume in 1990. CIAST offers a Foundry and Casting course, but the number of their participants is reported to be still small. Since its establishment in 1985, the number of graduates of the casting course at CIAST reached 51 (as of June 1989). But the existence of the CIAST or the course or foundry in CIAST is not yet well known any some casting factories.

IKM is engaged in the training of general technicians and has produced 250 graduates since its foundation in 1977. Each year 28 students graduate from the casting course, but not all of these seek employment in foundries complains were observed from some foundry managers that after finishing the training course many students are not willing to work at foundry plants.

The views of foundry managers with regard to the problem areas in training programmes and other aspects of labour management were investigated. The results are as shown in Table I.2-59.

Table I.2-59 Labour Management Problems

Problem	No. of firms	Percentage of total
Shortage of engineers	72	85%
Rapidly increasing wages	41	48
High separation rate (Job hopping)	38	45
Shortage of workers	28	33
Difficulty of negotiating with labour	9	11
High fringe benefits	6	7
Increased cost of training programmes	4	5
Other	2	2

Source: Questionnaires
Note: Responses were obtained from 85 factories.

The most frequently-noted problem in labour management was the shortage of engineers, indicated by 72 factories, or 85% of the total. The next most common problems were wage increases and high separation rates. Table I.2-60 summarizes the types of assistance these managers expect from the government on the personnel field.

Table I.2-60 Assistance Expected from the Government

	No. of firms	Percentage of total
1. On-the-job training by foreign experts	72	85%
2. Expansion of public training facilities	41	48
3. Subsidies for training	38	45
4. More frequent sponsoring of technical seminars	28	33
5. Dispatch of instructors from public institutions	9	11
6. Skills training for workers	6	7

Source: Questionnaires
Note: Responses were obtained form 92 factories.

More than 80% of the responding firms are looking towards foreign experts not just for theoretical instruction but for practical assistance in solving production problems at site. It was also suggested during the interviews that some of the current instructors are lacking in practical experience.

Reexamination of current curriculums in casting training courses would also be needed from the standpoint of emphasizing practicality. Some companies requested that short-term, intensive courses be held since long periods of training are impractical for small plants, which cannot afford to send workers for long periods of training.

Recently, younger Malaysian workers are showing a preference towards comanies offering a clean workplace with better wages and other conditions as in any other countries.

However, there is a prevalent image that most foundries are dirty and hot.and its work involves heavy labour. Thus, the common opinion was that it is difficult to hire ordinary workers. The industry would have to work to dispel these negative images, for which there remains great room for improvement of the plant working environment.

(5) Management

In the questionnaire sheet, 20 management-related items were presented, and respondents were asked to rank the 15 in which they had the most interest or concern.

The numbers in Table I.2-61 were obtained by assigning 15 points to the highest-ranked item, 14 to the next-highest-ranked item, and so on, and then dividing the total for each item by the number of respondents.

The items will be listed in order of the interest expressed.

Table I.2-61 Management-related Items of Concern/Interest

1.	Utilization of government incentives	11
2.	Quality improvement	8
3.	Expansion of production	8
4.	Securing of funds	8
5.	Procurement of high-quality, low-cost raw materials	8
6.	Cost reductions	8
7.	Reduction of the defect rate	7
8.	Hiring of good workers	7
9.	Modernization of equipment and facilities	7
10.	Stronger market development efforts	7
11.	Acquisition of technical information	6
12.	Improvement of productivity	6
13.	Training of workers	5
14.	Use of local raw materials	3
15.	Acquisition of overseas market information	3
16.	Introduction of new technologies	3
17.	Expansion of exports	3
18.	Development of high-added-value products	2
19.	Greater development efforts	2
20.	Shortening of delivery times	1

Source: Questionnaires
Note: The numbers are averages taken from all 67 respondents.

The following remarks can be made concerning Fig. I.2-61:

1) Utilization of government incentives was ranked highest. At large factories, however, it was ranked low.
2) At large factories, the improvement of quality and productivity and the reduction of costs were highly ranked. The smaller the operation, however, the less the interest shown in these areas.
3) Despite concern about quality improvement and reduction of the defect rate, there was little interest shown in such practical counter measures as the technology introduction and development in these areas.
4) The recreutment of high-quality and low-cost raw materials are considered to be the principal means of cutting costs.
5) All of the factories showed considerable interest in expanding production.
6) Although the procurement of funds was highly ranked among small and medium-sized firms, the larger operations were not particularly concerned.
7) The smaller the size of the operation, the greater the interest shown in the hiring of good workers.
8) The modernization of equipment and facilities is being viewed as a problem more among smaller companies than by the larger operations.
9) Little interest was shown with respect to acquiring information concerning export expansion and overseas markets.
10) Factories are under the impression that current delivery schedules are adequate.

Despite the interest shown in quality improvement, actual activities such as QC circles and the proposal system in particular were not being undertaken at casting plants, as shown in Table I.2-62.

Table I.2-62 QC Circles and the Proposal System

	Have adopted	Not adopted	Remarks
QC circles	11	90	Average of 3 circles per company
Proposal system	19	78	Average of 8 proposals/company in 1988

Source: Questionnaires

Table I.2-63 Employee Morale

	No. of plants	Evaluation of factories visited
Very high	1	0
Fairly high	14	5
Ordinary	74	16
Fairly low	6	1
Very low	7	1
Total	102	

Source: Questionnaires and interviews
Note: The 23 companies visited were included in the total number of plants.

Based on the results of both the questionnaires and interviews, employee morale was neither particularly high nor low. As work proceeds on modernization of the industry, this would become a more severe problem area that will have to be dealt with.

I-2-6. Peripheral Industries

(1) Raw Materials

Table I.2-64 shows the results of a survey on procurement of the raw materials used in casting.

The main raw materials which can be procured locally are sand, cement, and scrap metal.

Table I.2-64 Raw Material Procurement

	Material	Source		Suppliers	Ease of procurement		Quality	
		Local	Overseas		Easy	Difficult	Good	Poor
1.	Pig iron	Δ	O	China, Brazil, Australia, Taiwan	6	7	5	7
2.	Iron scrap	O			2	9	3	3
3.	Steel scrap	O			2	2	3	
4.	Cu ingot		O	U.K., Australia, China	4		8	
5.	Cu scrap	O					1	
6.	Al ingot		O	U.K., Australia, Taiwan, Singapore	2		2	
7.	Al scrap	O					3	1
8.	Zn ingot		O	Australia, Taiwan				
9.	Fe-Si		O	China, Norway, Taiwan	8		8	12
10.	Fe-Mn		O	Norway, Australia, Singapore	2	2	9	
11.	Coke		O	Japan, China, Taiwan, Australia	12	3	14	6
12.	Silica sand	O			23		7	4
13.	Bentonite		O	U.S., Australia, China	3	3	9	5
14.	Sodium silicate	O			15		8	
15.	Cement	O			38		12	

Source: Questionnaires
Symbols: O: Mainly sourced; Δ: Partially sourced
Note: Evaluations of the ease of procurement and quality represent the number of companies (out of 103) which responded accordingly in the questionnaire survey.

Most factories are of the opinion that silica sand, sodium, silicate, and cement are easy to obtain.

Malaysia has abundant deposits of good silica sand with a high silica content. At present, deposits have been discovered in southeast Johor, Trengganu, Sarawak, and Perak. Foundries requiring high-quality sand can turn to Johor products, but the price is high, at M$100 per ton. Sand from the Trengganu and Sarawak regions is not being used at present because of transportation difficulties.

Abandoned tin mines are also an excellent source of silica sand. This variety, referred to as tin mining sand, is sold on the market for about M$80/ton. Tin mining sand taken from Kundang in the Rawang district north of Kuala Lumpur is referred to as "Kundang sand."

Natural sand and mountain sand are generally of poor quality, but some factories make use of them because of their low cost, which is currently around M$10/ton. "River sand" is also available, but this is used mainly in the filtering of water.

The resin-coated sand used in shell moulding to fabricate cores is used by two pipe fitting manufacturers, and these firms sell the sand to other companies as well. The price is about M$500/ton. Some of this sand is imported from Taiwan.

Cement is easy to obtain because of the production of large amounts of limestone along the western coast of Western Malaysia.

Iron scrap, on the other hand, is one the materials said to be difficult to obtain. Although few of the companies indicated any problems at present, the increase of demand by general good economic condition in Malaysia tends to send prices high, and some companies are preparing for these conditions by stockpiling.

Fe-Si, noted by 12 firms, was the material with the most quality-related problems. China is the main supplier. China was also the main supplier of pig iron, another problematic material, while locally-produced pig iron was indicated by only one firm. Since Malaysian pig iron generally has a low Si content, it is used at only a few facilities.

Japanese coke was indicated as being the highest-quality available. It was also the most expensive, however, with current prices in the M$900-1,000/ton range.

A relatively long time power stoppage during the melting process would create a big problem of hardening of the molten metal in the furnace. As a result, stable supplies of electrical power are necessary. Due to this some companies that can not obtain enough power are forced to use their own generators. In the responses of to questionnaire survey, however, no significant problems were noted in this area.

(2) Casting Operations

1) Machining

The production process for castings, from melting to final finishing, is generally carried out within the same factory. A small number of operations contract out portions of the production process, but the dependence on such subcontracting as viewed by the ratio of subcontracting fees to sales is very low, at 5% (although one firm showed a figure of 27%).

Table I.2-65 Types and Extent of Subcontracting

Operation	No. of companies	Remarks
Machining	9	
Assembly	1	Assembly of machines for sale to other companies
Painting	3	
Chrome plating	1	Diecast products
Finishing	1	Deburring

Source: Questionnaires (103 respondents)

2) Wooden pattern

There are said to be 12 wooden pattern makers across Malaysia with 12-13 employees. Some smaller operations with only two or three workers also exist.

A factory visited in Kuala Lumpur was said to be the largest, with 15 employees. In addition to wooden pattern for use in casting, this facility was engaged in the production of wooden moulds for use with plastics and glass as well.

Concerning casting plans, the technology exists at these plants to design simple moulds for steel casting but pattern for ductile materials and aluminium alloys are said to be too difficult to produce. Materials being used include hard Tingai wood and the soft Jaraton variety.

Most of the large foundries visited had their own pattern shops. One of the factories had a computer-managed shop with a staff of 10 and several thousand wooden pattern in stock. This factory reported that the technical level of wooden pattern makers is still low.

3) Analysis and testing

Analysis and testing equipment is possessed by the larger factories but is entirely lacking at the smaller operations. Spectrometers, used for chemical analysis of samples, were found at only two of the large companies visited, with one more factory considering the purchase of one of these devices. When necessary, other factories sometimes sent their samples to one of these firms for testing.

There are said to be two private companies carrying out analysis, and the silica sand manufacturers also made use of them. SIRIM is equipped with analysis and testing devices and is utilized by some of the companies.

I-3. Cost Analysis

The following studies were carried out in order to determine the international price competitiveness of the Malaysian casting industry.

[1] An international comparison of selling prices for casting

[2] A feasibility study for a precision casting plant using lost-wax method

First, the selling prices of general castings currently being produced in Malaysia were compared with those of products being produced in other nations to determine their cost competitiveness, and selling costs were then broken down to determine the reasons behind the difference in selling prices.

Since there are as yet no foundries in Malaysia producing precision castings by investment casting, a model plant was posed and its financial viability was investigated.

I-3-1. Cost Analysis for Castings

(1) Selling price

Table I.3-1 provides a comparison of the average unit sales prices of various kinds of cast metal products in Malaysia and in Japan.

Table I.3-1 Comparison of Selling Prices in Malaysia and Japan

	Malaysia	Japan	No. of Malaysian factories surveyed
Cast iron(FC)	M$/kg 2.3	M$/kg 3.4	68
Malleable cast iron	4.3	6.7	1
Steel casting	3.6	—	9
Copper casting	12.2	16.4	20
Aluminium alloy casting	9.6	14.7	17
Aluminium diecast	8.4	12.1	8

Sources: Questionnaires and *Materials Process Industries Yearbook*, 1989
Note: Calculated at an exchange rate of M$1 = ¥53.

As can be seen from Table I.3-1, the selling prices of Malaysian products in all categories are lower than those of their Japanese counterparts. The Malaysian prices were based on information gained during the field interview survey in Malaysia, while the figures for Japan were obtained from official statistics by dividing total production value by total production volume for each material. The Malaysian figures are the average unit sales prices taken from the number of companies shown in the Table. The two sets of figures, however, should provide a reasonable basis for comparison.

Table I.3-2 shows selling prices for various Malaysian castings.

Table I.3-2 Selling Prices for Malaysian Castings

Selling price (M$/Kg)	Details			
	Product	Unit weight	Material	Buyer
Cast iron				
1.8~2.4	Manhole conver	180~90 kg	FC	Domestic
2.6~3.0	Dust collector cone	73~57	FC	Domestic
1.4~2.0	Iron weight	1.3~0.75	FC	Domestic
2.6~3.1	Gas burner	0.8~0.75	FC	Domestic
2.2~2.8	Gravel pump	1110~90	FC	Domestic
Steel casting				
4.0	Palm oil worm screw	200	1.5%Mn	Domestic
2.6~3.5	Counter weight	480~140	SC46	Foreign
2.8	Ship bollard & pollar	70~60	SC46	Foreign

Source: Interviews

Table I.3-3 provides a comparison of Malaysian prices with prices in other nations.

Table I.3-3 International Comparison of Selling Prices

	Malaysia (1989.11)	Korea (1989.11)	Taiwan (1989.11)	Thailand (1989.11)
Cast iron				
FC	2.3	2.2~2.8	1.7~2.1	
FC15 ~ 20				1.5
FC25				1.9~2.6
FC30		3.4		
Steel casting				
SC	3.6		2.5	

Source: Table III.4-1, *Report of Private Casting Technology Consultant in Tokyo*
Unit: M$/kg
Note: Calculations were made at the following exchange rates: M$1 = ¥53; ¥1 = 4.6 won; NT$1 = ¥4.4; 1 baht = ¥5.5.

The unit prices for export products indicated in Table I.3-2 are lower than the corresponding unit prices for local sales products. Many Malaysian companies consider that present export price levels are very severe. By one large company, the typical unit price was indicated as M$2.0/kg for cast iron and by another firm M$2.4-2.6/kg for cast iron and M$3.0-3.3/kg for ductile cast iron. As a result, many factories were giving serious consideration to productivity improvement measures such as the mechanization of sand processing and transport in an attempt to reduce production costs.

(2) Cost breakdown

A breakdown of Malaysian costs was drawn up for each material and compared with Japanese figures in Table I.3-4.

Table I.3-4 Cost Breakdown for Casting in Malaysia and Japan

Breakdown	Malaysia				Japan
	Cast iron	Steel casting	Light alloys	Average	
Raw materials	48%	35%	55%	48%	33%
Labour and subcontracting fees	28	25	24	27	42
Power	5	13	5	6	8
Depreciation	7	9	7	7	5
Miscellaneous	12	18	9	12	12
Total	100%	100%	100%	100%	100%

Sources: Questionnaires and *Small Business Price Indices* (Small and Medium Enterprise Agency), 1988 figures

Note: Data for Malaysia was obtained from 61 firms, with 11 manufacturers of steel casting and 24 light alloy producers.

In Malaysia, power costs for steel casting production and raw material costs for light alloys are higher than those for cast iron. This is thought to stem from differences in melting techniques and raw materials. In addition, labour and subcontracting fees account for a lower percentage of costs in Malaysia than in Japan.

Next, a breakdown of the costs involved in cast iron production in Malaysia and Japan were compared together with productivity figures. The results of this comparison are shown in Tales I.3-5 and I.3-6.

Table I.3-5 Cost Breakdown for Cast Iron in Malaysia and Japan

Breakdown	Malaysia (1)	Japan (2)	(1)/(2)
Raw materials	M$/kg 1.104	M$/kg 1.122	0.98
Labour and subcontracting fees	0.644	1.428	0.45
Power	0.115	0.272	0.42
Depreciation	0.161	0.170	0.94
Miscellaneous	0.276	0.408	0.67
Total	M$/kg 2.3	M$/kg 3.4	0.67

Sources: Tables I.3-1 and I.3-4

Raw materials, which constitute the largest single element in the cost breakdown, were virtually unchanged at 0.98 in Malaysia against an index of 1 for Japan. As products become more advanced, the gap in raw material costs between the two nations is expected to shrink even further. Labour and subcontracting fees and power costs constitute approximately twice the portion of total cost in Japan as in Malaysia.

The ratio of labour costs to subcontracting fees in Japan is 55:45. Since the productivity in Japan indicated in the Table is limited to in-house production, the publicly announced figure was halved. The same ratio for Malaysia is 93:7.

The difference in power consumption shown in Table I.3-5 is thought to stem from differing levels of mechanization. This gap in mechanization and automation is also thought to be responsible in part for the low productivity of Malaysian factories. In addition, the lack of quality-related facilities for annealing and surface treatment is also a factor in the low power consumption of Malaysian factories.

In summary, greater international competitiveness for Malaysian cast metal products will require the improvement of productivity accompanied by suitable improvements in product quality.

Next, Table I.3-6 shows a comparison of productivity for cast iron production.

Table I.3-6 Productivity in the Manufacture of Cast Iron

Country	Productivity	Productivity index	Remarks
Malaysia	17 ton/man/year	1	Average figure for 70 cast iron manufacturers
Japan	60 ton/man/year	3.5 times	Publicly announced figure = 120.6 ton/man/year

Source: Questionnaires and *Raw Material Yearbook*, 1989

(3) Unit cost

1) Raw material costs

Raw materials are responsible for about half of all casting costs. Imports are relied upon for the main raw materials -- pig iron, coke, and alloy steel and light alloy ingots -- which means that the prices of these materials are directly affected by exchange rate fluctuations and foreign market conditions. Available cast iron scrap and steel scrap consist mainly of locally-produced materials which have been recovered. Scrap prices are easily affected by changes in the business climate, with prices tending to increase during times of prosperity.

Malaysia boasts large deposits of silica sand, one of the materials critical to casting, and this ensures a steady supply. The supply of cement is also secured by its abundant deposit of linestore in Malaysia.

Raw material prices vary greatly depending on the grade of the material in question, in addition to the supply and demand conditions. In the case of coke, for example, prices vary as much as 100% depending on the country of origin, that is, the quality of the material. While Japanese coke sells for about M$1,000/ton, Chinese coke is valued at only M$500/ton. Even prices for local silica sand range from the M$10/ton of natural sand to M$100/ton for high-quality Johor sand. These grade-induced price differentials can be seen in the case of scrap as well. Foundries must constantly work to achieve a balance of cost and quality when selecting raw materials.

Table I.3-7 provides a summary of price levels for the main raw materials current as of November 1989. The figures in the Table are the averages of various grades of materials being used at the surveyed foundries.

Table I.3-7 Price Levels for Main Raw Materials

Material	Price (M$/T) 1988	1989	89/88	Comparable foreign prices (M$/T) Japan	Korea	Thailand	Taiwan
1. Pig iron	607	702	116%	590	600	590	
2. Iron scrap	435	559	129	570	510	470	
3. Steel scrap	352	449	127	530	560	440	
4. Cu ingot	9615	12210	127	8650			
5. Cu scrap	4776	5244	110	5660			
6. Al ingot	6300	6077	96	6280			
7. Al scrap	4171	4022	96	4670			
8. Zn ingot	5500	5450	96	3950			
9. Fe-Si	3089	3012	96	3250	3280	2590	
10. Fe-Mn	2018	2249	111	1570	1840	1970	
11. Coke	662	782	118	1170		830	760
12. Silica sand	75	83	110	220	140		
13. Bentonite	513	605	118	670	820	880	
14. Sodium silicate	473	526	111			830	
15. Cement	182	185	101	230			

Sources: Questionnaires (averages taken from valid responses); *Materials Process Industries Yearbook*, figures for December 1988, Japan Casting Industry Association, based on standard prices; *Report of Private Casting Technology Consultant in Tokyo*, figures for June and November 1989

Note: Calculations were made at the following exchange rates: M$1 = ¥53; 4.6 won = ¥1; NT$1 = ¥4.4; 1 baht = ¥5.5.

The overseas prices indicated in the Table are for specific grades and hence differ somewhat from the Malaysian figures, but should serve as reference.

Overall, Malaysian raw material prices are not particularly high in comparison with those in other nations. In particular, Malaysia has an advantage in the inexpensive supply of silica.

From the results of the questionaire survey, it was observed that prices for pig iron, scrap, and coke rose significantly from 1988 to 1989. By the field interviews, this point was confirmed and past trends were investigated. The results are shown in Table I.3-8.

Table I.3-8 Price Fluctuations for Steel Scrap

Period	Price	Index
1981~1984	M$/T 180~250	113~156
1985~1986	160~170	100~106
1987~1988	180~200	113~125
Nov. 1988	380~450	238~281

Source: Interviews
Note: The price index was set to M$160 = 100.

Table I.3-9 shows prices for the main raw materials imported from other countries/regions.

Table I.3-9 Prices of Imported Raw Materials

Supplier	Pig iron	Coke	No. of responses for pig iron	No. of responses for coke
Japan	M$/T —	M$/T 900	—	18
China	700	530	20	6
Taiwan	690	790	1	7
Australia	680	650	1	3
Brazil	720	—	2	—

Source: Questionnaires

In the case of pig iron, there is little difference among supplier nations, with Chinese products being the most commonly used. There was a major differential, however, for coke. A considerable number of factories were found to be using the expensive but high-quality Japanese coke.

Recently, however, the overall trend has been towards use of cheaper grades of coke due to rising prices. Some of the foundries visited had already switched over to less-expensive varieties, but they also indicated that the rate of defective pieces incapable of providing high melting temperatures had increased. This points out the importance of comprehensive cost reduction measures that take into account not only raw material selection but facilities and technical aspects as well.

2) Labour costs

Table I.3-10 shows that the average annual wage at a foundry in Malaysia is approximately M$8,400.

Table I.3-10 Average Wages

	Annual wage (M$/1988)	No. of responses
Staff	11,697	60
Skilled workers	9,710	86
Unskilled workers	5,777	73
Weighted mean	8,334	—

Source: Questionnaires

At foundries located around Kuala Lumpur there is a shortage of skilled labourers, and as a result wages at these facilities are on the rise. Some suggested the case that a maximum daily wage of M$40 was offered due to this labour condition. Assuming 290 working days per year, this would represent an annual wage of M$11,600.

From a worldwide standpoint, current wage standards in Malaysia are competitive. In order to take advantage of this, the upgreeding of efficiency in operations would be desired as well as the improvement product quality and the increase of the training oppotunities in technologies and skills.

3) Other costs

(a) Electrical power

Electrical power fees in Malaysia are divided` into basic fees and usage-based fees. Manufacturers in Malaysia are eligible for a 20% deduction of power fees. The basic fee is M$12 for the maximum load power during daytime hours. Users are exempted from this fee at night. The usage-based fee is 16 cents/kwh during the daytime and drops to 8 cents/kwh at night.

As a result of this fee structure, some of the steel casting manufacturers with numerous electric induction furnaces have set up their operating schedules to allow melting to be carried out at night. As a result of such scheduling and other factors, average power costs vary significantly from plant to plant. The average cost per kilowatt-hour at the companies visited ranged from 12 cents to 21 cents.

(b) Wooden pattern cost

When wooden moulds are ordered from a wooden mould manufacturer, the cost depends on the time required for production, with the standard fee being M$10/hour. In cases of volume orders, etc., a discount is often provided.

4) Cost reduction

Rising raw material costs is the largest problem to which Malaysian casting industry is facing in order to reduce production costs. This and other problems as determined from a questionnaire survey are summarized in Table I.3-11.

Table I.3-11 Problem Areas in Cost-related Factors

Problem	No. of firms facing to the problem (%)	
Rising raw material costs	70	(68.0)
Rising fuel costs	15	(14.6)
High electrical power costs	13	(12.6)
Insufficient production	11	(10.7)

Source: Questionnaires (103 respondents; multiple answers permitted.)

Cost reduction efforts aimed at dealing with the problems outlined in Table I.3-11 are naturally centered on the area of raw materials. One of the results of this is the aforementioned shift to less expensive raw materials. Table I.3-12 shows some of the cost reduction measures being implemented at Malaysian companies.

Table I.3-12 Cost Reduction Measures

Measure	No. of firms taking measures (%)	
1. Procurement of low-cost raw materials	61	(59.2)
2. Improvement of production technologies	45	(43.7)
3. Improvement of productivity (energy conservation)	41	(39.8)
4. Streamlining of raw material purchasing routes	24	(23.3)

Source: Questionnaires (103 respondents; multiple answers permitted.)

Malaysian foundries are trying to respond to the above-mentioned problems with very fundamental technical improvement measures. One of the most common is the use of technological improvements to reduce defect rates, improve yield, and eliminate a variety of losses. During the factory visits members of the study team were often asked about methods for reducing defect rates, and some facilities were visited again in order to work out possible solutions. At one factory where problems were pointed out in mould coating methods, improvement measures were immediately implemented.

Most of the Malaysian casting factories recognize the need for improved productivity, and the efforts for this are already being started in many factories. Some of the visited plants engaged in the fabrication of castings had already adopted productivity improvement as a clearly-stated corporate objective. This is indication that the environment surrounding these firms is forcing them to improve their productivity. These productivity-boosting measures are expected to lead to the further promotion of facility modernization and automation in the future.

Measures were also being taken to improve the distribution of raw materials. A new material supply company has been established by the support of industry association members in order to resolve the problem of price fluctuations caused by the lack of companies dealing in raw materials. As numerous firms are expected to move their operations to the industrial parks and to modernize their operations in the near future, further improvements, including the problem of raw material procurement, will also be needed.