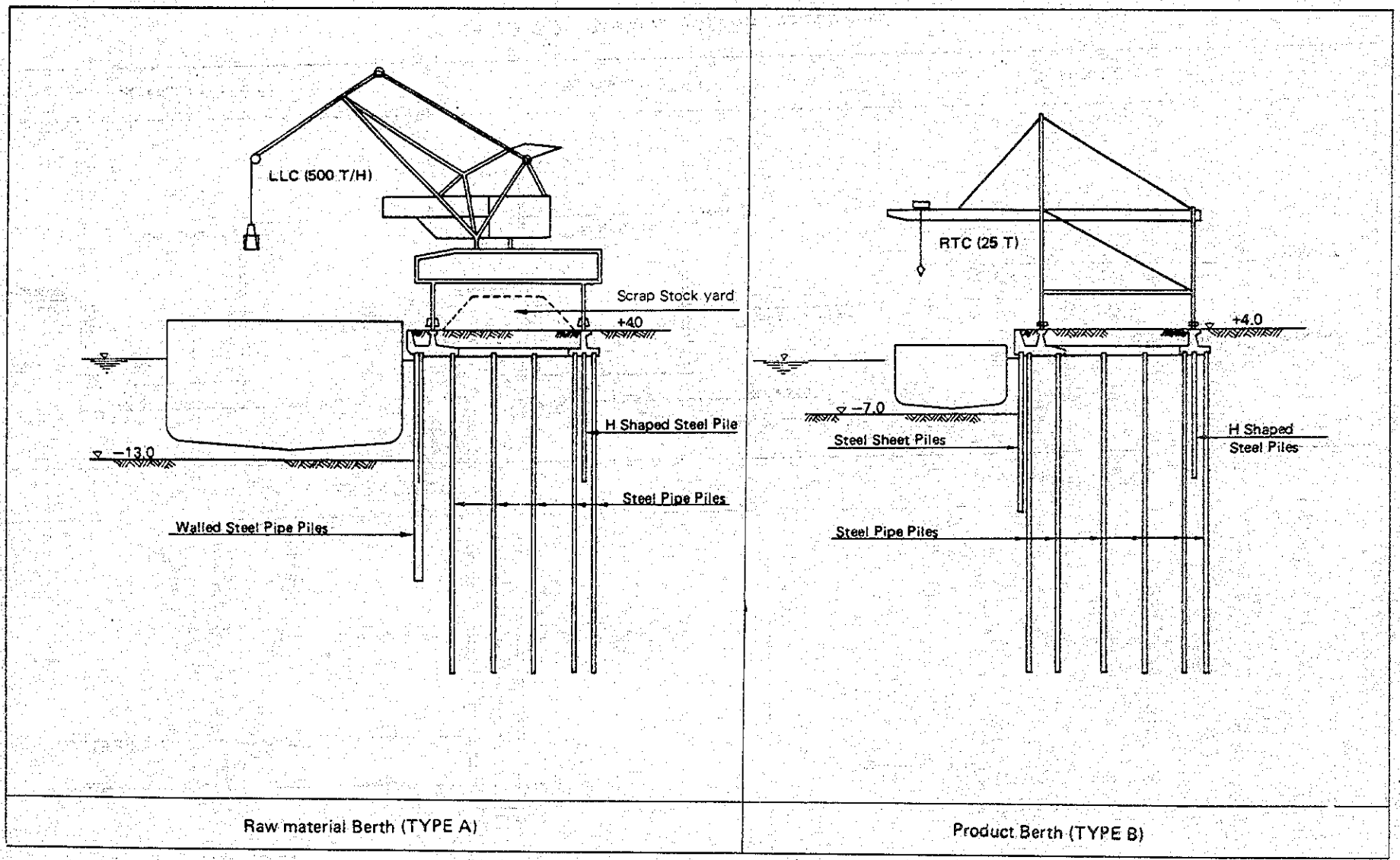


Fig. 13-2-6 Profile of raw material berth and product berth

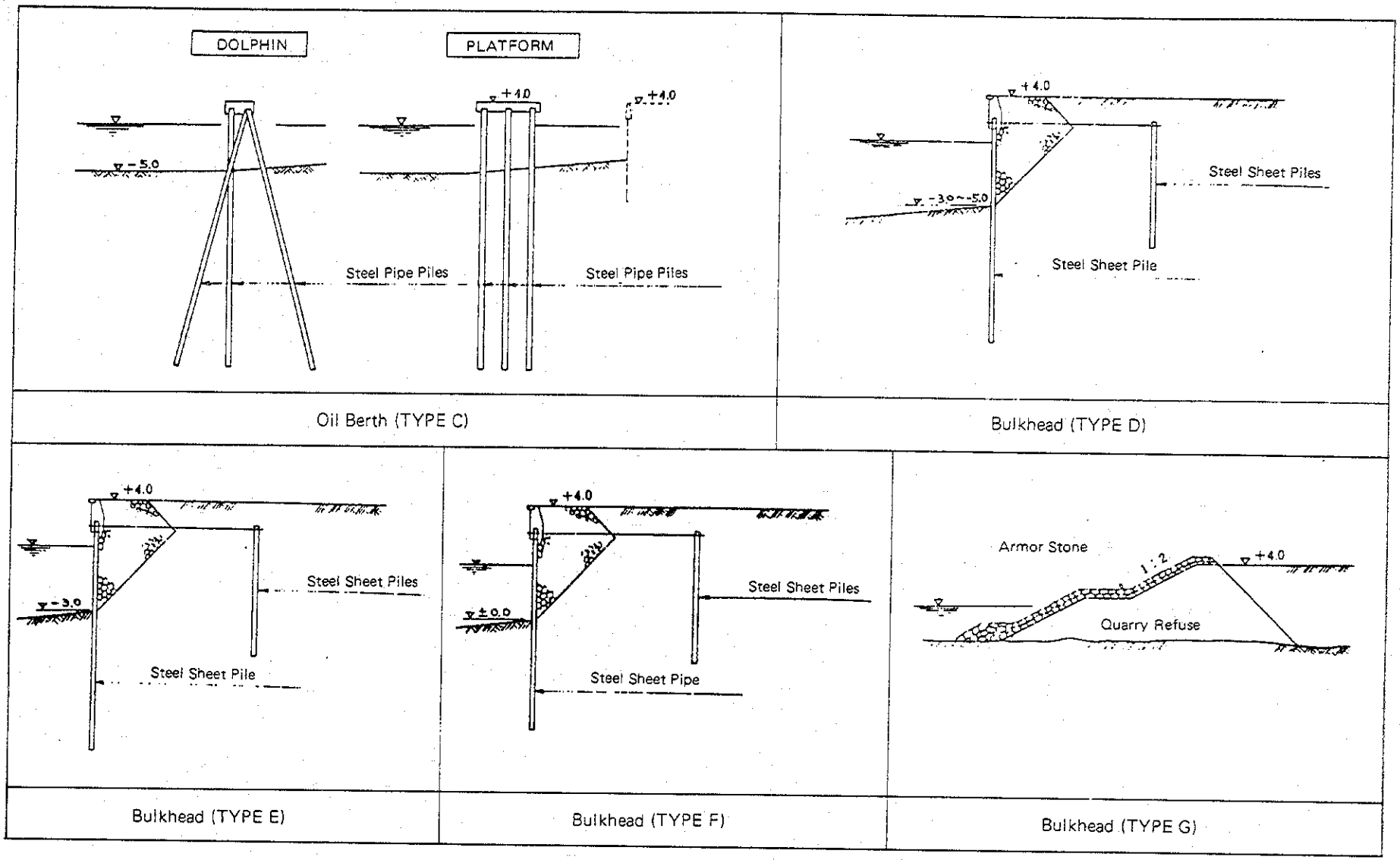
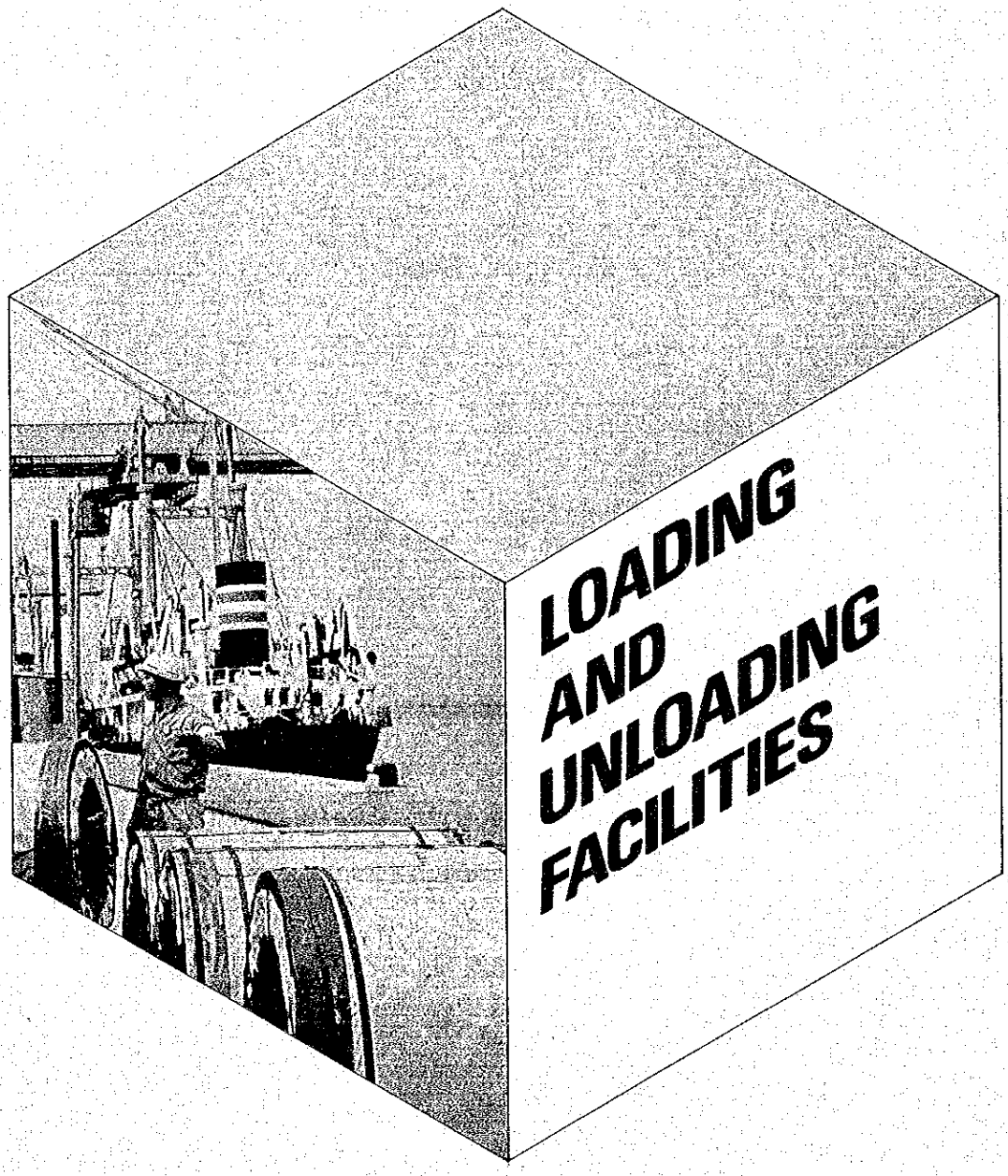


Fig. 13-2-7 Profile of oil berth and bulkhead

CHAPTER 13-3



LOADING AND UNLOADING FACILITIES

13-3 Loading and unloading facilities

13-3-1 General

These facilities unload necessary raw materials for the new steel works, and transport them to the storage area. Also they transport products and semi-finished products, shipped from the rolling mills to the berth and loads them onto vessels.

(1) Raw material unloading facilities

The material berth of P.S.C., near the new steel works is in deep water. Therefore it is possible for large ore carrying vessels to berth. However, there is not a capability to handle all materials for the new steel works. Therefore, in this study, imported ores wihich are mainly carried by large vessels are dependant upon the P.S.C. berth. Seperately, for unloading coal, other raw materials and scrap carried by vessels of under 50,000 DWT, another raw material berth is newly build.

The unloader for raw materials is a level luffing crane able to unload scrap. Its' capacity is $500^{t/hr} \times 2$ units to meet unloading volume. Of the unloaded raw materials, scrap and fluorspar are transported by dump truck. Other materials are carried by conveyor belt, of the raw material handling facilities, to the raw material yard.

At stage II, due to the lack of capacity for berthing of large vessels, an extension of the P.S.C. berth provided with additional large unloaders will be necessary.

(2) Loading of products and semi-finished products

Products and semi-finished products are carried from their respective yards by T.T. (tractor trailer) to the product berth.

They are either directly loaded onto vessels or temporarily held in the rear of the berth for later loading. Rope trolly type crane of a high loading efficiency is employed and has a lifting capacity of 25^{t} so as to load a maximum weight of the product.

At stage II, in order to meet increases of shipping volume and variation in type of products, an extension of the berth- expansion of the loader as well as establishment of a new warehouse will be necessary.

13-3-2 Preconditions

(1) Amount of handling on the raw materials and product berth.

Amount of handling on each berth is shown in *Table 13-3-1* and *13-3-2*.

Table 13-3-1 Amount of handling on the raw material berth

Type	Quantity (1,000 t/y)		Remarks (Type of vessel)
	Stage I	Stage II	
Coal	1,289	2,585	20,000 ~ 50,000 DWT
Limestone, iron sand and other miscellaneous raw materials	539	1,081	6,000 ~ 20,000 DWT
Scrap	143	259	20,000 ~ 30,000 DWT
Total	1,971	3,925	

Table 13-3-2 Amount of handling on the product berth

	Type	Maximum unit weight (t)	Handling volume (1,000 t/y)	
			Stage I	Stage II
Loading	Hot coil	18.2	1,052	1,481
	Hot sheet	—	—	226
	Slab	17.6	100	200
	Billet	8.6	150	630
	Bloom	17.6	144	144
	Sub total		1,446	2,867
Unloading	Ferroalloy		13	25
	Refractory materials, etc.		42	79
	Sub total		55	104
Total			1,501	2,971

(2) Working conditions

1) Working time: The working time of berth handling is consecutive 24-hours for 3 teams in 3 shift.

2) Rate of operation (average)

Equipment	Rate of operation (%)	Remarks
Loader	52	Loading: 48, Unload: 4
Unloader	54	Coal: 27, Other: 11, Scrap: 16
Tractor	35	

13-3-3 Facilities Plan

(1) Equipment Specification

Specification of main equipment is shown in *Table 13-3-3.*

Table 13-3-3 Equipment specifications

Equipment	Number		Specifications
	Stage I	Stage II	
1. Quay			
1) Unloader (500 ton/hr)	2	–	Capacity: 500 t/hr Lifting load: 16 t Type: Level luffing crane
(1,800 ton/hr)	–	2	Capacity: 1,800 t/hr Lifting load: 30 t Type: Rope trolley crane with elevated grider
2) Loader	2	2	Capacity: 25 t Type: Rope trolley crane with elevated girder
2. Transport equipment			
1) Tractor	5	4	
2) Trailer	13	12	60 t Loading bed: 3.5 m x 9 m
3) Semi-trailer	1	1	40 t Loading bed: 2.5 m x 7 m
4) Fork lift	1	1	25 t
5) Bulldozer	3	3	14 t
6) Paw crane	2	2	0.4 m^3
7) Dump truck	4	–	11 t with side board for 12 m^3
8) Small truck	1	–	2 t with crane
3. Buildings			
1) Sub-center	1	–	1,070 m^2, office, garage, electric power room
2) Product warehouse	–	1	15,000 m^2, with overhead travelling cranes

(2) Facilities layout

Layout of the loading and unloading facilities is shown in *Fig. 13-3-1.*

(3) Relation to stage II

Concerning the facilities for loading and unloading, as stated before, extention of the PSC berth will be necessary at stage II. It may be necessary to invest heavly for facilities, and a wide increase of handling capacity will be expected. Therefore, at stage I, it has been considered that the necessary minimum investment will be made for material handling equipment at stage I in order to minimize the raw material handling cost in this stage.

For the products shipping facilities, from the same point of view concerning the cost minimization at stage I, they are planned so that the products are carried directly from the factory yard to the loader for loading into vessels. The investment for product warehouse is transfered to stage II.

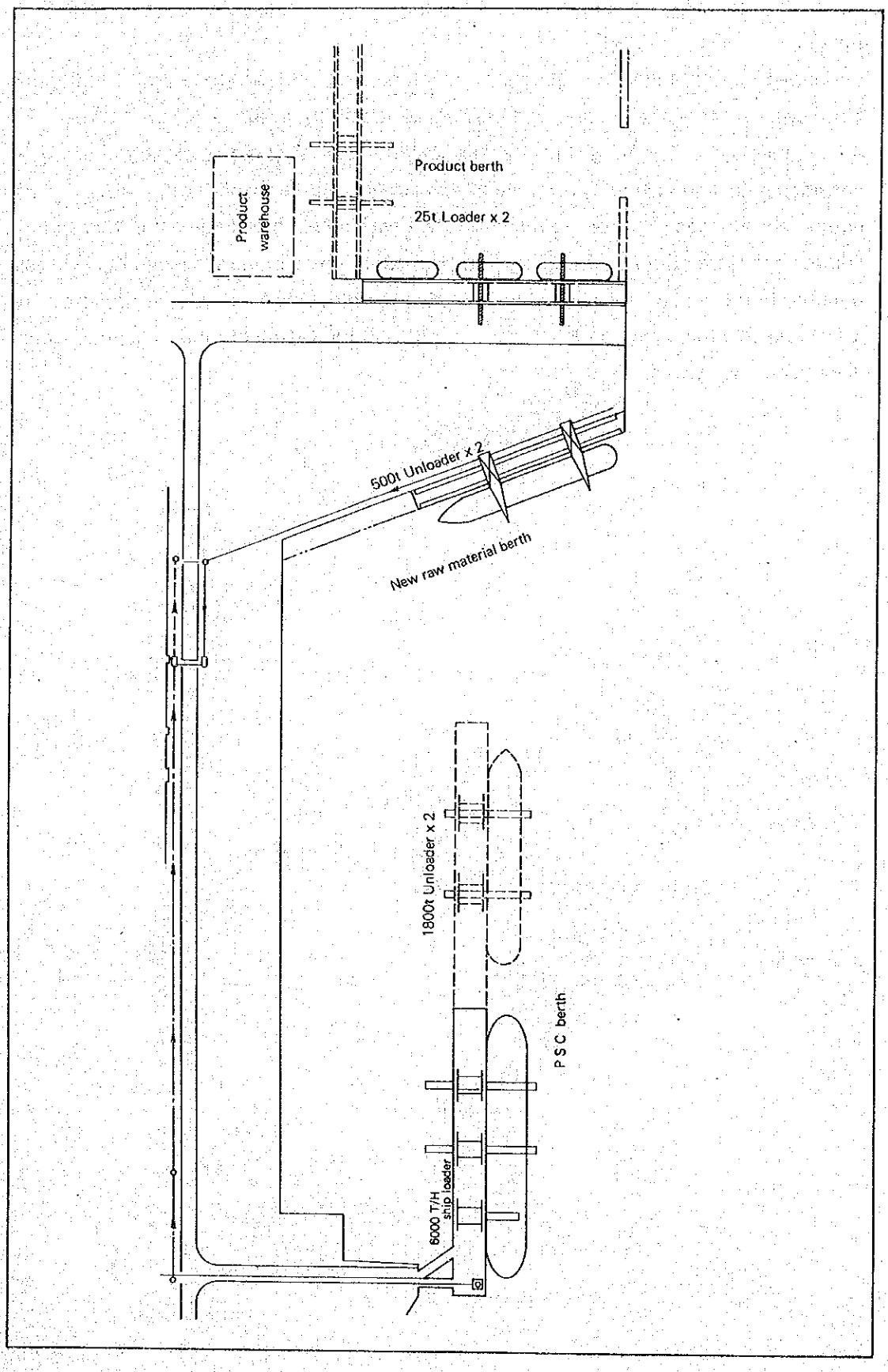


Fig. 13-3-1 Loading and unloading facilities

13-3-4 Technical explanation

(1) Rawmaterial berth

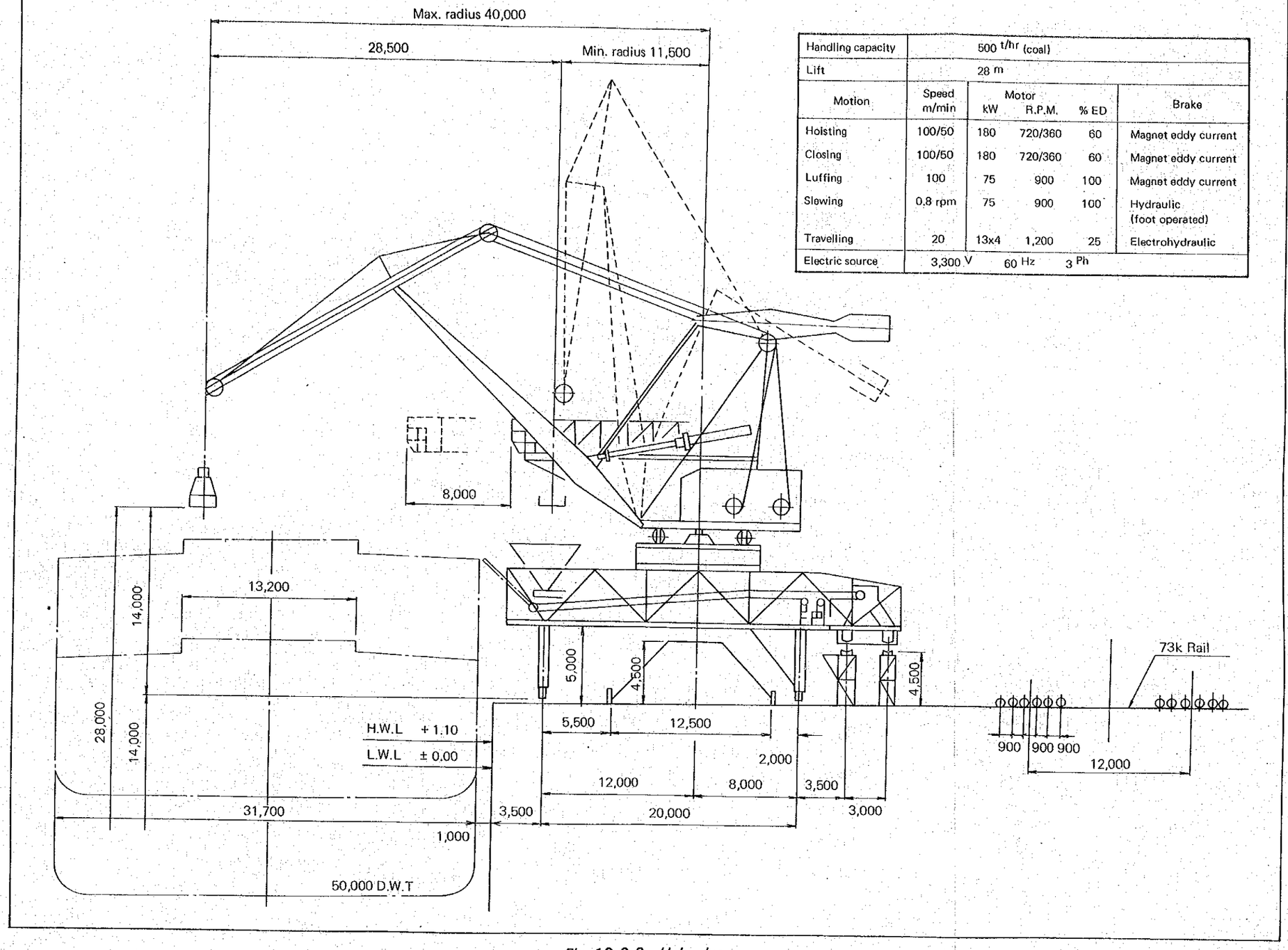
Coal and other materials of those which are handled on this berth are dropped into the hopper mounted on the unloader and countinuously supplied onto the belt conveyor via the feeder and conveyor on the loader. The raw materials are carried continuously to the raw material yard by the conveyor. Unlike this, in the case of scrap, the scrap is directly lodaded onto the dump truck by turning the crane after being unloaded by the polyp bucket or lifting magnet, or loaded onto the truck again by the crane after being temporarily stored on the quay. (Refer to *Fig. 13-3-2*) With the increase in size of larger vessels, a part of the cargo to be raked out for grabbing with bucket tends to increase. This trend will decrease the capability of the crane. In order to reduce unloading time and prevent demmurage charges, it is very important to efficiently and quickly rake out the materials from the interior of the ship. For this purpose, it is planned to mechanize the operations with bulldozers and paw cranes. However, it is also necessary to train skilled workers for efficient unloading.

(2) Product berth

This berth is for shipping the products to domestic market. Therefore, it is taken into consideration to meet variety of vessel types in 300~5,000 D.W.T. class. As the operator's cabin is set upon the main trolly of the loader, the operator's field of vision is excellent and operation is easy. Furthermore, establishing a backereach is utilized for works of loading materials onto trailer and temporary storage behind the loader. It is also convenient to load materials such as ferroalloy and refractory materials. Refer to *Fig. 13-3-3*.

In stage I, in order to save the investment and minimize the cargo handling cost, direct shipping system from the mill end yards to the berth is adopted. It is possible to temporarily store slab, bloom, billet, etc. in the area behind the berth. For the hot coil, it is necessary to arrange shipments so smoothly that the stock amount of the coil does not exceed the capability of the coil yard for 10 days stock.

In stage II, it is considered that in order to make classification, storage, shipment of sheet and shape more smooth, which are expected to increase in variety, and also to meet an increase of products to be stocked due to the increase of shipping volume of products, extension of the berth with additional loaders as well as establishment of new warehouse facilities will be carried out.

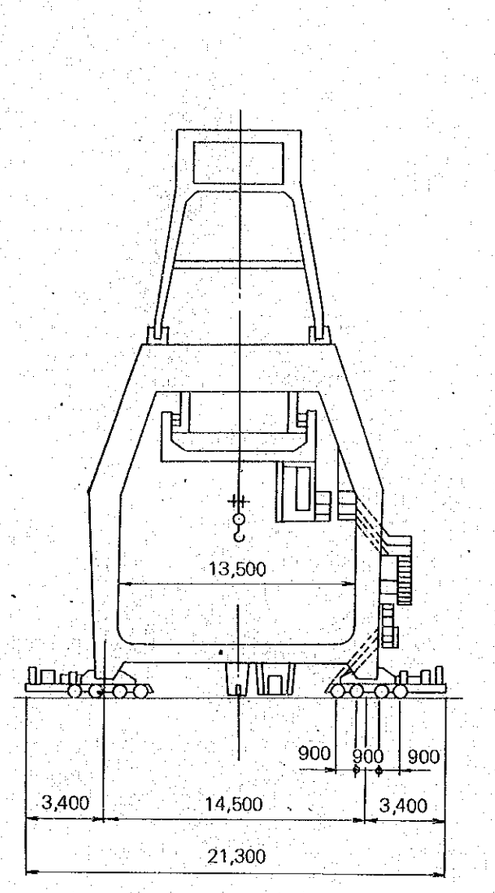


Handling capacity	500 t/hr (coal)				
Lift	28 m				
Motion	Speed m/min	Motor kW	R.P.M.	% ED	Brake
Hoisting	100/50	180	720/360	60	Magnet eddy current
Closing	100/50	180	720/360	60	Magnet eddy current
Luffing	100	75	900	100	Magnet eddy current
Slewing	0.8 rpm	75	900	100	Hydraulic (foot operated)
Travelling	20	13x4	1,200	25	Electrohydraulic
Electric source	3,300 V	60 Hz	3 Ph		

Fig. 13-3-2 Unloader

Specifications

Hoisting load	25 t				
Lift	22 m			Span	20 m
Motion	Speed m/min	Motor			Brake
		kW	RPM	% ED	
Hoisting	30	160	720	40	Magnet eddy current
Troley travel	60	22	1,200	40	Electro hydraulic (foot operated)
Boom hoist	6 min	33	1,200	25	Magnet eddy current
Ganitry travel	25	15 kW x 4	1,200	25	Electro hydraulic
Electric source	3 pH	3,300 V		60 Hz	



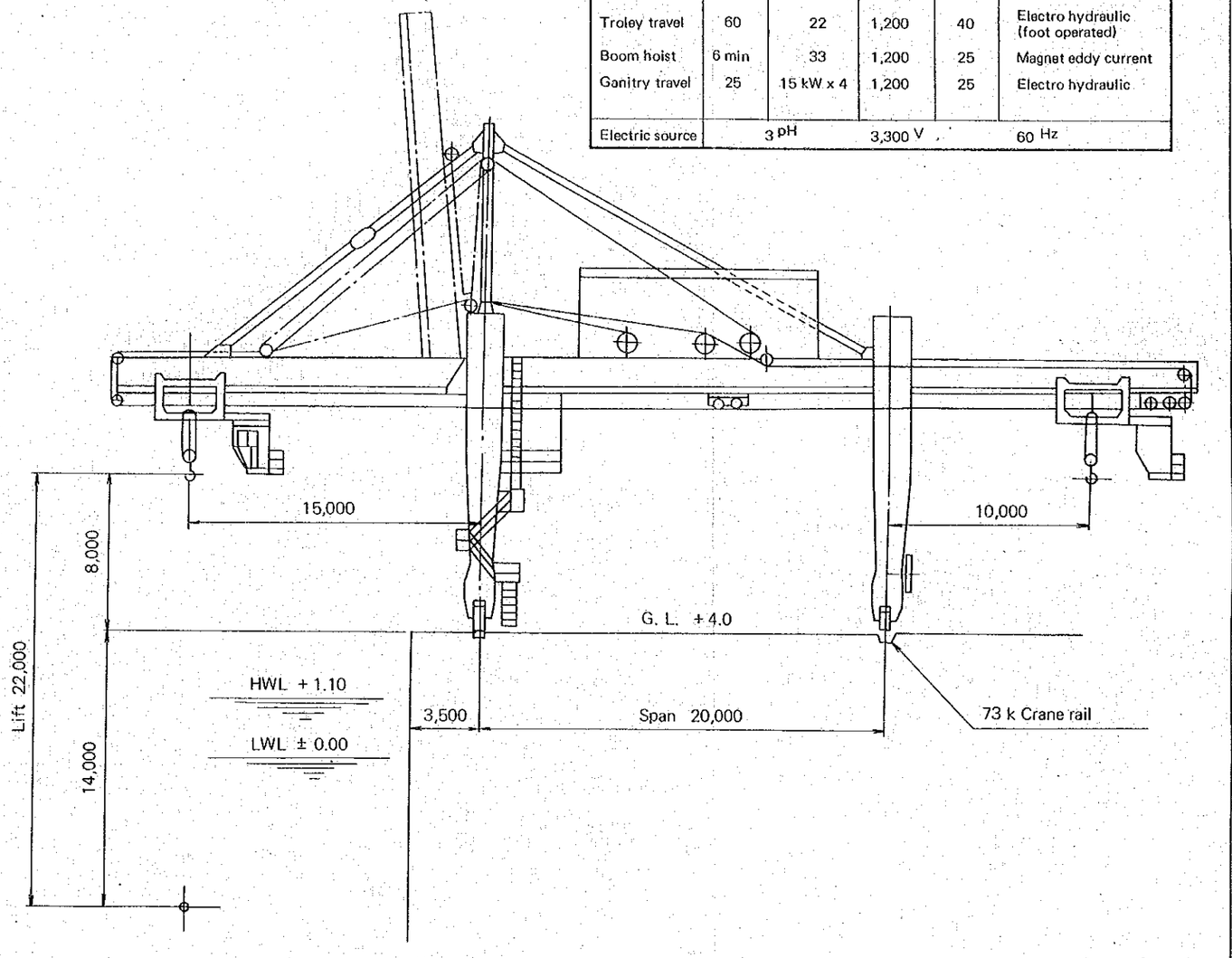


Fig. 13-3-3 Loader

(3) Product and semi-finished product transport in site

1) Basic policy

As explained in the previous Pre F/S report, for transportation of product and semi-finished product in the site, a trailer system is adopted, which allows a small initial investment and a high workability in the area of the loader on the berth. As for the calculation of the number of trailers necessary, it is a basic policy to maintain the transport capability to meet a peak of the loading capability of loader and also to effectively utilize an undue time.

2) T.T. (Tractor Trailer) and semi-trailer system

In transport works, there is a great deal of waiting time such as on-load operations. The T.T. (Tractor Trailer) system has advantage of reducing tractor dirver's waiting time and making transport operations more efficient by using one tractor to pull about 3 trailers in tandem. On the other hand, it is advantageous to employ semi-trailers which are maneuverable, for transportation operations that are infrequent, small volume lots or where the roads are narrow. In this study, T.T. system was adopted as the principal manner of transport and semi-trailer was adopted in part.

3) Load Capacity

As the result of this study of transport capability, versatility, difficulties of handling, etc., it was decided that the capacity of full trailer of T.T. system is 60 ton and 40 ton capacity for semi-trailer.

4) Number of T.T. necessary duirng peak on-loading time

In the T.T. system, the minimum necessary number of T.T., in order that the loader is not left idle during peak onloading time, is 3 T.T. units for stage I and 6 units for stage II. As they have a stock time except the peak loading time, they can be utilized for transport of ferroalloy and other materials (such as refractory materials).

5) Other transportation in the site

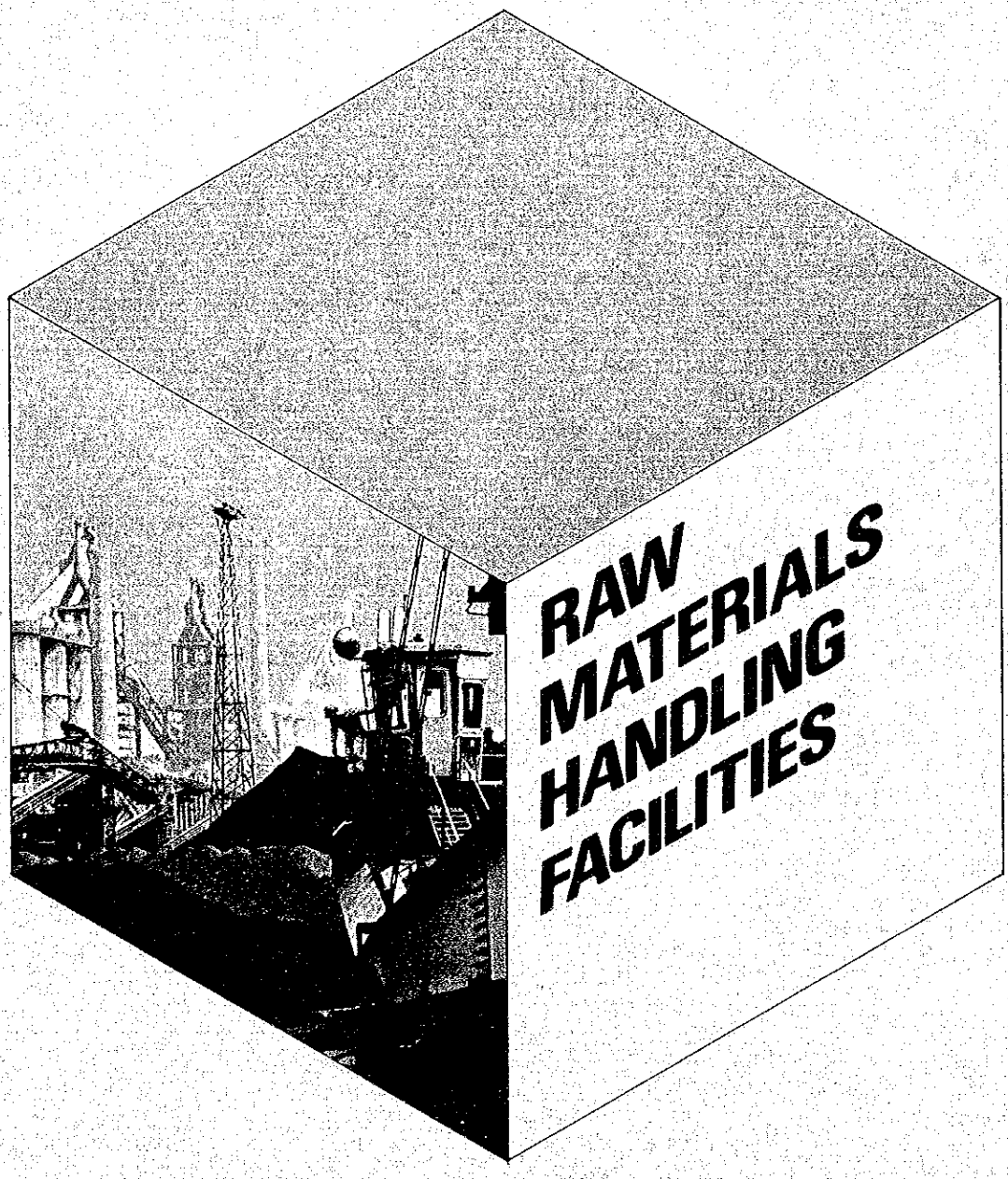
As the volume of slabs transported from the slab casters to the hot strip mill is very large, T.T. system is suitable. In stage I, this transportation is combined with the slab transportation to the berth. One T.T. team will be responsible for these transportation operations. Therefore, in stage I, including on-loading operations, 4 T.T. units in total will be necessary and one tractor and trailer should be kept in reserve.

As the volume of transport will increase in stage II, it is necessary to add T.T. units, which will bring the total number of units to 8.

On one hand, the transportation volume of bloom and billet is limited in stage I. As one trailer having a capacity of 40^{t} are able to transport them, a semi-trailer having an exclusive tractor is to be used. At the time of stage II, the transportation volume

of billets will increase. The transportation system will be changed to T.T. method. Two semi-trailers, of which one trailer is added, will be applied to transportation of bloom and shape.

CHAPTER 13-4



RAW MATERIALS HANDLING FACILITIES

13-4 Raw material handling facilities

13-4-1 General

These facilities receive, store, size, blend and supply necessary raw materials to the blast furnace, coke oven, sinter plant, steelmaking plant and lime plant, and 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, coal yard, etc. In the present study, in order to reduce construction costs and to utilize the limitted space efficiently, preparing a single space for all yard requirement is thought to be most advantageous. Planning for a single common yard where all raw materials are available was made.

(2) Conveyor system

A conveyor system has been designed so as to allow a number of materials to be moved to and from any optional place in the common yard. The multi-use yard will handle material recieved via the PSC berth and the new materials berth and ore treated at the sizing plant and sinter plant that require movement of materials in large and constant amounts.

(3) Stage II facilities

In stage II, the raw material yard, which is used for all materials, must be held to a minimum of space. It has been planned that the material handling equipment such as conveyor, stacker and reclaimer must be duly expanded to meet the increase of raw material demand and to meet the direct shipment of sinter to blast furnace. Also, additional equipments for sizing plant and blending yard will be necessary.

13-4-2 Preconditions

(1) 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 *Tables 13-4-1～13-4-7.*

Table 13-4-1 For blast furnace

Item	Unit consumption kg/t - pig iron	Quantity (t/d)	
		Stage I	Stage II
Pig iron tapped		4,136	8,295
Amount of ore charged (breakdown)	1,620	6,700	13,440
Sinter		3,946	7,916
Pellet		1,414	2,836
Sized ore		1,340	2,688
Manganese ore	9	40	75
Lump limestone	40	165	335
Total		6,905	13,850

Table 13-4-2 For coke oven

Item	Yield	Quantity (t/d)	
		Stage I	Stage II
Lump coke for blast furnace	85%	2,045	4,100
Coke production	74%	2,405	4,825
Coal charged to coke oven		3,250	6,520
Coal reclaimed from yard	Water content 8%	3,535	7,085

Table 13-4-3 For sinter plant

Item	Unit consumption kg/t - sinter	Quantity t/d	Remarks
Sinter production		16,200	
Fine ore	697	11,296	
Sinter fine	80	1,296	
Iron sand	48	778	
Mn ore	9	146	
Dolomite	46	745	
Quartzite	30	486	
Mill scale	13	211	
Fine dust	20	324	
Total raw materials supplied	943	15,277	

Tab 13-4-4 For steel making plant

Item	Unit consumption kg/t - steel	Quantity (t/d)	
		Stage I	Stage II
Tapped steel		4,670	9,370
Sized ore	20	93	187
Lamp limestone	6	28	56
Total		121	243
(Burnt lime)	(60)	(280)	(560)

Table 13-4-5 For lime plant

Item	Unit consumption kg/t - lime	Quantity (t/d)	
		Stage I	Stage II
Burnt lime production		450	900
Lump limestone consumption	2,333	1,050	2,100

Table 13-4-6 For sizing plant (Stage I)

Item	Blast furnace consumption (t/month)	Lump yield %	Sizing quantity		Under size t/d
			t/month	t/d	
Lump ore	40,200	55	73,100	3,655	1,645
Mn ore	1,100	50	2,200	110	55
Total	41,300		75,300	3,765	1,700

Note: 20 days of operation a month (due to the sinter receiving operation)

Table 13-4-7 For sizing plant (Stage II)

Item	Blast furnace consumption (t/month)	Lump yield %	Sizing quantity		Undersize t/d
			t/month	t/d	
Lump ore	80,600	55	146,500	5,230	2,350
Mn ore	2,200	50	4,400	160	80
Total	82,800		150,900	5,390	2,430

Note: 28 days of operation a month (free from the sinter operation)

(2) Premise for on loading of materials

Table 13-4-8 and *13-4-9* show the data related to the loading of materials in the yard. A years loading volume of material in the yard is about $4^{mil.t}$ at stage I and about $8^{mil.t}$ at stage II. *Fig. 13-4-1* and *13-4-2* show in the form of a diagram the flow of materials form the berth, yard and individual plants.

Table 13-4-8 Materials data (Stage I)

Materials	Annual consumption (1,000 t)	Number of brands	Domestic or imported	Ship size (1,000 DWT)	Particle size (mm)	Ratio of fine %
Coal	1,289	5	Imported	30 ~ 60	–50	–
Pellet	528	1	"	100	5 ~ 16	5
Lump ore	930	4	"	20 ~ 150	–200	45
Fine ore	637	4	"	20 ~ 100	–10	100
Mn ore	28	1	"	20	–200	50
Dolomite	75	1	Domestic	6	–3	100
Iron sand	75	1	"	6	–3	100
Quartzite	46	1	"	6	–3	100
Lump limestone	310	1	"	6	10 ~ 30	–
Receiving volume at berth	3,918	19				
BF undersize	145	2			–10	100
Mill scale	20	1			–10	100
Dust	31	1			–3	100
Inter-site receiving volume	196	4				
Yard receiving volume	4,114	23				

Table 13-4-9 Materials data (Stage II)

Materials	Annual consumption (1,000 t)	Number of brands	Domestic or imported	Ship size (1,000 DWT)	Particle size (mm)	Ratio of fine %
Coal	2,585	10	Imported	30 ~ 60	–50	–
Pellet	1,060	2	"	100	5 ~ 16	5
Lump ore	1,865	6	"	20 ~ 150	–200	45
Fine ore	1,268	6	"	20 ~ 100	–10	100
Mn ore	57	2	"	20	–200	50
Dolomite	150	1	Domestic	6	–3	100
Iron sand	150	1	"	6	–3	100
Quartzite	93	1	"	6	–3	100
Lump limestone	622	1	"	6	10 ~ 30	–
Receiving volume at berth	7,850	30				
BF undersize	290	2			–10	100
Mill scale	49	1			–10	100
Dust	60	1			–3	100
Inter-site receiving volume	399	4				
Yard receiving volume	8,249	34				

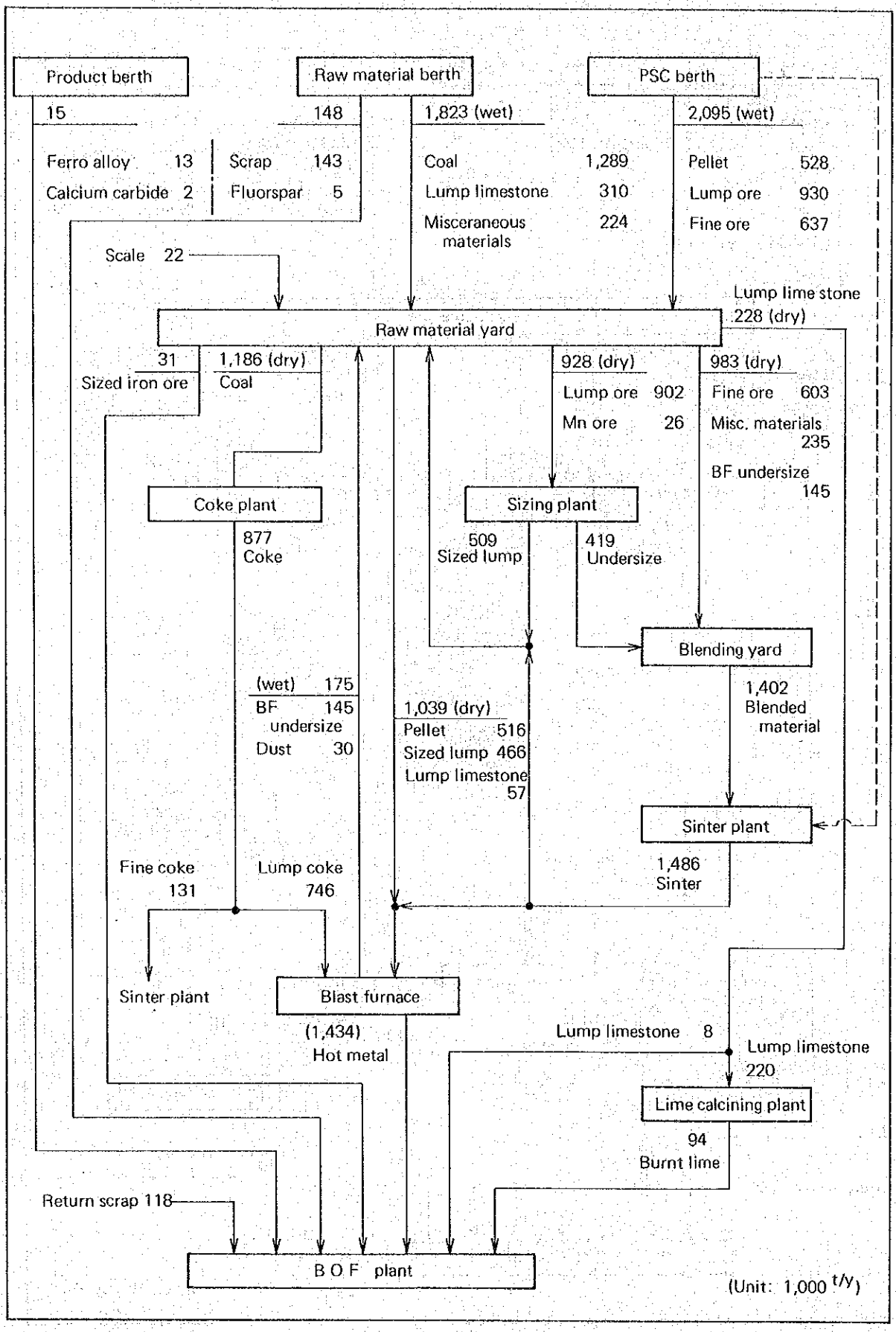


Fig. 13-4-1 Raw material flow (Stage I)

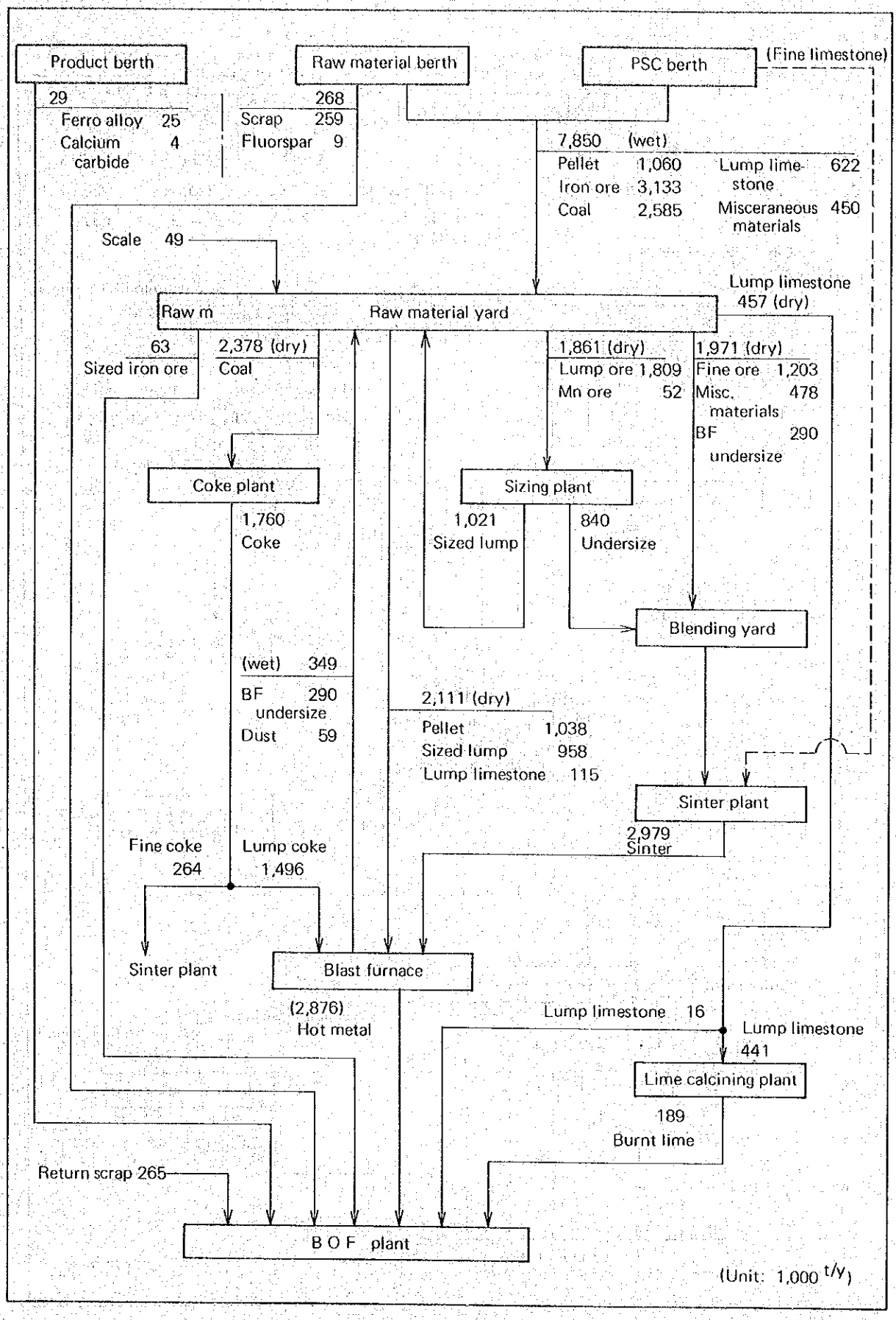


Fig. 13-4-2 Raw material flow (Stage II)

(3) Operating condition

1) Working hours

Material preparation work will be continuous operations for 24^{hr} in 3 shifts

2) Capacity of allied equipment

The capacity of the equipment directly connected to materials preparation work is shown in *Table 13-4-10*

Table 13-4-10 Allied equipment capacity

Equipment	Capacity	Allied materials preparation equipment
PSC unloader	1,800 t/hr x 2	Ore yard receiving belt conveyor, stacker
Coal unloader	500 t/hr x 2	,,
PSC sinter products release	800 t/hr	Sinter, miscellaneous materials yard receiving belt conveyor, stacker
PSC sinter raw materials receiving	1,500 t/hr	Blending yard reclaimer, belt conveyor

3) Sinter production and receiving

In stage I, the production of sinter was consigned to the PSC, supplied by a combination of materials. That is to say all materials except limestone and coke.

Sintered ore produced exceeding the volume of blast furnace usage is put in the ore yard to be set aside in the blast furnace storage bin.

In stage II, as the sinter plant is being newly established, sinter production will meet to usage and it will be directly transported to the blast furnace storage bin.

13-4-3 Equipment Plan

(1) Equipment specifications

Specification of main equipments are shown in *Table 13-4-11.*

Table 13-4-11 Equipment specifications

Item	Specification	
	Stage I	Stage II
1) Raw material yard		
1. Yard	50 m x 900 m x 3 yards Storage capacity: 900,000 t	50 m x 900 m x 1 yard Storage capacity: 300,000 t
2. Receiving conveyor	2,000 ~ 2,400 mmW x 3,600 t/hr x 5 units 1,200 ~ 1,600 mmW x 1,000 t/hr x 4 1,050 ~ 1,400 mmW x 800 t/hr x 14	2,000 ~ 2,400 mmW x 3,600 t/h x 8 units
3. Stacker	3,600 t/hr x 3 units	3,600 t/hr x 1 unit
4. Reclaimer	1,500 t/hr x 3 units	1,500 t/hr x 3 units
5. Releasing conveyor	1,050 mmW x 500 t/hr x 3 units 1,200 ~ 1,600 mmW x 1,500 t/hr x 13 units	1,200 ~ 1,600 mmW x 1,500 t/hr x 17 units 1,050 ~ 1,400 mmW x 800 t/hr x 8 units
2) Blending yard		
1. Yard	30 m x 400 m x 1 yard	30 m x 400 m x 1 yard
2. Receiving conveyor	1,200 ~ 1,600 mmW x 1,500 t/h x 7 units	1,200 mmW x 1,500 t/hr x 1 unit
3. Stacker	1,500 t/hr x 1 unit	1,500 t/h x 1 unit
4. Reclaimer	1,500 t/hr x 1 unit	
5. Releasing conveyor	1,200 mmW x 1,500 t/hr x 3 units	1,200 mmW x 1,500 t/hr x 2 units
3) Ore sizing plant		
1. Surge bunker	Storage capacity: 150 t x 2	
2. Crusher	Gyratory type x 2 units Hydro-cone type x 2 units	Hydro-cone type x 2 units
3. Screen	Single deck ripple flow type 6 ft x 12 ft x 2 units 6 ft x 16 ft x 6 units 7 ft x 20 ft x 6 units	Single deck ripple flow type 6 ft x 12 ft x 2 units 7 ft x 20 ft x 2 units
4. Belt conveyor	750 mmW x 300 t/hr x 14 units 900 mmW x 500 t/hr x 2 units 1,200 mmW x 800 t/hr x 4 units 1,600 mmW x 800 t/hr x 8 units	750 mmW x 300 t/hr x 4 units 1,600 mmW x 800 t/hr x 4 units

Item	Specification	
	Stage I	Stage II
5. Sized ore bunker	Storage capacity: 300 t x 9	
6. Dust collector	Bag filter: 6,000 m^3/min x 1	Bag filter: 2,000 m^3/min x 1
4) Building		
1. Electrical house and control room	Total floor area: 1,550 m^2	Total floor area: 800 m^2
2. Office and operator's house	Total floor area: 600 m^2	
5) Others		
1. Automatic sampler	Bucket type x 2 units	Bucket type x 1 unit
2. Rain gun car	Water tank capacity: 10 m^3 x 2 units	
3. Crane	Bridge type: 10 t x 1 unit	

(2) Equipment flow chart and layout

Figure 13-4-3 shows flow of material while Figure 13-4-4 shows layout.

(3) Relation with stage II facilities

In stage I, raw material facilities are limited to necessary minimum to save the investment and handling cost. Therefor, in stege II, handling equipments such as belt conveyor, stacker, reclaimer etc. shall be expanded to meet necessary capacity. As for the area of raw material yard, no large scale expansion is necessary even for the twice of raw material demand. Also, blending yard and sizing plant will be increased their capacity with a limited additional investment.

In total, necessary investment of stage II will be much less than that of stage I.

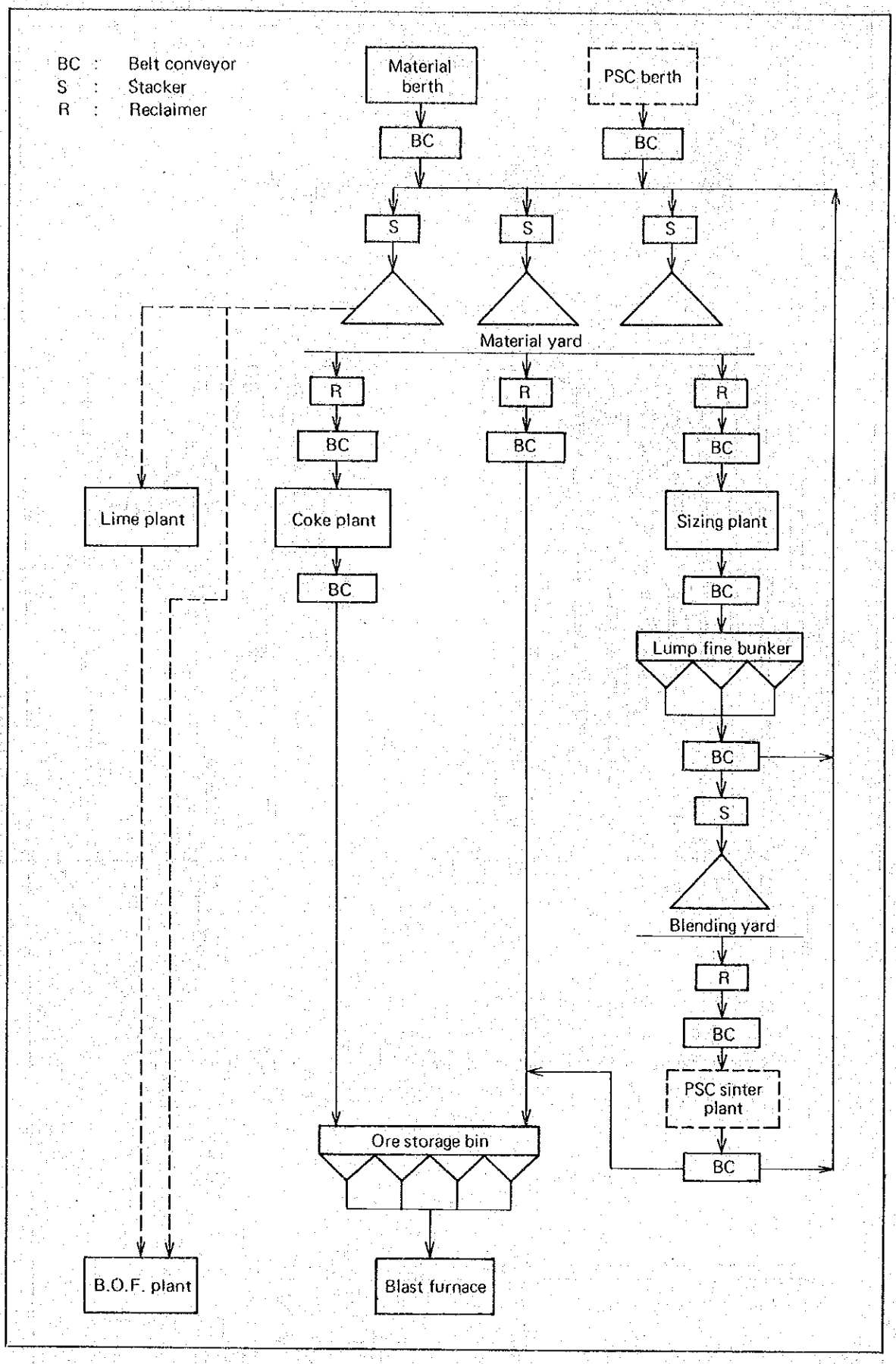


Fig. 13-4-3 Material treatment flow chart

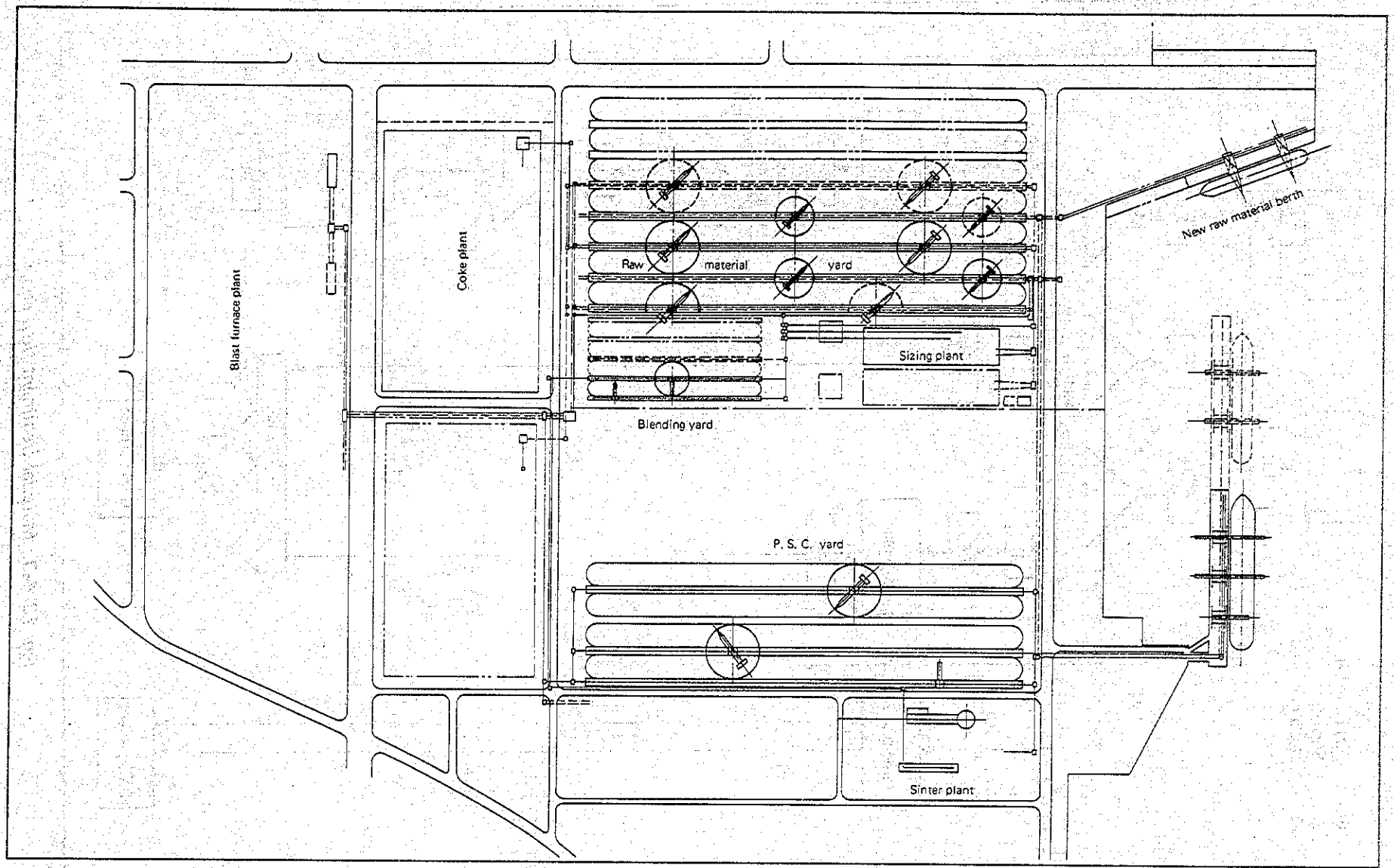


Fig. 13-4-4 Raw material handling facilities

13-4-4 Technical explanation

(1) Rawmaterial yard area

The area required for materials is determined to some extent by the number of brands, consumption, size of the received lot, and fluctuation of the arrival time. Concretely, the area now provided for will be enough for normal volumes of one vessel each for all imported materials and some extra volumes for compensation of arrival schedule fluctuation.

That is to say, even if the volume of material increases if the brands and ship sizes do not increase, enlargement of the yard will not be necessary. On the other hand, when numbre of brands and/or size of vessels increase, storage area must be expanded.

(2) Yard receiving conveyor

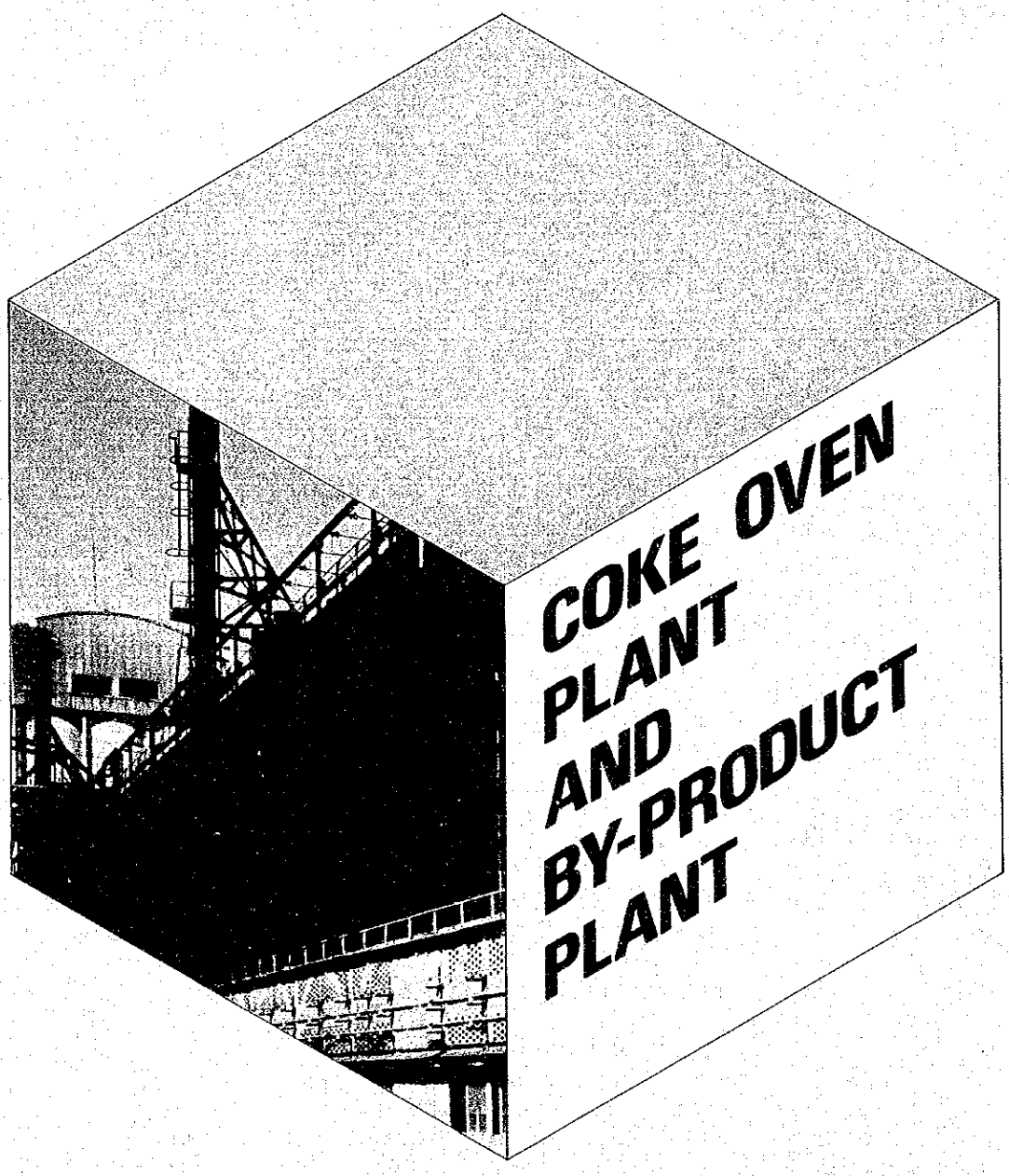
In relation to the berth capacity, in stage I, iron ores were mainly handled at the PSC berth, as well as other materials were handled mainly by the new materials berth. For both of the berth and their use, they will be very busy and easy to make demmurage. It is necessary to consider certain aspects for the entrance and berthing of ships. In order to avoid the demmurage, the berthing of small size ore ships at the new berth and coal and other material carrying ships berthing at the PSC berth must be considered as a possibility. A conveyor system must be planned so that materials can be carried from the respective berths to the specified areas of raw material yard. In stage II, with an extension of the PSC berth, 2 ships can be berthed at the same time. The conveyor system for receiving materials is expanded so that two brands of material can be simultaneously carried. There are many cases where 2 brands are carried from 2 different lines, and coal unloading time will be reduced. For this reason, the new material berth will have an additional conveyor line in the future.

(3) Conveyor line to the blast furnace storage bin

Usually the conveyor which supplies material to the ore storage bin is separated such as the sinter conveyor and other material conveyor. Since there is no sinter plant exclusively used for new steel works in stage I, the establishment of the sinter conveyor should be put off so that there is only 1 line of travel for the material going to the ore storage bin.

In stage II, demand for sintered ore will become greater. A new sinter plant for exclusive use of the steel works will be necessary and sintered ore should be carried directly to the blast furnace. To make this possible, an exclusive conveyor for carrying sinter will be built.

CHAPTER 13-5



13-5 Coke oven plant and by-product plant

13-5-1 General

The coke plant will be capable of producing all the quantity of coke to be used at the blast furnace — with one battery of coke ovens. The coke oven was given a precondition that the necessary amount of coke can be produced by one team. With consideration of the workers' load and economy, large coke oven with 6^{m} height has been determined. The by-product plant is to collect COG tar, light oil, that is minimum by-products, to aim to reduce facilities cost. Ammonium sulfate facility will be established in stage II.

The environmental-control equipment are planned to be installed with biological treatment facility that treats waste water generated from the coke oven and by-product plant, dust collector for charging car, coke guide car, crusher, coke cutter, coke screen, smokeless charge equipment for reducing operator's load and for dust prevention.

Sulphur and ammonia compounds are contained in the coke oven gas. Ammonia compounds can be eliminated by ammonia decomposition system or ammonia sulfate system. However, the desulphurization equipment is not built, but should be planned so as to be established in the future. In this plan, the layout is given consideration so that the coke dry quenching equipment can be built at stage II.

13-5-2 Preconditions

(1) Pre-process conditions

1) The facility plan is carried out in assumption that the size of raw coal supplied from the coal yard is below 50^{mm} and without mixture of foreign matter such as wood chips.

2) The BFG for the coke oven combution shall be planned in assumption that it is adjusted at the required calorie and supplied to coke ovens.

(2) Facility operation conditions

1) Coal blending conditions and coal handling quantities

Coal blending must be in such a blending ratio as to meet all the quality requirements (strength, ash content, sulphur content) necessary for the blast furnace. In this plan, this equipment is planned so as to be operated under the conditions that 5 kinds of coal are blended according to the *Table 13-5-1*.

Table 13-5-1 Coal blending plan

Coal type	Blending ratio (%)	First stage coal quantity		Second stage coal quantity	
		thsd. ton (dry)/y	thsd. ton (wet)/y	thsd. ton (dry)/y	thsd. ton (wet)/y
Low-volatitle U.S. coal	8	94.9	103.1	190.2	206.8
Medium-volatile U.S. coal	15	177.9	193.4	356.7	387.8
Australian hard coking coal	25	296.5	322.2	594.5	646.2
Australian medium coking coal	40	474.4	515.6	951.2	1,034.0
Australian soft coking coal	12	142.3	154.7	285.4	310.2
Total	100	1,186	1,289	2,378	2,585

2) Coke quality conditions

The coke quality supposed from the *Table 13-5-1* is shown in the *Table 13-5-2*.

Table 13-5-2 Coke quality expectation

Category	Percentage
Coke ash content	12%
Coke sulphur content	0.6%
Strength (drum index)	* $> DI_{15}^{150}$ 82%
Size	* > + 25 mm 90%

* Test samples are supplied from BF's coke bin.

3) Preconditions for operations

Since coke ovens, which from the main equipment of the coke and by-product plant, require continuous heating operations, so the 3-shift continuous operation mode will be taken. Operation hours by equipment of the coke and by-product plant are shown in *Table 13-5-3*. *Table 13-5-4* lists the rate of operation of major equipment.

Table 13-5-3 Operating hours of equipment

Equipment	Operating hours
Coal preparation equipment	18 hr/d
Coke oven	"
Coke transport equipment	"
By-product plant	Continuous for 24 hr

Table 13-5-4 Major equipment operating rate

Equipment	Rate of operation
Coke oven	* Average 145%
Belt conveyor	85%

* Rate of operation is set on the basis of high operation level.

4) Material yield

Yield and basic coefficient which are important factors for determining the equipment capabilities are shown in *Table 13-5-5*.

Table 13-5-5 Operational yield and coefficient

Category	Yield and coefficient	
Total coke yield	Against coal	74%
Breeze coke yield	"	11%
COG generating unit	"	320 Nm^3/t
COG generating peak ratio	—	1.20
Ammonia liquor generating unit	"	13%
Tar generating unit	"	3.5%
Light oil generating unit	"	0.9%
Steam consumption unit	"	33.2 kg/t
Standard heat consumption	"	630 kcal/kg

13-5-3 Equipment plan

Coke and by-product plant can be roughly divided into the following 6 equipment.

1) Coal preparation equipment, which crush, blend and carry coal released from the coal yard.
2) Coke oven facility, which treats coal for carbonization.
3) Coke transport equipment
4) Gas exhauster equipment, which handles gas and gas liquor generated from the coke oven.
5) Gas refining plant, which collects ammonia gas and light oil contained in the gas.
6) Biological treatment facility, which treats ammonia water and drainage from the by-product plant.

(1) Equipment specifications

Main specifications of each equipment are listed in *Table 13-5-6*.

(2) Process flow chart

Fig. 13-5-1 shows flow of materials in the coke and by-product plant.

Table 13-5-6 Equipment specifications

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
1. Coal preparation equipment				
(1) Coal receiving conveyor	1 system	Capacity: 500 t/hr Belt width: 1,050 mm Belt speed: 120 m/min		
(2) Surge hopper	2 units	Capacity: 90 t		
(3) Coal crusher	2 units	Capacity: 500 t/hr Type: Impact type (Gap remote control) Motor: 1,200 kw		
(4) Magnet separator		4 kw		
(5) Coal blending bin	16 bins	Capacity: 300 t/bin ($400\ m^3$/bin)	16 bins	Same as left
(6) Constant feed weigher	16 units	Capacity: 15–16 t/hr unit (Free adjusting)	16 units	Same as left
(7) Coal mixer	1 unit	Capacity: 300 t/hr	1 unit	Same as left
(8) Charging coal conveyor	1 system	Capacity: 300 t/hr Belt width: 900 mm Belt speed: 120 m/min	1 system	Same as left
(9) Charging coal bin	1 bin	Capacity: 1,200 t	1 bin	Same as left
(10) Dust collector for crusher	1 unit	Capacity: 600 m^3/min Type: Bag filter		
(11) Coal crusher room crane		Capacity: 20 t Span: 15 m		
(12) Coal preparation electric control center		First floor: 60 m^2 Second floor: 60 m^2 Building: 1		

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
2. Coke oven facility:				
(1) Coke oven	90 chambers	Coking chamber dim.: 6,000 x 430 x 15,800 mm (height x width x length) Effective inner volume: 36.0 m^3/oven Type: full under-jet type (compound system)	90 chambers	Same as left
(2) Stack	2 units	Stack height: 100 m	1 unit	Stack height: 100 m
(3) Charging car	2 units	Type: One point feeding type, equipped with oven-top cleaner and dust collector Coal feeding: Table feeder type	1 unit	Same as left Same as left
(4) Pusher machine	2 units	Type: One point pushing and leveling	1 unit	Same as left
(5) Coke guide car	2 units	Type: Movable grid type with dust collector	1 unit	Same as left
(6) Quenching car	2 cars	Capacity: 20 t	1 car	Same as left
(7) Electric locomotive	2 cars	Pulling capacity: 90 t	1 car	Same as left
(8) Quenching equipment	1 system		1 system	Same as left
(9) Quenching tower pump	2 units	Capacity: 800 m^3/hr	2 units	Same as left
(10) Gas reversing equipment	1 unit	Type: Hydraulic type	1 unit	Same as left
(11) Air blower for combustion	3 units	Capacity: 56,000 Nm^3/hr	3 units	Same as left
(12) Quenching tower	1 tower	Tower height: 40 m	1 tower	Same as left
(13) Dust collector for coke guide car	1 unit	Type: Bag filter Capacity: 4,500 m^3/min	1 unit	Same as left
(14) Charging car dust collector equipment		Type: Venturri type Capacity: 850 m^3/min		Same as left
(15) Water treatment equipment for above		Capacity: 4 m^3/min		
(16) Oven hoist	1 unit	Capacity: 2 t	1 unit	Same as left
(17) Door maintenance equipment	1 unit	Type: Lift type	1 unit	Same as left

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
(18) Butane gas generator for coke oven heating up	1 system	Gas generating capacity: 750 Nm^3/hr	1 system	
(19) Coke sub-center		First floor: 345 m^2 Second floor: 345 m^2 Building: 1		To be extended
3. Coke transport equipment				
(1) Coke wharf	1	Main dim.: 80 m x 9 m Coke holding amount: 8 chambers Angle of slant: 28 degrees	1	Same as left
(2) Coke transport conveyor	1 system	Capacity: 250 t/hr Belt width: 1,200 mm Belt speed: 90 m/min	1 system	Same as left
(3) Coke cutter	1 unit	Capacity: 120 t/hr	1 unit	Same as left
(4) Electric vibrating screen	1 unit	Capacity: 180 t/hr Screen mesh: 25–30 mm	1 unit	Same as left
(5) Breeze coke trasnport conveyor	1 system	Capacity: 70 t/hr Belt width: 800 mm Belt speed: 90 m/min		
(6) Coke storage bin	4 bins	Capacity: 150 t/bin (350 m^3/bin)	4 bins	
(7) Breeze coke bin	1 bin	Capacity: 180 t/bin (300 m^3/bin)		
(8) Coke wharf for stock coke	1 wharf	Main dimensions: 10 x 5 m Coke holding amount: 25 t	1 wharf	Same as left
(9) Dust collector for coke cutter	1 unit	Capacity: 700 m^3/min Type: Bag filter		
(10) Dust collector for screen	1 unit	Same as above		
(11) Dust collector for coke storage bin	1 unit	Capacity: 700 m^2/min Type: Bag filter		
(12) Coke cutter room	1 building	Building area: 220 m^2		
(13) Coke screen room	1 building	Building area: 470 m^2		
(14) Maintenance hoist	2 units	Capacity: 2 t		

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
4. Gas exhaust equipment				
(1) Coke gas exhauster	2 units	Capacity: 52,000 Nm^3/hr Boosting pressure: 2,000 mmAq Motor: 600 kw	1 unit	Same as left
(2) Primary gas cooler	4 coolers	Gas treating capacity: 17,500 Nm^3/hr cooler Conductive face: 3,000 m^2/cooler Type: Indirect vertical water pipe type	4 coolers	Same as left
(3) Electric mist precipitator	1 unit	Gas treating capacity: 52,000 Nm^3/hr unit Dust precipitating cap.: over 90%	1 unit	Same as left
(4) Ammonia liquor pump flushing	3 units	Volume: 500 m^3/hr unit Head: 45 m (water column)	3 units	Same as left
(5) Decanter	2 units	Volume: 150 m^3/unit	2 units	Same as left
(6) Tar decanter	1 unit	Volume: 50 m/unit	1 unit	Same as left
(7) Ammonia liquor tank	1 unit	Volume: 120 m^3	1 unit	Same as left
(8) Tar tank	1 unit	Volume: 1,300 m^3	1 unit	Same as left
(9) Underground pit	1 unit	Volume: 250 m^3	1 unit	Same as left
(10) Gas exhauster room crane	1 unit	Capacity: 10 t	1 unit	
(11) Gas exhauster room		Building area: 670 m^2 (Including power room)		
5. Gas refining facilities				
(1) Final gas cooler	1 unit	Capacity: 52,000 Nm^3/hr Type: Spray type		Same as left (Place of establishment is behind ammonium sulfate equipment)
(2) Ammonia scrubber	2 units	Capacity: 52,000 Nm^3/hr Type: Packing type Ammonia removal rate: over 95%		
(3) Ammonia still	1 unit	Treating capacity: 30 m^3/hr	1 unit	Treating capacity: 20 m^3/hr
(4) Ammonia decomposition equipment	1 system	Capacity: Equivalent to ammonia absorbing liquid of 30 m^3/hr		

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
Waste heat recovering boiler Ammonia water cooler (5) Ammonia sulfate production equipment			1 system	Capacity: 35 t/d
(6) Ammonium sulfate warehouse				Storage capacity: 60 d Building area: 2,200 m^2 Building: 1
(7) Benzole scrubber	2 units	Gas treating cap.: 52,000 Nm^3/hr unit Type: Spray type	2 units	Same as left
(8) Light oil stripping equipment		Washing oil treating volume: 200 m^3/hr Dehydration tower: 1 unit Stripping still: 1 unit Depitching still: 1 unit Heating furnace: 1 unit Heat exchanger: 1 unit	1 unit	Same as left
(9) Washing oil tank	1 unit	Volume: 80 m^3	1 unit	Same as left
(10) Light oil tank	1 unit	Volume: 1,000 m^3	1 unit	Same as left
(11) Chemical by-product equipment electric control center		1st floor: 160 m^2 2nd floor: 160 m^2 Building: 1		
6. Biological treatment facility				
(1) Deamoniated liquor tank	1 unit	Volume: 700 m^3	1 unit	Same as left
(2) Aeration tank	3 units	Ammonia liquor treating capacity: 1,100 m^3/d Volume: 1,000 m^3/unit	3 units	
(3) Settling tank	1 unit	Volume: 1,400 m^3	1 unit	
(4) Sludge tank	1 unit	Volume: 200 m^3		
(5) Dehydrator	2 units	Treating capacity: 10 m^3/hr		
(6) Dehydrator room	1 unit	Building area: 40 m^2		

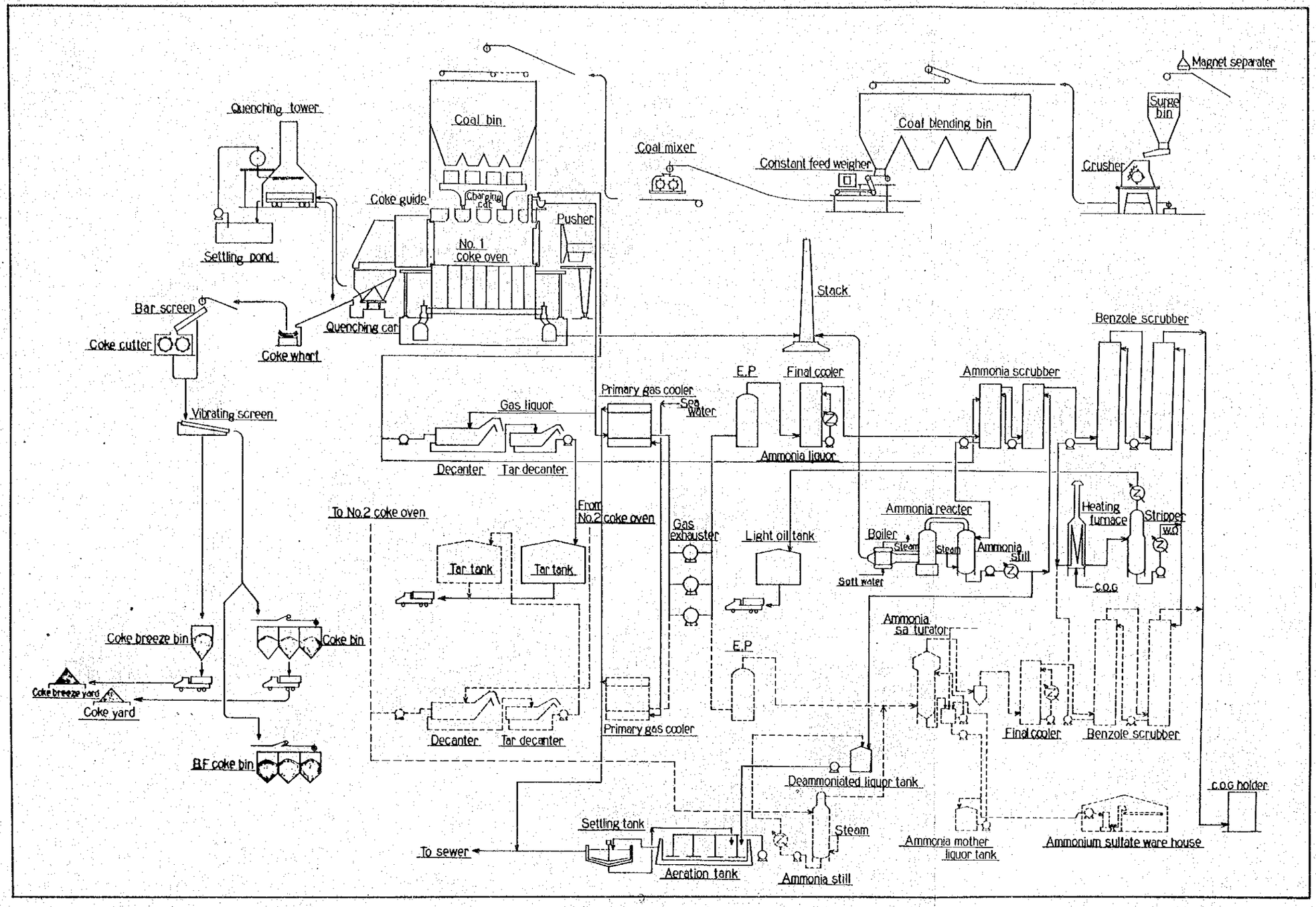


Fig. 13-5-1 Process flow

(3) Product and raw material balance

A flow and quantity blance of raw materials and products in the coke and by-product facilities is shown in *Fig. 13-5-2*.

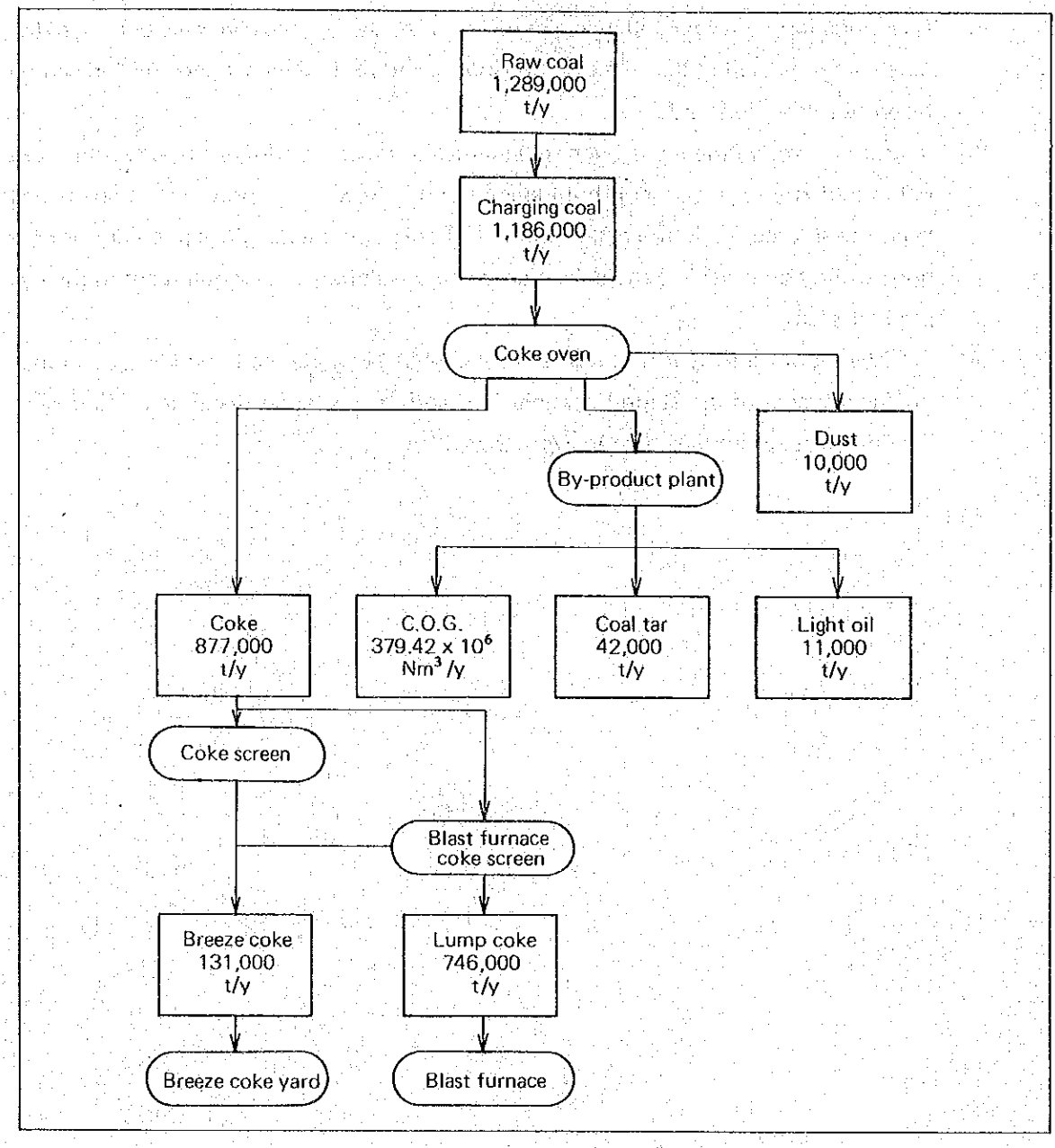


Fig. 13-5-2 First stage coke and by-product production balance