13-16 Main piping

13-16-1 General

The overall yard piping has been so planned and designed that blast furnace gas (BFG), coke oven gas (COG), and LD converter gas (LDG) produced from the new steelworks and oxygen gas (O_2), nitrogen gas (N_2), both produced at the oxygen plant, and heavy oil and steam can be used effectively at each stage of use.

The system consists mainly of large-diameter gas lines, upon which smaller pipe lines rest. The main gas pipings have been planned so that they can be in service through stage II of the project.

13-16-2 Equipment specifications

The main specifications of yard piping are provided in *Table 13-16-1*.

Table 13-16-1 Equipment specifications for yard piping

Line	Pipe diameter mmϕ	Line length m	Remarks
(1) BFG line			
Mains	3,600	1,200	
(2) COG line			
Mains (1)	1,700	1,100	
Mains (2)	800	200	
To LD	700	1,000	
To BF	400	800	
To pig casting machine	200	800	
(3) Mixed gas line			
Mains (1)	2,000	500	2,250 Kcal/Nm^3
Mains (2)	1,700	170	"
To hot strip mill	1,600	700	"
To billet mill	600	120	"
To cokes	2,300	200	1,000 Kcal/Nm^3
(4) LDG line			
To holder	2,300	150	
To power plant	1,000	1,500	
(5) Steam line			
Mains	300	250	
To B.F.	250	770	
To hot strip mill	200	1,100	
To cokes	150	80	
To billet mill	100	120	
To pig casting machine	80	600	
To main office	50	600	
To heavy oil tank	100	1,400	
To oxygen plant	50	100	
(6) BF blast line	1,700	800	
(7) Heavy oil line			
Mains	100	2,300	
To hot strip mill	80	1,100	
To billet mill	50	120	
(8) Oxygen line			
Mains	250	700	STP G38 sch40
To BOF	250	500	"
To BF	50	200	"
To pig casting machine	25	900	"
(9) Nitrogen line			
Mains	250	700	
To BOF	250	500	
To BF	250	200	
To hot strip mill	100	1,100	
To cokes	100	80	
To pig casting machine	25	900	
(10) Compressed air line			
Mains	25	700	
To BOF	25	500	
To BF	25	200	
To warehouse	25	400	

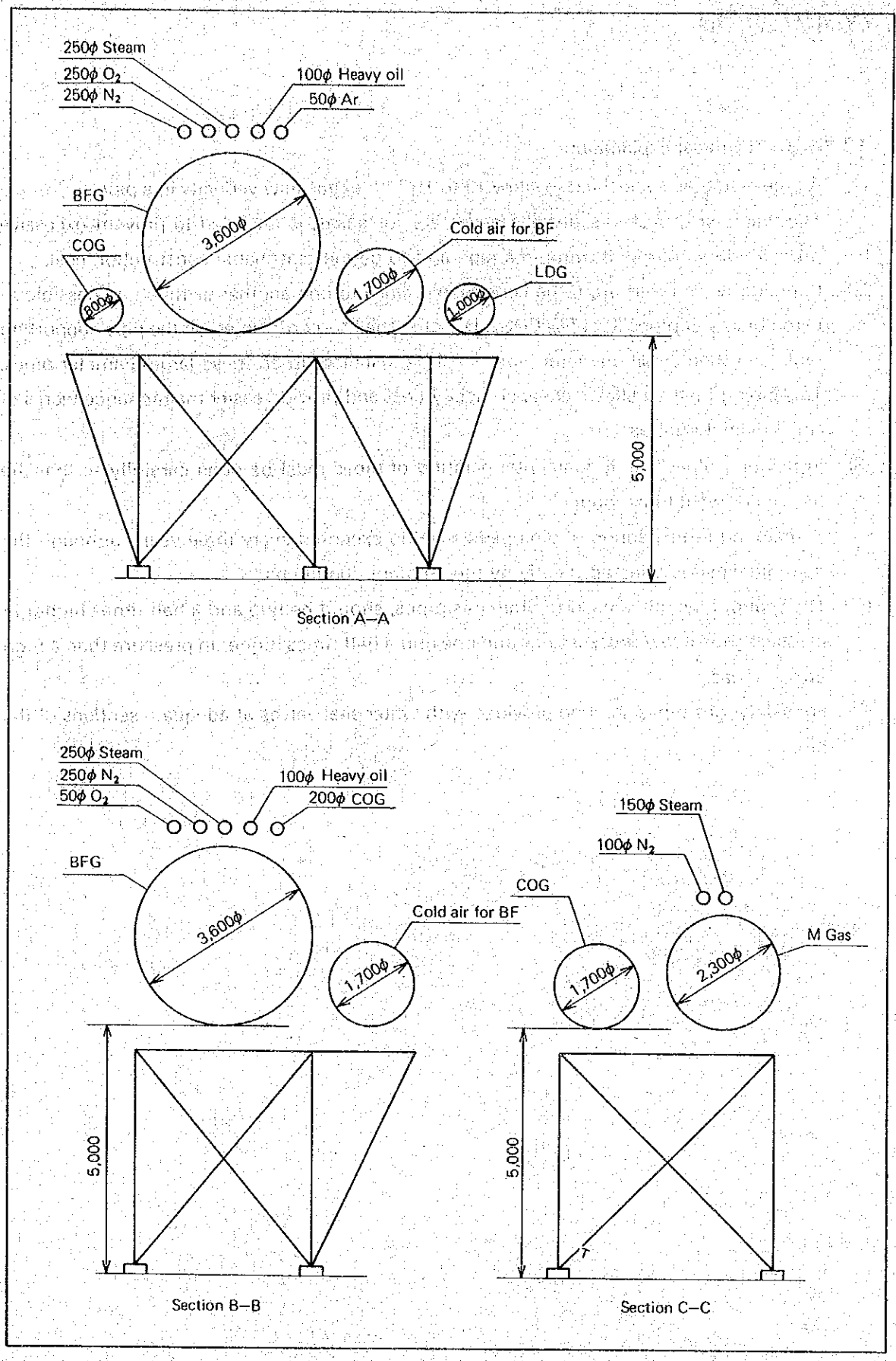

Fig. 13-16-1 Cross-section of pipe line

13-16-3 Technical explanation

(1) A pipe diameter is specified to allow 12 to 15$^{m/sec.}$ of gas flow verlocity in a pipe.
The diameter of pipes, especially necessary for gases, is intended to prevent excessive pressure-down of gas flowing in a pipe and to permit reasonable construction cost.

(2) In piping work, pipes are to be constructed close to one another as much as possible. Large-diameter pipes (for BFG, COG, LDG, etc.) shall be constructed on the pipe supporting table and then small-diameter pipes shall be installed up on these large-diameter pipes. This piping method allows cheaper facility cost and provide easier maintenance works of small-diameter pipes.

(3) In painting pipes, the fundamental painting of pipes must be done carefully so that the pipe paint would last longer.
Re-painting or inspection of pipe paint may be executed every three years, although the paint life span is affected greatly by the ambient conditions.

(4) The seal pot, which is used to drain gas pipes, should be two and a half times higher in pressure than a low pressure gas and one and a half times higher in pressure than a high pressure gas.

(5) For safety, gas pipes shall be provided with water seal valves at adequate sections of the pipe.

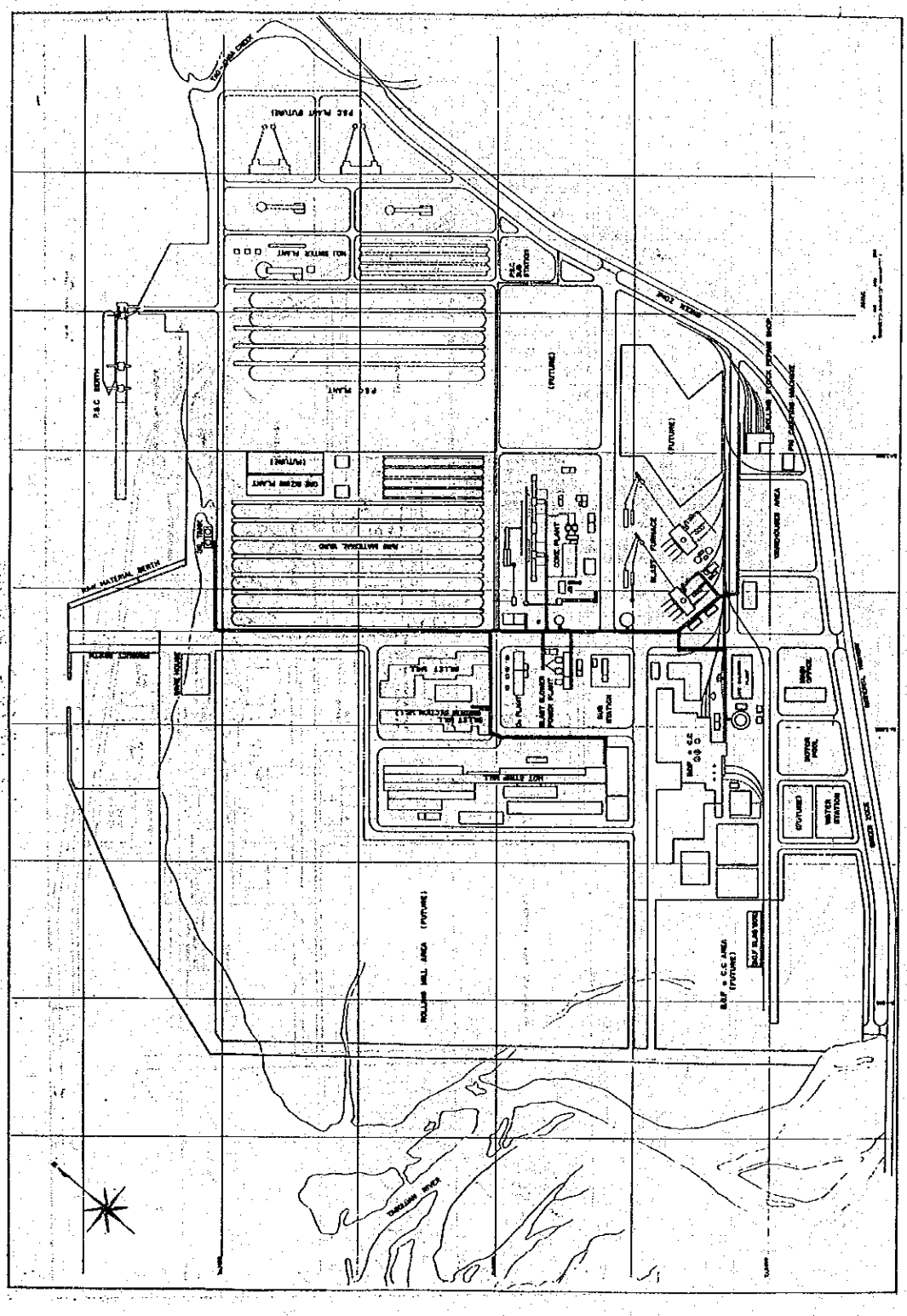

Fig. 13-16-2 General piping zone

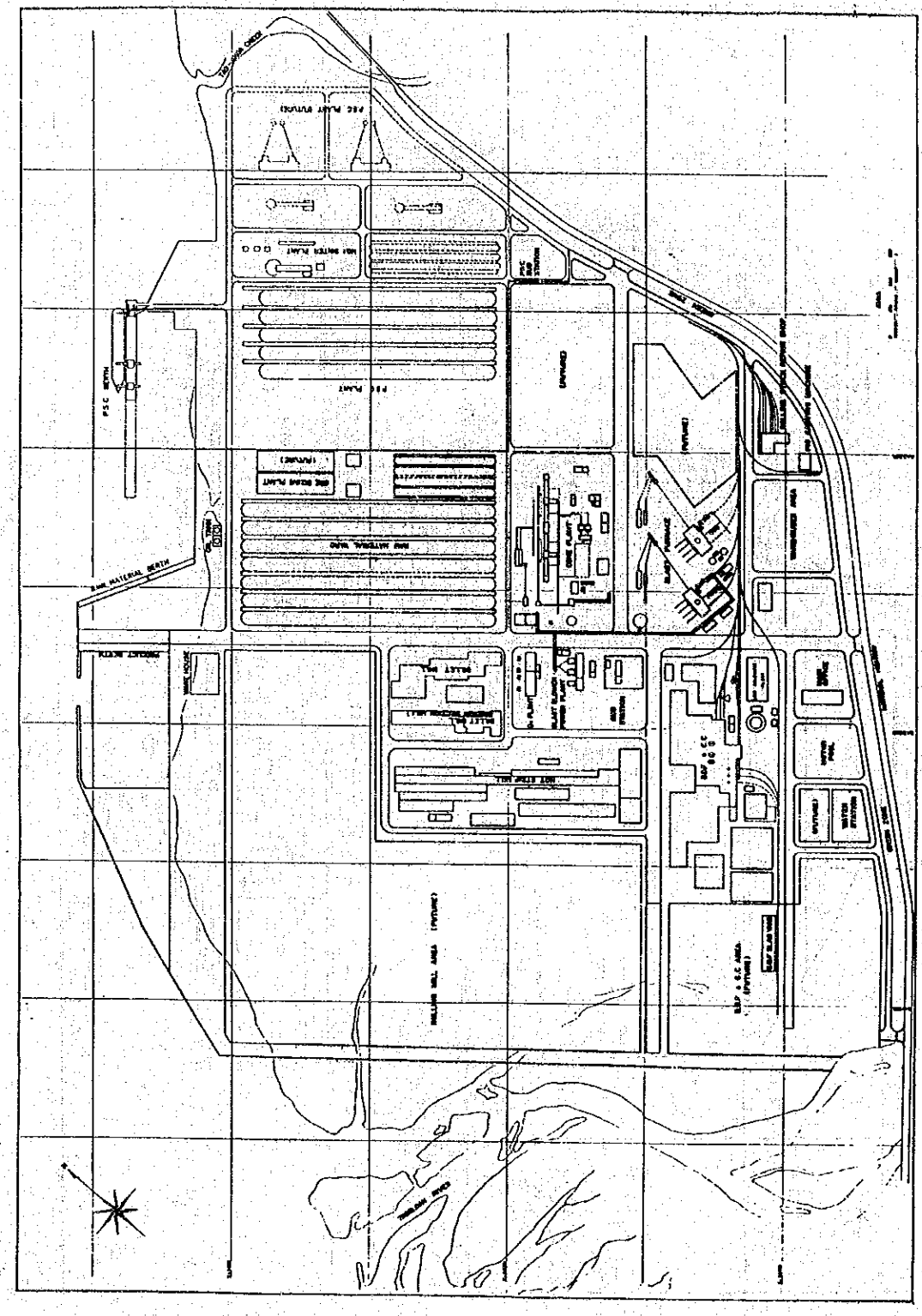

Fig. 13-16-3 BFG line

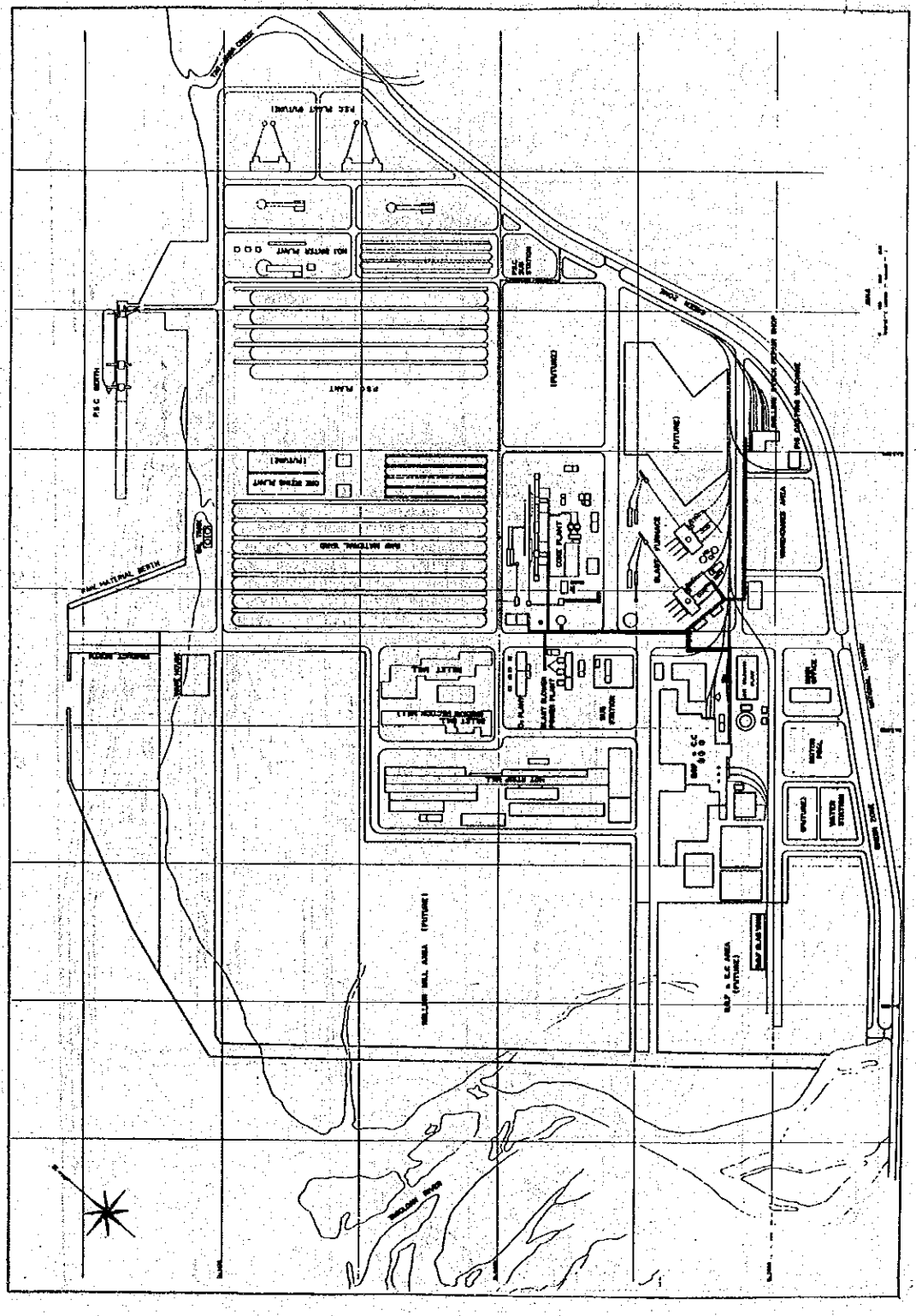

Fig. 13-16-4 COG line

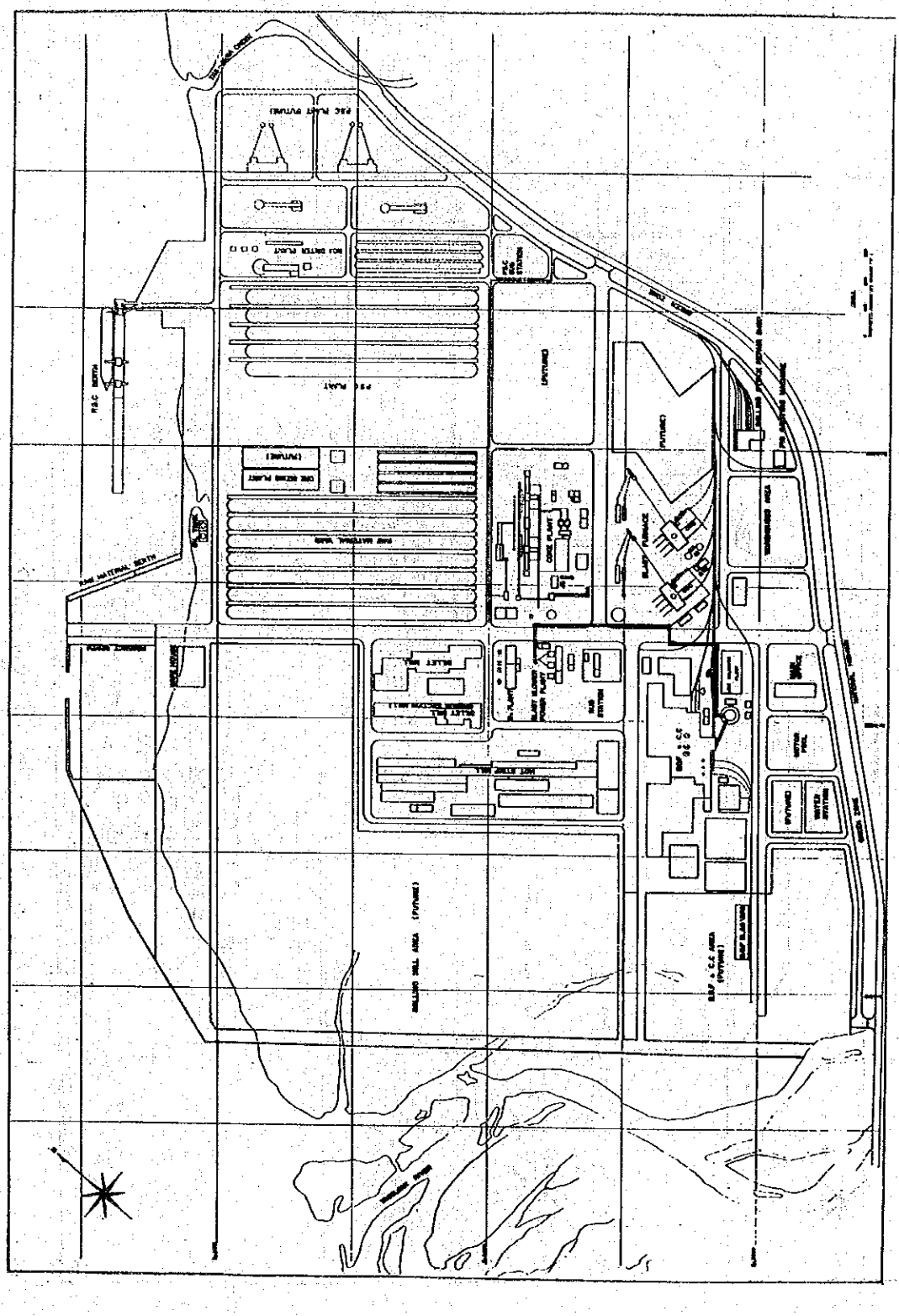

Fig. 13-16-5 LDG line

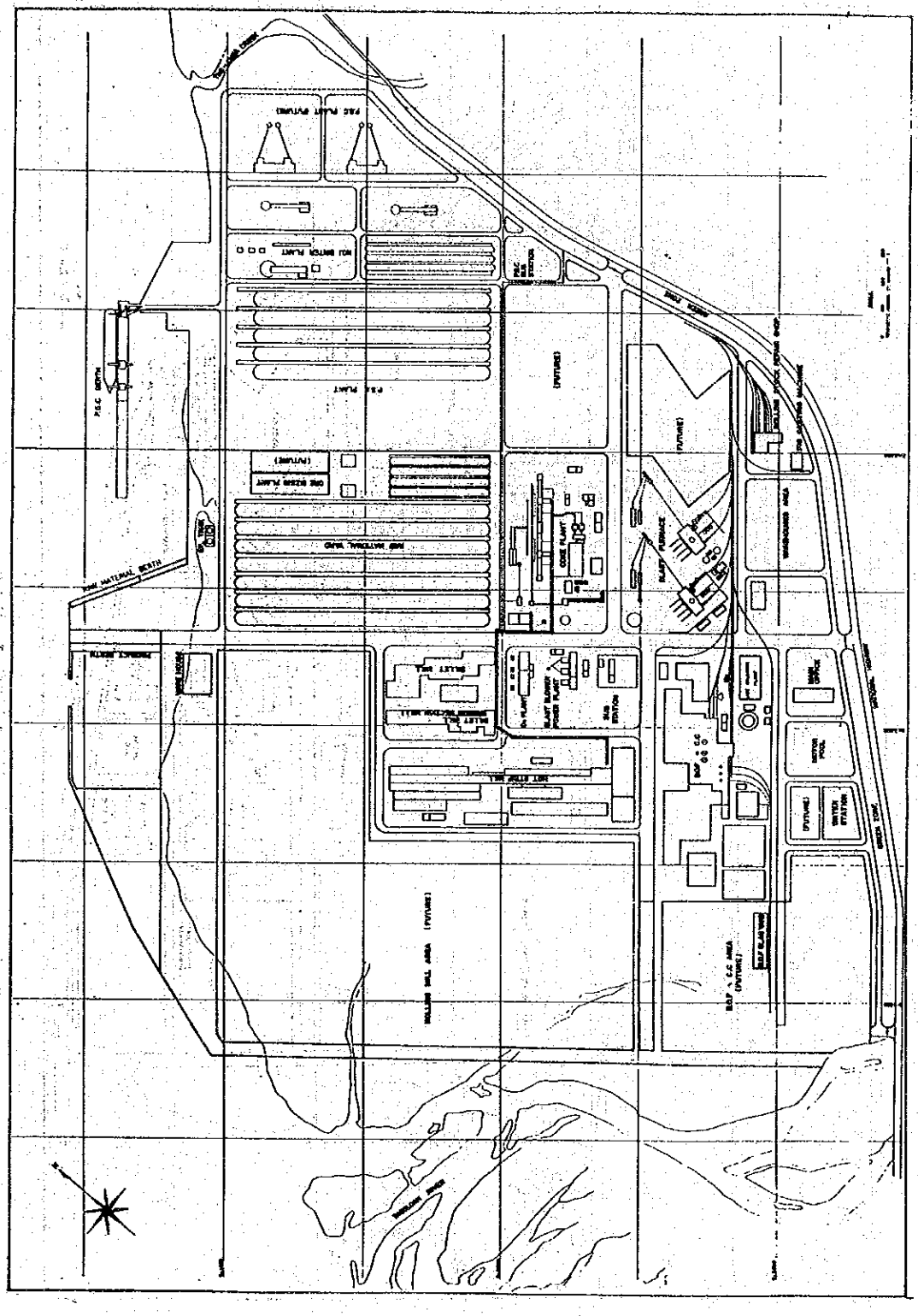

Fig. 13-16-6 Mixed gas line

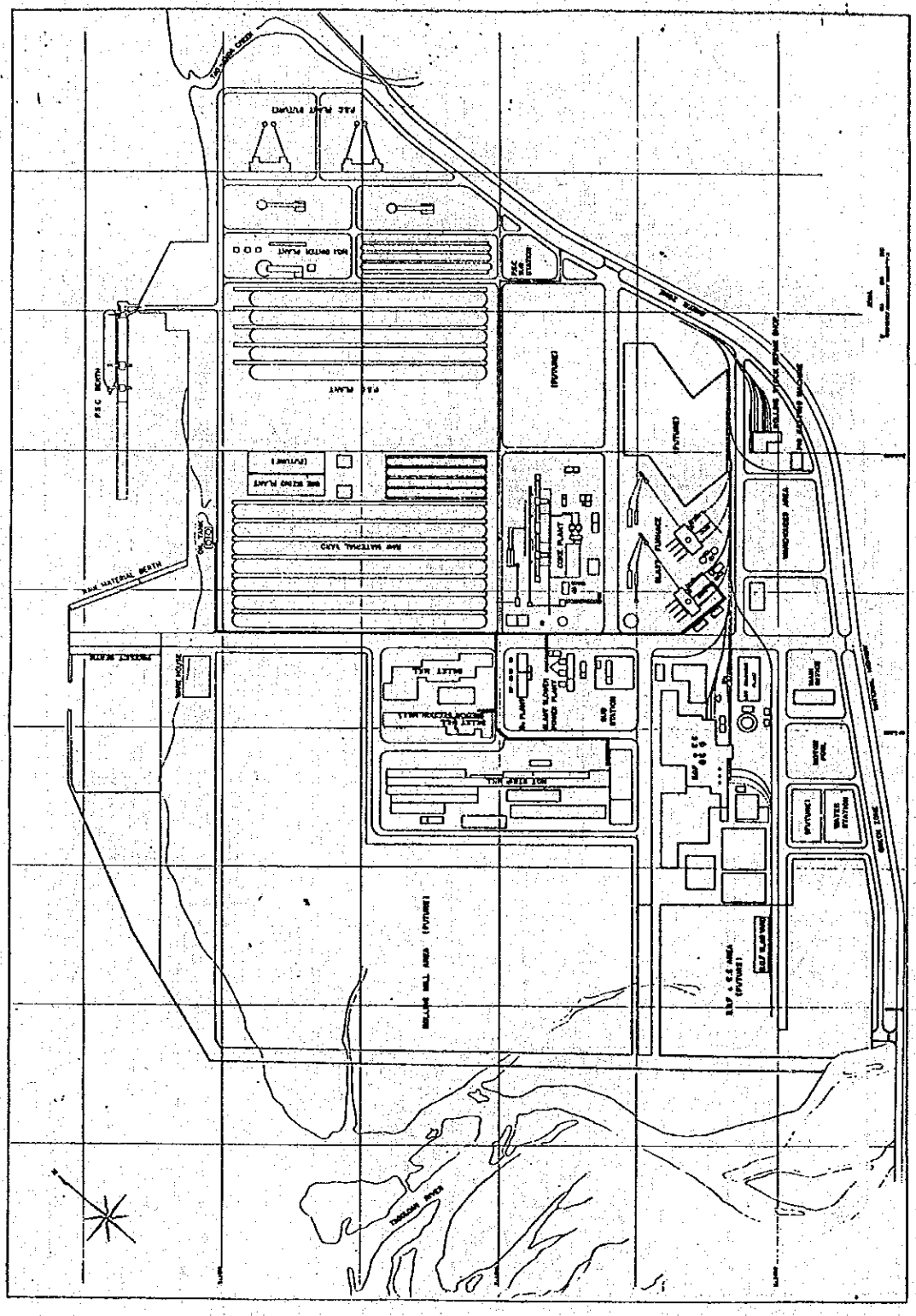

Fig. 13-16-7 Oil line

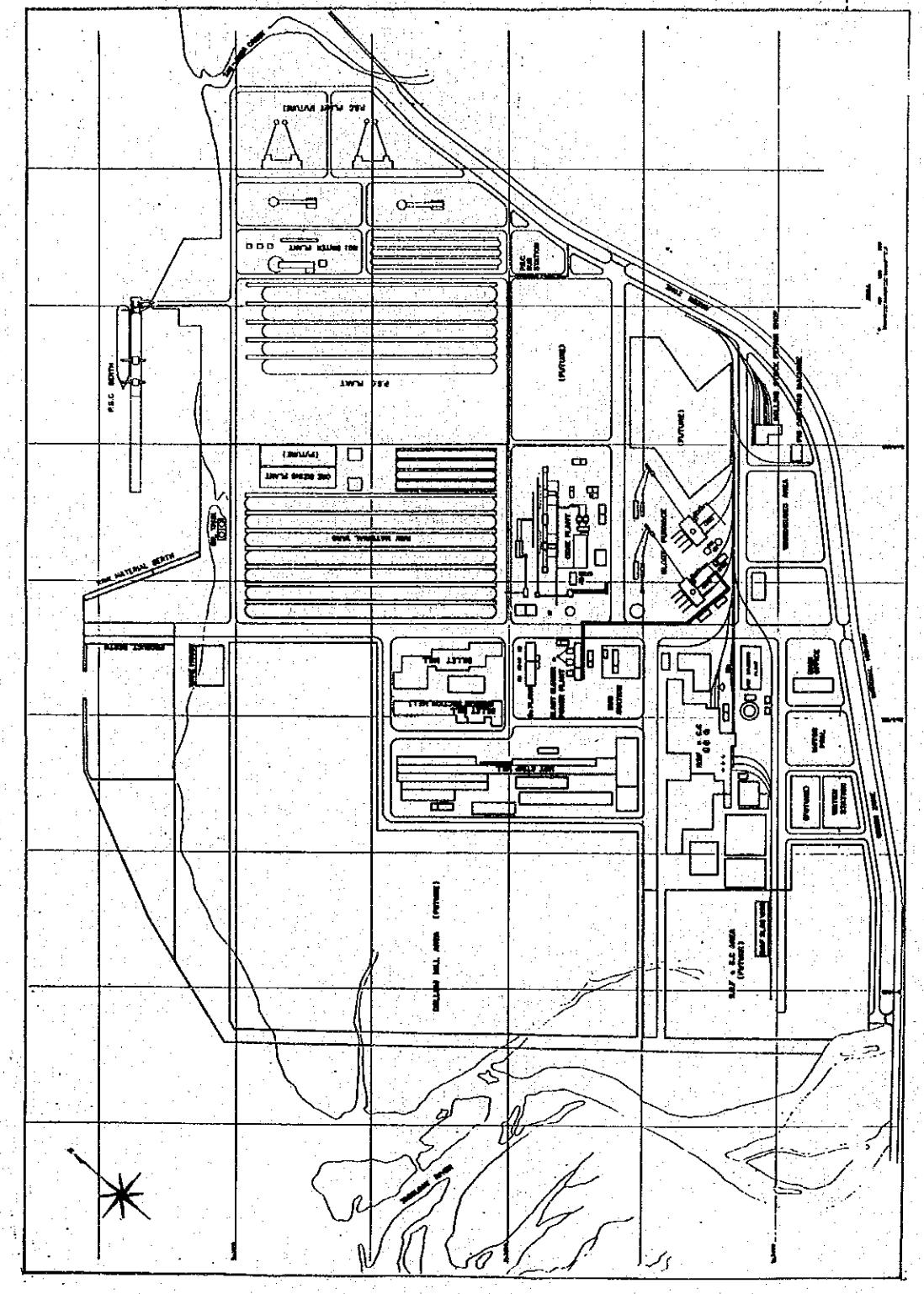

Fig. 13-16-8 Blast line

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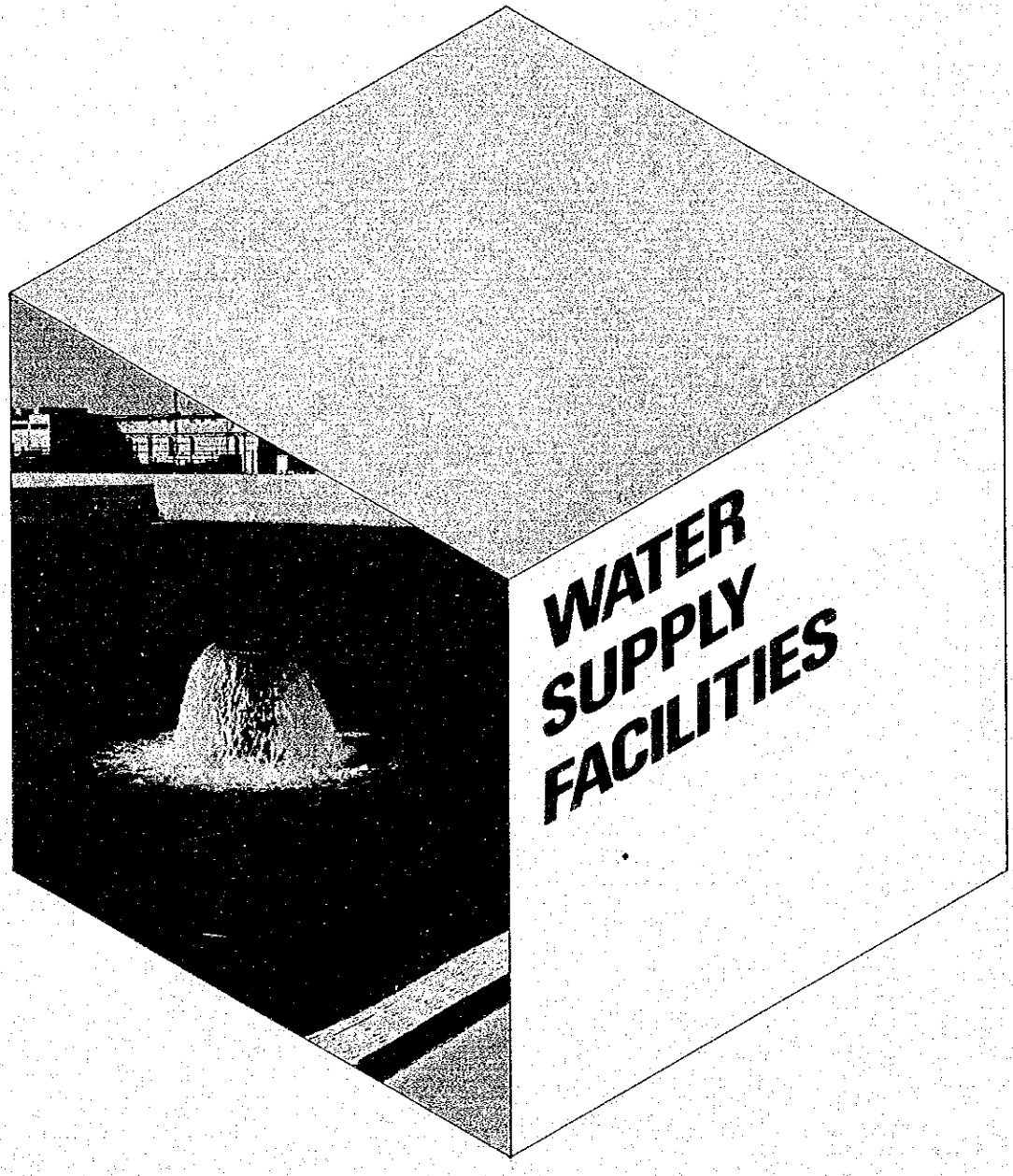


13-17 Water supply facilities

13-17-1 General

The water requirements of the new steelworks relies on two sources, river water and sea water. Water taken from the river first enters the reservoir. Next it is sent to the potable water/industrial water center, where it is treated in the coagulation sedimentation basin and separated into the industrial water system and potable water system.

The industrial water thus separated is distributed through an industrial water line via the head tank, to each water recirculation system for use as make-up water.

The potable water, on the other hand, filtered and sterilized with chlorine after being treated in the coagulation-sedimentation basin mentioned above, is distributed through a potable water line via the head tank as cooling and/or service water.

Sea water is taken from the sea area near the end of the new steel works and transported, after removal of rubbish by a travelling screen and sterilization with chlorine, and is distributed through a sea water line to the oxygen plant, coke by-product plant and the power station.

Moreover, diesel engine pumps are installed at industrial water system and sea water system for emergencies.

Table 13-17-1 Quantity of required water

(Unit: m^3/min)

No.	Plant name	Stage I			Stage II		
		I.W.	D.W.	S.W.	I.W.	D.W.	S.W.
1	Coke plant	1.70	0.11	32.2	3.47	0.14	64.4
2	B.F.	11.19	0.04	–	19.38	0.07	–
3	B.O.F.	3.25	0.56	–	6.50	1.13	–
4	Lime calcining	0.63	0.02	–	1.26	0.04	–
5	C.C.	4.92	0.13	–	9.84	0.25	–
6	Billet (1st)	0.58	0.22	–	1.32	0.23	–
7	Billet (2nd)	–	–	–	1.64	0.23	–
8	Hot strip mill	11.0	0.9	–	15.0	1.20	–
9	Main office	–	0.18	–	–	0.18	–
10	Power plant	0.5	0.01	300	1.2	0.01	520
11	O_2 plant	1.0	0.01	30.5	1.5	0.01	61.0
12	Scrap yard	0.12	0.18	–			
13	Raw material yard	0.6	–	–			
14	Ware houses	–	0.18	–			
15	Pig machine	–	0.12	–			
16	Yard office	–	0.06	–			
17	Coal berth	–	0.48	–			
18	Product berth	–	0.54	–			
	Total	35.49	3.74	362.7			

Remarks I.W. : Industrial water
D.W.: Drinking water
S.W.: Sea water

13-17-2 Preconditions

The quantity of water required by each system is shown in *Table 13-17-1.*

The quality and so on of water for each system is shown in *Table 13-17-2.*

Table 13-17-2 Quality and others of water

No.	Item	Conditions	
1	Industrial water	Raw water quality:	SS max. 1,000 mg/1 ave. 30 mg/1 PH 5.8 – 8.6
		Quality of treated water:	SS max. 15 mg/1 PH 5.8 – 8.6 Other variables should be in accordance with Japanese standards for industrial water quality.
		Water temperature:	29 ± 5°C
2	Drinking water	Raw water quality:	SS max. 15 mg/1 PH 5.8 – 8.6
		Quality of treated water:	Turbidity – not more than 2°, PH 5.8 – 8.6 Other variables should be in accordance with Japanese standards for potable water quality.
		Water temperature:	29 ± 5°C
3	Sea water	Sea water temperature:	Around 30°C
		Sea water level:	HWL + 1,280 LWL ± 0

13-17-3 Equipment plan

(1) Equipment specifications

Table 13-17-3 Specification

Item	Stage I	Stage II
(1) Water reservoir facilities	$150^{m} \times 100^{m} \times 6^{mH}$ x 1 reservoir Semi-underground $90{,}000^{m^3}$ HWL GL + 600^{mm} LWL GL – $5{,}400^{mm}$	Constructed in stage I so as to supply the quantity of water that will be used in stage I and II.
(2) Potable water/industrial water center facilities		
1) Coagulation sedimentation basin	$2{,}500^{m^3}$ x 1 basin (with declined parallel plates)	Same as at left
2) Treated water tank	$1{,}500^{m^3}$ x 1 tank	"
3) Filtration tank	$5^{m} \times 10^{m} \times 5^{mH}$ x 1 tank	"
4) Potable water storage tank	$1{,}000^{m^3}$ x 1 tank	"
5) Sterilizing equipment	1 set	"
6) Head tank (for industrial water)	200^{m^3} x 1 unit	"
7) Head tank (for potable water)	100^{m^3} x 1 unit	"
8) Pumps & others	1 set	"
(3) Potable water line	Piping & valve, 1 set	"
(4) Industrial water line	Piping & valve, 1 set	"
(5) Sea water intake facilities		
1) Water intake tower	$8^{m\phi} \times 2.5^{mH}$ x 2 units	Constructed in stage I so as to supply the quantity of water that will be used in stage I and II.
2) Screening facilities	1 set	
3) Water supply tank	$1{,}500^{m^3}$ x 2 tanks	
4) NaClO generator	1 set	
(6) Sea water supply facilities		
1) Pumps & others	1 set	Same as at left
2) Sea water line	Piping & valve, 1 set	"

(2) Water supply system figures

Figure 13-17-1 Industrial water supply system

Figure 13-17-2 Industrial water supply line layout

Figure 13-17-3 Potable water supply system

Figure 13-17-4 Potable water supply line layout

Figure 13-17-5 Sea water supply system

Figure 13-17-6 Sea water supply line layout

13-17-4 Technical explanation

(1) Water reservoir facilities

River water will enter into the reservoir by gravity from the intake of the river.

Retention time (Stage I) 38.2^{hrs}

(2) Potable water/industrial water center facilities (stage I only)

1) Coagulation sedimentation basin

Retention time 63.7^{min}

Settling velocity 0.1—0.2$^{m/min}$

2) Treated water tank

Retention time 38.2^{min}

3) Filtration tank (rapid filtration by gravity)

Rate of filtration 108$^{m/d}$

Filtration area 50$^{m^2}$

4) Potable water storage tank

Retention time 4.6^{hr}

5) Head tank (for industrial water 200$^{m^3}$)

Retention time 5.6^{min}

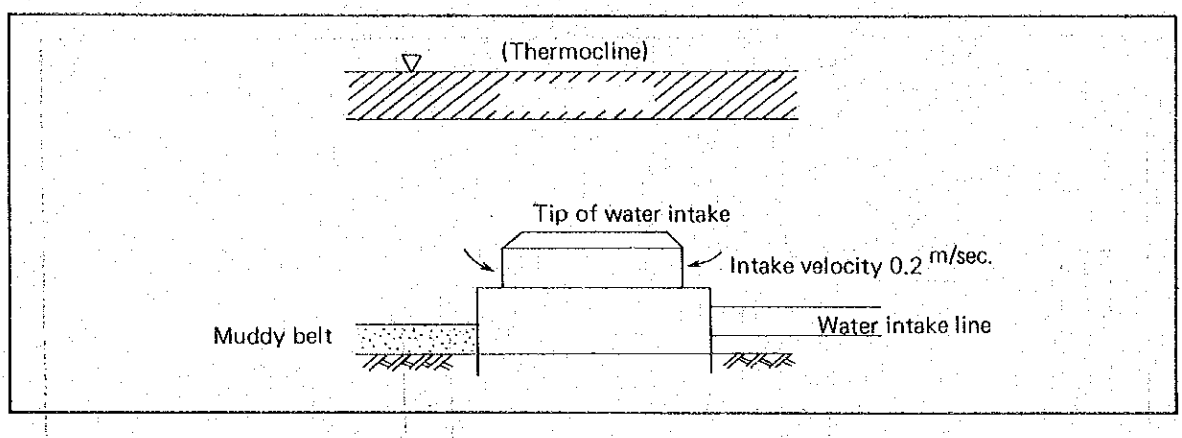
6) Head tank (for potable water 100$^{m^3}$)

Retention 26.7^{min}

(3) Sea water intake facilities

1) Deep zone sea water intake system. (Sea bottom intake pipe system)

The deep zone sea water intake system is employed to minimize the fluctuation of sea water temperature caused by hot drainage or the weather etc. Among the deep zone sea water intake systems, sea bottom intake pipe system will be used, which has little influence of suspended matter coming in and wave height.



2) NaClO generator

NaClO is generated by electrolyzing sea water and NaClO is used for chlorine sterilization.

(Reaction formula)

anode $2Cl^- \rightarrow Cl_2 + 2e^-$

cathode $2Na^+ + 2H_2O + 2e^- \rightarrow 2NaOH + H_2$

Reaction was made as follows inside the electrolysis tank.

$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$

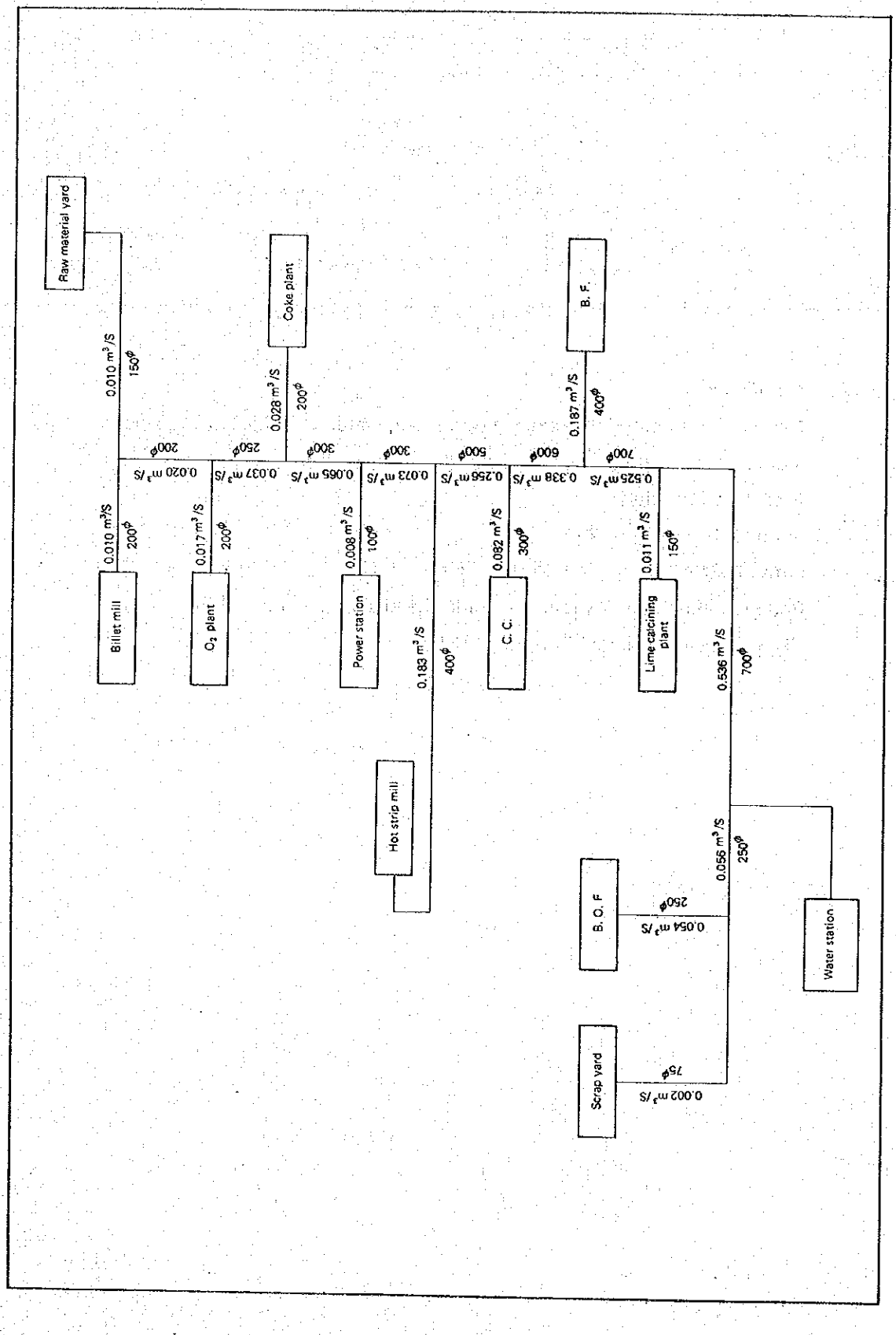


Fig. 13-17-1 Industrial water supply system

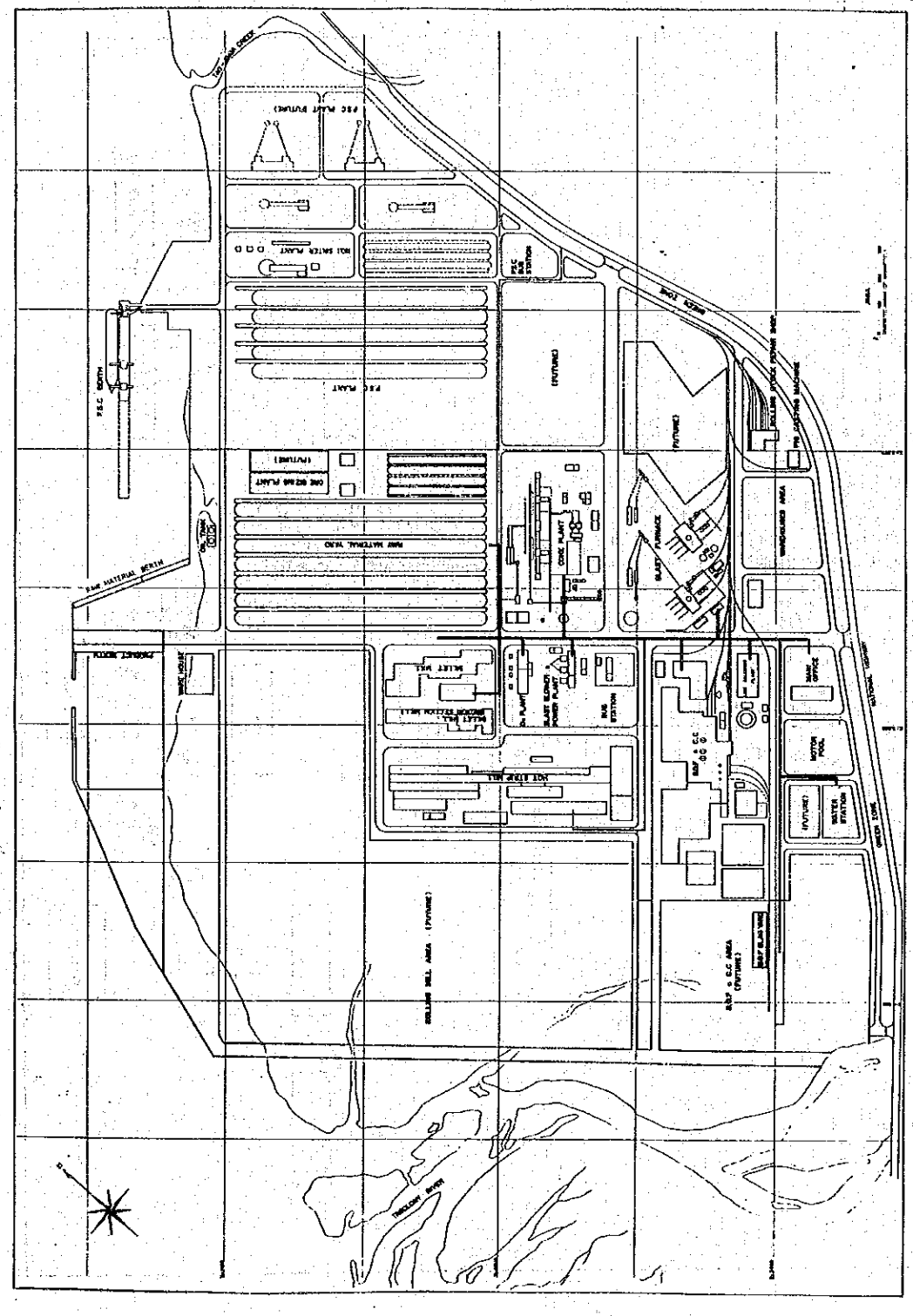


Fig. 13-17-2 Industrial water supply line layout

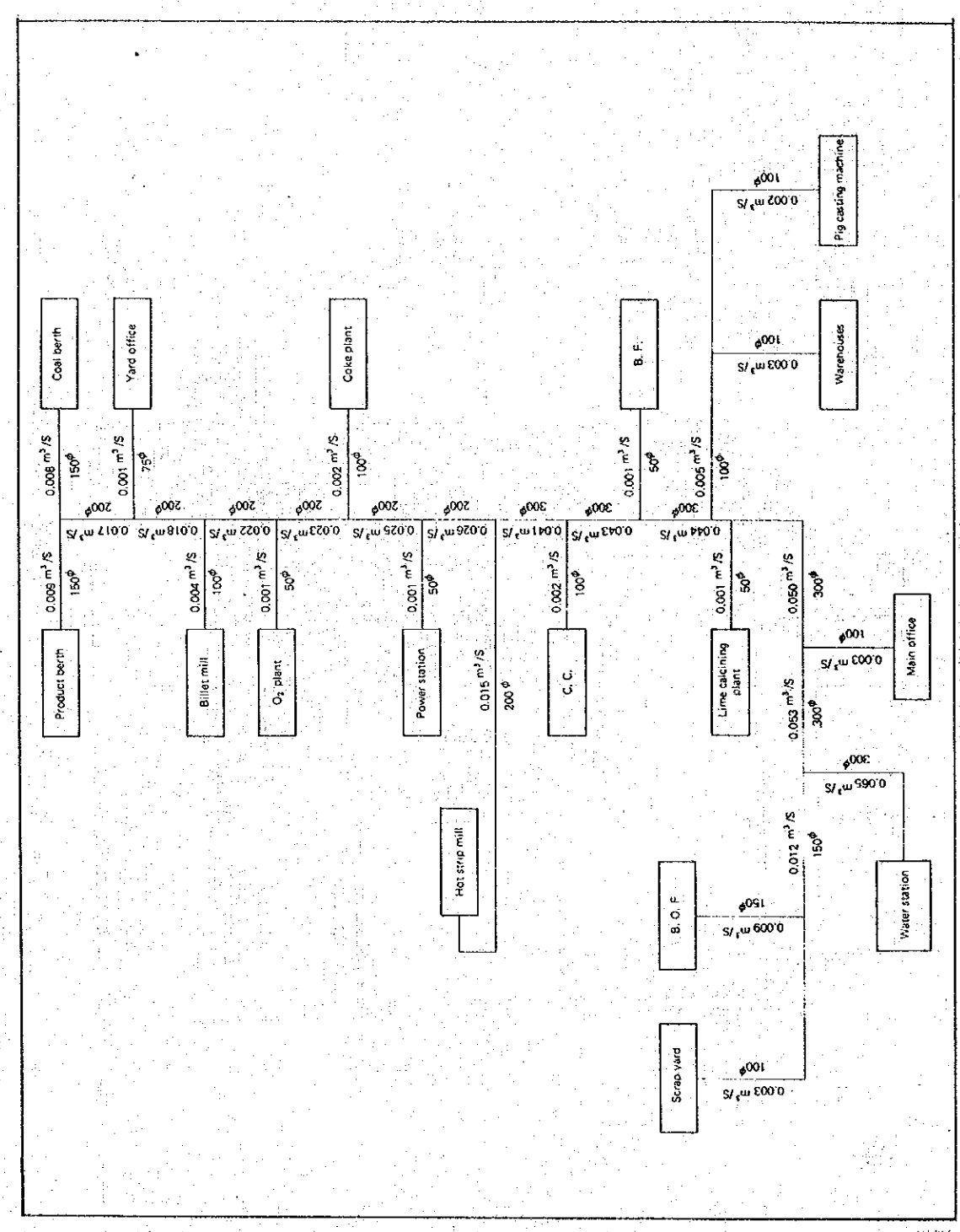


Fig. 13-17-3 Potable water supply system

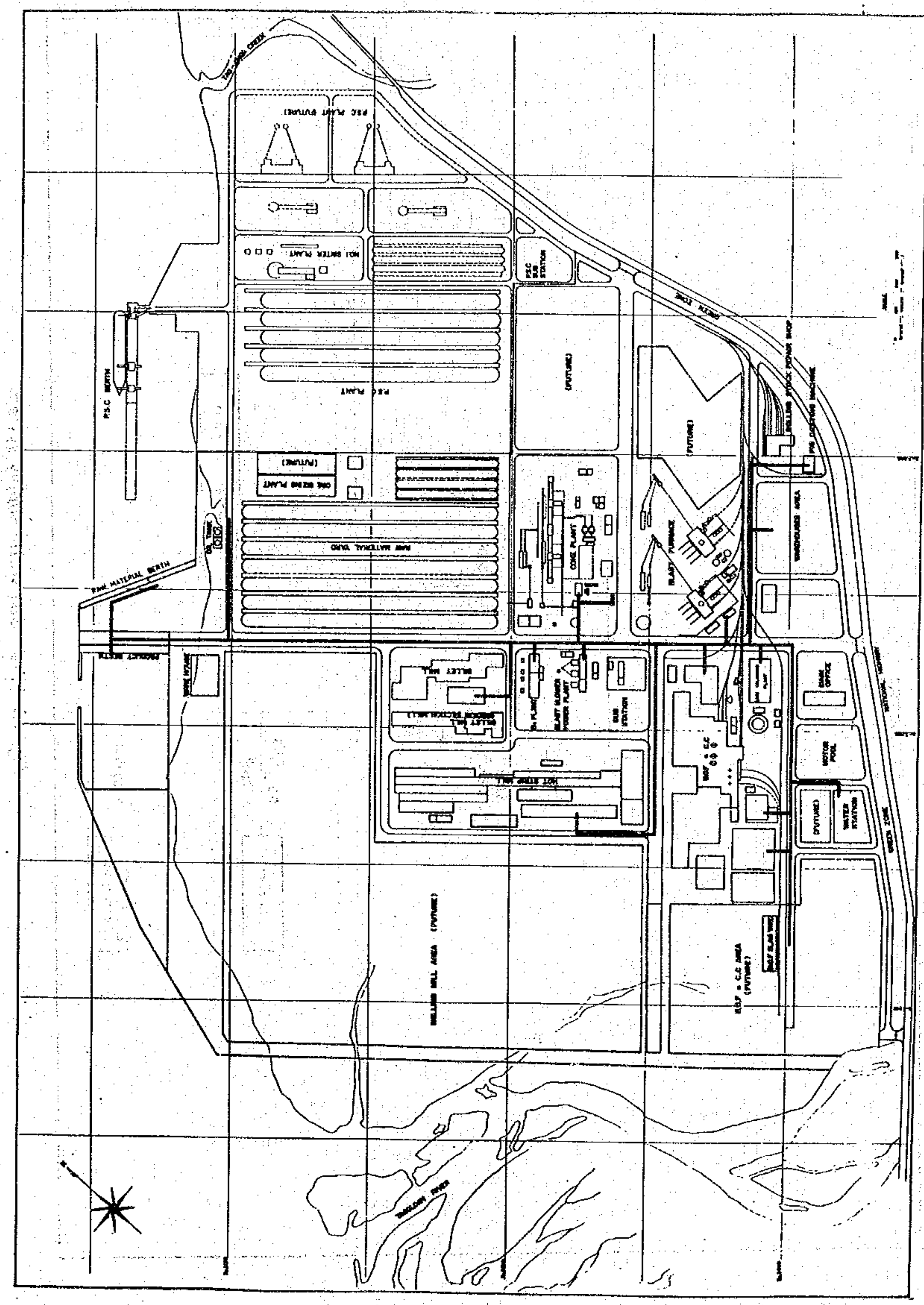


Fig. 13-17-4 Potable water supply line layout

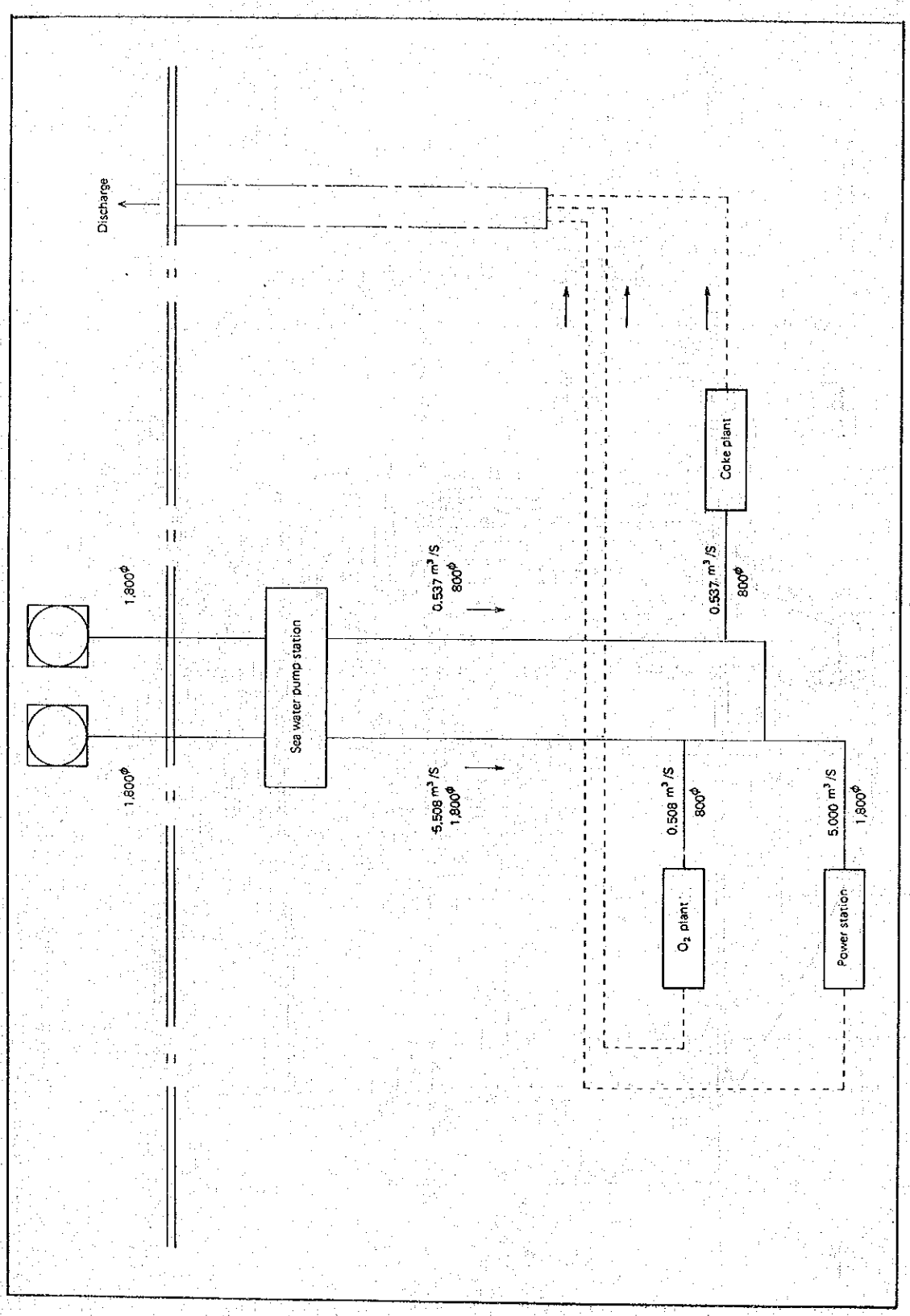


Fig. 13-17-5 Sea water supply system

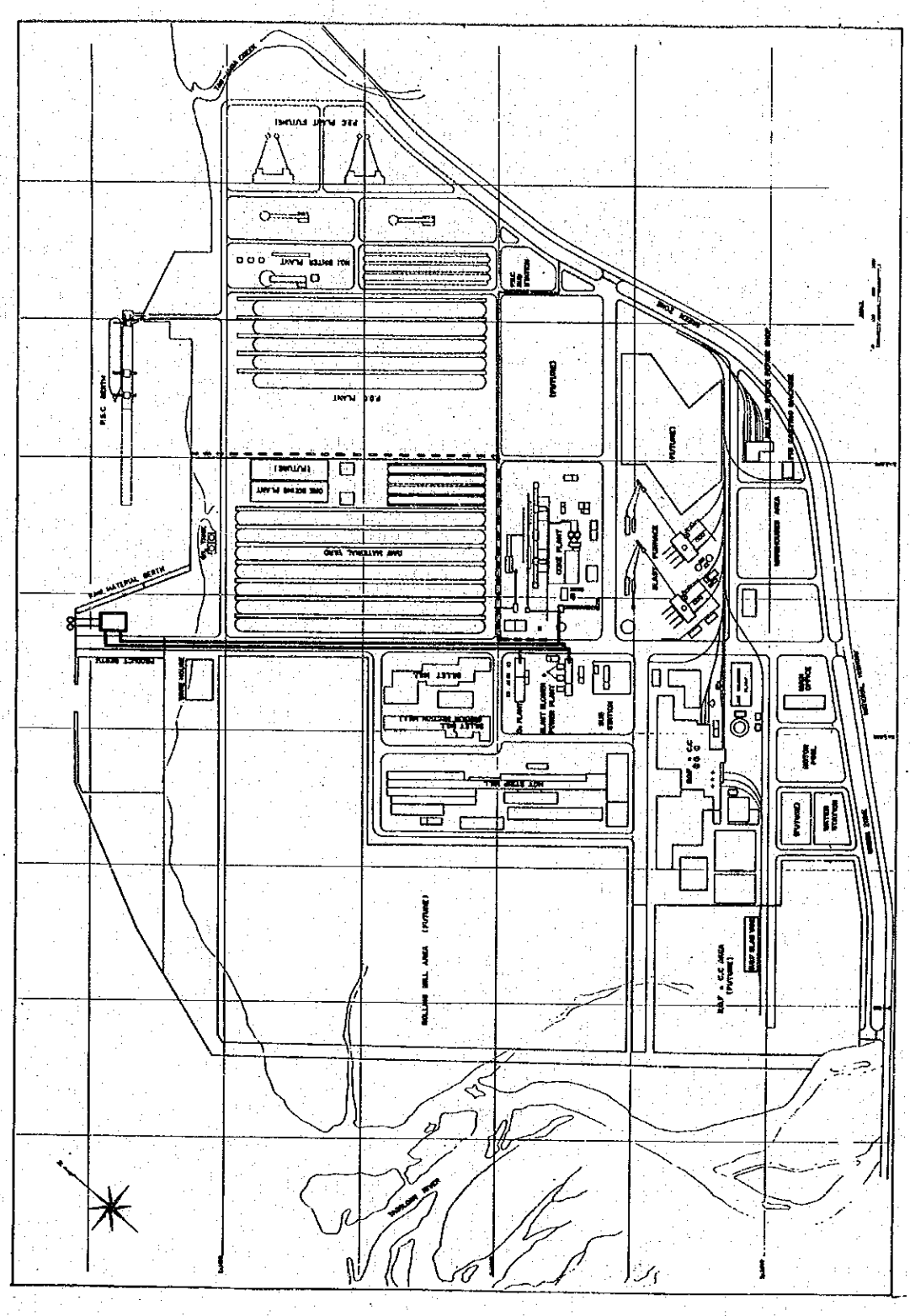


Fig. 13-17-6 Sea water supply line layout

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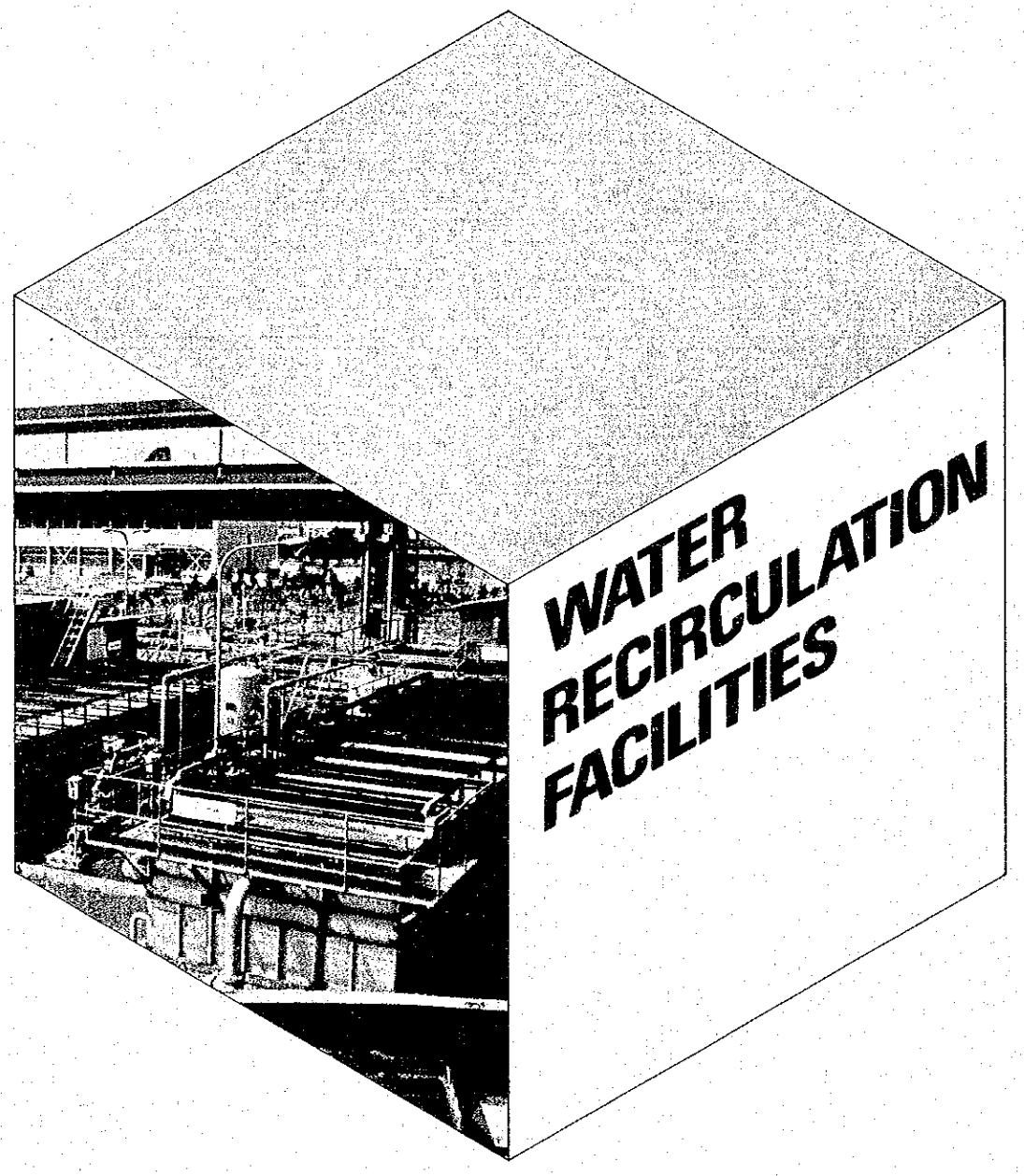


13-18 Water recirculation facilities

13-18-1 General

Fresh water to be used in each plant will be treated with independent water recirculating facilities installed in each plant for recirculation.

Recirculating water is roughly divided into the direct cooling water system and the indirect cooling water system.

In the direct cooling water system, return water from plants is high in both suspended solid content and water temperature. To cope with this, therefore, return water in the direct cooling water system will be treated as follows. It is first treated in the scale pit, sedimentation basin and filter to reduce the suspended solid content. Treated water is then collected in the return water pit and fed to the cooling tower to lower the water temperature. Since repeated recirculation increases salt concentration, some water is forcibly blown down.

In the indirect cooling water system, return water is not with suspended solids, unlike the direct cooling water system, so only the water temperature is raised. Return water in the indirect cooling water system is first collected in the return water pit and then fed to the cooling tower to lower water temperature. Cooled water is fed to the feed water pit where it is pumped to each plant. In the indirect cooling water system, too, repeated recirculation increases the salt concentration, so some water is forcibly blown down. As a rule, water recirculation facilities will be operated automatically, but the feed pumps for plants will be remote controlled from the operation room in the plants. The water recirculation facilities will be monitored from the operation room of each plant. The dehydrater will be operated from the operation room of the dehydrater which will be installed in the water recirculation facilities. In plants where emergency water supply is required, elevated tanks and diesel engine pumps will be installed.

The water recirculation facilities installed in stage I has only capacity appropriate for stage I.

13-18-2 Preconditions

Table 13-18-1 Shows preconditions for return water equipment.

Table 13-18-1 Pre-condition for recirculation water

Items	Stage I	Stage II
Water recirculation facilities for coke oven and coke by-product plant		
(1) Coke oven plant		
1) Quenching tower	Amount of recirculating water: 270 m^3/hr Suspended solids (hereinafter referred to as 'SS') in recirculating water: 100 ppm Feed water temperature: 90°C Return water temp.: 90°C Feed water pressure: 2 kg/cm^2	540 m^3/hr
2) Machinery cooling	Amount of water recirculating: 70 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 40°C Feed water pressure: 3 kg/cm^2	130 m^3/hr
3) Dust collection water for larry car	Amount of recirculating water: 110 m^3/hr SS in recirculating water: 100 ppm Feed water temperature: 60°C Return water temp.: 60°C Feed water pressure: 2 kg/cm^2	210 m^3/hr
4) Miscellaneous water	Amount of feed water: 60 m^3/hr Feed water temperature: 35°C Feed water pressure: 2 kg/cm^2	60 m^3/hr
(2) Coke by-product		
1) Machinery cooling	Amount of recirculating water: 80 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 40°C Feed water pressure: 2 kg/cm^2	150 m^3/hr
2) Metal cooling	Amount of feed water: 20 m^3/hr Feed water temperature: 35°C Feed water pressure: 1 kg/cm^2	40 m^3/hr
Water recirculation facilities for blast furnace		
(1) Cooling system for tuyeres, etc.		
1) Cooling of tuyeres, etc.	Amount of recirculation water: 2,600 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 41°C Feed water pressure: 5 kg/cm^2	5,200 m^3/hr
2) Cooling of cooling plate	Amount of recirculating water: 1,600 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 41°C Feed water pressure: 5 kg/cm^2	3,200 m^3/hr
3) Cooling of hot blast valve	Amount of recirculating water: 700 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 41°C Feed water pressure: 5 kg/cm^2	1,400 m^3/hr

Items	Stage I	Stage II
4) Miscellaneous water	Amount of recirculating water: 500 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 35°C Return water temp.: 41°C Feed water pressure: 5 kg/cm^2	1,000 m^3/hr
(2) Hearth bottom cooling	Amount of recirculating water: 1,500 m^3/hr SS in recirculating water: 20 ppm Feed water temperature: 50°C Feed water pressure: 2 kg/cm^2	3,000 m^3/hr
(3) Dust collection system		
1) Dust collection water	Amount of recirculating water: 1 vs 850 m^3/hr, 2 vs 850 m^3/hr SS in recirculating water: 100 ppm Feed water temperature: 35°C Return water temp.: 45°C Feed water pressure: 8 kg/cm^2	1 vs 1,700 m^3/hr 2 vs 1,700 m^3/hr
(4) Dry pit system		
1) Dry pit water	Amount of recirculating water: 200 m^3/hr SS in recirculating water: 50 ppm Feed water temperature: 60°C Feed water pressure: 4 kg/cm^2	400 m^3/hr
(5) Pig casting machine system		
1) Pig casting machine water	Amount of recirculating water: 600 m^3/hr Feed water temperature: 75°C Feed water pressure: 2 kg/cm^2	600 m^3/hr
Water recirculation facilities for lime plant		
(1) Limestone cleaning system	Amount of limestone treated: 219,630 t/y = 25.1 t/hr Amount of treating water: 200 m^3/hr Feed water quality: SS: 100 ppm Temp.: 50°C The rate of suspended solid generation is assumed to be 1% of raw limestone. Therefore, the amount of suspended solids will be 250 kg/hr Feed water pressure: 4 kg/cm^2 Remarks: The amount of suspended solids varies depending on the extent to which pre-treatment of raw limestone (flushing, cleaning, etc.) has been made in the mine. This plan is based on the assumption that 1% of raw limestone to be treated will be generated as suspended solids. In addition, because of lack of information on the grain size distribution of suspended solids, a course grain separating tank will be installed to prevent coarse grains over 100 in size from entering the sedimentation basin and subsequent processes.	440,540 t/y = 50.3 t/hr 400 m^3/hr 500 kg/hr
(2) Dehydrator cleaning water and dust collecting system	Amount of treating water: 220 m^3/hr Feed water quality: SS: 100 ppm Temp.: 50°C	440 m^3/hr

Items	Stage I	Stage II
	Feed water pressure: Dehydrator system: 3 kg/cm² Dust collector system: 2 kg/cm²	
(3) Machinery cooling system	Amount of recirculating water: 70 m³/hr Feed water quality : SS: 20 ppm Temp.: 35°C Feed warter pressure: 5 kg/cm²	140 m³/hr
Water recirculation facilities for BOF plant		
(1) OG cooling system		
1) OG cooling	Amount of recirculating water: Max. 2,300 m³/hr, Avg. 1,200 m³/hr SS in recirculating water: 5 ppm Feed water temperature: 53°C Return water temp.: 83°C Feed water pressure: 11 kg/cm²	Max. 3,500 m³/hr Avg. 2,400 m³/hr
2) Cooling of lance and vessel	Amount of recirculating water: Max. 700 m³/hr, Avg. 350 m³/hr Return water temp.: 70°C Feed water pressure: 14 kg/cm²	Max. 1,000 m³/hr Avg. 700 m³/hr
(2) Dust collecting system		
1) Dust collecting water	Amount of recirculating water: Max. 1,600 m³/hr, Avg. 800 m³/hr SS in the recirculating water: 100 ppm Feed water temperature: 50°C Return water temp.: 70°C Feed water pressure: 8.5 kg/cm²	Max. 2,400 m³/hr Avg. 1,600 m³/hr
2) High-pressure miscellaneous water	Amount of recirculating water: Max. 250 m³/hr, Avg. 130 m³/hr Feed water temperature: 35°C Feed water pressure: 7 kg/cm²	Max. 380 m³/hr Avg. 260 m³/hr
3) Miscellaneous water	Amount of feed water: Max. 280 m³/hr, Avg. 140 m³/hr	Max. 420 m²/hr Avg. 280 m²/hr
4) Soft water	Amount of water to be treated: 9 m³/hr Quality of raw water: M-alkalinity 50 ~ 62 ppm (as $CaCO_3$) SO_4 5 ~ 38 ppm (as SO_4^{--}) $C1^-$ 5 ~ 10 ppm (as $C1^-$) SiO_2 23 ~ 95 ppm (as SiO_2) Ca 16 ~ 35 ppm (as Ca^{++}) Mg 10 ~ 32 ppm (as Mg^{++}) (Na + K) 10 ppm (as $CaCO_3$) SS 10 ppm Total hardness 129 ~ 166 ppm (as $CaCO_3$) pH 7.5 ~ 8 Quality of treated water: SS 3 ppm Ca 1 ppm (as $CaCO_3$) pH Neutral	18 m³/hr
Water recirculation facilities for continuous casting		
(1) Mould machine system		
1) Mould (slab)	Amount of recirculating water: 840 m³/hr SS in recirculating water: 20 ppm	1,700 m³/hr

Items	Stage I		Stage II
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	10 kg/cm²	
2) Mould (bloom)	Amount of recirculating water:	600 m³/hr	1,200 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	10 kg/cm²	
3) Machine (slab)	Amount of recirculating water:	1,800 m³/hr	3,600 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temperature:	45°C	
	Feed water pressure:	5 kg/cm²	
4) Machine (bloom) & air conditioner	Amount of recirculating water:	800 m³/hr	1,600 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	5 kg/cm²	
(2) Spray system			
1) Slab	Amount of recirculating water:	840 m³/hr	1,700 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	11 kg/cm²	
2) Bloom	Amount of recirculating water:	740 m³/hr	1,500 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	11 kg/cm²	
(3) Scarfer dust collection system			
1) Scarfer dust collection water	Amount of recirculating water:	150 m³/hr	300 m³/hr
	SS in recirculating water:	50 ppm	
	Feed water temperature:	60°C	
	Feed water pressure:	6 kg/cm²	
(4) Scarfer recirculation system			
1) Scarfer scale removal water	Amount of recirculating water:	1,200 m³/hr	2,400 m³/hr
	SS in recirculating water:	100 ppm	
	Feed water temperature:	60°C	
	Feed water pressure:	15.5 kg/cm²	
2) Scarfer spray	Amount of recirculating water:	300 m³/hr	600 m³/hr
	SS in recirculating water:	100 ppm	
	Feed water temperature:	60°C	
	Feed water pressure:	5 kg/cm²	
Water recirculation facilities for hot strip mill			
(1) Reheating furnace cooling system	Amount of recirculating water:	2,200 m³/hr	3,400 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	55°C	
	Feed water pressure:	3 kg/cm²	
(2) Indirect cooling system	Amount of recirculating water:	2,300 m³/hr	3,500 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	

Items	Stage I		Stage II
	Return water temp.:	40°C	
	Feed water pressure:	3 kg/cm²	
(3) Direct cooling system			
1) Roughing mill cooling water	Amount or recirculating water:	1,900 m³/hr	2,900 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	42°C	
	Feed water pressure:	3 kg/cm²	
2) Finishing mill cooling water	Amount of recirculating water:	4,900 m³/hr	4,900 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	42°C	
	Feed water pressure:	3 kg/cm²	
(4) Runout table cooling system	Amount of recirculating water:	6,200 m³/hr	9,200 m³/hr
	SS in recirculating water:	50 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	39°C	
	Feed water pressure:	3 kg/cm²	
Water facilities for billet mill and medium section mill			
(1) Reheating furnace system			
1) Reheating furnace cooling water	Amount of recirculating water:	360 m³/hr	1,200 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	2.5 kg/cm²	
2) Indirect cooling water	Amount of recirculating water:	360 m³/hr	2,000 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	2.5 kg/cm²	
(2) Direct cooling system			
1) Direct cooling water	Amount of recirculating water:	270 m³/hr	1,300 m³/hr
	SS in recirculating water:	20 ppm	
	Feed water temperature:	35°C	
	Return water temp.:	45°C	
	Feed water pressure:	2.5 kg/cm²	

Table 13-18-2 Specification

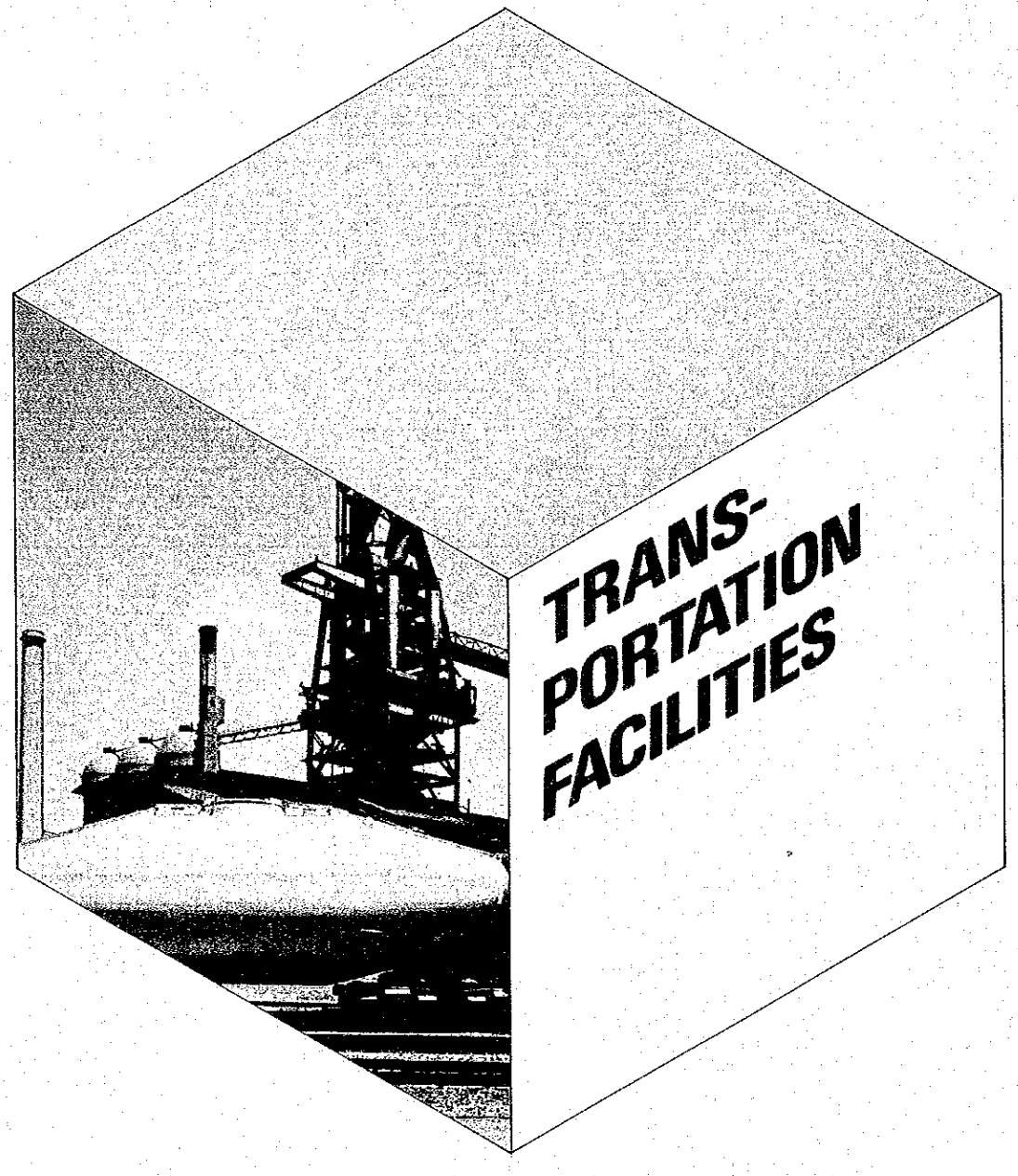
Item	Name of equipment	Stage I		Stage II	
		Quantity	Specifications	Quantity	Specifications
(1) Water recirculation facilities for coke oven and by-product plant					
1) Quenching tower	Sedimentation basin	1 unit	680 m^3/unit	1 unit	Same as at left
	Feed water pit	1 unit	70 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
2) Coke oven dust collecting system	Thickener	1 unit	420 m^3/unit		
	Feed water pit	1 unit	60 m^3/unit		
	Pumps, etc.	1 set			
3) Coke by-product machinery cooling system	Return water pit	1 unit	20 m^3/unit	1 unit	Same as at left
	Cooling tower	1 unit	4 m x 4 m x 3 m/unit	1 unit	Same as at left
	Feed water pit	1 unit	50 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
(2) Water recirculating facilities for blast furnace					
1) Cooling system for tuyers, etc.	Return water pit	1 unit	450 m^3/unit	1 unit	Same as at left
	Cooling tower	3 units	12 m x 15 m x 5 mH/unit	3 units	Same as at left
	Feed pump pit	1 unit	900 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
2) Hearth bottom cooling system	Feed water pit	1 unit	250 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
3) Dust collection system	Thickener	2 units	2,100 m^3/unit	1 unit	Same as at left
	Return water pit	1 unit	70 m^3/unit	1 unit	Same as at left
	Cooling tower	1 unit	9 m x 11 m x 6 mH/unit	1 unit	Same as at left
	2 VS Feed water pit	1 unit	210 m^3/unit	1 unit	Same as at left
	1 VS Feed water pit	1 unit	210 m^3/unit	1 unit	Same as at left
	Caustic soda dosing equipment	1 set		1 set	
	Polymer soda dosing equipment	1 set		1 set	
	Pumps, etc.	1 set		1 set	

Item	Name of equipment	Stage I		Stage II	
		Quantity	Specifications	Quantity	Specifications
4) Dry pit system	Return water pit	1 unit	20 m^3/unit	1 unit	Same as at left
	Feed water pit	1 unit	60 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
5) Pig casting machine system	Sedimentation basin	1 unit	600 m^3/unit		
	Feed water pit	1 unit	150 m^3/unit		
	Pumps, etc.	1 set			
(3) Water recirculation facilities for limestone					
1) Limestone cleaning system	Coarse particle separator	2 units	70 m^3/unit	2 units	Same as at left
	Thickener	2 units	520 m^3/unit	1 unit	Same as at left
	Feed water pit	1 unit	90 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
2) Dehydrator cleaning water, dust collector system	Thickener	1 unit	580 m^3/unit	1 unit	Same as at left
	Feed water pit	1 unit	110 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
3) Machinery cooling system	Cooling tower	1 unit	2 m x 3 m x 3 mH/unit	1 unit	Same as at left
	Feed pump pit	1 unit	20 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
(4) Water recirculation facilities for BOF plant					
1) OG cooling system	Cooling tower	1 unit	12 m x 15 m x 9 mH/unit	1 unit	Same as at left
	Feed water pit	1 unit	500 m^3/unit	1 unit	Same as at left
	Anti-corrosive dosing equipment	1 set		1 set	
	Soft water making equipment	1 set		1 set	
	Pumps, etc.	1 set		1 set	
2) Dust collection system	Dust separator	2 units	20 m^3/unit	2 units	Same as at left
	Thickener	2 units	800 m^3/unit	2 units	Same as at left
	Return water pit	1 unit	70 m^3/unit	1 unit	Same as at left
	Cooling tower	1 unit	8.5 m x 9 m x 7 mH/unit	1 unit	Same as at left
	Feed water pit	1 unit	200 m^3/unit	1 unit	Same as at left
	Plymer dosing equipment	1 set		1 set	

Item	Name of equipment	Stage I		Stage II	
		Quantity	Specifications	Quantity	Specifications
	Caustic soda dosing equipment	1 set		1 set	
	Sulfuric acid dosing equipment	1 set		1 set	
	Pumps, etc.	1 set		1 set	
(5) Water recirculation facilities for continuous casting plant					
1) Mould, machine system	Cooling tower	2 units	11 m x 15 m x 6 mH/unit	2 units	Same as at left
	Feed water pit	1 unit	1,000 m^3/unit	1 unit	Same as at left
	Elevated tank	1 unit	210 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
2) Spray system	Sedimentation basin	2 units	600 m^3/unit	2 units	Same as at left
	Filter	5 units	4.5 mφ x 5 mH/unit	5 units	Same as at left
	Cooling tower	2 units	10 m x 12 m x 6 mH/unit	2 units	Same as at left
	Feed water pit	1 unit	600 m^3/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
3) Scarfer dust collection system	Return water pit	1 unit	15 m^3/unit	1 unit	Same as at left
	Thickener	1 unit	300 m^3/unit	1 unit	Same as at left
	Coagulation dosing equipment	1 set		1 set	
	Pumps, etc.	1 set		1 set	
4) Scarfer recirculating system	Cooling tower	1 unit	4 m x 8 m x 8 mH/unit	1 unit	
	Pumps, etc.	1 set		1 set	
(6) Water recirculation faciliteis for hot strip mill					
1) Reheating furnace cooling system	Return water pit	1 unit	190 m^3/unit	1 unit	70 m^3/unit
	Cooling tower	1 unit	12 m x 15 m x 8 mH/unit	1 unit	Same as at left
	Feed water pit	1 unit	370 m^3/unit	1 unit	190 m^3/unit
	Elevated tank	1 unit	560 m^3/unit		
	Pumps, etc.	1 set		1 set	
2) Indirect cooling system	Return water pit	1 unit	190 m^3/unit	1 unit	100 m^3/unit
	Cooling tower	2 units	10 m x 15 m x 5 mH/unit	1 unit	Same as at left
	Feed water pit	1 unit	380 m^3/unit	1 unit	200 m^3/unit
	Pumps, etc.	1 set		1 set	

Item	Name of equipment	Stage I		Stage II	
		Quantity	Specifications	Quantity	Specifications
3) Direct cooling system	Roughing sedimentation basin	2 units	1,100 m^3/unit	1 unit	Same as at left
	Finishing sedimentation basin	2 units	1,700 m^3/unit		
	Filter	8 units	5 mϕ x 5 mH/unit		
	Cooling tower	3 units	12 m x 15 m x 5.5 mH	1 unit	Same as at left
	Feed water pit	1 unit	1,700 m^3/unit	1 unit	300 m^3/unit
	Pumps, etc.	1 set		1 set	
4) Runout table cooling system	Cooling tower	2 units	11 m x 15 m x 5 mH/unit	1 unit	Same as at left
	Pumps, etc.	1 set		1 set	
(7) Water recirculation facilities for billet mill and medium section mill					
1) Reheating furnace system	Return water pit	1 unit	60 m^3/unit	1 unit	210 m^3/unit
	Cooling tower	1 unit	7 m x 10 m x 6 mH/unit	4 units	Same as at left
	Feed water pit	1 unit	120 m^3/unit	1 unit	420 m^3/unit
	Elevated tank	1 unit	60 m^3/unit	1 unit	140 m^3/unit
	Pumps, etc.	1 set		1 set	
2) Direct cooling system	Sedimentation basin	1 unit	320 m^3/unit	2 units	Same as at left
	Filter	2 units	3 mϕ x 4.5 mH/unit	3 units	Same as at left
	Cooling tower	1 unit	5 m x 7 m x 6 mH/unit	3 units	Same as at left
	Feed water pit	1 unit	70 m^3/unit	1 unit	250 m^3/unit
	Pumps, etc.	1 set		1 set	

CHAPTER 13-19



13-19 Transportation facilities

13-19-1 General

The purpose of transportation facilities is the transportation of raw materials, by-products and semi-finished products in the steel-works site.

The railway facilities shall be used for the transportation of such high-temperature and heavy-weight materials as molten iron, BOF slag and steel ingots.

The road transportation shall be the method for transporting other kinds of raw materials and by-products.

(1) Railway transportation

As for the transportation of molten pig iron, the torpedo cars shall be used because molten pig iron is a high-temperature and heavy-weight material to be carried in a large amount at once. The torpedo car, widely used in steelworks of many countries, has an advantage in operation transportation costs and the quality aspects of products.

The BOF slag generated in the BOF plant shall be transported by effective means of slag ladle cars equipped with tilting functions.

The flat cars shall be used for transporting ingots. Diesel locomotives shall be used to pull these types of railway transportation equipment.

The auxiliary facility shall include a locomotive shed, which is used when the diesel locomotives are being checked for a daily inspection or are being fueled or being supplied with water, and the crossing signals and track illuminating equipment to enhance safety of railway transportation.

The rail gauge shall be 1,435^{mm} in consideration of the possibility of use by large trains.

(2) Road transportation

Flat-topped trucks shall be used for the transportation of maintenance materials, oil/grease, refractories and so on. Dump trucks and self-loading trucks shall be used to transport raw materials and by-products, which are loaded or unloaded by means of bulldozers, shovel loaders or crawler cranes. Truck cranes shall be used for the loading or unloading operations at the ingot yard and trailers shall be used for transporting ingots to the port.

The auxiliary facilities of road transportation shall include the automobile weighing equipment, (automobile weigh-bridge) which is used to grasp the transportation situation and make a record of stock, and the gas stations for supplying fuel to the vehicles.

The width or other elements of the roads are determined according to the types and traveling frequency of passing vehicles.

13-19-2 Preconditions

(1) The volume of transportation

The material balance sheet (*Fig. 13-19-1* and *13-19-2*) shows the volume of transportation, which is the basis for the transportation equipment plan.

(2) Operation conditions

3 shifts of continuous operations shall be the principle of transportation operations but the daytime operation shall be applied to the transportation of relatively small amount of items.

(3) Loading efficiency

The loading rate of torpedo cars, slag ladle cars and flat cars shall be 90% of their maximum loading capacity, and that of trucks shall be 50 to 100% depending on what kind of material they carry.

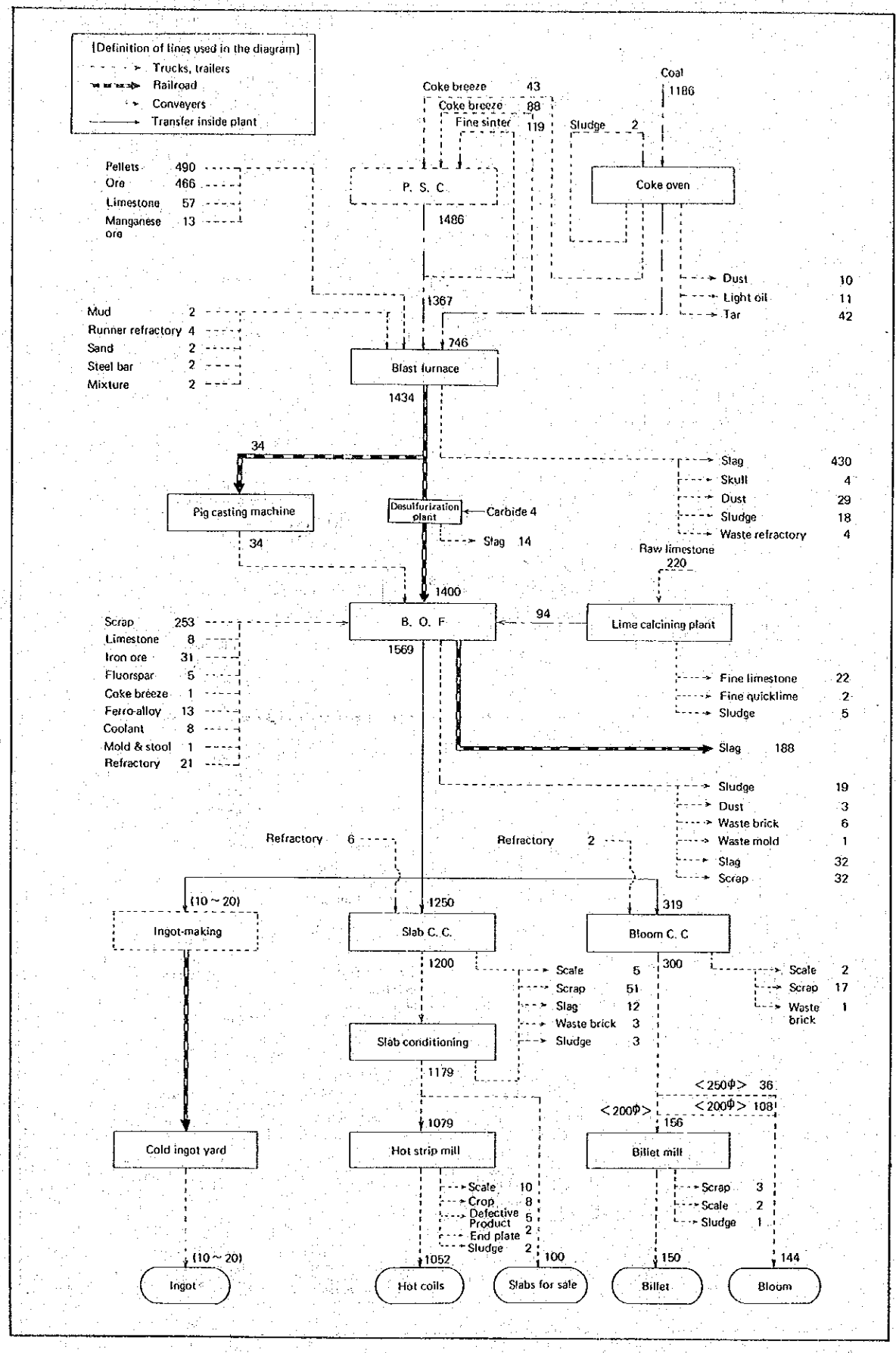


Fig. 13-19-1 Material balance flow sheet (unit: 1,000$^{t/y}$) stage I

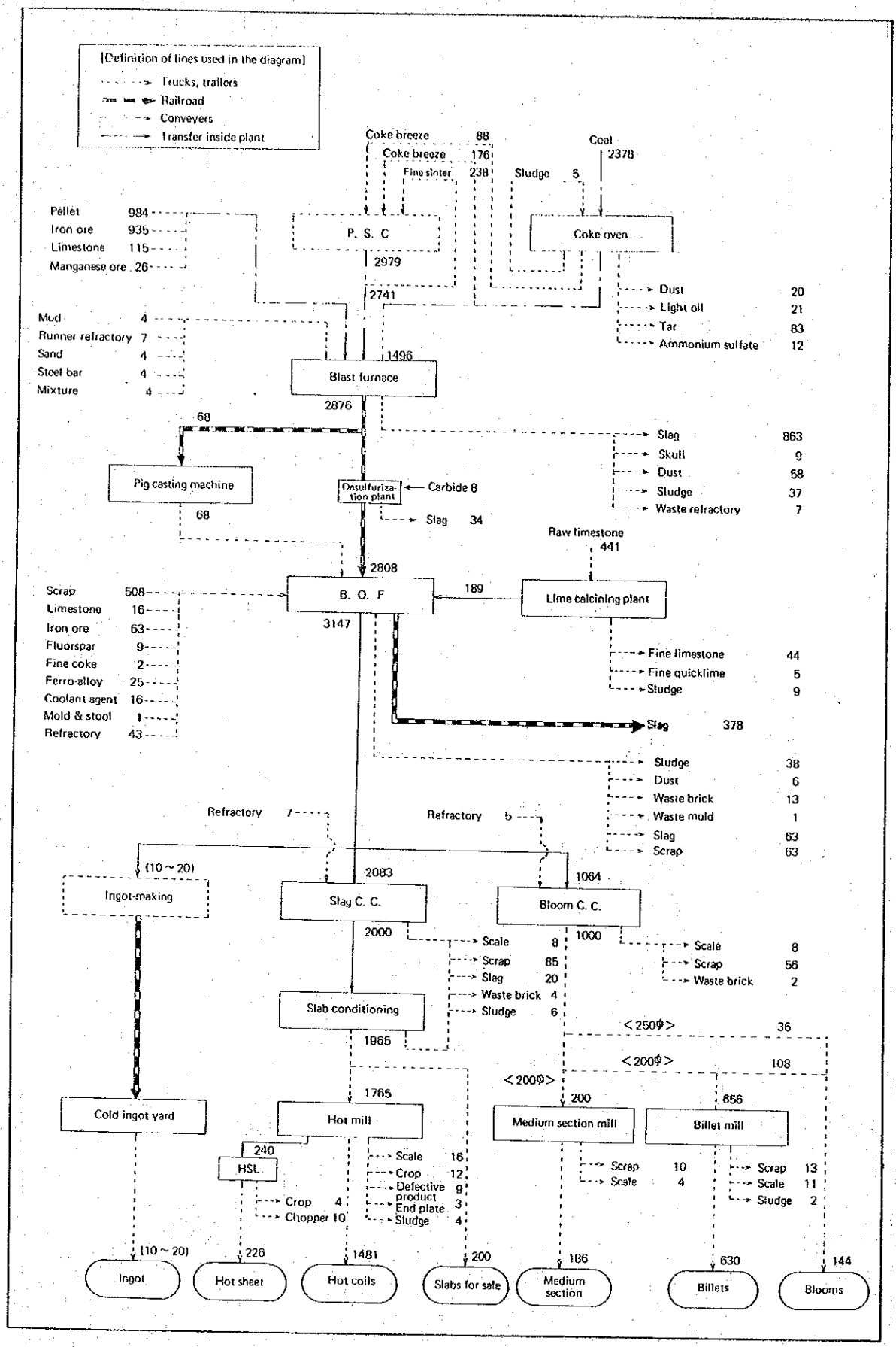


Fig. 13-19-2 Material balance flow sheet (unit: 1,000$^{t/y}$) stage II

Item	Specifications	
	Stage I	Stage II
(1) Railway equipment		
1 Torpedo car	Load capacity 320 t x 12 units	Load capacity 320 t x 12 units
2 Slag ladle car	" 20 t x 6 units	" 20 t x 6 units
3 Slag ladle	" 20 t x 6 units	" 20 t x 6 units
4 Flat-topped car	" 250 t x 8 units	"
5 Diesel locomotive	Own weight 60 t x 4 units	Own weight 60 t x 1 units
6 "	" 25 t x 2 units	" 25 t x 1 units
7 Highway crossing alarm	Electronic electric bell type 4 set	
8 Locomotive shed	Fuel station is provided (18 m x 18 m) 1 set	
9 Railway track	1,435 mm of gauge, 60 kg/m 10 km	1,435 mm of gauge, 60 kg/m 1 km
10 Track illuminating devices	1 set	1 set
(2) Road transportation equipment		
1 Flat truck	Load capacity 11 t x 3 units	Load capacity 11 t x 2 units
2 Dump truck	" 11 t x 26 units	" 11 t x 16 units
3 Self-loading truck	" 30 t x 2 units	" 30 t x 1 unit
4 Slag ladle	" 15 t x 6 units	" 15 t x 6 units
5 Shovel loader	Capacity 1.5 m³ x 5 units	Capacity 1.5 m² x 2 units
6 Bulldozer	Capacity (own weight) 20 t x 5 units	Capacity (own weight) 20 t x 2 units
7 Crawler crane	Lifting capacity 20 t x 3 units	Lifting capacity 20 t x 2 units
8 Truck crane	Lifting capacity 40 t x 1 unit	
9 Automobile fuel station	For diesel fuel 1 set	
10 Automobile weigh bridge	Weighing capacity 60 t x 1 unit	
(3) Shared facility		
Sub-center	Area 2,000 m² x 1	
Road	Total length: Approx. 17,810 m (Paved road area: Approx. 333,150 m²)	

13-19-4 Technical explanation

(1) Torpedo car

1) Features

The usual hot metal ladle car has been widely used as a transportation method for the hot metal of steelworks. In this method, a hot metal ladle car receives hot metal from the blast furnace, carries it to the steel-making plant to store it in the mixer and, later, to supply it to the steel-making furnace.

Recently, however, the hot metal ladle car is being replaced by the torpedo car which carries hot metal from the blast furnace but eliminates the need of use of the mixer. Since the furnace capacity of the torpedo car is larger, the composition of hot metal is effectively made uniform and the torpedo car is able to achieve the purpose of the conventional mixer, and therefore, eliminates the necessity for constructing mixers. The torpedo car has a cylindrical furnace body with conical ends.

Since the furnace has an opening at the center of the top, the torpedo car provides a higher heat-retaining capacity than the ladle car which has a fully open top.

Furthermore, it becomes possible to make the capacity of torpedo cars larger by lowering the gravity center of the cylindrical furnace body with conical ends.

Thus, use of torpedo cars simplifies the transportation of the hot metal and processing of hot metal.

2) Structure

For containing hot metal, the furnace of torpedo cars is constructed of welded steel plate.

The furnace has cast steel-trunnions at both ends and the inside of the furnace is covered with refractory materials.

The tilting equipment shall be mounted at the trunnion on either side of the furnace body and shall be controlled in operation by the control device installed on the ground. *Fig. 13-19-3* Shows the appearance of torpedo car.

3) Capacity of torpedo car

The iron production of the blast furnace is maximum 540^{t} per tapping, and the steel production of the converter is maximum 160^{t} per heat.

The torpedo car capacity is planned at 320$^{t/unit}$ so that two torpedo cars can receive the iron produced by one tapping of the blast furnace and one torpedo car can store the molten pig iron required to supply two heats of the BOF.

4) Maintenance

The maintenance of torpedo cars may be divided into the maintenance for mechanical portions and the repairing and maintenance for furnace brick portions. Since the

mechanical portion is a very few, most of the maintenance work shall be the bricklaying work for the brick portions.

Relining of the furnace brick shall be executed after every 600 to 700 uses for hot metal receiving. Partial repairing or relining of the brick performed several times during the period between two total relining works. The maintenance rate of torpedo cars is 75 to 80%.

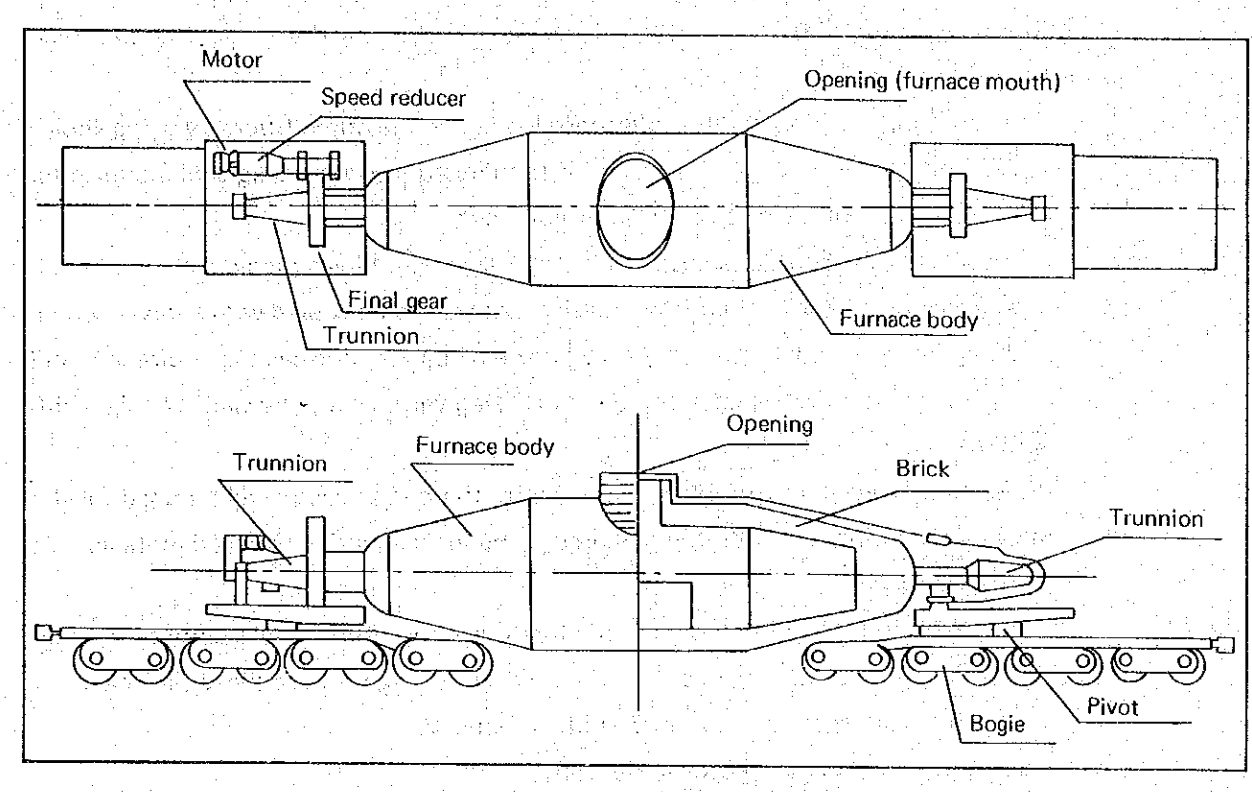


Fig. 13-19-3 Appearance of torpedo car

(2) Road transportation

1) Transportation of limestone and iron ore for steel-making.

Limestone is unloaded at the raw material berth, and carried by conveyer belt to the raw material yard for storage. In the same way as for iron ore and sintered ore, limestone shall be transported to the storage bin of the blast furnace by conveyer belt.

As for the limestone and iron ore for the lime calcining plant and the steelmaking plant, however, we recommend to use dump trucks for their transportation ($700^{t/d}$) because of their small amounts.

In the raw material yard, bulldozers and shovel loaders shall be used for loading

limestone and iron ore onto the dump trucks and for gathering scattered limestone and iron ore. Dump trucks shall be used for transporting the limestone undersize, burnt lime undersize and lime sludge, which are generated in the lime calcining plant. For the loading of sludge, the shovel loaders in the raw material yard shall be used when they are not used for other purposes.

In general, these transportation operations shall be done during daytime.

2) Transportation of slag, sludge and other waste.

The slag of the blast furnaces shall be thrown into the dry pit and cooled with sprayed water.

The cooled slag is gathered by bulldozers, loaded on the dump trucks by using shovel loaders, and transported to the place for abandoned slag. This slag shall be used for the reclamation of the site or for other purposes.

The BOF slag shall be transported to the BOF slag yard by slag ladle cars on the railway, and they are thrown out from the slag ladle car to be cooled with sprayed water.

The slag ladle is used to receive the slag made by continuous casting equipment and the self-loading truck transports it to the BOF slag yard, where the slag is cooled with sprayed water.

In the same way as for the blast furnace slag, the cooled slag shall be used for the reclamation of the site after it is gathered by bulldozers and is removed metallic part by magnet separater.

For the purpose of land reclamation or other purposes, dump trucks carry other slag, sludge, waste brick and others from their places of origin to the place for abandonment. This work shall be done in 3 shifts in general.

3) Transportation of scrap and cast pig iron

The scrap and cast pig iron shall be carried from their respective plants to the scrap yard by dump trucks, where they are stored.

The imported scraps also are transported from the berth to this scrap yard by dump trucks.

After the scraps are calssified and cut in the scrap yard, they are carried to the steelmaking plant's scrap pit by dump trucks, according to necessity.

A crawler crane with a lifting magnet shall be used to handle the scraps gathered in the scrap yard and to load them on dump trucks.

In general, this transportation operation shall be done by 3-shift operation system.

4) Transportation of dust, under-sized material and scale

The dust and under-sized material generated at the blast furnace and ore bin and the mill scale generated in the rolling mill plant shall be carried to the raw material yard

by dump truck because they can be used as raw material for sintering. The dust and under-sized material, which are generated at the coke plant and coke bin, shall be transported to the sinter plant yard so that they can be used as sinter feed.

In this transportation work, the transportation of under-sized material shall be done in 3 shifts of work and the transportation of others shall be daytime work.

5) Transportation of other types of material and by-products

In general, the flat-topped trucks shall take care of transporting runner refractory, tap hole mud, and steel bars for blast furnace, refractory for converters, fine coke for steel making, carbide for dusulfurization of molten iron, maintenance materials and grease/oil, etc.

Dump trucks shall be used to carry ferro-alloy, fluorspar, cast house sand and others.

As for other types of materials and by-products, flat-topped trucks, dump trucks, or trailer trucks shall be used depending on the necessity.

In general, this transportation activity shall be done during daytime.

6) Distribution of trucks for 3-shifts of work and daytime work.

	3 shift work	Daytime work	Reserves	Total
Flat-topped trucks	—	3 (5)	—	3 (5)
Dump trucks	10 (17)	13 (21)	3 (4)	26 (42)
Self-loading trucks	1 (2)	—	1 (1)	2 (3)

Note: ( ) shows the figures for stage II.
Spare vehicles shall be provided for the vehicles to be used for 3 shifts of work.