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REPORT ON EVALUATION STUDY ON THE ESTABLISHMENT PROGRAM OF THE MEDAN FOUNDRY CENTER IN THE REPUBLIC OF INDONESIA

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PREFACE

It is with great pleasure that I present this report entitled Report on Evaluation Study on the Establishment Program of the Medan Foundry Center in the Republic of Indonesia.

This report embodies the result of the survey which was carried out in Indonesia in January, 1981 by the Japanese survey team commissioned by the Japan International Cooperation Agency following the request of the Government of the Republic of Indonesia.

The survey team, headed by Dr. Shigeo Ueki, had a series of close discussion with the officials concerned of the Government of the Republic of Indonesia, and conducted a wide scope of field survey and data analyses.

I sincerely hope that this report will be useful as a basic reference for development of the casting industry in Indonesia.

I am particularly pleased to express my appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the Japanese team.

June, 1981

KEISUKE ARITA
President
Japan International Cooperation Agency

PROJECT LOCATION MAP


PROJECT LOCATION
VEDAN
L A N G K A T
D E L I
S E R D A N G
S E L A T   M A L A K A
T A N A H
K A R O
S I M A L U N G U N
A S A H A N
D A I R I
L A B U H A N
B A T U
T A P A N U L I   U T A R A
TAPANULI
TENGAH
S A M U D E R A
I N D O N E S I A
T A P A N U L I
S E L A T A N
B A R A T
PULAU PULAU BATU

In this report the following currency exchange rates are used:

US$1 = ¥205 = Rp.625

ABBREVIATIONS

DOI	Department of Industry
MIDC	Metal Industry Development Center
MFC	Medan Foundry Center
JFC	Jakarta Foundry Center
SFC	Surabaya Foundry Center
BAPPENAS	Badan Perencanaan Pembangunan National (National Development Planning Agency)
BAPINDO	Bank Pembangunan Indonesia
PLN	Persahaan Umum Listric Negara (State Electric Power Co.)
PAM	Persahaan Air Minum (Drinking Water Co.)
UNIDO	United Nations Industrial Development Organization
GDP	Gross Domestic Product
GNP	Gross National Product
LNG	Liquid Natural Gas
IRR	Internal Rate of Return
Y	Year
M	Month
D	Day
H	Hour
Min	Minute
Sec	Second
km	Kilometer
m	Meter
mm	Millimeter
km^2	Square Kilometer
m^2	Square Meter
mm^2	Square Millimeter
ha	Hectare (10,000 m^2)
m^3	Cubic Meter
l	Litre
kl	Kilolitre
t, Ton	Metric Ton
kg	Kilogramme

g	Gramme
V	Volt
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
kWh	Kilowatt-hour
Hz	Hertz (Frequency)
°C	Degree Centigrade
%	Percent
mn	Million
bn	Billion
JIS	Japanese Industrial Standard
FC	Symbol of Gray Iron Castings in JIS
SC	Symbol of Carbon Steel Castings in JIS
SCMnH	Symbol of High Manganese Steel Castings in JIS

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Summary and Conclusion

Summary and Conclusion

1. This project is a plan to construct the Medan Foundry Center (MFC) in the Medan area in northern Sumatra, as recommended by UNIDO more than ten years ago.

2. The Japan International Cooperation Agency dispatched a study team to Indonesia in response to a request by the Government of the Republic of Indonesia with the aim of reviewing the results of a survey conducted earlier and of assessing the feasibility of this project by conducting a comprehensive study from a broad viewpoint.

3. The study team conducted field surveys during the period from January 5th to 23rd, 1981, on the basis of which it examined and analyzed the project in detail. On their way back to Japan, the members of the study team conducted a survey of the casting industry of Singapore, in order to clarify its relationship with the Indonesian casting industry. This report is a compilation of the results of the feasibility study.

4. This survey, conducted to examine and assess the feasibility of the MFC Project from a broad viewpoint, primarily involves the following items of survey:

   1) Market Survey: This survey was conducted with the aim of clarifying the Indonesian market situation for castings, and in order to determine the kinds and volumes of products to be manufactured by MFC.

   2) Survey of items related to technical aspects: Surveys were conducted on items such as procurement of utilities and means for transporting materials and products in connection with the site proposed for foundry construction, also in order to determine manufacturing processes, raw materials and utilities requirements, manufacturing machinery and equipment required, construction of buildings and construction schedules.

   3) Estimation of required capital: The amount of capital required for the MFC Project was estimated, and a financing plan was drafted for the project.

   4) Financial analysis: MFC's manufacturing costs were calculated, and the viability of the Project was assessed through financial analysis.

5. The potential demand for castings in the Medan area was estimated at roughly 6,800 tons in 1984. When the output of 4,000 tons of castings produced in the area in 1984 is subtracted, the potential demand for MFC products will be about 2,800 tons.

6. The following basic thoughts were taken into consideration in determining the products recommended for MFC production:

   1) Castings having about the same level of quality as those presently being produced by foundries existing in the Medan area are to be excluded from MFC's product line.

   2) Products demanded in comparatively large quantities are to be manufactured.

   3) Products having high added value are to be manufactured.

7. The study team visited principal casting consumers in the Medan area and confirmed their desire to purchase castings manufactured by MFC, and furthermore, the possibility of selling MFC products to other users, was assessed. Based on the results thus obtained, the magnitude of potential demands for MFC products was estimated as follows:

Gray iron castings	1,481 t/Y
Steel castings (including SCMnH)	1,076 t/Y

8. In determining MFC's production scale against the potential demand described above, the following points were taken into consideration:

   1) Selection of products producible through effective capital investment.

   2) The ratios of orders to be received are to be taken into account by kind of product.

   3) Since MFC is a jobbing foundry, the limits of order soliciting activities are taken into consideration.

   4) The capacity to process raw castings has been taken into consideration.

Based on these considerations, the production scale was determined as follows:

Gray iron castings	600 t/Y

Steel castings	480 t/Y
High manganese steel castings	120 t/Y
Total	1,200 t/Y

9. Since the larger portion of products to be manufactured by MFC is presently being imported, MFC products are to replace these imported products.

10. For the plant site of MFC the Medan Industrial Estate situated to the north of Medan is proposed.

11. Roughly 80 ha of the Industrial Estate has already been prepared, and it is to be expanded to 200 ha in the future. This Estate satisfies all the conditions necessary for constructing the foundry center. Electricity is available from a nearby substation and underground water is supplied as planned. There is no problem in the aspects of soil bearing capacity and transportation.

12. Raw materials such as sand and steel scrap are available locally, while others are to be imported.

13. Two sets of high-frequency induction furnaces are employed for melting. These furnaces are to be employed for both temperature raising and melting by the method of power switching. Molding is to be performed by such process as the vacuum sealed molding process that requires few skilled workers, and also by the inorganic self-hardening sand process. The CO_2 gas process is to be adopted for preparing cores.

14. Electricity is to be purchased, for which a power receiving facility of 2,000 kVA capacity will have to be installed.

15. The foundry compounds will extend over an area of 12,000 m^2, of which 3,000 m^2 are necessary for the foundry building and 1,000 m^2 for incidental buildings.

16. A construction period of 17 months will be required after effectuation of contract, including time for test run, so if the contract is assumed to become effective in early June, 1982, the foundry will be completed in December, 1983.

17. The commencement of foundry operation is assumed to be January, 1984.

18. The foundry is to be operated under a 7 hours per day and 300 days per year operation with a single-shift system. The foundry operation rates for the initial year, 2nd year, 3rd year, 4th year and 5th and subsequent years are respectively 40%, 60%, 80%, 90% and 100%.

19. A total of 65 employees will be required. Engineers and skilled workers are to be mobilized from all parts of the country, and unskilled workers from the Medan area.

20. The capital required for this project is estimated on the basis of the following preconditions:

1) The construction is to be completed by the end of 1983, and production commenced from early 1984.

2) Machinery and equipment are procured by lumpsum contract with CIF plus supervisor system.
Foundry construction is undertaken by Indonesian contractors under MFC's supervision and under the guidance of supervisors dispatched by the suppliers of machinery and equipment. MFC is expected to employ consultants for supervision of all works from preparation of tender documents to completion of foundry construction. The method of competitive bidding is to be adopted for procurement of machinery and equipment as well as for the selection of local contractors.

3) Currency exchange rate: US$1.00 = ¥205 = Rp.625

4) Time of cost estimation: January, 1981

5) Price escalation (annual rate)

Foreign currency portion:	8%
Local currency portion:	15%

6) Preoperation capital expenditures

The following items are included:

Training costs for employees

Consulting fee
Management guidance costs
Connection charge for power receiving
Labor cost for establishment of MFC
Costs for test run

7) Contingency

Foreign currency portion: 5%
Local currency portion: 10%

21. The total cost of the project is estimated as follows:

Total Project Cost Required

Item	Foreign Portion		Local Portion	Total
	(¥1,000)	(Rp.1,000)	(Rp.1,000)	(Rp.1,000)
1. Land			112,200	112,200
2. Machinery & Equipment (FOB)	602,471	1,836,801	208,146	2,014,947
3. Ocean Freight & Insurance	37,373	113,941		113,941
4. Inland Transportation, etc.			38,070	38,070
5. Civil Engineering Works			89,585	89,585
6. Building Works			279,424	279,424
7. Erection Works			19,800	19,800
8. Supervision	39,370	120,031		150,031
9. Miscellaneous			80,488	80,488
10. Preoperation Capital Expenditure	229,018	698,316	208,544	906,860
11. Contingency	34,716	105,842	91,885	197,727
Project Cost	942,978	2,874,931	1,128,142	4,003,073
12. Initial Working Capital			65,842	65,842
Total Project Cost	942,978	2,874,931	1,193,984	4,068,915
13. Interest during Construction			217,890	217,890
Financing Required	942,978	2,874,931	1,411,874	4,286,805

22. The capital structure is assumed to be as follows:

Capital Structure

(Unit: Rp.1,000)

Equity Capital		2,672,805
Indonesian Government	1,737,805	
North Sumatra Government	860,000	
Private Foundry Company	75,000	
Debt		1,614,000
Long Term Loan	1,614,000	
Total		4,286,805

Note: Total Project Cost including Interest during Construction, Rp.4,286,805.

23. The following conditions are assumed for long-term loan:

Grace Period,	3 years
Term of repayment:	12 years
Interest (annual rate):	13.5%

24. The financial assessment of the project is based on the following conditions:

1) The project life is assumed to be 15 years.

2) The prices adopted here for calculating production costs and profit and loss are those existing as of January, 1984. These prices were obtained from the prices as of January, 1981 with price escalations of 8% per annum for the foreign currency portion and 15% per annum for the local currency portion in principle. These prices are assumed to be unchanged for the next 15 years.

3) The selling prices of MFC products are conceived to be influenced by the prices of imported products, so the prices of castings as of January, 1981 were estimated and then adjusted with price escalations of 8% per annum in order to obtain the

selling prices as of January, 1984. Accordingly, the selling prices of MFC products as of January, 1984 are assumed to be as follows:

Iron castings	Rp.693/kg
Steel castings	Rp.1,134/kg
High manganese steel castings	Rp.2,520/kg

25. The terms of depreciation are assumed to be as follows:

Machinery and equipment	15 years
Building	25 years
Others	5 years

26. The distribution of indirect costs is assumed to be as follows:

Iron castings	40%
Steel castings	48%
Hi-manganese steel castings	12%

27. The results of financial analysis of the standard case of Base Case are as follows:

1) Manufacturing costs

The manufacturing costs by kind of product are as follows:

Unit Product Cost

(Unit: Rp./Ton)

Year	FC	SC	SC MnH
1984	1,366,728	2,032,172	2,311,584
1990	709,215	1,015,871	1,325,283
1998	624,479	918,764	1,198,180

Price in 1984

It is observed that manufacturing costs are relatively high compared with selling prices, and that with the exception of high manganese steel castings, the manufacturing costs are higher than the selling prices in the first few years of foundry operation.

2) Internal rate of return

The internal rate of return is extremely low, as follows:

IRR (before tax):	4.304%
IRR (after tax):	1.537%

3) Financial condition

Deficits will continue for a few years after commencement of operation, resulting in a shortage of funds.

28. Even if the foundry operation rate is assumed to be 65%, 75%, 85% and 100%, respectively, in the initial year, 2nd year, 3rd year and 4th and subsequent years, as assumed in the Implementation Program prepared by the Government of Indonesia, the results would be still extremely poor as shown below.

1) Internal rate of return

The internal rate of return will be very low, as follows:

IRR (before tax):	4.962%
IRR (after tax):	2.556%

2) Financial condition

Deficit operation will continue for a few years after commencement of operations, and although calculations indicate that the project is saved from shortage of funds, the management condition will be extremely poor and shortage of funds will occur with even a slight aggravation of operating conditions, leading directly to financial disruption.

29. In this project, the return on investment will be extremely poor, making the management foundation very precarious.

30. Regarding the economic effects of the project, the amount of foreign currency saved by effectuation of the Project on the basis of the Base Case will be roughly US$17,000,000 (as of 1981 prices).

31. The promotion and development of industries in the Medan area is one of the most important themes for the balanced growth of the national economy. For achieving this theme, it is necessary to reorganize and establish the foundry industry in the area to give efficient support to other industries. Under this consideration, various studies on the establishment of MFC have been carried out in the past decade.

According to the result of the Evaluation Study by the JICA Team, it is concluded unfortunately that the immediate implementation of the establishment of MFC is financially not feasible.

However, the JICA Team also recommend DOI to carry out a feasibility study on putting up a foundry in the Medan area under a new concept in the future when a substantial numbers of fairly large consumers of castings are introduced to the Medan area and the market of castings in the area is fully expanded.

Introduction

Introduction

1. Background of Survey

The project to construct a foundry center in Medan, in the northern part of Sumatra has not yet been implemented to date despite a survey by UNIDO in 1969 and several subsequent surveys by the Japan Consulting Institute and the Japan Overseas Economic Cooperation Fund.

A period of about ten years has elapsed since these surveys were conducted, during which period several factors have exerted indisputable influences on the feasibility of this project, such as the economic upheavals brought about on a global scale by the oil crisis and the devaluation of the local currency of Indonesia.

His Excellency A. R. Soehoed, Minister of Industry observed the necessity or reassessing the feasibility of the project in the face of such conditions, and requested the Government of Japan formally through the Embassy of Japan in Indonesia to implement a feasibility study of the project.

In response to this request, the Government of Japan decided to implement the feasibility study and consigned the project to the Japan International Cooperation Agency.

The Japan International Cooperation Agency dispatched to Indonesia a study team headed by Dr. Shigeo Ueki and consisting of eight specialists from January 5th to 23th, 1981 with the purpose of conducting a feasibility study of this project.

2. Purpose of Study

The feasibility study was conducted with the following purposes:

1) To review the results of the surveys conducted in the past in connection with the project for constructing the Medan Foundry Center in the Medan area.

2) To assess the technical and economic feasibility of the MFC project.

3. Scope of Study

In order to attain the objectives of the study, the following items were included in the scope of study:

1) Situation of related industries
2) Situation of the casting industry
3) Market situations
4) Product mix
5) Production scale
6) Plant site
7) Situation surrounding raw materials, utilities and infrastructure
8) Manufacturing process
9) Production system and machinery and equipment plan
10) Plant layout
11) Plant construction
12) Production plan, sales plan
13) Management and technical guidance systems
14) Required investment
15) Financing plan
16) Financial analysis
17) Economic analysis
18) Problems faced in project implementation

4. Method and Schedule of Study

In this survey, the study team conducted field surveys in Indonesia over a 20-day period from January 5th, 1981, and the feasibility of the project was analyzed after the study team returned to Japan, based on the results obtained through the field surveys.

In carrying out these field surveys, the study team had an opportunity to hear the opinions of His Excellency A. R. Soehoed, Minister of Industry, and also deliberated in details with their counterparts consisting of officials related to the Department of Industry, headed by Ir. Eman Yogasara, Director General of Basic Metal Industries (Former Director for Programming) through whose kind cooperation various necessary data were obtained and the proposed plant site was surveyed.

The members of the study team also paid visits to foundries and industrial plants consuming castings in the Medan area, conducting detailed surveys, while three members visited Singapore to conduct a survey of the casting industry during the period from January 24th to 26th.

The methods adopted for conducting the principal items of survey of this project were as follows:

1) Market Survey of Castings

Since very few statistical data related to the consumption of castings in Indonesia on the Medan area were available, the study team conducted the following surveys in order to estimate the annual consumption of castings in the Medan area:

a) Industrial plants consuming castings were visited in order to elucidate the situation of their annual consumption of castings, and managers were interviewed in order to grasp the situation of consumption of castings by their respective industries.

b) Foundries were visited in order to survey the present situations regarding production and processing of castings, as well as to obtain data pertaining to their clients, or consumers of castings.

A survey was also conducted on these foundries as a means to sound out their disposition, or whether they would continue to produce castings or stop operating when MFC was constructed.

c) A detailed restudy was made of the results of a survey conducted earlier in 1976 by Mr. S. Ono, one of the members of the present study team and Mr. M. T. Nasution in connection with the demands for castings in the Medan area.

d) The results of the survey conducted by UNIDO earlier were reviewed.

e) Future demands for castings were projected on the basis of the demands estimated to exist at the present stage as confirmed through these surveys.

2) Selection of Production Scale

The market available for MFC products was calculated by subtracting the production volume of the existing foundries from the above-mentioned estimate of demands, and the demands anticipated for MFC's respective products were estimated accordingly.

wise demands were first multiplied by their respective anticipated productwise order receiving ratios in order to obtain the anticipated productwise order, from which the production scale was determined.

3) Survey of Items Related to Technical Aspects

Survey of items related to technical aspects of the project was performed as follows:

a) Plant Site Conditions

Site surveys were conducted and related organizations visited, in order to clarify the conditions of the land and procurement of utilities.

b) Procurement and Prices of Raw Materials

Various necessary data were obtained by visiting numerous foundries including those in Singapore. Also data related to the casting industries of countries exporting castings were also collected.

c) Other Items Related to Technical Aspects

Data and information related to other technical aspects of the project were acquired through field surveys and visits to related organizations and industrial plants.

4) Study on Items Related to Financial Assessment

In order to obtain necessary data, related organizations were visited and deliberation advanced actively, while the basic conditions to be adopted for financial assessment were determined through meetings with counterparts.

Prior to the finalization of this study, the Study Team has presented an interim report to the Indonesian Government and held meetings for four days from April 28, 1981 to discuss with the Indonesian counterpart team concerning the outcome of the study. Thus, the study has been finalized with full consideration of comments presented by the counterpart as well.

Acknowledgement

Our sincerest gratitude is offered herewith to His Excellency A. R. Soehoed, Minister of Industry, Ir. Eman Yogasara, Director General of Basic Metal Industries (Former Director for Programming), Department of Industry, Ir. Moh Toyib, Acting Director of Programming, Department of Industry and other officials of the Government of the Republic of Indonesia and related organizations, who offered the study team their kindest cooperation and aid in carrying out this study.

Chapter 1. Economy and Industry in Indonesia

Chapter 1. Economy and Industry in Indonesia

1.1 Economy in Indonesia

Indonesia has a vast land of more than 1,900,000 square kilometers and population of more than 140,000,000. She has various natural resources and extensive forests. In view of this, it may be said that Indonesia has a powerful background for the growth of the economy.

The export price of crude petroleum, which occupies more than half of her exported goods, has recently risen to a great extent, and also the prices of such primary products as timber and coffee have risen. Further, Indonesia has started exporting new industrial products. Coupled with these, her currency has been devaluated. These have served to improve remarkably her balance of international payments, and her foreign currency reserves attained a marked increase to about 7,000,000,000 dollars in July 1980, compared to the reserves of 2,500,000,000 dollars at the end of 1978.

Moreover, with a good harvest during the past three consecutive years, Indonesia is now almost able to meet the rice demand within the country. Also, various other problems are being solved. In this way, the economic situation in Indonesia is undergoing a drastic change. It may be said that Indonesia is now advancing toward a country of economic power.

1.1.1 Government Revenue and Expenditure

Table 1-1 shows the revenue and expenditure of the Indonesian Government.

As this table indicates, about two-thirds of the government revenue depends upon petroleum. As the government is strongly insisting on acquiring foreign currency by industries other than petroleum, it is expected that measures necessary for this purpose will be taken steadily.

1.1.2 External Trade

Table 1-2 shows the external trade from 1973 to 1978.

As the table indicates, crude oil, natural gas, forestry products, rubber, coffee, tin and palm oil constitute major exports.

Table 1-1

Trend of Government Revenue and Expenditure

(bn Rp.; Year ended March 31)

	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80a)
Revenue	1,985.7	2,733.5	3,689.8	4,308.8	5,301.6	10,556.9
Expenditure	1,977.9	2,730.3	3,684.2	4,305.7	3,299.8	10,556.9
Balance	7.8	3.2	5.6	3.1	2,001.8	-

a) Budget.

Breakdown of Government Revenue and Expenditure

(bn Rp.; Year ended March 31)

	1976/77	1977/78	1978/79	1979/80
Revenue				
Direct taxes	2,046.6	2,511.3	2,996.3	7,429.7
of which:				
income tax (private)	84.2	104.6	72.0	174.1
corporation tax	127.2	169.5	226.5	356.4
oil company tax	1,619.4	1,948.7	2,308.7	6,430.1
withholding tax	148.4	201.7	232.5	324.1
other	67.4	86.8	106.4	145.0
Indirect taxes	740.9	880.5	1,078.4	1,452.8
of which:				
sales taxes	265.5	318.0	346.6	397.7
excise tax	130.7	181.9	252.9	350.9
import duties	257.4	286.9	295.3	343.7
export tax	61.7	81.2	161.1	339.1
net profit from oil	15.7	-	-	-
other	10.7	12.5	18.0	21.4
Non-tax receipts	118.5	143.6	191.4	172.8
Foreign aid receipts	783.8	773.4	1,035.5	1,501.6
Total	3,689.8	4,308.8	5,301.6	10,556.9
Expenditure				
Routine expenditure	1,629.8	2,148.9	2,743.6	5,529.2
of which:				
personnel	636.6	893.2	1,001.6	2,055.5
equipment	339.7	376.8	419.5	683.6
regional subsidies	313.0	478.4	522.3	985.8
debt servicing	189.5	228.3	534.5	770.3
other	150.9	172.2	265.9	1,034.0
Development expenditure	2,054.5	2,156.8	2,555.8	5,027.7
Total	3,684.2	4,305.7	3,299.8	10,556.9

Source: Ministry of Finance.

Table 1-2. External Trade, 1973 to 1978

(Unit: mn US$)

	1973	1974	1975	1976	1977	1978
Exports (FOB)	3,061	7,426	7,103	8,547	10,853	11,643
Imports (CIF)	2,729	3,842	4,770	5,673	6,230	6,690
Balance	332	3,584	2,333	2,873	4,623	4,953

Main Commodities Traded

(Unit: mn US$)

	1975	1976	1977	1978	% of total
Exports					
Crude petroleum & products	5,311	6,001	7,298	7,439	63.9
Forestry products	512	802	973	1,024	8.9
Coffee	99	238	599	491	4.2
Rubber	358	530	588	717	6.2
Tin	140	165	231	281	2.4
Palm oil	152	136	184	209	1.8
Fishery products	83	124	140	162	1.4
Tea	52	57	118	95	0.8
Imports					
Machinery, electrical equipment & parts	1,173	1,714	1,675	1,598	23.9
Iron & steel	628	614	599	649	9.7
Rice	326	450	678	591	8.8
Petroleum	252	437	732	579	8.7
Chemicals	138	183	237	307	4.6
Sugar	31	107	101	183	2.7

Source: Central Bureau of Statistics.

Table 1-3 shows the exports in and after 1979.

The export of crude oil ranks first in all the exports in 1980 as it did in 1979. What is worth notice is that the export of natural gas in terms of LNG ranks second in 1980, displacing timber which had enjoyed second place until 1979. Natural gas is expected to rank second hereafter among the exported goods.

1.1.3 Prices of Commodities

The inflation rate had been on a relatively low level in 1978. But at the beginning of 1979 the prices of commodities began to rise suddenly and in the middle of 1979 a much higher inflation rate registered. Although this trend continued for some more months after the devaluation of the Rupiah carried out in November 1979, the inflation rate is becoming lower.

In 1980 the salaries of government employees were raised, prices of petroleum products, electricity rates, transportation and communication charges were raised, and also prices of building materials, industrial products, etc. were raised one after another.

In spite of these, as Table 1-4 indicates, the rise of the consumer price index was less than 20% over the corresponding month of the previous year. Further, the wholesale price index is gradually calming down.

According to the above-mentioned circumstances, the annual inflation rate of Rupiah was assumed to be 15% in doing the financial analysis in the Report.

1.1.4 Long-term Plan

The Second Five-Year Plan (1974/75 – 1978/79) failed to attain its target owing to the oil crisis and financial matters arose in the country. The oil crisis of course resulted in increasing the government revenue of Indonesia, which, however, entailed an aggravation of the inflation.

The Second Five-Year Plan aimed at enhancing the living standard of the people and at achieving, on an average, a 7.5% annual increase in GDP, but the real annual increase registered only 6.9%. Table 1-5 shows the GDP growth rates from 1974 to 1978.

In the Third Five-Year Plan (1979/80 – 1983/84) it is expected to attain a 6.5% real annual increase on an average. In the industrial sector an annual increase of 11% is anticipated.

Table 1-3. External Trade (1979 – Oct., 1980)

(Unit: mn US$)

Item	1979		Jan. – Oct., 1980	
		Compared with previous year (%)		Compared with corresponding period of previous year (%)
I. Total Exports	15,590.1	+33.9	17,903.6	+42.0
II. Petroleum, natural gas	10,163.7	+27.3	12,741.3	+54.8
Crude petroleum	8,124.2	+15.8	9,406.5	+42.3
Petroleum products	746.6	+76.1	975.5	+63.1
Natural gas, etc.	1,292.9	+134.4	2,359.3	+131.1
III. Exports other than petroleum	5,426.4	+48.3	5,162.3	+17.8
Fish	220.4	+22.0	175.5	-2.2
Coffee	614.5	+25.1	606.8	+17.1
Tea	83.4	-12.0	89.8	+22.2
Spices	65.9	-24.9	61.1	+9.0
Animal feed	86.8	+20.9	86.2	+28.8
Tobacco	56.5	+3.5	51.8	-5.7
Rubber	940.3	+31.0	951.4	+19.8
Material wood	1,551.3	+70.6	1,346.1	+12.0
Nonferrous metals, ores	188.3	+60.2	340.9	+142.6
Vegetable oil including palm oil	219.4	+2.5	200.4	+24.8
Tin	382.0	+35.8	339.7	+6.7
Timber	245.4	+186.0	214.0	+7.6
Clothing	66.1	+340.7	78.8	+72.7
Diode transistor, etc.	75.8	+229.8	79.0	+18.0
Plywood	39.4	+80.7	49.3	+65.7
Textile	33.1	+1,555.0	24.9	+0.5
Cassava, etc.	73.3	+272.3	31.4	-44.8
Hides	34.4	+73.7	17.6	-38.9

Source: Central Bureau of Statistics

Table 1-4. Price Index

	General consumers' price index in Indonesia			Wholesale price index in Indonesia excluding export		
	(1977/78 = 100) (Index at year end)	Compared with previous month	Compared with corresponding month of previous year	(1971 = 100) (Average)	Compared with previous month	Compared with corresponding month of previous year
1973						
1974				196		29.8
1975				217		10.7
1976				256		18.0
1977				292		14.1
1978				320		9.6
1979	143.07	(21.77)*		430		34.4
1980						
1978 Jul.				317	0.9	7.8
Aug.				320	0.9	8.1
Sept.				321	0.3	6.3
Oct.				323	0.6	5.9
Nov.				332	2.8	7.1
Dec.				358	7.8	15.1
1979 Jan.				376	5.0	21.7
Feb.				384	2.1	23.1
Mar.	121.77			394	2.6	26.3
Apr.	125.45	3.02		406	3.0	30.1
May	129.27	3.05		419	3.2	34.3
Jun.	132.27	2.32		431	2.9	
Jul.	135.58	2.50		445	3.2	40.4
Aug.	138.75	2.34		453	1.8	41.6
Sept.	139.78	0.74		458	1.1	42.7
Oct.	141.03	0.89		463	1.1	43.3
Nov.	141.40	0.57		467	0.9	40.7
Dec.	143.07	0.87		471	0.9	31.6
1980 Jan.	144.77	1.19		478	1.5	27.1
Feb.	146.82	1.42		487	1.9	26.8
Mar.	147.14	0.22	20.8	490	0.6	24.3
Apr.	148.67	1.04	18.5	499	1.8	22.9
May	154.31	3.79	19.4	520	4.2	24.1
Jun.	156.61	1.49	18.4	524	0.8	21.6
Jul.	158.33	1.10	16.8	529	1.0	18.9
Aug.	160.21	1.19	15.5	551	4.2	21.6
Sept.	160.78	0.26	15.0			
Oct.	163.49	1.69	15.9			
Nov.	167.12	2.22	17.8			
Dec.						

* December

Table 1-5. Trend of Gross Domestic Product

	1974	1975	1976	1977	1978
Total: (bn Rp.)					
At current prices	10,708	12,643	15,467	18,706	21,788
At constant 1975 prices	12,043	12,643	13,513	14,515	15,561
Real annual increase (%)	7.6	5.0	6.9	7.4	7.2
Per head: (Rp.)[a]					
At current prices	80,785	92,936	110,779	131,937	150,158
At constant prices	90,856	92,936	96,784	102,376	107,243
Real increase (%)	4.9	2.3	4.1	5.8	4.8

a) These figures are based on the population growth rates indicated by the 1971 census and it may be safely assumed that the per head figures should be much higher.

Source: International Monetary Fund.

1.2 Industries in Indonesia

1.2.1 Mining

Table 1-6 shows the output of mining proudcts.

Table 1-6. Annual Output of Major Mining Products

(Unit: 1,000 Ton)

	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80
Crude petroleum (10^6 barrels)	485.5	497.9	568.3	616.0	582.9	577.2
Coal	171.7	204.0	183.3	248.3	256.0	267.3
Tin (metallic)	15.0	18.8	23.2	24.6	24.3	28.4
Nickel	781.1	751.2	1,177.4	1,316.7	1,178.0	1,771.5
Copper dressing ore	212.6	201.3	223.2	189.1	180.9	188.8*
Iron sand	349.2	346.2	299.7	317.2	120.2	78.5
Bauxite	1,284.2	935.8	1,048.5	1,221.8	964.5	1,160.7

* Calendar year, 1979.

Source: Presidential Report, Aug. 16, 1980.

1) Crude oil

The production of crude oil is bringing the largest income to the Indonesian Government, and is playing the most important role in acquiring foreign currency. The government is endeavoring to enhance the share of other exported goods in the acquisition of foreign currency, but the position crude oil occupies in the export will not be weakened at all. As the output of crude oil is on the decrease from the peak in 1977/78, the government is strongly encouraging explorations. Therefore, the output is expected to increase after 1981.

2) Natural gas

The output of natural gas is increasing rapidly due to the export of LNG. Some quantity is being consumed for the production of urea domestically, but this quantity being small compared to that of export, it can be said that a fairly large quantity of natural gas, now being produced, is being exported.

At present, the output of natural gas at Arun, North Sumatra, and at Badak in East Kalimantan are increasing rapidly.

3) Tin

Generally speaking, the output of tin ore is influenced by the trend of tin consumption in the world. It may be said that tin production in Indonesia is on the steady increase. An annual increase rate on the average in the past five years has registered a little less than 14%.

4) Bauxite

The total quantity of bauxite being produced is exported. Its output is affected by the condition of the world aluminum market.

However, when the aluminum smelter now under construction at Asahan, North Sumatra, starts its operation, bauxite would come to be consumed within the country, serving to stabilize the bauxite production to a certain degree in the future.

5) Coal

With a rapid rise in the petroleum price, a plan is being formed for the development of the coal industry.

1.2.2 Manufacturing Industry

The manufacturing industry is developing rapidly, and the share this industry occupies in GDP has risen to 13.4% in the period of 1971 – 1978 from 8.3% registered in 1965 – 1971. These figures show that the manufacturing industry achieved a greater increase than the overall economic growth which attained only 6.0% and 7.9% in the growth rate respectively during the above two periods. This explains that the manufacturing industry has developed by far greater than other industries. Especially after the devaluation of currency in November 1979, the output of manufacturing industry has made a remarkable increase.

Nevertheless, the manufacturing scale is so small that most of the workers are engaged in the cottage industry, and the percentage of workers, who are engaged in the small and medium scale industries, is only about 13%.

The development of the manufacturing industry is resulting in the replacement of import goods and in increasing employment. Although gradual, this trend is growing steadily.

Table 1-7 shows the output trend of major manufactured products (see next page.)

1) Chemical fertilizer

The production of urea has rapidly increased with the completion of PUSRI IV and the Kujang Plant, and the production capacity has now amounted to 2.2 million tons. Part of the product is being exported. When the ASEAN Project at Aceh, North Sumatra, and East Kalimantan Project in Kalimantan are completed, the production and export will make a marked increase undoubtedly.

2) Cement

As the production capacity of cement has reached 5,700,000 tons a year, the import quantity has tremendously decreased. Indonesia is now exporting part of the product.

Table 1-7. Production of Selected Manufactured Products

(1,000 Ton, except as stated)

	1975/76	1976/77	1977/78	1978/79
Textiles (mn meters)	1,017	1,247	1,332	1,400
Yarn (1,000 bales)	445	623	678	900
Cement	1,241	1,979	2,879	3,640
Paper	47	54	84	166
Salt	147	560	786	165
Car tyres (1,000 units)	1,796	1,884	2,339	2,641
Coconut oil	268	276	276	319
Vegetable oil	31	33	31	38
Cigarettes (bn units)	24	24	23	24
Kretek (clove) cigarettes (bn units)	33	38	41	45
Helicopters	-	13	6	33
Aeroplanes	-	3	7	16
Radios (1,000 units)	1,071	1,100	1,000	1,128
Television sets (1,000 units)	166	213	482	611
Motor car assembly (1,000 units)	79	75	84	99
Motor cycle assembly (1,000 units)	300	268	272	320
Reinforcing iron	202	296	240	300
Galvanised iron sheet	145	156	185	185

Source: Central Bureau of Statistics.

3) Pulp and paper

The domestic consumption of pulp and paper is estimated to be about 500,000 tons a year. The domestic output is still small. What was produced in 1978/79 was only about 170,000 tons.

The government has a plan to enhance the production of pulp and paper. When the plants to be constructed in East Sumatra and East Kalimantan should be completed, the domestic production of pulp and paper will increase rapidly.

4) Automotive vehicles and parts

In 1979 the production of automoibles maintained the level of about 100,000 as in 1978. In 1980 it is expected to attain a 50% increase.

The rate of domestic production of automotive parts is anticipated to become higher gradually.

5) Household electric appliances

Since 1978 an explosive increase in the manufacture of household electric appliances has continued.

1.2.3 Agriculture and Forestry Industry

Despite the fact that the rate of contribution of the agriculture and forestry industry in the whole industry is decreasing gradually, its contribution rate is still high as Table 1-8 indicates.

Table 1-8. Industrial Origin of Gross Domestic Product

(1973 constant prices)

	1973		1978	
-	(bn Rp.)	(% of total)	(bn Rp.)	(% of total)
Agriculture, forestry & fishing	2,710	40.1	3,204	34.1
Mining	831	12.3	1,040	11.1
Manufacturing	650	9.6	1,159	12.3
Construction	262	3.9	494	5.3
Transportation & Communication	257	3.8	451	4.8
Public utilities	30	0.5	53	0.6
Trade, finance & other	2,013	29.8	2,991	31.8
Total GDP	6,753	100.0	9,392	100.0

Description will be made below on agriculture and forestry in Indonesia.

1) Rubber

Due to the transplantation of rubber trees and the rehabilitation of rubber estates, the production of rubber increased since 1963, and the construction of crumb rubber factories has increased the value added of rubber product.

Table 1-9 shows the production of rubber in recent years.

As this table indicates, the output of rubber remains on the same level in recent years.

Table 1-9. Production of Natural Rubber in 1976

(Unit: 1,000 Ton)

	1974	1975	1976	1977	1978a)	1979a)
Estate	248.7	244.1	246.8	248.8	272.0	-
Smallholder	606.6	577.5	600.0	586.2	572.0	162.0
Total	855.0	822.5	847.0	835.0	844.0	-

a) Provisional.
Source: Rubber Statistical Bulletin.

2) Palm oil

The output of palm oil in Indonesia ranks second in the world. Table 1-10 shows the output and the exports of palm products.

Table 1-10. Output and Exports of Palm Products

(Unit: 1,000 Ton)

	1972	1973	1974	1975	1976	1977	1978a)
Production:							
Palm oil	269	290	351	411	434	496	519
Palm kernels	59	64	74	84	87	88	103
Exports:							
Palm oil	236	263	281	386	406	405	413

a) Provisional.

Source: Central Bureau of Statistics; Presidential Report.

3) Rice

The implementation of the BIMAS and INMAS Programs and the introduction of a high-yield-variety rice plant has made it possible to gradually enhance the overall output. Table 1-11 shows the production in recent years. In 1980 the production is anticipated to achieve some 20,000,000 tons, and it is likely to achieve the long-standing desire of the self-supply of rice.

Table 1-11. Rice Production

	1973	1974	1975	1976	1977	1978	1979
Crop area (1,000 ha)	8,537	8,509	8,495	8,569	8,369	8,893	-
Production (1,000 Ton)	14,607	15,276	15,185	15,845	15,876	17,525	17,918

Source: Department of Agriculture; Central Bureau of Statistics.

4) Timber

Timber output had been inactive until about 1973, but the rise in the selling price has spurred on the output in recent years. As is shown in Table 1-12, timber is now the third largest source of acquiring foreign currency following petroleum and natural gas. Timber is mostly exported without being processed. Timber processing in the country is recently encouraged by the government. And the government abolished the export duty on processed timber in 1978, while the rate of taxation on the export of unprocessed timber was raised from 10% to 20%.

Table 1-12. Timber Output and Exports

	1974	1975	1976	1977	1978[a)]
Production (1,000 cu.m.)	23,280	16,296	21,427	22,939	31,091
Exports (mn$)[b)]	615	527	885	943	1,130
Exports (1,000 Ton)[b)]	12,435	11,385	15,770	15,651	16,050

a) Provisional. b) Fiscal years which end in March following year stated.

Source: Central Bureau of Statistics, Bank of Indonesia.

1.3 Industries of North Sumatra Province

The plan to establish MFC in Medan must be examined from the aspects of the present situation of the industries of North Sumatra and its deep bearing on the future industrial growth of North Sumatra.

The Province of North Sumatra has a land area of 71,680 km² (roughly 3.7% of the land area of Indonesia) and a population of 7,940,000 as of 1978 (roughly 5.8% of the population of Indonesia). Medan, the provincial capital with a population of roughly 1,200,000 (as of 1978), is the third largest city in Indonesia and the center of social, economic and industrial activities in the northern part of the island of Sumatra.

Table 1-13 indicates the investments and number of people employed by kind of industry in North Sumatra Province.

Table I-13 Regional Investment in North Sumatra Since 1968 till 1978

Activity Field	Investment		No. of Employee	
	Application	Fund (mn Rp.)	Indonesia	Foreign
1. Industry	133	88,465	25,189	30
2. Plantation	63	142,153	169,339	2
3. Fishery	3	2,035	1,140	–
4. Tourism	10	6,567	1,391	–
5. Forestry	12	18,113	3,006	90
6. Health Service	5	603	335	–
7. Communication	2	573	107	–
8. Facilities	2	1,114	2,000	–
9. Breedery	1	158	25	–
10. Publishing & Printing	6	454	462	–
11. Transportation	1	59	48	–
12. Accomodation	4	8,678	1,570	–
Total	242	268,972	204,612	122

Source: Regional Investment Coordination Province of North Sumatra.

1.3.1 Agriculture and Forestry

As shown in Tabl 1-13, over 80% of laborers in North Sumatra are engaged in agriculture and forestry and the ratio of investments in agriculture and forestry runs up to roughly 60% of total provincial investment, indicating that the province still relies largely on agriculture and related industries.

About 57% of the land area of North Sumatra consists of forests, roughly 16% of which is covered by big estates and small holders, while about 6% of the land area consists of paddy fields.

Of the 16% of land covered by the above-mentioned big estate and small holders, the land areas diverted to rubber and oil palm cultivation are roughly 10.8% and 1.7%, respectively, which together assume 12.5% of the total land area of the province.

This demesne of such a vast land area for the cultivation of rubber and oil palm, which serve as cash crops, is a major characteristic of the agriculture and forestry in this province.

1.3.2 Industry

As shown in Table 1-13, the number of workers employed in industry in North Sumatra as of 1978 runs up to only slightly over 12% of the total labor force in the province. Meanwhile, industry accounts for approximately one-third of total investments, ranking it second following agriculture and forestry in aspects of scale of investment.

Table 1-14 indicates the number of employees by kind of industry, from which it can be seen that light industries such as the food processing, tobacco manufacturing, textile and forestry products industries form the backbone of the industry in North Sumatra.

Rubber processing plants and palm oil manufacturing plants for extracting oil from oil palm seeds exist here and there and they are the principal palnts in the province.

Table I-14. Number of Large and Medium Industries in North Sumatra 1977

Industrial Group	Number of Industry	Paid employees			Unpaid Employees	Total of Employees
		Production	Others	Total		
1. Food Products	68	3,424	509	3,933	62	3,995
2. Beverage	2	42	19	61	–	61
3. Tobacco Products	16	5,279	479	5,758	2	5,760
4. Textile Products	34	2,534	514	3,048	8	3,056
5. Ready made Clothing Products	2	48	7	55	–	55
6. Leather Products	1	28	–	28	1	29
7. Food Wear Products	3	124	18	142	1	143
8. Wood Products	93	3,229	1,088	4,317	107	4,424
9. Furniture Products	5	68	7	75	6	81
10. Paper Products	3	200	47	247	–	247
11. Publishing & Printing Products	20	652	136	828	4	832
12. Chemical Products	13	547	147	694	4	698

Source: Census & Statistical Office of North Sumatra.

Table 1-15 indicates the amounts of foreign currencies earned through exports of rubber and palm oil from North Sumatra Province, realistically indicating the vital importance of manufacture of rubber and palm oil.

The provincial capital of Medan is therefore one of the leading centers of industrial activities in Indonesia, as described above, for which reason UNIDO has recommended the establishment of a foundry center here. However, as pointed out above, existing industries belong to the category of light industries and are not necessarily sufficient in both scale and number.

Table 1-15. Exports from North Sumatra Province

	1974 US$ million	1975 US$ million	1976 US$ million	1977 US$ million	1978 US$ million	Until Nov. 1979 Volume Ton	Until Nov. 1979 US$ million
Rubber	163.75	132.46	205.97	233.158	254.253	290.756	328.512
Palm Oil	176.91	163.76	139.85	178.590	176.650	425.057	219.768
Tobacco	15.57	16.22	17.11	20.797	17.070	1.678	17.915
Coffee	9.08	8.70	30.01	76.390	87.050	24.893	72.891
Tea	9.87	13.53	14.52	29.145	23.410	11.869	18.144
Shrimp	14.62	16.93	29.32	29.442	28.170	6.349	32.989
Others	22.06	20.32	28.74	38.632	25.120	489.181	78.676
	411.86	371.93	465.52	606.154	611.723	1.249.783	768.895

As can be judged from Tabl 1-16, although a tendency of progress is evident also in the metal and machine industries, these industries have not yet attained sufficient levels in scale.

Table I-16. Industries in North Sumatra Province

I. Total Number of Enterprises

Industry Sector	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
Miscellaneous Ind.	6,701	6,435	7,776	10,619	8,323	8,451	8,839	9,834	10,748
Textile Ind.	189	189	219	140	115	114	116	117	104
Metal & Machine Ind.	62	87	92	82	65	68	68	71	83
Chem. Ind.	179	152	179	192	199	109	109	27	88
Total	7,131	6,836	8,266	11,033	8,702	8,742	9,132	10,049	11,023

II. Total Number of Employees

Industry Sector	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
Miscellaneous Ind.	24,634	22,798	33,215	40,955	46,627	51,436	53,446	65,551	68,803
Textile Ind.	5,824	5,824	7,270	5,364	4,408	5,024	5,455	5,514	5,115
Metal & Machine Ind.	1,579	2,319	3,072	2,511	2,420	2,494	3,095	3,643	3,865
Chem. Ind.	2,617	2,415	2,441	4,478	4,485	2,017	3,547	3,050	3,453
Total	34,654	33,356	45,998	53,308	57,940	60,971	65,543	77,758	81,236

III. Total Horse Power of Motors (H.P.)

Industry Sector	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
Miscellaneous Ind.	60,866	62,985	64,597.82	100,026.44	96,906.82	101,388	123,276	153,371	153,860
Textile Ind.	6,506.8	6,506.8	6,506.8	7,363.9	6,984.2	6,617	8,871	9,467	6,361
Metal & Machine Ind.	865.5	1,163.55	1,436	8,834.8	4,727	13,870	37,914	42,663	45,077
Chem. Ind.	101.7	793.5	1,091	6,878.3	6,732.91	8,229	9,254	4,349	7,019
Total	68,340.10	71,448.85	82,781.62	133,122.44	115,350.93	130,094	179,315	209,850	212,317

IV. Investigation (mn Rp.)

Industry Sector	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
Miscellaneous Ind.	23,230.7	13,653.2	32,754.0	45,521.2	54,314.3	61,116.5	95,653.0	141,015.5	162,676.5
Textile Ind.	962.8	962.1	1,254.8	2,997.6	4,208.2	5,539.8	12,427.0	13,672.3	15,393.9
Metal & Machine Ind.	675.2	962.2	5,747.7	5,860.4	3,905.1	4,075.5	10,540.1	15,853.6	25,736.9
Chem. Ind.	1,709.8	1,510.4	1,897.9	5,196.8	7,448.6	11,173.4	25,535.6	23,984.5	26,881.5
Total	26,578.5	17,087.9	41,654.4	59,576.0	69,876.2	81,905.2	144,155.7	194,525.9	230,688.8

V. Total Production (mn Rp.)

Industry Sector	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78
Miscellaneous Ind.	22,306.8	19,439.2	28,648.6	23,073.9	80,911.5	67,116.4	133,806.4	166,523.1	211,553.1
Textile Ind.	2,299.8	2,299.8	4,893.6	4,356.4	5,291.7	6,538.8	7,956.6	8,349.7	9,480.3
Metal & Machine Ind.	1,270.3	2,195.4	7,630.3	7,070.3	8,550.9	9,055.6	21,372.7	32,552.1	36,878.3
Chem. Ind.	1,013.6	989.8	1,978.5	1,364.4	5,787.0	2,043.1	2,406.0	1,219.2	3,226.1
Total	26,890.5	24,924.2	43,151.0	35,865.0	100,541.1	84,753.9	165,541.7	208,644.1	261,137.8

The provincial government is presently constructing the Medan Industrial Estate (Mabur) at a site north of Medan with the aim of promoting the establishment of various kinds of industrial plants there. The industrial estate now extends over an area of 80 ha, but is scheduled to undergo further expansion to 200 ha before long.

While there is at present no large scale industry in North Sumatra Province, an LNG plant is already in operation in Aceh. This plant is not near to Medan and is handling inflammable substances, so it cannot be expected to become a big source of demand for castings produced by MFC, but at any rate it can be added among MFC's clients. The cement plants in operation in Padan can also be listed among MFC's clients.

1.3.3 Outlook for Industry

A large industrial estate is being prepared to the north of Medan, as described earlier. Although no industrial plant has been constructed there so far, various kinds of plants are certain to be attracted there, and upon construction of these plants in the industrial estate, the industry of North Sumatra Province is certain to undergo substantial diversification. At the same time, MFC will gain numerous clients, with the result that the market for its products will be greatly expanded.

An aluminum smelter is presently under construction at a site east of Medan and scheduled to go into operation in the near future. This smelter is also conceivable as a user of MFC products.

Meanwhile, the construction of a urea fertilizer plant is scheldduled to be started soon in Aceh. Since this plant is designed for operation at high pressure, it may not appear as a promising user of MFC products at the present stage, but is conceivable as user of castings for low-pressure applications, as in the sector of water supply system of this plant.

Chapter 2. Casting Industry in Indonesia

Chapter 2. Casting Industry in Indonesia

Casting being the basic material for making machinery, it is natural that the casting industry in Indonesia ought to be discussed in connection with the whole industry in Indonesia, and at the same time, it must be discussed while taking into consideration the trend of the world casting industry as well as the current situation of the casting industry in the neighboring countries.

2.1 Trend of the World Casting Industry

2.1.1 Casting Industry as One of the Basic Industries for Machine Industry

With the rapid development of various metal processing methods such as welding, press, forging, powder metallurgy or with the development of various inorganic and organic synthetic materials, the casting industry has reportedly fallen into a fading state. On the contrary, the casting industry has developed side by side with that of the machine industry. In other words, the casting industry has rather developed steadily as the basic industry for machine industry. Table 2-1 shows the output of castings and its transition in the principal casting producing countries in the world. From this table it can be understood that the output of castings increases together with the growth of economy. (See Table 2-1 on the next page.)

2.1.2 Progress of Casting Technique

Along with the development of various industries, the requirement for castings as material has naturally become strict. Castings are no longer a mere material. Castings must improve their quality as basic component. Castings are required not only to improve such quality as strength, hardness, heat resistance but also to have the exact dimensions, smooth surface or the complicated structure. Thus, castings must have their own character as parts. Also, with respect to their internal defect which is regarded as the defect of casting itself or the lack of uniformity of material, their improvement had strictly been demanded. In response to this demand by users, the manufacturing technique of castings has remarkably been improved in recent years.

Table 2-1. Transition of Production of Castings in Principal Industrial Countries

(Unit: 1,000 Ton)

Year	Country	Ferrous Casting	Non-Ferrous Casting	Others	Total
1975	U.S.A.	13,712	1,117	31	14,860
	Japan	5,034	503	1.9	5,539
	West Germany	3,922	333	23	4,278
	England	3,287	240	-	3,527
	France	2,640	230	1	2,871
	Italy	1,680	266	4	1,946
1976	U.S.A.	15,266	1,398	32	16,696
	Japan	5,392	585	2.4	5,980
	West Germany	4,106	392	25	4,523
	England	3,218	232	-	3,450
	France	2,635	271	0.5	2,906
	Italy	1,755	327	4	2,086
1977	U.S.A.	16,085	1,441	36	17,562
	Japan	5,615	623	2.9	6,242
	West Germany	4,007	413	25	4,445
	England	3,041	233	15	3,289
	France	2,517	275	5	2,797
	Italy	1,840	368	4	2,212

Source: Casting Year Book Japan, 1978.

2.1.3 Specialization of Foundry

As the casting technique has been advanced, various processes have been developed one after another. In the past, most of the foundries had developed as an independent enterprise with the form of the so-called jobbing foundry that collects orders from various users and manufacture what they can make on orders they selected. However, with the modernization of the casting process, foundries were gradually specialized, and they have developed in the way that a special foundry makes a special product. Consequently, what is called the captive foundry is becoming larger and is increasing in number. In view of this, the existing jobbing foundry has come to substantially take a form similar to the captive foundry by becoming a kind of subcontractor of a certain user or by a related enterprise.

Users of castings have requested a reduction in the price, in addition to the foresaid request for technical improvement. Responding to this, the casting process has been mechanized, enhancing the productivity. This is one of the causes that has brought the technical development of casting. And the mechanization of the process has contributed to the specialization of products.

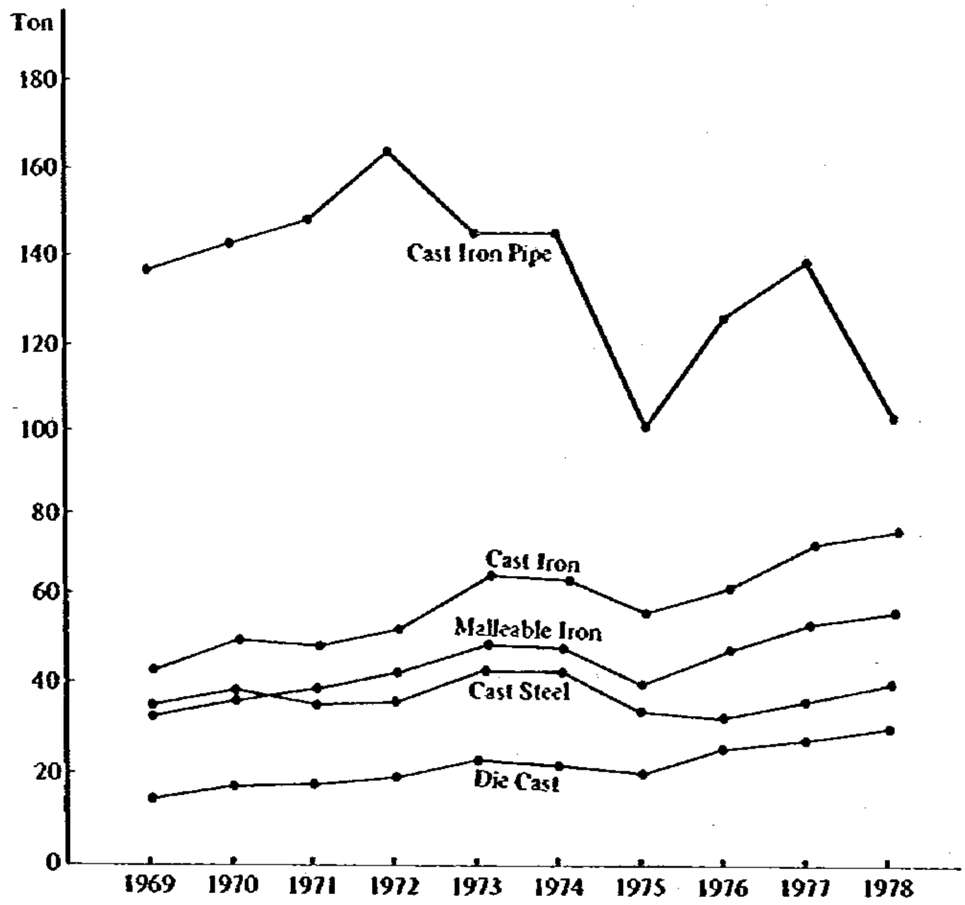
The enhancement of productivity by mechanization of foundries has naturally resulted in reducing the number of foundries. Fig. 2-1 shows the transition of productivity and Fig. 2-2 the transition of the number of foundries in Japan.

What has just been mentioned is summarized as follows; the foundries before modernization were a small labour intensive industry, where manual work was mainly employed, and were the jobbing foundry being managed by one-man control, which produce only about 50 tons a month; on the other hand, the recent modernized foundries are well mechanized and automated and are run under organized management. Most of them are operated almost like the captive foundry, putting out 500 to 1,000 tons a month.

Castings to be produced at modernized foundries are specific ones which are sold solely to specific users. Nevertheless, they have strong competitiveness in prices. The idea in the past of buying necessary castings from a nearby foundry has faded away. It is natural that part of the castings is being distributed as international goods.

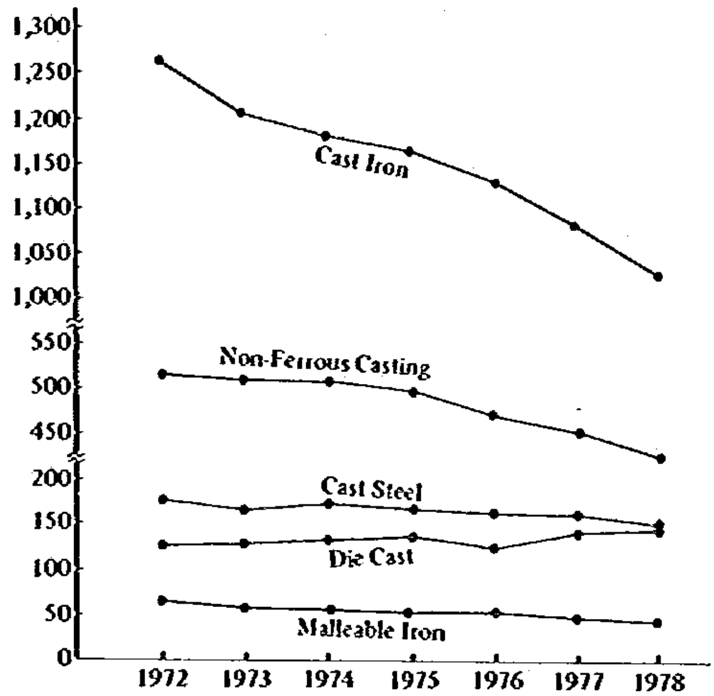
Fig. 2-1. Transition of Productivity of Foundries in Japan

Production per Head per Year



Source: Casting Year Book, 1978.

Fig. 2-2. Transition of Number of Foundries in Japan



2.2 Casting Industry in Asian Countries

In the above section, explanation was made on th difference between the foundry that has undergone modernization and the one remaining unmodernized. This difference is seen between the casting industry in the industrially developed countries and the casting industry in developing countries.

Most of the foundries in the principal casting producing countries are modernized, while the majority of foundries in Asian countries, which are shown in Table 2-2, are not modernized, while the majority of foundries in Asian countries, which are shown in Table 2-2, are not modernized yet. Of these countries, Korea and Taiwan have reportedly made a step forward to the modernization process. Table 2-3 shows the number of foundries in ASEAN countries. The real situation in the ASEAN countries will be understood if they are compared with the number of foundries and the number of laborers in Japan shown in Fig. 2-2 and Fig. 2-3.

Table 2-2. Production of Castings in Asian Countries
(1977 Base)

(Unit: Ton/Y)

Country	Cast Iron	Cast Steel	Copper Alloy Casting	Aluminum Alloy Casting	Other Kind of Casting	Total
India (1975)	490,000	68,000	-	-	-	558,000
Korea	420,200	51,400	-	-	-	471,600
Taiwan	296,260	24,100	5,850	7,250	4,800	338,260
Philippines (1976)	58,264	34,890	2,610	2,830	610	99,204
Indonesia (1975)	30,473	300	756	50	-	31,579
Malaysia (1976)	-	-	-	-	-	30,000
Thailand (1976)	-	-	-	-	-	25,000
Singapore (1976)	-	-	-	-	-	25,000

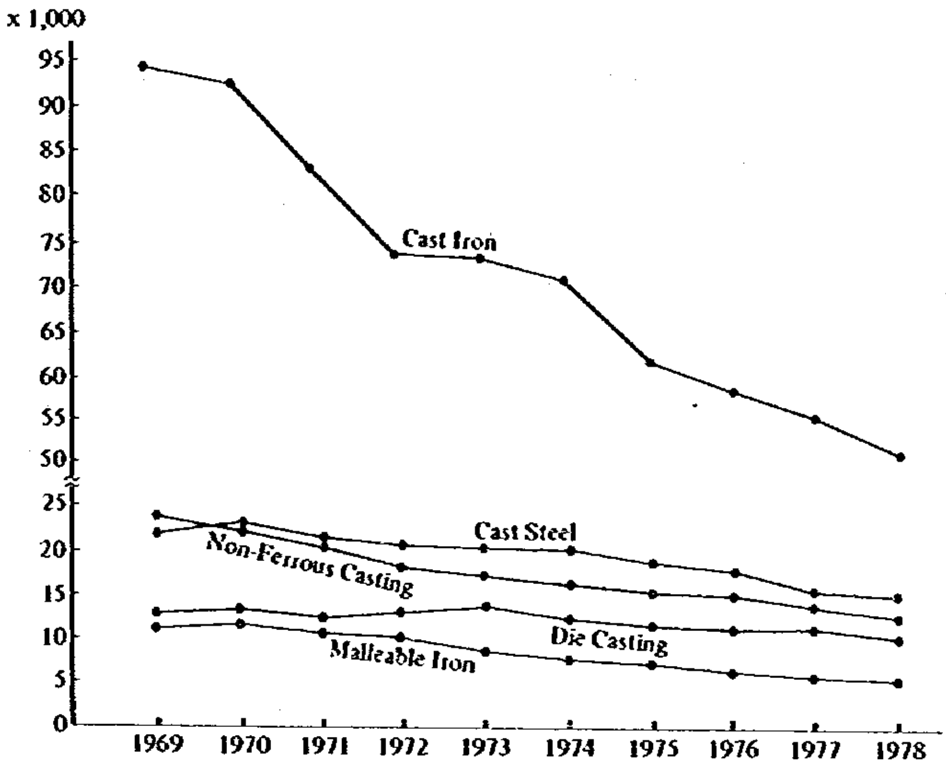
Source: Casting Year Book Japan, 1978, Sogo Imono, June 1978.

Table 2-3. Number of Foundries and Laborers in ASEAN Countries

Country	No. of Foundries	No. of Laborers
Indonesia	250 and less	Approx. 5,000
Singapore	50 and less	Approx. 1,000
Malaysia	150 and less	Approx. 4,000
Thailand	250 and less	Approx. 3,000
Philippines	270 and less	10,141

Source: Sogo Imono, June 1978.

Fig. 2-3. Transition of Laborers in Japanese Foundries



Source: Casting Year Book, 1978.

2.3 Casting Industry in Indonesia

2.3.1 General Condition

As was mentioned earlier, the casting industry in Indonesia has not yet been modernized as in the case with other industries, the users of castings. Statistics about castings being not sufficiently available, the details are unknown. However, when the overall annual output is assumed to be 30,000 tons and the number of foundries about 250, an averaged monthly output per foundry becomes 10 tons.

The present survey shows that part of the joint enterprises and state-owned enterprises that have introduced foreign funds, are modernized, while the majority of local enterprises have not yet been modernized and are struggling to come out as modernized foundries.

It is certainly an advisable and timely policy that the Indonesian Government has taken up the modernization of the casting industry as one of the important themes toward the modernization of her whole industry.

However, the modernization of the casting industry is never easy to materialize, as cases in other developing countries speak themselves. Unlike ironworks or petro-chemical industry, the modernization of casting industry cannot be realized by merely installing large-scale facilities. It is by no means easy for the casting industry to realize that when demand, raw material and others are taken into account. Also, its manufacturing process is varied according to products. Even if the facilities are available, it does not mean that good product can be manufactured.

Therefore, in order to realize the modernization, it is necessary for the Indonesian Government to adopt strong measures and to render assistance, and also the casting industry itself must make steady and long-term efforts.

2.3.2 Foundries in the Medan Area

The study team paid a visit to several foundries in the Medan area. Table 2-4 shows the general condition of those foundries. (See Table 2-4 on the next page.)

The table may not represent the entire casting industry, but the team has drawn from the present survey the following conclusion on the real state of the foundries.

1) Product is mainly cast iron (not standardized) and not of high quality.

2) The manufacturing process is mainly hand molding or floor molding, and machine molding is little employed. The products are low in their dimension precision. Most of the products are simple in their shape. For drying of molds, surface drying with charcoal is adopted.

3) Sand is mainly local river sand, and some foundries use synthetic sand made by mixing silica sand with clay.

4) For melting only a simple cupola is used.

5) Material is mainly scrap generated locally, and fuel is mainly coke from Taiwan.

Table 2-4. Examples of Local Foundries in Medan Area

Foundry		A	B	C	D	E
Factory Area (m²)		500	500	330	170	330
No. of Laborers (Foundry only)		15	20	25	4 + α	20
Production (Ton/M)		20	10	16	6	10
Process	Melting	Cupola 1.5t	Cupola 2.5t	Simple cupola 0.5t	Simple cupola 0.3t	Cupola 1.5t
	Molding	Hand mold charcoal dry	Hand mold charcoal dry	Hand mold charcoal dry	Hand mold charcoal dry	Hand mold charcoal dry
Material	Iron	Scrap iron	Scrap iron	Scrap iron	Scrap iron	Scrap & Pig iron
	Coke	Taiwan	Taiwan	Japan	Taiwan	Taiwan & Japan
	Sand	River sand (Local)	River sand & Banka silica	River sand	River sand	River sand & Banka silica
Product	Material	Cast iron	Cast iron	Cast iron	Cast iron	Cast iron
	Name	Gear, roll, etc.	Gear, roll, etc.	Gear, roll, etc.	General	Parts of vehicles
Wage (Rp./M)	Skilled	2,000	–	1,750 + 200	2,115 + 300	–
	Unskilled	750	–	–	–	–
Customer		Private use (Mainly)	Private use (Mainly)	Private use (Mainly)	Private use (Mainly)	Private use
Selling Price (Rp./kg)	General	450		400		
	Special	360 (for roll)				

6) The temperature in the melting process is low and the melting reaction seems to be in the oxidizing atmosphere. Products have defects such as blow hole and pin hole. However, as most of the products are used as parts of a comparatively simple machine like vegetable oil manufacturing equipment or an agricultural machine, no severe inspection is made.

7) Quality control is scarcely done.

8) In most cases, management is conducted by one-man control, and managing system is not well organized.

9) Almost all of the foundries that are being well managed belong to machine manufacturers. Seemingly, they look like jobbing foundries, but they are managed substantially as captive foundries.

10) It is very interesting that although the foundries have not yet been modernized, they are gradually shifting from the type of jobbing foundry to that of captive foundry.

2.3.3 State-owned Foundries and Joint Venture Foundries

Survey was made on some of the state-owned foundries and privately-owned joint venture foundries in other places than the Medan area. These foundries were built several years ago and have modernized facilities. Table 2-5 (on the next page) shows the general condition of these foundries.

These foundries have adopted the technique of industrially advanced countries, and are endeavoring to manage and control systematically. The privately-owned joint venture foundries seem to have gained success in their management, while this does not appear to be the case with the state-owned foundries.

The privately-owned enterprises were established for the purpose of obtaining profit and have gradually modernized their facilities, and have made a strong effort in their sales campaign and production; while the state-owned enterprises, that have installed highly productive large-scale production facilities, seem to have fallen short in their activity to improve their technique, production and sales. The former set up their foundries because there exists a market, from where they can expect a profit; while the latter seem to have given consideration to the sales of their products after completion of the foundries. The former have gradually

Table 2-5. Examples of Modernized Foundry in Indonesia

Factory		A	B	C	D
Type of Enterprise		Government Management	Government Management	Joint Enterprise	Joint Enterprise
Business Result		Loss	Loss	Profitable	Profitable
Potential Capacity (Ton/year)		5,000	4,500	2,500	2,400
Production (1980) (Ton/year)		1,000	500	2,500	2,000
Kind of casting		Cast steel	Cast iron & Cast steel	Malleable iron	Malleable & Cast iron
No. of Laborers		260	160		240
Operating Shift		1	1	3	3
Equipment	Melting	Heroult 5t Hi-FQ induction 1t ME-FQ induction 1t	Hi-FQ induction 5t, 1t	LW-FQ induction 5t	LW-FQ induction 3t
	Molding	Full automatic line 2	Automatic line 1	Automatic line 2	Simple machine 9
Salary (Rp./year)	Engineer	125,000 (Bonus included)	140,000 (Bonus included)		
	Skilled	100,000	60,000		50,000 + α
	Semi-skilled	50,000	40,000		
	Unskilled	20,000	30,000		18,000 + α
Selling Price (Rp./kg)		Cast steel (Wheel) 900 Cast steel (Cement ball) 500 Mn steel (13%) 2,500 Stainless steel 5,000	Cast iron (General) 1,300 White iron (Cement ball) 9,000 Cast steel (General) 1,500 Cast steel (Joint) 1,300 Cast steel (Anchor) 2,000 MN steel (Low alloy) 1,700		

expanded their facilities and improved their technique to enhance the productivity; while the latter are not well operated, despite that they have excellent facilities, and the present problem is how to improve the present low rate of operation and low productivity.

2.3.4 Distribution Route of Castings

As was mentioned in the preceding Chapter, generally speaking, the various industries, users of castings, have not sufficiently grown themselves, and the sales campaign by casting manufacturers is not satisfactory. Some of the joint venture enterprise are more closely related with their parent enterprises in foreign countries than with local industries and are hardly inclined to foster local foundries. Further, local foundries have no power to manufacture quality goods nor special goods. In view of this situation, a fairly large quantity of castings are reportedly being imported. Some say that 15,000 tons are imported a year, but no accurate data that supports this report is available. The survey conducted by the team has revealed the fact that most of cast steel requiring expensive manufacturing faciliteis and quality cast iron, not to mention high quality products, are all depending on imports. Table 2-6 shows some examples of imported castings.

Table 2-6. Examples of Imported Castings

Factory	Kind of castings	Name of part	Price (Rp./kg)	Exported from
A	Cast steel	Wheel	2,400 (FOB)	Singapore
B	Cast steel	Coupler	–	Singapore
C	Cast steel	Wheel, Flange	–	Singapore
C	Cast steel (Heat resisting)	Gate valve	–	Belgium
D	Cast steel	Ingot case	740 (C&F)	Japan
D	Cast iron	Ingot case	375 (C&F)	Taiwan
D	Cast iron (Alloyed)	Roll	1,500 (C&F)	Japan

Local industries have not yet established a footing, and the foundries do not make a move to unite themselves as an industrial group, and there is a strong tendency for specific foundries to form their own distribution route with specific users. There are cases where some of the users of castings depend on imports without making effort of getting necessary castings from local foundries.

2.3.5 Level of Casting Technique

Some foundries have the same level of technique as that in developed countries, but foundries are, in general, still in a lower level as was already mentioned. And even if a highly advanced technique is employed, there are many cases in which such technique is used only partially. The systematic casting technique or the so-called control technique such as production control and quality control in the casting process seems to be very low. It is quite opportune that the government established MIDC in Bandung, with aids from Belgium and West Germany and is making use of it effectively. Without doubt this is anticipated to bear fruit some time in the future.

Chapter 3. Market of Cast Products

Chapter 3. Market of Cast Products

3.1 Outline of the Various Surveys and Studies Made in the Past Years

To grasp the market situation of cast products of a nation as accurately as possible, it is necessary to begin with efforts to fully understand the actual consumption of cast products in that country. For this purpose, an accurate survey focusing solely on castings alone is essentially required. However, in many cases, the castings are used as the functioning components of the machines, and therefore, it is very difficult to compute precisely the consumption in the form of independent castings. In Indonesia, the majority of high grade castings are imported as being assembled as the components of the machines or as the components of the machine parts, and accordingly, it is impossible to ascertain the facts of imported castings by means of analyzing the national import statistics.

In addition to the above, it is possible to say that the relative industries to support the stable demand of cast products in Indonesia have not been well developed yet, and also the circulation networks of industrial products are complicated and are not constant at all.

From these reasons as stated above, the accurate computation of the consumption of castings in Indonesia is inevitably difficult. However, surveys with the aim of detecting the market conditions of castings in Indonesia have been carried out several times during the last decade. Namely, the demand survey by the joint work between UNIDO experts and the officials of the Department of Industry of Indonesia, the feasibility studies by Japan Consulting Institute, the market survey in the Medan area entitled as "Final Market Survey" which was carried out in 1976 at the request of MFC in the form of a joint task of Mr. S. Ono*, a Japanese private expert and Ir. M.T. Nasution, a technical director of MFC, and some others can be cited.

Among these surveys, the UNIDO–DOI joint survey has the largest scale of survey in the respects of the covered area, the manpower used and the survey period. In a sense, this survey has grasped the market of castings in the whole Indonesia including North Sumatra in rather a macroscopic view point.

On the other hand, the "Final Market Survey" by Ono–Nasution team was aimed at the detailed survey of demand in each consumers mainly in the Medan area.

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* a member of the present JICA study team.

3.2 Manner of Study

In this survey, importance is attached to finding the market conditions of castings in the Medan area, so it has been decided to carry out the survey and the analysis of data in the following manner. Namely, the demand figures in the Medan area given by UNIDO survey are to be modified and converted to the present basis considering the lapse of time, while the demand figures given by Ono-Nasution report are to be revised or reconfirmed by the JICA study team to obtain the most reasonable figures of the present basis. Thus, the size of market in the Medan area is to be deduced from the figures obtained by the above two methods, while the demand of the castings recommended to be included in the production program of MFC is also to be figured out with higher accuracy.

3.3 Potential Demand of Castings in Indonesia

An extensive demand survey was carried out by a UNIDO metalworking expert with the assistance of staffs of Directorate General of Basic Industry in July, 1969, and the result of the survey was issued in April, 1971. The result is quoted here in Table 3-1.

Table 3-1. Potential Demand of Iron and Steel Castings in Indonesia

(Unit: Ton/Y)

Area	Cast Iron	Cast steel
East Java	9,000	2,000
West Java	6,000	2,000
North Sumatra	5,000	2,000
South Sumatra	2,000	500
Bangka (Tin mines)	1,500	900
Belitung (Tin mines)	1,000	700
Singkep (Tin mines)	500	500
Southeast Kalimantan	500	200
Others	1,100	1,500
Total	26,600	10,300

Total Iron and Steel Castings in Indonesia: 36,900 Ton/Y

Total Iron and Steel Castings in North Sumatra: 7,000 Ton/Y

In 1975, the same survey team carried out the survey of the potential demand of castings in North Sumatra including such provinces as Aceh, North Sumatra, Riau, West Sumatra and Jambi. The outlined summary of the result of survey is quoted in Table 3-2.

Table 3-2. Potential Demand of Castings in North Sumatra

(Unit: Ton/Y)

Item	Demand per Year
1. Agricultural Use	775
(Irrigation pumps, rubber and palm-oil processing machines, rice and corn processing machines, etc.)	
2. Public Works	2,975
(Stone crushers, construction equipment, pipes and fittings, valves, manhole covers, etc.)	
3. Industrial Use	2,275
(Parts for cement mills, rolling mills and other machine parts including sewing machines and diesel engines)	
4. Shipbuilding	825
5. Mining and Forestry (Wheels)	100
6. Crude Oil and Natural Gas (Valves and fittings)	500
7. Household (Pumps and utensils)	2,000
8. Miscellaneous	1,450
Total	10,900

3.4 Production of Castings in Indonesia

Out of the various surveys carried out in the past to detect the volume of production of castings in Indonesia, the one made by the joint work of UNIDO – Department of Industry in 1969 is still considered as the most detailed. The result of the survey is summarized and quoted below in Table 3-3.

Table 3-3. Production of Castings in Indonesia (1969)

Area	Numbers of Foundry	Output (Ton/Y)
West Java (Jakarta, Bandung, Tirebon)	9	3,240
Central Java (Jogja, Solo, Tegal, Semarang)	4	900
East Java (Surabaya, Malang)	13	4,476
North Sumatra (Medan)	4	660
Central Sumatra	4	576
Bangka and Belitung	2	1,560
Kalimantan	1	120
Total		11,532

According to the result of this survey, the production of castings in Indonesia in the year 1969 was estimated as 11,532 tons. By comparing this volume of production with other representative countries, the position occupied by Indonesia among other countries in the field of the production of castings is detected. For this purpose, a study was made to clarify the level of per capita production of castings in Indonesia among other countries and their relations with per capita GNP figures. The result are shown in Table 3-4.

Table 3-4. Per Capita Production of Ferrous Castings in Representative Countries (1970)

Country	Population (x 1,000)	Per Capita GNP (US$) (1974)	Total Production (Ton/Y)	Per Capita Production (kg/Y)
Australia	11,751	4,959	713,000	60.7
Canada	20,441	5,678	1,172,181	57.3
West Germany	67,872	5,466	5,135,705	75.7
India	511,115	133	2,477,620	4.8
Japan	99,920	3,251	6,533,654	65.4
Philippines	34,656	229	24,527	0.7
Taiwan	13,142	-	159,723	12.2
Singapore	1,956	-	17,417	8.9
U.S.A.	199,118	6,030	20,269,972	101.8
U.S.S.R.	236,000	-	24,361,000	103.2
Indonesia	120,000	122	11,532	0.1

The fitures of production of castings in these countries other than Indonesia quoted in the above Table 3-4 are extracted from the data which appeared in the December, 1970 issue of "Modern Castings", while the figures of Indonesia was quoted from the above Table 3-3. The comparison indicates the fact that the per capita production of castings in Indonesia in 1970 is standing at a very low level. Table 3-4 also suggests that the per capita production of castings is proportionate to the per capita GNP figures. Among the group of countries showing a higher per capita GNP, the industry – based countries show a higher level of production of castings than the agriculture – based countries, suggesting a deep relationship between the production of castings and the level of industrialization.

In Indonesia, many new foundries have started their operations one after another in recent years. These manufacturers include P.T. Baninusa, P.T. Bakrie-Tubemakers, P.T. Kaliuran, P.T. Indomachine, P.T. Sri Riken, Singer Industries and MIDC. By totaling the production of castings from these foundries alone, it is obvious that the total output of castings in Indonesia today is far above the level of about 12,000 t/Y which was estimated in 1969.

Based on the analysis of the results of the surveys carried out in the past and also based on the newest information, the actual production of castings in Indonesia today is estimated and illustrated in Table 3-5.

Table 3-5. Production of Castings in Indonesia (1981)

Area	Numbers of Foundry	Output (Ton/Y)	
		Cast Iron	Cast Steel
West Java	15	12,000	360
Central Java	30	3,600	-
East Java	13	4,200	720
North Sumatra	20	3,600	20
Central Sumatra	6	600	-
Bangka, Belitung	2	1,800	-
Kalimantan	1	200	-
Total :	87	26,000	1,100

Total Iron and Steel Castings: 27,100 Ton/Y

One of the reasonable methods to estimate the actual production of castings in a country is to study the consumption of raw materials used in th foundries. As the foundry grade coke and pig iron are not yet produced in Indonesia, the output of castings can be computed with a considerable accuracy by obtaining the volume of importation of these raw materials. The importation record of coke is obtained from the Central Bureau of Statistics of Indonesia and is quoted here as Table 3-6.

Table 3-6. Importation of Coke

Year	Ton
1963	819
1964	264
1965	3,112
1966	2,448
1967	3,411
1968	1,464
1969	14,063
1970	1,863
1971	18,183
1972	10,152
1973	4,764
1974	18,184

The volume of coke imported each year varies greatly, so the average of 5 years from 1970 upto 1974 is taken into consideration. The mean yearly import during the above 5 years becomes 10,630 tons. In the meantime, it is almost sure that more or less 70% of the imported coke is consumed by sugar industries, city gas supply and other miscellaneous industries, so the remaining 30%, namely 3,200 tons of coke is considered to be consumed by the foundries in Indonesia. Presuming the average coke ratio in the operations of small cupolas as 15%, the total melt becomes about 21,400 tons. The total yield which is composed of the casting yield (melting loss, pattern yield, grinding loss, etc.) and the rejects, is considered as 60%, so the total weight of good castings becomes about 13,000 tons.

In the same manner, the total production of castings in Indonesia has been calculated on the basis of pig iron as the major material for cast iron production. The record of import of pig iron is shown in the following Table 3-7 which is quoted from the data issued by the Central Bureau of Statistics of Indonesia.

Table 3-7. Importation of Pig Iron

Year	Ton
1963	6,167
1964	3,386
1965	165
1966	36
1967	118
1968	2,664
1969	n.a.
1970	1,295
1971	7,505
1972	25,272
1973	22,325
1974	7,138

Again, there is an obvious irregularity of figures, and the most reasonable way is to take the average. The mean value of importation in the period of 5 years from 1970 upto 1974 is about 12,700 tons per year. The majority of small scale cupolas being used in Indonesia are operated with pig iron as the only metallic raw material, and taking the return scrap into consideration, the pig iron ratio per ton of melt is estimated as 40%. From this assumption, the total melt of cast iron is deduced as about 32,000 tons and the annual production of good castings is calculated as about 19,000 tons under the total yield of 60%. The mean value between 19,000 tons obtained from the consumption of pig iron and 13,000 tons obtained from the consumption of coke is 16,000 tons, which is presumed as the yearly cast iron production by cupolas in Indonesia.

On the other hand, the volume of production of cast iron and cast steel by electric melting facilities in Indonesia is believed to be more or less 10,000 tons. By adding these figures, it is possible to obtain 26,000 tons as the total production of castings in Indonesia. This value closely resembles to 27,100 tons given in Table 3-5, and this fact suggests that the survey by the joint team of UNIDO-DOI accurately grasps the actual condition of the foundry industry in Indonesia and the report of the survey is quite reliable.

Even if this value of 27,100 tons reported by UNIDO–DOI survey as the annual production volume of castings is transposed to the column of Indonesia in the foregoing Table 3-4, the per capita production of castings reaches only a little above 0.2 kg, and it is all the more possible to realize its low level of production.

Viewing from the fact that the development of industries is the first priority of the Government of Indonesia, the production of castings should by all means be increased on a large scale, and it will surely be increased, but it is not possible to expect a remarkable growth of the foundry industry without the simultaneous growth of the general machine industry which constitutionally supports the foundry industry.

3.5 Production of Castings in the Medan Area

It is confirmed by the survey that there are about 20 foundries operating in the city of Medan and its suburbs. They are of small scale and are producing more or less 15 tons average of low grade grey iron castings per month. It is observed that the total output of castings from these existing foundries is about 300 tons per month or 3,600 tons per year.

The JICA study team paid their visits to several existing workshops and held interviews with the representative persons to investigate the actual status of the production of castings in the Medan area. The discussions extended over the activities of management with regard to the present operations of foundries as well as their thoughts on the future plans of operations. During the above visits, a great deal of information was obtained regarding the availability, method of procurement and costs of raw materials and utilities, sales network and selling prices of products, and many others. The names of workshops visited by the JICA team during this survey are as follows:

P.T. Sumatra Raya Sari
P.T. Hari Subur & Sons
P.T. Super Andalas Steel
P.T. Tenaga Baru
P.T. Bengkel Gelugur
P.T. Growth Sumatra

These 6 factories are equally competent manufacturers in Medan, and especially, P.T. Suamtra Raya Sari and P.T. Hari Subur & Sons are holding a part of shares of the MFC project. These two factories and P.T. Tenaga Baru and P.T. Bengkel Gelugur are still running their foundries as before, but P.T. Super Andalas Steel discontinued the foundry operation due to the reasons that they could not compete with the cheap castings produced by smaller back yard foundries in the outskirts of Medan and also that their operations of steel fabrication shop, which was their main line of business, became quite busy keeping pace with the activeness of palm oil industry in recent years. In case of P.T. Growth Sumatra, the only well-furnished foundry in Medan having 2 units of low frequency induction furnaces of a fairly large scale, is now producing a small volume of castings for their own repair parts requirement of the bar mill equipment, and the majority of thier melting capacity is used for producing ingots to support their active rolling mill operations.

From the information gathered from these factories it has been reconfirmed that the production of castings in the Medan area has been maintaining a constant level in the past decade, and the greater part of their products are delivered to the rubber and palm oil processing factories scattered widely in the plantation estates of North Sumatra.

3.6 Conditions of Market Related Directly to MFC

According to the survey carried out by the joint team of UNIDO and DOI in 1975, it is estimated that the potential demand of castings in North Sumatra (consisting of such states as Aceh, North Sumatra, Riau, West Sumatra and Jambi) is 10,900 tons per year. The contents diversify greatly in such varieties as pumps, parts for rubber processing machines and palm oil processing machines, road rollers, parts for construction machines, water pipes and soil pipes, pipe fittings and joints, manhole covers and frames, parts for cement plant equipment, sewing machines, parts for Diesel engines, winches and anchors, valves for petroleum and natural gas industries, hand pumps, daily utensils including cooking pans, automobiles repair parts, truck wheels and so on. Among these stated above, such items as pumps, palm oil processing machines, road rollers, construction machines, valves, etc. rely greatly on castings because a large portion of their component materials is made of castings, but at the same time, these items require other components which are manufactured by a higher and more complicated technology and engineering requirement to develop their proper functions. Even though MFC can produce the component castings for these items, it is not always possible to sell these items as the complete functioning commodities.

From this point of view, the JICA study team visited the undermentioned consumers of castings and exchanged views with the responsible persons with the aim of reviewing the potential demand indicated by UNIDO–DOI team and also checking the contents of the aforementioned "Final Market Survey" report expecting the possible changes after the lapse of 5 years.

P.T. Atmindo (Manufacturers of palm oil processing plant equipment)
P.J.K.A. (Indonesian National Railway)
P.T. Sawit Malinda (Palm oil refinery)
P.T. Adei Crumb Rubber Factory (Rubber processing)
Perkerjaan Umum (Field service unit of Department of Public Works)
P.T. Indonesia Asahan Aluminium (Aluminum smelter)
Gunung Gahapi (Bar rerolling mill)

Besides, the following producers of castings and an organization were visited by the JICA team in Jakarta, Surabaya and Bandung.

P.T. Barata Foundry Gresik (Surabaya Foundry Center)
P.T. Sri Riken Indonesia (Pipe fittings)
P.T. Barata Foundry Jakarta (Jakarta Foundry Center)
P.T. Bakrie–Tubemakers (Pipe fittings and automobile parts)
MIDC (Metals Industry Development Center)

Taking the results of above visits into account, the JICA study team set the level of 5,450 tons as the potential demand of castings salable independently, which is 50% of the potential demand estimated by the UNIDO–DOI survey.

As stated before, the region covered by the demand survey of UNIDO–DOI team was concentrated on North Sumatra including such states as Aceh, North Sumatra, Riau, West Sumatra and Jambi, whereas the marketing activity of MFC will cover the area closer to Medan (perhaps so-called "Greater Medan") and it is considered that the potential demand of castings in this area is more or less 80% of the potential demand of independently salable castings in North Sumatra. Accordingly, the potential demand pursuable by MFC has been estimated as 4,360 tons per year.

It is necessary to realize that the aforementioned survey of UNIDO–DOI was carried out in 1975. On the other hand, the start up of the operation of MFC, if this project is materialized, will be the early part of 1984.

Looking at the market once again, it is recognized that the major consumers of castings in Medan and its surroundings are the processing factories of rubber and palm oil, and the increase of production in these factories is depending on the increase of plantation acreage. Because of this peculiarity, it is not possible to expect a sharp increase of demand of castings in rubber and palm oil factories. Accordingly, the total growth ratio of demand of castings including other miscellaneous industires is considered more or less as 5% per annum. With this growth rate of 5% per annum, the aforementioned 4,360 tons of the potential demand of independently salable castings estimated on the ground of 1975 can be translated into 6,760 tons in 1984.

By visiting and interviewing the foundries in and around the city of Medan, the study team realized that these existing foundries were intending to continue their casting works even after the start up of MFC simply for assuring themselves of the steady supply of cast materials for their machine shops. The total output of these foundries is estimated as 3,600 tons in 1981 and it is anticipated that the output will perhaps reach the level of 4,000 tons in 1984. Comparing this figure with 6,760 tons given above, the potential demand is calculated as approximately 2,800 tons per year. In other words, the potential demand of independently salable castings as aimed at by MFC will be about 2,800 tons per year which is the balance obtained by deducting the output of the existing foundries from the anticipated potential demand.

3.7 Demand of Castings which are Recommended for MFC to Produce

In selecting the products recommendable for MFC, it is necessary to eliminate the grades and kinds of castings similar to those which are currently produced in the existing foundries in the Medan area. The reason is very simple. These castings produced in the Medan area are generally of simple shapes and are low in quality from the aspects of chemical composition and physical property, and accordingly, the added value thereof is low. It is obvious that MFC cannot compete cost-wise with these existing castings even if MFC fully utilizes its skill and technology. The next point to consider is that the castings to be recommended for MFC should have a reasonable quantity as one lot of order. If there are many cases of a few piece orders, the cost of production becomes inevitably high.

Standing on this basic concept, the team has carried out the investigation to choose the castings with a higher added value recommendable for the production in MFC among the potential demand of castings (including positive demand in the very near future) in the Medan area. The result of selection is illustrated in Table 3-8.

As shown in the below Table 3-8, the demand of recommendable castings for the production in MFC has been calculated as 1,481 tons of cast iron and 1,076 tons of cast steel per year. For translating the above listed varieties of demand into the production program of MFC, it is essential to add so-called "reliability ratio" of securing orders to the considerations, and further, it is necessary to refer to the very low operating efficiency and slow start up which are actually experienced in Foundry Center Jakarta and Gresik, Surabaya.

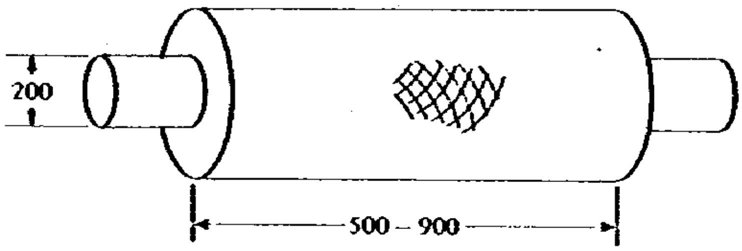
Table 3-8. Demand Analysis

(Dimension Unit: mm)

1. Gray Iron & Alloy Iron Castings

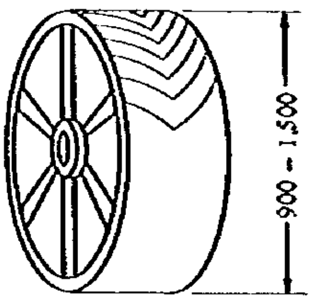
1-1 Rolls for Rubber Mill

Average Unit Weight:	600 kg
Expected Quantity per Month:	40 pcs.
Demand per Month:	24 t
Material:	FC-20/FC-Ni-Cr



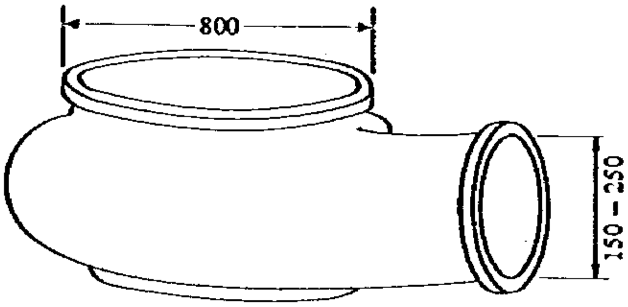
1-2 Herical Gears for Rubber Mill

Average Unit Weight:	350 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	7 t
Material:	FC-20



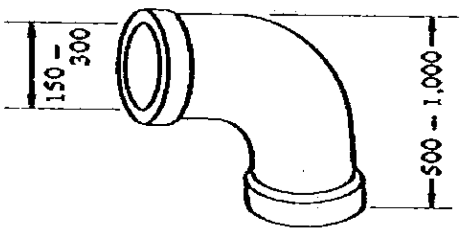
1-3 Pump Casing for Tin Mines

Average Unit Weight:	800 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	16 t
Material:	FC-20



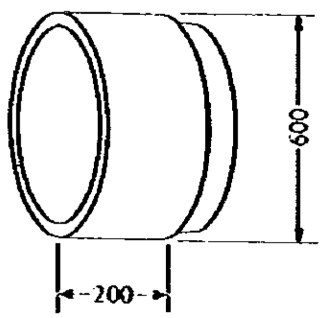
1-4 Soil Pipe Joints and Fittings

Average Unit Weight:	50 kg
Expected Quantity per Month:	80 pcs.
Demand per Month:	4 t
Material:	FC-20



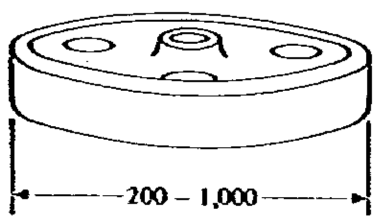
1-5 Brake Drums for Trucks & Buses (for immediate future)

Average Unit Weight:	80 kg
Expected Quantity per Month:	200 pcs.
Demand per Month:	16 t
Material:	FC-20



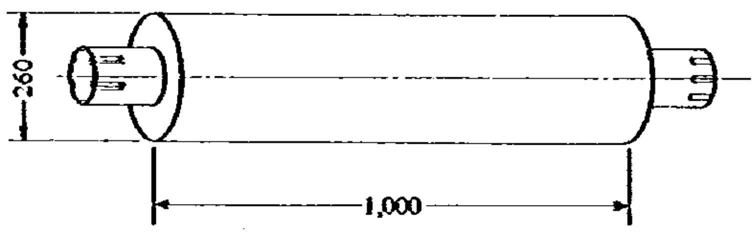
1-6 Fly Wheels for Diesel Engines (for immediate future)

Average Unit Weight:	50 kg
Expected Quantity per Month:	100 pcs.
Demand per Month:	5 t
Material:	FC-25



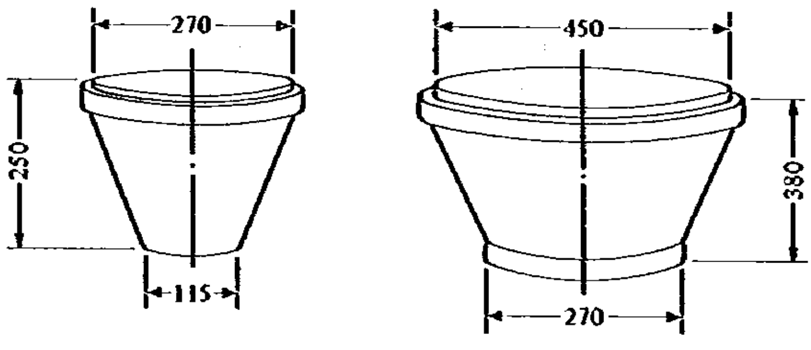
1-7 Rolling Mill Rolls

Average Unit Weight:	400 kg
Expected Quantity per Month:	40 pcs.
Demand per Month:	16 t
Material:	FCD alloy (Ductile cast iron)



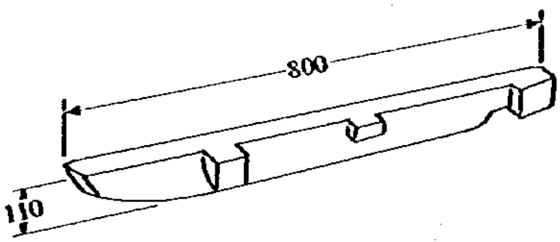
1-8 Hydrocyclone Parts

Average Unit Weight:	30 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	0.6 t
Material:	27 Cr FC



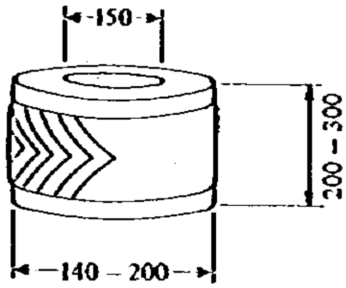
1-9 Roaster Bar

Average Unit Weight:	8 kg
Expected Quantity per Month:	800 pcs.
Demand per Month:	6.4 t
Material:	Ni-resist



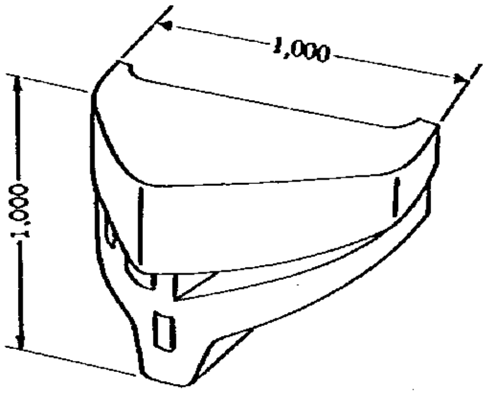
1-10 Clutches & Pinions for Rubber Rolls

Average Unit Weight:	50 kg
Expected Quantity per Month:	120 pcs.
Demand per Month:	6 t
Material:	FC-20



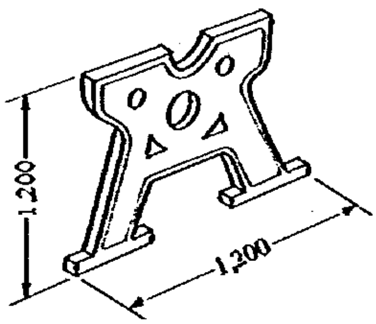
1-11 Counter Weight for Forklifts (for immediate future)

Average Unit Weight:	1,000 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	20 t
Material:	FC-15



1-12 Rubber Roll Frames

Average Unit Weight:	400 kg
Expected Quantity per Month:	6 pcs.
Demand per Month:	2.4 t
Material:	FC-20

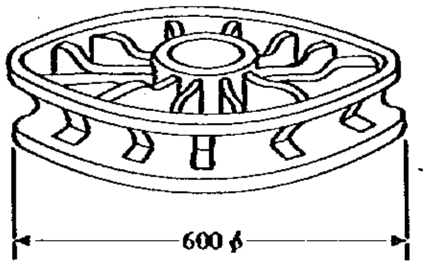


Total Monthly Demand of Cast Iron: 123.4 t (1,480.8 Ton/Y)

2. Plain Carbon Steel & Alloy Steel Castings

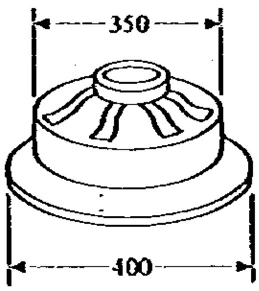
2-1 Sprockets (for immediate future)

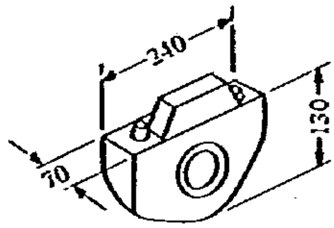
Average Unit Weight:	200 kg
Expected Quantity per Month:	40 pcs.
Demand per Month:	8 t
Material:	SC



2-2 Wheels and Axle Boxes

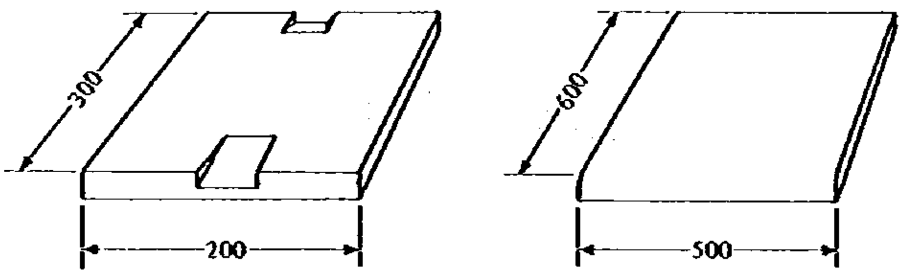
Average Unit Weight:	25 kg
Expected Quantity per Month:	350 pcs.
Demand per Month:	8.75 t
Material:	SC





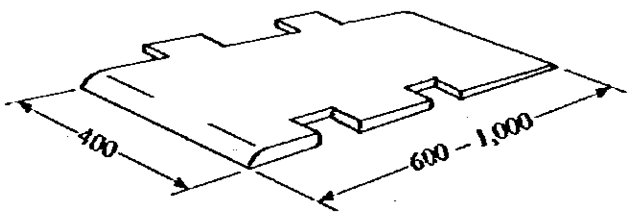
2-3 Cement Mill Liners & Other Liners

Average Unit Weight:	55 kg
Expected Quantity per Month:	80 pcs.
Demand per Month:	4.4 t
Material:	SC Mn H



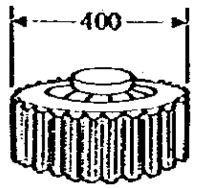
2-4 Truck Pads (for immediate future)

Average Unit Weight:	50 kg
Expected Quantity per Month:	60 pcs.
Demand per Month:	3 t
Material:	SC Mn H or Low alloy



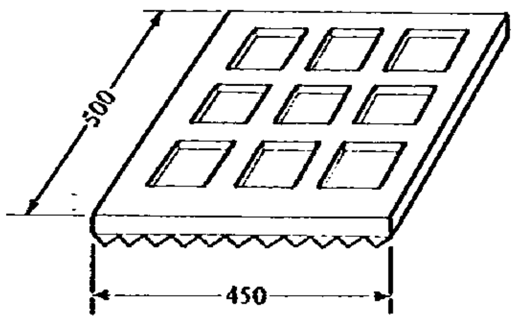
2-5 Various Gears

Average Unit Weight:	50 kg
Expected Quantity per Month:	30 pcs.
Demand per Month:	1.5 t
Material:	SC



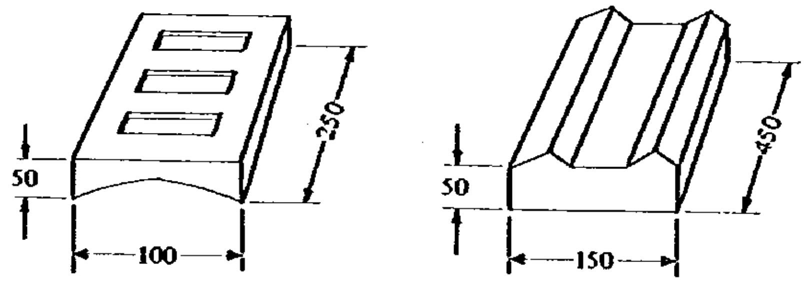
2-6 Jaws for Crushers

Average Unit Weight:	80 kg
Expected Quantity per Month:	15 pcs.
Demand per Month:	1.2 t
Material:	SC Mn H



2-7 Hammers for Crushers

Average Unit Weight:	20 kg
Expected Quantity per Month:	80 pcs.
Demand per Month:	1.6 t
Material:	SC Mn II

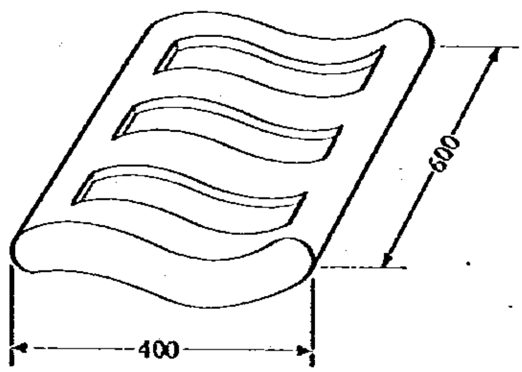


2-8 Rolling Stock Parts

Average Unit Weight:	20 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	0.4 t
Material:	SC

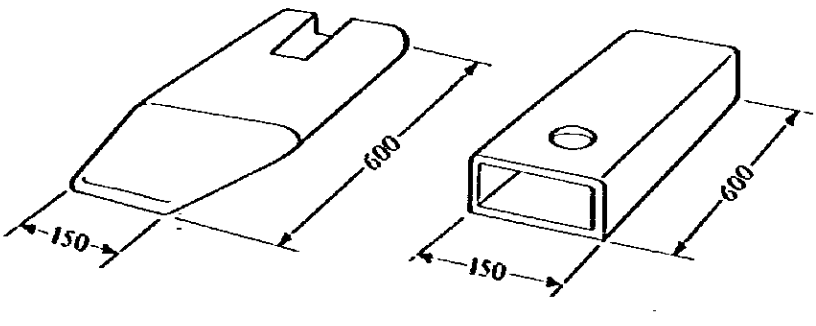
2-9 Toggle Seat for Stone Crusher

Average Unit Weight:	120 kg
Expected Quantity per Month:	15 pcs.
Demand per Month:	1.8 t
Material:	SC Mn H



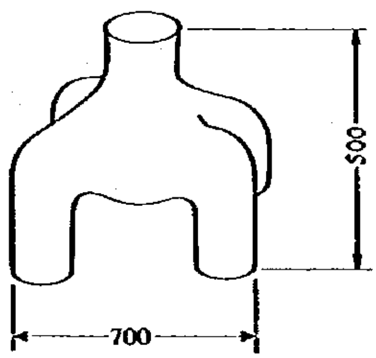
2-10 Teeth & Adapters (for immediate future)

Average Unit Weight:	60 kg
Expected Quantity per Month:	200 pcs.
Demand per Month:	12 t
Material:	Low alloy steel



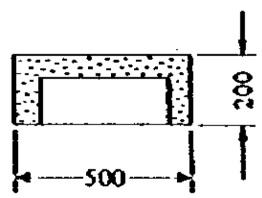
2-11 Electrode Holder for Aluminum Smelting (for immediate future)

Average Unit Weight:	300 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	6 t
Material:	SC



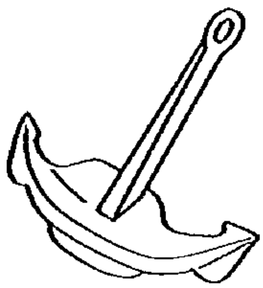
2-12 Piling Heads

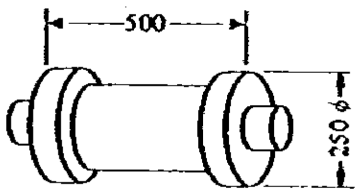
Average Unit Weight:	200 kg
Expected Quantity per Month:	15 pcs.
Demand per Month:	3 t
Material:	SC



2-13 Anchors & Winch Parts

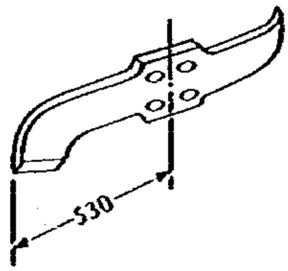
Average Unit Weight:	500 kg
Expected Quantity per Month:	6 pcs.
Demand per Month:	3 t
Material:	SC





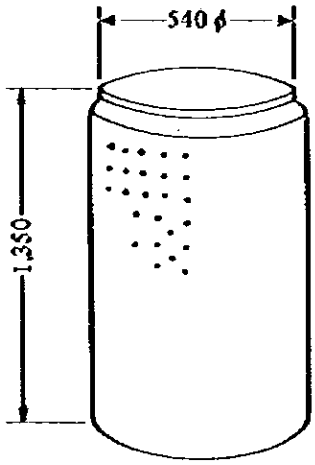
2-14 Digester Blades

Average Unit Weight:	35 kg
Expected Quantity per Month:	100 pcs.
Demand per Month:	3.5 t
Material:	Alloy steel



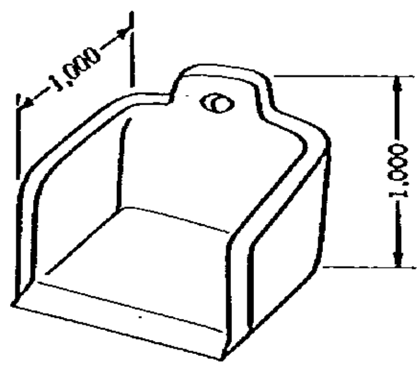
2-15 Press Cage

Average Unit Weight:	750 kg
Expected Quantity per Month:	6 pcs.
Demand per Month:	4.5 t
Material:	Alloy steel



2-16 Dredger Buckets

Average Unit Weight:	1,200 kg
Expected Quantity per Month:	20 pcs.
Demand per Month:	24 t
Material:	SC Mn H



2-17 Other Miscellaneous Steel Castings

Average Unit Weight:	100 kg
Estimated Quantity per Month:	30 pcs.
Demand per Month:	3 t
Material:	SC

Total Monthly Demand of Cast Iron: 89.65 t (1,075.8 Ton/Y)

Chapter 4. Selection of Product Mix and of Production Scale

Chapter 4. Selection of Product Mix and of Production Scale

4.1 Product Mix

4.1.1 Sales Prediction Estimated from Demand Projection

According to the amount of annual demand for products by kinds which was estimated in Chapter 3, the annual demand for product is calculated as follows; Cast iron: 1,481 tons, cast steel: 644 tons, and high manganese cast steel: 432 tons. However, it is a matter of course that consumption or demand do not necessarily result in receiving orders. It is not recommended for the time being to produce such castings that require high manufacturing technique and those that require manufacturing facilities which have a low rate of utilization. Also, even if users should have purchased castings newly manufactured by MFC, they might be unable to use them immediately owing to their delay in making preparations. Further, due to a lack of sales campaign on the part of a supplier, they may not be able to receive as many orders as are expected from demand.

In case what has just been mentioned above is taken into account, it seems advantageous to receive orders preferentially for cast steel and high manganese cast steel products, most of which are now imported and whose prices are high, and to receive orders for cast iron having high quality, for which no competition seems to take place with the existing foundries. It is likely to be able to receive orders of 1,200 tons for castings if various conditions can be satisfied. Details on the castings to be produced and sold will be described later referring to demand prediction.

4.1.2 Selection of Product Mix

Needless to say, when a foundry is set up, it is required to carry on profitable operation, by installing the minimum scale of production facilities and making its operation at a high rate. Consequently, it is advisable to select the products which have the same chemical composition and the size within a certain range. However, at a place like the Medan area where the casting market is not large enough, it is impossible to limit the product to one kind. Because of this, it is advisable to design a foundry that manufactures three kinds of products, namely cast iron, cast steel and high manganese cast steel.

There are two kinds of castings, (1) such castings as coupling, manhole frames and covers, and liners and teeth of crushers which are made of high manganese cast steel: They, as cast or by simple machining, can be the final products, (2) castings that become parts of complete machines after several steps of machining and by being combined with other parts.

In the case of (2), it is presupposed that there exists an enterprise that assembles parts into a complete machine and that there exists an intermediate machining shop. No machine manufacturing industry, which consumes a large quantity of castings, has yet been established in the Medan area. There are plenty of demand for the pump casing used in the tin mines as wear-resistant parts, but these casings are being ordered to foundries in Java Island and overseas. Therefore, it is difficult for a newly established foundry to obtain all the orders. Demand for casting parts such as brake drums, flywheels and counterweight can be expected when the machine industry comes to develop in the future. It is not possible to receive plenty of orders at the initial stage of a foundry newly established.

Consequently, the percentage of orders to be received for ductile cast iron roll which is used for rolling of sections, and for the hydroclone parts made of 27% chromium cast iron which is used for squeezing palm oil was assumed to be 20% respectively, and the percentage of orders for other products 40%. According to calculation, the amount of orders for cast iron was estimated to be 600 tons a year.

As regards cast steel, there being no competition with other local manufacturers, the percentage of orders to be received was put at about 75%, and the annual amount of orders was estimated to be 480 tons. As to high manganese cast steel, there is an annual demand of 288 tons for the dredger bucket, but even the smallest type of this bucket requires about 2 tons of as cast weight which requires the setting up of a large melting furnace. Therefore, manufacturing of dredger bucket is not advisable. Products other than the dredger bucket are mostly used as wear-resistant parts by cement factories and by public enterprises, and it may be possible to receive orders for these products all the time. Accordingly, the percentage of receiving orders was supposed to be more than 80%. The total annual amount of orders has been calculated to be 120 tons.

4.2 Selection of Production Capacity

4.2.1 Output and Unit Weight of Castings

According to the quantity of orders to be received, which was mentioned in Paragraph 4.1, the annual production capacity of cast iron was selected to be 600 tons, cast steel 480 tons, and high manganese cast steel 120 tons, totaling 1,200 tons. The unit weight of castings was fixed at less than one ton in terms of as cast weight in order to keep, to a minimum size, the melting furnace and the capacity of an overhead traveling crane. When the unit weight is calculated in terms of the average weight of castings, it will become as follows: cast iron 700 kg, cast steel 500 kg and high manganese cast steel 600 kg. These figures may vary according to the shape of product. The output and unit weight will become the basis, on which facilities and operation are planned.

4.2.2 Selection of Product Mix

Table 4-1, 4-2 and 4-3 show the products by kinds.

Table 4-1. Item of Iron Castings

Name	Average Unit Weight (kg)	Material	Production (Ton/Y)
1. Rolls for Rubber Mill	300	FC 20	72
2. Herical Gears for Rubber Mill	350	FC 20	42
3. Pump Casing for Tin Mine	800	FC 20	96
4. Soil Pipe Joints & Fittings	50	FC 20	24
5. Brake Drums for Trucks & Buses	80	FC 20	96
6. Fly Wheels for Diesel Engines	50	FC 25	30
7. Mill Rolls	400	FCD alloy	38
8. Hydroclone Parts	30	27 Cr	2
9. Roaster Bars	8	Ni-resist	30
10. Clutches & Pinions for Rubber Rolls	50	FC 20	36
11. Counter Weights	1,000	FC 15	120
12. Rubber Roll Frames	400	FC 20	14
Total			600

Table 4-2. Item of Carbon Steel and Low Alloy Steel Castings

Name	Average Unit Weight (kg)	Material	Production (Ton/Y)
1. Sprockets	200	Carbon Steel	72
2. Wheels & Axleboxes	25	Carbon Steel	79
3. Various Gears	50	Carbon Steel	20
4. Rolling Stock Parts	20	Carbon Steel	5
5. Teeth & Adapters	60	Low Alloy Steel	108
6. Electrode Holders for Aluminum Smelting	300	Carbon Steel	54
7. Piling Heads	200	Carbon Steel	27
8. Anchors & Winch Parts	500	Carbon Steel	28
9. Digester Blades	35	Mn-Cr-Ni Steel	25
10. Press Cages	750	ST 70	35
11. Other Miscellaneous	100	Carbon Steel	27
Total			480

Table 4-3. Item of High Manganese Steel Castings

Name	Average Unit Weight (kg)	Material	Production (Ton/Y)
1. Cement Mill Liners	55	Hi-Mn Steel	44
2. Jaws for Crushers	80	Hi-Mn Steel	12
3. Hammers for Crushers	10 – 30	Hi-Mn Steel	16
4. Toggle Seats	120	Hi-Mn Steel	18
5. Truck Pads	50	Hi-Mn Steel	30
Total			120

4.2.3 Philosophy in Selecting Production Capacity

The following points of view form the basis for the selection of the production capacity.

1) Accoridng to the report submitted earlier, the monthly output of castings in the Medan area is 200 to 300 tons. Supposing that this production is taken over by MFC, the monthly production of cast iron was fixed as 250 tons. However, according to the present survey, even if MFC should start its work, many of the existing enterprises still desire to continue their production of castings. These enterprises can hold a dominant position in machining the castings they make or in assembling the finished products into a complete machine and selling it directly to users. As MFC has no sufficient capacity for machining and for assemblage of machine, MFC cannot compete favourably with these enterprises.

2) The drainpipe, which is manufactured by a centrifugal casting equipment, has recently come to be produced at a low price by specialized foreign manufacturers. Accordingly, the drainpipe is not included in the present production item. Also, as manhole parts are now generally made by a special machine at a low price, the manhole cover and frame are excluded from the production item. As MFC is scheduled to produce various kinds of castings of high quality, it is difficult for them to manufacture such products as manhole covers and frames at a low price.

3) Cast steel and high manganese cast steel, which are all imported at present, are priced far higher than cast iron. Hence, MFC is planning to put stress on the production of these high-priced products. As to the production of cast iron, it is advisable to select such products that do not compete with the existing enterprises. For this reason, MFC is projected to manufacture high quality cast iron.

4) As was mentioned in Paragraph 4.1.2, it was thought advantageous, from the point of effective investment, to give up the manufacture of some cast steel products, and the percentage of orders that can be obtained was fixed accordingly. Thus, the production capacity of cast steel was selected to be 480 tons a year.

5) It is necessary to keep a high rate of operation of the facilities in order to enhance the effectiveness of investment. For this purpose, the production capacity needs to be fixed at a rational level.

As to the details of the facilities, a machine which is only used in manufacturing a specific product and has a low rate of operation will not be installed. Instead, it is necessary to install such a machine that can manufacture various kinds of product.

6) What is rational in establishing this kind of foundry is to fix the initial investment at a low level, and to enhance profitability by means of a high rate of operation under sufficient guidance on management and production, and during that time, improvement is to be made in all aspects.

And when the production capacity was found unable to meet an increasing demand, additional investment should be made to expand the facilities. This way of operation is intended to minimize the risk of this kind of foundry.

Based on the result of the market survey on one hand, and taking the above-mentioned philosophy into consideration on the other hand, the production capacity of 1,200 t/Y was determined as most appropriate.

This production capacity is considered to be suitable from the points of view on the limit of activities for receiving order and on capacities of machining shops in the Medan area.

Chapter 5. Selection of Plant Site

Chapter 5. Selection of Plant Site

Based on the results of the surveys conducted several times in the past, it was found that the Medan Industrial Estate was the most suitable site on every necessary condition. In the present survey detailed investigations were also made as to whether the proposed site would meet all the necessary conditions. As a result, the study team has reached the conclusion that the Medan Industrial Estate is suitable as the plant site.

5.1 Medan Industrial Estate

Map 5-1 shows a plan of the Medan Industrial Estate. The 80 ha ground of the Estate has been leveled off as an industrial estate which is anticipated to be expanded up to 200 ha by absorbing the adjacent land, and is expected to become an important industrial estate in Sumatra in the future.

The Industrial Estate is furnished with main roads and a complete sewer system. At rpesent, the Estate is only a vast field, in the middle of which stands a superintendent's office where several employees are working. Factories are being invited and their construction is expected to start one after another. For the present, though the plant site has not been decided yet, it is possible to select any place in the Estate as the plant site.

5.2 Plant Site

When future expansion is considered, the plottage for factory is the wider the better, and at least an area of 12,000 m^2 must be secured. A thirty-year lease for land along a main road is Rp.9,350 per m^2.

The land rent can be paid in 5-year installments. In this case, down payment is 25% of total payment and annual interest rate is 15%. This interest rate being high, it may be advantageous to pay the whole rent at one time. Accordingly, in the present project it is planned that the rent be payed in a lump sum.

Some leveling of the ground of this Estate has already been made, but because the leveling so far is not sufficient for foundry.construction, it is necessary to prepare the ground more perfectly.

5.3 Nature of the Soil

According to the result of the geological survey conducted at the setting up of the Medan Industrial Center, the ground is sufficiently hard for the installation of heavy machinery.

Although it is thought that the soil bearing capacity of the Medan Industrial Estate may be enough for the present project, yet piling will be necessary for installation of heavy machinery and equipment.

5.4 Drainage

The underground water level in the Estate is about two meters. This area has never been flooded. The drainage flows into a river nearby and then into the sea. When a drainage ditch is thoroughly furnished in the Estate, there will be no need of anxiety about the drainage even during the rainy season. But the level raising by filling earth 50 cm shall be done as a precaution against a possible flood.

5.5 Transportation

The Estate is located along a road linking Medan City with Belawan port and lies almost midway between Medan and Belawan as is shown in Map 5-2. The road is wide and is kept relatively well maintained, and can stand the transport of heavy or bulky things. The road will pose no problem at all in transporting products to users in the Medan area, and in transporting from Belawan port to the Estate raw material and imported equipment which is to be used at the time of construction. Thus, the Estate is said to be conveniently situated.

5.6 Availability of Electric Power

Regarding the availability of electric power, it will be described in Chapter 6 in detail. It seems to be possible to rely on the supply capacity of the Persahaan Umum Listrik Nagara (PLN), the State Electric Power Co.. As to the transmission of electric power, there already exists a substation at Mabur along the road west of the Estate, which will enable the Estate to receive 20 kV electricity. But the transmission line from the substation to the Estate has not yet been completed, and it is necessary to construct the line before construction of the foundry starts.

5.7 Availability of Water

For the operation of the foundry, a fairly large quantity of water is required to cool the electric furnace and other facilities. Details on this matter will be described in Chapter 6. The Persahaan Air Minum (PAM), the Drinking Water Co., has already dug a deep well in the Estate to get underground water, and when once a motor is furnished, water will become available. Also, water can be drawn from the Sungall River near the Estate.

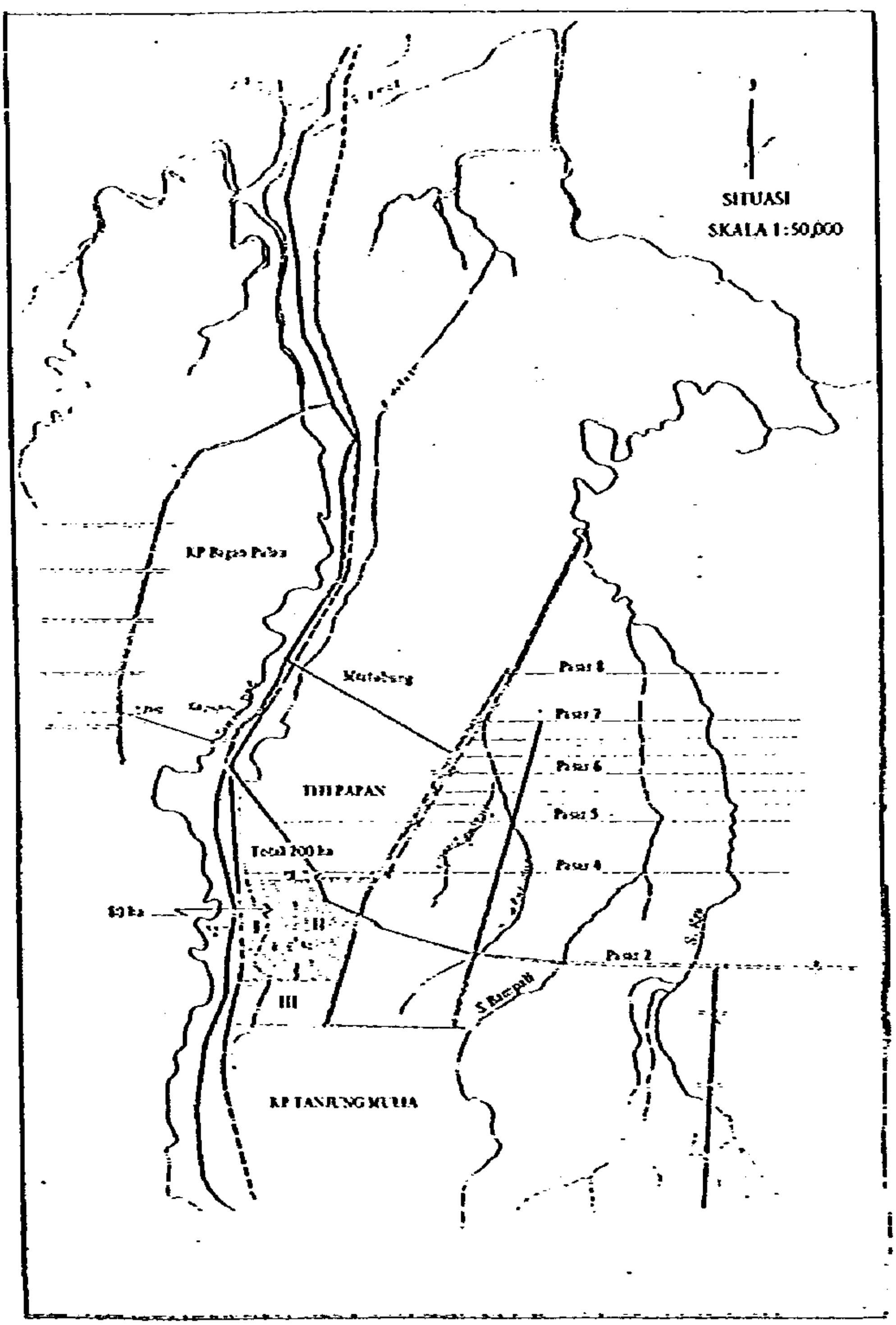
A storing reservoir will be constructed within the site and the cooling water will be cycled to minimize make-up water. Accordingly, there will be no problem in obtaining the make-up water required by the foundry.

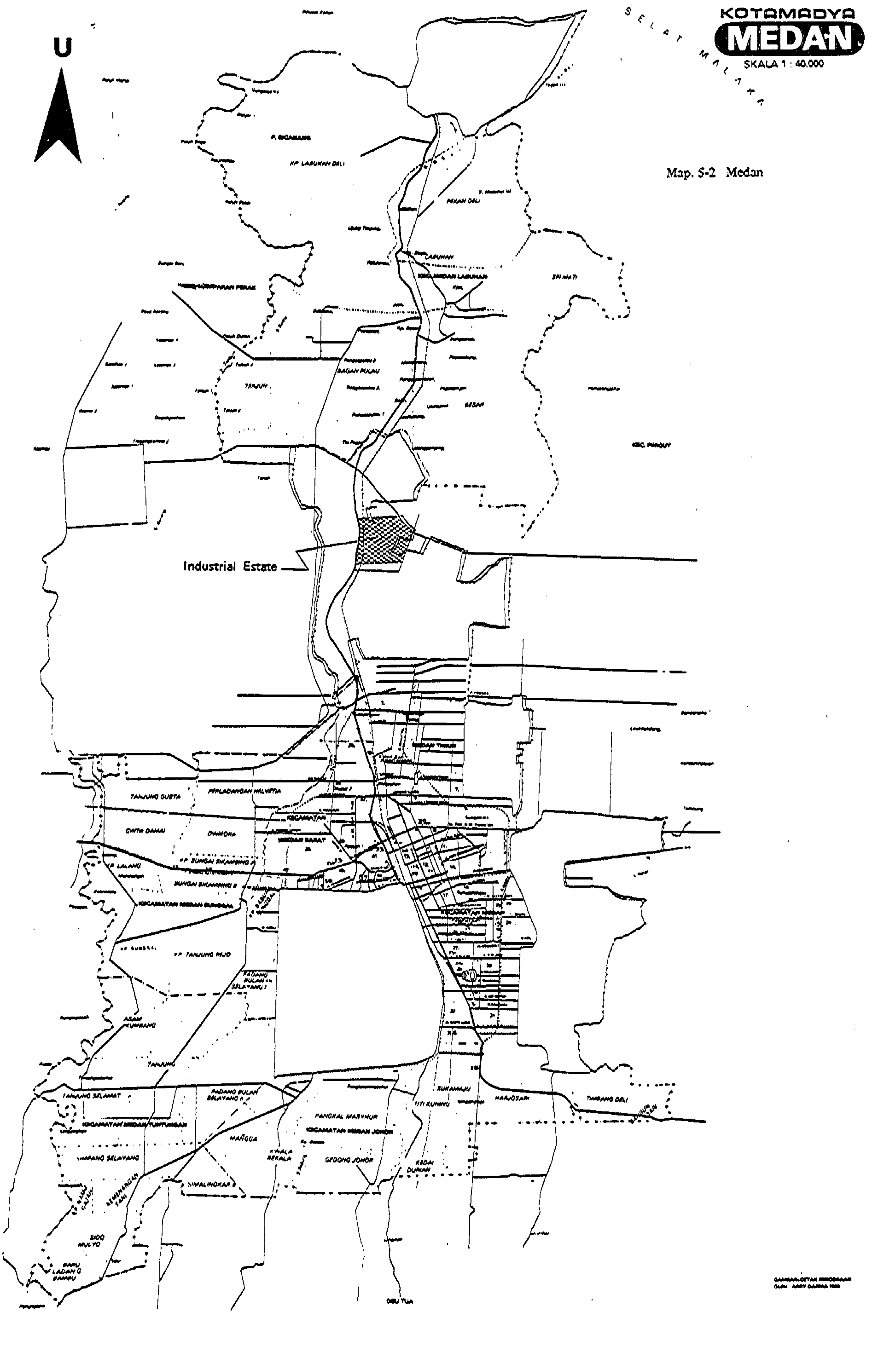
As regards the cooling water for the electric furnace, it is necessary to obtain such quality of water that causes no trouble within the cooling pipe. PAM has not yet conducted a survey on this point. It is necessary to wait and see the results of such survey in the future.

5.8 Procurement of Laborers

There will be problems in obtaining skilled workers, but it may not be difficult to secure unskilled workers because the Estate is located near Medan, a large city. Regarding the commutation and housing of employees, it will not be necessary to give special consideration to them.

Map. 5-1 Medan Industrial Estate




KOTAMADYA
MEDAN
SKALA 1 : 40.000
SELAT MALAKA
U
Industrial Estate
TANJUNG GUSTA
PERLADANGAN HELVETIA
CINTA DAMAI
KECAMATAN MEDAN BARAT
KECAMATAN MEDAN SUNGGAL
KP TANJUNG RIJO
PADANG BULAN SELAYANG I
TANJUNG SELAMAT
PADANG BULAN SELAYANG II
PANGKAL MASYHUR
KECAMATAN MEDAN JOHOR
KECAMATAN MEDAN TUNTUNGAN
MANGGA
GEDONG JOHOR
SUKAMAJU
TITI KUNING
HARJOSARI
TIMBANG DELI
SIMPANG SELAYANG
SIMALINGKAR B
SEMBAHAN TANI
SIDO MULYO
LADANG BAMBU
DELI TUA
KP LABUHAN DELI
PEKAN DELI
KEC. MEDAN LABUHAN
SEI MATI
TANJUN
BAGAN PULAU
BESAR
KEC. PERCUT
MEDAN TIMUR

Map. 5-2 Medan

Chapter 6. Raw Materials and Utilities

Chapter 6. Raw Materials and Utilities

6.1 Conditions of Raw Materials for Foundry Use in North Sumatra

For the smooth development of the foundry industry, it is necessary to secure an easy availability of various raw materials and auxiliary supplies required for the production of castings.

The majority of raw materials and foundry supplies are coming from organic or inorganic chemical industries, the ceramic industry, iron and steel mills and their subordinate manufacturers, metal smelting and ferro-alloy industries, lumber mills, miscellaneous machine industries and so forth.

In most of the industrially advanced countries, the circulation of materials is facilitated by the existence of specialized dealers. The circulation networks are well established, and these dealers of foundry supplies are ready to recommend the most suitable materials and supplies to each consumer based on their own studies and investigations regarding the quality and purchasing specifications required by the users. On the other hand, the manufacturers of foundry materials and supplies likewise put their constant efforts to grasp demand tendencies of materials and supplies in the foundry industry and to develop and manufacture the products which meet accurately to the requirement of the foundry industry.

In the industrial countries where the circulation networks of foundry materials and supplies have been established as stated above, the most up-to-date information and data regarding foundry materials and supplies are easily obtainable by foundry management and engineers, and one telephone call will make it possible to have instant delivery of any desired material. The foundry industry supported by such a huge, powerful and well organized base will continue to grow with the improved quality and productivity. In fact, this is what is lacking and therefore wanted in Indonesia.

The history of metal casting in Indonesia is quite long. There is a village with a foundry called Ceper in the suburbs of Surakarta, Central Java. It is said that the casting operations in this village have been continued for over several hundred years. They produce gray iron castings in a traditional way by utilizing small top charge cupolas and natural sand collected from surrounding rivers. An old foundry in East Java was established during the Dutch mandatory and the foundry is still producing heavy machine parts even now. Besides these old, traditional foundries, serveral new foundries with modern facilities and technology have been established in the key cities in the past decade, and it is possible to ascertain that the foundry industry in Indonesia is on a path of development.

However, viewing from the side of the foundry industry, it is not possible to say that all the relative industries who supply raw materials to the foundries have been developed as well, and the narrowness of base industries is unavoidably recognized. Furthermore, Indonesia is composed of dispersed islands over very wide territorial seas, and consequently, the procurement of domestic raw materials will inversely cause a possible increase of material cost due to long distance transportation.

Keeping pace with the remarkable progress of technology in the international foundry industries in recent years, a great variety of new materials and additives for foundry use have been introduced in the international market one after another, and it is often more advantageous to import these materials whatever required for the immediate application from overseas than manufacturing the equivalent materials locally.

As the availability of materials and supplies required for the proper running of modernized foundries in the local market in Indonesia is quite limited, accordingly, a large number and great variety of foundry materials and supplies are currently imported. A typical example of a foundry operating under a joint venture with foreign capital was actually observed, where they were importing practically all materials and supplies from overseas excepting silica sand and scrap steel.

6.2 Main Raw Materials for Melting

6.2.1 Pig Iron

Pig iron, as one of the main raw materials, is not yet produced commercially in Indonesia, and therefore, supply depends totally on import from such industrial countries as Australia, Taiwan, Japan, and so on. Pig iron can be divided into various grades in accordance with the variations of contents of five critical elements such as carbon, silicon, managanese, phosphor and sulfur, and the proper grade is selected by each foundry considering the suitability for their products.

In Indonesia, however, the selection of pig iron depends more on price than on grade, because the majority of local foundries only produce gray iron castings. As there is no one in Indonesia who produces ductile iron castings which require the pig iron of extra-low sulfur contents, and, as most of the existing foundries do not pay much attention to the standard practice of analyzing chemical compositions of materials and molten metal, it seems that any specific selection of the grade of pig iron is not required at the present moment. However, a greater interest of Indonesian foundrymen should be invited to the selection of proper grade of pig iron for stepping into the production of iron castings applicable to the international standards in the near future. It is reported that sponge iron production by direct reduction process has been started recently in West Java. It is ovbious that sponge iron is suitable as the material for steel making by arc furnaces in which the refining process of metal is possible, but further studies on the characteristics of sponge iron will be necessary before judging the applicability of sponge iron as the material of castings to be melted by cupola or induction furnace as a substitute for pig iron.

6.2.2 Scrap Steel

Scrap steel is indispensable for the production of high grade iron castings having a higher tensile strength from both technical and economical reasons. Among various kinds of scrap steel, odds and ends of mill rolled mild steel like steel plates, sheets, bars, profiles are most welcomed on account of their consistency and uniformity of chemical compositions and the minimized contents of such harmful elements as phosphor and sulfur. Especially the rust free scraps of cold rolled sheet generated from automobile industries and punch press shops are most favorably used, and the actual melting operation with this type of scrap steel was observed by the study team in a foundry in Java. Miscellaneous scrap steel pieces reclaimed from dismantled machines, cars and broken up ships often contains special elements like nickel, chromium, copper, etc. which require serious selection and close examination.

Use of thin scrap steel covered with thick red rust after being weathered for a long time should be avoided. It was observed by the study team that good scrap steel at a reasonable price was available rather easily not only in Java but also in the Medan area during this survey, and no serious difficulty was expected in the actual operation for the time being. However, it may be necessary to carry out a periodical check of the scraps from local bar mills because some of them are using induction furnaces for melting ingots where there is a fear of accumulating some particalar elements due to the insufficient refining by crucible induction melting.

6.2.3 Cast Iron Scrap

It is a common practice in gray iron foundries to use cast iron scrap purchased from outside in addition to other main materials such as pig iron, scrap steel and return scrap. Cast iron scrap of unknown identity should be avoided because there is the possibility of containing harmful elements. Selection and judgement of the nature of cast iron scrap will be done by observing the shape, ie., engine castings, brake drums, soil pipe joints, pump casings, etc., but in some cases it is not possible to tell their original shapes. Castings for marine, mining and boiler use are usually containing nickel, chromium, copper, etc. If these cast iron scrap pieces with uninvited elemnts are mixed in the charge for melting by cupola or induction furnace, there is a danger of spoiling the property of products because these types of melting furnaces do not have metal refining functions. In Indonesia, it is almost impossible to secure cast iron scrap of identified nature and also it is practically impossible to analyze the whole variety of purchased scrap individually. As a whole, it is not recommendable for MFC to rely on the purchase and use of cast iron scrap especially when MFC is aiming at the production of quality castings. Instead of utilizing cast iron scrap, the following countermeasures are commonly applicable.

1) Incrase the charging ratio of pig iron with a sacrifice of a slight increase of metal cost.

2) Increase the charging ratio of scrap steel and carry out a proper adjustment of metal composition by adding carburizing agent, ferro-silicon and ferro-manganese.

The latter method will have a limit if it is applied for cupola, but for induction melting as in MFC there is no limit of scrap steel ratio.

6.2.4 Ferro-Alloys

Among many kinds of ferro-alloys, ferro-silicon and ferro-manganese are indispensable for the production of iron and steel castings. Both of them are currently imported from Japan and Taiwan. The most common grade of ferro-silicon is the one with 75% silicon contents, and that of ferro-manganese is the cheaper one containing a higher percentage of carbon. These grades are quite sufficient and acceptable for the production of ordinary iron castings, carbon steel castings and high manganese steel castings, but for the production of special steel castings with extra-low carbon contents (for example, stainless steel), it is necessary to change the grade.

Aside from the theme of this survey, the domestic production of ferro-alloys in Indonesia is considered to be quite interesting as the supply of electricity is abundant and is cheaper than in other Asian countries, and also as the demand of ferro-alloys is sharply increasing along with the upgrading of steel mills.

Ferro-nickel is produced in Sulawesi and is available locally, but ferro-chromium and other ferro-alloys are all imported.

6.2.5 Foundry Coke

Electric melting by crucible induction furnaces is becoming popular for the production of iron castings in Indonesia in recent years, but the majority of existing foundries is still using coke-fired cupolas or simple top charge drum furnaces (primitive cupola). Coke used for these cupolas is imported from Taiwan and Japan. Many small foundries are using cheap, general fuel grade coke from Taiwan. Foundry grade coke of a high quality could not be found among the foundries visited during this survey.

Most of cupola foundries are melting and casting on a once-a-week basis, and accordingly, the study team could not have the opportunity of witnessing the actual melting operations in the limited span of time allowed for the survey. However, judging from the conditions of casting defects, the cause of gas defects represented by blowholes was obviously coming from a low pouring temperature. It is possible to say that the cause of this difficulty is not entirely attributable to the design and performance of cupola but is largely to the quality of coke, and some foundries were already aware of this fact. As the present planning for MFC does not include cupola, there is no immediate possibility of the problem of this nature, but it is advised that the application of foundry grade coke will be essential in case there is any cupola based expansion program in the gray iron casting department of MFC sometime in future.

6.2.6 Other Materials for Melting

Besides the main raw materials listed above, such additives as carburizing agent, inoculant for cast iron, spheroidizing agent for ductile iron castings, etc. will be needed by MFC for the proper production of scheduled castings. It is initially planned that all of these additives will be imported from outside excepting aluminum blocks which will be added to the molten steel at the final stage of deoxidation. In a foundry in West Java it was recognized that charcoal was used in place of carburizing agent because charcoal is much cheaper and easily available. A charcoal bundle thrown into the surface of molten metal inside the induction furnace floated on the surface of molten metal because of its light weight and burst into flames with a heavy soot and dust, whereas it was slightly doubtful of the yield of carburization. However, even if the yield is poor, there is still room for considering the use of charcoal if it is economically balancing with such probable handicaps as poor yield of carbon.

6.3 Auxiliary Materials and Supplies

6.3.1 Molding Sand

There are numbers of rich deposits of foudnry grade silica sand in Indonesia, and foundries freely choose the origin of sand putting priority to the convenience of transportation and cost. The majority of fine sand available in the major islands of Indonesia contains more or less 85 to 90% of silica (SiO_2) and is satisfactory for cast iron production. However, the refractoriness of these kinds of sand is insufficient as the molds for cast steel. At present, the sand from Pulau Bangka and Pulau Belitung containing over 99% of silica is actually used for the production of steel castings. It is a common practice in most industrial countries that the silica sand is mined from deposit bed and washed, dried and sifted into various standards of grain fineness distribution and packed and delivered by specialized sand distributors. However, in Indonesia, such cases are more frequently found that the raw, natural sand is delivered to the users directly from deposit without any treatment, and accordingly, such sand often contains a lot of impurities like grass roots, wood chips, shells and so on, and in most cases the delivered sand contains a high moisture. As it seems quite impossible to obtain the well controlled sand locally for the time being, it is necessary to carry out a suitable treatment such as drying, sifting and cooling on the delivered sand before bringing it into the sand circulating system.

In the basic planning of MFC, one kind of sand is used for both cast iron and cast steel. Therefore, the quality and property of sand should satisfy requirements of steel which is certainly more demanding. From this point of view, the sand from Pulau Bangka is recommended.

As it is explained in detail in the chapter of Production Process, a recommendation was made by the study team to adopt the new molding technique named V-Process (Vacuum Sealed Molding Process) in MFC. The property of sand preferred by the V-Process specifies SiO_2 contents of over 95% and very fine range such as 90 to 130 in AFS grain fineness index. On the other hand, Bangka sand used currently in several local foundries is quite coarse, and the AFS index of this sand was observed more or less 65. It is not possible to say that all Bangka silica sand has the same fineness distributions. There are many instances where the fineness of sand differs in accordance with the location of mines even when the mines and deposit beds are all located in the same area. Accordingly, a detailed survey on the actual situations of silica sand production in Bangka and, if necessary, Belitung should be carried out as soon as the implementation of this project is decided. The above mentioned silica sand having a fineness grade of AFS 65 is not acceptable for the V-Process, but it can be used for self-hardening process and cores. It is necessary to import olivine sand which is used as the face sand for high manganese steel castings.

6.3.2 Plastic Film

Mold making by the V-Process requires two different kinds of plastic films; one is used for forming (pattern face) and another for back up (outside of mold). The requirements for forming films are more stringent than those for back up films. Forming film should have a uniform thickness and property, a larger stretching ratio for all directions at a plasticity temperature zone, and the film should not generate gases harmful to the health when it burns. Among the various kinds of plastic films, EVA (ethylene vinyl-acetate copolymer) is currently selected as the best forming film. The recommended thickness of forming film is 0.1 mm, and they will be imported in the form of 100-meter rolls with varieties of width. As the back up films will neither be preheated before applying to the molds nor exposed directly to the molten metal, ordinary polyethylene films (PE) which are available in common market are acceptable. Thickness of back up films is 0.03 mm, and they will be imported in rolls. Special care should be taken for storing the purchased film. It is advisable to store them in a well ventilated storage yard sheltered from direct rays of the sun, avoiding excessive piling up of more than 3 stacks. If the films are piled up high in a hot place for a long time, the rolled layers of films will adhere to each other locally, and become difficult to unroll. This is one of the major causes of failures at the time of film forming on patterns resulting in a serious time loss and inefficiency.

6.3.3 Binders

There are a great many varieties of molding and core making techniques and processes currently employed in the international foundry industry, whereas in Indonesia the master molds are popularly made only by the green sand process and the skin dry process and cores are made by the shell process and the CO_2 process.

Air-setting self-hardening processes represented by the furan no-bake process and the dicalcium silicate process which are very widely employed among Japanese foundries, are being practised by only one foundry in Java. The circumstances of binders indispensable for these processes are briefly reported here below.

1) Bentonite

Bentonite is, under the present technology, considered as the most suitable for the green sand molding process, but the bentonite of foundry grade is not yet produced domestically in Indonesia, and is still depending on imports. However, in recent years a bagging plant in Jakarta is regulary importing sodium-base Western bentonite from the United States and is bagging it for immediate delivery to the local foundries.

2) Clay

Clay is the most popular binder of sand since ancient days. Clay is available easily in most areas of Indonesia at a cheap price. However, the quality and characteristics of clay vary greatly in accordance with the producing areas, and it is necessary to select the most suitable grade for each applicating condition.

3) Water Glass

A large volume of water glass is being used in various industrial needs other than foundry in Indonesia today, so the locally made water glass is available easily. However, strictly speaking, the water glass for foundry use should meet the severe requirement of specifications such as specific gravity and mol ratio ($Na_2O\%/SiO_2\%$), and it was not possible to clarify whether any attention is paid by the local producers to these specifications or not.

4) Organic Resin

Organic resin like furan and phenol resin is imported from overseas. Phenol resin is a thermosetting binding agent to be used for making cores of small, mass production items.
Organic resin has been used worldwide for improving productivity and quality of castings in the last two decades, and is expected to gain popularity in Indonesia from now on.

6.4 Utilities

6.4.1 Electricity

Persahaan Umum Listrik Negara (PLN) supplies the Medan area with electricity generated by such major-stations as Glugur, Titi Kuming and Raya Pasir. The recent status of power supply in the Medan area can be referred to in Table 6-1.

Table 6-1. Installed Capacity, Available Capacity and Peak Load

(Unit: kWh)

Name of Power Plant	Type of Power Plant	No. of Unit	Installed Capacity	Available Capacity	Peak Load
Glugur	D, GT	7	49,990	40,560	23,350
Titi Kuning	D	6	24,846	24,000	14,750
Raya Pasir	GT	4	69,092	64,000	17,800
Total	D + GT	17	143,928	128,560	55,900

Source: "Statistics" Apr. 1979 – Mar. 1980
PLN – Region II / North Sumatra

(D = Diesel, GT = Gas Turbine)

PLN further plans to install 2 units of gas turbine generators in Raya Pasir power station before the end of 1983 furnishing this station with an additional output of 65,000 kW, and by the end of 1984 transmission lines will link Asahan hydroelectric-power station to the power line system in the Medan area to supply the industries in the Medan area with 50,000 kW which is expected to be an excess over the consumption in Asahan aluminum smelting plant. Against this background, the power requirement of MFC on the basis of its proposed production capacity of 1,200 metric tons of good castings per year is shown in Table 6-2, the figures in which explain that the demand of MFC alone will be satisfied by securing 2,000 kVA with the considerations of power factors and loading efficiency. This report recommends the purchase of electricity from PLN because the stability and reliability of PLN supply were reconfirmed.

Mabur substation of PLN is conveniently situated to the west side of the proposed plantsite of MFC along Medan-Belawan national road, and the power is easily receivable by connecting the distance of a few kilometers with 20 kV power cables.

Under the regulations of PLN, the consumer should pay Rp. 40,000/kVA as cable connection charge and Rp. 500/kVA as inspection charge. These expenses should be included in the initial investment. Table 6-3 indicates the tariff of electricity which is currently applied in the Medan area.

Table 6-2. Annual Power Consumption Designed for MFC

(Unit: kWh)

	Consumption (Approx.)
Melting	1,808,400
Molding, etc.	840,000
Lighting	86,400
Total	2,734,800

Table 6-3. National Tariff of Electric Power

	Hour	Rp.	Unit
1. Fixed Charge		1,600	kVA . Month
2. kWh Charge	22:00 – 18:00	15	kWh
	18:00 – 22:00	24	kWh
3. Surcharge		5	kWh

6.4.2 Water

About 60% of the total water consumption by MFC will be served as cooling water. For the purpose of saving the cooling water and increase the cooling efficiency, it is advisable to install a reservoir in the plantsite to allow the cooling water recycle in the system with much bigger heat radiation allowance. The expected consumption of water in MFC under the planned production rate of 1,200 metric tons of good castings per year is illustrated in Table 6-4 hereunder.

Table 6-4. Annual Water Consumption

(Unit: m^3)

Use	Consumption
Cooling Water (Melting Furnace)	4,320
Cooling Water (Molding Process)	2,160
Cooling Water (Compressor, etc.)	1,080
Water Quenching (High Manganese Steel)	1,200
Others	3,600
Total	12,360

From this table, the daily water consumption can be calculated as 41.2 m^3.

In the Medan Industrial Estate, 14 kilometers north of Medan, there is a deep well constructed by Persahaan Air Minum (PAM) aiming at the ample supply of industrial water to the tenants. As the electricity is not yet connected to the site, the pumping unit has not been installed. Therefore, the data regarding water supply capacity of this deep well was not obtainable. According to PAM officials, however, the construction of another deep well in the Industrial Estate is scheduled in the middle of 1981, and under this plan the study team believes, the well will be capable of supplying MFC with about 42 m^3 of industrial water daily without any difficulty. PAM has also completed a blue print of the main water pipeline having a diameter of 30 cm along the main road, inside the Industrial Estate. During the survey, the analysis data of characteristics of the water from the deep well was not available. As MFC utilizes the underground water for cooling the heat generating machinery and equipment, the level of contamination with impurities such as calcium and silica will become the problem. According to PAM, this water is drinkable, but it is recommended to analyze the water before the final designing of the plant. The water tariff applicable to the forthcoming industries in the Industrial Estate has not been prepared yet, so it was not possible to clarify the cost of water and pipe connection charge. For the convenience of estimating the production cost, the current price of water in the city of Medan, ie., Rp. 250/m^3 was tentatively allocated in this report.

6.5 Summary

Summarizing the various data and information obtained during the survey, it is generally confirmed that there is no serious difficulty nor problems to secure the materials and utilities of a good quality and quantity requried for the normal production activities of MFC.

Chapter 7. Production Process

Chapter 7. Production Process

7.1 Production Process Selected for MFC.

The batch capacity of melting furnaces planned in the design of this project will automatically place a limitation on the maximum single piece weight of castings. From this concept, the maximum weight for three different species of metal is set as 700 kg for cast iron, 500 kg for cast steel and 600 kg for high managanese steel casting, and it was designed that the plant can manufacture whatever castings lighter than the above mentioned limitations.

For selecting the molding process, it is necessary to pay considerations to the fact that the availability of good manpower in North Sumatra is, and will be quite difficult. The most labor-saving molding process today is, of course, the full automatic high speed machine molding with green sand, but this is only good for mass production. For the jobbing operations in MFC, such a process as vacuum sealed molding process (V-Process), for instance, is rather recommendable because V-Process minimizes casting defects caused by labor factors and offers, on the other hand, a lot of advantages for jobbing operations. However, it is also considered that the application of the V-Process alone may be lacking versatility against varieties of molding needs. Accordingly, it is planned that the V-Process will cover 1,000 tons of castings per year and the remaining 200 tons of production per year be covered by inorganic self-hardening process.

For the production of cores, it is recommended to utilize the CO_2 process in which the control of sand is rather simpler than other similar processes. Thus having two different systems for molding will inevitably make the relative facilities and the control of operations complicated, but this is unavoidable for the production of castings of a wide variety in MFC.

The V-Process requires special molding boxes which are rather costly. Therefore, it is necessary to study and decide the dimensions of boxes carefully so that the molding boxes can be utilized for a wider range of products. The castings larger than the predetermined dimensions of molding boxes in the V-Process, and those which have complicated shapes requiring hand ramming, will be handled by the self-hardening process using sodium silicate and inorganic hardening agent.

For the melting process, 2 units of high frequency induction furnaces each of 1-ton batch capacity with one melting power pack and one superheating (holding) pwoer pack will be applied. These two units of furnaces will be operated alternately for melting and superheating.

Such an arrangement is also considered as the first furnace is equipped with acid (silica based) lining and the second is with basic (magnesia based) lining, and the former is used for melting gray iron while the latter is for melting carbon steel and high manganese steel. It is possible to melt gray iron and steel (plain carbon steel and low alloy steel) by the acid-lined furnace, but is not recommendable to use this furnace for melting high manganese steel because of the quick erosion of silica lining. Melting of gray iron by the basic-lined furnace is certainly possible but it will increase the melting cost of gray iron castings because the cost of basic lining is much more expensive than acid lining.

7.2 Production Flow Chart

The outlined flow of production in MFC is illustrated in Fig. 7-1.

7.3 V-Process

7.3.1 Outline of the V-Process

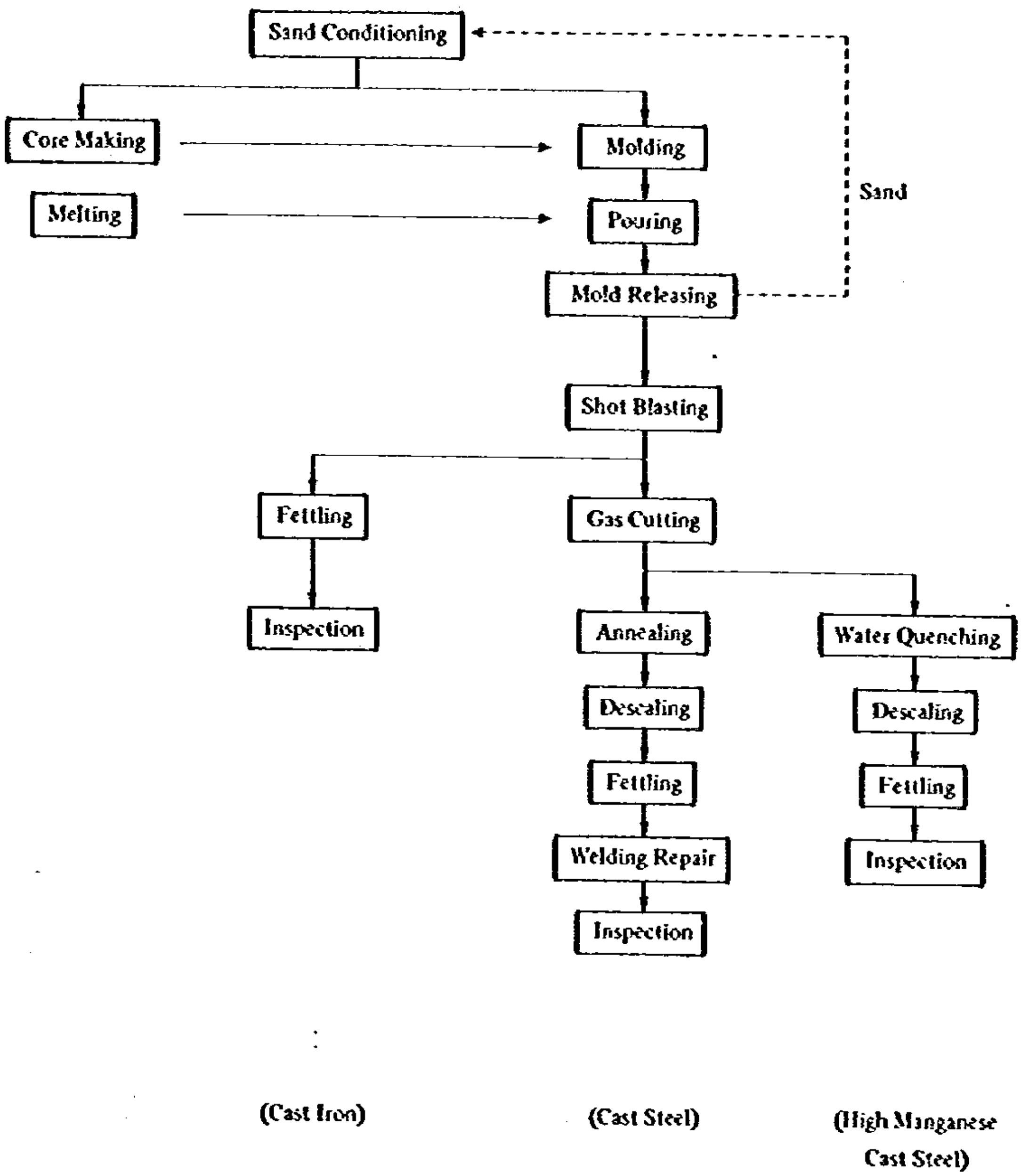
The V-Process is the shortened name of "Vacuum Sealed Molding Process". This unique molding process was invented in Japan in 1971 and has been developed and industrialized quickly during the last decade, and it is now regarded by the international foundry industry as one of the best molding processes. In the V-Process, only the dry sand is used as the mold material. No binder is required. The dry, loose sand mold is sealed by plastic films and is connected to the vacuum pump to maintain the inside of the mold under reduced pressure. By the difference of pressure between inside and outside, the mold is hardened instantly. Keeping the reduced pressure, cope and drag are closed and the completed mold is poured with molten metal. Nearly 200 foundries are licensed for the application of this new molding technology in the world and many of them are already enjoying very successful productions.

7.3.2 Molding Method

The main equipment used in the V-Process operation and their functions in the process are specified as follows.

Vibration Table:	To fill sand
Suction Box:	To mount the patterns and give vacuum suction
Film Heater:	To heat the plastic film for better forming

Fig. 7-1. Flow Chart



Molding Box:	Walls are provided with cavity for suction and suction tubes are often attached
Mold Releasing Device:	Separation of sand and castings
Sand Coller:	Cooling of reclaimed sand
Vacuum Pump:	To give reduced pressure to the mold and suction box
Dust Collector:	To remove dust

A pattern with back up plate and with a large number of fine vent holes for vacuum suction is set firmly upon a suction box mounted on a vibration table. The plastic film for forming which is temporarily supported by a wooden frame for easier handling is brought to the film heater. The film is heated up to a thermo-plasticity temperature zone and is placed over the pattern. Simultaneously the suction box under the pattern is connected to vacuum suction piping by opening a stop valve, then the air left between the film and the pattern is sucked out through the suction box and the film adheres closely to the surface of pattern and back up plaste. A moldwash of a volatile nature is often sprayed over the surface of film whenever it is necessary and the moldwash is dried instantly. Then, a molding box is set on the film covered pattern plate and the box is filled with dry silica sand. The vibration table gives adequate vibrations allowing the box to be completely filled with sand. The surface of sand is levelled and is covered by a back up film. As the sand mold inside the molding box is sealed by top and bottom films, it is hardened immediately by connecting the molding box to the vacuum suction piping. By cutting off the vacuum suction on the pattern and by lifting up the molding box, the hardened mold is easily stripped from the pattern. Both cope and drag are separately molded in the same manner, and are closed to form a complete mold and then the molten metal is poured. Cores are made separately in the core making shop and are set in the drag before closing the cope and the drag. After the molten metal is solidified and is cooled down to a proper temperature, the whole mold is brought into mold releasing device and the vacuum suction of the mold is shut off. Then, the sand mold is collapsed and separated from castings. The suction is continued throughout the process from molding up to mold releasing by the vacuum pump unit which is connected to the molds by pipelines and flexible air hoses.

Torn pieces of plastic films and other foreign substances are separated from the released sand. Then, the sand is transported to sand cooler where the temperature of sand is lowered to a normal level, and is returned to the overhead hopper at the molding station ready for immediate reuse.

The difference of pressure between the inside of sand mold and the cavity side allows the mold to maintain its shape during the application of the vacuum suction. Even when molten metal enters into the cavity during a pouring operation, the mold can keep its shape as long as the cavity is connected to the atmosphere through vent holes (or professionally called communication holes) provided at the top side of mold cavity.

A normal sequence of operation is summarized and illustrated in Fig. 7-2.

7.3.3 Characteristics of the V-Process

1) Uniformity of casting dimensions

2) Smooth surface finish

3) Sand can be recycled without any expensive sand conditioning system. Only a sand cooler is required.

4) Patterns require base plastes for an effective vacuum sealing purpose. Wood patterns are mostly used and the life of patterns is nearly permanent because there is almost no fear of wear and damage during sand ramming and mold stripping.

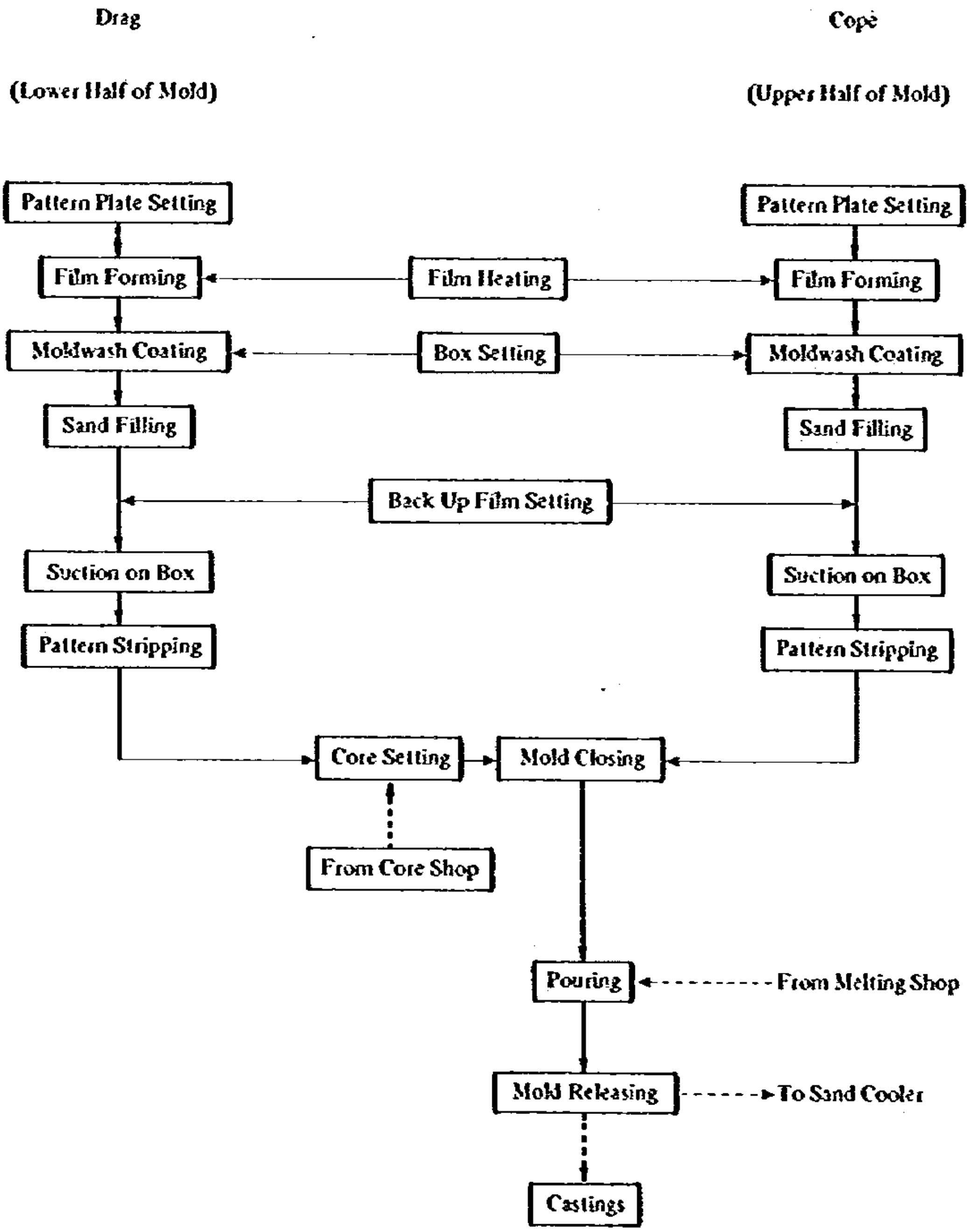
5) Process of molding is simple and easy and operators can master the required techniques in a short period of time.

These are just some of the numerous advantages of the V-Process and it is recognized as the ideal method for lot-production (or jobbing) foundries due to its simplicity in molding. It is advisable to pay a higher level of technical considereations to the pattern planning (pattern scheme) which is certainly a common importance in all molding processes.

7.4 Comparison of Various Molding Processes

The majority of metal casting processes utilizes silica sand as the main raw material for making molds, but there are many different kinds of binders used as additives and activating agents for hardening the sand molds, and the processes are generally classified and named by the kinds of binders and hardening agents. In the case of MFC, these processes as green sand, CO_2, sodium silicate (water glass) self-hardening are considered as the possible targets of selection.

Fig. 7-2. Sequence of Operation of the V-Process



Sodium silicate self-hardening processes can be subdivided into several varieties commonly called the Di-cal Process (Di-calcium Silicate Process) using metallic oxides and metallic chlorides, the N-Process using ferro-silicon powder, and the like. A recommendation is made for MFC to take up the Di-cal Process because the control of sand in this process is easier and a technical standard is established through its long history and wide popularity of application. The key points of some of important molding process are explained in the following paragraphs.

7.4.1 Green Sand Process

In the green sand process, silica sand is used as the basic material and bentonite is used as the binder. These are mixed with water to obtain a compressive strength required for molding. Coal dust, and dextrin are added whenever as they may be needed. This process today is commonly used for machine molding and is suitable for mass production of rather smaller pieces of castings. A great portion of sand is reclaimed and reconditioned for repetitive use. Accordingly, the cost of sand becomes cheaper in this process but the proper control of sand property is rather difficult and it requires bulky, expensive sand conditioning equipment. It is generally impossible to use the same sand for making molds common to cast iron and cast steel. In almost all cases, green sand molds for cast steel require facing sand which is mixed separately with a different mixing procedure. Furthermore, it requires a very high molding skill in case of making a green sand mold manually for a casting or castings exceeding the capacity of molding machine. As MFC should produce a wide variety of castings in size, weight, shape and material, also as there are not many items to be produced in a mass, it is judged that the green sand molding process is not advantageous for MFC.

7.4.2 CO_2 (Carbon Dioxide) Process

Silica sand (or other kinds of sand can be used as well) is mixed with sodium silicate (water glass) and an addition of collapsing agent of carbon family is used for making a mold. Then, pressurized CO_2 gas is blown into the mold from its surface. As the gas permeates into the sand grains, the gelation by the reaction of sodium silicate and CO_2 gas advances and the sand mold is hardened. After the hardening is completed, the mold becomes very hard and easy for handling. Dimentions of mold is quite accurate and it is possible to assure the stable availability of sound castings of a fine surface finish. The application of CO_2 Process, however, is limited today due to the high price of CO_2 gas and the necessity of special mold releasing and sand reclamation equipment attributable mainly to its poor mold collapsibility. On the other hand, the easiness of mold forming and handling is appreciated by a large circle of modern foundries and CO_2 Process is still widely used especially for making heavy cores.

7.4.3 Di-cal Process

In this process, water glass and dicalcium silicate as the hardening agent are added to the base sand and are mixed and fed over a pattern in a molding box before the sand is hardened. This moldable time between mixing and molding (professionally called as bench time) is adjustable by the volume of hardening agent to be added. The merits of Di-cal Process are similar to those in the CO_2 Process which were explained in the foregoing paragraph 7.4.2, but in case of the Di-cal Process, there are two additional advantages, ie., the mold is hardened without gassing, and the hardening is performed in the natural air within a predetermined time. The Di-cal Process or similar water glass based self-hardening processes are quite popularly used in general foundries appreciating its easy molding characteristics, the availability of castings with a same quality, and the economy in the cost of sand. Various additives are commonly used to improve the mold collapsibility after pouring.

The Di-cal Process is considered as suitable for MFC where it is planned to produce only 200 tons per year of castings having various sizes. This process is also applicable for cast steel production.

7.4.4 Furan Self-Hardening Process

In this process, the sand is mixed with the furan resin which is used as the binder with the addition of phosphoric acid or sulfonic acid or other similar acid, any of which is used as hardening agent. The time required for hardening is determined in accordance with the timing of molding. The Furan Process has becom quite popular in the past decade due to these advantages as the superior collapsibility of mold under a high temperature and the excellent reclamation ratio of sand after being treated by sand reclaiming equipment. This process is quite suitable for making molds for heavy and large pieces of cast iron and cast steel. If there is a foundry in which the control of sand is perfectly achievable, the advantages of this process of a high productivity can be developed in full scale.

In the Furan Process, the control of sand requires the maximum attention. The temperature of sand during mixing should be maintained at a certain constant level, the sand should be completely dried and the measuring of additives should be very accurate. In a strict sense of control, it is necessary to use furan and acid having different properties for cast iron and cast steel. It is not wise at all to carry out this strict control of sand for a small volume of production. Besides, a substantial volume of gas is generated from the mold during pouring, and it is essential to pay considerations to let the gas out from the mold, and it is also necessary to select the molding boxes which are best matching to the sizes of castings for the purpose of minimizing the expensive sand. All these delicate considerations and adjustments required for molding procedures do not justify the application of the Furan Process in MFC. Above all, as it was explained in the previous Chapter 6, furan resin is imported from abroad.

7.5 Comparison of Various Types of Melting Furnaces

There are differences of more or less 150 to 200°C of both tapping temperature and pouring temperature between cast iron and cast steel, and in the normal practice, iron and steel are melted by different types of furnaces. Generally speaking, cast iron is popularly melted by coke-fired cupolas and/or low frequency induction furnaces whereas cast steel by arc furnaces and/or high frequency induction furnaces. However, it is considered that the waste in the respects of equipment cost and operation control will be tremendous if two different types of furnaces are used in such a small scale foundry as MFC. It is by all means preferable to install one type of furnace which can be used commonly for cast iron and cast steel. Advantages and disadvantages among various types of furnaces are described here below, and the application of a high frequency furnace is recommended for MFC simply because it is commonly effective for iron and steel melting and the requirement of operation skill is not so high.

7.5.1 Cupola

This conventional and traditional furnace utilizes coke as fuel and also as carburizer, and is specialized for melting iron castings. The upright, drum-shaped furnace is charged with coke up to a certain level which is burnt with the assistance of the air blown into the layers of coke through the air nozzles (professionally called as wind box and tuyeres) furnished at the lower level of cupola body. The melting materials such as pig iron, scrap steel, cast iron scrap, return scrap, etc., and additives such as ferro-alloys and limestone are dropped from the top of the cupola. The molten iron drips down through coke layers and during this passage it is superheated and accumulated in the bottom of furnace. As the molten iron is exposed to the reducing atmosphere throughout the above superheating process, the molten metal is prevented from an excessive oxidation, and the quality of metal is improved by the moderate carburizing action. However, the absolute conditions to tap out a high quality molten metal at a reasonably high temperature are to secure the supply of a high grade foundry coke and to use the cupola which is so designed that the proper air blowing into the furnace (technically called as balanced blast) is possible. Furthermore, a delicate adjustment of metal composition inside the cupola is impossible, so the predetermination and preparation of charge materials should be done accurately.

7.5.2 Low Frequency Induction Furnace

This type of furnace utilizes electricity of commercial frequency (50 Hz, 60 Hz) and the charged materials are heated and melted by the induced current generated inside the charged materials themselves. There are two types; crucible and channel, but the crucible type is more popularly used for melting, and explanation will be made only about the crucible type having water-cooled induction coils around the furnace body. The advantages of induction melting compared with cupola exist in such points as it does not emit heavy fumes and dust, and as the adjustment of metal composition and temperature can be performed easily inside the furnace. Due to these advantages induction melting practice is quite popularly used in the international foundry circles for melting cast iron replacing cupolas.

Starting this type of furnace with small pieces of cold materials is not very easy. In case of cold starting, it is essential to charge the furnace with a large block of material (called starting block) which is melted and cast beforehand. Even in case of continuous operation, it is not desirable to tap out all the molten metal, but more or less one third of the molten metal should be left in the furnace to receive the next charge of cold materials. Moreover, as the power input is usually smaller, it takes a longer time for melting cast steel. Most applications of low frequency induction furnaces are specialized for cast iron melting with acid linings utilizing a high grade silica sand.

7.5.3 Arc Furnace

Arc furnaces are most commonly used for steel melting even now. Furnace capacities of 1-ton up to 200-ton are commercially available, but the most popular range is from 2-ton to 30-ton. Materials are heated and melted by the arc generated between the charged materials and 3 units of graphite electrodes which are suspended over the materials penetrating the furnace roof. In this type of furnace, it is possible to melt a large volume of materials in a short time. Outer shell of arc furnace is of steel plate welded structure, and the inside of shell is lined with refractory materials such as chromium bricks, magnesia bricks, Mg-Cr (magnesia-chromium) bricks, etc. and the bottom bed of metal bath basin is formed by lining materials. Furnace roof swings out to receive a bottom-open charging bucket and a full batch of raw materials is dropped into the furnace. Molten metal is tapped out to a receiving ladle from a tapping spout by tilting furnace body.

The lining materials can be divided into silica based acid lining and dolomite or magnesia based basic lining. A suitable selection should be performed between the two paying considerations to the purpose of service and economy. The merits and demerits of acid lining and basic lining are illustrated in Table 7-1.

Table 7-1. Characteristics of Acid Lining and Basic Lining

	Acid Lining	Basic Lining
Cost of Material	Low	High
Removal of P.S.	Impossible	Possible
Refining Time	Short	Long
Erosion by Mn	Severe	None

This table indicates that it is more advantageous to utilize an acid lining furance in case a high grade scrap of less P and S contents is available and in case there is no possibility of melting high manganese steel. On the contrary, it is recommendable to use basic lining for melting a low grade scrap contaminated by high P and S contents or for melting high-manganese steel. In all, arc furnace is applicable for melting all types of steel, but at the same time, it is possible to melt cast iron as well. In most cases, arc furnaces are accompanied by powerful transformers such as 400 to 500 kVA for every 1 ton of furnace volume so that it is possible to melt down charged materials in a shorter time by supplying a large electric current. Furthermore, in the early stage of melting operation, the electric arc between electrodes and materials is not stable causing a violent fluctuation of voltage in the supply line. To cope with this problem, it is essential to have a power receiving sub-station of a large capacity. Considering these problems as voltage fluctuation and heavy requirements on sub-station capacity, it is not recommendable for MFC to install an arc furnace.

7.5.4 High Frequency Induction Furnace

1) Characteristics of Furnace

In this type of furnace, the heat is generated inside the melting materials by delivering a large power input. With its high thermal efficiency, the furnace features quick induction heating and melting. The principles of induction heating and melting are explained as follows.

Supplying alternating current to the coil wound around the conductor, the induced current having the reverse direction to the current in the coil is generated in the conductor by means of electromagnetic induction effect. This induced current runs in such a way as it is dense in the zone near to the surface of conductor and is getting scarce as it penetrates (professionally called as the Skin Effect). Here, the materials to be melted are playing the role of conductor, and the materials are heated and melted by Joule heat which is created by the electric resistance owned by the charge materials. For carrying out the most efficient heating, it is necessary to select the most suitable frequency in connection with the furnace volume and the materials to be melted.

If the selected frequency is much higher than that actually needed, it will increase not only the equipment cost, but also the running cost. There will be a substantial loss in wiring circuit and the total efficiency will be decreased. Generally speaking, the frequency of 500 to 1,000 Hz is appropriate for the furnaces having a batch capacity of 1 to 2 tons. This frequency range can effectively melt iron and steel as well. The melted material, in other words the molten metal, receives a compressive force directed to the central zone of furnace created by a mutual effect between the magnetic flux of coil and the induced current running in the molten metal, and the molten metal is stirred automatically. The stirring power of molten metal is greatly influenced by the frequency of input power and the power density. The stirring action and the rise of molten metal become harder and higher when the frequency is lower and also the power density is higher for the same melting materials. It is possible to say that the basic characteristics of high frequency induction furnaces are based on the combination of these three major factors as frequency, input power and the degree of stirring action. The input power to the furnaces used for melting iron and steel can be selected in the range of 600 to 1,000 kW, and naturally, the time required for melting becomes shorter if the input power is greater. The structure of high frequency induction furnace is illustrated in Fig. 7-3.

2) Outline of Equipment

The composiiton of high frequency induction heating equipment is shown here below.

a) Power Receiving Sub-Station
b) Frequency Convertor (Rectifier transformer and thyristor inverters)
c) High Frequency Capacitor Bank
d) Operation Panel with Selecting Switch Unit

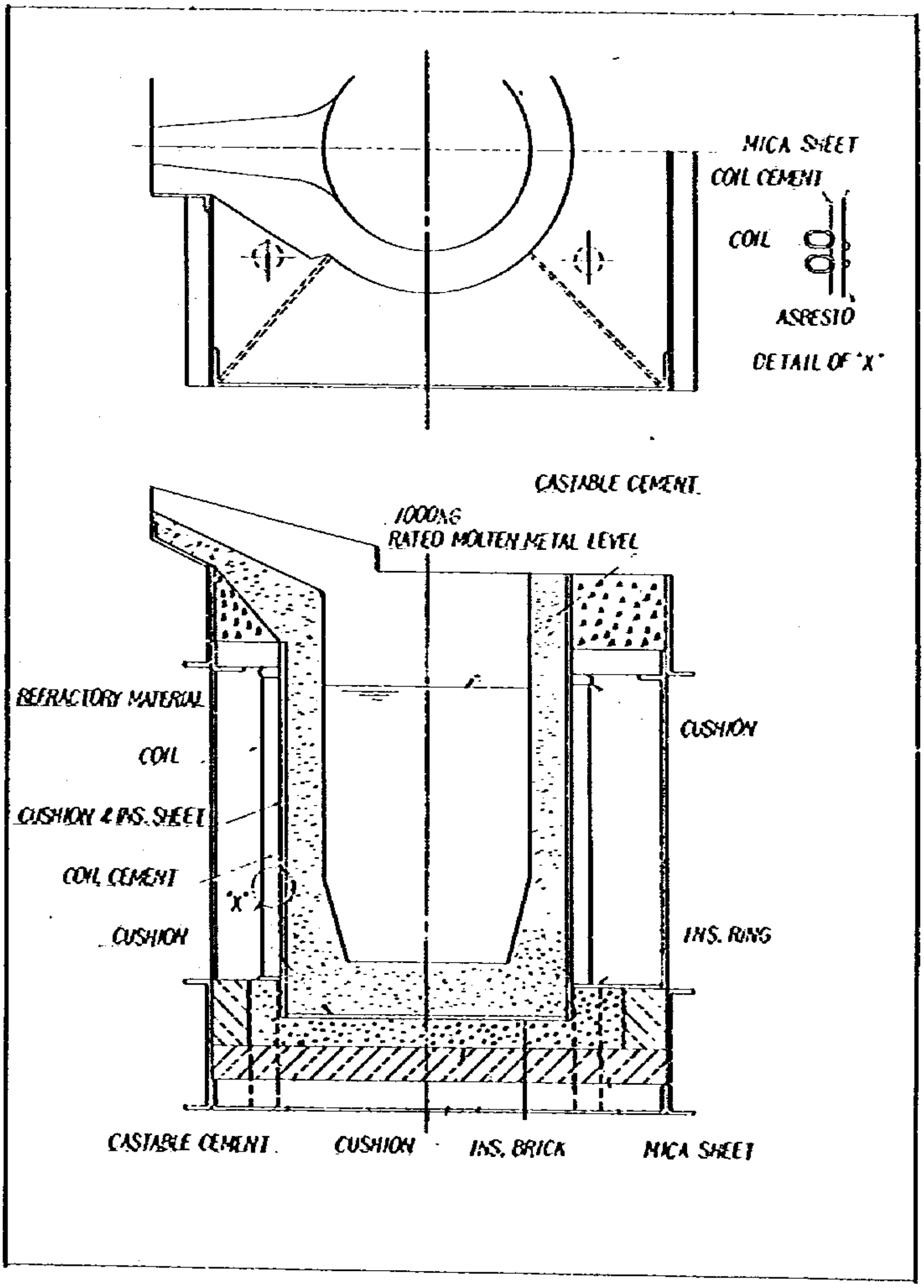


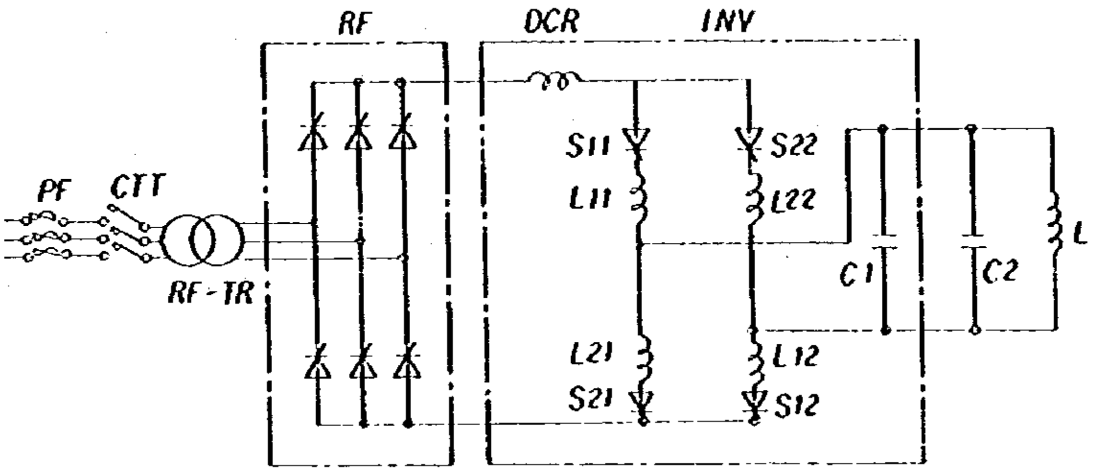
Fig. 7-3. Melting Chamber of High Frequency Furnace

e) Induction furnace

The fundamental circuit of thyristor frequency convertor is illustrated in Fig. 7-4. The alternating current with commercial frequency is stepped down by Rectifier Transformer (RfTr) and is once converted to direct current by Thyristor Rectifier (Rf) and the ripple portion is smoothened by Direct Current Reactor (DCR). The smoothened direct current is converted to high frequency current by Thyristor Inverter (Inv.). High frequency current control and impedance matching device are composed of control panel to control the whole melting equipment, matching transformer to match the impedance between the power source and the induction furnace, and condensor bank to improve power factor. Matching device is furnished with commutating condensors, starting device, and if necessary, high frequency transformer with tap changer is installed to increase or to drop the supply voltage to the furnace. The power factor of a high frequency induction furnace is quite low. Condensor bank is used to improve the power factor to the level of nearly 100%. Power selecting switch unit of the furnace is used to supply high power to the melting process and low power to the holding process of the furnaces alternately. The framework of high frequency furnace is made of non-magnetic metal and the induction coil and coil supports are housed inside the framework, and it is so designed that the deformation of furnace structure caused by the thermal expansion of lining material can be relieved to the upper direction. The induction coil is made of copper tube with insulation treatment and is connected with water-cooling flexible cable. A substantial volume of cooling water is required for cooling the coil around the furnace body and power-pack including thyristor frequency convertor, but in common practice, the cooling water is recycled and cooled for reuse by utilizing a combined system of water pool, cooling tower and pumping units. The cooling water should be free from the contents of impurities such as dust, mud and other organic substances which may encourage the growth of scales and slime inside the water circuit or these which may corrode metals. If the water contains such impurities, it is necessary to install filters and water treatment systems.

3) Refractory Materials

Among the various factors for determining the capacity and economy of high frequency induction furnaces, the refractory materials and the method of constructing the furnace lining are ranked at the most important position. Refractory materials can be divided into acid materials represented by high grade natural silica



PF:	Power Fuse
CTT:	Magnetic Contactor
RF-TR:	Rectifier Transformer
RF:	Thyristor Rectifier
INV:	Invertor
DCR:	DC Reactor
$S_{11}-S_{22}$:	Invertor Thyristor
$L_{11}-L_{22}$:	Annode Reactor
C_1:	Current Condenser
C_2:	Power Factor Condenser
L:	Induction Furnace

Fig. 7-4. Basic Circuit of Thyristor Frequency Convertor

sand or fused silica, and basic materials of magnesia or spinel based. The selection between the two should be done by evaluating such factors as maximum melting temperature, kind of materials to be melted, and economy. The highest temperature acceptable by silica-based materials is 1,650°C, while the limit for magnesia-based materials is 1,800°C. In common practices, acid lining is used for melting cast iron and plain carbon steel castings, and basic lining is preferred for melting special alloy steel casting and high manganese steel casting or high carbon steel castings requiring a very high tapping temperature.

The method of lining construction can be divided roughly into dry method and wet method. Generally, the dry method is selected in case the importance is put on the curtailment of time and labor required for lining construction, whereas the dry method is taken up in case the priority is given to the cost saving related to refractory materials and consumables. The wet method requires such additives as water, sodium silicate, bittern, etc., and it requires a longer time for drying and also requires a high grade of skill for drying. Due to these reasons, the recent trends indicate a wider popularity of dry stamping method in the foundry industry.

7.6 Method of Melting Various Kinds of Castings Classified by Chemical Composition.

7.6.1 Cast Iron

The melting temperature of gray cast iron varies in accordance with the size and wall thickness of products, but it is generally known that the temperature between 1,450 and 1,500°C is most suitable. In this planning for MFC, one out of two units of high frequency induction furnace is lined by acid refractory material for the exclusive use of melting cast iron. The acid lined furnace can be heated upto 1,600°C, and there is no fear of causing a severe wear of lining as long as the temperature is maintained below this limit.

In the melting practice by a high frequency induction furnace, the stirring action of molten metal is not so fierce compared to the melting by low frequency furnace, and consequently, the degree of oxidation of molten metal caused by the exposure to the air is much lower than that of low frequency melting, and it is possible to obtain the molten metal of more stable property.

According to Japanese Industrial Standards (JIS), the properties of gray cast iron are classified by such symbols as FC15, FC20, FC25, FC30 and the like. The figures given here represent the tensile strength of test pieces. For instance, FC20 indicates the gray cast iron having a tensile strength of 20 kg/mm². Carbon and silicon are the most influential elements over tensile strength of gray cast iron, and it is essential to control the contents of these two elements within a predetermined range. Furthermore, the fineness and shape of precipitated graphite and properties of composite matrix change delicately in accordance with the cooling speed at the time of solidification, and these changes give immediate influence on tensile strength and hardness. Therefore, it is necessary to carry out a delicate adjustment of carbon and silicon corresponding to the wall thickness of products. It is possible to adjust the size and shape of precipitated graphite to improve the property of cast iron by adding ferro-silicon based granular inoculant in a ladle at the time of tapping.

Among the products-mix planned for MFC, the production of spheroidal graphite cast iron (technically called as SG iron or ductile cast iron) is included. SG iron castings can develop much higher tensile strength and ductility than ordinary gray cast iron. For spheroidizing the precipitated graphite, magnesium based ferro-alloys or the similar agent are preset in the bottom of ladle before receiving molten metal. In this ladle, the molten metal reacts severely with magnesium alloys, and a part of magnesium combines with sulfur in the molten iron to form MgS and floats on the surface of molten metal as dross, but a part of it promotes the sphroidization of graphite in the form of residual magnesium. Viewing this fact, the most effective procedure to save the amount of spheroidizing agent is to keep the sulfur contents in the molten metal to the minimum level. For this purpose, pig iron and scrap steel with a low sulfur contents should be selected for the furnace charge. Commonly, the sulfur contents in the molten metal before spheroidization treatment should be lower than 0.03%. If the sulfur contents in the molten metal is higher than this level, it is even necessary to carry out a suitable desulfurization before the magnesium treatment.

Attention should also be paid to the manganese contents in the molten metal. If it is too high, the scheduled elongation capacity will not be obtained in an as-cast state. In this case, the as-cast products should be annealed to improve the elongation value. It is recommended to keep the manganese contents under 0.3% to obtain the standard elongation without annealing procedures.

7.6.2 Cast Steel

The term Cast Steel referred to here contains general carbon steel and low alloy steel. The method of melting of both carbon steel and low alloy steel can be considered much the same except that the addition of alloying elements in the form of ferro-alloys is required for the production of low alloy steel castings. The melting temperature of cast steel is normally in the range of 1,600 up to 1,680°C. As mentioned previously, the running temperature limit of acid lining of high frequency induction furnace is 1,600°C, and the above melting temperature of cast steel exceeds the limit. Therefore, an acid lined furnace is scarcely used for melting steel excepting unavoidable cases. From this reason, it is common to use basic lining of magnesia-base for melting cast steel on the ground of its high refractoriness. Magnesia-base lining is, as described above, advantageous for high temperature melting, but, on the other hand, it is physically weak for the repetition of sharp heating and cooling, and the lining is liable to have cracks and further to have serious metal penetration. Accordingly, it is recommended to pay extra care for constructing the lining and to consider some suitable measures to keep the lining hot after tapping out the molten metal.

Melting operation by high frequency furnace can be divided into such functions as melting the charged materials, composition adjustment, superheating to the target temperature and tapping out the molten metal. In this type of furnace, it is impossible to perform effective refining of metal to eliminate unwelcom elements contained in charged materials and to remove hydrogen gas. Therefore, it is necessary to select the charging materials carefully to avoid any mixutre of indistinct elements and heavy rust. Special care is required for handling the return scrap of low alloy cast steel. After cutting ingates, risers and runners at gas cutting stations, it is recommended to make assortment of these returns in accordance with the varieties of chemical composition and store them in separate storing sections.

Melting of high manganese steel castings is quite the same as carbon steel excepting that in case of high manganese steel a large volume of ferro-manganese is added to the metal after it is molten down.

7.7 Fettling and Heat Treatment

7.7.1 Desanding (Remove Sand by Shotblasting)

The silica sand grains sticking to the surface of castings after mold releasing are removed by shotblasting. In this process, the castings are picked up by monorail hoist and sent into a totally enclosed cabinet. There are several units of bladed wheels rotating at a very high speed, and steel shots are projected to the self-rotating castings to remove sand effectively. The dust which inside the blasting cabinet is drown out as exhaust by the dust collector. It is recommended to cool down the castings preferably below 100°C before feeding them to the shot blasting machine to protect bags of dust collector from damages. To remove cores inside deep pockets of castings is not very easy for the mechanical shotblasting, so they are usually removed manually by utilizing pneumatic hammers.

7.7.2 Cutting of Ingates and Risers

The ingates and risers of cast iron are easily breakable by hammer strikes, but those of cast steel are cut off by oxygen-propane gas torches. Arc-air blasting is popularly used for smoothening the surfaces of stumps evaluating its high productivity. In some cases, small cracks are found on the cut surfaces of high manganese steel castings, and it is a common practice to leave higher stumps when cutting ingates and risers under room temperature. Occasionally, big risers of high manganese steel castings are cut after preheating the castings or even after heat treatment to avoid such cracks.

7.7.3 Grinder Finishing

Rough surfaces, stumps and burs of cast products are normally finished by grinders. There are such varieties in grinders as stationary type, pendulum (swing) type, portable type, etc., and are suitablyselected by paying considerations to the size of castings and grinding positions.

7.7.4 Heat Treatment

The production processes of carbon steel castings and low alloy steel castings include annealing or the normalizing process. Especially for low alloy steel castings demanding very severe standard of physical properties and hardness, it is a common practice to apply tempering after normalizing. Annealing is a kind of heat treatment in which the castings are heated up to 900 – 920°C and after keeping the temperature for several hours, they are cooled down inside the furnace. In case of the normalizing process, the castings are heated up and sustained as same as the above annealing procedure, but the castings are taken out from the furnace for the purpose of expecting a faster cooling in the room temperature. Normalizing treatment will give a higher strength and hardness to steel castings than annealing. These heat treatments can not improve strength of castings so much, but the improvement of elongation capacity is remarkable.

In case of high managanese steel castings, they are heated up to the temperature of 1,000 – 1,100°C and are kept under this temperature for hours and are quenched by water bath. High manganese steel in its as-cast state shows martensitic structure which is hard and brittle, but the matrix is changed to austenite structure by the above heating. The austenite structure obtained by heating will remain unchanged if it is cooled down sharply by water quenching, and it develops a very high wear-resistant property.

In this planning for MFC, all the above varieties of heat treatment process are handled by one multipurpose furnace. The burner units of this furnace, therefore, are designed to be capable of heating the furnace atmosphere upto 1,100°C, and the refractory bricks are also resistible against this temperature.

7.7.5 Descaling (Removal of Scales by Shotblasting)

Oxidized scales grown on the surfaces of steel castings after heat treatment are to be removed by shotblasting. Then, the grinder finishing is required just as in the case of cast iron.

7.8 Quality Control

Application of systemized quality control is by all means recommended to MFC not only for satisfying the demand of domestic customers, but also for manufacturing high quality castings equivalent to the international standard and promoting exports to the world market in the near future. It is impossible to obtain good castings of constant and reliable quality by simply operating the plant equipment and by consuming the purchased materials. It is desirable to establish the standards of quality of all materials to be used, work rule of every process, melting and pouring temperatures, heat treatment and the method of inspecting products, and it is desirable to record the results of checking and inspection, and feed them back to the total quality control. However, it is quite difficult to put all of the above control procedures into practice at once. In the beginning stage of production, the priority is to be given to the measurings and testings as stated below. Measuring and testing tools are included in this plan as a part of laboratory equipment.

Sand Testing
Chemical Composition Analysis
Measuring of Molten Metal Temperature
Quick Analysis
Testing of Physical Properties and Hardness
Inspection of Surface Defects
Microscopic Test

Besides the above, it is certainly required to carry out dimensional checking of wooden patterns and castings.

Chapter 8. Planning of Production Facilities

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In selecting production facilities required for Producing the various products-mix which were determined in the foregoing Chapter 4, the study team applied the following basic concept.

1) Select machinery and equipment which can offer the maximum efficiency of production and the minimum production cost.

2) Select those which do not require a very high level of technology and skill.

3) Select those which can improve the quality of castings in accordance with the leveling up of the existing manufacturing techniques in the Medan area.

In this sense, a unique molding process like the so-called V-Process, for example, is recommended in the previous Chapter 7. In this chapter, therefore, the selection of machinery and equipment has been done on the assumption that the V-Process will be adopted for the molding section.

8.1 Machinery and Equipment to be Imported

1) Sub-Station Equipment

(1) Outdoor Sub-Station Unit — 1 set

Receiving capacity:	2,000 kVA
Primary voltage:	20 kV
Secondary voltage:	3 kV

(2) Indoor Substation (Cubicle Type) — 1 set

Receiving Capacity:	600 kVA
Primary Voltage:	3 kV
Secondary Voltage:	0.4 kV

2) Melting Equipment 1 set

High frequency induction furnace

1,000 Hz, 1,000 kg/batch 2 units

Power pack: 750 kW/250 kW with changeover system for connecting these two power inputs alternately with 2 furnace bodies.

Complete with cooling tower, emergency stand-by generator set with water pumps. One furnace body is to be lined with basic refractory material while another one is with acid lining.

(EPC = Estimated power consumption = 1,000 kW)
(EWC = Estimated cooling water consumption = 420 l/Min.)

3) Auxiliary Equipment for Melting Shop 1 set

Ladle drying burner	3 units
Lifting magnet 800 mm dia.	1 unit
2-ton ladle	1 unit
1-ton ladle	4 units
50 kg platform scale	1 unit
1-ton hoist for material handling	1 unit

(Monorail is to be obtained locally)
(EPC = 20 kW)
(EOC = Estimated Fuel Oil Consumption = 20 l/H)

4) V-Process Equipment 1 set

Vibration table	1 unit
Film heater	1 unit
Vacuum pump & suction pipings	1 set
Sand transporting equipment	1 set
Sand cooler	1 unit
Bag type dust collector	1 set

Molding boxes

1,500 x 1,500 x 310/310 mm	6 sets
2,200 x 1,000 x 310/310 mm	2 sets

Standard molding speed: 2 molds/H

(Sand hopper, dusthood, duct, screw conveyor and pattern-suction boxes are to be fabricated locally)

(EPC = 130 kW)
(EWC = 200 l/Min.)

5) Self-Hardening Process Equipment 1 set

Continuous trough mixer	1 set
Capacity: 4.5 t/H	
Sand feeding conveyor	1 unit
Pneumatic rammer	2 units

(EPC = 3 kW)

6) Sand Reclamation Plant for Self-Hardening Process 1 set

Reclamation unit consists of sand lump crusher, magnetic separator, bucket elevator, sand sifter, pneumatic reclaimer and bag filter:	1 set
Reclaiming capacity: 1.5 t/H	
Sand recovery belt conveyor	1 unit
Sand recovery bucket elevator	1 unit

(Sand storage is to be fabricated locally)

(EPC = 20 kW)

7) CO_2 Core Making Shop

One-touch Mixer 1 unit

Capacity: 50 kg/batch
(Work bench is to be obtained locally)
(EPC = 3.7 kW)

8) New Sand Dryer 1 set

Capacity: 1 t/H
(Drum shell, portable conveyor for charging and cyclone dust collector are to be fabricated locally)
(EPC = 23 kW)
(EOC = 30 l/H)

9) Crane Type Shotblasting Machine 1 set

Max. size of work: 1,500 dia. x 2,000 mmh
Max load capacity: 2 tons
Complete with bag type dust collector
(Ductings are to be fabricated locally)
(EPC = 30 kW)

10) Gas Cutting & Fettling Shop

1 set consists of:

Double head grinder	2 units
Swing grinder	1 unit
Arc-air blasting device	1 unit
Arc welder 300A	2 units
Chipping hammer	4 units
Oxygen cutting torch	2 units

(EPC = 75 kW)

11) Laboratory Equipment — 1 set

1 set consists of:

Chemicals and tools for chemical analysis	1 set
Carbon-equivalent meter	1 unit
Sand testers	1 set
Silicon meter	1 unit
Pyrometers	2 units
30-ton universal testing machine	1 unit
Color check materials	1 set
Hardness testers	1 set
Sample cutter & polisher	1 set
Microscope	1 unit

(EPC = 20 kW)

12) Multi-purpose Heat Treatment Furnace — 1 set

Capacity: 3 t/batch
Operating temperature: 600°C – 1,100°C
(Furnace shell, bogie, stack, exhaust ducts and water quench pool are to be fabricated locally)
(EPC = 15 kW)
(EOC = 180 l/H)

13) Platform scale — 1 set

Scale graduation: 0.5 – 2,000 kg

14) Maintenance Machine Tools — 1 set

1 set consists of:

Center lathe 1,800 mmL	1 unit
Tool grinder	1 unit
Shaper 500 mm stroke	1 unit
Vertical milling machine 800 mm dia.	1 unit
Radial drill 1,500 mm dia.	1 unit

(EPC = 30 kW)

15) Transporting Equipment — 1 set

1 set consists of:

500 kg capacity electric hoist	2 units
1-ton capacity electric hoist	1 unit
2-ton capacity forklift truck	1 unit

(Monorails for hoist and 5-ton cargo truck are to be procured locally)
(EPC = 5 kW)

16) Woodworking Shop Equipment — 1 set

1 set consists of:

Band saw	1 unit
Crosscut saw	1 unit
Wood lathe	1 unit
Wood planer	1 unit
Other miscellaneous hand tools	1 set

(Work tables are to be made locally)
(EPC = 15 kW)

17) Air Compressor — 1 set

1 set consists of:

37 kW air compressor	2 units

Complete with after coolers and air receivers
(EPC = 75 kW)

18) Standard Spare Parts for 2 Years Normal Operation — 1 set

19) Consumables for 2 Years Normal Operation — 1 set

Including lining materials of furnaces and grinding wheels

20) Materials for Secondary Wiring and Piping — 1 set

21) Pattern Plates for Start Up Period — 1 set

For 10 regular castings

22) Engineering Drawings for Local Fabrication — 1 set

Total consumption of power and fuel oil for the annual production of 1,200 tons of castings, and the total volume of cargos of the machinery and equipment to be imported are estimated as follows:

Total Power Consumption ≒ 1,465 kW = 1,700 kVA

(Subject to the operating efficiency of 100%)

Total Fuel Oil Consumption ≒ 230 l/H

Total Volume of Packages for the machinery to be imported ≒ 2,000 m^3

8.2 Machinery, Equipment & Installations which are Considered to be Available Locally.

Generally speaking, the machinery, equipment and installations required for foundries – especially jobbing foundries – are consisted of a substantial volume of bulky structures and welded constructions made of steel sheets and profiles, and it is recommended to procure the steel fabricated structures from the local market as much as possible for the purpose of saving expensive packing charges and ocean freight.

Initially, in the field of machinery, the overhead traveling cranes which are currently fabricated in Surabaya and are well reqputed in the respects of performance and price, cargo trucks which are sold in North Sumatra, simple cyclone collectors, light-duty portable belt conveyors, screw conveyors and toilet-shower systems have been converted to the scope of local supply, but there is a high possibility of adding other machines of a higher technical level such as air compressors, power sub-station, water pumps and the like to the local portion in case there is a recommendation from so-called "the KEP PRES 10 Team" (one of the governmental units to promoted the application of locally made machines and equipment to the indusrial plants which are to be built newly in Indonesia) and in case the capacity, quality and performance of these locally built items are technically acceptable.

The following items are planned to be built, fabricated and/or purchased in Indonesia.

1)	Cooling Water Pool or Reservoire	
	Volume = 200 m^3	1 unit
2)	Overhead Water Tank for Emergency Cooling Water Supply	
	Level = +6 m Volume = 10 m^3	1 unit
3)	Monorail and Supports of Electric Hoist for Handling Charge Materials	1 set
4)	Sand Hopper of 5 m^3 Capacity, Dusthood for Mold Releasing, Ductings, Screw Conveyor and Pattern Suction Boxes for V-Process Molding Shop	1 set
5)	Sand Hopper for Di-cal Process Molding Shop.	1 set
6)	Drum Shell, Cyclone Collector and Portable Conveyor for Sand Charging for New Sand Dryer Station	1 set
7)	Ductings for Monorail type Shotblasting Machine.	1 set
8)	Hand Pushing Traverser	1 unit
9)	Furnace Shell, Bogie, Stack and Ductings and Quenching Water Pool for Multi-purpose Heat Treatment Furnace	1 set
10)	Monorails and Supports for All Hoists	1 set
11)	5-ton Cargo Truck	1 unit
12)	5-ton 15m-span Overhead Traveling Crane	2 units

13)	3-ton 15 m-span Overhead Traveling Crane	2 units
14)	Toilet & Shower Faciliteis	1 set
15)	Wooden Work Table for Core Making	2 sets
16)	Steel Racks for Storing Cores	2 sets
17)	Wooden Work Table for Wood Pattern Shop	2 sets
18)	Wiring and Piping Materials Required for Primary Side	1 set

8-3 Plant Layout

Based on the concept design shown above, plant layout and machinery layouts drawings are prepared as follows:

Fig. 8-1	General layout of the Plant
Fig. 8-2	Layout of Foundry
Fig. 8-3	Layout of V-Process Plant (1)
Fig. 8-4	Layout of V-Process Plant (2)
Fig. 8-5	Layout of High Frequency Induction Furnace

8-4 Electric Power Supply for the Plant

Power source required for the plant is supplied from the public utility power grid through 20 kV/3 kV, 2,000 kVA 3ϕ transformer.

The high frequency induction heating equipment is connected directly to 3 kV circuit. 3 kV/0.4 kV 600 kVA 3ϕ transformer is equipped for 400 V circuit, and 400 V source is supplied to the auxiliary machines such as pumps, crane, and others through the 400 V circuit breakers respectively.

Single line diagrams for the electric power supply system are shown on Fig. 8-6, and Fig. 8-7.

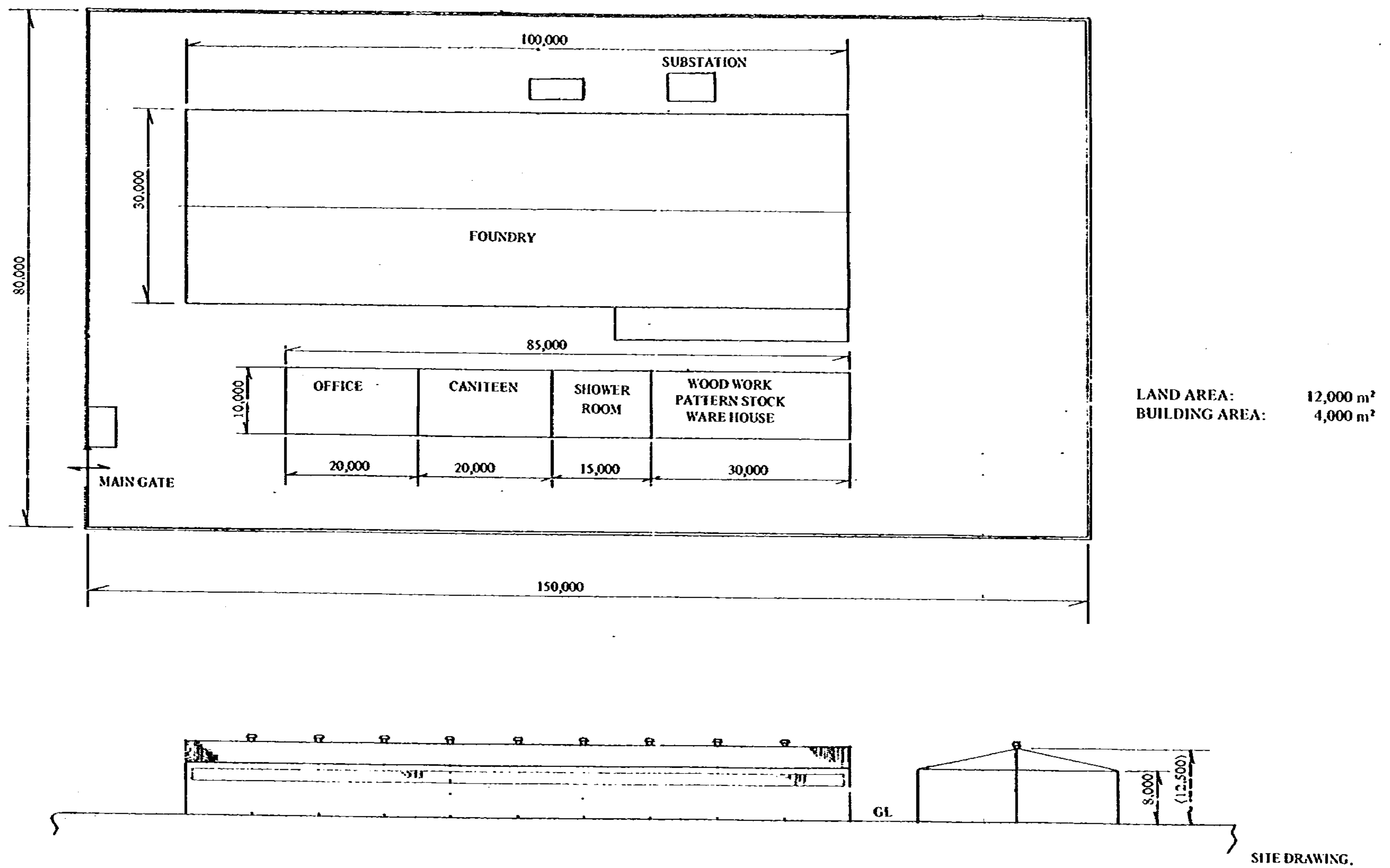


Fig. 8-1. General Layout

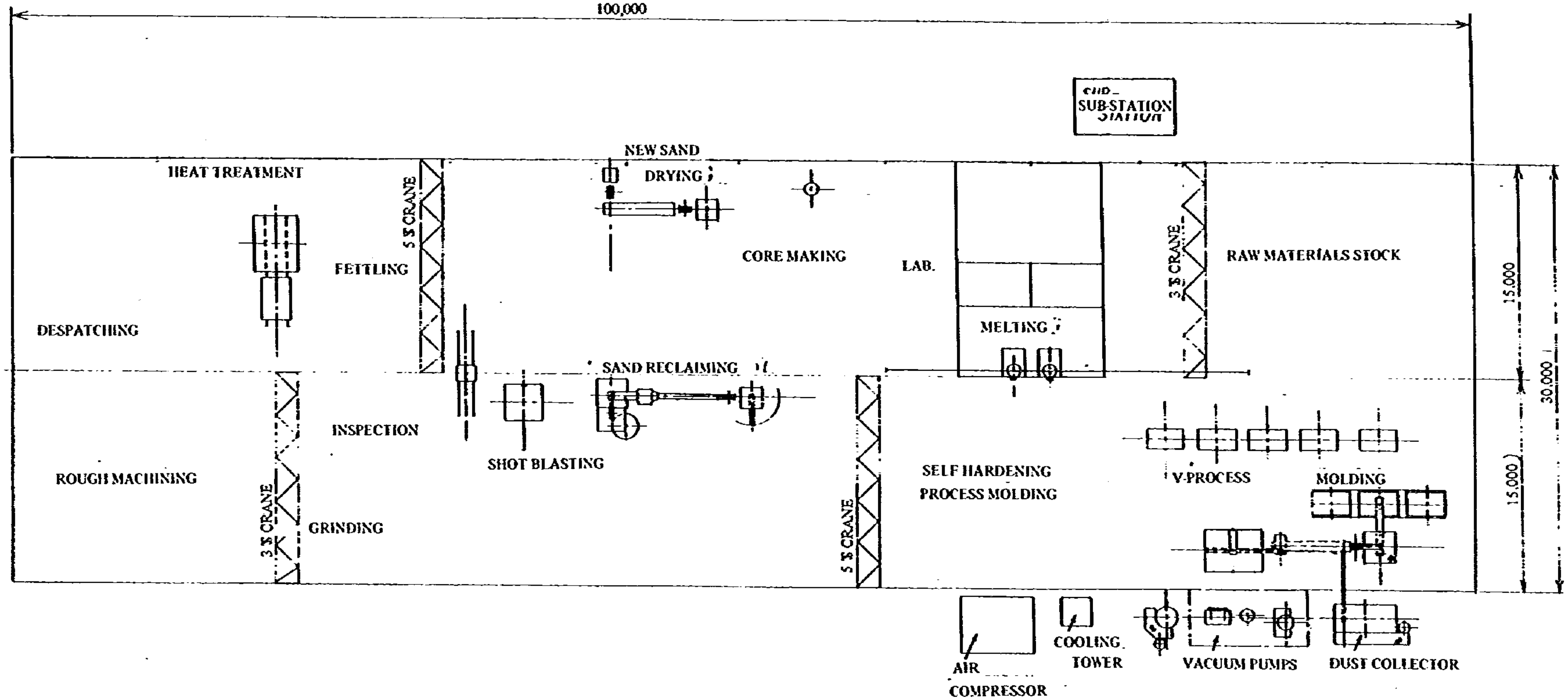


Fig. 8-2. Layout of Foundry

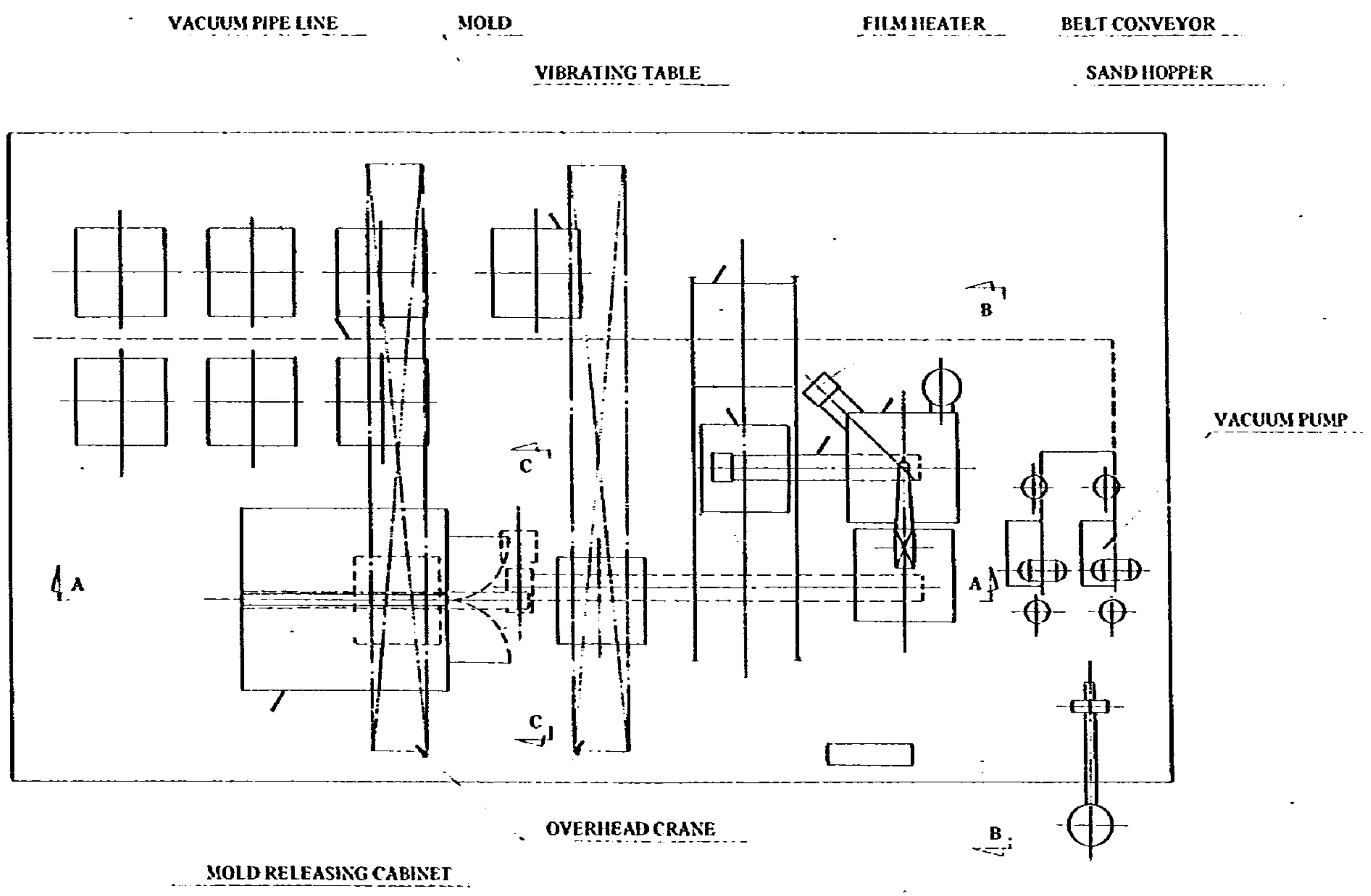
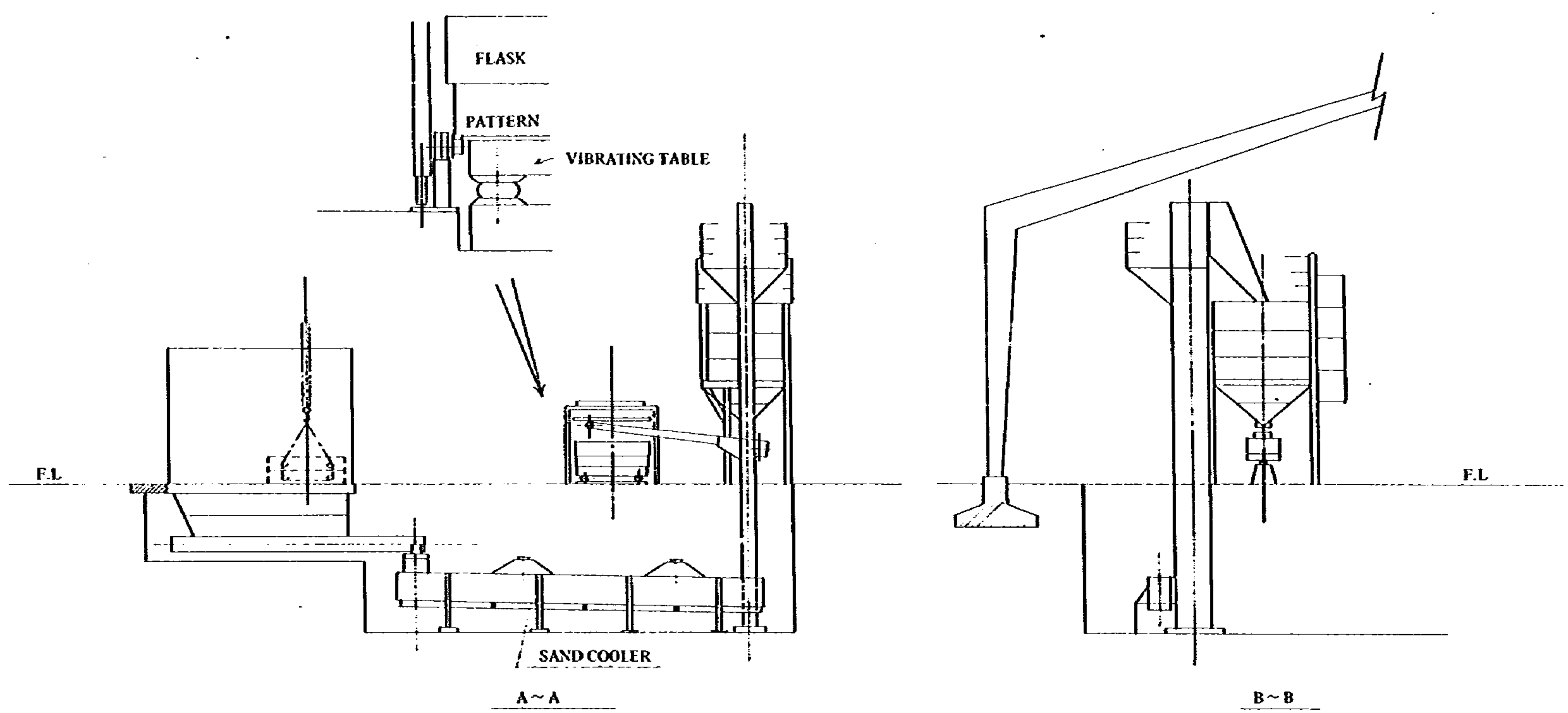


Fig. 8-3. Layout of V-Process Plant (1)



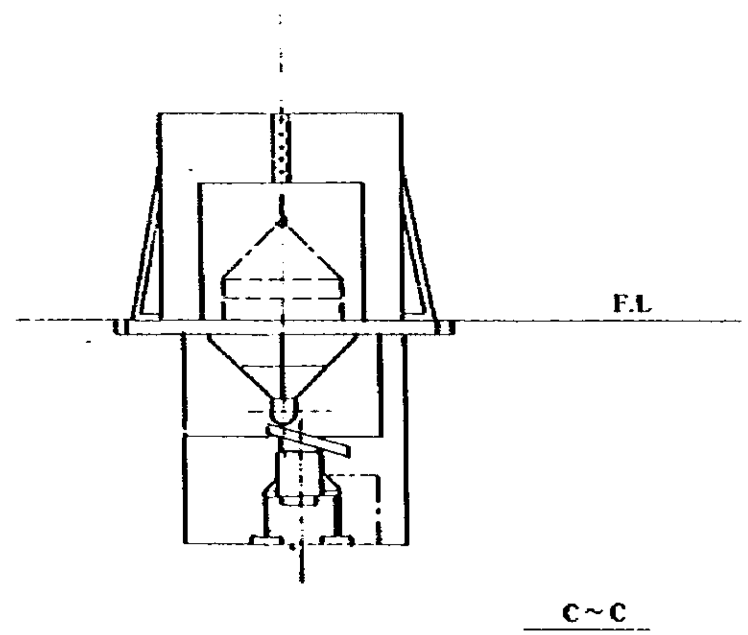


Fig. 8-4. Layout of V-Process Plant (2)

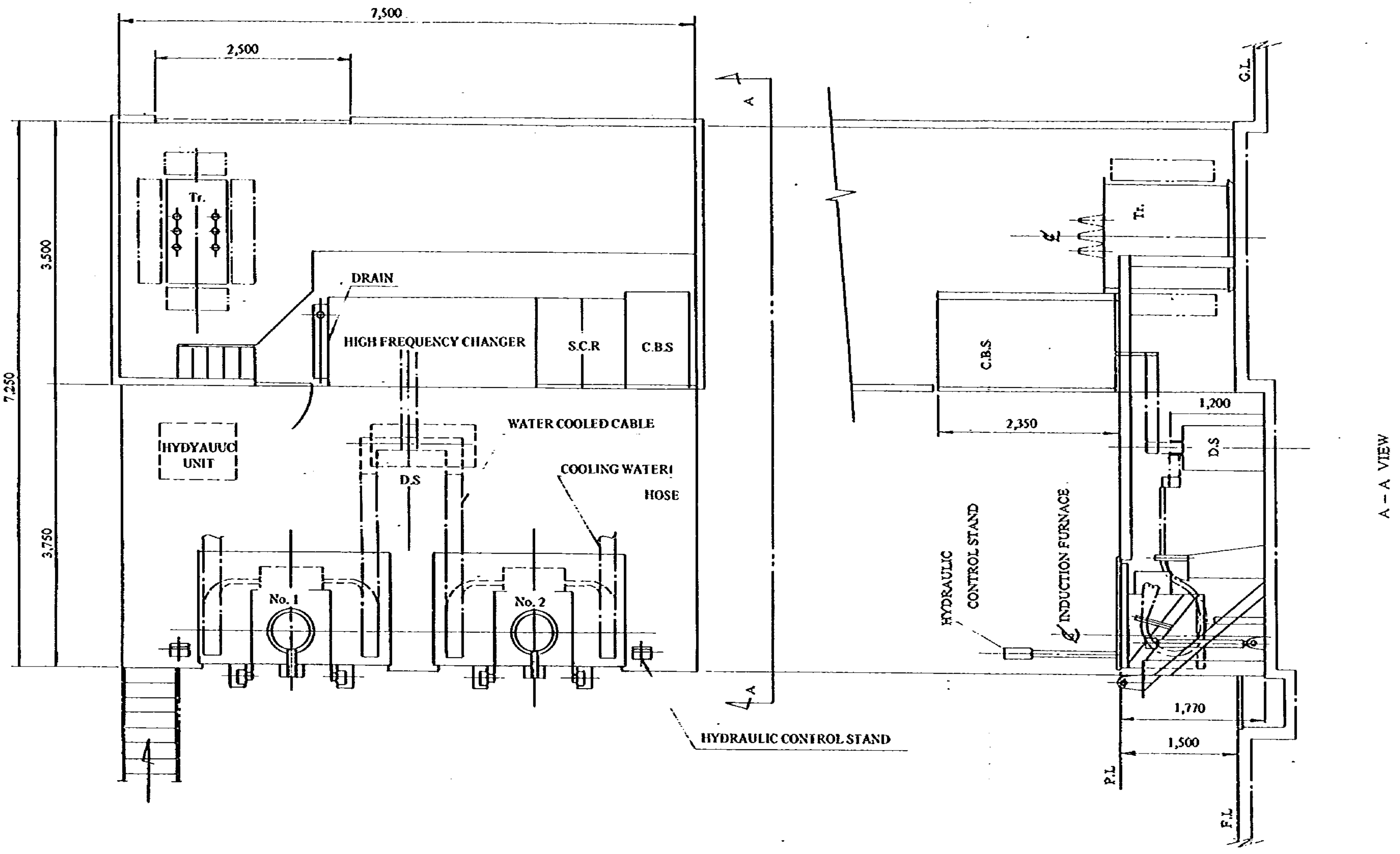


Fig. 8-5. Layout of High Frequency Induction Furnaces

Fig. 8-6. Single Line Diagram

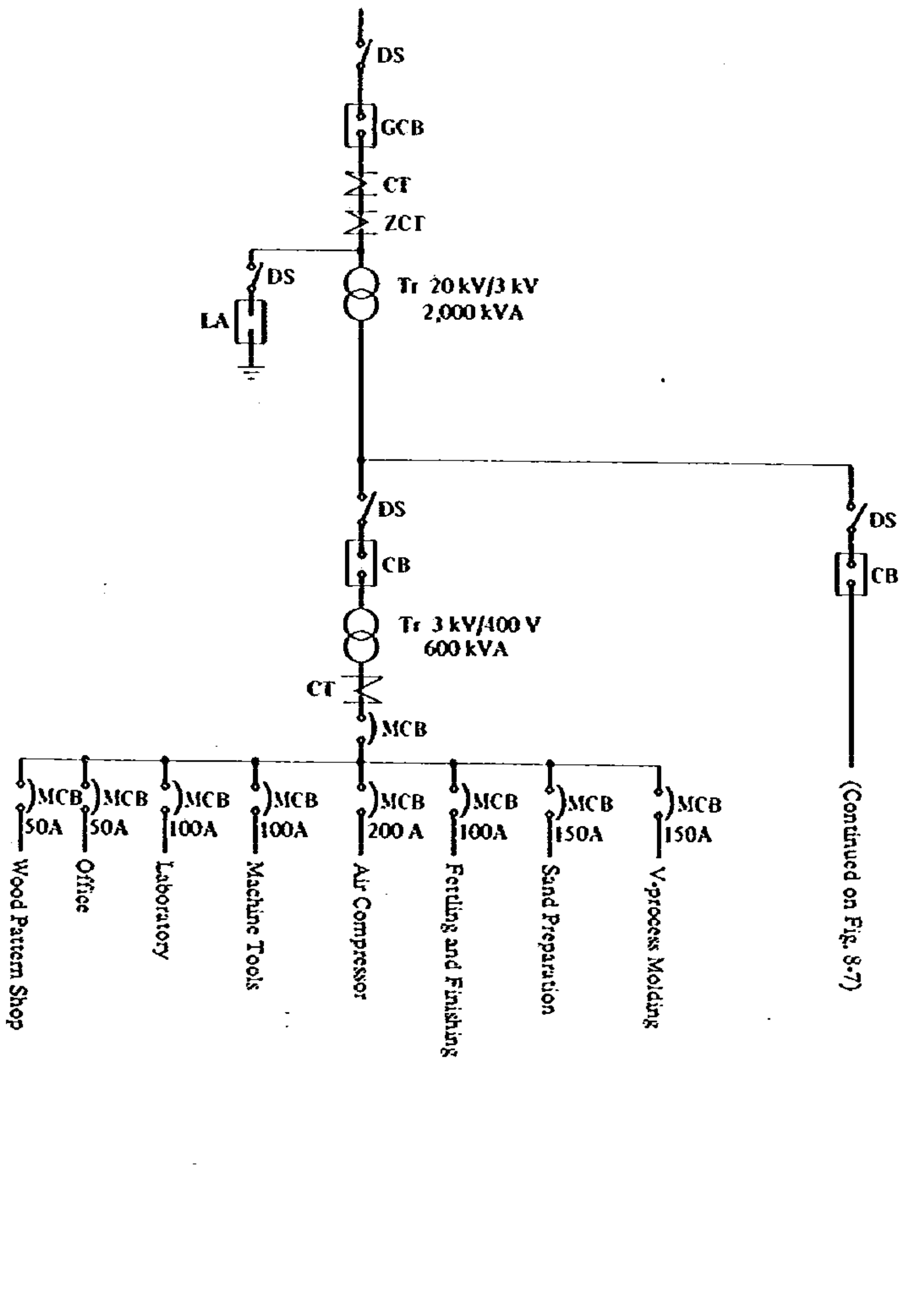
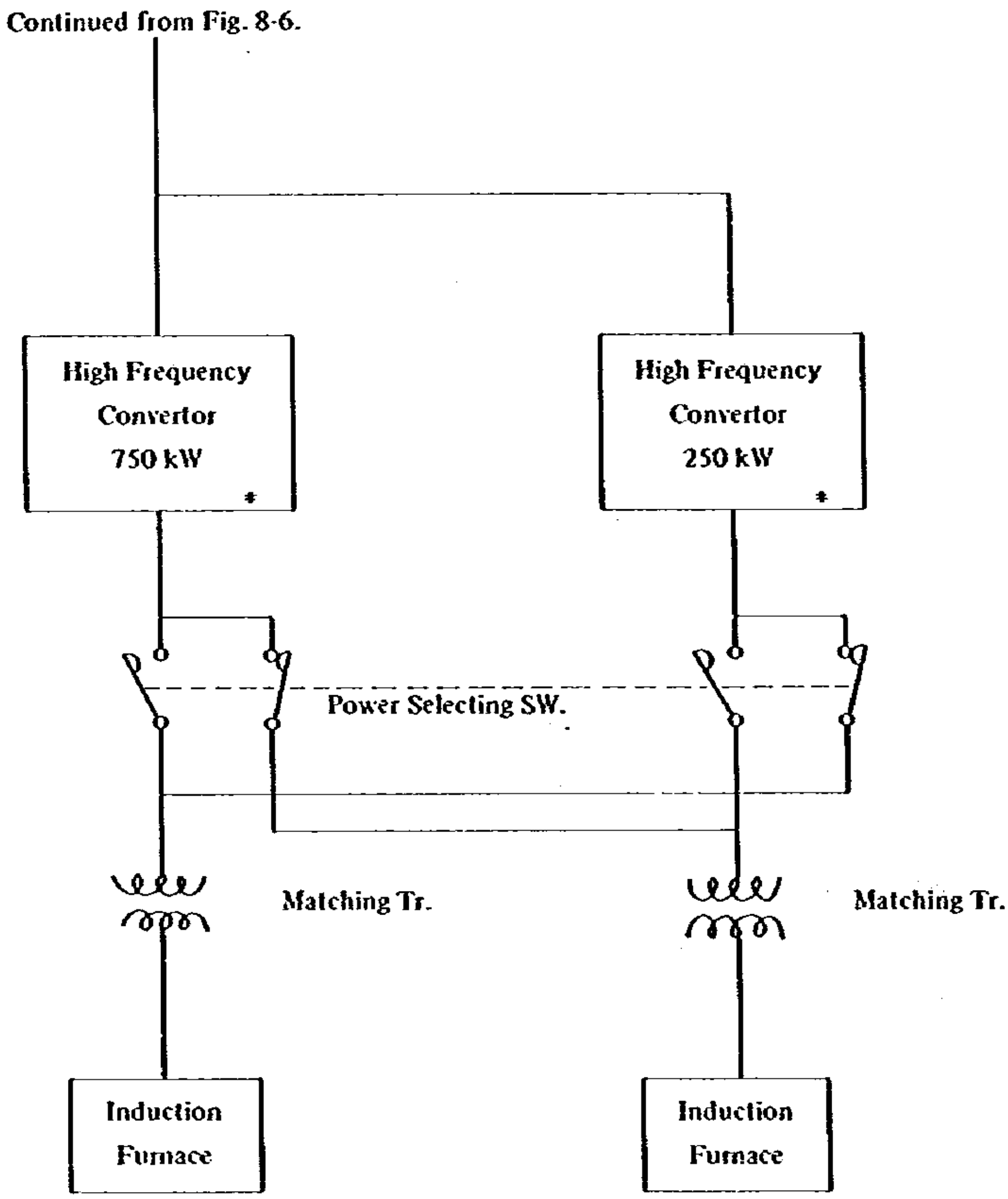


Fig. 8-7. Power Supply Device for Induction Furnaces



Remark: * Refer to Fig. 7-4.

Chapter 9. Construction of the Plant

Chapter 9. Construction of the Plant

9.1 Land Area and Building Area

9.1.1 Land Area of the Plant

Scheduled requirement of land = 12,000 m^2

The total area allocated to the project of the Medan Industrial Estate is 200 hectares, and 80 hectares of land out of the said 200 hectares has been leveled and prepared. According to the site office managers of the Estate, several different types of manufacturers are scheduled to use a part of the land sometime in future, but most of the land is still open.

As the whole land is flat and there is no neighboring building yet, MFC can select any part of the above Estate freely at least at the present moment. The planned land area for MFC is not big enough for a large scale expansion in future, but it is quite sufficient for the present production program.

9.1.2 Building Area

a) Designed area of main plant building: 30 m x 100 m = 3,000 m^2

b) Designed area of auxiliary building: 1,000 m^2

This auxiliary building consists of such facilities as office, canteen, wood pattern shop, warehouse, toilet and shower facilities, receiving substation, etc.

9.2 Civil Works

9.2.1 Land Preparation

As mentioned above the schedule land for MFC has been leveled, but the surface elevation is almost the same as the level of surrounding farm land and roads. The waterway provided alongside the main road in the Estate is nearly on the same level as the plantsite. Such being the case, there is a possibility of flood in the rainy season. To minimize this hazard, it is recommended to elevate the level of land for about 500 mm by filling the soil. The cost of elevating the land is calculated as follows.

Estimated cost of sand & gravel = Rp.4,000/m^3
12,000 m^2 x Rp.4,000 x 0.5 m^3 = Rp.24,000,000

The labor cost related to the land elevation is calculated as follows:

Estimated wage per day per worker = Rp.2,500
Rp.2,500 x 10 men x 80 days = Rp.2,000,000

Estiamted rental of road roller = Rp.100,000/day
Rp.100,000 x 20 days = Rp.2,000,000

From the above calculations, the total expense for the land preparation including soil filling consisted with cost of soil, labor and machine rental becomes Rp.28,000,000

9.2.2 Foundation Work and Construction Work

1) Foundation work (Indoor)

The design of machinery and equipment of this plant is based on the concept that the requirement of foundation pit should be minimized. Therefore, the total volume of the pit becomes only about 100 m^3, made up as follows:

Mold releasing area:	27 m^3
Furnace area:	12 m^3
Vacuum suction pipings:	30 m^3
Shotblasting machine:	5 m^3
Heat treatment furnace:	10 m^3
Water quench pool:	16 m^3

The deepest pit unaboidably reaches 3 meters below floor level. As the underground water level at the plantsite is said to be 2 meters below ground level, it is necessary to furnish the deep pit with a careful waterproof treatment. Several concrete piles are to be used for reinforcing the foundation of heavy installations and vibrating machines.

This excavation work, piping and drainage work, macadam, steel bars reinforcement (Rp.400,000 x 30 tons), 8 pieces of concrete piles (Rp.3,100,000), concrete pavement of the floor inside the plant building (Rp.2,000,000) are estimated to be 5% of the cost of machinery and equipment.

Foundation work and materials: Rp.65,100,000

2) Construction work (Outdoor)

Waste water drainage inside the plot, paved road for the trucks for bringing in the raw materials and for shipping the products, fence on boundary line and gate are included in the planning. For the start, the simple fence made of barbed wires and concrete posts is recommended to save the expense. It is important to finish these works in time keeping pace with the completion of building. The cost of materials required for the above outdoor work is estimated to be Rp.50,000,000.

3) Labor cost estimated for the above 1) & 2)

Rp.2,500/man.day x 30 men x 90 days = Rp.6,750,000

9.3 Design and Construction of Building

9.3.1 Design of Building

One main plant building 100 meters in length with a width of 30 meters is proposed. The width of 30 meters is divided into 2 bays of each 15 meters span. The framework of the building is made of structural steel and slates are used for the roof and walls. Doors are made of steel sash. Special attention should be paid for designing the building because the completely dried molding sand used in the plant as well as all machinery and equipment, especially electrical, and furnaces installed in the plant, should be protected from rain water, while moderate ventilation is required for the people working in hot and dusty job surroundings. It is also necessary to consider better natural lighting to secure a well-lighted job environment and also to save cost of lighting. Considering these conditions as stated above, it is advisable to install adequate numbers of skylights for natural lighting and openings for air ventilation at a higher level of the walls. It is also advisable to furnish these skylights and openings with long pent roofs to prevent rain from entering. The auxiliary building for office, wood pattern shop and other service facilities will follow the similar design as the main plant building, but it is also possible to use bricks for walls of this building as is commonly seen in North Sumatra. The substation room