V-3-3. Trends in Major Supply Countries

Production of CRTs in leading countries was covered in Section V-3-1., where world supply and demand trends were reviewed. This section will focus on trends in the major producing countries competing in the market for small -to- medium-sized (14- to 21-inch) CRTs which it is assumed to be produced in Malaysia.

However, given factors such as the size of CRTs to be produced, geographical conditions, and trade friction, it is likely that buyers of Malaysian products would be mainly Asian countries which are simultaneously competitors with Malaysia. At present, the main CRT suppliers to the same area are Japan, Singapore and Korea. Recently, the supply of CRTs is becoming short because colour TV production in the area is expanding radically. However, it is clear from the number of factories currently in operation and those whose establishment has been announced that Asian CRT production will increase rapidly by 1992. This is indicated in Table V.3-11, based on the information published in April 1989 on the future of CRT production in main supplying countries. Production capacity of the main countries, excluding Japan, will expand rapidly to about 2.6 times the 1987 level in 1992. Most of the newly established CRT plants in Asia are operated by Japanese firms which plays a role in replacing the supply from Japan. As a result, Japanese exports to the area would be reduced.

Table V.3-11 Expansion Plans of CRT Production in Asia

(Unit: 1,000 sets / year)

	Volume of Production in 1987	Future Production Capacity	Year of Full-Scaled Production	Expected Export Volume
Singapore	4,100	5,400	1990	3,500-4,000
Thailand	0	3,000	1992	1,600
Korea	11,890	26,400	-	5,310
China	1,000	8,000~9,000	1992	1,600~1,800
Sub Total	16,990	42,800~43,800	-	12,710
Japan	21,040	21,040	-	-
Total	38,030	64,840	-	-

* As for Korea, estimated figures for 1988 were used both for future production capacity and expected export quantity. As for Japan, the actual figures for 1988 were directly used.

(1) Japan

1) CRT Production

Table V. 3-12 shows CRT production trends in Japan. Production has been on the decline since peaking at 30 million units in 1985. The main factors behind this phenomenon are reduced price competitiveness with new rival countries such as Korea and Taiwan, resulting in a shift of emphasis from quantity to quality and from domestic to overseas production, in addition to the reduction in domestic production of color televisions.

Table V. 3-12 Trend of CRT Production in Japan

Year	Production Volume (1,000 Pcs)	Average Annual Growth (%)	
1975	7,470.0	Average of Ratio by Year (75-80)	20.7%
1980	19,100.0	Average of Ratio by Year (80-84)	8.5
1984	26,470.0		7.9
1985	30,090.0		13.7
1986	24,244.0		-19.5
1987	24,713.0		2.0
1988	25,930.0		4.9

Source: Monthly Report of Machinery Statistics

At present, there are six Japanese manufacturers of CRTs: Toshiba, Hitachi, Matsushita, Mitsubishi, NEC, and Sony. All but Sony introduced technology from the U.S. company RCA in the early 1960s and commenced production of shadow-mask CRTs for colour televisions. Sony developed its own Trinitron system in 1967, and production has continued into the present. Sony units have no reciprocality with those of the other five manufacturers.

Japan's manufacturers of CRTs, although their production only took off after 1966, were accused of dumping as early as 1964 in the U.S., and in 1967 they were placed on a list of imports for monitoring in the U.K. As world demand for their compact size and high quality products spread, however, the exports increased and the production grew steadily. Despite meeting stiff competition from Korea and Taiwan, Japan has managed to remain the world's largest exporter of CRTs (on a value base) during the 1980s by increasing the added value and moving towards production of larger models. The shift towards industrial CRTs is also active, with NEC having halted virtually all production of CRTs for colour televisions in favour of industrial units. Currently, only 6 and 9-inch miniature CRTs remain and only in small quantities. Domestic production shares by Japan's manufacturers (excluding Sony and NEC) are as shown below.

Table V. 3-13 The Market Share of CRTs by Major Manufacturers in Japan

(Unit: %)

Name of Manufacturer	1986	1987	1988	Sizes of Products
Toshiba	37.2	36.9	39.3	4"-32"
Hitachi	27.4	24.9	21.9	6"-33"
Matsushita	25.2	27.3	28.4	3"-33"
Mitsubishi	10.1	10.9	10.4	14"-37"
Total	100.0	100.0	100.0	

Source: Electronic Industries Association of Japan

The recent trend towards larger models becomes readily apparent in terms of the production size. The share ratio of 14-inch models dropped from 28.8% in 1986 to 11.3% in 1988, while the figure for 20-inch models dropped from 10.3% to 8.5% during the same period.

Table V. 3-14 Production of CRTs in Japan by Size

(Unit: %)

Size	1975	1980	1986	1987	1988
3"-17"	44.1	52.0	49.6	36.3	26.6
18"-20"	47.0	36.3	26.3	31.6	32.7
21"-24"	8.9	8.0	17.6	18.3	20.1
More Than 25"	0	3.7	6.5	13.8	20.6
Total	100.0	100.0	100.0	100.0	100.0

Source: Electronic Industries Association of Japan

2) Export Trends

Table V. 3-15 shows Japan's CRT export trends by country for the past five years. On the whole, although shipments plummeted by 74.7% in 1985 due to a drastic drop in U.K. demand, they returned to previous average levels in the following year.

Concerning the destination of export, the shares of advanced countries such as the U.S. and West Germany have been falling, while the importance of China, Hong Kong, and Singapore continues to increase. It is believed that a considerable portion of the shipments to Hong Kong are actually re-exported to China. The average rate of growth for exports to the latter country during the last four years was 117.7%.

Table V. 3-15 Trend of Colour CRT Export by Japan

(Unit: pcs, %)

Country Region	1984 Value	1984 Share	1985 Value	1985 Share	1986 Value	1986 Share	1987 Value	1987 Share	1988 Value	1988 Share
Taiwan	1,475,069	13.6	291,390	10.6	1,407,241	10.9	1,374,473	10.1	1,068,168	7.4
U K.	1,031,624	9.5	11,504	0.4	1,075,289	8.3	1,084,541	8.0	1,017,529	7.1
Hong Kong	722,081	6.7	84,160	3.1	877,765	6.8	888,312	6.5	1,463,780	10.2
Korea	713,156	6.6	161,385	5.9	506,190	3.9	728,356	5.4	631,550	4.4
West Germany	658,502	6.1	133,066	4.8	705,519	5.4	394,679	2.9	276,240	1.9
U.S.A	738,509	6.8	252,657	9.2	1,142,662	8.8	541,508	4.0	495,281	3.4
China	326,984	3.0	1,461,597	53.2	1,433,317	11.1	3,104,179	22.8	5,016,480	34.8
Singapore	596,135	5.5	62,096	2.3	908,251	7.0	1,329,498	9.8	1,259,686	8.7
Total Volume (Including Others)	10,857,683		2,745,571		12,957,136		13,597,605		14,407,698	

Source: Japan Exports & Imports

3) Overseas Operations of Japanese Companies

Overseas production by Japan's CRT manufacturers has become more active in the 1980s. Table V. 3-16 lists those companies with operations abroad together with those who have announced such plans as of January 1989. The shift towards overseas production is proceeding at a rapid pace, with Japanese-affiliated production bases being established in eight locations around the world: the U.S. and Asia were the most common destinations, with three firms announcing investment in the U.S. and China in 1988 alone. Glass manufacturers have been quick to respond, investing in three foreign countries and establishing a new factory in Singapore.

Table V. 3-16 Overseas Production by Japanese CRT Manufacturers

Name of Manufacturer	Year	Location	Annual Production Capacity (Million Pcs)		Comments
•Hitachi	1978	Singapore		4.1	In Operation
	1988	China (Shenzhen)		1.6	Start in '90
•Mitsubishi	1983	Canada		-	In Operation
	1988	Thailand		1.4	Start in '89
•Toshiba	1985	U.S.A.		1.4	In Operation
	1988	China (Shanghai, Hanyang)		2.6	Start in '90
	1988	Thailand		1.6	Start in '90
•Matsushita	1988	China (Peking)		1.8	Start in '89
	1988	U.S.A.		-	Unknown
•Sony	1982	England		-	In Operation
	1988	U.S.A.		-	Unknown
*Asahi Glass	1985	Singapore	Panel	7.0	Staryt in '89
	1985	Taiwan	Panel	5.0	In Operation
	1988	Thailand	Panel	7.5	Start in '89
			Funnel	14.0	
	1988	U.S.A.		-	Start in '89
	1988	Brazil		-	Unknown

Notes: 1. Except Technical Tie-ups.
2. *Only Finishing Works at Present as for Asahi Glass Singapore.

(2) Singapore

1) Production and Export Trends

At present Hitachi Electronic Device is the only company engaged in production of CRTs in Singapore. As a result, this firm's production and export figures represent those of the country as a whole. Table V.3-17 shows the production and the ratio by size for the past five years. The average growth rate for the past five years has been 26.5%, with a gradual trend toward the manufacture of larger models and production of 21-inch units beginning in 1988.

Table V. 3-17 Trend of CRT Production in Singapore

	1984	1985	1986	1987	1988
Production Volume (Million Pcs.)	1.6	2.0	2.9	3.5	4.1
Share by Size (%)					
14 Inch	75	75	65	60	55
20 Inch	25	25	35	40	35
21 Inch	-	-	-	-	10

Source: Hitachi Electronic Device

This company was established in 1978 with 100% investment by Hitachi Co., Ltd., and has steadily increased its production ever since. The plant is now operating at full capacity due to the current supply shortage in the region, and in 1988 it announced that the process for deflection yoke fixing would be transferred to a plant in Johor, Malaysia to meet increased production demands. Although local supply remains at a low level of around 10%, commencement of production at Asahi Technovision in April 1989 will make possible local supply of panels, raising the local content ratio to over 40%.

A breakdown of sales for the past five years is shown in Table V.3-18. Since anti-dumping taxes were levied on Singapore's CRTs by the U.S. in 1987, exports to that country have been on the decline. The Asian region, including Japan, has continued to provide the largest market for exports, accounting for 75% of all shipments in 1988.

Table V. 3-18 Destination of Sales of CRTs Made in Singapore

(Unit: %)

	1984	1985	1986	1987	1988
Domestic	50	30	20	20	25
Malaysia	15	20	25	30	28
India	-	7	12	18	12
U.S.A.	10	20	15	10	3
Japan	10	5	10	8	10
Europe	3	3	3	8	13
Total	100	100	100	100	100

Source: Hitachi Electronic Device

2) Material Procurement

A supply of high-quality raw materials, and glass products in particular, is the key to successful CRT production. In 1985 Asahi Glass established Asahi Technovision as a wholly-owned subsidiary. This company has been importing materials from Japan for the processing of funnels while also importing finished panels directly from Japan. It was decided, however, that the company would begin the production of panels for 14 to 16-inch CRTs in April 1989. Production capacity will be 7 million units a year, and there is a plan for the future production of funnels as well.

(3) Korea

1) Production Trends

Korean production of CRTs has shown tremendous growth, increasing 2.2-fold in value terms from US$267.01 million in 1984 to US$593.93 million in 1987, when CRTs accounted for 8.2% of all electronic component production in Korea. In 1988 Korea produced a higher volume of CRTs than Japan did, and it is expected to soon become the world's largest producer on a value base as well. Production during the past four years is as shown in Table V.3-19. The average growth rate (quantity-based) was high at 33.4%, and an export ratio of 42.8% was achieved in 1987.

Table V. 3-19 Trend of CRT Production in Korea

	Production Volume (1,000 Units)	Production Value (US$ 1,000)
1984	5,012	267,013
1985	6,916	314,031
1986	10,461	430,276
1987	11,885	593,934

Source: Association of Korea Electronic Industry Promotion

CRT production in Korea began in 1978 with the introduction of Toshiba technology by Orion Electric. This was followed by similar agreements between Samsung Electron Devices and NEC in the first half of 1979, and between Gold Star and Hitachi in the second half of the same year. At first, a lack of domestic demand hampered production efforts, but the advent of colour television broadcasting in 1980 caused demand to leap from US$70 million to US$200 million in the following year. The three CRT manufacturers have conducted large-scale investment since the end of 1986 and are promoting aggressive plans to supply 25% of the world CRT market eventually. At present, the competitiveness of Korean products in the low- and middle-end ranges is increasing due to Japan's shift to larger, high-quality models (as a result of the strong yen), domestic colour television production is experiencing a dramatic growth, and increased colour television production in China has resulted in a supply pinch in the region. Daewoo has announced that it will establish a joint-venture plant located in Korea with China for the production of CRTs for exclusive export to China, and further increases in China's demand are expected.

Production scale and share for each of the three CRT manufacturers are shown in Table V.3-20. The three companies have a combined annual production capacity of 26.4 million units.

Table V. 3-20 Production Capacity and Shares of Major Korean CRT Manufacturers

	Product Size	Capacity of Production (1,000 Units/Month)	Share (%)
Samsung	12"-20"	950	43
Gold Star	Unknown	800	36
Orion	14"-20"	450	20

Source: Association of Korea Electronic Industry Promotion

Concerning quality, the Association of Electronics Industry Promotion in Korea estimates Korea's product quality at 85, in comparison with Japan at 100. Main components and materials being produced domestically include electron guns, panels, funnels (partially imported, according to product type), and red phosphor. Glass is being produced by two companies: Samsung Corning, which has a technology tie-up with Corning of the U.S., and Korea Electric Glass with Nippon Electric Glass.

The current activity of the Korea's CRT industry is expected to continue for the next three to five years, but after that, given industry and product life cycles, late-arriving competitors are believed likely to take over. The Association of the Electronics Industry in Korea predicts that production will grow at an annual rate of 15.7%, reaching US$946 million in 1991, while exports will increase at an annual rate of 14.7%, reaching US$447 million in the same year.

2) Export Trends

Table V. 3-21 shows the export destinations of Korea's CRTs by country for the past four years. Major destinations vary widely from year to year. Moreover, an anti-dumping judgement by the U.S. in 1987 resulted in a drastic drop in shipments, and the export climate for Korean products in the industrialised countries is steadily deteriorating.

Table V. 3-21 Trend of CRT Export from Korea

(Unit: 1,000 Pcs)

	1984	1985	1986	1987
Total	1,034.8	3,062.4	4,044.9	5,308.5
	(100.0)	(100.0)	(100.0)	(100.0)
Japan	8.5	362.5	337.7	507.9
(Share: %)	(0.8)	(11.8)	(8.3)	(9.6)
Hong Kong	278.9	512.8	424.2	1,281.6
(Share: %)	(26.9)	(16.7)	(10.5)	(24.1)
Singapore	2.7	287.4	344.3	695.6
(Share: %)	(0.3)	(9.4)	(8.5)	(13.1)
India	314.2	462.1	296.3	342.3
(Share: %)	(30.4)	(15.1)	(7.3)	(6.4)
England	37.3	131.3	273.2	368.6
(Share: %)	(3.6)	(4.3)	(6.8)	(6.9)
U.S.A.	336.7	965.0	1,367.0	219.8
(Share: %)	(32.5)	(31.5)	(33.8)	(4.1)

Source: Association of Korea Electronic Industry Promotion

(4) Other Asian Countries

Recently, the establishment of large-scale CRT plants has been announced by both Thailand and China. By 1992, when these facilities are expected to enter into full production, the supply and demand relationship in the Asian CRT market may change significantly.

1) Thailand

As of 1988, Thailand produced only CRTs for monochrome television sets, but the Board of Investment (BOI) has given its approval to two new projects as follows.

1. Thai CRT Co., Ltd.

Production Starts from	: Middle of 1989	
Annual Production Capacity	: 1.4 million pcs per year	
Market	: Mainly for Export the remains for Domestic.	
Composition of Capital	: Joint Venture of 15 Domestic	
	TV Manufacturers	40%
	Mitsubishi Electric (Japan)	30%
	Siam Cement Co., Ltd.	30%

2. Toshiba Display Devices (Thailand) Co., Ltd.

Production Starts from	: February 1990	
Annual Production Capacity	: 1.6 million pcs per year (6 inchs - 17 inchs)	
Market	: 100% for Export	
Composition of Capital	: Toshiba Corp. (Japan)	90%
	Thai Electric Industry Co., Ltd.	5%
	Mitr Siam International Co., Ltd.	5%

The two plants will have a combined annual production capacity of 3 million units. Thus, even if domestic demand for CRTs increases from the present 0.6 to 1.0 million units by 1995 (according to BOI estimates), 2 million units will be available for export both direct and indirect. The resulting impact on neighbouring countries would be significant.

The Thai government is promoting the domestic production of television sets through import tariff arrangement and investment promotion schemes rather than import restrictions. Already, two projects for the supply of materials and components for CRTs have received official approval.

One of these is a joint venture between Asahi Glass of Japan and Siam Cement of Thailand which will begin production of glass products for 14- to 21-inch CRTs in 1991. The plant will have an annual production capacity of 7.5 million panels and 14 million funnels, far exceeding domestic demand, and the firm has plans to export the majority to other Asian countries. Another company to receive approval was Muramoto Electron, another Japanese-Thai joint venture which will produce inner magnetic shields, bands, and other CRT components.

On 1 January 1987 import duties on flyback transformers and deflection yokes were raised from 10% to 30%, and duties on CRTs as well will be increased from 10% to 30% starting October 1, 1990.

2) China

China's CRT market is rapidly expanding, with 1988 domestic demand exceeding 10 million units. In Hanyang, there exists the only company with a CRT plant currently in operation and it maintains a technical tie-up with Hitachi. This facility, with an annual production capacity of approximately 1 million units, is capable of supplying a mere 10% of the market. There are plans for the establishment of six CRT plants, however, and construction has already begun on some of them. When these facilities enter into full-scale operation they will probably be able to supply 8 - 9 million units a year. An outline of these facilities is given below. Since the plants must agree at the time of establishment to export a certain percentage of their products, exports will be started in spite of a supply shortage in the domestic market. Although the exact figure remains unclear, if the 20% ratio quoted by one of the plants holds true for the others as well, China will become an exporter of approximately 1.6 - 1.8 million CRTs in the future.

Table V. 3-22 Outline of CRT Production Plans in China

	Form of Participation	Location	Annual Production Capability (1,000 Pcs)	Inaugural Programme of a Company
1. Hitachi	Joint Venture	Shenzhen	1,600	1990
2. Toshiba	Joint Venture	Shanghai	2,600	1990
3. Toshiba	Joint Venture	Hanyang		
4. Matsushita	Joint Venture	Peking	1,800	1989
5. GE	-	-	-	-
6. Philips	-	-	-	-

V-4. Feasibility Analysis of Investment

V-4-1. Introduction

In order to develop the CRT industry or to invite the investment of overseas CRT manufacturers successfully in Malaysia, the basic requirement would be the fact that the CRT factories established in Malaysia could produce products competitive in the international market both in quality and price, and the operation of the factory be financially viable. For this reason, a rough financial feasibility analysis has been conducted based on the assumption that a new CRT plant would be established in Malaysia. The outline of the assumed model factory is as follows.

Outline of the Model C-CRT Factory

Total Land Area		:	60,000m^2
Total Building Area;	Production Area	:	25,300m^2
	Office & Auxiliary Area	:	5,000m^2
Total Initial Investment Costs		:	M$445 Million
Number of Employees		:	811
Production Item		:	Colour-CRT
Production Capacity		:	1.4 Million Pcs/Year

The major assumptions used for the analysis were as follows:

Basic Assumptions for the Analysis

Project Life	:	15 years
Construction Period	:	1 year
Prices	:	1988 Constant price
Investment Incentives	:	- Exemption from import tax for equipment and materials
	:	- 10 year exemption from corporation tax (pioneer status) or the corporation tax exemption based on Investment Tax Allowance (ITA:100%)
Exchange Rates	:	M$1.00=¥46, US$1.00=M$2.64

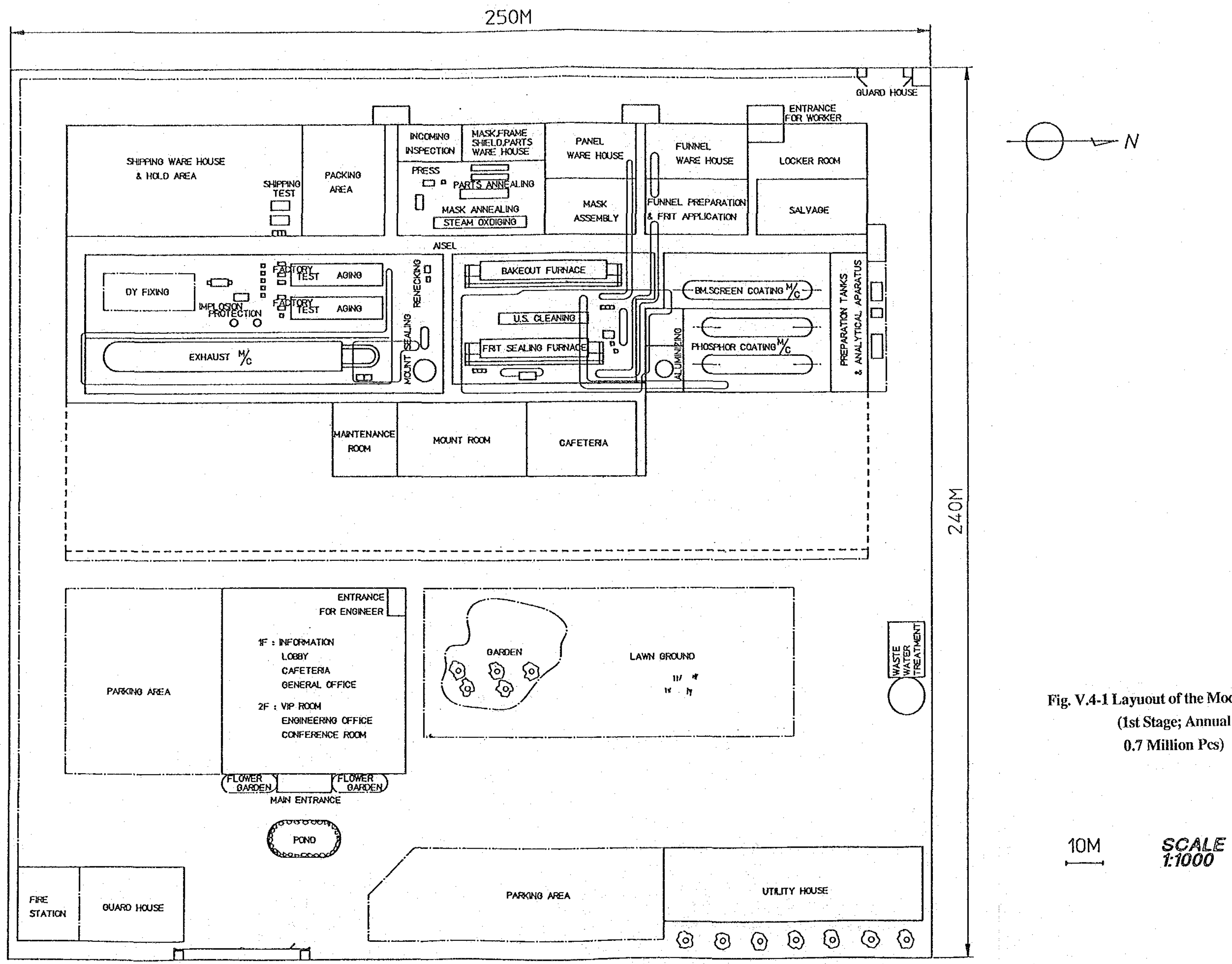


Fig. V.4-1 Layuout of the Model C-CRT Factory
(1st Stage; Annual Production Capacity of 0.7 Million Pcs)

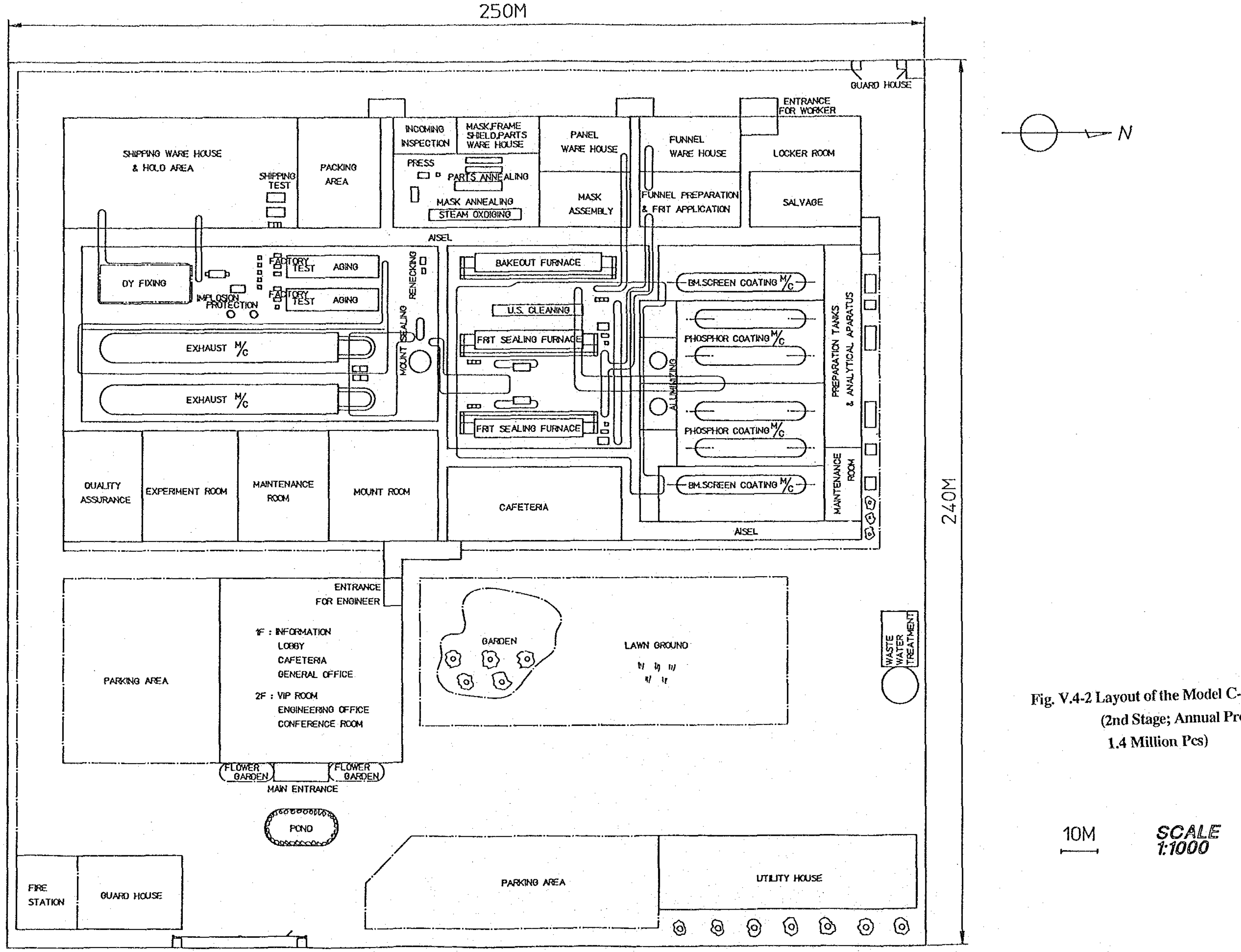


Fig. V.4-2 Layout of the Model C-CRT Factory (2nd Stage; Annual Production Capacity of 1.4 Million Pcs)

V-4-2. Production Item and Production Capacity

(1) Production Item

As the kind of CRT to be produced in Malaysia, the following sizes of colour CRT would be recommended.

Product	:	Colour CRT for T.V. set assembly
Size	:	14" (13" V), 16" (15" V), 20" (19" V) and 21" (20" V)
Neck Size	:	Conventional neck (Ø 29.1 mm)

1) Product

From the recent trend of colour T.V. set assembling in Malaysia the domestic production of colour CRTs (C-CRT) would be desired. At present, there is no production of black and white T.V. sets in Malaysia, and the demand in nearby countries is also not large. In the future, the demand for colour display tubes for computer use is expected to grow. With the accumulated production know-how of C-CRTs for T.V. sets, it would be possible to change to the production of colour display tubes in the future.

2) Tube Size

The distribution of tube sizes demanded in Malaysia in 1988 was estimated as follows:

6" & 10"	:	1.0%
14"	:	62.8%
16"	:	5.8%
20"	:	17.8%
21"	:	12.1%
29"	:	0.5%

From the above distribution, the sizes to be produced in Malaysia would be 14", 16", 20" and 21". In particular, the major weight would be placed on 14" and 20" in the initial stage. According to shift in market demand, the sizes of CRTs produced in the model factory would change. However, the production of many sizes of CRTs at one time, or the frequent change of sizes would create a large productivity loss.

3) Neck Size

As to the neck size of C-CRTs, there are presently three types applied, narrow neck (Ø 22.5 mm), conventional neck (Ø 29.1 mm) and wide neck (Ø 36.5 mm). The wide neck type is used only for large size T.V. sets such as over 21". While the narrow neck has an advantage in lower power consumption, the conventional type has an advantage in the ease of production. Further, the conventional neck could cover a wider range of tube sizes from 14" to 26", while the narrow neck is applied usually only for small sizes such as 14". From the expected tube sizes produced in Malaysia, the conventional neck is considered to be preferable at least at the initial stages of local production.

(2) Production Capacity

1) Minimum Economic Scale of Production

The actual production volume of a factory would vary largely according to the skill level and efficiency of workers and other relevant conditions. However, the minimum economic production scale of one line would be decided by the production capacity of critical machines, such as the Black Matrik Machine.

3,600 sec / 18 sec x 0.95 (Actual operating rate) x 21 hrs / day
x 0.9 (Yield ratio in black matrix coating process)
x 0.85 (Yield phopher screen coating process)
x 0.90 (Yield in flit sealing)
x 0.95 (Yield in shipping test)
x 270 days / year
= 704,634 tubes / year / line
= 700,000 tubes / year / line

In the above calculation, the following plant working conditions are supposed:

Working hours	: 7 hours / day / shift
Working days	: 270 days / year
Working shifts	: 3 shifts
Machine operating ratio	: 95%

2) Production Capacity of a Proposed Factory

From both the growing demand for C-CRT in Malaysia and the economy of scale for CRT production, the production capacity of a factory to be examined is set as 1.4 million tubes / year.

V-4-3. Initial Investment

(1) Initial Investment Cost

Initial investment cost for the planned construction of the colour CRT plant is assumed to be about M$445 million.

Table V. 4-1 Breakdown of Initial Investment Costs

(Unit: M$1,000)

Item	Investment Amount
1. Land	5,167
2. Building Construction	31,570
3. Auxiliary Facilities	54,316
4. Production Facilities	312,469
5. Vehicles & Stationeries	400
6. Contingency	41,478
Total	445,400
(Local Procurement)	(219,129)

(2) Land

As to the site conditions for the colour CRT manufacturing plant, a location convenient for transportation is desired because transportation plays such an important role for both products and raw materials. Presently, colour CRT assembly manufacturers are concentrated in the suburbs of Kuala Lumpur or in the state of Johor. For the site of the new plant, the outskirts of Kuala Lumpur would be more advantageous than the state of Johor because of its nearness to the products' market and to the main port for the convenience of raw material import. The state of Johor, on the other hand, is in the vicinity of the biggest suppliers market, at present, Singapore.

It is impossible to decide on a specific site for the plant since a detailed site selection survey was not conducted this time. However, the Shah Alum Industrial Complex in the suburbs of Kuala Lumpur is examined as an assumed candidate plant site for the purpose of cost calculation.

Purchase Method	: 99 year lease
Land Price	: M$8.00 / ft^2
Fixed Asset Tax	: M$0.14 / ft^2
Administration	: M$100.00 / block
Sewage	: M$0.50 / ft2
Terms of payment	: Within one month after permit of purchase : 20%

Within six months after permit of purchase: 80%

The land space required of about 60,000m^2 (6ha), would be valued at about M$5.17 million.

(3) Construction Costs

The outline of the building required is as follows:

Plant (production) space	:	25,300m^2 Flat Bldg., Height; 6m^2 Anti-Weightpressure; 500kg / m^2 Air-conditioned
Office & auxiliary facilities space	:	2,500m^2 x 2 Floors 2 Floor Bldg. Partially air-conditioned
Outline of auxiliary facilities	:	Guard House, Power Station, Bin Center, Pump House Shed, External Works, Pumping, Water Mains Shed & Fire Fighting

Construction would be conducted by local contractors. Construction cost is estimated to be M$31.57 million.

(4) Costs of Auxiliary Facilities

The cost breakdown of anxiliary facilities is as folows:

Electric wiring	M$ 4,800 thousand
Air-conditioning system	M$43,688 thousand
Waste water disposal system	M$ 2,068 thousand
Pure water supply equipment	M$ 3,760 thousand
Total	M$54,316 thousand

The details of major auxiliary facilities are as folows:

High Tension Power Receiving Equipment

1) Capacity: 5,000KVA

2) Operation method: Full automation

3) Mainly composed of:

- LS (Line Switches)
- ACB (Air-blast Circuit Breakers)
- OC (Over Current Relays)
- OCG (Over Current Grund Relays)
- MOF (Metering Outfits)
- DS (Disconnecting Switches)
- Main Transformers
- RDF (Ratio Differential Relays)
- PT (Potential Transformers)
- VCB (Vacuum Circuit Breakers)
- GPT (Ground Potential Transformer)
- Low Voltage Transformer
- SC (Static Capacitors)
- LA (Lightning Arrestors)
- Other Switches
- Other Relays
- Other Metres

Air Conditioning System

1) AHU1:	Room temperature	22°C - 25°C
	Moisture	50% ± 5%
	Space	$900m^2$ x 3m (H)
AHU2:	Room Temperature	20°C -23°C
	Moisture	75% ± 5%
	Space	$700m^2$ x 4m (H)
AHU3:	Room temperature	25°C - 27°C
	Moisture	60% ± 5%
	Space	$700m^2$ x 4m (H)

Other area: Ordinary air-conditioning

2) Chilled water supply system, 450USRT Chiller 3 unit

3) Clean Room: class 1,000

4) Heater & Steam Spray Equipment

Waste Water Disposal System

1) Capacity: 80T / Hr x 24Hr / day = 1,920T / day

2) Operation Method: Full automation

3) Mainly composed of:

- Waste Water Reservoirs
- Chemical Tanks
- Pumps
- Clarifier
- Quick Filter Units
- Vacuum Filter Units
- Control Panel

Pure Water Supply System

1) Capacity: 50m x 24Hr / day = 1,200m / day

2) Operation Method: Full Automation

3) Mainly Composed of:

- Filter Columns
- Dumps
- Degasifiers
- Chemical Tanks
- Cation Column and Anion Column
  or Reverse Osmosis Filter
- Pure Water Tank
- Mono-bed Ion Exchanger
- Control Air Chamber
- N_2 Gas Mixing Chamber
- Control Panel

(5) Production Facilities

As to production facilities, 2 production lines (Production capacity: 0.7 million units / line) would be installed. Considering the period of employee training, one line would be installed in the 1st year and the other would be added in the 2nd year.

Production facilities are detailed in Table V. 4-5. The procurement cost is as follows.

Table V. 4-2 Procurement Costs of Production Facilities

(Unit: M$1,000)

Item	Procurement Costs
(Imports)	
Imported Machineries (FOB)	161,622
(1st Stage)	(90,939)
(2nd Stage)	(70,683)
Transportation Cost (FOB x 5%)	8,081
Installment Cost (FOB x 35%)	56,568
Total Imported Machineries	226,271
(Local Procurement)	
Locally Procured Facilities	71,832
(1st Stage)	(40,417)
(2nd Stage)	(31,415)
Installment Cost (20%)	14,366
Total Local Procurement Cost	86,198
Total	312,469

(6) Vehicles and Stationery

As other equipment cost, the procurement cost of 3 vehicles and one set of stationery is assumed as follows.

Table V. 4-3 Procurement Costs of Vehicles & Stationery

(Unit: M$1,000)

Item	Procurement Costs
Vehicles, M$100,000 x 3 Vehicles	300
A Set of Stationery	100
Total	400

(7) Contingency

The amount of 10% of total investment cost is assumed as contingency.

(8) Depreciation Cost

Method of depreciation to be taken is as follows:

Building :	30 year straightline depreciation
Auxiliary Facilities :	20 year straightline depreciation
Production Facilities :	15 year straightline depreciation

Vehicles & Stationery : 5 year straightline depreciation

The result of calculation of annual depreciation costs based on the above methods are as follows.

Table V. 4-4 Annual Depreciation Costs

(Unit: M$1,000/Year)

Item	Value (Initial Year)	
Buildings	1,052	(1,052)
Auxiliary Facilities	2,716	(2,716)
Production Facilities	20,831	(11,721)
Vehicles & Stationery	80	(80)
Total	24,679	(15,569)

Table V. 4-5 Production Facilities and Their Procurement Sources

1/8

Item	Q' ty	Source	
		Import	Local
I. <u>Mask Forming & Shadow Mask Assembly</u>			
1. Hydrogen Furnace for Shadow Mask	1		X
(1) Mask Tray	35		X
(2) Thermo Couple	1		X
(3) Chain Block	1		X
(4) Thermorecorder	1		X
2. Roller Leveller	1	X	
3. Press Machine for Shadow Mask Forming	2	X	
(1) Basket Tray for Mask	200		X
(2) Light Table for Mask Inspection	2		X
(3) Carrying Cart	3		X
(4) Fork Lift	1		X
4. Shadow Mask Forming Punch and Die (21", 20" & 14")	3	X	
5. Degreaser	2		X
(1) Basket Tray for Frame	150		X
(2) Basket Tray for I/S	150		X
(3) Trichlene Recovering Equipment	1		X
(4) Balancer	1		X
6. Steam Oxidizing Unit for Shadow Mask, Frame and Internal Magnetic Shield	1		X
(1) Tracing Light Table	1		X
(2) Thermo Couple	1		X
(3) Microscope	1	X	
7. Clip-Frame Welder (21", 20" & 14")	3	X	
(1) Master Panel	3	X	
(2) Brock for Weld Strength Checking	3	X	
(3) Welding Current Checker	1	X	
8. Mask-Frame Welder	2	X	
(21", 20" & 14")	1		
(1) Die for Mask Repair	3	X	
(2) Light Table for Inspection	3		X
9. M-P Inspection Device	3	X	
(1) Light Table for Inspection	1		X
(2) Master Gauge	12	X	
10. Support Plate Welder	2	X	
(1) Splash Shield (21" & 20")	4	X	
11. US Mask Cleaner	1		X
II. <u>Black Matrix Application, Phosphor Application & Aluminizing</u>			
1. Black Matrix Screen Coating Machine	1	X	
(1) Light Table for Mask Inspection	3		X
(2) Light Table for Mask Inspection	3		X
(3) Heat Exchanges with Pump for City Water	1		X
(4) Heat Exchange with Pump for Deionized Water	1		X
(5) Dispenser for Photo Resist Slurry	1	X	
(6) Graphite Application Tank	1	X	

Item	Q' ty	Source	
		Import	Local
(7) H_2O_2 Head Tank	1	X	
(8) Die for Mask Repair	2	X	
(9) Transformer	1		X
(10) Microscope	3	X	
(11) Thermometer	1	X	
(12) Time Limited Hand Tachometer	1	X	
2. Photo Exposure Unit for Black Stripe Application (21", 20" & 14")	11	X	
(1) Gauge for Photo Exposure Unit	2	X	
(2) Brightness Check Equipment	1	X	
(3) Microscope	3	X	
(4) Automatic Voltage Regulator	1		X
3. Cooling Device for Photo Exposure Unit	1		X
4. Phosphor Screen Coating Machine	1	X	
(1) Light Table for Inspection	3		X
(2) Microscope for Screen Inspection	2	X	
(3) Thermometer	1	X	
(4) Heat Exchanger with Pump for City Water	1		X
(5) Heat Exchanger with Pump for Deionized Water	1		X
(6) Dispenser for Phosphor Slurry	6	X	
(7) Heat Tank for Emulsion	1	X	
(8) Pressure Tank for Emulsion	1	X	
(9) Transformer	2		X
(10) Head Tank for Procoating Solution	1	X	
(11) Die for Mask Repair	2	X	
(12) Microscope	3	X	
(13) Time Limited Hand Tachometer	5	X	
5. Preparation Tanks for Chemicals			
(1) PVA Dissolving Tank	1		X
(2) PVA Storage Tank with Pump	1		X
(3) Preparation Tank for Photo Resist Slurry	2		X
(4) Carrying Tank for Photo Resist Slurry	1		X
(5) Graphite Preparation Tank	4		X
(6) H_2O_2 Preparation Tank	2		X
(7) NH_3F Preparation Tank	1		X
(8) Other Preparation Tanks	12		X
(9) Phosphor Preparation Tank	9		X
(10) Emulsion Preparation Tank	3		X
(11) PVA Solution Tank	2		X
(12) PVA Storage Tank	2		X
(13) Preparation Tank for Precoat Solution	1		X
(14) Storage Tank for Precoat Solution	1		X
(15) Carriage Tank for Precoat	1		X
(16) Other Storage Tanks	16		X
6. Analytical Apparatus			
(1) Wrench	5		X
(2) Wrench	1		X
(3) Stainless Steel Beaker 201	4		X
(4) Stainless Steel Beaker 101	4		X

Item	Q' ty	Source	
		Import	Local
(5) Drying Oven	2		X
(6) Bakeout Porcelain	1		X
(7) Crucible	20		X
(8) Viscosimeter	2		X
(9) Hydrometer Set	5		X
(10) Platform Scale	2		X
(11) Measuring Cylinder	5		X
(12) Automatic Buret with Stop Cock	1		X
(13) Stainless Steel Vessel	5		X
(14) Polyethylene Bottle	5		X
(15) PH Meter	3		X
(16) Stainless Steel Beaker 1l	1		X
(17) Stainless Steel Beaker 0.5l	4		X
(18) Stainless Steel Beaker 0.1l	4		X
(19) Polyethylene Beaker	10		X
(20) Tong	5		X
(21) Glass Thermometer	2		X
(22) Analyrical Balance	1		X
(23) Polyethylene Beaker 1l	4		X
(24) Polyethylene Beaker 0.5l	4		X
(25) Automatic Buret Set	1		X
(26) Hydrometer	2		X
(27) Polyethylene Cylinder 1l	2		X
(28) Polyethylene Cylinder 0.25l	2		X
(29) Polyethylene Cylinder 0.1l	2		X
7. Photo Exposure Unit for Phosphor Screen Machine (21", 20" & 14")	21	X	
(1) Brightness Check Equipment	1	X	
(2) Microscope	3	X	
(3) Automatic Voltage Regulator	1		X
8. Red Phosphor Recovery System	1	X	
(1) Centrifugal Separator	2		X
9. Aluminizing Unit	2	X	
(1) Washing Sink	1		X
(2) Working Table	2		X
(3) Graphite Mixing Equipment (A)	2	X	
(4) Graphite Mixing Equipment (B)	1		X
(5) Carrying Cart	4		X
(6) Drying Oven	1	X	
(7) Vacuum Check Meter	1	X	
(8) Aluminum Thickness Meter	1	X	
(9) Chain Block	2		X
III. <u>Bakeout</u>			
1. Bakeout Furnace	1		X
2. Automatic Loader & Unloader for Bakeout Furnace	1		X
3. Automatic Stacker & Unstacker for Panel Support Fixture	2		X
4. Panel Support Fixture	1,450		X

Item	Q' ty	Source	
		Import	Local
5. Ultrasonic Mask Cleaner	1		X
(1) Light Table for Inspection	3		X
IV. <u>Funnel Preparation & Frit Sealing</u>			
1. Panel Carriage	1		X
2. Funnel Washing Machine	1	X	
3. Neck Graphite Coating Machine with Internal Graphite Coating Table	2	X	
(1) Graphite Mixer	2	X	
(2) Gauge	2	X	
(3) Brash	1		X
4. Funnel Drying Oven	1		X
5. Graphite Ball Mill Machine	2		X
6. Frit Preparing Equipment	1		X
(1) Measuring Cylinder	1		X
(2) Beaker	1		X
(3) Scale	1		X
7. Frit Application Machine	2	X	
(1) Frit Tank	2	X	
(2) Spatula	5		X
(3) Balances	1	X	
(4) Surface Thermometer	1		X
(5) Self-recording Type Hygrometer	1		X
8. IS Welding Equipment	2	X	
(1) Tray for Contact Spring	2		X
(2) Tray for IS Clip	2		X
9. Dust Removing Machine for Panel-mask Assembly	1	X	
10. Sealing Plane Wiping Workbench	1		X
(1) Tray	1		X
11. Frit Sealing Furnace	1		X
12. Automatic Loader for unloader for Frit Sealing Furnace	1		X
13. Frit Sealing Fixture	620		X
(1) Alignment Check Gauge	3	X	
14. Frit Break-down Checker	1	X	
15. Dust Removing Machine for Sealed Bulb	4	X	
(1) G Meter	1	X	
V. <u>Mount Assembly</u>			
1. Parts Annealing Furnace	1		X
(1) Tray	50		X
2. Ultra-Sonic Cleaning for Mount Sub-assembly	1		X
(1) Cage for Cleaning	10	X	
3. Centrifugal Separator	1		X
4. Drying Oven for Gun Parts	1		X
(1) Tray	20		X
5. Bench Welder for Gun Parts Ass'y	12		X
(1) Jig	12	X	
(2) Gauge	12	X	

Item	Q' ty	Source	
		Import	Local
6. Beading Machine	2	X	
(1) Parts Gray	6	X	
(2) Gauge	1	X	
(3) Pt Bed	4	X	
(4) Thermometer	1		X
7. Cooling Unit for Bead Mount	2	X	
8. Gun Bead Mandrel	18	X	
(1) Center Check Gauge	2	X	
(2) Jigs	6	X	
(3) Micrometer	1		X
(4) Slide Calipers	1		X
9. Cathode Span Setting Machines	3	X	
(1) Pin Set	3		X
(2) Eye Gauge	3		X
(3) Mount Tray	100	X	
10. Air Micrometer for Cathode-G2 Gap with Air Probe Nozzle	3	X	
(1) Set Up Gauge	2	X	
(2) Jig for Fasten or Unfasten of Nozzle	3	X	
11. Bench Welder for Heater Welding	7	X	
(1) Pinset	7		X
(2) Eye Gauge	7		X
(3) Jigs	7	X	
12. Bench Welder for Stem Welding	3	X	
(1) Stem Setting Jig	3	X	
(2) Pinset	2		X
(3) Eye Gauge	2		X
(4) Jigs	3	X	
13. Bench Welder for Gun Mounting	11		X
(1) Jig	11	X	
(2) Pinset	11		X
(3) Eye Gauge	11		X
14. Shield Cup Welding Machine	1	X	
(1) Jigs	2	X	
15. Mount Checker	1	X	
16. Measuring Equipment for Mount Aligment Inspection	1	X	
(1) Master Gauge	1	X	
17. Bench Welder for Funnel Getter with Jig	1	X	
(1) Jig	1	X	
(2) Pinset	1		X
18. Dust Removing Machine	1	X	
VI. <u>Mount Sealing, Exhausting & Aging</u>			
1. Mount Sealing Machine	1	X	
(1) Camera	1	X	
(2) Monitor TV	1	X	
(3) Lamina Flow Benc	1	X	
(4) Carrying Cart for Mount	1	X	
(5) Polarimeter	1	X	

Item	Q' ty	Source	
		Import	Local
(6) Pinset	2		X
(7) Glass Cutter	1	X	
2. Mount Rotation Measuring Device	1	X	
(1) Master Gauge	1set	X	
3. Annealing Furnace	1	X	
(1) Thermometer	1		X
(2) Thermocouple	1		X
4. Exhaust Machine			
(1) Exhaust Furnace	1		X
(2) Exhaust Carts	210	X	
(3) NGR Set	1	X	
(4) Power Supply	1	X	
(5) Torque Wrench	2	X	
(6) Cart for Test	1	X	
(7) Trichlene Degreaser	1		X
(8) Drying Oven	1		X
(9) Manometer	4	X	
(10) Vacuum Meter	2	X	
(11) Exhaust Tip Salvaging Equipment	1	X	
(12) Diamond Rasp	2	X	
(13) Electric Tip-off oven Testing Equipment	1	X	
(14) Cutting Pliers	1	X	
(15) Megatester	1	X	
(16) Messcylinder	1		X
(17) Surface Thermometer	1		X
5. Getter Flash Bombarder	4	X	
(1) Stop Watch	1		X
6. Aging Set	1	X	
7. Glass Lather for Re-Neck	1	X	
(1) Annealing Oven	2		X
8. Dust Removing Machine for Sealed Bulbs	2	X	
VII. Factory Test, Implosion Protection, Shipping Test & York Fixing			
1. Test Equipment for P, IHK, MIK	1	X	
(1) Digital Multimeter	1	X	
2. Automatic Test Equipment	1	X	
3. Screen Test Set	7	X	
(1) HRS VRS Gauge	7	X	
(2) Convergence Gauge	7	X	
(3) Spot Size Gauge	7	X	
(4) Deflection Yoke	7	X	
(5) Microscope	7	X	
(6) Rupe	7		X
(7) Degausing Coil	7		X
(8) High Voltage Meter	1		X
(9) Gauss Meter	1	X	
4. Banding Machine	4	X	
5. Taping Machine	3	X	
6. Check Jig	1	X	

Item	Q' ty	Source	
		Import	Local
7. External Conductive Coating Conveyor	1		X
(1) Spray Cover	6	X	
(2) Spray Gun	2	X	
(3) Jig for Silicone Spray	2	X	
(4) Mixing Machine	1	X	
(5) Washing Sink	1		X
8. Drying Oven	1		X
(1) Surface Thermometer	1		X
9. Automatic Shipping Test Equipment	1	X	
10. Manual HV Aging Equipment	4	X	
(1) G1-G2 HV Aging Equipment	2	X	
11. Manual Emission Aging Equipment	1	X	
12. Deflection Yoke Fixing Unit	22	X	
(1) Gauge For Convergence	22	X	
(2) PCC Gauge	2	X	
(3) Micro Scope	22	X	
(4) Rupe	22	X	
(5) Pen Light	22	X	
(6) Tape Cutter	2		X
(7) Degausing Coil	22		X
(8) High Voltage Meter	1		X
(9) Torque Driver	22		X
(10) Digital Multimeter	1	X	
(11) Gauss Meter	1	X	
VIII. Salvage			
1. Glass Lathe for Re-Neck	1	X	
(1) Polariscope	1	X	
2. Bulb Dis-assembling Machine	1	X	
3. Glass Etching Machine for Panel and Funnel	2	X	
4. Washing Machine for Panel & Funnel	2	X	
(1) Washing Machine for Funnel Graphite	1	X	
(2) Mask Washing Sink	1		X
(3) Drying Oven for Funnel and Mask	2		X
5. Seal Edge Grinding Machine	1	X	
6. Panel Face Polishing Machine	1	X	
(1) Repairing Equipment for Panel and Funnel	2	X	
(2) Grinder	3	X	
7. Other Machines			
(1) Neck-Cutting Device	1	X	
(2) De-Banding Equipment	1	X	
(3) Light Table for Inspection	1		X
(4) Carts for Panel and Mask	2		X
IX. Quality Assurance			
1. Life Test Set	80	X	
(1) Signal Generator	3	X	
(2) Shelf Rack	14		X
(3) High Voltage Meter	1		X
2. Heater Test Set	1	X	

Item	Q' ty	Source	
		Import	Local
3. Cathode Test Set	1	X	
4. P/IHK/MIK Testing Machine	2	X	
(1) Digital Multimeter	1	X	
5. Screen Test Set	3	X	
(1) Gauge for Convergence	3	X	
(2) Gauge for Spot Size	3	X	
(3) High Gauge	1		X
(4) Microscope	3	X	
(5) Rupe	3		X
(6) Slide Calipers	1		X
(7) Torque Driver	1		X
(8) Degousing Coil	3		X
(9) Safety Goggle	3		X
(10) Brightness Meter	1	X	
(11) High Voltage Meter	1		X
(12) Digital Multi-meter	1	X	
(13) Universal Bridge	1	X	
6. Signal Generator	1	X	
7. Pyrometer	1	X	
8. Hot & Cold Testing Machine	1		X
9. Temperature & Humidity Testing Machine	1	X	
10. Bulb Vibration Testing Machine	1		X
(1) Bulb Holder	3		X
(2) G Meter	1		X
11. X-Ray Inspection Equipment	1	X	
(1) Foot-lambert Meter	1	X	
12. Pressure-resistance Testing Tank	1		X
13. Impact Tester	1		X
14. Drop Test Equipment	1		X
15. Ground Magnetism Neutalizer	1		X
(1) Gauss Meter	1	X	
16. Equipments for Incoming Inspection			
(1) Light Table for Inspection	1		X
(2) Microscope (x100)	1		X
(3) Standard Level Plate	1		X
(4) Slide Calipers	5		X
(5) Height Gauge	1		X
(6) Micrometer	3		X
(7) Binocular Microscope	3		X
(8) Projector	1		X
(9) Torsion Balance	1		X
(10) Hardness Tester	1		X
(11) Dial Gauge	3		X
(12) Jigs & Gauges	1set	X	

V-4-4. Production and Sales

(1) Production Plan

The flow of annual production volume of the model factory is projected based both on the maximum production capacity and on the assumed operating rate of the model factory, the results of which are shown in Table V.4-6.

Table V. 4-6 Flow of Production Volume

(Unit: 1,000 Pcs)

Line	1st Year	2nd Year	3rd Year	4th Year	5th Year	After 6th Year
1st	126	378	553	665	700	700
2nd	-	126	378	553	665	700
Total	126	504	931	1,218	1,365	1,400
(Operating Rate)	(18%)	(36%)	(67%)	(87%)	(98%)	(100%)

The CRT sizes produced in the model factory would be changed according to shifts of market demand. For the purposes of calculation, however, it was assumed that 60% of the production would be the 14" size of CRTs and 40% of 20" size of CRTs.

Table V. 4-7 Flow of Production Volume by Size

(Unit: 1,000 Pcs)

Line	1st Year	2nd Year	3rd Year	4th Year	5th Year	After 6th Year
14"	75.6	302.4	558.6	730.8	819.0	840.0
20"	50.4	201.6	372.4	487.2	546.0	560.0
Total	126.0	504.0	931.0	1,218.0	1,365.0	1,400.0

(2) Unit Sales Prices

The following unit sales prices by size shown in Table V.4-8 were set for the products of the model factory. The unit sales prices were set taking into consideration (1) international transaction terms of colour CRTs at present, (2) present transaction prices in Malaysia and (3) the export prices of Korean-made colour CRTs which would be one of the major competing products.

Table V. 4-8 Assumed Unit Sales Prices

Size	International Prices (US$)			Unit Sales Prices
	CRT without Deflection Yoke	Deflection Yoke	Total	(M$)
14"	47-50	3-4	50-54	138.84
20"	69-74	6	75-80	206.92

The present major supply sources of colour CRTs to Malaysia are Singapore, Japan, Taiwan and Korea. It is said that the prices of Singapore-made products are slightly higher than those of Taiwan or Korean-made ones, and that those of Japanese products are still higher than the Singaporean ones.

For reference, the export prices of colour CRTs made in Korea in November 1988 were as shown in Table V.4-9.

Table V. 4-9 Unit Export Prices of C-CRTs from Korea (FOB Prices)

(Unit: US$)

Size	A Company	B Company	C Company
14"	48-50	50-52	-
16"	60-66	-	-
18"	-	-	77
20"	68-70	74-80	78-80

Source: Korea Electronics Association, Bank of Korea Export Statistics and the Results of a Field Interview Survey

(3) Projection of Annual Sales Flow

Based on the above assumed production volume and unit sales prices, the flow of annual sales of the model factory was projected as shown in Table V.4-10.

Table V. 4-10 Projection of Annual Sales Flow Value

(Unit: M$1,000)

Size	1st Year	2nd Year	3rd Year	4th Year	5th Year	After 6th Year
14"	10,496	41,985	77,556	101,464	113,710	116,626
20"	10,429	41,715	77,057	100,811	112,978	115,875
Total	20,925	83,700	154,613	202,275	226,688	232,501

V-4-5. Material Cost Projection

(1) Unit Material Cost

For the production of colour CRTs a very large number of parts and components have to be procured. Because it requires a very high level of technical knowledge to procure these parts directly from various parts suppliers, most of the parts and components would have to be procured from an overseas manufacturer giving technical assistance to the model factory in Malaysia at the initial stage. Table V.4-12 shows the list of those parts and components needed for the production of colour CRTs and their potential supply sources.

The estimated unit material cost is M$ 94.22 for 14" and M$ 144.90 for 20", at the initial stage of production. Only the deflection yokes could be procured at the initial stage, and the local procurement rate is 10% and 8% for 14" and 20", respectively.

Table V.4-11 Unit Material Costs

(Unit: US$/Pc)

	14" (Convention Neck)	20" (Convention Neck)
Imported CKD Parts		
1 Panel Assembly Parts	8.13	14.93
2 Funnel Assembly Parts	0.52	0.69
3 Electron Gun Parts	5.02	5.85
4 ITC Parts	1.36	1.49
5 Other Parts	1.19	2.44
6 Packing & Transportation	0.57	0.89
Sub-Total	16.79	26.29
	(M$44.83)	(M$70.19)
Direct Procurement, Imports		
1 Panel	8.29	13.84
2 Funnel	6.14	9.21
3 Packing & Transportation	0.51	0.81
Sub-Total	14.94	23.86
	(M$39.89)	(M$63.71)
Total Imports	31.73	50.15
	(M$84.72)	(M$133.90)
Direct Domestic Procurement		
1 Diflection Yoke	M$9.50	M$11.00
Total Material	M$94.22	M$144.90

TableV. 4-12 List of Parts and Materials and Their Procurement Sources

(At Initiation Stage)

Item		Quantity/pc 14"	Quantity/pc 16"	Procurement Measures Local	Procurement Measures Direct	Procurement Measures CKD
1. Panel Processing						
(1)	Panel	1 Pc	1 Pc		x	
(2)	Flat Shadow Mask	1 Pc	1 Pc			x
(3)	Frame	1 Pc	1 Pc			x
(4)	Hook Spring 1/3	1 Pc	-			x
(5)	" 2/4	2 Pcs	-			x
(6)	" Assy-17	-	3 Pcs			x
(7)	" Assy-18	-	1 Pc			x
(8)	Contact Spring	2 Pcs	2 Pcs			x
(9)	Electron Shield	1 Pcs	-			x
(10)	Inner Shield	2 Pcs	2 Pcs			x
(11)	Phosphor (Green)	3,897mg	7,093mg			x
(12)	" (Blue)	4,079mg	7,423mg			x
(13)	" (Red)	1,662mg	3,025mg			x
(14)	Other 21 Items	-	-			x
2.Funnel Processing						
(1)	Funnel	1 Pc	1 Pc		x	
(2)	Flit Glass	48,744mg	57,000mg			x
(3)	Other 6 Items	-	-			x
3.Electron Gun Assembly						
(1)	Stem	1 Pc	1 Pc			x
(2)	Glass Rod	2 Pcs	-			x
(3)	Heater	3 Pcs	3 Pcs			x
(4)	Cathode Ass'y	3 Pcs	3 Pcs			x
(5)	Shield Cup	1 Pc	1 Pc			x
(6)	Getter Support-1	1 Pc	1 Pc			x
(7)	Getter	1 Pc	1 Pc			x
(8)	Other 21–25 Items	-	-			x
4.ITC Assembly						
(1)	Deflection Yoke	1 Pc	1 Pc	x		
(2)	Convergence Purity Magnet	1 Pc	1 Pc			x
(3)	Wedge	3 Pcs	3 Pcs			x
(4)	Other 8 Items	-	-			x
5.Other Parts						
(1)	Tension Band	89.2g	-			x
(2)	Shrinkage Band	-	1 Pc			x
(3)	Base	1 Pc	1 Pc			x
(4)	Other 6–8 Items	-	-			x

(2) Flow of Unit Material Costs

In order to decrease the material costs and increase the financial viability of the investment project., it is necessary to raise the direct procurement rate. The possibility of direct procurement is mainly dependent on the development of the technical capability of parts suppliers mainly in Malaysia and partly in other neighbouring countries such as Singapore. For the financial analysis, it was assumed that 15% of imported CKD parts from an original licensor would be changed into direct procurement, the cost merit of direct procurement would be 35%. The flow of unit material cost thus estimated is as shown in Table V.4-13.

Table V. 4-13 Flow of Unit Material Costs

(Unit: M$/pcs)

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
14"							
Import							
CKD	44.83	38.11	32.38	27.53	23.40	19.89	16.91
Direct	39.89	39.89	39.89	39.89	39.89	39.89	39.89
Domestic	9.50	13.87	17.59	20.74	23.42	25.70	22.64
Total	94.22	91.87	89.86	88.16	86.71	85.48	84.44
20"							
Import							
CKD	70.19	59.66	50.71	43.11	36.64	31.14	26.47
Direct	63.71	63.71	63.71	63.71	63.71	63.71	63.71
Domestic	11.00	17.84	23.66	28.60	32.81	36.39	39.43
Total	144.90	141.21	138.08	135.42	133.16	131.24	129.61

(3) Projection of Material Cost Flow

The flow of material cost projected based on the assumed production schedule by size and on the unit material cost is as shown in Table V.4-14.

Table V. 4-14 Projection of Raw Material Cost Flow

(Unit: M$1,000)

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
14"	7,123	27,781	50,196	64,427	71,015	71,803	70,930
20"	7,303	28,468	51,421	65,977	72,705	73,494	72,582
Total	14,426	56,249	101,617	130,404	143,720	145,297	143,512

V-4-6. Costs for Indirect Materials, Repair, Facility Leasing and Utilities

(1) Indirect Material Cost and Repair Cost

The costs for indirect materials and for repair were estimated at M$ 3.00 and M$ 0.60 per piece of product based on the experience both in Japan and in other countries. From these unit prices and the production volume assumed, the flows of indirect material cost and repair cost were projected as shown in Table V.4-15.

Table V. 4-15 Projected Indirect Material and Repair Cost Flow

(Unit: M$1,000)

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
Indirect Materials	378	1,512	2,793	3,654	4,095	4,200	4,200
Repair Cost	76	302	559	731	819	840	840

(2) Facility Leasing Cost

As for the supply facilities of liquid nitrogen, liquid hydrogen, or LPG gas, they could be leased from domestic gas supply companies in Malaysia. The leasing costs of these facilities are estimated as shown in Table V.4-16.

Table V. 4-16 Leasing Fees for Facilities

(Unit: M$1,000)

	Monthly Costs	Annual Costs
Liquid Nitrogen	1.5	18
Liquid Hydrogen	1.1	13
Trailer Hydrogen	0.9	11
LPG	4.5	54
Total	8.0	96

(3) Utility Cost

In the C-CRT factory, a large volume of special gas such as nitrogen, oxygen or hydrogen is used in addition to those utilities such as electric power, LPG gas or water. The consumption volume and costs of these utilities in the factory with an annual production capacity of 1.4 million pieces are estimated and shown in Table V.4-17.

Table V. 4-17 Costs for Utilities

(Unit: M$1,000)

	Consumption Per Hour	Unit Cost	Annual Costs
Power	4,124 Kwh	M$0.12 /Kwh	2,806
Water	29 ton	M$0.88 /$m^3$	145
LPG Gas	671 kg	M$0.88 /kg	3,348
Oil-free Dry Air	520 m^3	M$0.08 /$m^3$	235
N_2 Gas	39 m^3	M$0.70 /$m^3$	155
O_2 Gas	32.5 m^3	M$0.80 /$m^3$	147
H_2 Gas	7.6 m^3	M$3.00 /$m^3$	129
Total	-	-	6,965

Annual Operation Hours = 7 Hours x 3 Shifts x270 Days

V-4-7. Personnel Costs

(1) General

For the operation of a C-CRT factory, a large number of engineers and technicians covering various fields would be needed. In the model factory assumed, around 50 engineers and technicians are needed. The availability of these employees is one of the key factors for the site selection of the factory. In addition to engineers and technicians, around 60 foremen and 360 skilled workers would be needed in the model factory.

(2) Estimated Number of Employees and Labour Costs

The number of workers needed for the operation of the model factory was calculated. The average personnel cost by each job category is examined based on the various statistics available in Malaysia and the results of a field interview survey. In these personnel costs, not only the basic salary but also all of the various fringe benefits are included. The number of workers and total annual personnel expenses thus calculated are as shown in Table V.4-18.

Table V. 4-18 Projection of Annual Labour Costs

(Unit: M$1,000)

	Average Wages (M$/Month)	1st Year No.	1st Year Annual Costs	After 2nd Year No.	After 2nd Year Annual Costs
(Manufacturing)					
Plant Manager	3,500	1	42	1	42
Section Manager	2,800	3	101	3	101
Section Chief	1,500	8	144	8	144
Engineers	1,500	15	270	25	450
Asst. Engineers	1,000	5	60	10	120
Foremen	650	30	234	60	468
Skilled Workers	500	200	1,200	360	2,160
Unskilled Workers	250	200	600	360	1,080
Sub-total	-	462	2,651	827	4,565
(Administration)					
General Manager	4,000	1	48	1	48
Section Manager	2,500	3	90	3	90
Office Clerk	1,500	20	360	20	360
Sales Staff	1,500	10	180	10	180
Typist	500	2	12	2	12
Driver	550	3	20	3	20
Others	300	15	54	15	54
Sub-Total	-	54	764	54	764
Total	-	516	3,415	881	5,329

(3) Education Level and Required Skill for Engineers and Technicians in CRT Plant Operation

Relatively large numbers of engineers and technicians are required in colour CRT plant operation. Knowledge and skills in actual operation could be obtained through on-the-job training, however, it would be disirous that the engineers and technicians in each job category should have completed basic education in the various fields and at the level shown generally in Table V.4-19.

Table V. 4-19 Required Education Level and Speciality for Engineers and Technicians in Each Job Category of Colour CRT Plant

Job Category	Outline of Job	Graduated from	El.	M.	C.	P.	En.	TV.	Total
General Technology	Technical service related to designing and manufacturing would be conducted through application of knowledge and technology included in electronic engineering, physics, chemistry, material engineering, etc., for the production of colour CRTs for sale or to be used in house. (New product development is excluded.)	University	3	1	2	2			8
		Polytechnics, etc.	2	1	2	2		1	8
		Senior Secondary Technical School	2	2	1	1			6
Quality Control	Required credibility for CRT quality would be reflected in the designing through the use of systematic theory and high level of knowledge and technology for the credibility engineering related to systems, equipment, circuits and component materials, etc.	University	2						2
		Polytechnics, etc.	2					2	4
		Senior Secondary Technical School	2						2
Production Technology	Designing and drawing of tools/machinery and equipment as well as experimental and measuring instruments required for the purpose of production or inspection. Manner of manufacturing of the equipment as above would be also designated and instructed. Research and development for new technology necessary for manufacturing would also be conducted. In concrete terms, design planning, design drawing, manufacturing designation and instruction or making of specifications for outside order, making of materials for standardization , cost estimation survey and so forth would be conducted.	University	1	2	1	1	1		6
		Polytechnics, etc.	1	2	1		2	2	8
		Senior Secondary Technical School	1	2					3
Applied Technology	In the sales activities of CRT, business assistance for clients through technological services in order to increase sales efficiency to achieve the object of sales value would be conducted along with technological operation such as planning of new product and developed designing and testing of applied circuits etc.	University	2						2
		Polytechnics, etc.	2					2	4
		Senior Secondary Technical School	2						2
TOTAL			22	10	7	6	3	7	55

Abbreviation: El: Electric, Communications, Electronics
M: Machinery, Precision Machining
C: Chemistry, Applied Chemistry, Industrial Chemistry
P: Phisics, Applied Phisics, Metalic Material
En: Industrial Engineering, Industrial Management
TV:Television (School Specializing in TV)

V-4-8. Financing Plan

For the establishment of a colour CRT factory, a large amount of initial investment cost is required. Because of the very competitive international market condition of colour CRTs, the profitability would not be very high, and it is anticipated that there would be a relatively long period to recover the investment. For this reason, the availability of a financing scheme with favorable terms would be one of the key factors for success of the investment project.

For the purpose of a financial evaluation of the model factory, the following financing plan was assumed.

Outline of Financing Plan

Item	Amount (M$) million)	Terms
Paid-in Capital	200	-
Long-term Loans	245	10 years Equal Repayment, with 2 Years of Grace Period, Interest 6.0% /Year
Short-term Loans	Operating Funds	Repayment within One Year, Interest 8.0% /Year

Of the total investment cost of M$ 445 million, M$ 200 million was assumed to be procured as paid-in capital, and the remaining cost of M$ 245 million would be financed by long-term borrowing. From the nature of the project in which a large amount of stable (long-term) financing is required, the use of some institutional financing schemes either in Malaysia or in other overseas countries would be needed. From this point of view, an interest rate of 6.0% per annum which is a little lower than the usual market rate is assumed for long-term loans. The requirement of operating funds is assumed as approximately one month of the sales of the model factory, and all of these operating funds are assumed to be financed from bank borrowing. The interest rate is posed as 8.0% per annum, which is the current market rate in Malaysia.

V-4-9. Long-term Profit and Loss Projection and the Result of Financial Viability Analysis

Based on the results of the projections for both the sales and major cost items, the long-term profit and loss projection of the model factory has been conducted. For some cost items, they were roughly measured by the percentage rates of the sales, based on the experiences both in Japan or in other countries.

The results of the profit and loss projection thus conducted are summarized and shown in Table V-4-20.

Further, the long-term cash flow projection is shown in Table. V.4-21. The procurement conditions of the funds are as has been assumed in the financing plan. From the cash flow table, the annual interest payment costs are calculated for each year and fed back as the amount of non-trade expenditures to Table V.4-20.

From the above long-term profit and loss projection and the cash flow projection, the financial internal rate of return (IRR) of the assumed CRT plant is calculated at 4.8%, the loan repayment period at 11 years after starting operation, and the investment payback period at 14 years after starting operation. The results would be judged to be more or less a satisfactory level for this type of large-scale investment project.

Summary of Financial Analysis of the assumed CRT plant is as follows:

Total Initial Investment Costs	:	M$445 million
Operating Profit	:	from 3rd year of operation
Net Profit before Tax	:	from 5th year of operation
Loan Repayment Period	:	10 years after operation
Investment Payback Period	:	14 years after operation
Internal Rate of Return (IRR)	:	4.8%

The cash flow table used for IRR calculation is as shown in Table V. 4-22

Table V. 4-20 Projection of Long-Term Profit and Loss Flow

(Unit: M$1,000)

	1st Year	%	2ndYear	%	3rdYear	%	4thYear	%	5thYear	%	6thYear	%	7thYear	%
Annual Sales	20,925	100.0	83,700	100.0	154,613	100.0	202,275	100.0	226,688	100.0	232,501	100.0	232,501	100.0
Production Costs														
Material	14,426	68.9	56,249	67.2	101,617	65.7	130,404	64.5	143,720	63.4	145,297	62.5	143,512	61.7
Indirect Material	378	1.8	1,512	1.8	2,793	1.8	3,654	1.8	4,095	1.8	4,200	1.8	4,200	1.8
Utility	4,179	20.0	6,965	8.3	6,965	4.5	6,965	3.4	6,965	3.1	6,965	3.0	6,965	3.0
Leasing Fee	96	0.5	96	0.1	96	0.1	96	0.1	96	0.1	96	0.1	96	0.1
Repairement	76	0.4	302	0.4	559	0.4	731	0.4	819	0.4	840	0.4	840	0.4
Depreciation	15,569	74.4	24,679	29.5	24,679	16.0	24,679	12.2	24,679	10.9	24,679	10.6	24,679	10.6
Labour	2,651	12.7	4,565	5.5	4,565	3.0	4,565	2.3	4,565	2.0	4,565	2.0	4,565	2.0
(1) Others	628	3.0	2,511	3.0	4,638	3.0	6,068	3.0	6,801	3.0	6,975	3.0	6,975	3.0
Sub-total	38,003	181.6	96,879	115.7	145,912	94.4	177,162	87.6	191,740	84.6	193,617	83.3	191,832	82.5
Administration Costs														
Labour	764	3.7	764	0.9	764	0.5	764	0.4	764	0.3	764	0.3	764	0.3
(2) Packing & Transportation	504	2.4	2,016	2.4	3,724	2.4	4,872	2.4	5,460	2.4	5,600	2.4	5,600	2.4
(3) Others	419	2.0	1,674	2.0	3,092	2.0	4,046	2.0	4,534	2.0	4,650	2.0	4,650	2.0
Sub-total	1,687	8.1	4,454	5.3	7,580	4.9	9,632	4.8	10,758	4.7	11,014	4.7	11,014	4.7
Operating Profit	-18,765	-89.7	-17,633	-21.1	1,121	0.7	15,481	7.6	24,190	10.7	27,870	12.0	29,655	12.8
Non-trade Expenses	15,860	75.8	17,660	21.1	18,485	12.0	18,215	9.0	16,785	7.4	14,555	6.3	11,845	5.1
Net Profit	-34,625	-165.5	-35,293	-42.2	-17,364	-11.2	-2,734	-1.4	7,405	3.3	13,315	5.7	17,810	7.7

(1) 3.0% of Annual Sales
(2) M$4,00/Unit
(3) 2.0% of Annual Sales

Table V. 4-21 Cash Flow Estimates

(Unit: M$1,000)

	Before Operation	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	11th Year	12th Year	13th Year	14th Year	15th Year
Carry Over	0	128,904	450	605	511	984	533	143	132	151	7,160	33,319	36,783	91,117	145,451	199,785
Capital	200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sales	0	20,925	83,700	154,613	202,275	226,688	232,501	232,501	232,501	232,501	232,501	232,501	232,501	232,501	232,501	232,501
Product Cost	0	38,003	96,879	145,912	177,162	191,740	193,617	191,832	191,832	191,832	191,832	191,832	191,832	191,832	191,832	191,832
Administ.	0	1,687	4,454	7,580	9,632	10,758	11,014	11,014	11,014	11,014	11,014	11,014	11,014	11,014	11,014	11,014
Operating Rev. Bal.	0	-18,765	-17,633	1,121	15,481	24,190	27,870	29,655	29,655	29,655	29,655	29,655	29,655	29,655	29,655	29,655
Prev. Year	0	0	1,744	6,975	12,884	16,856	18,891	19,375	19,375	19,375	19,375	19,375	19,375	19,375	19,375	19,375
This Year	0	1,744	6,975	12,884	16,856	18,891	19,375	19,375	19,375	19,375	19,375	19,375	19,375	19,375	19,375	19,375
Working Capt. Bal.	0	-1,744	-5,231	-5,909	-3,972	-2,034	-484	0	0	0	0	0	0	0	0	0
Depreciation	0	15,569	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,279	24,679	24,679	24,679	24,679
Investment	308,746	136,654	0	0	0	0	400	0	0	0	0	400	0	0	0	0
Investment Bal.	-308,746	-121,085	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,679	24,279	24,679	24,679	24,679	24,679
L/T Borrow	245,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Principal	0	0	0	24,500	24,500	24,500	24,500	24,500	24,500	24,500	24,500	49,000	0	0	0	0
Interest	7,350	14,700	14,700	13,965	12,495	11,025	9,555	8,085	6,615	5,145	3,675	1,470	0	0	0	0
(Year-End)	245,000	245,000	245,000	220,500	196,000	171,500	147,000	122,500	98,000	73,500	49,000	0	0	0	0	0
L/T Bal.	237,650	-14,700	-14,700	-38,465	-36,995	-35,525	-34,055	-32,585	-31,115	-29,645	-28,175	-50,470	0	0	0	0
S/T Borrowing	0	29,000	45,000	68,000	75,000	69,000	56,000	38,000	17,000	0	0	0	0	0	0	0
Principal	0	0	29,000	45,000	68,000	75,000	69,000	56,000	38,000	17,000	0	0	0	0	0	
Interest	0	1,160	2,960	4,520	5,720	5,760	5,000	3,760	2,200	680	0	0	0	0	0	0
(Year-End)	0	29,000	45,000	68,000	75,000	69,000	56,000	38,000	17,000	0	0	0	0	0	0	0
S/T Bal.	0	27,840	13,040	18,480	1,280	-11,760	-18,000	-21,760	-23,200	-17,680	0	0	0	0	0	0
Financ. Bal.	237,650	13,140	-1,660	-19,985	-35,715	-47,285	-52,055	-54,345	-54,315	-47,325	-28,175	-50,470	0	0	0	0
Corp. Tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Balance	128,904	-128,454	155	-94	473	-450	-390	-11	19	7,009	26,159	3,464	54,334	54,334	54,334	54,334
Carry-Over	128,904	450	605	511	984	533	143	132	151	7,160	33,319	36,783	91,117	145,451	199,785	254,119

Table V. 4-22 CRT Plant Cash-Flow for IRR Calculation

(Unit: M$1,000)

Year	Cash Outflow	Cash Inflow			Net Cash Flow
		Operating Rev.	Depreciation	Total Inflow	
0	-308,746				-308,746
1	-138,398	-18,765	15,569	-3,196	-141,594
2	-5,231	-17,633	24,679	7,046	1,815
3	-5,909	1,121	24,679	25,800	19,891
4	-3,972	15,481	24,679	40,160	36,188
5	-2,034	24,190	24,679	48,865	46,835
6	-894	27,870	24,679	52,549	51,665
7		29,655	24,679	54,334	54,334
8		29,655	24,679	54,334	54,334
9		29,655	24,679	54,334	54,334
10		29,655	24,679	54,334	54,334
11	-400	29,655	24,679	54,334	53,934
12		29,655	24,679	54,334	54,334
13		29,655	24,679	54,334	54,334
14		29,655	24,679	54,334	54,334
15	53,906 1)	29,655	24,679	54,334	108,240

1) Residual Value of Land (5,167), Building (15,785), Auxiliary Facilities (13,579) and Working Capital (19,375)

IRR = 4.84%

V-4-10. Sensitivity Analysis

In order to examine the financial stability of the assumed CRT project, the senstivity test has been conducted for the following six alternative plans.

Outline of the Alternative Plans

Alternative Plan I	:	Unit Product Sales Prices	5% Up
Alternative Plan II	:	"	5% Down
Alternative Plan III	:	Initial Investment Cost	10% Down
Alternative Plan IV	:	"	10% Up
Alternative Plan V	:	Parts & Material Costs	5% Down
Alternative Plan VI	:	"	5% Up

For each of the alternative plans, the long-term profit and loss projection and cash-flow projection have been made and IRR has been calculated. The results of the analysis are briefly summarized as follows. (For the details of the calculation, refer to Annex-9.)

Summary of the Sensitivity Test

Original and Alternative Plans	Internal Rate of Return	Loan Repayment Period (After Operation)	Investment Payback Period (After Operation)
Original Plan	4.84%	11 Years	14 Years
Alternative Plan I	7.22%	9 Years	12 Years
Alternative Plan II	2.19%	14 Years	-
Alternative Plan III	6.04%	9 Years	13 Years
Alternative Plan IV	3.80%	13 Years	15 Years
Alternative Plan V	6.45%	10 Years	13 Years
Alternative Plan VI	3.13%	13 Years	-

The results of sensitivity tests reveal that the factor that has the largest impact on the project profitability is the change of unit sales prices. In case the unit sales price increases 5%, the IRR of the project would increase to 7.2% from 4.8% under the original assumption.

The factor that would have the largest impact on the profitability of the project next to the changes in unit sales prices would be the change in parts and material procurement costs. A decrease of procurement costs by 5% would increase the IRR of the project to 6.5%.

Compared with the above two factors, the impact of the change of initial investment costs on the profitability of the project would be rather small.

V-5. Future Direction

V-5-1. A Scenario for the Development of the CRT Industry in Malaysia

A scenario for the development of the CRT industry in Malaysia is shown in Fig.V.5-1. The final goal of the scenario is the achievement of the export promotion of Malaysia. Prior to the evaluation of the possibility of achieving that goal, there are two factors evaluated. One is the degree of importance of the domestic production of CRTs in Malaysia, and another is the technical and financial possibility of starting domestic production.

(1) Requirements for the Domestic Production of CRTs

The annual production volume of colour T.V. sets in Malaysia was around 1.2 million in 1987. Since the domestic demand was estimated at around 0.2 million in the same year, most of the production was for exports. Due to the rapid increase of investments in Malaysia by T.V. set assemblers since 1988, it is estimated by MIDA that the annual production volume would reach approximately 6.0 million in 1990. Although the C-CRT is the most important component for colour T.V. set assembly occupying about 35% of the total parts and components costs, there is no domestic production of CRTs and all of them are presently imported from such countries as Singapore, Japan, Taiwan or Korea. Due to the very tight world-wide supply and demand situation of CRTs, it is reported that the stable procurement of CRTs is difficult at present.

From the view of the industrial development policy of Malaysia, the electronics industry is the core sector of Malaysian industry. As to the future development strategies of the electronics industry, IMP states that they are directed (1) to expand the production of consumer products in order to redress the imbalance in the intra-industry structure which is heavily dependent on industrial semiconductor components, and (2) to strengthen the supply of parts and components for domestic assemblers. From these Malaysian industrial development strategies, the promotion of the CRT industry has a very significant meaning, and CRTs have been listed as one of the priority products, the manufacture of which qualifies for tax relief for a maximum of 10 years.

From the above, it is judged that the domestic production of CRTs in Malaysia is highly needed both from the market demand and from the political development policy.

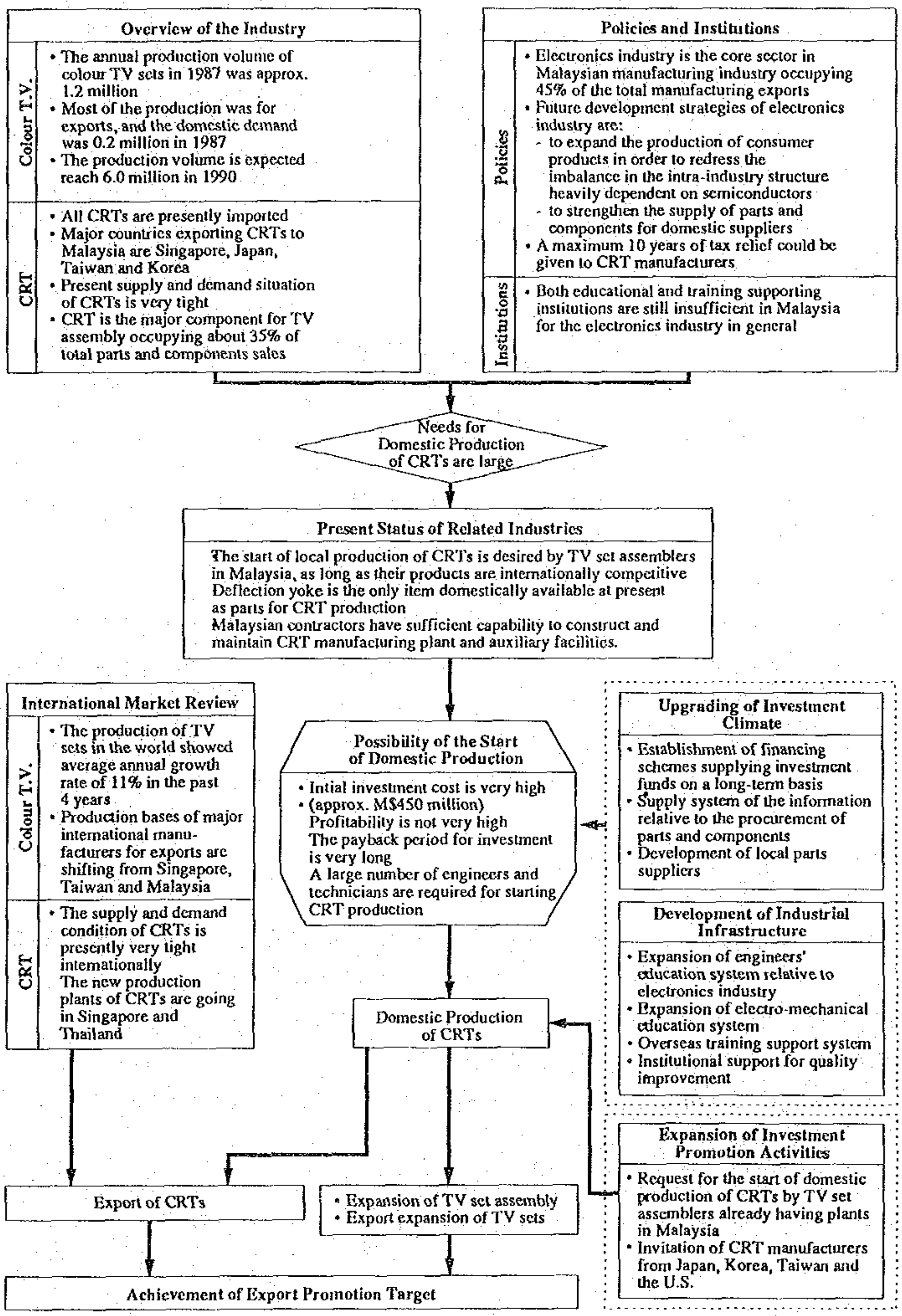
(2) Possibility of Starting Domestic Production of CRTs

The possibility of starting domestic production of CRTs is evaluated both from the production environment and from the financial viability.

From the view of the production environment, firstly, there would be no problem of market size because the local procurement of CRTs is highly needed by local T.V. set assemblers. There are mostly no problems foreseeable in the area of the construction of production factories or the installation and maintenance of auxiliary facilities. For the local procurement of parts and components, however, there are still problems left. The parts presently available in Malaysia are only the deflection yokes, and all other parts have to be imported.

In the area of financial viability, the problem is still large, and it is considered to be one of the major reasons that no CRT manufacturers have yet decided to invest in Malaysia even though the market demand in Malaysia has expanded so rapidly. Another major problem area is the very high initial investment cost required, which is estimated at around M$450 million. On the other hand, the unit sales price of colour CRTs could not be set too high due to very hard competition in the international market. This factor, together with the high material costs due to low local procurement ratio, makes the operating profit level low, which leads to a long recovery period of investments. Further, a large number of engineers and technicians would have to be recruited, and a large number of foremen and skilled labourers would have to to be trained in a short period for the start of CRT production, which could be one of the bottleneck areas for domestic production in Malaysia.

Fig. V. 5-1 Development Scenario of the CRT Industry in Malaysia



V-5-2. Measures to Achieve the Goal of the Development Scenario

The measures which would be needed for achieving the goal of the development scenario shown in Fig.V.5-1 were examined, the results of which are summarised and shown in Fig.V.5-2. The measures would largely be divided into (1) those for the strengthening of investment promotion activities, (2) those for the elimination of bottleneck areas of production and (3) those for the improvement of financial viability of investments.

(1) Strengthening of Investment Invitation Activities

For the start of domestic production of colour CRTs which requires very sophisticated manufacturing know-how, the invitation of overseas CRT manufacturers having such manufacturing know-how is essential.

1) CRT Manufacturers Presently having Colour TV Set Assembly Plants in Malaysia

Among foreign affiliated T.V.set assemblers, there are a few companies having CRT manufacturing divisions in their companies. In order to promote the investments from these companies, the above mentioned measures for both the improvement of financial viability and the elimination of production bottleneck areas would be needed. In addition, the support for the domestic sales of their products which surpass their own demand to other manufacturers or for exports would also be effective.

2) Other Overseas Manufacturers

Worldwide, the number of companies having manufacturing know-how of CRTs is very limited. The investment promotion activities specifically targetted toward these companies should be strengthened. The supply of industrial information specific to the colour CRT industry, the dispatch of invitation missions and the establishment of better accommodation facilities of study missions from overseas manufacturers would be effective measures.

(2) Measures to Eliminate the Bottleneck Areas of Starting Production

For the successful invitation of CRT manufacturers in Malaysia, the bottleneck areas which would have a bad affect on the domestic production should be eliminated in advance.

1) Strengthening of Industrial Supporting Institutions

One of the major areas of concern for potential investors in CRT production would be the availability of a large number of engineers, technicians and skilled workers. Because the supply of these workers is not sufficient in the electronics industry in general, the expansion of educational and training facilities to supply a sufficient number of the necessary manpower would be desired.

2) Improvement of Infrastructure

The infrastructure in Malaysia is generally very highly developed, especially in such areas as transportation, power supply or water supply. However, there still remain problems in such areas as waste water discharge systems or industrial sludge disposal systems.

(3) Measures for the Improvement of Financial Viability of Investment

Basically, the profitability of the investments has to be improved through the investors' own efforts. However, the following could be considered as indirect supporting measures:

1) Increase of Unit Sales Price

The most effective measure to increase the profit level of investments would be to raise the unit sales price of products. In the actual market transactions there are around 10% of unit sales price differences according to brands. In order to set higher unit sales prices, however, the quality level of products must be admitted by customers to be higher than other competing products, for which the technical training of a wide range of production staff members covering from engineers, technicians, and skilled workers to unskilled workers is indispensable. In this field, the technical support from public institutions for quality control and improvement would be effective.

2) Upgrading of Initial Operating Ratio

In such a large-scale factory as a colour CRT plant, it is very difficult to increase the operating ratio of the plant to near the maximum production capacity. This low operating ratio of the plant in the initial stage of operation is one of the reasons weakening the financial viability of the plant. In order to upgrade the initial operating ratio at its earliest stage, the implementation of the trainings of skilled and unskilled workers as well as managerial staff members most effectively and thoroughly in a short period has to be completed.

3) Decrease of Raw Material Costs

It is most desirable to decrease raw material costs by increasing local procurement ratio in Malaysia. Because most of the parts are not multi-purpose, however, the procurement ratio would have to be increased gradually by supporting the development of local suppliers' technical level. As for CRT glass products which occupy around 40% of the total parts costs, the invitation of overseas CRT glass manufacturers along with CRT manufacturers is desired.

Even if some parts would not be procured in Malaysia, the parts costs could be lowered considerably if they are procured from such neighbouring countries as Singapore. The training of parts procurement staff members of the plant would be needed. The establishment of some public institutions to support the collection of the information relative to the procurement of parts would be welcomed.

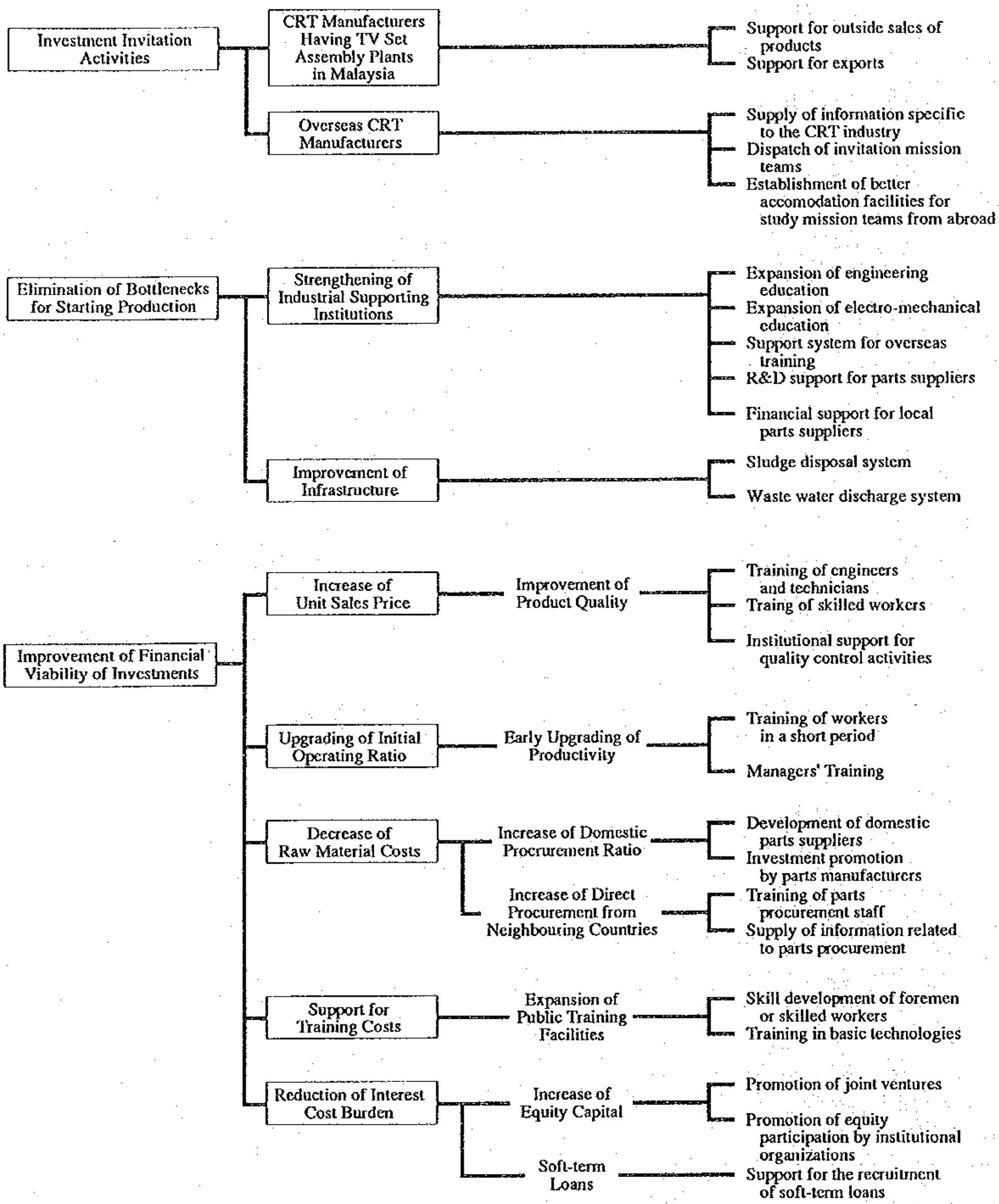
4) Support for the Employee Training Costs

In colour CRT plants, the training of a large number of production and management staff members has to be conducted at the initial stage. By implementing a part of such training in public institutions with relatively low costs, the training cost burden for investors could be lowered.

5) Reduction of Interest Cost Burden

For the establishment of colour CRT plants, a very large amount of initial investment funds is needed. In the case that most of these funds were recruited by outside borrowing, a high level of interest payment burden would lower the financial viability of the investment project. One of the measures to reduce that burden particularly in its initial stage would be to increase the volume of equity capital by gathering domestic and overseas investors. For that portion of the funds which would be beyond the equity capital, the use of some financing sources which could supply loans in a long-term and a low interest rate would be suggested.

Fig. V. 5-2 Measures to Achieve the Goal of the Development Scenario of the CRT Industry



VI. Ceramic IC Packages/Substrates Industry

VI. Ceramic IC Packages/Substrates

VI-1 Overview of the Industry

VI-1-1 Product Description

(1) Outline of IC Packages/Substrates

1) IC Packages

It is a well known fact that the IC is extremely small in size and very fragile. Therefore, in its handling by humans, even a slight touch of the finger tip might damage its circuit lines due to stains or dust. Once stained by handling, the whole function of the IC might be ruined, making it unusable.

There is a limit to direct human manipulation of the object. In short, the chip should be put in a certain size of container in order to make the chip easier to handle. Furthermore, the chip has to be electrically connected with the outer world by very thin bonding wires (one-quarter the thickness of a human hair) which are re-connected by brazing to a little bit thicker internal leads and external leads.

In order to meet the requirements as above, the IC chip is put in a container called an IC package. So to speak, the IC chip puts on its clothes. The IC package has, mainly, the following important functions.

1. To shut the chip out from the outer-world to protect it from stains and moisture which might cause damage.
2. To make it easier for humans to handle the chip owing to the adequate size of container into which the chip is put.
3. To keep mechanically the position of internal leads or external leads stable.
4. To discharge the heat generated from the IC.

The electric function and quality of the IC depends on the design and manufacturing technology of the IC chip itself, however, manufacturing technology of packages should be considered as a decisive factor in order to ensure various quality requirements of the IC such as long time usage without trouble, easy fitting on PCB (Printing Circuit Board), good heat discharge, and so on.

Therefore, manufacturing technology of IC packages plays a very important role, because a bad quality package might affect the functions of IC as a whole, leading to quality deterioration which might cause big problems.

A small IC chip of 5 mm^2 is composed of several hundred thousands of discrete devices such as transistors, diodes, rectifiers, and so on. In order to provide the ICs the full capacity of reliable and stable operation, IC packages should be protected from all types of bad effects such as the changes of temperature and moisture, dust and stains, while at the same time, conveying input and output electrical signals and discharging the heat generated from the ICs.

2) Ceramic Substrates

A ceramic substrate is a kind of ceramic board on which high density electrical circuit lines are formed by either the thick film method or thin film method. It is ordinarily used for various discrete semiconductors such as ICs, transistors, diodes and resistors, etc., to be mounted on the surface. Both surfaces of the ceramic substrate would be usable for mounting if small through-holes are punched on it.

A ceramic substrate with electrical circuit lines serves as a small circuit board. The size of a ceramic substrate ranges generally from 10mm x 10 mm to 100 mm x 100 mm.

(2) Kinds of IC Packages

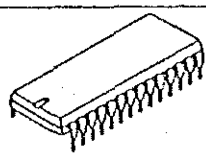
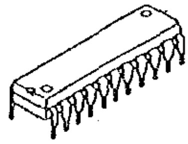
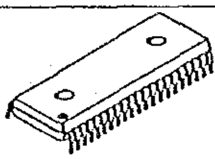
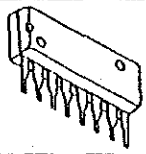
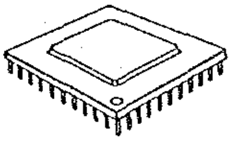
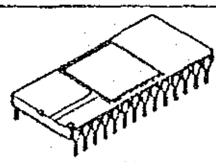
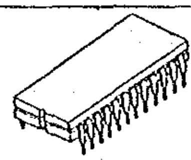
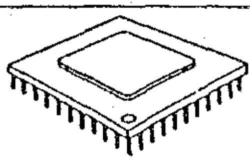
The IC packages categorised by usage of material are two types, i.e. plastic packages and ceramic packages.

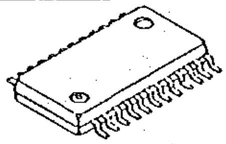
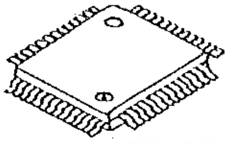
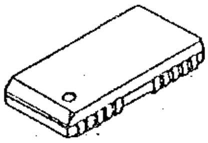
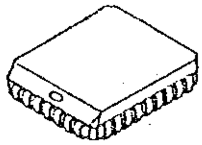
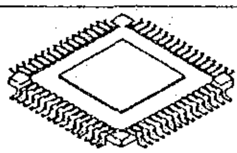
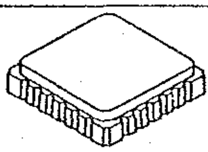
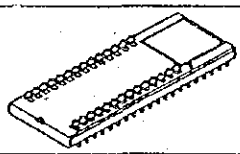
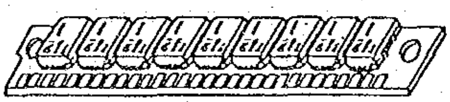
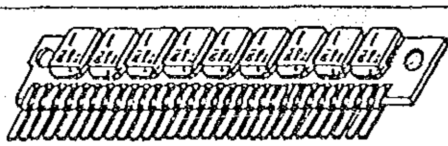
Plastic packages have been said to be inferior to ceramic packages in some characteristics of packaging such as airtightness, endurance and heat resistance. However, due to the recent progress of IC surface protection techniques and general amelioration of plastic material quality, plastic packages have expanded their share of applied usage. They have rapidly taken the place of the relatively expensive ceramic packages. Nowadays, the share of plastic packages in the total of IC packages reached about 90%. A tendency is seen among users of IC packages (IC assembly manufacturers) that they prefer to use the ceramic packages for the start of new products but soon after the stage of mass production of the product comes, they would change the package used from ceramic to plastic. At present, the usage of ceramic packages is mainly for the use for computers, satellite communications, space rockets and military use, etc., where various severe characteristics of IC packages such as airtightness, endurance, etc., are required.

Ceramic packages are categorised in general into two types i.e., cerdip packages produced by relatively simple production processes and having no printed circuit lines on them, and laminate packages. On the other hand, laminate packages are composed of multi-layers of ceramic sheets with printed electric circuit lines. As for the present market share of IC ceramic packages on a quantity basis, the cerdip type has a share of about 90% and the laminate type has 10%. As for the compared average price, the cerdip type is priced at twice that of the plastic packages and the laminate type is about eight times that of the plastic package.

The IC packages could also be categorised in two types by the method of mounting, i.e., insertion type and surface mount type.

Fig. VI.1-1 Kinds of IC Packages

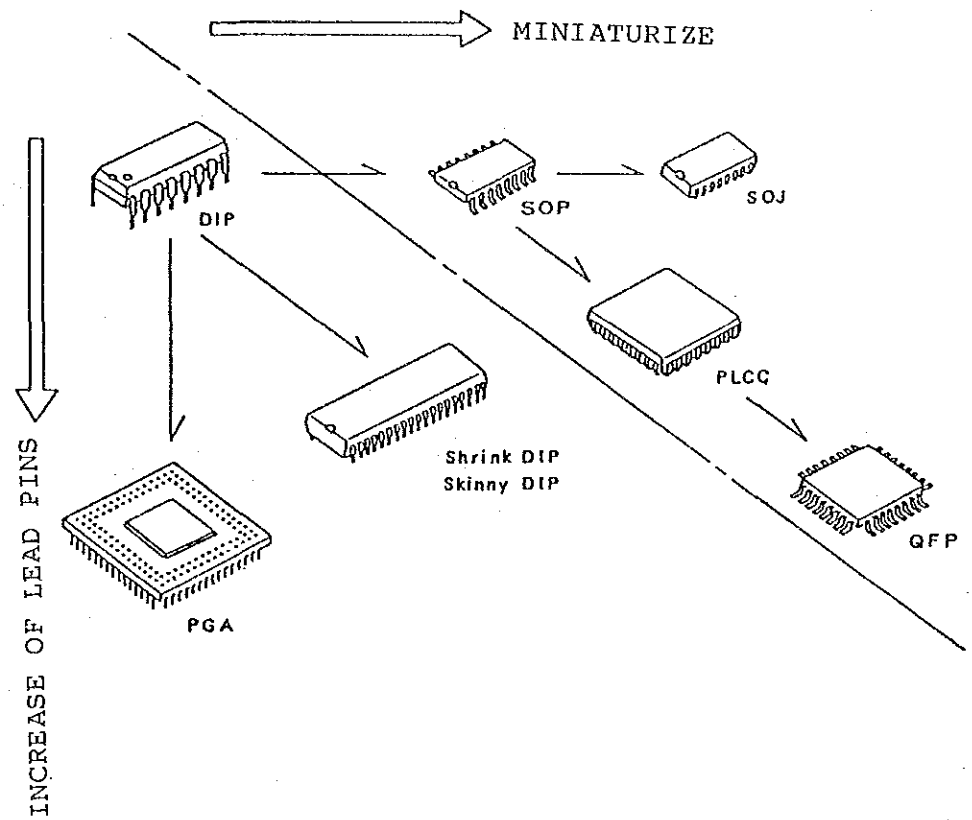
	KINDS OF PACKAGES				REPRESENTATIVE NUMBER OF LEAD PINS
INSERT TYPE	PLASTIC	DIP	STANDARD		8,14,16,18,22,24, 28,40,42,48
			SKINNY		20,22
			SHRINK		42,64
		SIP			8
		PGA			1 88,120,132,176, 208
	CERAMIC	STANDARD DIP			14,16,18,22,24,28 40,42,48
		CERDIP			8,14,16,18,22,24, 28,40
		PGA			72,88,120,132, 176,208

					REPRESENTATIVE NUMBER OF LEAD PINS
	KINDS OF PACKAGES				
SURFACE MOUNT TYPE	PLASTIC	FP	SOP		8,16
			QFP		2 3 24,32,44,56(S),56(L), 60, 64, 80, 88, 100
		PLCC	SOJ		26
			PLCC		18,20,22,28,32, 44,68,84
	CERAMIC	QFP			42,60,64,80
		CC			14,24,28,44
PARTICULAR PACKAGES	PIGGY BACK				40,42
	SIMM				30
	SIMP				30

(3) Trends of IC Packages

The conventional basic functions of IC packages have been the protection of IC chips from the outer-world and convenience of handling. The standard DIP type packages (Dual Inline Package) which satisfy these basic functions have been utilised for a long time in a wide range of electronic devices and equipment. However, because of the recent high integration and ultrarapidity of ICs in addition to the trend of miniaturisation of size and weight of electronic devices, the higher density mounting method for IC packages has been increasingly required.

Fig. VI.1-2 Trend of IC Packages



VI-1-2 Outline of the Semiconductor Industry in Malaysia

(1) Trends of Production

In the Malaysian statistics, the production of semiconductors in Malaysia is categorised as MIC 38329 including semiconductors, other electronics parts and communications equipment. Therefore, the statistical figures related to the semiconductor industry itself are not shown clearly. The trend concerned with the MIC 38329 for the past five years (January-August in 1988) is shown in Table VI.1-1. The sales value of the category MIC 38329 occupies about 78.5% of total sales value of MIC 383 (Electric Electronics Industry) in 1988. The employees in the category MIC 38329 are 77,2% of the total employees in MIC 383. These figures indicate that the category MIC 38329 has a very important position in the Malaysian electric and electronics industry.

In the semiconductor industry, there is a peculiar worldwide trend of demand and supply, the so called "Silicone Cycle." The year 1985 was a period of stagnation in the cycle of worldwide scale. In Malaysia, too, the sales value of the year 1985 was down by 12.5% compared to the previous year. In the year 1986, however, the sales value surpassed the level of the year 1984, the highest level at that time. Afterwards, steady increases' of 31.8% (1987) and 46.2% (1988, Jan-Aug) have been achieved and productions continue to expand.

The production volume of semiconductors in three categorises i.e., transistors, ICs, and another semiconductors,is shown in Table VI.1-2.

Table VI. 1-1 Principal Statistics of Semiconductors and Other Electronic Components and Communications Equipment and Apparatus (MIC 38329) in Malaysia

	1984	1985	1986	1987	1988 (Jan.-Aug.)
Number of Companies	56	54	55	63	66
Sales Value (M$1,000)	5,369,512	4,771,037	5,694,325	7,506,916	6,536,220
Total Persons Engaged	68,717	53,354	57,459	71,344	80,562

Source: Monthly Industrial Statistics

Table VI. 1-2 Production of Semiconductors in Malaysia

(Unit: Million Pcs.)

	1984	1985	1986	1987	1988 (Jan.-Aug.)
Transistors	3,831	3,450	3,719	4,714	3,640
(%)	(47.5)	(Δ9.9)	(7.8)	(26.8)	(21.7)
IC	3,874	2,561	3,278	3,911	3,105
(%)	(44.1)	(Δ33.9)	(28.0)	(19.3)	(23.9)
Other Semi-Conductors	2,011	1,468	1,554	1,953	1,468
(%)	(26.2)	(Δ27.0)	(5.9)	(25.6)	(19.1)
Total	9,716	7,479	8,551	10,579	8,213
(%)	(12.0)	(Δ23.0)	(14.3)	(23.7)	(22.0)

Figures in brackets are annual percentage changes.
Source: Monthly Industrial Statistics

(2) Export Trend

The export trend of semiconductors is shown in Table VI.1-3. It is noticeable that the export of discretes, especially diodes, has decreased while that of ICs has increased. The ratio of ICs in the export share of semiconductors went up from 48.1% in 1983 to 84.2% in 1987.

Table VI. 1-3 Exports of Semiconductors in Malaysia

(Unit: M$1,000)

	1983	1984	1985	1986	1987
Transistors (SITC 776 310)	364,197	429,310	377,702	379,081	533,617
Diodes & Similar (SITC 776 390)	1,265,441	1,023,810	371,310	553,457	395,773
Electronic Micro-circuits (SITC 776 400)	1,526,224	2,599,782	3,158,799	4,066,732	4,956,511

Source: Malaysia Annual Statistics of External Trade.

Export destination for each product in 1987 is as follows.

Transistors:	1.	U.S.	(30.2%)
	2.	Singapore	(26.2%)
	3.	W.Germany	(14.9%)
	4.	Others	(28.7%)

Diode & similar semiconductor devices:	1.	U.S.	(49.9%)
	2.	Singapore	(25.8%)
	3.	W.Germany	(8.9%)
	4.	Others	(15.4%)
Electronic microcircuits:	1.	U.S.	(57.9%)
	2.	Singapore	(10.8%)
	3.	W.Germany	(9.1%)
	4.	Others	(22.2%)

For all the products, the U.S. is the largest export destination country. The fact is that Malaysian semiconductor manufacturers do not have their own sales companies in Malaysia and they export most of the products to their parent companies in the U.S.

(3) Present Status of Procurement of Raw Materials

The survey was conducted on the manufacturers who are assumed to use ceramic IC packages and/or ceramic substrates. MIDA had already conducted a survey on the domestic demand for ceramic IC packages in 1981 which was followed by another general survey in 1986 concerned with the Malaysian semiconductor industry. A survey on the procurement of raw materials was also included in the MIDA survey in 1986.

In order to select the manufacturers to visit for the field survey this time, the data obtained from MIDA's two previous surveys, information provided from NGK Singapore office, and other public information from PDC (Penang Development Corporation), etc., were used for reference. As the result, 12 companies are identified as users' of ceramic IC packages. However, the information on their use of ceramic IC packages was provided by 10 of the companies out of the 12, the names of which are listed in Table VI.1-4 with the description of their business outlines.

The contents of the survey were concerned mainly with volume of demand for ceramic IC packages and substrates, supply sources, purchasing methods, and desires for local procurement etc. The information on these matters shown in this report, accordingly, is the summary of the present status of the selected semiconductor manufacturers covered by the field interview survey, and not of the whole semiconductor manufacturers in Malaysia.

The rate of local procurement of materials at the IC manufacturers is generally at a very low level. (The lowest is 0.1% and the highest is 20%). Locally procurable items are ralatively minor consumables such as shipping tubes and carton boxes etc.

Table VI. 1-4 Outline of Semiconductor Manufacturers in Malaysia

	Company	Year of Establish-ment	Location	No. of Employees	Annual Sales Value (87)	Parent Company Nation-ality	Main Products Manufactured	Production Volume (million pcs)	Usage of Ceramic Packages/Substrates	
									Packages	Substrates
1	Intel Technology	1972	Penang	2,600	M$140m	U.S.A.	IC (Memory, MPU)	90	YES	—
2	Harris Semiconductor	1974	KL	874	—	U.S.A.	IC (Telecom, Lines, Memory, MPU)	16.1	YES	—
3	SGS-Thomson	1974	Johor	2,250	US$150m (88)	Italy	IC (Bipolars, Logic Memory)	700	YES	—
4	Motorola	1974	Penang	1,800	—	U.S.A.	IC (Hybrids)	—	YES	YES
5	Carsem	1972	Ipoh	2,400	—	Malaysia	IC, Transistors	9.6	YES	—
6	Motorola	1972	Petaling Jaya	4,000	M$500m	U.S.A.	IC (Memory, Digital, Analog Gate Array)	—	YES	—
7	Integrated Device Technology	1988	Penang	200	US$200m	U.S.A.	IC	6-8	YES	—
8	Advanced Micro Devices Export	1972	Penang	4,800	US$250m	U.S.A.	IC (Digital, Memory, MPU)	783.4	YES	—
9	Siemens Litronix	1972	Penang	732	US$18.8m	U.S.A.	Opto Isolation Processed Dies	49.3	YES	—
10	Motorola		Senawang	500	—	U.S.A.	Components for RF, IC	—	YES	—

Meanwhile, the IC chips as a major material are all imported because the wafer printing process (so called "first half process") is not yet available in Malaysia at present. Import sources are mostly from their parent companies situated near the final users of the assembled ICs (the final products). Except for lead frames, other major components and materials such as bonding wires, moulding compound, ceramic packages/substrates are not locally produced and all of them are imported.

Present status of material procurement is shown briefly in Table VI.1-5.

Table VI. 1-5 Main Suppliers of Materials and Components

Items*	Local Product	Name of Main Suppliers
Leadframes	Yes	DCI, KITAKO (Malaysia) Mitui Hitech (S'pore) Sumitomo Metal (Japan) SPT (US), QPL Holdings (HK)
Bonding Wires	No	Tanaka Electronics (S'pore) American Fine Wire (S'pore)
Moulding Compound	"	NITTO (Japan) NIHON DENKO (Japan) Plaskon (S'pore) Sumitomo Bakelite (Japan)
Combo Lids	"	Simi Alloys (US) Advanced Material Technology (US) Richard Metal (US)
Preforms	"	Cominco (US) Advanced Material Technology (US)
Metal Cane & Headers	"	Oro Electronics (HK) Shinko Electric (Japan)
Tin Anode	Yes	Emis (Malaysia), Multicore (Malaysia)
Solder Bar	"	Multicore (Malaysia)
Shipping Tubes	"	PPM (S'pore) Ampang, Kamejuam, Meritex (Malaysia)

*Excluding Ceramic IC Packages/Substrates and IC Chips

VI-1-3. Supply and Demand of Ceramic IC Packages/Substrates in Malaysia

(1) Demand for Ceramic IC Packages in Malaysia

The total annual volume of ceramic IC packages used by the 10 companies in 1987 was about 142.8 million pieces. (cerdip type; about 108.0 million pieces, laminate packages: about 34.8 million pieces). Total annual value is assumed to be about M$193.2 million (cerdip type; about M$54.0 million, laminated packages; about M$139.2 million). As for demand in value, most of the companies surveyed could give the demand in volume basis, and the total demand in value was estimated assuming unit price for each product. The average unit price of the cerdip type is assumed to be M$0.50/piece and laminate packages to be M$4.00/piece in Malaysia.

Among ceramic packages, cerdip packages occupy a higher share of 75.8% in total volume, however, the demand for laminate packages is said to be increasing more rapidly than that of the cerdip type in Malaysia. As for the volume used by each company surveyed, AMD, INTEL, MOTOROLA (Selangore) and HARRIS were the top 4 users in that order. The volume used by the other companies surveyed was limited.

IC products which use ceramic packages occupy about 3.7% of the total quantity of IC products in Malaysia in 1987.

(2) Demand for Ceramic Substrates in Malaysia

Only one company was identified as the user of ceramic substrates in Malaysia.

The usage of ceramic substrates covers extensive fields such as home electric apparatus, communication equipment, audio equipment, etc. In Malaysia, the ceramic substrate which is actually used or purchased is the circuit printed substrate. Furthermore, in many cases the users purchase the ceramic substrate as an electronic component with various types of discrete devices such as resistors, capacitors, ICs, etc., mounted on it.

There are only a few companies in Malaysia who are undertaking the mounting process of discrete devices on the ceramic substrates. In the case of PCBs (Printed Circuit Boards), too, companies in Malaysia import all of the PCBs and just assemble them.

As a result of this field survey, one company (MOTOROLA in Penang) is identified as the only manufacturer who possesses the process of printing circuit lines on ceramic substrates in Malaysia. They produce hybrid ICs for use in pocket-bells, walki-talkies and 2 way radios. The ceramic substrates used by the company in 1988 amounted to 375,000 sheets (4x4 inches/sheet). The annual value of the substrates ceramic used by the company went up steadily from M$325,000 in 1986, to M$360,000 in 1987 and M$460,000 in 1988.

Table VI. 1-6 Domestic Demand for Ceramic IC Packages/Substrates in Malaysia (1987)

	Quantity (Million Pcs.)	Value (M$ Million)
Ceramic IC Package	142.8	193.2
Cerdip Type	(108.0)	(54.0)
Laminate Type	(34.8)	(139.2)
Substrate	0.375	0.36
Total	-	193.56

(3) Major Suppliers

As there are no manufacturers who produce ceramic IC packages and or substrates, all the products are imported.

Major supply sources are shown as follows:

Kyosera	(Japan)
NTK	(Japan)
Narumi	(Japan)
General Electric	(U.S.A.)
Shinko	(Japan)
MPI	(Singapore)

The market share for each company is not clear but the shares of Kyosera and NTK are said to be larger among others.

Each semiconductor manufacturer chooses more than two supply sources for the advantage in price negotiations as well as to avoid risk. All the companies interviewed replied that supply sources once chosen would not be changed so easily or frequently.

(4) Method of Purchase

All the companies selected for the field survey this time, except CARSEM, are 100% foreign capitalised. For those companies, their parent companies in principle make the decisions as to supply sources and the purchase quantity of raw materials as well as on product items and volume. However, there are some companies among them who can decide on product items to be purchased up to 50% of the total purchase volume. There are also some companies who are negotiating at present so as to obtain from their parent companies the right of purchase decision making. It seems to be a general trend for each of the Malaysian semiconductor manufacturers to possess the self-decision of the purchase.

In order to decide on the purchase of products from a new supply source, a fairly complicated and long experimental process is necessary. In such a case, the approval of the qualifications shall be conducted by the parent companies. However, each Malaysian semiconductor manufacturer interviewed, does, at least, its proposals for the next purchase order. They said in the interviews that they thought in that sense, they already shared a "co-decision right" with their parent companies.

(5) Demand Trend for the Future

Many of the companies interviewed predicted that the demand for ceramic IC packages would be stable for years to come and immune to the effects of the adverse economical cycles owing to the peculiarity of the fields where they are used.

The volume of demand for ceramic IC packages in Malaysia identified in section VI-1-3(1), compared with those of MIDA survey in 1981 and 1986, is shown in Table VI.1-7.

Table VI. 1-7 Domestic Consumption of Ceramic IC Packages

	1978	1979	1980	1986	1987
Volume (Million Units)	69.3	92.2	145.6	147.4	142.8
Value (M$ Million)	102.6	128.8	156.8	120.7	193.2

Although direct comparison of the values used in each year is impossible because of the assumption made in the year 1987, as far as volume is concerned, it can be said that the rate of increase of the ceramic IC packages on a quantity basis has continued to go down from the beginning of the 1980s. The main reasons are as follows.

- They are more expensive than plastic IC packages
- Automation in the manufacturing process is more difficult than that of plastic packages.

- Owing to the rapid quality amelioration of plastic materials, the characteristics such as heat resistance and endurance have been improved to the level of ceramic packages.

It is also noticeable that the share of the cerdip type in the market of ceramic packages in gradually shrinking, partly because of the alternative of plastic to ceramic in the cerdip types of packages. In addition, the higher density integration of the IC itself requires increasingly the types of laminate ceramic packages with many lead pins such as PGA, FLAT type, and so on.

VI-1-4. Advantages of Local Production of Ceramic IC Packages/Substrates

Each company surveyed shows keen interest in the local procurement of raw materials. The locally procurable items are minor materials such as solder bar and shipping tubes, etc. The highest rate of local procurement given by the companies surveyed is 20%. All of them desire an increase in local procurement including the ceramic IC packages for which all of them expressed their intentions to purchase when domestic production is realised.

Most companies surveyed consider quality as the most important factor among the three factors, quality, price and delivery, itemised for the selection of supply sources. However, the advantage of the nearness of supply sources seems to be highly recognised by most of them judging from the replies given by some companies who regard also delivery, location and various services as important factors in addition to quality and price. The wording "just in time" seems the most proper expression of their preference for the nearer supply sources. Many companies interviewed expressed their efforts to achieve "just in time" supply. Their ordinary duration of the stock ranges from 2-3 months at the longest to 2 weeks at the shortest. Because of the irregular orders from the parent companies and the many varieties and frequent changes of specifications, their desires to have the parts suppliers in the vicinity were strongly expressed for the sake of "just in time".

The necessity of supporting industries, mainly such as the parts suppliers, is widely recognised. There are many companies who are providing advisory assistance to their vendors concerning the managerial and/or technical areas. As the most typical case, MOTOROLA has adopted a so called "SPC Method" (Statistical Process Control). The method is for the purpose of achieving the realisation of standard manufacturing processes. MOTOROLA applies the method not only for in-house execution but also to each supplier, demanding the amelioration of the production process under their inspective guidance. According to MOTOROLA, the SPC method is based on the concept that good quality leads to mutual development. The semiconductor manufacturers in Malaysia expressed good-will feelings of welcome for local production of IC ceramic packages not only from the delivery and /or quality point of view but also from the point that cost competitiveness and quicker services could be expected.

The domestic demand for ceramic IC packages was about 142.8 million pieces in 1987. This volume is 2.4 times the size required for minimum economical production (i.e. 60 million pieces per year) for a single ceramic IC package manufacturer. Therefore, there will be no problem as to the market size for the local production of ceramic IC packages in Malaysia. However, as far as ceramic substrates are concerned, the local market in Malaysia is extremely small because the number of local users is limited. The largest market in the world for ceramic substrates is Japan. Export to the Japanese market is almost impossible when the extremely hard competition and the extra transportation costs are taken into consideration. Therefore, there would be small advantage to local production of ceramic substrates in Malaysia.

VI-2. Present Status of the Industries Related to the Domestic Production of Ceramic IC Packages/Substrates in Malaysia.

VI-2-1. Outline of the Production Process of Ceramic IC Packages and Substrates

(1) Ceramic Substrates

The outline of the manufacturing process and the raw materials & consumables required for ceramic substrate production are shown in Fig. VI.2-1.

Fig. VI. 2-1 Process Flow & Raw Materials Used for Substrate Production

PROCESS		MATERIALS & CONSUMABLES
Material inspection	Material inspection	Al_2O_3, Glass Powder Binder, etc.
Blending	Glass blending	Organic solvent
Sheet casting		
Punching		Punching die
Pre-baking		
Firing		Setter & Platform car
Grinding		Diamond grinding wheel
Snap-lining		
Glass printing		Screen mask, Organic solvent, etc.
Glass firing		
Inspection		
Delivery		Tray

A. Material Inspection and Blending of Raw Materials

The main materials such as Al_2O_3 or organic solvents after having passed the material inspection proceed forward to the milling and blending stage.

Except for ordinary organic solvents such as toluene, mathyle-ethyle-ketone, etc., it is difficult to change the composition of such main materials as Al_2O_3or other materials of extremely small quantity such as $Fe_2O_3$and molybdenum because the change has a great affect on the ceramic characteristics such as anti-shock, bending moment, thermal conductivity, electric insulation, etc. For the change of composition, it would take several months for testing, and acquiring the qualification approval from users would take a further several months.

At this stage of blending, the raw material is in liquid form and is called "slurry".

B. Sheet Casting

The slurry is developed by doctor blade onto the carrier film in equal thickness and dried and cut off into the required size. This cut-off portion is called a "sheet". The sheet could either be white or green in colour. Normally the thickness is about 0.2-1 mm. White sheet is used for white-coloured substrate and green sheet for black-coloured substrate.

C. Punching

The next process is the punching of holes in the sheet by a punching die. In some cases, snaplines are punched on the sheet at the same time by using the same punching die. Generally speaking, ceramic shrinks by about 20% after firing. The shrunken size is the actual size of the final ceramic product.

In order to maintain the exact size of the product after firing, the design of the punching die is a very important factor.

As to the punching die, the permissible tolerance of diameters of holes, widths of snaplines, relative positions and pitch distances between holes and/or snaplines is only ±0.02 mm.

The punching die can be manufactured in two different ways. One way is in-house production and the other is the use of sub-contractors. In both cases, equipment such as EDM (Electric Discharge Machine), wire-cut EDM, etc., is used.

The punching die is a very important tool because its precision directly affects the product quality.

D. Pre-Baking & Firing

Before firing, a pre-baking process is undergone in order to remove the organic solvents and binders from the ceramic sheet by using the method of heat resolution.. Then the sheet is fired at about 1,500°C in an oxidisation atmosphere. (Firing temperature may be different according to various materials.) The interior of the firing furnace is generally tunnel-shaped with a wall of many fire bricks.

All through the firing process, platform cars and various sizes of setters (a kind of weight for pressing) made of firestones are used as auxiliary materials. Fire bricks once placed in the wall would be changed very rarely but those firestones used for platform cars or setters are consumables because of the damage and wear and tear caused by repeated exposure to the frequent and extreme changes of temperature.

E. Grinding

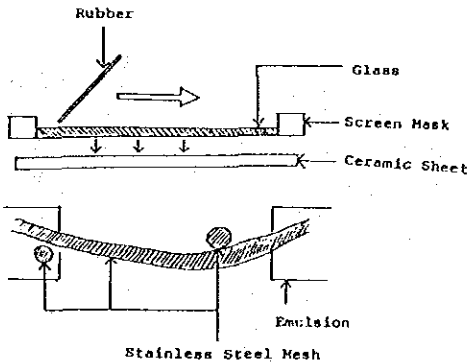
Depending on the specification of each product, the grinding process requires a very severe dimension control capability. Therefore, according to the specifications for outer dimension, thickness, surface roughness, etc., a plain grinding machine equipped with a diamond wheel is used. The diamond grinding wheels are also deemed consumable materials.

F. Snap-lining

The snap-lining process is for the purpose of easy-separation of each sheet in the later process. They look like squares in a bar of chocolate. The snap lining of the ceramic substrate is done by either the substrate makers themselves or at the users side.

G. Glass Printing

In many cases, ceramic substrates are also used without glass printing. The process of glass printing is similar to those for cerdip or laminate packages. In the case of laminate packages, the printing paste mainly consists of tungsten ink compared to the glass paste used for substrate or cerdip packages. A common characteristic of printing in those three types of ceramics (i.e. substrate, cerdip, laminate package) is the usage of a screen mask as shown in the drawing.



The screen mask is of stainless steel mesh tightly set in an aluminium frame. The stainless steel mesh is painted by emulsion with mesh holes corresponding to various patterns to be printed on the surface of the ceramic substrate. For the screen mask printing, a red film must be very accurately cut according to the required pattern to be printed. The red film is of about ten magnifications which has to be reduced by very accurately controlled camera-work to the actual size of each substrate. The reduced film is for the use of the repeater machine in order to make the original film. And an original film which contains many of the same patterns is produced so that a ralatively large number of substrates are to be printed at the same time on the same sheet. These original films or screen masks would be either in-house production or ordered from sub-contractors.

H. Glass Firing, Inspection and Delivery

The final manufacturing process is glass firing, and after inspection, the product is delivered to the users.

(2) Cerdip Type of Ceramic IC Package

The outline of the manufacturing process and raw materials and consumables required for cerdip type ceramic package production are shown in Fig. VI.2-2.

Fig. VI. 2-2 Process Flow & Raw Materials Used for Cerdip-type IC Packages

PROCESS		MATERIALS & CONSUMABLES
Material inspection ↓	Material inspection ↓	Al_2O_3, Glass powder Binder
Blending ↓	Glass blending (→ Glass printing)	Organic solvent
Making powder ↓		
Powder press ↓		Press mould
Firing ↓		Setter & Platform car
Dotting of D/A material ↓		D/A (Au, Ag-Pd, Ag-Pt, etc.)
Grinding ↓		
Glass printing ↓		Screen mask, Organic solvent
Glass firing ↓		
Inspection ↓		
Delivery		Tray

A. Material Inspection, Blending & Making Powder

Until the slurry stage, all the manufacturing processes are the same as those of ceramic substrate. The slurry is made into powder by a spray dryer and is pressed by a powder press machines into the required form. The powder press mould requires extremely accurate precision in the fit of the male and female moulds. Even a tiny chink between them may invite an unwelcome intrusion of the powder causing the product to be unusable. Therefore, the required fit tolerance of the moulds is on the micron order.

B. Firing

Ceramic plate formed by the powder press is fired in an oxidisable atmosphere.

Unlike the case of ceramic substrates or laminate ceramic packages, no special process of heat resolution is required for cerdip type packages. However, as in the case of the ceramic substrate, platform cars and setters are required as consumable materials. The edges of the pressed ceramic are very sharp and have a kind of stingers so small in size as to be on the micron order, which are often caused in the moulding process,, For prevention, fired ceramic plates are put in a barrel grinding process in many cases.

C. Dotting of D/A Material

The process of dotting the die attach material shall be applied only to the lower base of the cerdip and not to the upper cap of the cerdip. The place of dotting is where the die (IC chip) shall be attached later on. The materials for attaching the die are Au, Ag-Pt, Ag-Pd, Glass, Ag-Glass, etc., which also serve as bonding agents.

D. Glass Printing and Glass Firing

The processes of both glass printing and glass firing in ceramic packages are the same as in the case of ceramic substrates. A screen mask is also required as in the case of the ceramic substrate. However, the tolerance of precision required is not so severe (±0.03 mm). Glass printing must be repeated several times until the required thickness is attained. Normally repetition about 2 to 4 times would be enough for this purpose. As the glass printing serves the purpose of sealing the IC chip, the control of the thickness (i.e. volume of sealing glass) must be conducted with careful attention. For this purpose, the thickness control of the emulsion to be painted on the screen mask is an important factor.

As to the lower base of the cerdip package (base ceramic), the process of leadframe attachment could be conducted either by the ceramic package makers or the IC assemblers. Generally speaking, IC assemblers conduct the process in many cases.

Thus, the finished cerdip product (upper cap and base ceramic) could be shipped out to the users after inspection.

(3) Laminated Ceramic Packages

The outline of the manufacturing process and raw materials and consumables required for production of laminate ceramic packages (DIP type) are shown in Fig. VI.2-3.

Fig. VI. 2-3 Laminated Package Process Flow & Raw Materials

Process		Materials & Consumables
Material Inspection ↓	Material Inspection ↓	Al_2O_3, Binder
Blending ↓	Paste Blending ↓ (to Circuit Printing)	Tungsten Organic Solvent
Sheet Casting ↓		
Punching ↓		Punching Die
Circuit Printing ↓		Screen Mask, Organic Solvent
Laminating ↓		Organic Solvent
Cutting ↓		
Chamfering ↓		
Side Printing ↓		Screen Mask, Organic Solvent
Firing ↓		Setter, Platform Car, H^2, N^2
Ni Plating ↓		Acid, Alkali, $NiSO^4$, $NiCl^2$
Brazing ↓		Leadframe (Ag-Brazing)
Ni, Au Plating ↓		Acid, Alkali, $NiSO^4$, etc.
Inspcetion ↓		
Delivery		

A. Material Inspection, Blending, Ink Blending and Sheet Casting

The process from material inspection to sheet casting is almost the same as that substrates.

B. Punching

Cavity portions and vertical holes are made by using a punching die. The holes in the sheet are called "Via Holes" or "Through Holes." The purpose of these holes is for electric conduction between the layers of the package.

The diameter of holes differs according to the usage, the size and density of circuit lines of the package, and is so small as to range from 0.1 mm to 0.4 mm.

The punching pin is for punching out a small hole and is very difficult to manufacture to ensure frequent usage. The punching pin is easily broken due to its smallness. Furthermore, the punching die with such a large number (several hundreds to several thousand pieces) of pins with a small diameter is also difficult to manufacture.

C. Circuit Printing (Metallisation)

Each layer of the laminate package shall be provided with circuit printing (metallisation). The layers are laminated in the later process for integration into a whole circuit line. It is not similar to the case of the PCB (Printed Circuited Board), which is a single-layer, because the laminate package is multi-layered, composed of a 3- dimensional circuit.

The paste for circuit printing is mainly composed of tungsten. The circuits serve to connect the electric terminals of the IC chip and the external lead of the package. Careful attention should be given in the circuit printing because the width and the thickness of the circuit affect greatly the electric characteristics such as resistance, capacitance, inductance, etc. The process of circuit printing requires the usage of a screen mask. The screen mask is produced in the same way as in the case of the substrate and cerdip package but a more severe precision of the screen mask is required for the laminate package. It is absolutely required that the tolerance of line width should be ±0.01 mm and that of relative position should be ±0.02 mm. In addition, the sharpness of the sectional edges of the emulsion is a very important factor.

D. Laminating

The printed circuit layer shall be laminated. Mixed oil, mainly composed of organic solvents, shall be used as an adhesive agent. The surface of each layer shall be melted shallowly and laminated by heat and pressure. As with the process of screen printing as stated in the case of substrates, a sheet contains many pieces of packages. Generally, each layer of the sheet could be laminated at the same time to produce a large quantity of laminate packages at one time.

E. Cutting and Chamfering

The process of cutting is to cut off many pieces of packages from the laminated sheet. At this stage, the laminated sheet is still soft enough to be cut off easily by an ordinary kind of blade.

The soft ceramic package after the cutting has very sharp sectional faces and edges which would cause chipping and cracking in the later process. To prevent this, chamfering shall be done at this stage in the same way as cutting.

F. Side Printing

The side printing serves the role of connector between internal leads and external leads.

G. Firing

The furnace is a combination pre-baking furnace and firing furnace. As explained in the case of ceramic substrates, the pre-baking furnace is of an oxidisable atmosphere type and a relatively lower temperature can be used. Meanwhile, the firing furnace is of a high temperature deoxidisable atmosphere type and saturated with H_2 and N_2 gases which prevent the printed paste of the circuits (Tungsten)from oxidising.

H. Ni plating

Ni plating is done as a preparation process for the later process of Au plating. The flow of brazing material in the brazing process is promoted by the Ni plating. As is the general case of plating, degreasing and acid dip for pre-treatment solution is required in this stage.

I. Brazing

The process of connection between the ceramic and the lead frame which has passed inspections, Ag. Cu alloy is most often used. Eutectic brazing material

(Ag 72%) with lowest melting point could be used as well as brazing material (Ag 85%) with a relatively higher melting point, according to usages.
Lead frames (KOVAR or 42 Alloy) used for plastic packages and cerdip packages could also be used for laminate DIP packages.

J. Au plating

The final process is that of Au plating. Au is chemically a very stable material and has excellent electric characteristics, therefore, it is frequently used for laminate packages. There are other plating materials such as Cu, Sn, solder, etc., for special usages such as mother board but the quantity used is very small. The composition of the Au plating solution is very delicate and requires extreme purity. The thickness of Au plating requires very strict control because Au is very expensive and the thickness itself greatly affects the yield of wire bonding.

K. Cutting, Inspection and Delivery

The connected portions of the package which are unnecessary are cut off by a diamond cutter. The connection has served an electrical purpose in the Au plating process. The connection becomes unnecessary after the plating has been conducted.

The laminate packages which have completed all the processes are forwarded to the final inspections and are delivered to the IC assemblers.

VI-2-2. Overview of the Related Industries in Malaysia

(1) General

In order to manufacture ceramic packages and substrates, many production processes are required as has been seen in the preceding paragraphs. For the manufacturing of punching dies and/or powder press moulds and the process of glass printing, Japanese ceramic package manufacturers utilise sub-contractors in many cases. Of course, if such sub-contractors are not available, they would have no choice but in-house manufacturing, in which case, there would be problems such as a big investment burden and time-consuming personnel development. Therefore, the survey in Malaysia was conducted from the view point of the availability of such mould and die manufacturers and glass printing companies.

As a result of the survey, the mould and die manufacturers who are capable of making the punching dies and the powder press moulds with enough precision to support the manufacturing of ceramic packages and substrates were found to exist. However, printing companies with the required capacity for glass printing could not be found at present in Malaysia.

(2) The Mould and Die Industry

The mould and die industry in Malaysia is rapidly developing as a peripheral industry of the semiconductor industry. The plastic moulding for plastic IC packages and the punching dies for lead frames could be taken as examples.

As stated in the preceding paragraphs, the precision punching dies and powder press moulds are necessary tools for the ceramic IC package production. With these, the production processes of ceramics before the firing stage are relatively easy because at those stages the ceramic sheets are soft and the ceramic powders are not difficult to form.

The survey conducted this time is limited to those technically top-level mould and die manufacturers located in the Free Trade Zones because they are considered as the manufacturers who are capable to meet the requirements of ceramic package production, judging from the survey results of last year on the mould and die industry in Malaysia.

The present situations of the mould and die manufacturers surveyed in the FTZ are as follows:

1) Designing

Except for one case which is a company technically joined with a local company, the other manufacturers (fully foreign capitalised) have been equipped with CAD systems for designing and have accumulated comprehensive know-how of technical applications in designing.

2) Machinery and Equipment

Much machinery and equipment such as NC EDM (Electric Discharging Machine), NC lathe and dimensional measurement equipment, rooms for measurement and calibration, CAD systems for designing, etc., are satisfactorily available at the manufacturers surveyed at this time. Satisfactory manners of usage of the equipment was also indentified.

3) Drawing and Working Standards

The range of tolerance for the parts and the moulds and dies of the manufacturers surveyed at this time is from 0.002-0.005 mm which could be considered as the tolerance of precision high enough for the manufacturer of punching dies for the laminate packages and/or the substrates.

Judging from the above 1), 2), 3), most of the mould and die manufacturers surveyed in the FTZ could be said to be capable enough for the manufacturing of moulds and dies for IC ceramic packages.

Findings of specific problems could be summarised as follows:

a) They have no actual experience in manufacturing powder press moulds.

As mentioned in the preceding paragraphs which explain the production process of the cerdip packages, powder press moulds are required for them.

In the case of punching dies to be used for substrates or laminate packages, the tolerance of fitness would be not so severe (about ±0.01mm). On the contrary, in the case of powder press moulds, the tolerance of precision in the fitness between female and male moulds is extremely severe because even the smallest misfit might invite the powders in the slit between the moulds and cause the cerdip packages to be unusable.

b) They have no experience in manufacturing the extremely small punching pins.

As mentioned in the preceding paragraphs, in the case of laminate packages, for the purpose of electric conduction, very small holes (0.1-0.4 mm of diameter) must be punched through the sheet by a punching die with many punching pins.

Therefore, extreme difficulties for the makers who have experience in manufacturing only punching pins of more than 0.6 mm in diameter could be assumed.

Such specific problems as the above a) and b) could be resolved by technology transfer, technical training and technological guidance, etc.

(3) The Printing Industry

As stated in the preceding paragraphs as to the processes of laminate package production, there is a process of circuit printing called "metallisation". For the process, a screen mask is required. The circuits serve the electric conduction between the electric terminals of the IC chip and the external leads through the area where the terminals are wire-bonded with aluminum wires. The conduction is composed mainly of tungsten and is in the state of paste. At this stage the connection is not electrically conductive but after being fired in the later process, it becomes electrically conductive.

Further, the glass to be printed on the surface of substrates or used as sealing glass for the cerdip packages should also be printed with the use of a screen mask. The printing glass is made by mixing powdered glass and organic solvents into the state of paste. For the laminate packages, a screen mask is also used. The required precision for the screen mask for the use of laminate packages is ±0.01 mm in line width and ±0.02 mm in both the relative pitch and the total pitch. Meanwhile, for the cases of substrates and cerdip packages, the required precision is ±0.03mm.

When the required precision for the screen printing mentioned above is taken into consideration, no Malaysian printing company could be said to be adequate at present to serve as a supporting industry in the production of ceramic IC packages and substrates.

In Malaysia, there are some printing companies which are conducting printing with the use of screen masks called "silk screen mask." As a result of the field survey this time, the silk screen masks which they use are found to be inadequate from such view points as precision or volume control of paste, etc. There are also some film companies to produce original films for the use of off-set printing but these companies are not available as the suppliers of original films for the screen masks to be used for the production of IC ceramic packages and substrates because they lack the required precision of the micron order.

The measures of solution of the specific problems as above stated are listed as follows in the order of possibility.

1) To procure from Singapore (Screen masks for the use of circuit printing for substrates are available in Singapore).
2) Manufacturers of IC ceramic packages themselves would produce the original films and the screen masks.

3) To introduce the required equipment to Malaysia and technically tie-up with the original film companies and/or the silk screen printing companies in Malaysia in order to develop the supply sources.

4) Film companies and/or screen mask manufacturers of USA and/or Japan should be established in Malaysia.

VI-2-3. Feasibility of Procurement of Raw Materials and Consumables

(1) General

Many kinds of raw materials and consumables are required in the manufacturing process of ceramic packages and substrates.

The results of the field surveys which was conducted regarding the availability of local procurement of raw materials and consumables in Malaysia are as shown in Table VI. 2-1 and Table VI. 2-2.

Table VI. 2-1 Raw Materials and Consumables Available in Malaysia.

Raw materials & consumables		Remarks
Moulds & Dies	Punching die	Small punching pins
	Powder press mould	Fitness
Organic solvents	Acetone Toluene Xylene M.E.K. 1.1.1. Trichlor-ethylene Trichlor-ethylene N. butanol	Other ordinary organic solvents are available
Gases	H_2 N_2 NH_3	
Firestone	Platform car Setter	
Inorganic substance	$NiSo_4$ $NiCl_2$ $CoSo_4$ Boric acid	
Lead frame		

Table VI. 2-2 Raw Materials and Consumables not Procured in Malaysia

Raw materials and Consumables		Remarks
Materials for composition of ceramic packages & substrates	Al_2O_3 Fe_2O_3 Mo Au Tungsten Binder Glass	
Printing	Original Film Screen Mask	Available in Singapore

It is difficult to change the composition of the main materials of ceramic packages and substrates because the change greatly affects the ceramic characteristics and the approval from the users is required as mentioned in the preceding paragraphs. Even if the main materials are available in Malaysia, they would not be locally procured for the production of ceramic packages and/or substrates unless the following conditions are satisfied.

a) Cheaper than imported materials.
b) Delivery must be done within the desired period.
c) Conditions of production would not be much affected by the change of materials.
d) The ceramic characteristics would not be deteriorated at all.
e) The approval of the users could be received.
f) Technology required for the change of materials should be obtained.

The conditions as above listed are all indispensable factors for the change of materials. Therefore, if all the conditions could be satisfied, the materials which are available in Malaysia could be used for the ceramic packages and/or substrates. However, it is assumed that it would take at least 2-3 years after the actual production of the ceramic package and/or substrates in Malaysia is begun, before the local procurement of the materials and consumables listed in Table VI. 2-2 is possible.

VI-3. Present Status of Overseas Market of Ceramic IC Packages/Substrates

VI-3-1. World Market Trends

The definite market size of ceramic IC packages and substrates is unknown because this data is not included in trade statistics. However, when acknowledging the estimate that Japan supplies about 90% of the world market, the scale of the world market would be roughly estimated. Because the announcement of statistics relating to the products in Japan began in 1986, only a short-term trend could be obtained. Statistics prior to this could only be obtained from the results of questionnaire survey by the Japan Fine Ceramics Association conducted annually from 1984. However, from this only the production value is available.

The world market size of ceramic IC packages/substrates for the past three years (for 1988, January-July) estimated mainly based on the Fine Ceramics Statistics in Japan compiled by MITI, is as shown in Table VI. 3-1.

Table VI. 3-1 Size of World Market for Ceramic IC Packages/Substrates (Estimate)

(Unit: Million Pcs.)

	1986	1987	1988 1] (Jan.-July)
Ceramic IC Packages	1,904.0	2,455.1	1,297.3
(Annual Growth, %)	(-)	(28.9)	(18.7)
Cerdip Type	1,713.4	2,244.0	1,138.5
(Annual Growth, %)	(-)	(31.0)	(15.9)
Laminate Type	190.6	211.1	158.8
(Annual Growth, %)	(-)	(10.8)	(43.1)
Substrates	2,749.5	3,330.5	582.6
(Annual Growth, %)	(-)	(21.1)	(-68.1)

1] Growth rates are compared to the same period of the previous year

There was a recession in the semiconductor industry in 1985 and 1986. In 1987, however, production of packages rose 28.9% over the previous year and substrate production rose 21.2%.

The ratio that ceramics and plastics occupy in the IC package is 1:9. Because the quality of plastics is becoming better every year, replacement by plastics is taking place and the use of ceramics is declining. However, due to the fact that the IC industry itself is continuing to grow, the ceramic IC package market is still expanding.

The Japan Fine Ceramics Association predicts that future world demand will expand as shown in Table VI. 3-2, until the year 2,000.

Table VI. 3-2 Market Forecast for Ceramic IC Packages/Substrates

(Unit: ¥10 Million)

	1987	1990	1995	2000	Average Annual Growth Rate
Case I		1,960	2,880	4,230	8.0%
Intermediate Value	1,556				
Case II		1,780	2,230	2,790	4.6%

* Average Annual Growth Rate is from 1987 to 2000.
Source: Japan Fine Ceramic Association

Case I is based on the 8.0% of an average annual growth rate between 1985 and 1987 projected by the association. Case II is based on the 4.6% (average growth for 1986-1991) projected by the Business Communication Circuit Company for the large American market.

By product type, the ratio of cerdip to laminate packages is approximately 9:1. But because of high accumulation and the compactness of chips, it is thought that in the future the laminate ratio will grow.

The market size by country for this product is unknown because the information on the product use cannot be obtained. Therefore, it was estimated by using the figures of IC production.

Table VI. 3-3 shows the trends in the main countries producing ICs during the past four years. The growth of the world's IC production in the past four years averaged 13.5% per year. The 1987 production, in order of value, was as follows:

1. U.S. (share it holds in world production)	38.4%
2. Japan	33.5%
3. Malaysia	5.2%
4. Korea	5.1%
5. Singapore	3.6%

Except for large markets of the U.S. and Japan, the ratio that Southeast Asia holds is large. It holds 18.1% compared Europe's 9.2%. The area is the third largest market for the ceramic IC package. The average growth rate of world production was 13.5%, while Malaysia's was 26.5%, Singapore's 18.2%, Thailand's 35.3% and Korea's 21.2%.

Thus, there are great expectations for the future market of Southeast Asia. However, due to the fact that the low-end ICs are mainly produced in Southeast Asia, it is considered that the ratio of Southeast Asia's use of ceramic packages is rather low compared to the U.S. and Japan, where ceramic packages are used for ICs of high accumulation and for industrial use.

There is an estimate that about 90% of the world's demand is supplied by Japan. Though details of Japan's production is shown in Section VI. 3-3, three firms, Kyosera, NTK and Narumi, form a unique oligopoly with a 90% share.

Table VI. 3-3 Production of ICs in Main Producing Countries

(Unit: US$ Million)

Country	1985	1986	1987	1988	Average Growth Rate
U.S.A	10,910	10,623	12,070	13,680	7.8
Canada	61	58	65	72	5.7
Brazil	85	120	140	170	26.0
Australia	4	3	7	13	48.1
Austria	9	18	18	21	32.6
Belgium	5	6	7	8	17.0
Denmark	2	2	2	2	-
Finland	9	18	22	26	42.4
France	447	539	577	635	12.4
Ireland	188	169	187	220	5.4
Italy	166	192	215	255	15.4
Holland	167	294	312	359	29.1
Norway	3	8	9	11	54.2
Spain	5	7	9	11	30.1
Sweden	36	131	147	151	61.3
Swiss	24	46	47	50	27.7
U.K.	532	631	657	764	12.8
W.Germany	483	743	694	763	16.5
(Europe Total)	2,076	2,804	2,093	3,276	16.4
Japan	7,707	10,526	10,881	11,952	15.7
Hong Kong	142	112	103	96	-12.2
Indonesia	-	-	-	-	-
Malaysia	918	1,195	1,550	1,860	26.5
Philippines	-	-	-	-	-
Singapore	778	886	1,101	1,284	18.2
Thailand	307	456	684	760	35.3
Korea	1,010	1,169	1,499	1,800	21.2
Taiwan	393	580	603	640	17.7
India	6	9	16	28	67.1
Grand Total (Inc. others)	24,397	28,541	31,622	35,631	13.5

Source: Yearbook of World Electronics Data 1988, Benn Electronics

VI-3-2. Trends in the Major Market

The outline of the market is as mentioned in section VI. 3-1. About 70% is shared by the U.S. and Japan. The situation in the two countries is as follows:

(1) The United States

Production of ICs in the U.S. has changed as shown on Table VI. 3-4. The average yearly growth rate from 1980 to 1984 was 18.4%. For 1985 and 1986 there was a decrease because of the semiconductor recession. However, there was a recovery in the latter half of 1987.

Table VI. 3-4 Flow of IC Production in the U.S.

	Value (US$ Million)	Annual Percentage Change
1980	6,605.7	-
1984	12,960.1	-
1985	10,806.0	-16.6%
1986	10,443.1	-3.4
1987	11,905 (Estimate)	14.0

Source: Department of Statistics

The ceramic IC package market in the U.S. was estimated at U.S.$3.420 million in 1986. The ratio of ceramic-made items in the packages is 28.5%. This is a very high ratio. The demand for 1991 is estimated as follows:

Table VI. 3-5 Market Forecast for IC Packages in the U.S.

(Unit: US$ Million)

	1986		1991		Average Annual Growth Rate
Ceramic	3,420	(Share 28.5%)	4,294	(Share 19.0%)	4.6%
Plastic	8,340	(69.5%)	18,080	(80.0%)	16.8
Metal	240	(2.0%)	226	(1.0%)	
Total	12,000	(100.0%)	22,600	(100.0%)	13.5

Source: Business Communication Circuits Co., Inc.

They are supplied mainly from Japan. There are some ceramic IC package and substrate manufacturers in the United States. However, their production is small and is mainly for in-house use.

(2) Japan

Japan is a large producer and also a huge consumer. Domestic sales and the export trend from 1986 are as shown in Table VI. 3-6.

Table VI. 3-6 Domestic Sales of Ceramic IC Packages/Substrates

(Unit: Million Pcs, ¥ Million, %)

	1986		1987		1988 (Jan.-July)	
	Quantity	Value	Quantity	Value	Quantity	Value
Ceramic IC Package						
Sales	1,730.9	95,279	2,232.0	113,000	1,209.4	71,137
Domestic Use	575.0	39,616	554.6	42,811	345.2	29,305
Ratio of Domestic Use	(33.2)	(41.6)	(24.8)	(37.9)	(28.5)	(41.2)
• Cerdip Type						
Sales	1,557.6	35,604	2,040.0	35,266	1,034.9	21,318
Domestic Use	510.0	17,065	469.8	14,431	273.1	8,140
Ratio of Domestic Use	(32.7)	(47.9)	(23.0)	(40.9)	(26.4)	(38.4)
• Laminate Type						
Sales	173.3	59,675	191.9	74,734	144.4	49,816
Domestic Use	65.1	22,551	84.1	28,380	72.1	21,165
Ratio of Domestic Use	(37.6)	(37.8)	(43.8)	(38.0)	(49.9)	(42.5)
Substrate						
Sales	2,499.5	24,949	3,127.7	29,154	529.6	8,961
Domestic Use	1,997.2	21,066	2,378.4	25,119	363.9	7,681
Ratio of Domestic Use	(79.9)	(84.4)	(76.0)	(86.2)	(68.7)	(85.7)
Grand Total						
Sales	-	120,228	-	142,154	-	80,098
Domestic Use	-	60,682	-	67,922	-	36,986
Ratio of Domestic Use	(-)	(50.5)	(-)	(47.8)	(-)	(46.2)

Source: Fine Ceramic Statistics.

Looking at the numbers for 1988, 26.6% of the world's demand for IC packages and 62.5% of demand for substrates comes from the Japanese domestic market.

The ratio of domestic consumption, especially for substrates, is high. Concerning packages, the ratio that Japan occupies in world demand is high: 24% in cerdip and 45% in laminate types of products. This shows that the ratio of high-end products and/or industry-use IC production in Japan is high. It is hard to grasp the actual situation of substrate market because the production know-how for substrates is less complicated than that for packages and that some component manufacturers produce ceramic substrates for their own use.

The production of ICs in Japan is shown in Table VI. 3-7. After 1984, when there was a 52.7% increase over the previous year, there were declines in 1985 and 1986, influenced by the semiconductor recession. In 1986 there was a quick recovery in quantity and it surpassed the 1984 totals. Based on the table, among the ICs produced in Japan, the ratio of ICs using the ceramic package declined to 4.6% in 1987, compared to the 6.0% in 1986.

Table VI. 3-7 Trends of IC Production in Japan

(Unit: Million Pcs, ¥ Million, %)

	1984	1985	1986	1987	1988 (Jan.-Nov.)
Production Volume	9,516.4	9,350.4	11,139.2	12,015.4	13,031.9
(Annual Growth)*	(52.7)	(-1.7)	(19.1)	(7.9)	(-)
Value	1,973,850	1,841,790	1,780,235	1,925,000	2,253,359
(Annual Growth)*	(73.2)	(-6.7)	(-3.3)	(8.1)	(-)

* L Figurers are Annual Percentage Change
Source: Japan Machinery Statistic, Monthly Report

VI-3-3. Trends in the Major Supply Countries

As mentioned, Japan supplies 90% of the world's needs for IC ceramic packages. Although production is made both in the U.S. and West Germany, it is very small and is used mainly for the manufacturers' own use.

There were no countries in Southeast Asia producing the product. in the past. However, through the introduction of U.S. technology in Korea and Singapore, there is now some production in those two countries. Production in Singapore, coming under the aegis of a U.S. company, has started to supply the market to which the parent company had supplied before.

(1) Japan

1) Trends in Production and Exports

The production trend from 1986 to July 1988 is shown in Table VI. 3-8. The production figures prior to 1986, according to the Japan Fine Ceramics Association Reports are as follows: The total production value of ceramic IC packages and substrates was ¥14.1 billion for 1984 and ¥14.4 billion for 1985.

Table VI. 3-8 Production of Ceramic IC Packages/Substrates

(Unit: Million Pcs, %)

	1986 Quantity	1987 Quantity	1988 (Jan.-July) * Quantity
Ceramic IC Package	1,693.1	1,283.0	1,157.5
(Annual Growth)	(-)	(-24.2)	(16.5)
• Cerdip Type	1,526.6	1,091.6	1,011.9
(Annual Growth)	(-)	(-28.5)	(13.3)
• Laminate Type	166.5	191.4	145.6
(Annual Growth)	(-)	(15.0)	(44.2)
Substrate	2,487.0	3,175.3	551.9
(Annual Growth)	(-)	(27.7)	(-66.8)

* Growth Rate are Compared to the Same Pediod of the Previous Year
Source: Fine Ceramic Statistics.

Exports of products are as shown in Table VI. 3-9. The export ratio is high.

Table VI. 3-9 Trend of Export of Ceramic IC Packages/Substrates

(Unit: Million Pcs, ¥ Million, %)

	1986		1987		1988 (Jan.-July)	
	Quantity	Value	Quantity	Value	Quantity	Value
Ceramic IC Package						
Sales	1,731	95,279	2,232	113,000	1,209	71,137
Export	1,156	55,663	1,677	67,189	834	41,829
(Export Ratio)	(66.8)	(58.4)	(75.2)	(59.5)	(69.0)	(58.8)
• Cerdip Type						
Sales	1,558	35,604	2,040	35,266	1,035	21,318
Export	1,048	18,539	1,570	20,835	762	13,178
(Export Ratio)	(67.3)	(52.1)	(77.0)	(59.1)	(73.6)	(61.8)
• Laminate Type						
Sales	173	59,675	192	74,734	144	49,816
Export	108	37,124	107	46,354	72	28,651
(Export Ratio)	(62.4)	(62.2)	(55.9)	(62.0)	(50.1)	(57.5)
Substrate						
Sales	2,500	24,949	3,128	29,154	530	8,961
Export	502	3,883	749	4,035	166	1,280
(Export Ratio)	(20.1)	(15.6)	(24.0)	(13.8)	(31.3)	(14.3)
Grand Total						
Sales	-	120,228	-	142,154	-	80,098
Export	-	59,546	-	71,224	-	43,109
(Export Ratio)	(-)	(49.5)	(-)	(50.1)	(-)	(53.8)

Source: Fine Ceramic Statistics

2) Major Production Companies

Major producers according to products are as follows:

a) Ceramic IC packages

Kyosera, NTK, Narumi, Nihon Gaishi, Shinko Electric

b) Ceramic Substrates

Kyosera, NTK, Narumi, Nihon Gaishi, Shinko Electric, Hitachi Chemical Industries, Hokuriku Ceramics, Maruwa Ceramic, Nikko, Matsushita Electronic Components, Nihon Carbide Industries, Noritake.

In recent years there has been a trend in which component manufacturers have started producing ceramic substrates for their own use. With packages it is hard for new firms to participate because it takes time to achieve the know-how and because companies already involved are apt to hold on to their markets.

The changes in the shares of makers (shipment value) are as follows. There is no change in the situation in which three companies monopolise the market.

Table VI. 3-10 Market Share of Ceramic IC Packages/ Substrates in Japan by Firm

(Unit: %)

	1986	1987	1988
Kyosera	58.7	52.7	57.0
NTK	19.5	19.2	19.4
Narumi	6.5	6.7	6.7
Others	15.3	21.4	16.9
Total	100.0	100.0	100.0

Source: Yano Research Institute

It was in the latter part of the 1960s that ceramics started to be used in the IC package. Afterward, ceramic use was developed along with IC development. The yearly rate of growth of this industry was 13 - 15% in the 1970s and 10 - 15% from 1978 to 1984.

The three large Japanese companies developed their own techniques in bringing about the IC package. Thus, the manufacturing technology is different for each company. These three companies were originally pottery and porcelain manufacturers. The main reason for their development was that they already had the high techniques for blending materials and firing.

(2) Others

1) The United States

All companies that produce ceramic IC packages and substrates in the U.S. are not known but the companies shown below are producers of these items:

* Microelectronics Packaging Industries (MPI)
* General Electric
* Ceramatech

2) Korea

The ceramic IC package and substrate industry in Korea has just started. Though the present amount of production is uncertain, it is said that the production of cerdip types of IC packages has been started.

In February 1988, Samsung Corning obtained about 10% of MPI's stock in the U.S., received a license to use the DIP technology and built a plant in Korea with 700 employees. In December 1988, the Samsung General Research Institute and a research team from Samsung Corning succeeded in the development of the production technology for laminate ceramic IC package, It is reported to start production in 1989. If the production goes smoothly there will be a substantial import substitution of 70 billion won annually.

The Korean Mining Refinery Corporation is also trying to advance into the precise ceramic IC field. For this purpose, this company invested 5 billion won and it plans to complete an IC package plant in the latter half of 1989 that produces 20,000 units annually. This company, with the cooperation of American Ceramatech, is planning to start producing laminate ceramic IC packages in 1989.

The products of above two companies will be used mainly for import substitutes, but there will be the possibility of exports after 1990.

3) Singapore

In Singapore, an American company, Microelectronics Packaging Industries (MPI), has started production. Details concerning this company are uncertain. However, they sell to markets in Singapore, Malaysia and Southeast Asia.

VI-4. Feasibility Analysis of Investment

VI-4-1. Study of Production Size

In this section, in order to evaluate the adaptability of Malaysia for an industry site of ceramic IC packages/substrates, a quite rough analysis of investment feasibility was conducted,on the assumption that the following three types of plants are to be newly constructed in Malaysia.

Table VI. 4-1 Type of Plants and Production Size

Type	Production Capacity (Monthly)	
1. Ceramic Substrate Plant I	Blank Substrate	800,000 Pcs
2. Ceramic Substrate Plant II	Blank Substrate	370,000 Pcs
	Glazed Substrate	30,000 Pcs
3. Ceramic IC Package Plant	Cerdip Type IC Package	5,700,000 Pcs

Production items and production size are assumed from the following considerations.

(1) The size of the domestic market in Malaysia for the ceramic substrates is quite limited (about 400k pieces/month). It is not economically feasible to construct a plant if it is destined only to cover the domestic market. Therefore, the plant should be an export oriented factory. There are two big overseas markets, Japan and the U.S., for the products. Japan is taken up here as the assumed export market because of its nearness to Malaysia. The feasibility of adaptability of Malaysia for a substrate manufacturing plant of minimum economic size was conducted on the assumption that the product could be exported to Japan.

Two types of substrate factories are studied. One is a factory to produce only blank substrates and the other is that to produce both blank and glazed substrates.

Concerning the comparison of the two types of substrates, glazed substrate requires relatively higher manufacturing technology and is a more value-added product than the blank substrate. However, the demand for the blank substrate is bigger than for the glazed one in the general market.

(2) The size of the domestic market in Malaysia for ceramic IC packages of cerdip type is about 9 million pieces per month.

A feasibility study of plant construction for the cerdip type was conducted on the assumption of monthly production size of 5.7 million pieces calculated from the market size and the production capacity of one firing furnace.

(3) As to the laminate package, which is a more value added type than the cerdip type, the production is far more difficult and complicated than those of cerdip packages and substrates due to the sophisticated production processes. However, the production technology used for cerdip packages and substrates could also be applied to the laminate packages.

It would be more recommendable that the feasibility of the production of laminate packages should be re-studied after the experience of cerdip/substrate plant operation in accordance with the need plant size at that time and the extent of the accumurated manufacturing know-how of cerdip packages and substrates.

Thus, the feasibility analysis of investment as to laminate packages was not conducted in this survey.

For reference, the monthly size of the Malaysian domestic market for laminate packages is about 2.9 million pieces.

VI-4-2. Investment Environment

It is said that the most important problem in the construction and operation of a plant is the constant supply of electricity. Electricity as the energy source for ceramic firing must be indispensably secured. If the installation of an in-house power plant for use in the case of outage of electricity is prohibited or if it is insufficient, the products would actually be damaged and the operation would be forced to stop. Cooperation as to constant supply of electricity from the government or the state is absolutely necessary. As to other kinds of utilities and industrial disposal, though there remain some problems, they are said to be solvable problems.

The advantageous aspect in Malaysia regarding plant construction is that the incentive measure of pioneer status can be utilised for the maximum period of 10 years. This fact is the evidence that the Malaysian government considers the ceramic IC packages/substrate industry to be an important high-tech industry in Malaysia. This represents, indeed, a very favourable incentive to induce any investor companies.

VI-4-3. Outline of the Plants and Initial Investment Costs

(1) Outline of the Plant

Outline of the plants assumed for the purpose of feasibility of investment is as follows.

1) Ceramic substrate plant I

Product item	:	Ceramic blank substrate
Production capacity	:	800,000 pcs/month
Employees	:	153
Land	:	15,000 m^2
Building	:	4,825 m^2
Initial Investment	:	M$25.5 million

2) Ceramic substrate plant II

Product item	:	Ceramic blank substrate & ceramic glazed substrate
Production capacity	:	Blank substrate 370,000 pcs/Month Glazed substrate 30,000 pcs/Month
Employees	:	166
Land	:	15,000m^2
Building	:	4,100m^2
Initial investment	:	M$36.6 million

3) Ceramic IC package plant

Production item	:	Cerdip type IC package
Production capacity	:	5,700,000 pcs month
Employees	:	111
Land	:	16,500 m^2
Building	:	5,500 m^2
Initial investment	:	M$39.7 million

(2) Initial Investment Value

1) Premises

In order to evaluate the funds necessary for initial investment, the following premises were assumed.

- The plants would be located in the Prai Industrial Complex in the state of Penang, considering the access to the market. Not based on strict survey, the selection of this site was made just for the purpose of the assumption in cost calculation
- The factories were assumed to be partially air conditioned and steel frame block type with a clean room portion.
- Most of the major equipment and materials would be imported from Japan. Procurement of materials available in Malaysia and neighbouring countries would also be considered.

2) Ceramic substrate plant I

Initial investment value for the plant of blank substrates only is assumed to be about M$ 25.5 million.

VI. 4-2 Initial Investment Value for Ceramic Substrate Plant I

(Unit: M$1,000)

Item	Calculation Base	Value
a. Land	15,000m2XM$43.06/$m^2$	646
b. Factory Construction		11,319
Factory Building	4,825m2XM$750/$m^2$	(3,619)
Utilities Supply Equipment		(7,600)
Guarantee for Outside Gutter and Water Supply, etc.		(100)
c. Machinery and Equipment		9,082
Mixing Sheet Making		(2,384)
Before Firing Process		(286)
Pre-Baking		(780)
Firing		(5,392)
Quality Guarantee		(200)
Packing		(40)
d. Vehicles, Stationery		220
Two Trucks	M$100,000/Truck	(200)
Stationery 1 Set		(20)
e. Contingency	((1)+(2)+(3)+(4)) x 20%	4,253
Total		25,520

3) Ceramic substrate plant II

Initial investment value for the plant of blank substrates and glazed substrates is assumed to be about M$ 36.6 million.

Table VI. 4-3 Initial Investment Value for Ceramic Substrate Plant II

(Unit: M$1,000)

Item	Calculation Base	Value
a. Land	$15{,}000m^2$XM$43.06/$m^2$	646
b. Factory Construction		14,670
Factory Building	$4{,}100m^2$XM$1,700/$m^2$	(6,970)
Utilities Supply Equipment		(7,600)
Guarantee for Outside Gutter and Water Supply, etc.		(100)
c. Machinery and Equipment		14,994
Mixing Sheet Making		(2,384)
Before Firing Process		(226)
Pre-Baking		(780)
Firing		(5,312)
Glass Mixing		(312)
Secondary Process		(5,440)
Quality Guarantee		(40)
Packing		
d. Vehicles, Stationery		220
Two Trucks	M$100,000/Truck	(200)
Stationery 1 Set		(20)
e. Contingency	((1)+(2)+(3)+(4)) x 20%	6,106
Total		36,636

4) Ceramic IC package plant

Initial investment value for the plant of cerdip type IC packages is assumed to be about M$ 39.7 million.

Table VI. 4-4 Initial Investment Value for Ceramic IC Package Plant

(Unit: M$1,000)

Item	Calculation Base	Value
a. Land	16,500m^{2}XM$43.06/m^2	710
b. Factory Construction		18,383
Factory Building	5,500m^{2}XM$1,700/m^2	(9,350)
Utilities Supply Equipment		(8,933)
Guarantee for Outside Gutter and Water Supply, etc.		(100)
c. Machinery and Equipment		18,100
Raw Material		(2,320)
Press		(3,080)
Firing		(930)
Au Dotting		(1,320)
Glass Printing		(6,870)
EP•ROM Sealing		(1,270)
Attaching of Leadframe		(750)
Quality Guarantee		(260)
Packing		(100)
Others		(1,200)
d. Vehicles, Stationery		220
Two Trucks	M$100,000/Truck	(200)
Stationery 1 Set		(20)
e. Contingency	((1)+(2)+(3)+(4)) x 20%	7,483
Total		39,671

5) Depreciation

The Method of figuring depreciation for the above investment is assumed as follows.

Building	.....20Years Straightline Depreciation
Utilities Supply Equipment	.....10Years Straightline Depreciation
Machinery/Equipment	.....10Years Straightline Depreciation
Vehicles/Stationery	..... 5Years Straightline Depreciation

The annual depreciation cost for the investment is shown as follows:

Table VI. 4-5 Annual Depreciation Cost

(Unit: M$1,000)

Item	Annual Depreciation Cost
1. Ceramic Substrate Plant I	1,893.2
Factory Building	(181.0)
Utilities Supply Equipment	(760.0)
Machinery and Equipment	(908.2)
Vehicles, Stationery	(44.0)
2. Ceramic Substrate Plant II	2,651.9
Factory Building	(348.5)
Utilities Supply Equipment	(760.0)
Machinery and Equipment	(1,994.4)
Vehicles, Stationery	(44.0)
3. Ceramic IC Package Plant	3,214.8
Factory Building	(467.5)
Utilities Supply Equipment	(893.3)
Machinery and Equipment	(1,810.0)
Vehicles, Stationery	(44.0)

Fig. VI.4-1 Layout of Ceramic Substrate Plant

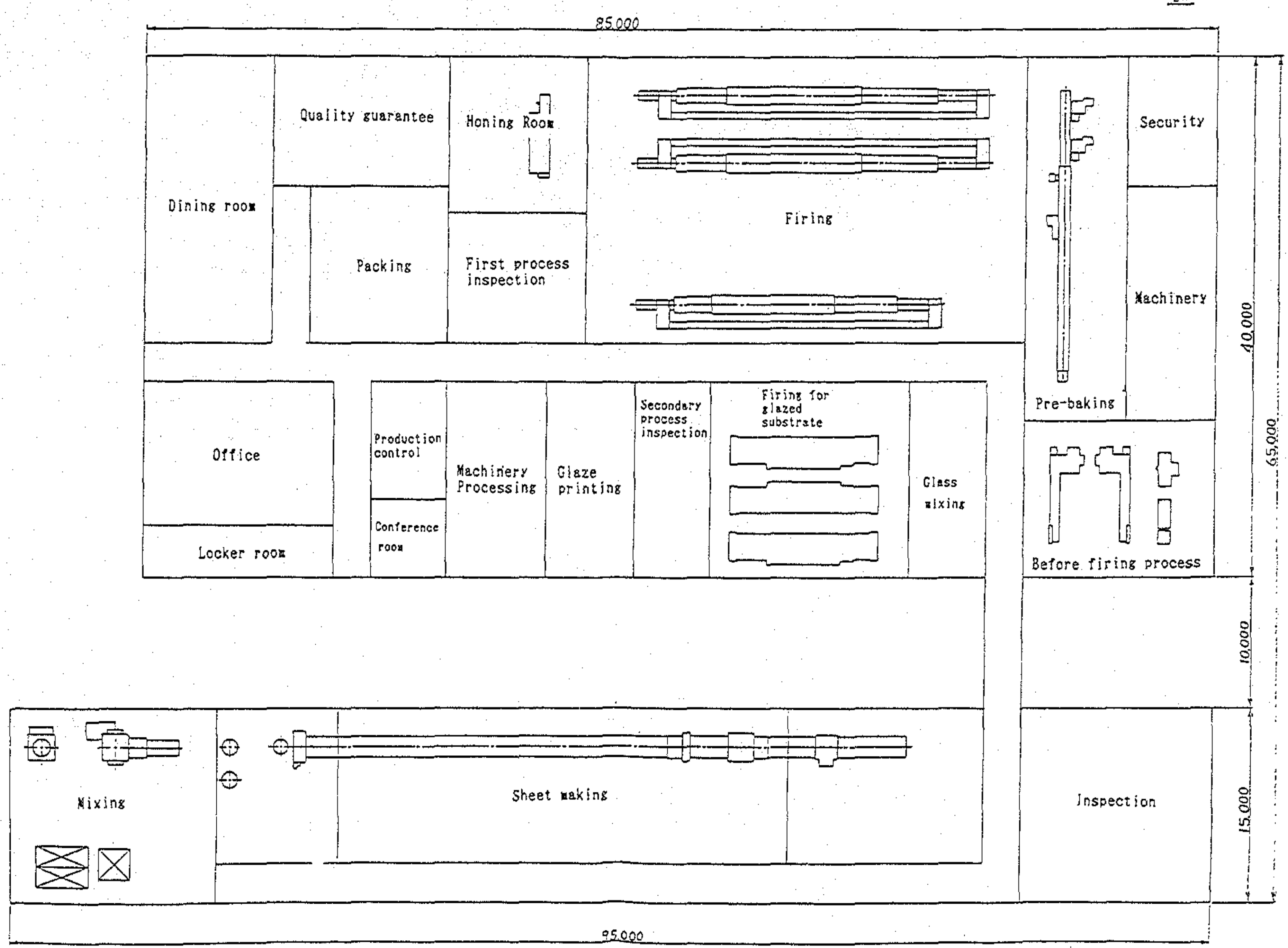
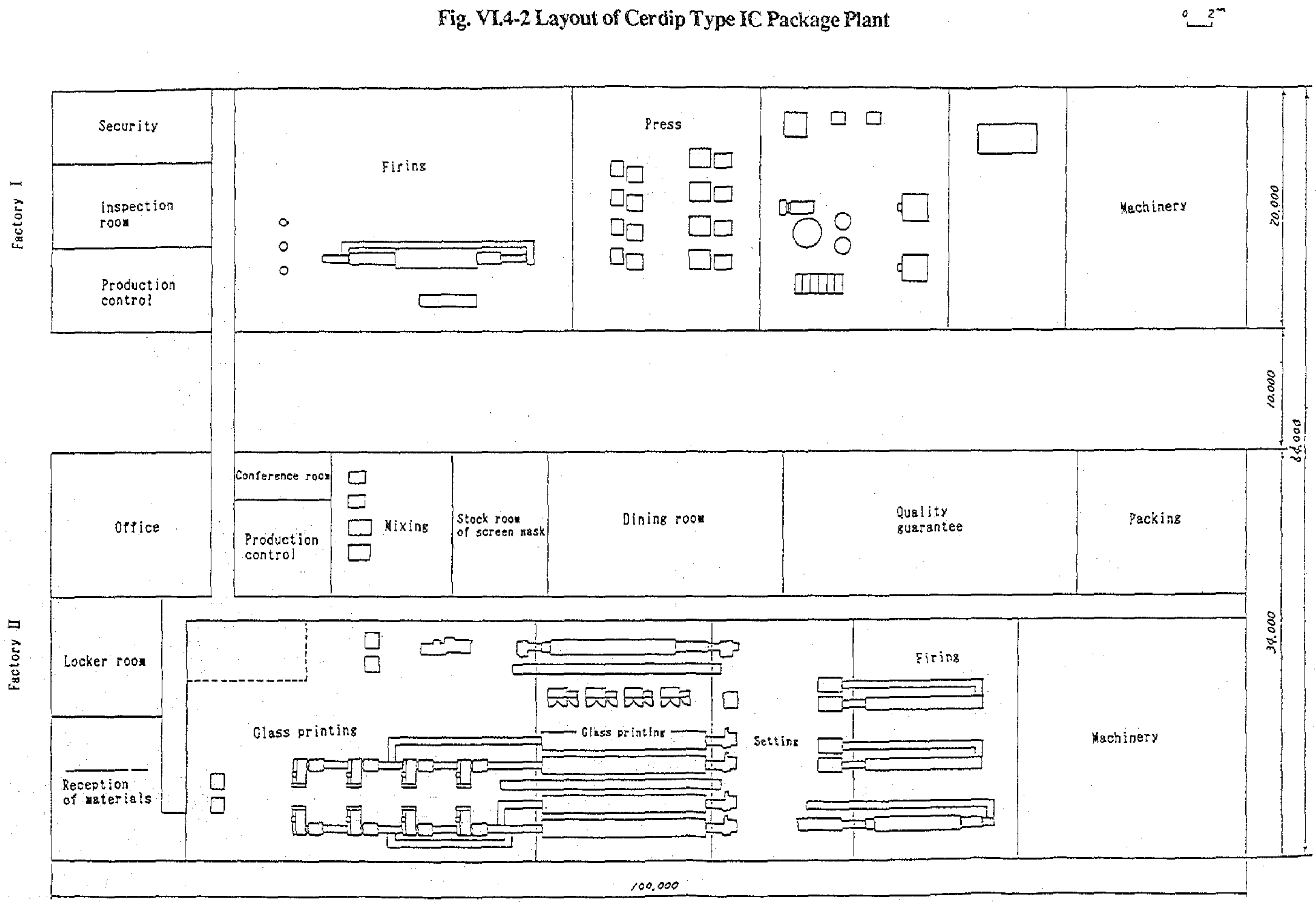


Fig. VI.4-2 Layout of Cerdip Type IC Package Plant



VI-4-4. Production and Sales

(1) Production

Annual volumes of production are assumed as follows based on the production capacity and initial operation ratio of each plant.

Table VI. 4-6 Production Programme for Ceramic Substrate Plant I

(Unit: 1,000 Pcs)

		1st Yr.	2nd Yr.	After 3rd Yr.
Production Capacity	: Blank Substrate	9,600	9,600	9,600
Annual Production	: Blank Substrate	5,760	9,600	9,600
Operation Rate		60%	100%	100%

Table VI. 4-7 Production Programme for Ceramic Substrate Plant II

(Unit: 1,000 Pcs)

		1st Yr.	2nd Yr.	After 3rd Yr.
Production Capacity	: Blank Substrate	4,440	4,440	4,440
	Glazed Substrate	360	360	360
Annual Production	: Blank Substrate	2,664	4,440	4,440
	Glazed Substrate	216	360	360
Operation Rate		60%	100%	100%

Table VI. 4-8 Production Programme for Ceramic IC Package Plant

(Unit: 1,000 Pcs)

		1st Yr.	2nd Yr.	After 3rd Yr.
Production Capacity	: 14 Lead Cerdip	39,600	39,600	39,600
	EP•ROM28 Lead Cerdip	19,440	19,440	19,440
	EP•ROM28 Lead Cerdip with Leadframe	9,360	9,360	9,360
Annual Production	: 14 Lead Cerdip	19,800	27,720	39,600
	EP•ROM28 Lead Cerdip	9,720	13,608	19,440
	EP•ROM28 Lead Cerdip with Leadframe	4,680	6,552	9,360
Operation Rate		50%	70%	100%

(2) **Unit Sales Price**

Average unit sales prices of each product are assumed as follows, based on Malaysian market prices and Japanese manufacturing costs of each product. As to substrates, the unit sales prices are assumed to be equal to assumed Japanese market prices in order to be competitive when they are exported to Japan, because there is very limited domestic market in Malaysia. On the other hand, the unit sales prices of IC packages (cerdit type) for which there is an enough size of domestic market in Malaysia, are assumed to be equal to assumed imported prices from Japan.

Table VI. 4-9 Unit Sales Prices of Substrates

(M$1=¥46)
(Unit: M$/Pc)

Production Item	Unit Sales Price	Ocean Freight & Insurance	Duty	Japanese Market Price
Blank Substrate	0.80	0.01	0	0.81
Glazed Substrate	8.00	0.04	0	8.04

Table VI. 4-10 Unit Sales Prices of IC Package

(Unit: M$/Pc)

Production Item	Japanese Market Price	Air Freight & Ins.	Duty	Unit Sales Price
14 Lead Cerdip	0.115	0.025	0	0.14
EP•ROM28 Lead Cerdip	0.768	0.082	0	0.85
EP•ROM28 Lead Cerdip with Leadframe	0.915	0.085	0	1.00

(3) **Sales Forecast**

Sales forecast for each plant was made taking into consideration the production volume and the unit sales prices.

Table VI. 4-11 Flow Forecast of Annual Sales Value of Each Plant

(Unit: M$1,000)

		1st Yr.	2nd Yr.	After 3rd Yr.
Ceramic	Substrate Plant I	4,608	7,680	7,680
	Blank Substrate	(4,608)	(7,680)	(7,680)
Ceramic	Substrate Plant II	6,163	10,272	10,272
	Blank Substrate	(4,435)	(7,392)	(7,392)
	Glazed Substrate	(1,728)	(2,880)	(2,880)
Ceramic	IC Package Plant	15,714	22,000	31,428
	14 Lead Cerdip	(2,772)	(3,881)	(5,544)
	EP•ROM28 Lead Cerdip	(8,262)	(11,567)	(16,524)
	EP•ROM28 Lead Cerdip with Leadframe	(4,680)	(6,552)	(9,360)

VI-4-5. Raw Materials and Utilities

(1) Raw Materials to be Imported

As already stated in the preceding paragraph, the very important material, Al_2O_3, is to be imported from Japan at least for the first 5 years. Lenses for EP.ROM cerdip and gold are also to be imported from Japan.

Table VI. 4-12 Flow of Annual Import Cost of Raw Material (Al_2O_3)

	1st Yr.	2nd Yr.	After 3rd Yr.
(Ceramic Substrate Plant I)			
Blank Substrate Production Volume (1,000 Pcs)	5,760	9,600	9,600
Product Weight (g/Pcs)	6.03	6.03	6.03
Material Input (Kg/Weight)	2.0	2.0	2.0
Annual Consumption (Ton)	69.5	115.8	115.8
FOB Unit Price (M$/Kg)	5.52	5.52	5.52
Cost of Raw Material (M$1,000)	384	639	639
Annual Import Cost (M$1,000)	422	703	703
(Ceramic Substrate Plant II)			
Blank Substrate Production Volume (1,000 Pcs)	2,664	4,440	4,440
Glazed Substrate Production Volume (1,000 Pcs)	216	360	360
Product Weight of Blank Substrate (g/Pcs)	6.03	6.03	6.03
Product Weight of Glazed Substrate (g/Pcs)	6.69	6.69	6.69
Material Input (Kg/Weight)	2.0	2.0	2.0
Annual Consumption (Ton)	35.0	58.4	58.4
FOB Unit Price (M$/Kg)	5.52	5.52	5.52
Cost of Raw Material (M$1,000)	193	322	322
Annual Import Cost (M$1,000)	212	354	354
(Ceramic IC Package Plant)			
14 Lead Cerdip (1,000 Pcs)	19,800	27,720	39,600
28 Lead Cerdip (1,000 Pcs)	9,720	13,608	19,440
28 Lead Cerdip with Leadframe (1,000 Pcs)	4,680	6,552	9,360
Product Weight (14 Lead, g/Pcs)	0.95	0.95	0.95
Product Weight (28 Lead, 28 Lead with Leadframe, g/Pcs)	3.25	3.25	3.25
Material Input (Kg/Weight)	1.25	1.25	1.25
Annual Consumption (Ton)	82.0	114.8	164.0
FOB Unit Price (M$/Kg)	6.74	6.74	6.74
Cost of Material (M$1,000)	553	774	1,105
Annual Import Cost (M$1,000)	608	851	1,216

Table VI. 4-13 Flow of Annual Import Cost of EP•ROM Lens and Gold

	1st Yr.	2nd Yr.	After 3rd Yr.
(Ceramic IC Package Plant)			
EP•ROM Lenz (1,000 Pcs)	7,200	10,080	14,400
28 Lead Cerdip (Volume x 1/2)	(4,860)	(6,804)	(9,720)
28 Lead w/Leadframe (Volume x 1/2)	(2,340)	(3,276)	(4,680)
FOB Unit Price (M$/Pcs)	0.12	0.12	0.12
Cost of Material (M$1,000)	864	1,210	1,728
Annual Import Cost (M$1,000)	951	1,331	1,900
Gold			
14 Lead (Volume x 1/2, 1,000 Pcs)	9,900	13,860	19,800
28 Lead •28 Lead w/Leadframe (Volume x 1/2, 1,000 Pcs)	7,200	10,080	14,400
FOB Unit Price (14 Lead, M$/Pcs)	0.06	0.06	0.06
FOB Unit Price (28 Lead, 28 Lead w/Leadframe, M$/Pcs)	0.25	0.25	0.25
Cost of Material (14 Lead, M$1,000)	594	832	1,188
Cost of Material (28 Lead, 28 Lead w/Leadframe, M$1,000)	1,800	2,520	3,600
Annual Import Cost (M$1,000)	2,419	3,386	4,836

(2) Raw Materials Domestically Procured

1) Minor consumable materials

Minor cosumable materials such as organic solvents are domestically available and are less expensive than in Japan.

Table VI. 4-14 Local Unit Prices of Minor Consumable Materials

Item	(Unit)	Local Prices (M$)	Prices in Japan (M$)	Prices in Japan (Yen)
Toluene	(kg)	1.31	1.04	52
M.E.K.	(kg)	4.00	2.96	148
Acetone	(kg)	2.30	3.08	154
Xylene	(kg)	1.24	2.32	116
Tricholo-Ethylene	(kg)	1.90	2.50	125
N-Butanol	(kg)	2.75	8.20	410
1.1.1.Tricholo-Ethane	(kg)	2.30	2.60	130

Table VI. 4-15 Consumable Volume Rate of Representative Minor Consumable Materials

Unit: Kg Per Product Weight Ton of Ceramic Substrate

Item	Rate
Toluene	88.05
M.E.K.	415.09

Table VI. 4-16 Flow of Annual Cost of Minor Consumable Materials

(Unit: M$1,000)

	1st Yr.	2nd Yr.	After 3rd Yr.
(Ceramic Substrate Plant I)			
Toluene	3	6	6
M.E.K.	58	96	96
Others	61	102	102
Total	122	204	204
(Ceramic Substrate Plant II)			
Toluene	2	3	3
M.E.K.	29	48	48
Others	31	51	51
Total	62	102	102

2) Screen Mask (consumables)

The screen masks to be used for glass printing occupy a major portion of the consumable materials. There is a problem that there is no existing industry in Malaysia to supply the screen masks. The counter-measures to the problem are shown as follows in the order of possibility.

i) To procure from Singapore

ii) The ceramic package/substrate manufacturers themselves would manufacture them.

iii) Technical tie-ups with similar Malaysian companies having similar technology such as silk screen printing companies which would introduce the necessary manufacturing equipment for screen masks.

iv) To realise the investment of foreign original film manufacturers and mask film manufacturers in Malaysia.

If the above counter measures are not available, the screen masks are to be imported from Japan or the U.S.

In this survey, the screen masks are assumed to be procured from Singapore with the following assumed unit prices.

Table VI. 4-17 Assumed Unit Prices of Screen Masks

(Unit: M$/1,000 Pcs)

Products	Unit Price
Glazed Substrate	220
Cerdip Type IC Package	
14 Lead	1.81
28 Lead	6.02
28 Lead with Leadframe	6.02

Table VI-4-18 Flow of Annual Cost of Screen Masks

(Unit: M$1,000)

Plant	1st Yr.	2nd Yr.	After 3rd Yr.
Ceramic Substrate Plant I	-	-	-
Ceramic Substrate Plant II	48	79	79
Ceramic IC Package Plant	123	172	245

3) Utilities

Electricity is the most important utility for the plants assumed in this survey. As to other utilities such as water supply and fuel, etc., they are considered to be at a negligibly low level.

Table VI. 4-19 Electricity Consumption and Costs

Plant	Monthly Consumption (1,000 Kwh/Month)	Unit Price (M$/Kwh)	Annual Cost (M$1,000)
Ceramic Substrate Plant I	750	0.21	1,890
Ceramic Substrate Plant II	750	0.21	1,890
Ceramic IC Package Plant	700	0.21	1,764