7. Generated substances

7.1 Substances generated at the steel plant

1) Table 1-15 shows the substances generated at the steel plant and treatment of these substances.
2) The generated substances are classified into slag, dust, sludge, scrapped brick, waste alkali, waste acid, waste oil, and others. Others include the belts of belt conveyor, plastics and other substances generated during production activity.

7.2 Treatment of generated substances

(1) Concept of treatment
1) Generated substances that can be used are recycled and the amount of generated substances that are discharged from the steel plant is thus minimized.
2) Landfill areas are secured within the steel plant and generated substances that cannot be recycled or sold outside are dumped and used for landfilling. However, those that cannot be dumped or can be incinerated are incinerated. For this purpose, an incineration plant is installed within the steel plant.

(2) Slag treatment
1) Although blast-furnace slag can be used as a raw material for cement and converter slag can be used as a road base material when they are water-granulated, Viet Nam is abundant in raw materials for cement and the demand for road base material is opaque. In the initial stage, therefore, slag is dumped near the steel plant and used for landfilling.

(3) Dust treatment
The dust generated from the dust collectors, etc. is recycled as a raw material at the steel plant.

(4) Sludge treatment
1) The sludge generated from the water treatment facility is dumped and used for landfilling.
2) Rolling mill sludge and pickling sludge are recycled at the steel plant.

(5) Treatment of scrapped brick
At the steel plant, scrapped brick is generated from converters, ladles, etc. Those which cannot be recycled are dumped and used for landfilling.

(6) Treatment of waste alkali and waste acid
The waste acid generated in the rolling department is treated and recycled or neutralized. Waste alkali is treated and recycled or incinerated.

(7) Treatment of waste oil
Lubricating oil, rolling oil, etc. are generated. They are incinerated.

(8) Others
The belts of belt conveyor, plastics and other inflammables are incinerated in an incinerator.

Table 1-15 Treatment of substances and emissions

Substances	Volume	Treatment
1.BF slag	1,325 $\times 10^3$ ton/Y	
2.LD slag	363 $\times 10^3$ ton/Y	
3.Dust	454 $\times 10^3$ ton/Y	
(1).Raw-materials dust		Recycling
(2).BF flue dust		Recycling
(3).Steelmaking dust		Recycling
(4).Lime dust		Recycling
4.Sludge	82 $\times 10^3$ ton/Y	
(1).Water treatment sludge		Landfill disposal
(2).Rolling Sludge		Recycling
(3).Pickling sludge		Recycling
(4).Plating sludge		Recycling
5.Scrapped brick	23 $\times 10^3$ ton/Y	Recycling, landfill disposal
6.Waste acid	36 $\times 10^3$ ton/Y	Reprocessing, neutralization
7.Waste alkali	6 $\times 10^3$ ton/Y	Reprocessing, incineration disposal
8.Waste oil	23 $\times 10^3$ ton/Y	Incineration disposal
9.Others	86 $\times 10^3$ ton/Y	
(1).Rubber debris		Incineration disposal
(2).Waste plastics		Incineration disposal
(3).Others		

8. Investment of environmental control measures

1) Investment of environmental control measures is 8% of total investment in equipment. (about four hundred million US$)
2) Investment of environmental control measures is included in the estimate of individual equipment.

Appendix (Results of investigation of Dung Quat)

1. Investigation of environment of planned construction site

1.1 Investigation item

A water quality investigation and a noise investigation were conducted as the environmental investigations of the planned construction site

1.2 Water quality

1) Sampled water was analyzed twice as a water quality analysis. The average analytical values are shown in Table 1-16. The water quality of sea water, river water and the underground water near river water were analyzed.
Because the pH of the river water in Muiron is low, an ion analysis and an analysis of organic chlorine-base substances were conducted for the river water. The results of the ion analysis are shown in Table 1-17.
2) Any of the sea water, river water and underground water was not in an especially dirty or contaminated condition.
3) However, because the results of the ion analysis revealed that the chlorine ion (Cl^-) concentration of groundwater is high, it might be thought that this is affected by the salt contained in soil. Anti-corrosion measures will be needed for civil and building work.

Table 1-16 Water quality

No	Parameters and substances	Unit	Dung Quat		
			D	E	F
1	pH value	–	8.3	6.8	7.0
2	BOD	mg/l	–	–	
3	COD	mg/l	1.8	1.9	1.8
4	Suspended solids	mg/l	14	12	
5	Mineral oil and fat	mg/l	–	–	
6	Animal-vegetable fat and oil	mg/l	–	–	
7	Phenol	mg/l	< 0.01	< 0.01	
8	Copper	mg/l	< 0.05	< 0.05	< 0.05
9	Zinc	mg/l	< 0.05	< 0.05	< 0.05
10	Iron	mg/l	0.56	0.04	
11	Manganese	mg/l			
12	Chromium	mg/l			< 0.05
13	Fluoride	mg/l	0.30	0.14	
14	Coliform	MPN/ml	–	–	
15	Total nitrogen	mg/l	0.20	0.37	
16	Total phosphorous	mg/l	0.04	0.05	< 0.01
17	Cadmium	mg/l	< 0.01	< 0.01	< 0.01
18	Cyanide	mg/l	0.1	< 0.1	
19	Organic phosphorous	mg/l	< 0.1	< 0.1	
20	Lead	mg/l	< 0.01	0.01	0.01
21	Chromium (VI)	mg/l	< 0.05	< 0.05	
22	Arsenic	mg/l	< 0.01	0.01	
23	Mercury	mg/l	< 0.0005	< 0.0005	
24	Alkylmercury	mg/l	–	–	
25	Polychlorinated biphenyl	mg/l	< 0.0005	< 0.0005	
26	Trichlorethylene	mg/l	–	< 0.03	
27	Tetrachlorethylene	mg/l	–	< 0.01	
28	Dichloromethane	mg/l	–	< 0.002	
29	Carbon tetrachloride	mg/l	–	< 0.002	
30	1,2-Dichloroethane	mg/l	–	< 0.004	
31	1,1-Dichloroethylene	mg/l	–	< 0.02	
32	Sys1,2-Dichloroethlene	mg/l	–	< 0.04	
33	1,1,1-Trichloroethane	mg/l	–	< 1	

No	Parameters and substances	Unit	Dung Quat		
			D	E	F
34	1,1,2-Trichloroethane	mg/l	—	< 0.006	
35	1,3-Dichloropropene	mg/l	—	< 0.002	
36	Tetramethylthiuram disulfide	mg/l	—	—	
37	2-chloro-4,6-bis(ethylamino) -1,3,5-triazine	mg/l mg/l	—	—	
38	S-4-chlorobenzyl diethythiocarbamate	mg/l mg/l	—	—	
39	Benzene	mg/l	—	< 0.01	
40	Selenium	mg/l	< 0.01	< 0.01	

D : sea water

E : river water

F : underground water

Table 1-17 Results of ion analysis of water

	Cl^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
River water	5.7 mg/l	0.84 mg/l	0.41 mg/l	2.5 mg/l
Underground water	101 mg/l	—	—	—

2. Effects of SOx and NOx on neighborhood of steel plant

When the new integrated steel plant is constructed in Dung Quat, production balance, production facilities, environmental control measures, energy-saving measures, etc. are the same as when it is constructed in Muiron. However, because meteorology and topography are different and the layout of the facilities of steel plant is different, an investigation was made into the effects of SOx and NOx on the district.

2.1 Conditions for examination

1) The combustion exhaust gas from the steel plant is diffused in the air through high stacks. An investigation is made as to what effect the SOx and NOx in the combustion exhaust gas have on the neighborhood of the steel plant.
2) In conducting this examination, the diffusion simulation of the SOx and NOx emitted from the steel plant was carried out. The conditions for the diffusion simulation are the same as the Muiron case.
3) For the wind directions in the Dung Quat district, there are two seasonal winds:

east-north winds and west-south winds. As with Muiron, an examination was made into the case of east-north winds that affect land, and in a windless case.

2.2 Effect of SOx

1) Figure 1-7 and Figure 1-8 show the ground concentrations of SOx emitted from the steel plant in the surrounding district in a windless case, and in a case where the wind velocity is 4 m/s, respectively. The relationship between wind velocity and maximum ground concentration of SOx (Cmax) is shown in Table 1-18.
2) In the windless case, the maximum ground concentration Cmax is 0.0015 ppm within the steel plant.
3) The maximum ground concentration Cmax is highest at a wind velocity of 4 m/s and is 0.00324 ppm at a point 14,100 m distant from the boundary of steel mill (distance of maximum ground concentration = Dcmax).
4) In Japan's environmental quality standard for SOx, the daily average value of hourly values is 0.04 ppm and less and the hourly value is 0.1 ppm and less.
In consideration of this environmental quality standard, it might be thought that there is no problem in the effect of SOx emissions from the steel mill.

Table 1-18 Wind velocity and maximum ground concentration

Wind velocity	0 m/s	2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s
Cmax (ppm)	0.0015	0.00309	0.00324	0.00324	0.00318	0.00309	0.00298
Dcmax (m)	—	18,400	15,600	14,100	12,700	11,550	11,300

2.3 Effect of NOx

1) Figure 1-9 and Figure 1-10 show the ground concentrations of NOx emitted from the steel plant in the surrounding district in a windless case and in a case where the wind velocity is 5 m/s, respectively. The relationship between wind velocity and maximum ground concentration of NOx (Cmax) is shown in Table 1-19.
2) In the windless case, the maximum ground concentration Cmax is 0.0027 ppm within the steel plant.
3) The maximum ground concentration Cmax is highest at a wind velocity of 5 m/s and is 0.00639 ppm at a point 15,600 m distant from the boundary of steel mill (distance of maximum ground concentration = Dcmax).
4) It might be thought that there is no problem in the effect of NOx emissions from the steel mill.

Table 1-19 Wind velocity and maximum ground concentration

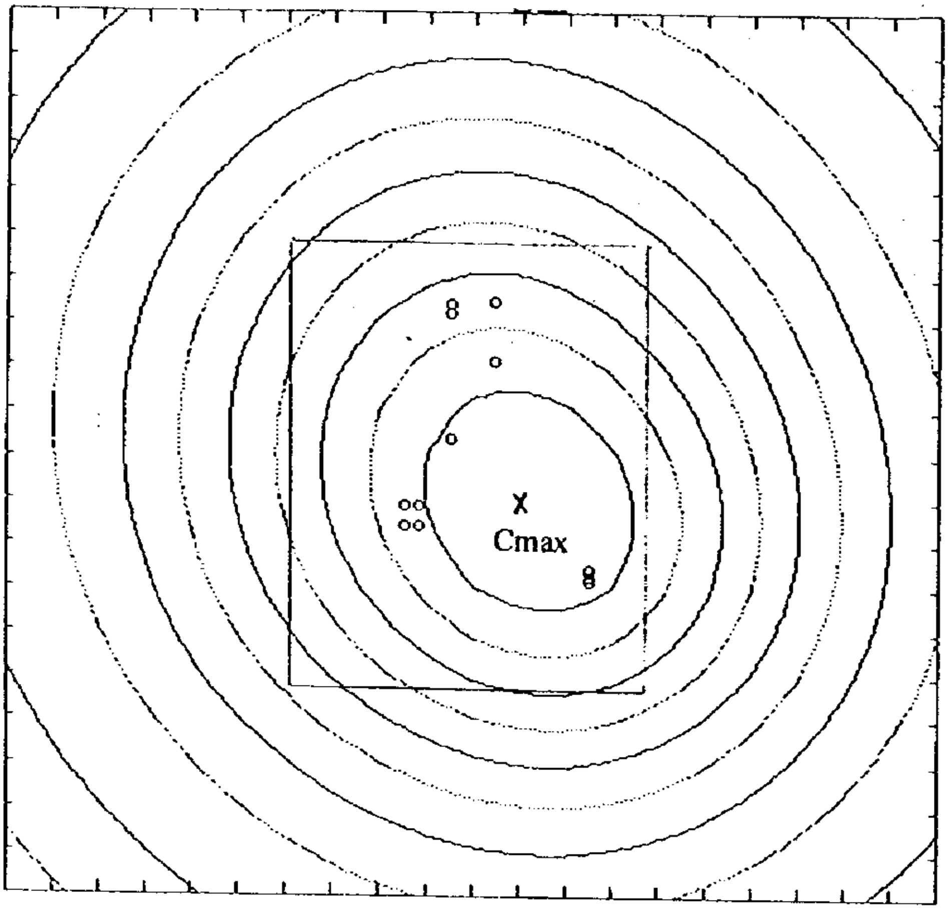
Wind velocity	0 m/s	2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s
Cmax (ppm)	0.0027	0.00546	0.00614	0.00636	0.00639	0.00634	0.00623
Dcmax (m)	–	22,600	21,200	18,400	15,600	14,400	14,100

2.4 Environmental impact as industrial district

Although there are plant construction plans for an oil refinery, etc. other than the steel plant construction plan in the Dung Quat district, the SOx and NOx emission conditions of these plants are unknown at the present stage. Therefore, the environmental impact was evaluated this time individually for the steel plant only.

However, it is desirable to evaluate the environmental impact of SOx and NOx as a comprehensive environmental impact evaluation of the whole industrial district including these plants.

Wind velocity : windless



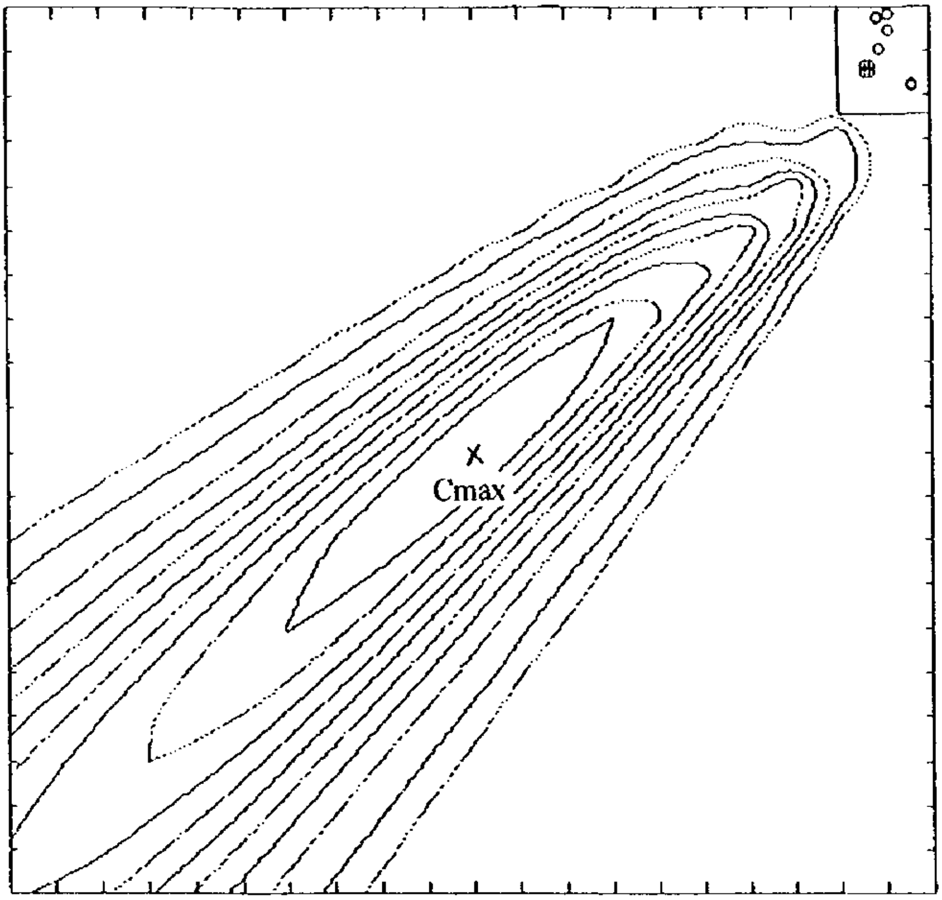
Distance : 5,000m all sides

Concentration ratio to Cmax (0.0015ppm)

9.00E-01	8.00E-01
7.00E-01	6.00E-01
5.00E-01	4.00E-01
3.00E-01	2.00E-01
1.00E-01	5.00E-02

Figure 1-7 Ground level concentration distribution of SOx

Wind velocity : 4m/s



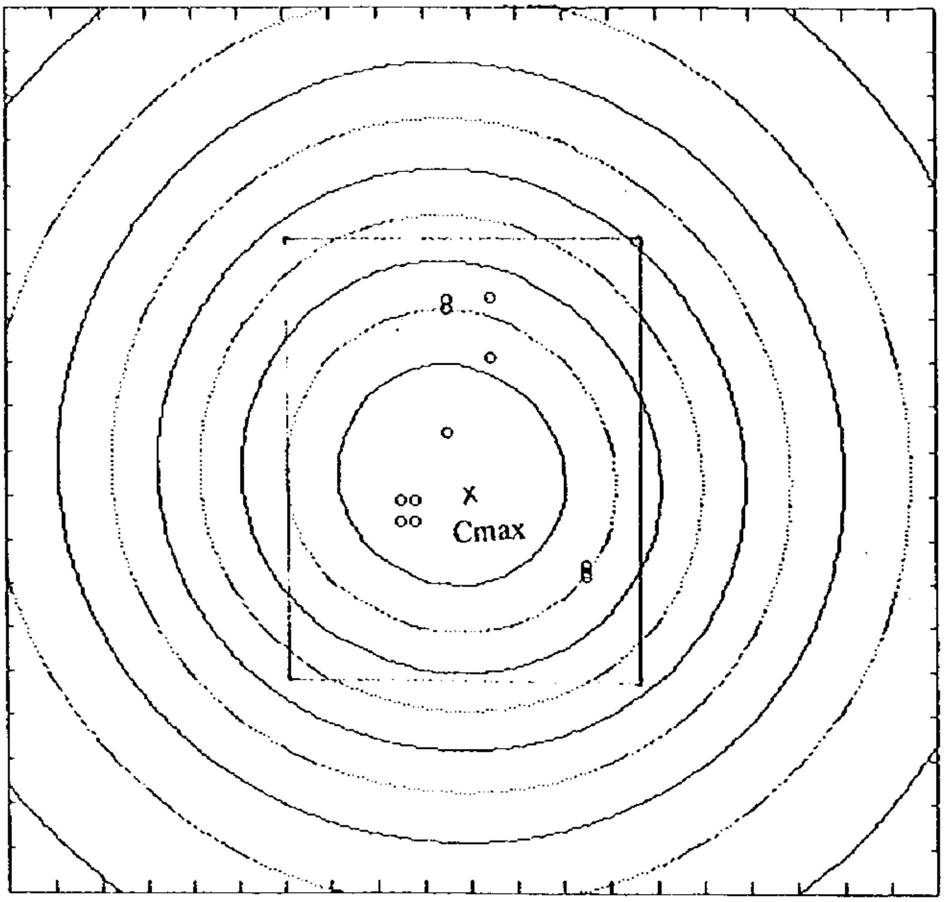
Distance : 20,000m all sides

Concentration ratio to Cmax (0.00324ppm)

9.00E-01	8.00E-01
7.00E-01	6.00E-01
5.00E-01	4.00E-01
3.00E-01	2.00E-01
1.00E-01	5.00E-02

Figure 1-8 Ground level concentration distribution of SOx

Wind velocity : windless



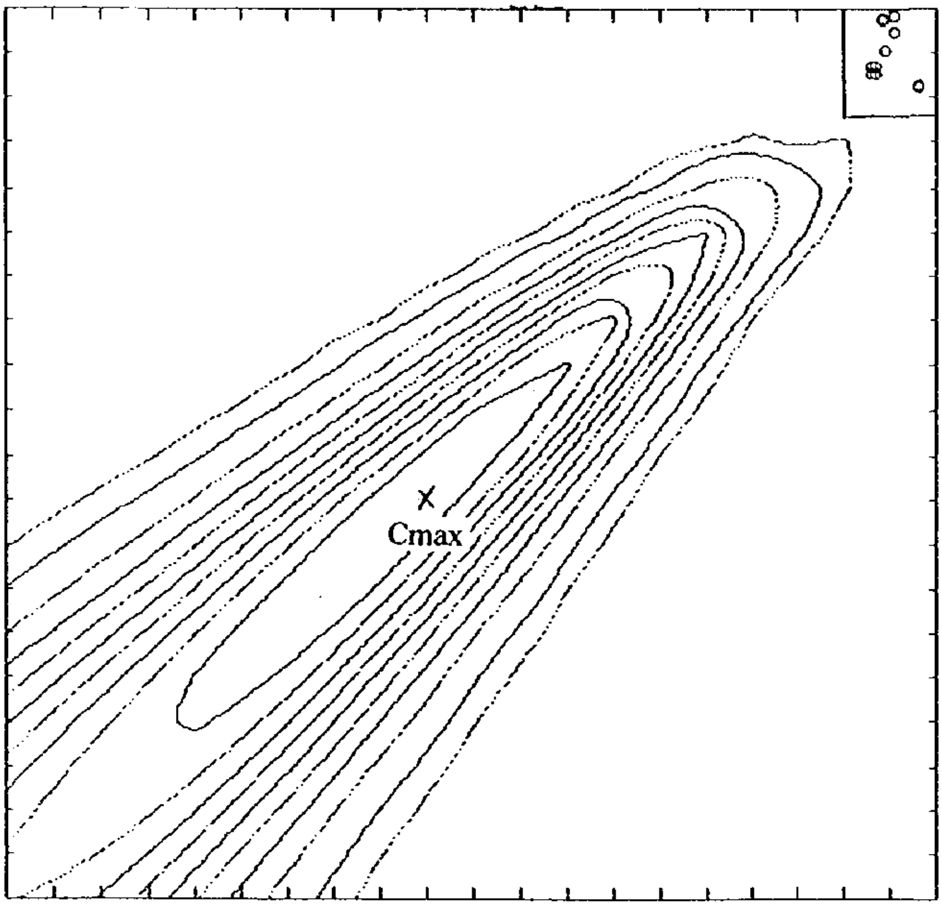
Distance : 5,000m all sides

Concentration ratio to Cmax (0.0027ppm)

9.00E-01	8.00E-01
7.00E-01	6.00E-01
5.00E-01	4.00E-01
3.00E-01	2.00E-01
1.00E-01	5.00E-02

Figure 1-9 Ground level concentration distribution of NOx

Wind velocity : 5m/s



Distance : 20,000m all sides

Concentration ratio to Cmax (0.00639ppm)

—— 9.00E-01	······ 8.00E-01
—— 7.00E-01	······ 6.00E-01
—— 5.00E-01	······ 4.00E-01
—— 3.00E-01	······ 2.00E-01
—— 1.00E-01	······ 5.00E-02

Figure 1-10 Ground level concentration distribution of NOx

Part 13 Recommendations

Section 1 Recommendations from the Results of Pre-feasibility Study

Contents

1. Viewpoint of Investigation of Supply and Demand

According to the investigation executed by JICA on supply and demand to the year 2010, it is predicted that the annual demand for steel products, which is presently 1.3 million tons, will increase to 6.4 million tons. This prediction was made through projections of the national economic growth and the growth of each industrial sector in Viet Nam, i. e., from the two aspects of macroscopic projection and microscopic projection. This is a methodology which is usually adopted. Whether demand expands as predicted can be judged only from results. It is needless to say, however, that as described in the recommendations of master plan (III-5), it is necessary for the government to take various measures for carrying out industrialization policies and for creating demand for steel.

Judging from analogy with growth patterns of the neighbouring countries, it is not difficult to imagine that Viet Nam will eventually enter a period where demand for steel products exceeds the above level. In particular, how to cope with an increase in demand for flat products that are not presently produced may be an urgent issue.

As a matter of course, it is one of the conceivable means to import such necessary products. This investigation work was carried out, however, from the viewpoint that a system for domestically producing such necessary products should be realized by promoting a national industrialization policy.

Incidentally, the production facilities for non-flat products are not included in the equipment of the integrated steel plant, on Viet Nam's understanding that these facilities are to be constructed near the consuming region of such products as required in the form of joint ventures with equity participation from abroad, as the case may be, because the construction of such facilities does not require great cost. For the rolling equipment considered to be necessary, however, three types of equipment were taken into consideration. They are described in IV-16 attached, for reference, to the end of the prefeasibility study report.

2. Viewpoint of Situation of Raw Materials and Fuels

It has been widely recognized that Viet Nam is a country rich in natural resources such as iron ore and coal for steelmaking. On the basis of the results of later investigations, it was announced (July 1997) that the exploitation of the Thach Khe iron mine would be suspended in terms of profitability, and it is pointed out that the Hon Gai coal which is produced in the northern part is anthracite coal, and hence poses problems in the ironmaking by BF process, if it is widely used without special treatment.

In other words, it is necessary for Viet Nam to recognize that the country is not rich in resources for steelmaking, when it intends to construct and operate a large-scale integrated steel plant.

Furthermore, it is necessary to recognize that natural gas, which is indispensable for gas based direct reduction (DR) process whose production technologies have been established, produces only in the southern part of Viet Nam, whereas in the middle to the northern part (where the proposed sites of steel plant are situated) there are no gas fields which produce enough gas to meet the volume required by the steel plant.

Scrap is also a raw material necessary for steelmaking. By many projections, the scrap market will become tighter and tighter in the future owing to the worldwide spread of electric arc furnaces and mini mills. Good-quality scrap is necessary for producing flat products. It is also widely recognized that it is very difficult to procure for a long period large amounts of good-quality scrap stably.

Therefore, when the construction of a large-scale integrated steel plant is aimed at, it is inevitable to examine the appropriate processes on the basis of the importation of iron ore and coal.

Incidentally, the Thach Khe ore may possibly be used, to some extent, for the small- and medium-scale processes such as DR process, although the chemical composition of the ore may limit its consumption in the case of the integrated steel plant.

3. Viewpoint of Selection of Process Technology

Although technologies are progressing constantly, processes to be applied should be determined by consideration on the kind of products and their amonut to be produced, available raw materials and energy resources.

If a process is selected from the presently established proven technologies on the basis of the production scale of 4.6 million tons/year, which includes approximately 3.0 million tons of flat products, it would be the BF-BOF process.

However, because the funds required by the integrated steel plant are immense, a proposal has already been made to construct the steel plant from the downstream processes of comparatively high profitability on a step-by-step basis. Therefore, whether the BF-BOF process is the most appropriate process at the time of construction of the upstream processes may be re-examined by comparing this process with other processes that might be established by that time (the engineering for construction will be started four years prior to the operation commencement).

In selecting process technology, attention should be paid to environmental consideration. In the present examination, the installation of desulfurization equipment is proposed for the exhaust gas from the sintering plant, which accounts for the greater part of SOx emissions from the steelworks. However, investment cost for the environmental preservation equipment is limited to a minimum essential scale as far as any emissions and effluents clear the evironmental regulations.
The same concept applies to the energy-saving equipment, which is proposed for only minimum essential portions.
The introduction of environmental preservation equipment and energy-saving equipment on a step-by-step basis should be examined in consideration of the surrounding environmental conditions, energy price, etc., when the operation of the integrated steel plant is started and a definite operation level is achieved.

4. Viewpoint of Site Selection

The ten sites for the steelworks initially proposed by the Vietnamese side were all in the coastal zone from the middle to the northern part. This proposal from the Vietnamese side can be judged to be appropriate from the standpoint of the construction of a deep-sea port necessary for the steel plant. The ten proposed sites were narrowed down to three, and Mui Ron in Ha Tinh Province was nominated as the site for pre-feasibility study. Dung Quat in the middle district was added as an object of investigation, and the details are described in III-4.

Whether the construction of another integrated steelworks is planned in a different place or the first integrated steelworks is expanded in the site planned this time is an important factor in judgment. When an existing steelworks is expanded, an increase in production is generally possible with relatively small funds because the existing infrastructure can be utilized. It is needless to say that a huge investment is required again when the second steelworks is to be constructed in a completely different place.

For the site conditions of a steelworks, a site of high profitability should be selected on the basis of pure market principle. However, it could not be rejected that area development and the economic development of the district may sometimes be great objectives.

5. Viewpoint of Investment Scale

There was a time when steel analysts of the world estimated the investment necessary for constructing an integrated steelworks in a green field at US$ 1,000 per ton of crude steel/year (the 1970s). However, this figure is greatly influenced by the kinds of products and the quality required by the market.
After the two oil crises and a rise in price, a price breakdown is presently to be observed, due to the export offensive lead by low-price materials from the former USSR, in the aftermath of the end of the cold war, with the global mega-competition, and with the world economy being in the doldrums.

The prices of equipment to be made to order, such as plant equipment, vary greatly depending on the economic situation at the time of order placing and the power relationship between the purchaser and the manufacturer. Furthermore, prices are also influenced by the method of procuring equipment; that is, prices naturally differ depending on the method of procurement; for example, the case where purchased articles such as equipment are imported and the installation work itself is carried out by the purchaser by requesting the dispatch of advisors who give guidance in installation (the FOB method), the case where installation is conducted by the manufacturer, and not by the purchaser (the turn-key method), and the case where equipment is constructed by the manufacturer with the manufacturer's funds and products are purchased by the purchaser having the manufacturer operate the equipment for a given period (the BOT method).

If equipment prices are to be strictly estimated, it is advisable, after the determination of the procurement method, to request the manufacturer to submit reference estimates on the condition that orders are placed with that same manufacturer. The method adopted in the present estimation is based on the results (FOB Port of Japan and converted it in CIF landed at port of Viet Nam) of the construction work of similar equipment executed relatively recently (not only within Japan, but on a global scale). It may be said that the accuracy of estimation is high if equipment is procured in a timely manner.

If the operation of the rolling equipment in the downstream process among the equipment of the integrated steelworks is to be planned at a certain timing, then orders for the equipment must be placed three and a half years prior to such timing, at latest. Estimates should be obtained again at this point of time by determining various conditions such as the method of procuring equipment.

Attention should be paid to the fact that detailed site conditions (ground conditions by boring tests, etc.) are not taken into consideration because this is a stage of pre-feasibility study.

6. Viewpoint Related to Profitability and Future Developments of the Construction of the Integrated Steelworks

As described in IV-10, the profitability of an integrated steel plant is not always high.
The measures to improve the profitability should be taken at first.

A case is first proposed in which facilities of downstream processes are first constructed, and then cold-rolled sheets and strips, metal-finished products, and hot-rolled plates, sheets and strips, etc., are produced using these facilities. In such a case, slabs, which are semi-finished products, must be imported. The difference between the import price of slabs and the selling price of products manufactured produces a profit as added value.

Although profitability is unequivocally determined by the import price of semi-finished products and the selling price of products, attention should be paid to the fact that the import price of semi-finished products tends to rise, as described in IV-5, and that even when steel products are domestically sold, their prices are influenced by international prices because they are international goods. Furthermore, it is necessary to carefully examine whether large quantities (not less than 1.7 million tons per year) of semi-finished products can be continually procured in a stable manner.

If the self-sustenance of Viet Nam with steel products is the national policy, the above difficulties must be inevitably conquered, and how to construct and operate a steelworks that has worldwide competitiveness is the most important point. Concretely speaking, competitiveness means whether good-quality steel products can be produced at low cost and supplied to customers timely.

For this purpose, it is necessary to construct equipment according to a careful thought-out plan, and to operate the steelworks using the most up-to-date technology under the consistent concept of engineering and operational technology.

The next page shows the principal steps to be taken by the Vietnamese side after this prefeasibility study in a case where the construction of the steel plant is carried out in the schedule planned by the Vietnamese side.

Year	Master Schedule (by VSC)	Major Job Items	Financial Aspects, Others
1998.01 02 03	JICA Pre-F/S completed	Explanation of Draft Final Report Submission of Final Report	Support from foreign organization
	(Support) Gov't appraisal: Organization of promoting team Decision of site	Designation of consultant for F/S	Fund for F/S (Source?)
1999.01	(Detailed F/S)	1. Site: Soil investigation (boring), climatic/infra-st detail survey (port, road/railway, power/tele-com) 2. Setting raw materials conditions: brand, price, storage days, source, etc. of ores/coals 3. Production conditions: Steel grade, mix, transp cond 4. Equipment plan: Scope, quality level, productivity	Preliminary idea for procurement of loan (ODA, IBRD, ADB, Exim Banks, Private Banks, etc.)
2000.01	F/S completed Gov'tl appraisal, finance Appointment of consult't Contract with consult't	5. Estimate condtn: Procurement method 6. Collection of cost data 7. Financing source 8. Concept plant design, estimate 9. Management method, producm cost, financial study	Concrete plan of finance scheme Negotiation with financing institutions Fund for engineering service agreement with consultant Confirmation of financing sources
2001.01	Beginning of engineer'g Preparation for procurement	Basic engineering 1. Document preparation for procurement Inquiry demnt, GTS, technical inquiry for each pckge 2. Bidding Pre-qualify, announcement, PBC, bid evaluation, negotiation with bidders 3. Selection of suppliers, contract	
2002.01	Civil work start Hot/Cold: Contract	4. Design meeting with suppliers 2-Step: Basic engineering for Step-2 equipment	
2003.01	Design/manufacture/ erection	5. Attendance at suppliers' shop test 6. Erection advisor	
2004.01	Prodct berth; Hot/Cold: Erection start completed	2-Step: Same nature of engineering services as Step-1	
2005.01	Hot/Cold: Erection/Test run **1-Step**	7. Test run guidance 2-Step Contract with suppliers	Securing financing sources for Step-2 construction
2006.01	Hot/Cold Strip Mill **Start-Up**	8. Start-up operation assistance 3-Step: Basic engineering for Step-3 equipment	Fund for engineering service agreement with consultant
2007.01			
008.01			
009.01	**2-Step**	3-Step: Contract with suppliers	ecuring financing sources for Step-3 construction
2010.01	No.1 BF/BOF Start-Up Cold Expansion		
2011.01		3-Step: Same nature of engineering services as Steps-1 & 2	
012.01			
013.01	**3-Step** (Final)		
014.01	No.2 BF/BOF Start-Up		

Figure 1-1 Future Steps to be Taken for the Development of Integrated Steelworks

7. Suggestions for promotion of integrated steelworks construction

As already described, the construction of an integrated steelworks is enormously expensive and does not always prove highly profitable.
Since upstream processes require very large amounts of investment, it is suggested that work should first proceed on downstream processes with relatively high profitability.
Joint ventures now manufacturing construction materials in Viet Nam are engaged in the construction of their plants by following the same idea. If they bring their production right on track, have the prospects of purchasing enough scrap, and think it possible to earn profits with the current electricity rates, they will go into the construction of electric arc furnaces. (For example, Vinakyoei is reported to be studying the timing of electric arc furnace construction.)

In some countries, integrated steelworks have been successfully constructed, operated and developed into a core industry. If Viet Nam is to promote the construction of an integrated steelworks as a national project, all of its leaders must be ready to raise necessary funds and to organize a construction promotion body by themselves.

If Viet Nam, about to take off as a modern industrializing nation, starts with the construction of downstream processes, it may later think it necessary to build an integrated steelworks complete with both upstream and downstream processes. Here are introduced some of the information that may help Viet Nam in that event.

Conditions required for construction of integrated steelworks as a national project

(1) Improvement of social and economic bases
The section "market study" has discussed in detail that demand for steel in a country increases with the growth of its economy. If this situation is left to market principle, many foreign companies will participate in the construction of downstream steel production processes with relatively high profitability, and the steel market of the country will be dominated by such small and medium-sized joint ventures.
Of importance here is that the shortage of foreign companies willing to participate in the construction of upstream steel production processes of relatively low profitability will force the country to continue import of slabs semi-permanently.

The construction and subsequent operation of an integrated steelworks greatly impacts the society and economy of the country, such as reduction in imports of semifinished steel products or in foreign currency payments, development of refractories, lubricants and other supporting industries, and increase in employment opportunities.
The construction of an integrated steelworks, especially for flat-rolled products, requires a huge capital expenditure and involves many risks, however. Herein lies the reason why foreign private firms are reluctant to enter this field.
As stated in the section on raising funds for projects in general (III-5-4), Viet Nam will have to prepare its own funds, including state bonds, equivalent to about 25 to 30% of the total amount required for the construction of an integrated steelworks as a national project.
The total cost of the integrated steelworks project is estimated at US$5.7 billion as described in IV-2-8-1. This means that Viet Nam will have to prepare its own funds of US$1.4 to 1.7 billion.
The total cost of constructing downstream processes alone is put at US$1.36 billion (refer to IV-2-8-1). The amount of self-financing by Viet Nam in this case is US$300 million to 400 million. This is the reason why the construction of downstream processes is suggested at the beginning.
If Viet Nam plans to introduce official funds from the ADB, IBRD or other international financing organizations, it will have to improve its social, economic and legal bases to accept such funds. These bases will have to be improved as rapidly as possible while respecting the opinion of experts. For this very reason, the governments of Brazil, Korea, Taiwan, Malaysia and Indonesia, to name a few, took the initiative in constructing integrated steelworks.
It is a well-known fact that the integrated steelworks in these countries were privatized as they got on the right track.

(2) Organization of construction promoting body
The leaders of many countries committed themselves to the construction of their integrated steelworks.
An organization, named something like "XX steelworks construction promotion headquarters" is established, centering on the department to plan the construction. The organization is headed by a powerful person who can represent the country concerned.
The head of the organization is given the rights to budget, personnel and negotiation with foreign companies, and has the trust and confidence of the leader of the country.
The functions of the organization and its main departments may be illustrated as shown below.

Example of the organization

- XX steelworks construction promotion headquarters
  - Consultation committee composed of members representing relevant ministries and agencies
  - <u>General construction planning department</u>
    Real estate, budget acquisition, foreign capital financing, and laws and regulations
  - <u>Construction promotion department</u>
    Technical planning (including employment of consultants) and overall engineering, such as equipment planning and construction
    - Consultant (A)
  - Operation preparation department
    Overall operational preparations (such as procurement of operating materials and supplies, and recruitment and training of operating personnel)
    - Consultant (B)

It is usually desirable that consultant (A) should be the same as consultant (B). This is because the equipment design philosophy must be fully reflected in the operating technology of the integrated steelworks.

A steel engineer will be soon dispatched from Japan to VSC for about two years under the expert dispatch system of JICA. It is essential that VSC should consult him as a good adviser about the techniques for organizing the integrated steelworks construction promotion body and carrying out the integrated steelworks construction project.

(3) Other necessary considerations
One way for reducing the initial capital outlay required for constructing an integrated steelworks is the build, operate and transfer (BOT) system as already noted in item 5 above.

The following plants can be built on a BOT basis, and products from them can be purchased by the integrated steelworks:

Coke oven plant
Sintering plant
Lime calcining plant
Metal finishing lines (CGL and ETL)
Power plant
Oxygen plant

This BOT system seems worth studying because the initial investment outlay required for the construction of the integrated steelworks can be substantially reduced if foreign companies interested in participation are invited with favorable conditions.

Part 14 Individual Plant Description

Section 1 Land Preparation

Contents

1. General

The land preparation is to be undertaken in accordance with the following conditions;

1) Ground levels shall be planned to insure their full function as the new integrated steelworks.
2) Ground levels shall be sufficiently high to prevent from being submerged by sea water due to waves or high tide in the front sea area or flooding from the area behind.
3) Ground levels shall be planned so as to make draining of rainfall water flows to outside from all the site area by natural hydraulic gradient.

The land preparation is basically to be planned in advance of all other plants in the works. The plan is to construct the new integrated steelworks in 3 steps, the 1st step (downstream), the 2nd step (BF× 1 and BOF× 2), and the third step (BF× 1 and BOF× 1) from the viewpoint of improving the result of the construction investment. So, the land preparation is planned based on the above mentioned concept.

2. Precondition

(1) The cost to replace several rivers presently flowing in the candidate site is out of scope in this pre-feasible study. (However, it is included in the cost of reclamation for the original river in the site.)

3. Technical explanation

(1) Ground levels during operation

The ground levels during operation shall be set at HWL + 5m based on the condition described in item 1. The present ground level of all the site area is equal to LWL or lower than as described in Chapter Ⅳ Part 4 Site description. Therefore, the banking shall mainly be conducted as the land preparation.

(2) Soil used for land preparation.

Basically, the dredged soil from the channel newly constructed is used for land preparation from the viewpoint of the investment cost reduction. However, because of protecting corrosion of tubes laid underground and bearing heavy load at site, the land and mountain soil near the site should be used within the range of 1 to 2m from surface .

(3) Amount of soil for land preparation

The boring test of the proposed site has never been conducted to date and not conducted in this investigation. Therefore, the amount of the soil used for the reclamation shown in Table 1-1 is roughly estimated figures. It is necessary to carry out detail soil test in order to calculate exactly the amount of soil required at the phase of detailed feasibility study and/or basic engineering in the future.

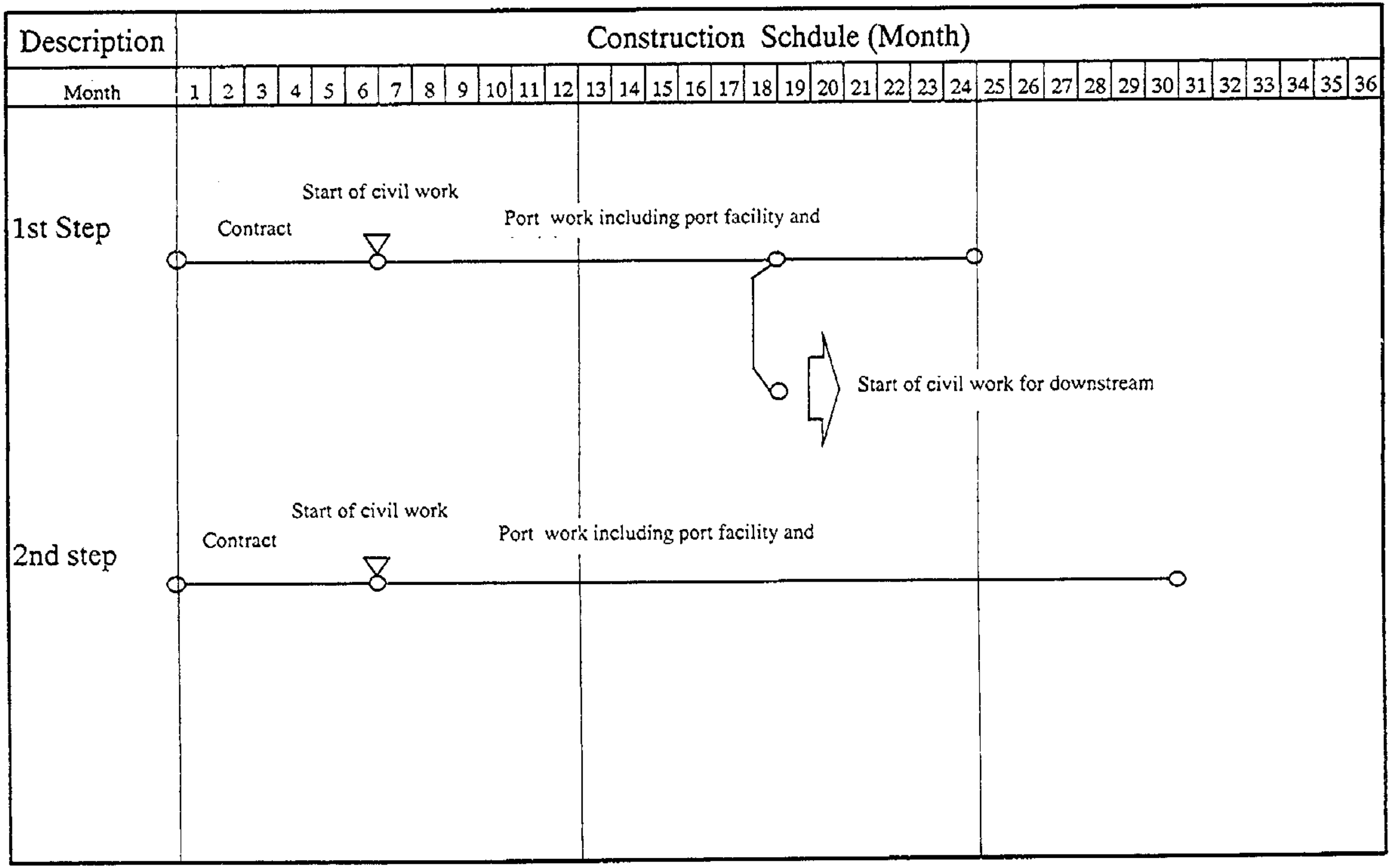
Table 1-1 Amount of soil for land preparation

	Area	Amount of soil
Up to 1st step	130 ha (For down stream)	Around $10\times10^6m^3$
Up to 2nd step	310 ha (For up stream)	Around $25\times10^6m^3$
Up to 3rd step	0 ha	$0\ m^3$
Total	440 ha	Around $35\times10^6m^3$

4. Construction schedule

Construction schedule for land preparation is shown in Table 1-2.

Table 1-2 Construction schedule for port and port facility



Section 2 Port and Port Facility

Contents

1. General

As a rule, the port construction is planned on the premise that the raw materials are imported from foreign countries. Moreover, most of the products are transported to market areas by ship. 200,000 DWT vessel is used for raw materials transportation, and 2,000DWT vessel is used for products transportation. However, considering import of products and semi products in the future, the product berth should be constructed to be able to receive vessels up to 20,000DWT.

2. Precondition

1) Quantity of imported raw material

Quantity of imported raw materials for planning of port is shown in Table 2-1.

Table 2-1 Quantity of imported raw materials for planning of port

Kind of imported raw material	Ore	Coal
Quantity (wet)	6,500,000 t/year	3,900,000 t/year

2) Quantity of steel product transportation

Estimated quantity of steel product transportation used for the planning of port is shown in Table 2-2.

Table 2-2 Quantity of steel product transportation for planning of port

	To south	To north
Quantity of transportation	2,700,000 t/year	1,200,000 t/year

3. Technical explanation

3.1 Equipment plan

Specifications of berths are shown in Table 2-3.

Table 2-3 Specifications of each berth

Name	Length	structural type	Water depth	Applicable vessel	Description
Raw material berth for ore and coal	1,000m	Steel pipe-pile type quay	Around -20m	200,000 DWT	- Unloader 2,000 t/hr 3 units - Conveyer 1 set
Raw material berth for others	300m	Steel pipe-pile type quay	Around -20m	50,000 DWT	- Unloader 500 t/hr 1 unit - Conveyer 1 set
Product berth	1,500m	Steel sheet-pile type quay	Around -10m	2,000 DWT	- Crane Max 50 t 8 units

3.2 Dredging

The scope of dredging is shown on the next page. Basically, the dredged soil from the new channel is utilized for land preparation from the view point of the investment cost reduction.

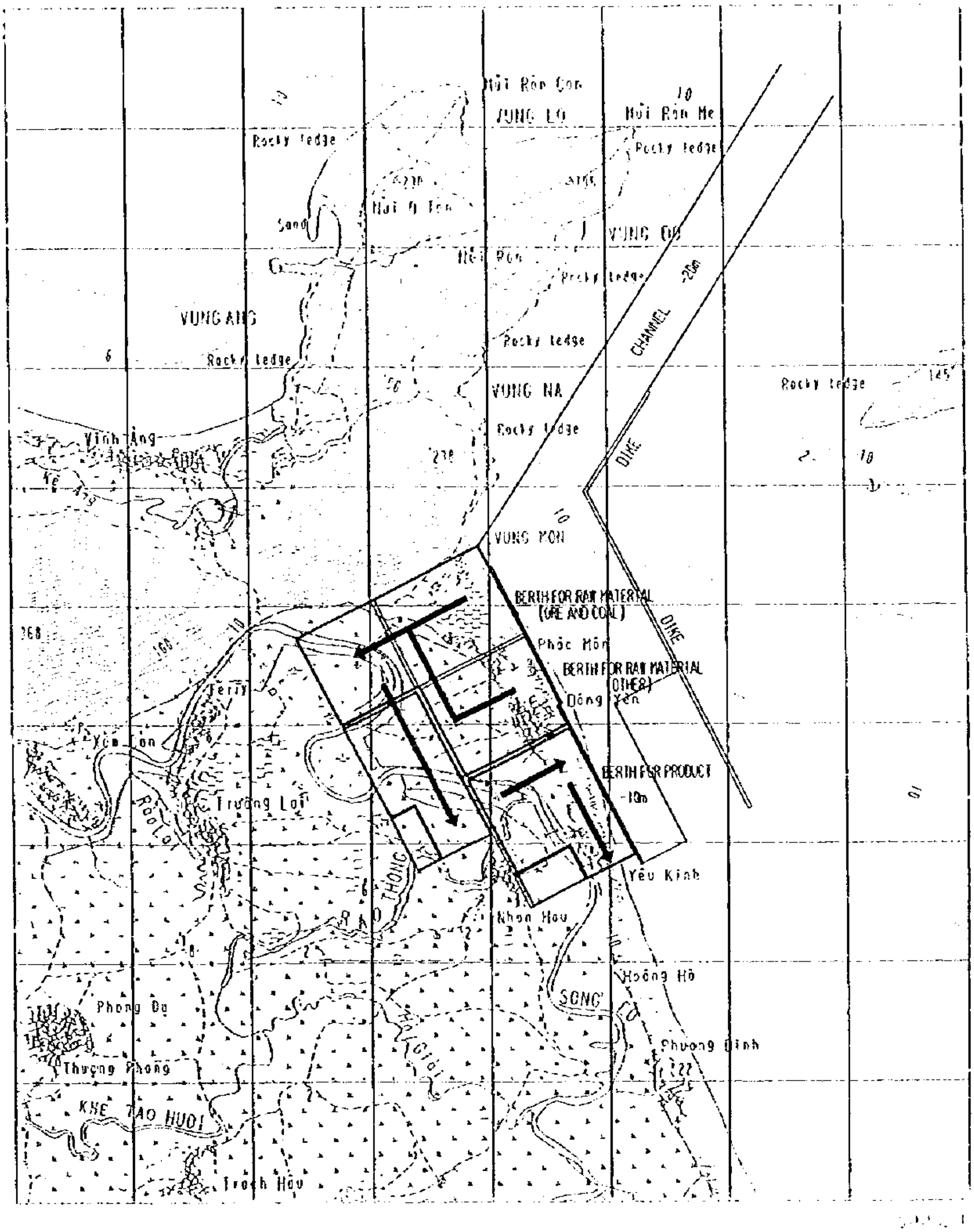
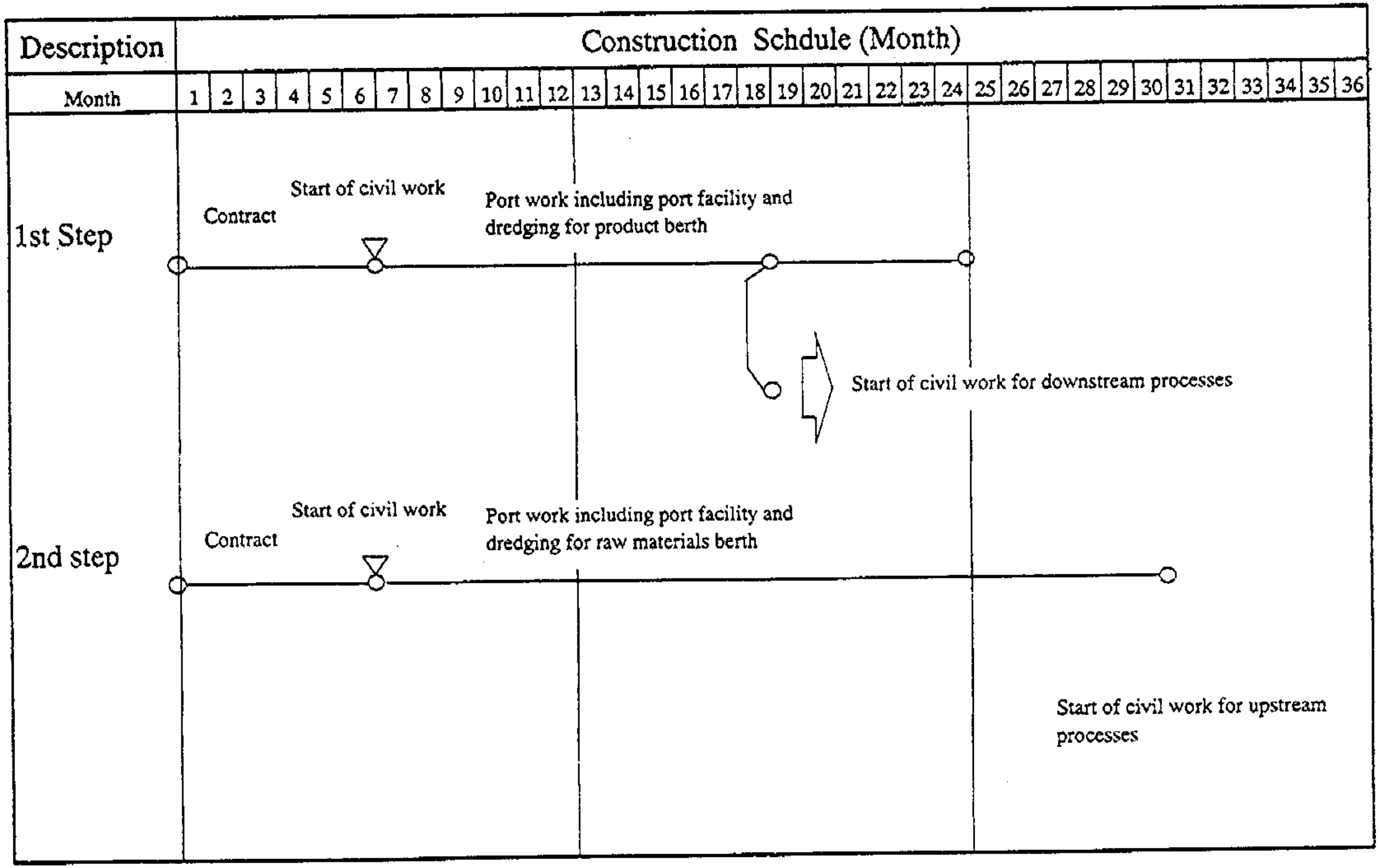


Figure 2-1 Scope of dredging

3.3 Construction schedule

Construction schedule is shown in Table 2-4.

Table 2-4 Construction schedule for land preparation



Section 3 Raw Materials Handling Facilities

Contents

1. General

These facilities have the function of receiving, storing, sizing and blending of raw materials to supply arranged raw materials to the blast furnace, coke oven, sinter plant, steelmaking plant and lime plant. They consist of the common yard for ore, coal, and other miscellaneous materials blending yard, sizing plant and receiving/releasing belt conveyors.

(1) Raw material yard

The raw material yard is generally divided into several areas such as the crude ore yard, sized ore yard, lime and other raw materials yard, stored sintered ore yard, coal yard, stored coke yard etc.

(2) Conveyor system

A conveyor system is designed so as to allow a number of materials to be moved to and from any optional place in the yard.

2. Preconditions

2.1 Materials receiving plan

The quantities of material receiving at the yard to which the raw materials are supplied from foreign or domestic mines are shown in Table 3-1 and Table 3-2.

2.2 Materials consumption plan

The quantity of material consumption at each plant to which the raw material is supplied from the raw materials yard is shown in Table 3-3.

2.3 Raw material flow

Raw material flows from berth to basic oxygen furnace are shown in Figure 3-1 and Figure 3-2.

Table 3-1 Materials data (Step 2)

Materials	Annual consumption (1,000 t-dry/y)	Number of brands	Domestic or imported	Ship size (Maximum) (1,000 DWT)
Coal	1,788	24	Import	200
Lump ore	1,123	6	Import	200
Fine ore	2,209	8	Import	200
Limestone	598	1	Domestic	30
Dolomite	232	1	Domestic	30
Silica	39	1	Domestic	30
Fluorspar	12	1	Import	50
BF dust	36	1		
LD dust	32	1		
Scale	45	1		
BF Slag	11	1		
LD Slag	48	1		

DWT : Dead Weight Ton

Table 3-2 Materials data (Step 3)

Materials	Annual consumption (1,000 t-dry/y)	Number of brands	Domestic or imported	Ship size (Maximum) (1,000 DWT)
Coal	3,464	24	Import	200
Lump ore	2,176	6	Import	200
Fine ore	4,279	8	Import	200
Limestone	1,159	1	Domestic	30
Dolomite	450	1	Domestic	30
Silica	76	1	Domestic	30
Fluorspar	23	1	Import	50
BF dust	69	1		
LD dust	61	1		
Scale	88	1		
BF Slag	22	1		
LD Slag	92	1		

Table 3-3 Consumption of raw materials at each plant

Plant	Item/Brand	Unit consumption (kg/t-pig iron)	Quantity (t/d)	
			Step 2	Step 3
Blast furnace	Pig iron production		6,210	12,020
	Ore Ratio	1626		
	Sinter	(80.6%)	9,050	17,500
	Sized ore	(19.4%)	1,960	3,790
	Coke		3,140	6,090
	PCI coal		620	1,200
Coke oven	Coke		3,100	6,010
	Coal (Dry)		4,270	8,290
	Coal (Wet)	(Water content 9%)	4,750	9,210
Sinter plant	Fine ore		6,050	11,700
	Lump ore fine		990	1,930
	Limestone		810	1,560
	Dolomite		640	1,230
	Silica		1,070	210
	Others		470	910
Steel making plant	Sized ore		130	250
	Burnt lime		350	680
	Fluorspar		30	60
Lime plant	Limestone		830	1,610
	Burnt lime		390	810
Sizing plant	Lump ore		2,950	5,700

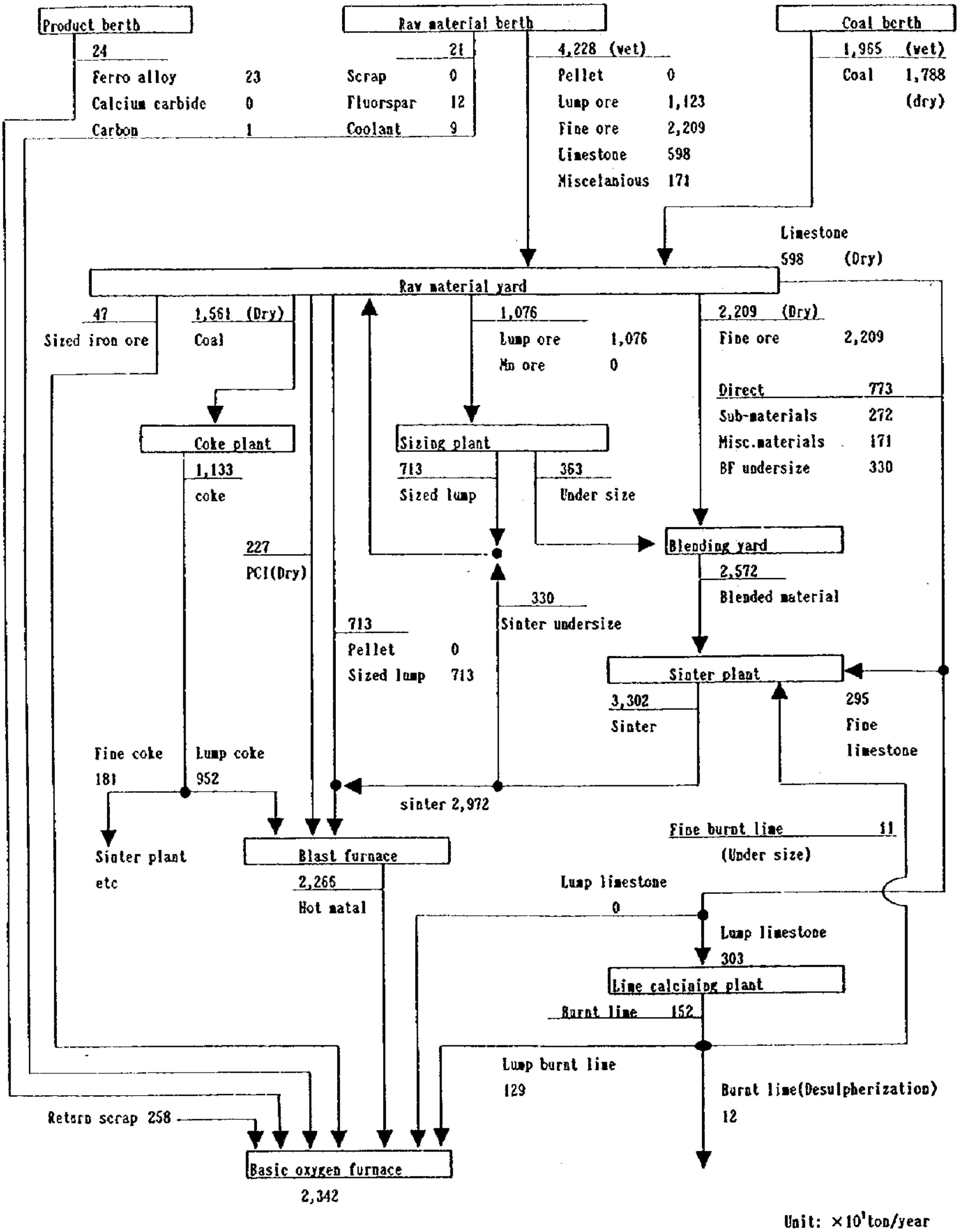


Figure 3-1 Raw material flow (Step 2)

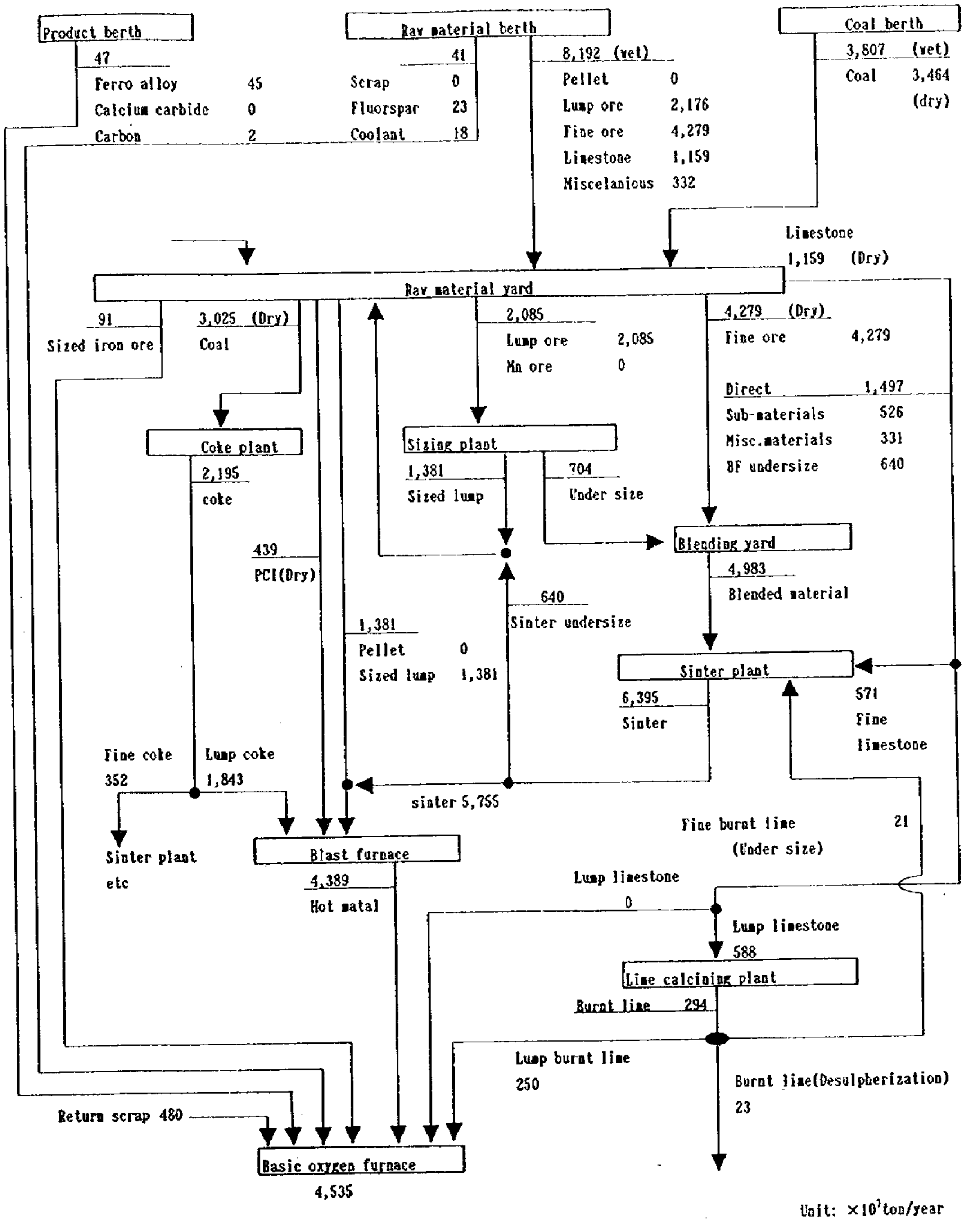


Figure 3-2 Raw material flow (Step 3)

3. Equipment plan

3.1 Equipment specifications

Specifications of main equipment are shown in Table 3-4.

3.2 Equipment flow chart

Figure 3-3 shown material treatment flow chart.

3.3 Layout

Figure 3-4 shows layout of raw material handling facilities.

3.4 Manning plan

Manning plan is shown in Table 3-5. The workers are set with 4 crews-3 shifts.

Table 3-5 Manning plan of raw material yard

	Manager	Section manager	Staff	Foreman	Skilled worker	Unskilled worker	Sub-total
Step 2	2	4	12	14	135	73	240
Step 3	0	0	3	0	20	11	34
Total	2	4	15	14	155	84	274

4. Technical explanation

The handling facilities of raw material yard are consisted of stacker and reclaimer. The transportation facility is consisted of belt conveyor.
The main materials of blast furnace and sinter plant are stored in ore yards. The sub-materials such as lime stone and the ores after sizing are stored in sub-material yard. The coals for coke oven and PCI are stored in coal yard. Most of ores, miscellaneous materials and sub-materials are blended in bedding yard.
The area required for materials is determined by the number of brands, consumption, size of the received lot, and fluctuation of the arrival time.

The storage days of materials are as follows.

Imported main materials and fuels:	45 days
Domestic sub-materials:	25 days
The other materials:	10 days

5. Construction plan

The construction plan of raw material handling facilities is shown in Table 3-6. The construction plan of step 3 is as same as step2.

Table 3-4 Specifications of raw material handling equipment

Equipment	Step 2		Addition at step 3	
	Quantity	Specifications	Quantity	Specifications
1. Raw material yard	1set	Yard area: 40,000 $m^2 \times 3$ 24,500 $m^2 \times 3$	+1set	Yard area: 40,000 $m^2 \times 1$ 24,500 $m^2 \times 1$
2. Coal yard	1set	Yard area: 21,000 $m^2 \times 1$ 25,000 $m^2 \times 3$	+1set	Yard area: 25,000 $m^2 \times 3$
3. Blending yard	1set	Yard area: 24,500 $m^2 \times 1$	+1set	Yard area: 24,500 $m^2 \times 1$
4. Yard equipment	1set	Receiving conveyor, Stacker, Reclaimer, Releasing conveyor	+1set	Receiving conveyor, Stacker, Reclaimer, Releasing conveyor
5. Sizing equipment	1set	Crusher, Screen, Surge bunker Belt conveyor		

BC: Belt conveyor
S: Stacker
R: Reclaimer

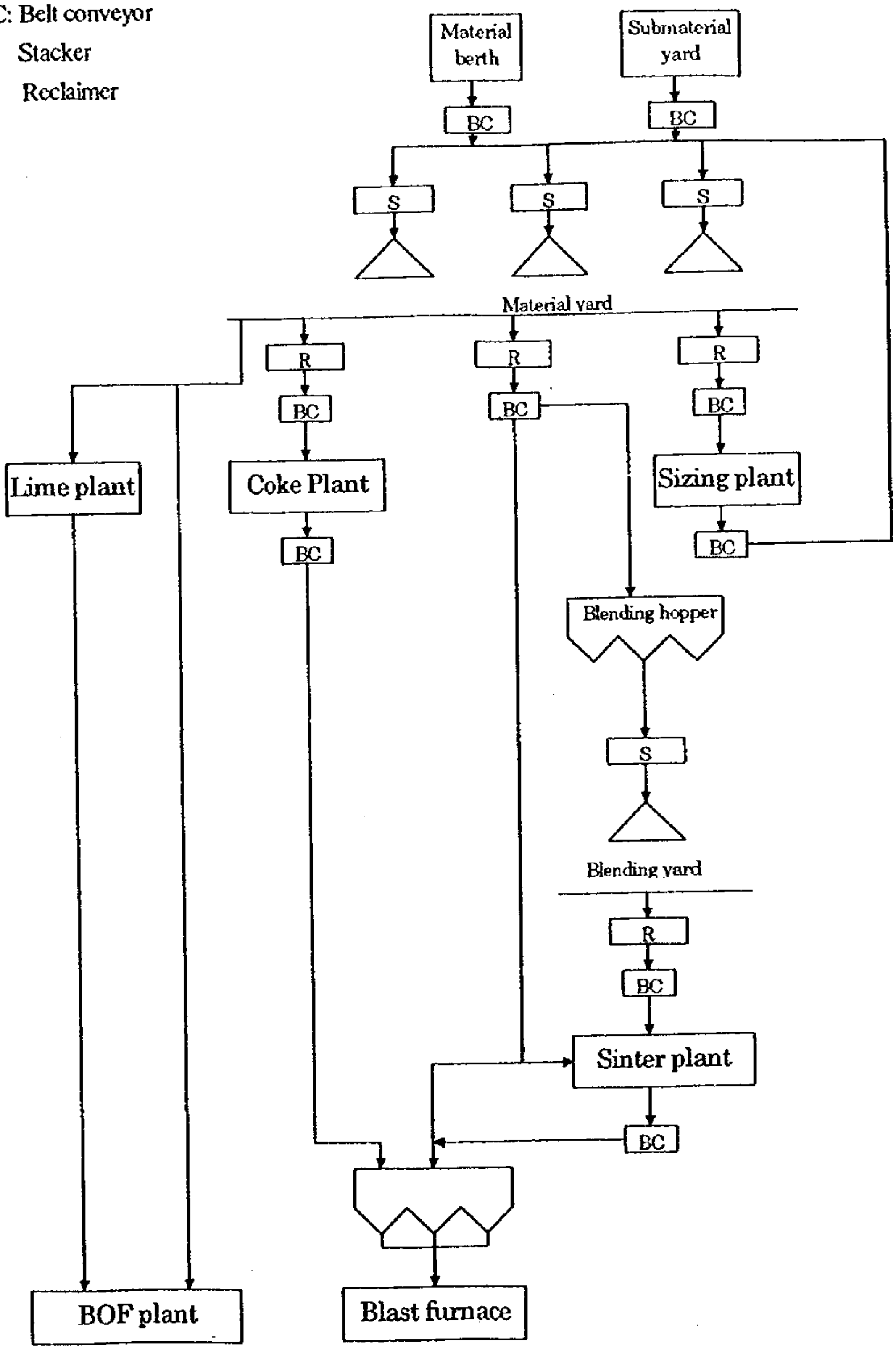


Figure 3-3 Material treatment flow chart

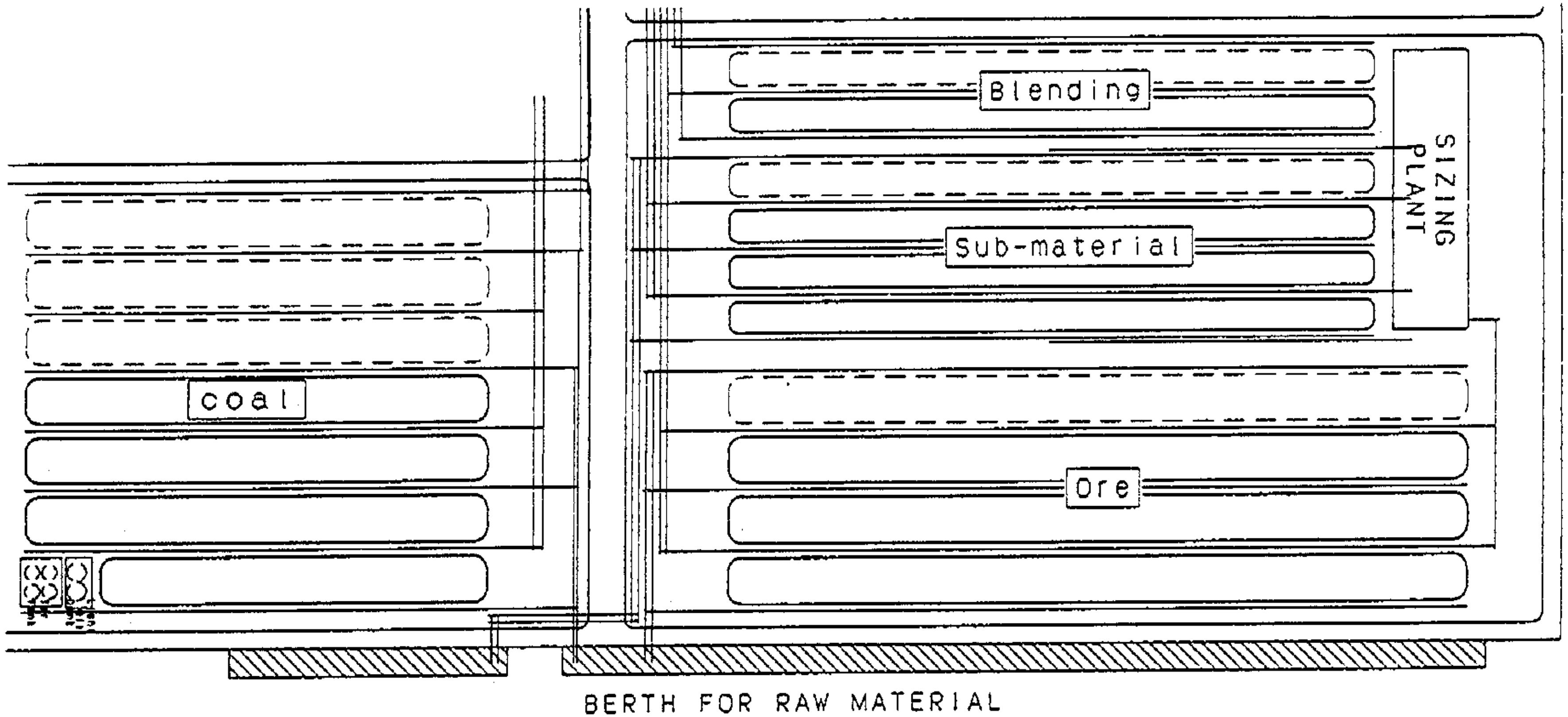
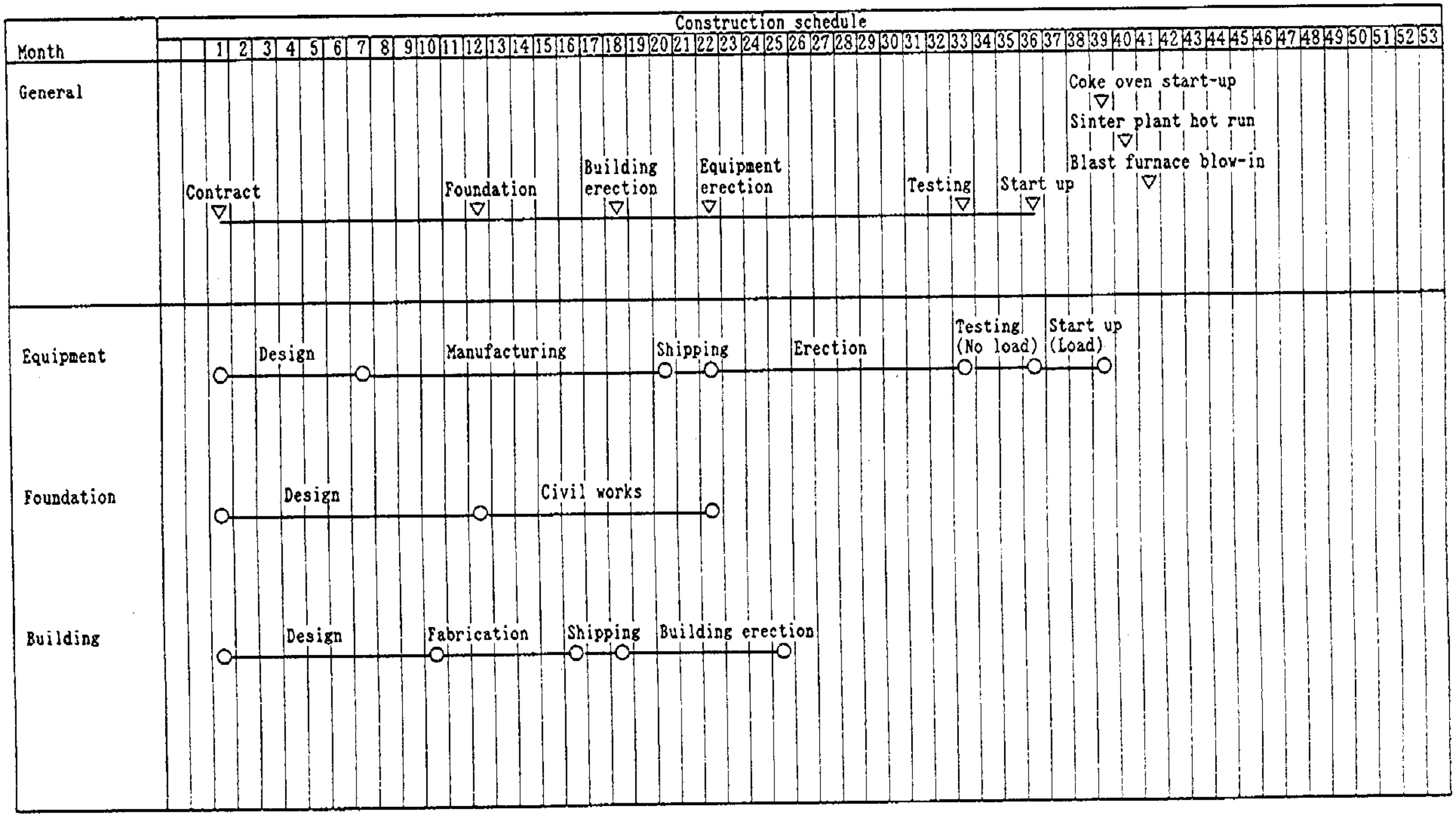


Figure 3-4 Layout of raw material handling facilities

Table 3-6 Construction schedule of raw materials and fuels yard equipment



Section 4 Sintering Plant

Contents

1. General

A sintering plant is built in step 2, having an sintering area of 320 m^2 and production capacity of 3,302,000 ton/year. In Step 3, an additional sintering plant with the same capacity as Step 2 will be built and provide a total production capacity of 6,395,000 ton/year.

2. Preconditions

2.1 Materials precondition

The chemical composition of raw materials and sub-materials is shown in Table 4-1.

Table 4-1 Chemical composition of raw, sub-materials and sinter

	T.Fe	SiO_2	CaO	Al_2O_3	MgO	LOI
Fine	62.8	3.5	0.2	1.8	0.1	3.8
Lump ore fine	65.2	3.1	0.1	1.7	0.0	4.6
Lime stone		0.6	55.0	0.0	0.6	42.6
Serpentine		39.2	1.5	0.7	36.8	12.6
Dolomite		1.1	30.2	0.3	20.5	46.1
Silica		92.7	1.6	0.1	2.5	1.0
Recycling	33.6	5.9	24.4	1.7	2.8	9.8
Sinter	56.7	4.6	9.6	1.7	1.9	
Lump ore	65.8	2.8	0.1	1.2	0.0	

Note LOI : Loss on ignition

2.2 Sinter product quality

The sinter product quality is shown in Table 4-2.

Table 4-2 Sinter product quality

Mean size	Ratio of -5mm of sinter product	Shatter index
18 mm	5.0 %	85 %

Note: Shatter index = A/B × 100
A : Oversize sinter weight of 10mm screen (kg) after 4 times of 2 m drop test.
B : Sinter sample 20 kg between 10 mm and 50 mm

2.3 Production plan

Production plan of the sinter plant is shown in Table 4-3.

Table 4-3 Sinter production plan

		Step 2	Step 3
Average hot metal production	ton/year	2,266,000	4,389,000
	ton/day	6,210	12,020
Sinter plant	set	1	2
Sinter production : year	ton/year	3,302,000	6,395,000
P	ton/day/unit	9,050	8,760
Pmax	ton/day/unit	10,100	9,700
Net working rate	%	90	
Sinter fine ratio	%	10	
Condition Unit consumption of raw materials to be charged to BF : 1626 kg/t-pig Sinter ratio : 81 % Sinter fine ratio : 10 %			

2.4 Operating conditions

Quantity of main and sub-materials is shown in Table 4-4.

3. Equipment plan

3.1 Equipment specifications

Main equipment specifications of the sinter plant are shown in Table 4-5.

3.2 Process flow

Process flow of the sinter plant is shown in Figure 4-1.

Table 4-4 Quantity of main and sub-materials

Item	Unit consumption (kg/t-sinter)	Quantity (ton/day)	
		Step 2	Step 3
Sinter plant		1	2
P		9,050	8,800
Fine ore	780	7,060	6,900
Fine lime stone	90	810	790
Fine dolomite	70	630	620
Mill scale , Dust etc	50	450	440
Sinter fines	1,00	910	880
Sub- total	1,090	9,860	9,630
Coke breeze	50	450	440
Total	1,140	10,310	10,070

3.3 Utility consumption

Utility consumption of the sinter plant is shown in Table 4-6.

Table 4-6 Unit consumption and quantity of utilities

	Unit consumption	Quantity	
		Step 2	Step 3
Coke oven gas	3.0 Nm^3/t-sinter	27,000 Nm^3/d	53,000 Nm^3/d
Make-up water	2.0 m^3/t-sinter	18,000 m^3/d	35,000 m^3/d
Electric power	35 kWh/t-sinter	315,000 kWh/d	615,000 kWh/d

3.4 Layout

The layout of sinter plant is shown in Figure 4-2.
Nos. 1 and 2 sinter plant are planned similarly. The sinter plants have desulfurization equipment of main exhaust gas.

3.5 Manning plan

Manning plan is shown in Table 4-7. The workers are set with 4 crews-3 shifts.

Table 4-5 Specifications of sinter plant equipment

Equipment and facility	Step 2		Additional step 3	
	Quantity	Specifications	Quantity	Specifications
1. Sinter mix line	1 unit	Storage bins Constant feed weigher Mixer	+1 unit	Same as left
2. Material feeding equipment	1 unit	Charging hopper Drum feeder	+1 unit	Same as left
3. Ignition equipment	1 unit	Ignition furnace & hood	+1 unit	Same as left
4. Sinter machine	1 unit	Type : DL Effective area : 320 m^2 Cooler	+1 unit	Same as left
5. Crusher & screen	1 unit	Hot & cold crusher Screen : 3 stage	+1 unit	Same as left
6. Main exhaust equipment	1 unit	Main EP & blower Main stack	+1 unit	Same as left
7. Coke breeze grinding equipment	1 unit		+1 unit	Same as left
8. Desulferization equipment of main exhaust gas	1 unit		+1 unit	Same as left

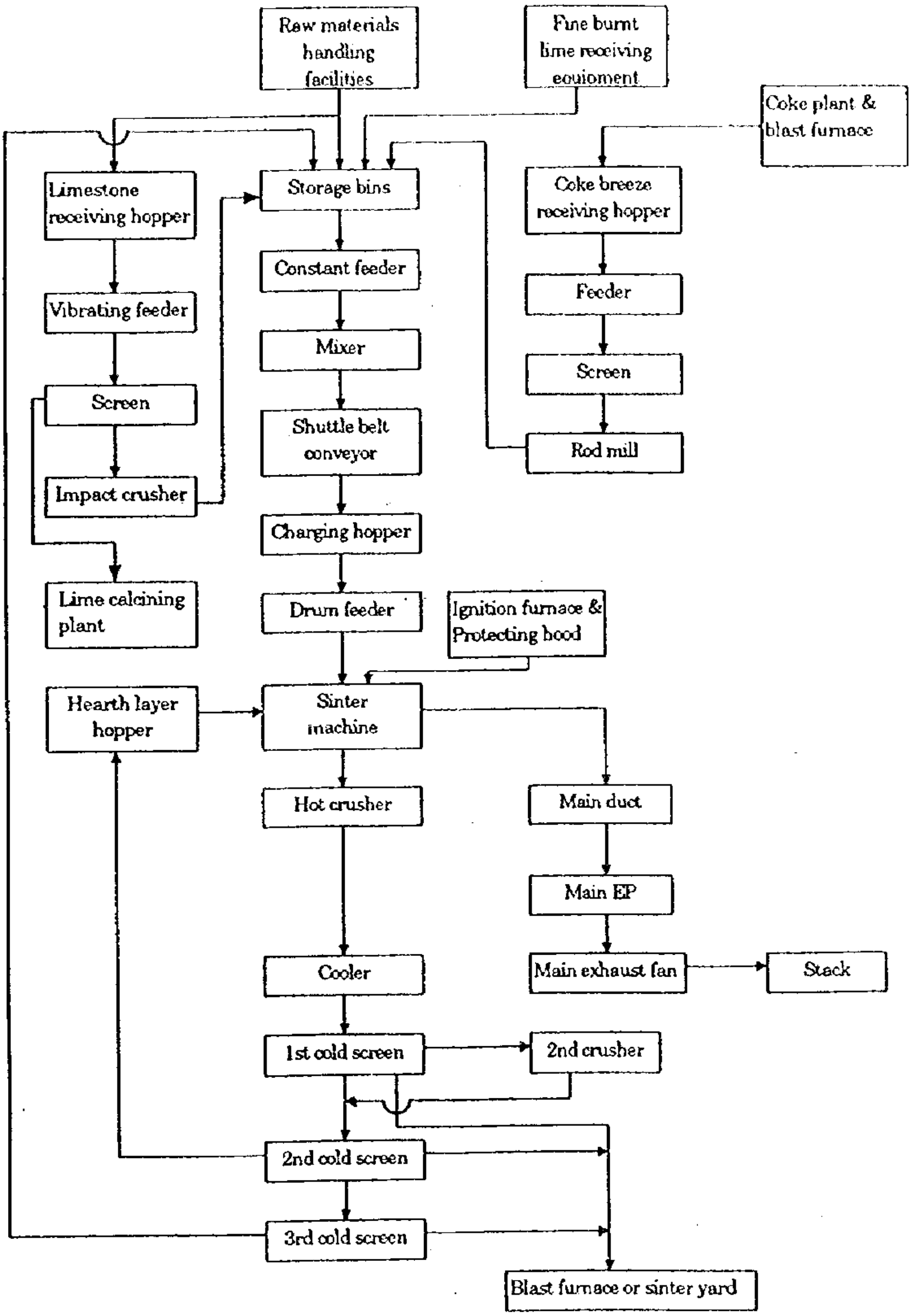


Figure 4-1 Sinter plant process flow

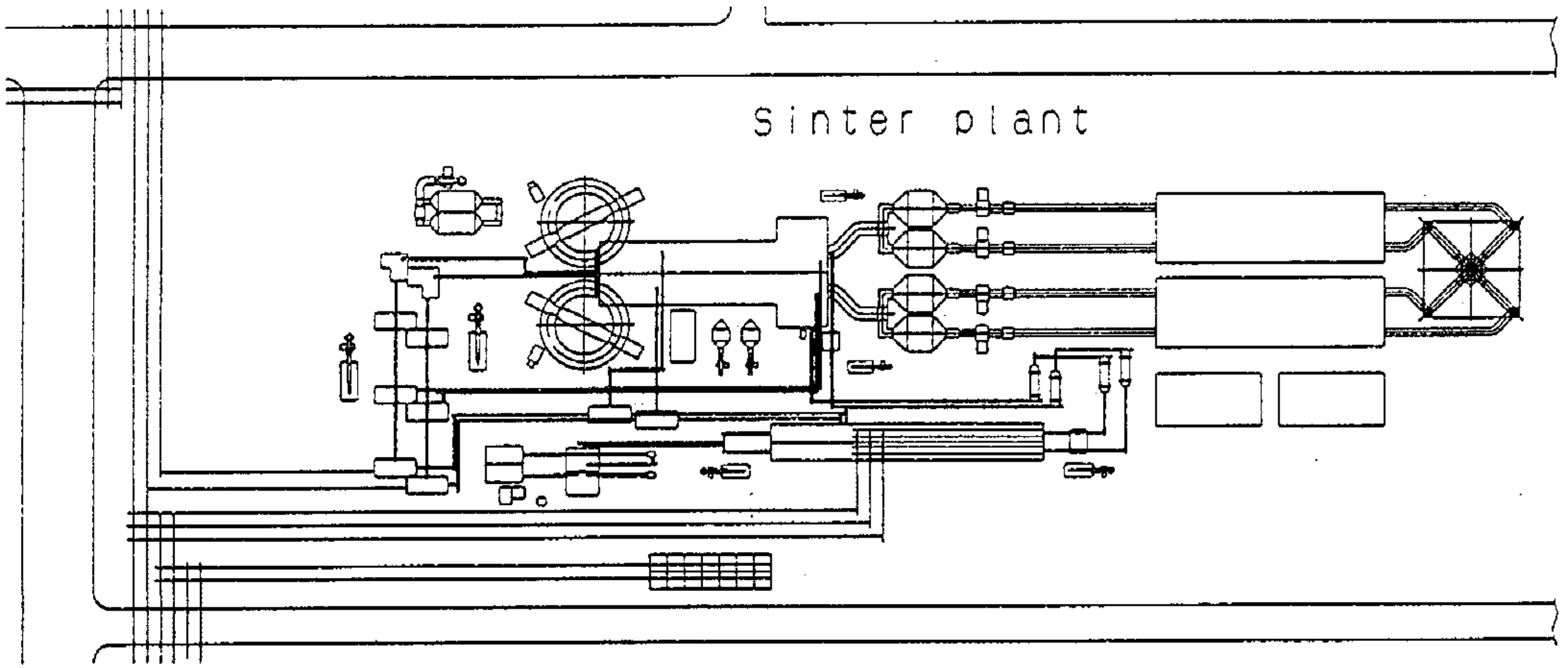


Figure 4-2 Layout of Sinter plant

Table 4-7 Manning plan of sinter plant

	Manager	Section manager	Staff	Foreman	Skilled worker	Unskilled worker	Sub-total
Step 2	0	1	10	9	75	41	136
Step 3	0	1	2	0	36	19	58
Total	0	2	12	9	111	60	194

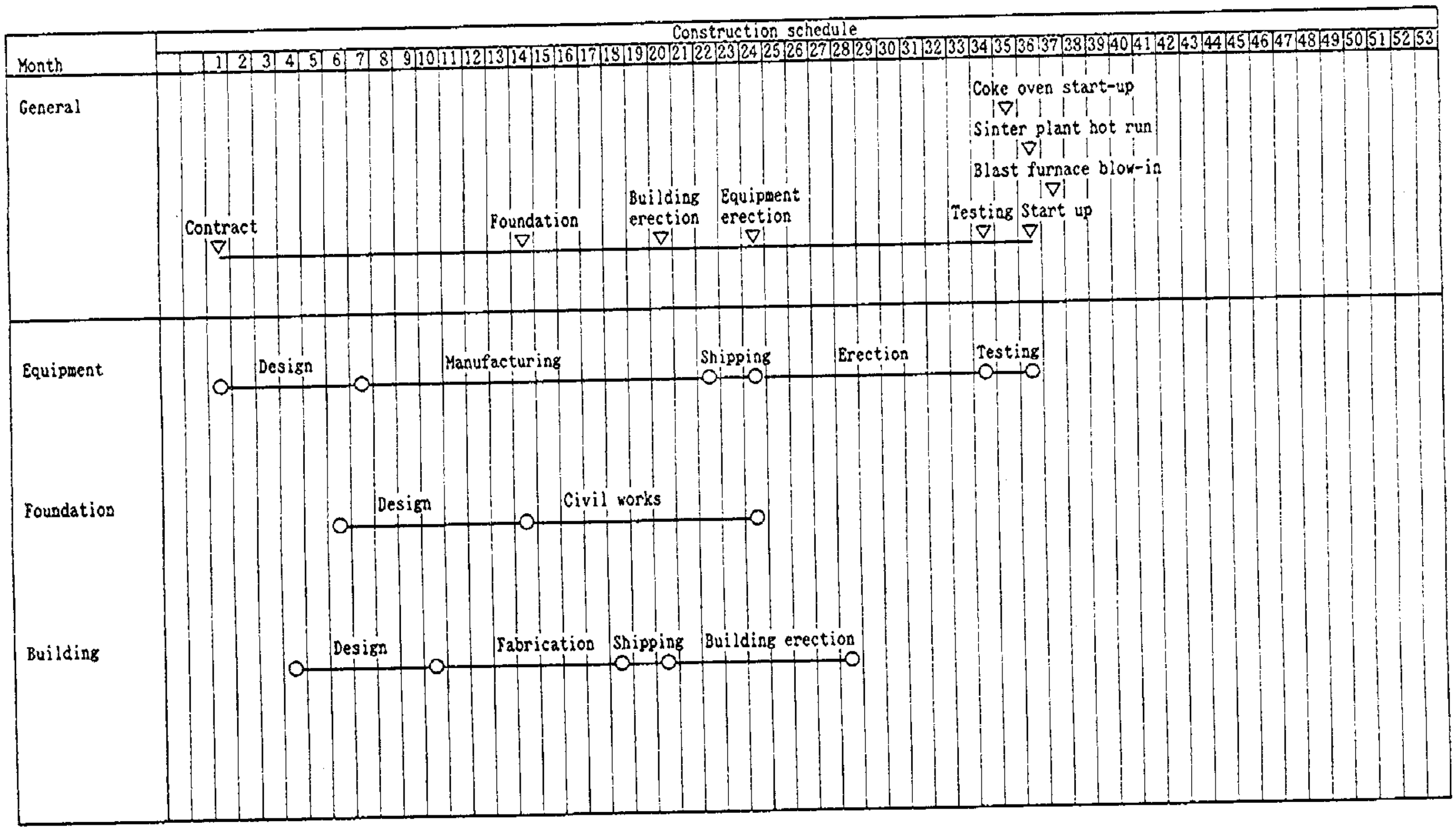
4. Technical explanation

The Dwight-Lloyd type is applied to sinter machine. The productivity of sintering plant is set at 30.3 ton/day/m^2. This value is average level of Dwight-Lloyd type sintering machine in Japan.
The other equipment except sintering machine is installed outside the building. The heating material of ignition equipment is coke oven gas. The sinter plants have desulfurization equipment of main exhaust gas. Many dust collectors are installed for the environmental preservation.

5. Construction plan

The construction plan of sintering plant is shown in Table 4-8. The construction plan of step 3 is as same as step 2.

Table 4-8 Construction schedule of sinter plant



Section 5 Coke Plant

Contents

1. General

The coke plant capable of producing the quantity of coke needed for the blast furnace will include two batteries of coke ovens during Step 3 of the project. Large-sized coke ovens that are 6.5 meters in height will be installed, taking workers load and economical efficiency into consideration. By-product plants to collect COG, tar and light oil will be constructed in order to minimize total cost. The plant shall also include an ammonia sulfate facility.

Environmental measures will include an activated-sludge treatment plant that treats waste water generated from the coke ovens and by-product plants as well as dust collectors for the charging car, the coke guide car, crusher, coke cutter and smokeless charge equipment for reducing operator loads and for dust prevention.

As coke oven gas contains sulfur and ammonia compounds, ammonia compounds will be eliminated by an ammonia sulfate system. Desulfurization equipment will be installed where sulfuric acid will be collected and fed to the ammonia sulfate facility.

In this plan, coke dry quenching equipment is not included; however there is space for future installation.

2. Preconditions

2.1 Production plan

The production plan of the coke plant is shown in Table 5-1 and 5-2.

Table 5-1 Production plan of coke plant

	Hot metal production (average)	Total coke production (average)
Step 2	2,266,000 t/y (6,210 t/d)	1,147,000 t/y (3,140 t/d)
Step 3	4,389,000 t/y (12,020 t/d)	2,223,000 (6,090 t/d)

Conditions;
Unit consumption of coke to be charged in blast furnace: 420kg/t-pig
Unit consumption of coke to be charged in sintering plant: 50kg/t-sinter
Coke screen undersize in blast furnace feed: 10.0%

Table 5-2 Production balance of coke plant (Step 3)

	Unit	Quantity
Coke oven batteries	-	2
Cokes production : Average	t/d	6,010
Maximum operating ratio	%	123
Coke breeze ratio	%	16.0

2.2 Coal blending conditions and required coal quality

Coal will be blended in such a ratio as to meet all the requirements (strength, ash content, sulfur content, etc.) necessary for the blast furnace. In this plan, coal blending will utilize four kinds of coal as shown in Table 5-3.

Table 5-3 Coal blending plan

Coal type	Blending ratio				
	Distribution	Australia	CIS	China	USA
Hard coking coal	40	25	12	3	
Coal from USA	10				10
Semi coking coal	12	10		2	
Soft and weak coking coal	25	22		3	
Sub-total	87	57	12	8	10

Each kind of coal in the above table is estimated to have following qualities as shown in Table 5-4.

Table 5-4 Required coal quality

Coal classification	Distribution	Quality*				Ash composition*		
		Ash	MFD	Ro	Contr.	SiO_2	CaO	Al_2O_3
Hard coking coal - total	40	8.9	2.3	1.2	5.0	47.0	2.6	25.9
Coal from USA	10	7.7	4.2	0.9	15.4	51.0	0.9	26.0
Semi - coking coal	12	9.0	3.2	0.9	18.6	54.5	0.8	29.4
Soft and weak coking coal	25	8.9	1.9	0.9	16.0	54.6	2.5	24.8
Average		8.8	2.5	1.0	11.2	50.7	2.1	26.1

MFD : Maximum fluidity degree
Ro : Reflecting ratio
Contr.: Contraction
* : (%)

2.3 Coke quality conditions

Coke quality expected from the Table 5-4 is shown in the Table 5-5.

Table 5-5 Coke quality expectation

Category of property	Quality of cokes
Ash Content	Less than 12%
Sulfur in coke	Less than 0.6%
Drum index ($DI_{150/15}$)	More than 82%
Size fraction (Cokes for B.F./Gross)	More than 82%

2.4 Operation conditions

Since coke ovens require continuous heating, continuous operation in three shifts will be undertaken.

2.5 Material yield for determining the equipment capabilities

Yield and basic coefficient, which are important factors for determining the equipment capabilities, are shown in Table 5-6

Table 5-6 Operational yield and coefficient

Category	Yield and coefficient
	Against coal
Total coke yield	73.5%
Coke breeze yield	16.0%
Unit generation	
COG	300 Nm3/t-coal
Tar	0.03 t/t-coal
Ammonia sulfate	0.00538 t/t-coal
Light oil	0.01 t/t-coal
Unit consumption	
COG	40 Nm3/t-coal
BFG	450 Nm3/t-coal
Electric power	50 kWh/t-coal
Nitrogen	0.4 Nm3/t-coal
Industrial water	1.0 Nm3/t-coal

3. Equipment plan

3.1 Equipment specifications

The main specifications for each equipment and facilities are listed in Table 5-7.

Table 5-7 Equipment specifications

Equipment / system / facility	Step 2		Addition for Step 3	
	Quantity	Specifications	Quantity	Specifications
1. Coal preparation system (conveyor, bin, weighing feeder, crusher, dust collector)	1 set		1 set	
2. Coke oven facility (coke oven, stack, charging car, electric locomotive, wet quenching system, gas receiving equipment, blower, dust collector, water treatment)	1 set	Coking chamber: 120 chambers Coking chamber type: 6,500Hx450Wx15,560L Stack height: 120m	1 set	Coking chamber: 120 chambers Coking chamber type: 6,500Hx450Wx15,560L Stack height: 120m
3. Coke transport equipment (coke wharf, conveyor, vibrating screen, bin, dust collector)	1 set		1 set	
4. By-product plant (primary cooler, direct cooler, tar decanter, blower, scrubber, tar cottrell, desulfurizing system, final cooler, tank)	1 set	Gas handling capacity: 150,000 Nm^3/h	1 set	Gas handling capacity: 150,000 Nm^3/h
5. Waste water treatment system (tanks for deammoniated liquid/ aeration/ setting/ sludge and dehydrator)	1 set	Activated sludge process	1 set	Activated sludge process

3.2 Process flow chart

Figure 5-1 shows the schematic process flow of materials in the coke and by-product plants.

3.3 Raw material and product balance

A flow and quantity balance of raw material and products in the coke and by- product facilities is shown in Figure 5-2.

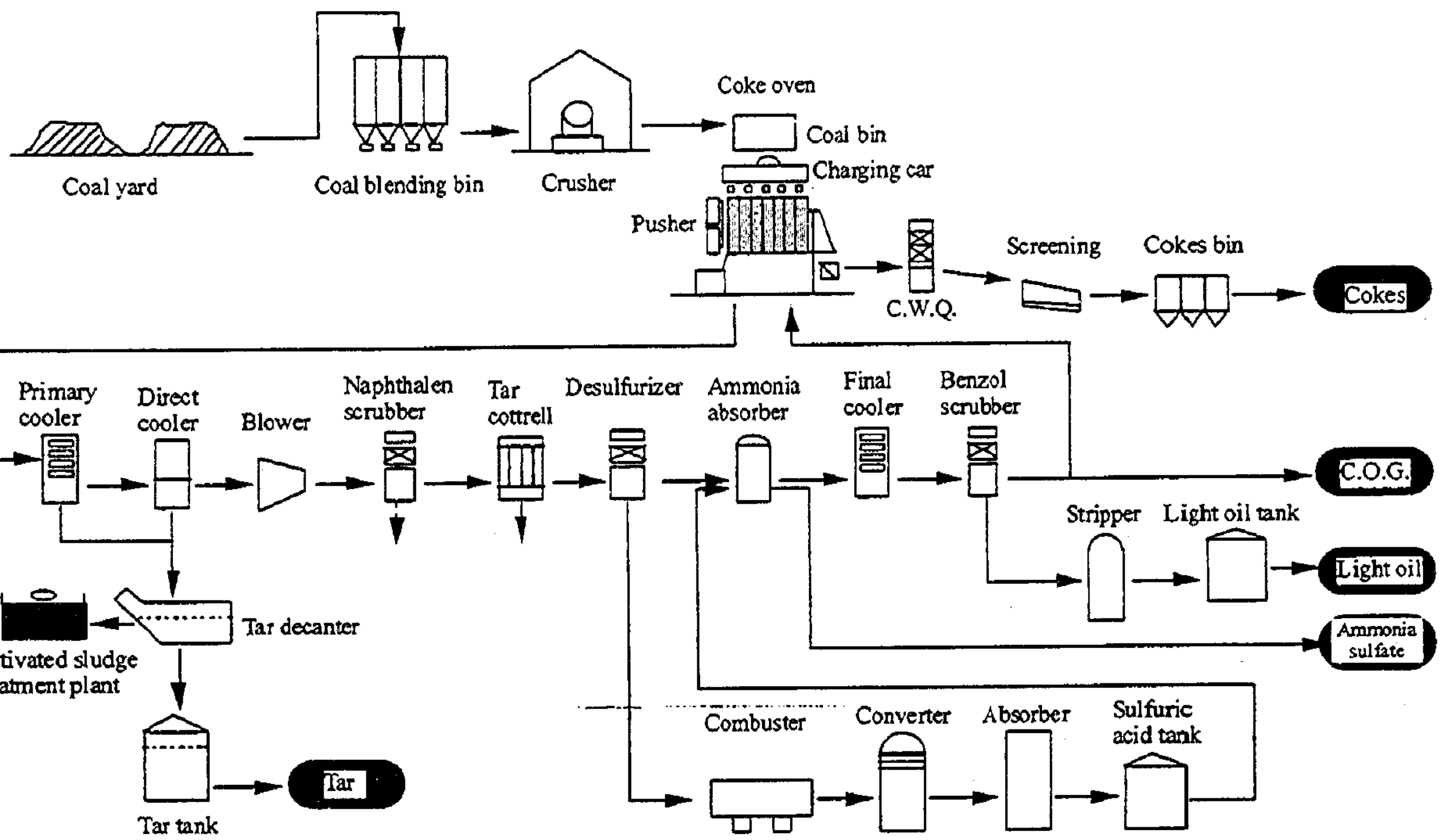


Figure 5-1 Schematic process flow

Unit: 1,000 ton/year

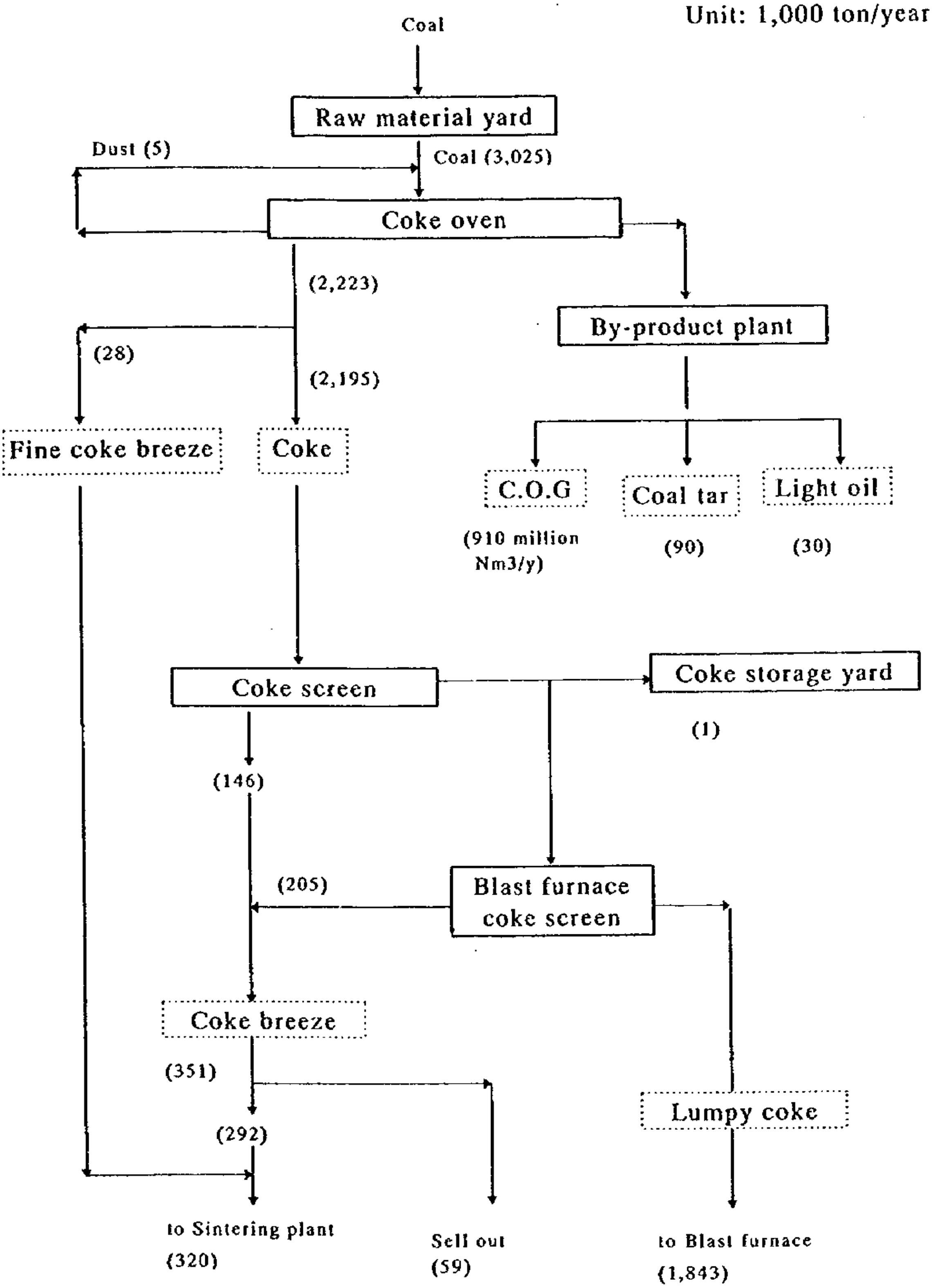


Figure 5-2 Raw material and product balance (Step 3)

3.4 Plant layout

The plant layout is designed for the effective flow of raw materials and products as well as to provide for future installation of equipment. Its three main particular features are summarized as follows.

(1) The coal transport conveyor is planned so as to shorten coal transportation.

(2) In order to reduce the amount of investment in facilities as much as possible, coke dry quenching equipment has not been included in this plan. However, space has been provided for future inclusion of this equipment.

(3) The coke transport conveyor to the blast furnace has been planned and laid out so that the facility cost is minimized and transport distance is shortest.

The plot plan of coke and by-product plant is shown in Figure 5-3.

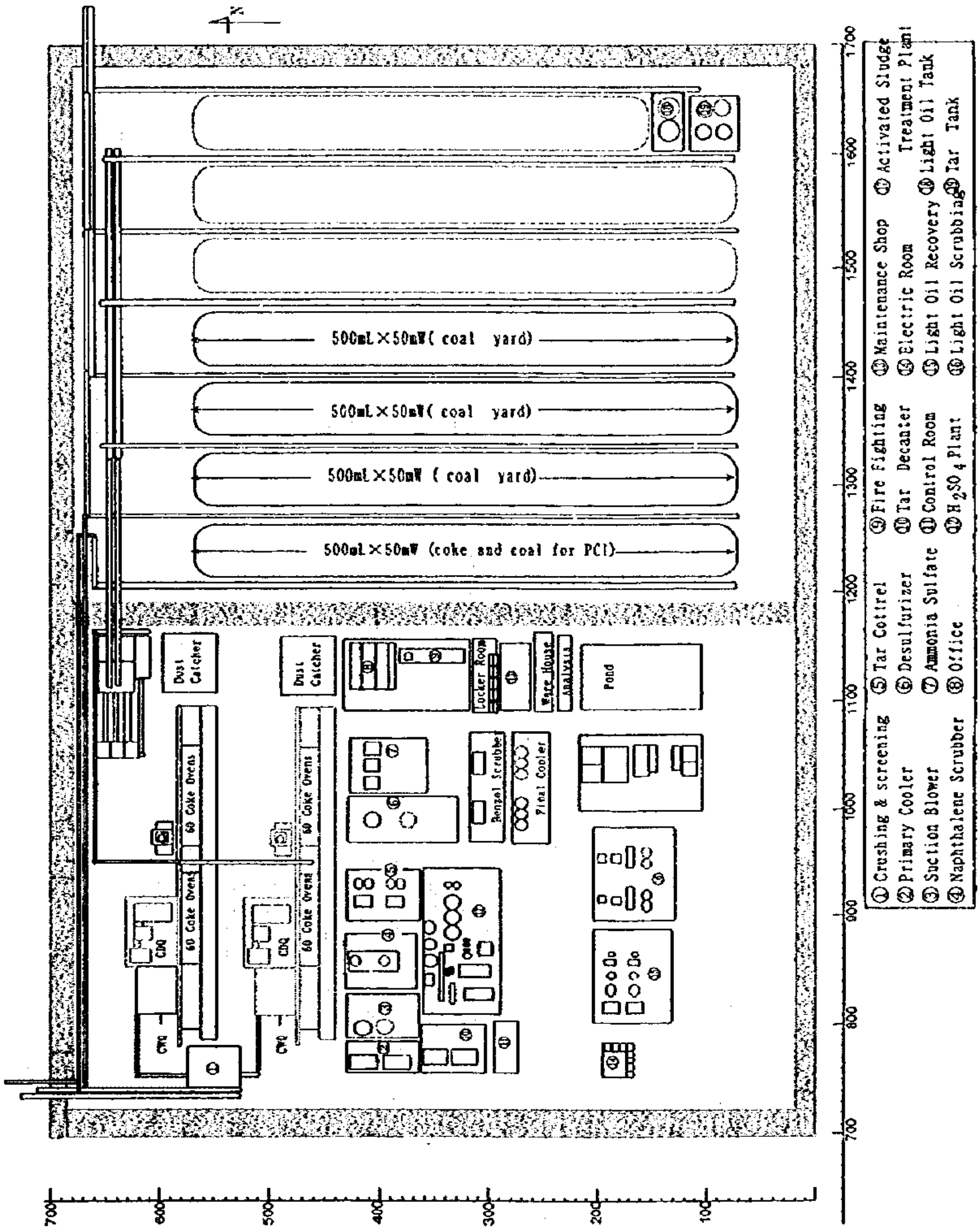


Figure 5-3 Plot plan of coke and by-product plant

3.5 Products and unit consumption

In order to assure the planned production of lumpy coke, (1,133,000 t/y at the step 2 and 2,195,000 t/y at the step 3) the amount of coal required under normal operation levels of the coke ovens is shown in Table 5-8. Utility unit consumption and quantities of products and by-products for each step are shown in Table 5-9 and 5-10 respectively.

Table 5-8 Quantity of coal

Coal	Blending distribution	Unit consumption (t/t-total coke)	Step 2 Annual consumption (1,000 t/y)	Step 3 Annual consumption (1,000 t/y)
Hard coking coal	40	0.63	721	1,396
Coal from USA	10	0.15	178	346
Semi coking coal	12	0.19	217	422
Soft and weak coking coal	25	0.39	445	861
Total	87	-	1,561	3,025

Table 5-9 Utility requirements and quantity of products and by-products (Step 2)

	Utility		Quantity
	Unit/t-coal	Annual consumption	Products (1,000t/y) and by-products
Coke oven gas	40 Nm^3	62,400 Nm^3	468 million Nm^3/y
Blast furnace gas	450 Nm^3	702,500 Nm^3	
Electric power	50 kWh	78.1 megaWh	
Nitrogen	0.4 Nm^3	600 Nm^3	
Industrial water	1.0 m^3	1,600 m^3	
Lumpy coke			1,133
Coke breeze			181
Tar			46.8
Light oil			15.6
Ammonia sulfate			7.8

Table 5-10 Utility requirements and quantity of products and by-products (Step 3)

	Utility		Quantity
	Unit/t-coal	Annual consumption	Products (1,000t/y) and by-products
Coke oven gas	40 Nm^3	121,000 Nm^3	907.5 million Nm^3/y
Blast furnace gas	450 Nm^3	1,361,300 Nm^3	
Electric power	50 kWh	151.3 megaWh	
Nitrogen	0.4 Nm^3	1,200 Nm^3	
Industrial water	1.0 m^3	3,000 m^3	
Lumpy coke			2,195
Coke breeze			351
Tar			90.8
Light oil			30.3
Ammonia sulfate			15.1

3.6 Manning plan

Table 5-11 shows the manning plan for the coke and by-product plants during Steps 2 and 3.

Table 5-11 Manning plan for coke and by-product plants

	Step 2	Step 3
Plant manager	1	1
Section manager	5	5
Engineer and Staff	29	29
Foreman	23	27
Skilled worker	233	300
Unskilled worker	125	162
Total	416	524

4. Technical explanation of the process

From the raw material handling facility, different types of coal are transported to the coke plant separately. The coal is blended and controlled by the bin blending method to get the required coke quality and then crushed. Since the characteristics of coal fluctuate within the case of same type, it is necessary at all times to have an accurate and quick understanding of the coal characteristics in order to perform proper blending.

The coke oven is a complex brick structure with silica bricks in the main, and is normally heated to 1,280℃-1,300℃. In regard to oven temperature, control of the average oven temperature is as important as maintaining the end flue temperature and temperature deviation between the flue at prescribed levels.

When carbonization is completed, coke is quenched at the quenching tower, and undergoes sizing and screening in the coke handles while being carried to the blast furnace coke bin.

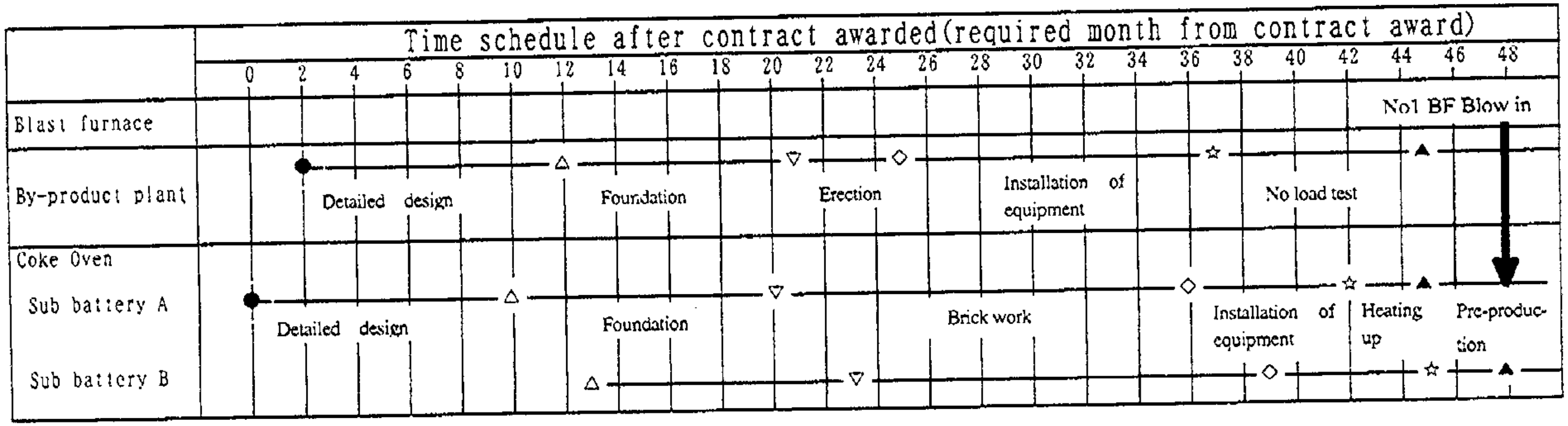
In this process, good coke screening is a determining factor in the fluctuation of coke yields and blast furnace operation results. It is a critical control element.

Coke oven gas, tar and other by-products generated during carbonization are brought to the by-product plants, where they are treated for COG cooling and recovery and elimination of various components. COG then becomes a purified gas that can be used for fuel at the steel works in this plan. For removal of ammonia in COG, the ammonia sulfate facility is employed, whose advantages include inexpensive equipment cost, ease of operation and ease of equipment control.

5. Construction time schedule

Table 5-12 outlines construction time schedule for the coke plant which shall be established within 48 months after the detailed design of the plant starts.

Table 5-12 Construction time schedule for coke plant



Section 6 Blast Furnace Plant

Contents

1. General

A blast furnace is built in step 2, having an inner volume of 3200m^3, and produces 2,266,000 ton/year of pig iron. In step 3, an additional blast furnace with the same volume as step 2 will be built and have total production capacity of 4,389,000 ton/year of pig iron.

2. Preconditions

2.1 Materials precondition

In order that the operation of the blast furnace is stable, the quality of raw materials and fuels must be stable. The material and fuel conditions are shown in Table 6-1.

Table 6-1 Material and fuel conditions

Material	Item	Unit	Value	Remarks
Sinter	T.Fe	%	56.7	
	CaO/SiO_2	-	1.25	
	Shatter index	%	88.0	
	Fine ratio	%	10	
Coke	Ash	%	11.9	
	Drum index	%	84.5	
	Fine ratio	%	10	
Sized ore	Decrepitation	%	< 5.0	

2.2 Material and fuel unit consumption

Material and fuel unit consumption is shown in Table 6-2. In order to secure the stability of operation, sinter ratio is about 80%.

2.3 Operating conditions

Operating conditions are shown in Table 6-3.

Table 6-2 Material and fuel unit consumption

Material and fuel		Unit	Unit consumption	Remarks
Material	Sinter	kg/t-pig	1,311	80.6%
	Lump ore	kg/t-pig	315	19.4%
	Sub-total	kg/t-pig	1,626	
Fuels	Coke	kg/t-pig	420	
	PCI	kg/t-pig	100	
	Sub-total	kg/t-pig	520	

Table 6-3 Blast furnace operating conditions

Item		Unit	Planned value	
			2nd step	3rd step
Blast furnace inner volume		m^3	3,200	3,200
Pig iron production	Annual	kt/y	2,266	4,389
	Normal day ave.	t/d	6,210	12,020
	Normal day max.	t/d	6,600	12,800
	Productivity coefficient average	$t/d/m^3$	1.94	1.88
	Productivity coefficient max.	$t/d/m^3$	2.06	2.00
Fuel ratio	Coke ratio	kg/t	420	
	PCI ratio	kg/t	100	
	Fuel ratio	kg/t	520	
Fuel condition	Sinter ratio	%	80.6	
	Coke ash	%	12.0	
	Slag volume	kg/t	300	
Operating condition	Blast temperature	℃	1,200	
	Blast volume	Nm^3/min	4,900	4,800
	Oxygen	Nm^3/hr	9,700	9,400
	Top pressure	kg/cm^2	2.0	
BF gas generation		Nm^3/t	1,600	

3. Equipment plan

3.1 Equipment specifications

Main equipment specifications of the blast furnace are shown in Table 6-4.

3.2 Process flow

Process flow of the blast furnace is shown in Figure 6-1.

3.3 Utility consumption

Utility consumption of the blast furnace is shown in Table 6-5.

Table 6-5 Utility consumption of blast furnace

	Unit	Unit consumption (/t-pig)	Yearly volume (/y)	
			2nd step	3rd step
Blast	Nm^3	1080	$2,450\times 10^6$	$4,750\times 10^6$
Oxygen	Nm^3	35	80×10^6	155×10^6
HS BFG	Nm^3	460	$1,050\times 10^6$	$2,020\times 10^6$
HS COG	Nm^3	20	45×10^6	90×10^6
Electric power	kWh	35	80×10^6	155×10^6
Nitrogen	Nm^3	30	70×10^6	130×10^6
Steam	kg	10	23×10^6	44×10^6
Industrial water(make up)	m^3	1.5	4×10^6	7×10^6
Sea water	m^3	15	35×10^6	70×10^6

3.4 Layout

The layout of blast furnace is shown in Figure 6-2.
No.1 and 2 blast furnaces are planned similarly. The hot metal transportation equipment consists of torpedo car. The blast furnace slag is transported to the slag discharge yard by the slag ladle. The slag granulating system is not adopted because of reducing construction cost. A pig casting machine is constructed near the No.2 blast furnace in Step 2.

Table 6-4 Specifications of blast furnace equipment

Equipment and facility	Step 2		Addition at step 3	
	Quantity	Specifications	Quantity	Specifications
1. Blast furnace	1 unit	Inner volume : 3,200 m^3 Iron tap hole : 3 Charging system : Belt conveyor	+1 unit	Same as left
2. Hot blast stove	3 units	Inside combustion chamber type Blast temperature : 1,200℃	+3 units	Same as left
3. Gas cleaning equipment	1 unit	Dust catcher 2 stage venturi scrubber Septum valve and silencer	+1 unit	Same as left
4. Raw materials and coke treatment	1 unit	Ore bins , Coke bins Charging belt conveyor	+1 unit	Same as left
5. Slag treatment equipment	1 unit	Slag discharging field Slag products stock yard	+1 unit	Same as left
6. Pig casting machine	1 unit	Fixed roller type		

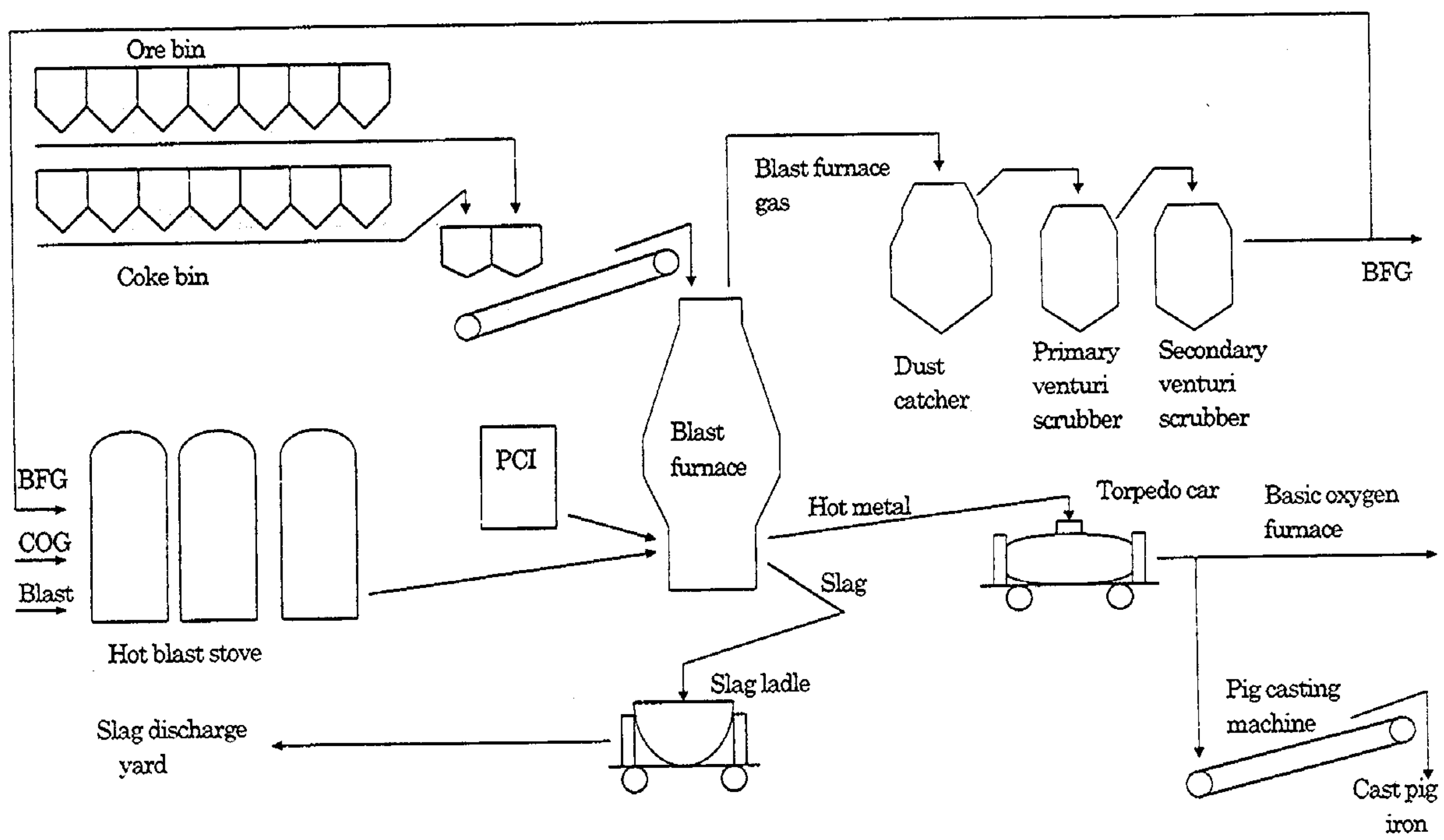


Figure 6-1 Blast furnace process flow

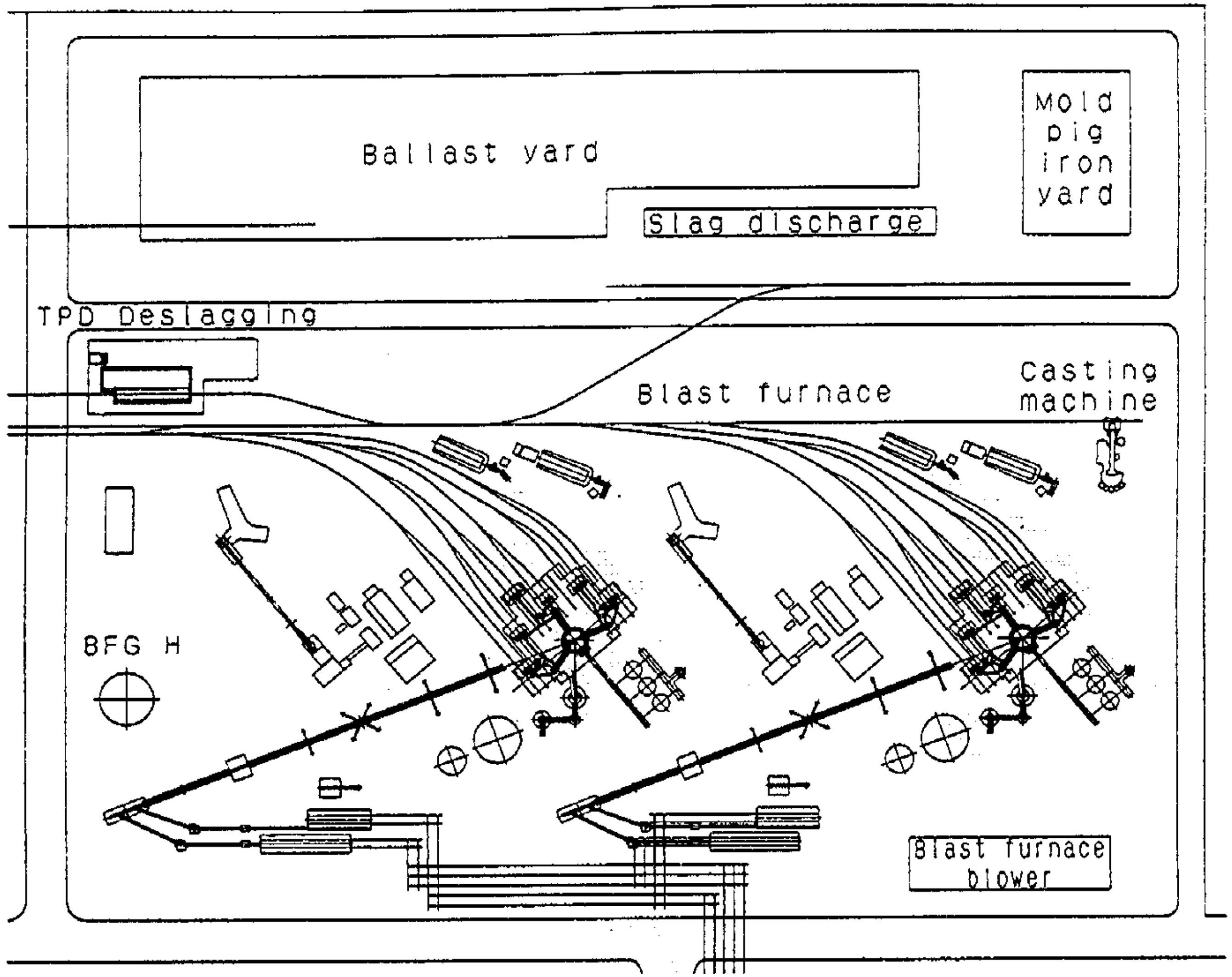


Figure 6-2 Layout of Blast furnace

3.5 Manning plan

Manning plan is shown in Table 6-6. The workers are set with 4 crews-3 shifts.

Table 6-6 Manning plan of blast furnace

	Manager	Section manager	Staff	Foreman	Skilled worker	Unskilled worker	Sub-total
Step 2	1	2	7	20	98	53	181
Step 3	0	1	2	12	63	34	112
Total	1	3	9	32	161	87	293

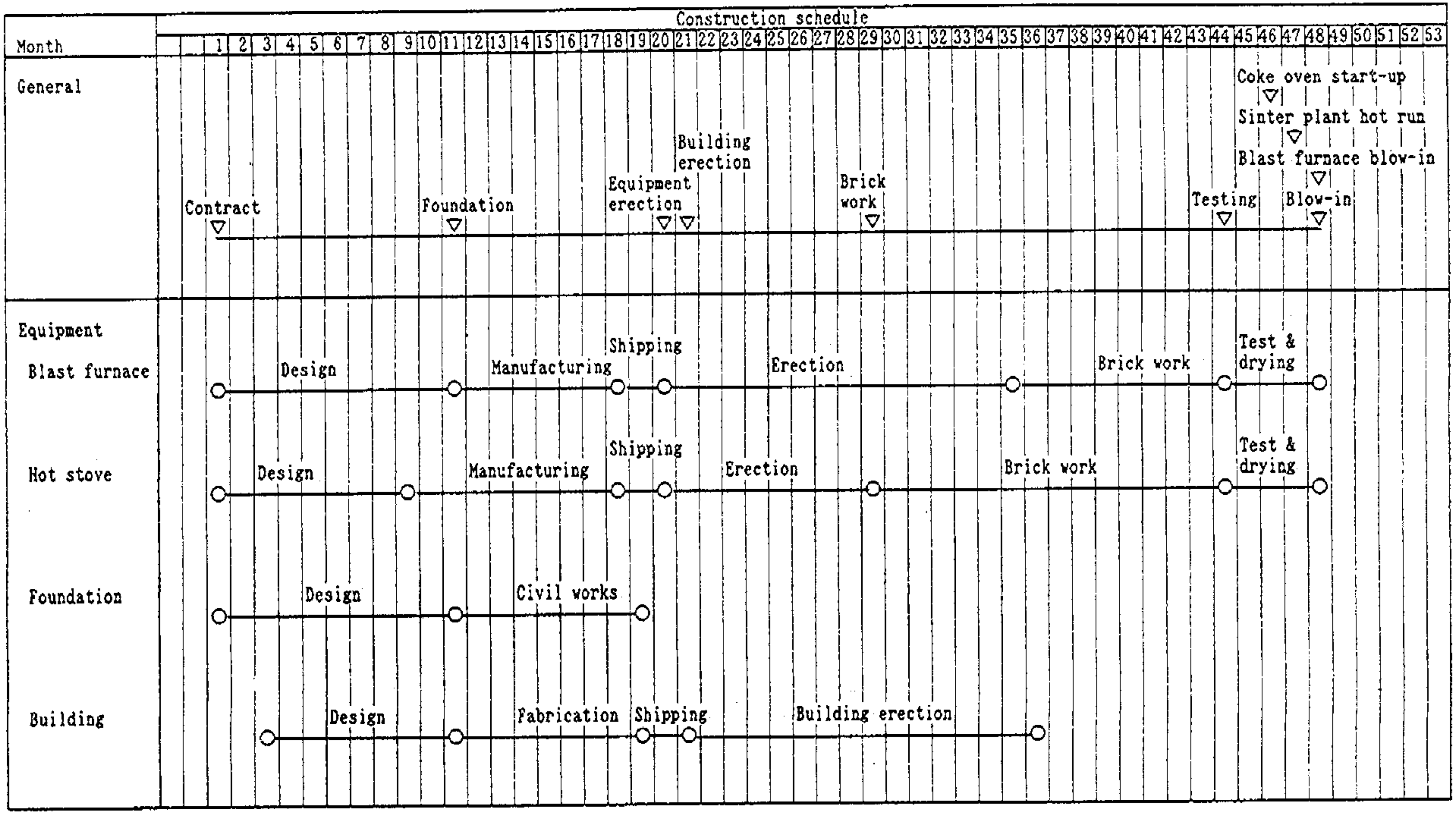
4. Technical explanation

The maximum productivity coefficient of blast furnace is set at about 2.0 $t/d/m^3$ which is the average level of blast furnace productivity of Japan.
For the blast furnace plant equipment operation, it is essential to keep the temperature and gas distributions inside the furnace proper in good condition and maintain a smooth descent of charging materials.
The blast furnace proper is protected by the cooling system.
Stable function without disturbing the blast furnace operation is required for the raw materials transporting facilities, hot stove, gas cleaning equipment.
A casting machine having 30,000ton/M capacity is installed near the No.2n blast furnace in step 2. This machine is mainly used in case of steelmaking trouble.

5. Construction plan

The construction plan of blast furnace plant is shown in Table 6-7.
The construction plan of step 3 is as same as step 2.

Table 6-7 Construction schedule of blast furnace



Section 7 Lime Calcining Plant

Contents

1. General

1) Two lime calcining kilns with a capacity of 500 t/d each are installed at final step to calcine approx. $250x10^3$t/y of necessary lumpy burnt lime for the production of $4,535x10^3$t/y of molten steel at BOF. (at Step-2, one kiln shall be installed.)
2) The rotary type kilns are applied for the calcining plant of NISW, the rotary kilns provide rather soft-calcined (easier slag formation) and stable burnt lime which suits for BOF process.
3) The raw lime stone is dug and sized at the domestic mines, and transported to the NISW by sea. The lime stone of Hoang Mai mains is designated by VSC for feasibility study of NISW.
4) The COG (coke-oven gas) is used as fuel for calcining, waste gas is heat-exchanged in the preheater and exhausted into the atmosphere via a dust collector.
5) A portion of under size burnt lime is pulverized and used for desulfurization treating of hot metal, and the rest is used in sintering plant.

2. Preconditions

2.1 Production plan

Table 7-1 shows the production plan of the lime calcining plant according to the production plan of the BOF.

Table 7-1 Production plan of lime calcining kiln

	Unit consumption	Required quantity	
		Step-2	Step-3
Production of steel	Molten steel Slab & billet	$2,342 x10^3$t/y $2,230 x10^3$t/y	$4,535 x10^3$t/y $4,320 x10^3$t/y
Lumpy burnt lime (CaO) for BOF	55 kg/t (molten steel)	$129 x10^3$t/y	$250 x10^3$t/y
CaO powder for desulfurization	7.0 kg/t (-treated hot metal)	$12 x10^3$t/y	$23 x10^3$t/y (to sinter 9x103t/y)
CaO discharged from kilns		$146 x10^3$t/y	$282 x10^3$t/y
Raw lime stone transported to ISW	— — —	$303 x10^3$t/y	$588 x10^3$t/y

2.2 Raw material and product balance

Figure 7-1 shows the material balance of lime calcining plant (at Step3).

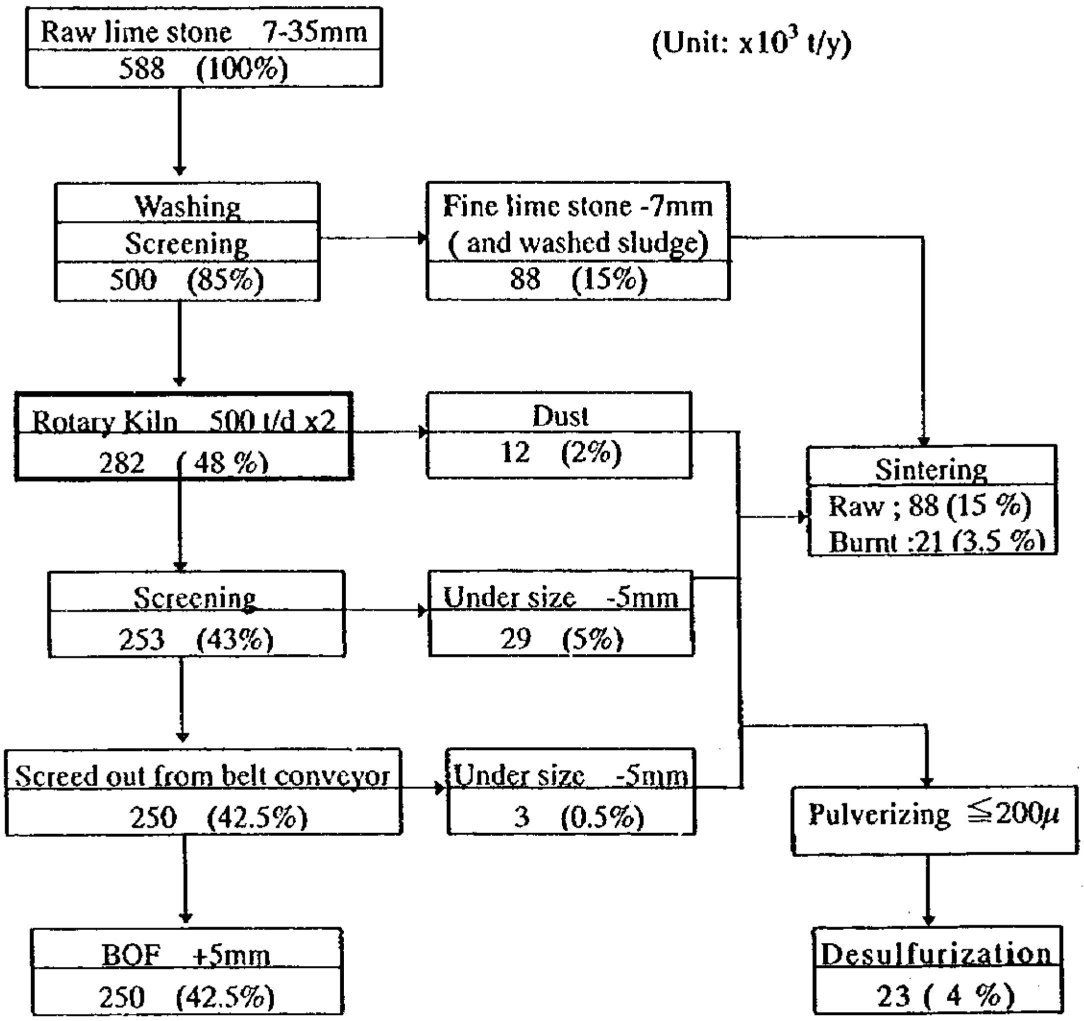


Figure 7-1 Raw material and product balance

2.3 Property of lime stone

The lime stone is transported from Hoang Mai lime stone deposit.
The property of lime stone is assumed in Table 7-2.

Table 7-2 Property of lime stone

Contents(%)	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	LOI	Grain size
Hoang Mai	55.0	0.6	0.6	0.0	--	42.6	7~35mm

LOI: Loss of ignition

2.4 Desired property of product

Table 7-3 and Table 7-4 show the property of burnt lime desired generally.

Table 7-3 Desired property for BOF

Contents	CaO	SiO_2	$MgO+Al_2O_3$	P	S	CO_2	Grain size
%	≧91.3	≦2.8	≦2.0	≦0.1	≦0.025	≦2.0	≧ 5mm

Table 7-4 Desired property for other use

For TDS	For sintering
Grain size	
≦200 μ, (≧80%)	≦5mm

TDS: Torpedo car desulfurization

2.5 Operating condition

Table 7-5 shows the basic operating conditions.

Table 7-5 Operating condition

		Planned value	
		Step-2 (2009)	Step-3 (2019)
1) Working time ratio	(Total steelmaking time /calendar time)	approx. 85 %	
2) Operating time	a) Annual operating day b) Monthly operating days c) Periodical repairing	317 d/y 26.4 d/month 4 d/ month	
3) Production (Discharged from kiln)	a) Annual ton b) Monthly ton c) Daily ton	146,000 t 12,170 t 460 t	282,000 t 23,500 t 890 t

3. Equipment plan

3.1 Equipment specification

Table 7-6 shows the main capacity of the kilns.

Table 7-6 The capacity of kilns

Average required kiln capacity (Discharged from kiln)	Step-2	Step-3
	460 t/d x 1 unit	445 t/d x 2 unit
Capacity of kilns	500 t/d x 2 unit (109 % of average)	

Table 7-7 shows the main specifications of the lime calcining plant.
The general functions and plans of each equipment are described as follows.

(1) Raw lime stone handling equipment
a) Normally the lime stone sized of 7~35mm is transported from raw material yard to the calcining plant by belt conveyer.
b) The lime stone is washed in the drum washer, screened for sizing required, and stored in silo.

(2) Kiln equipment
a) The one kiln is designed with the capacity of 500 t/d, and the number of kiln is two in accordance with the amount of burnt lime required for BOF at step-3.
b) The rotary kiln consists of a grate traveling type preheater, a rotary kiln, combustion equipment, a grate type cooler, and a dust catcher.
c) The fuel of calcining is COG.

(3) Burnt lime handling and storage equipment
a) The burnt lime is screened out, stored into respective silos. The lumpy burnt lime is transported to the overhead bunkers of BOF by belt conveyers.
b) Undersized burnt lime is used for desulfurization, and for sintering plant.

(4) Pulverizing of burnt lime
Under size burnt lime is pulverized by the roller mill, and transferred to torpedo car desulfurization station by lorry.

3.2 Equipment flow (process flow)

Figure 7-2 shows the equipment flow (process flow) of calcining plant.

Table 7-7 Equipment specifications of calcining plant (CaO)

Equipment	Quantity		Main specification
	step-2	Step-3	
1. Lime stone receiving equipment			
1) Lime stone transporting belt conveyer	1 set	---	(Included in raw material handling equipment)
2) Washer and screen	1 set	---	Type: Drum washer type, and water circulating equipment
2. Lime stone charging equipment	1 set	+1 set	
3. Preheater	1 set	+1 set	
1) Preheater proper			Type: Grate traveling type
4. Kiln	1 set	+1 set	
1) Kiln proper			Type; Rotary kiln Capacity; 500 t/d discharge
2) Combustion equipment			Fuel: COG Capacity: approx. 8,000 Nm^3/h
5. Cooler equipment	1 set	+1 set	Type : Grate traveling type
6. Waste gas treatment equipment	1 set	+1 set	1) Gas cooler 2) Dust catcher etc.
7. Product transporting and storage equipment	1 set	---	1) Lump product silo 2) Fine product silo 3) Belt conveyor to BOF
8. Burnt lime pulverizing equipment	1 set	---	1) Screw feeder 2) Roller mill 3) Dust catcher
9. Electrical equipment	1 set	+1 set	
11. Instrumentation	1 set	+1 set	Measuring, controlling and supervising
12. Civil engineering and foundation	1 set	---	1) Foundation 2) Support of reinforced concrete structure
14. Building	1 set	---	1) Reinforced concrete building 2) Steel frame building

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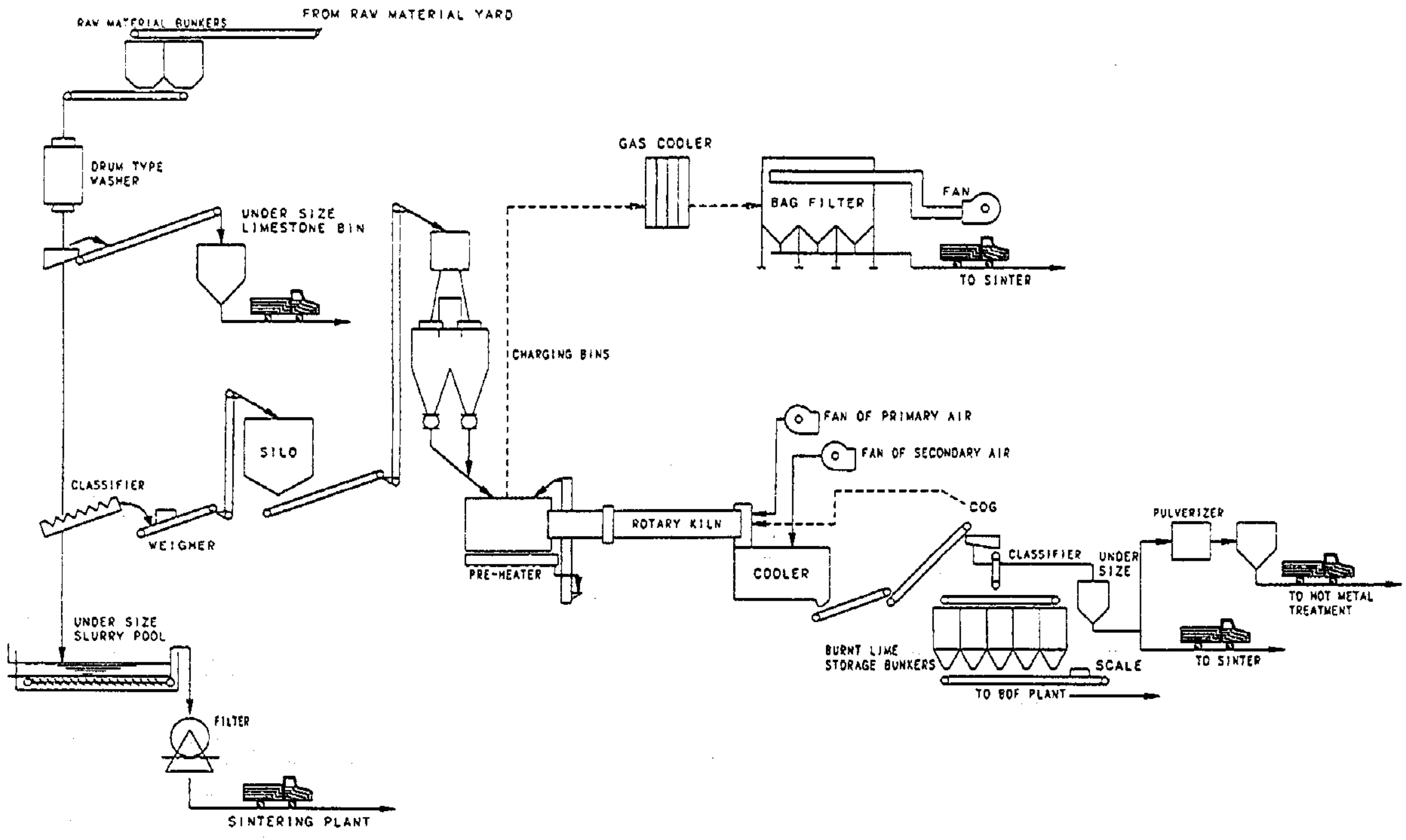

Figure 7-2 Equipment flow of lime calcining process

3.3 Production and unit consumption

Table 7-8 lists the production and unit consumption of the calcining plant.

Table 7-8 Production and unit consumption

t; burnt lime discharged from kiln = 282 x 10^3t/y

Item	U.C		Q'ty	Supply	Property
	Unit		unit/y		
1) Materials					
· Lime stone	kg/t	2,083	588,000 t	Domestic	Transported to NISW from the mine
2) Utility					
· Electric power	kWh/t	40	11.3×10^6 kWh	NISW	
· Water	m^3/t	3.2	902.4×10^3 m^3	NISW	Washing
· Comp. air	Nm^3/t	α		NISW	
3) Fuel					
· COG	Nm^3/t	300.0	84.6×10^6 Nm^3	NISW	COG 4,700 kCal/Nm^3
4) Refractory					
· Kiln	kg/t	0.7	197.4 t	Import	

3.4 Manning plan of calcining plant

Table 7-9 summarized the manning plan of the calcining plant.

Table 7-9 Manning plan of calcining plant (unit: persons)

CaO plant	General control	Operation		Machine operation	Refrac-tory	Mainte-nance		Technical division	Total	
Step	2 &3	2	3	2 &3	2 &3	2	3	2 &3	2	3
General manager										
Section manager		1							1	
Assistant manager		1				1		1	3	
Engineer		1			1	2		1	5	
Foreman		4				2			6	
Skilled worker		13	15			6	10		19	25
Unskilled worker		5	7			3	4		8	11
Clerk										
Secretary		1							1	
Total		26	30		1	14	19	2	43	52

3.5 Construction schedule

Table 7-10 shows the construction schedule of calcining plant.

Table 7-10 Construction schedule of lime calcining plant (CaO)