7-6-3. Facilities plan

(1) Layout

In Fig. 7.5.2 is shown layout of steelmaking shop and casting plant.

Bloom-1 caster and billet-1 caster are located in the southern part of the building and their casting floor is at the same level. Tundishes and molds for the both machines are prepared at the mold and tundish preparation area in the north of the machines. On the other hand, power required for the both machines is supplied from the electric room in the south of the machines. Cooling water is supplied from the water treatment facilities located on the south of the building. Between the two machines are main pulpit and torch and shear pulpit used in common. Cast blooms and billets are transferred by chain transfer at discharge side of each machine to the cooling bed, and after air cooled, sent by trailer to rolling mills or open air storage yards.

On the other hand, billet-2 and billet-3 casters, tundish preparation area, electric room, water treatment and others for these casters are in the north of the building in line symmetrical arrangement with the facilities of the bloom-1 and billet-1 casters. But in the space between the two machines there is mold and roller apron preparation area, and torch pulpit for each machine is provided on the north of the machine.

Between those machines and new bar mills, billet delivery tables are installed to enable hot charge or warm charge.

(2) Specifications of facilities

Figs. 7.6.2 through 7.6.4 show sketch of each continuous caster. Main specifications of four casters are given in Table 7.6.8.

1) For ladle handling equipment for bloom-1 caster and billet-1 caster, ladle stand of simple structure is adopted as batch casting is employed for those two machines. On the other hand, sequential casting is employed for both billet-2 and billet-3 casters, and ladle turret is adopted to facilitate quick change of ladles or tundishes. In addition, two tundish cars are prepared for each of billet-2 and billet-3 casters.

2) The machines are of curved mold type which is most popular, but for bloom-1 caster, as discussed later in machine radius, 2 point unbending type is adopted to lower the height of machine and reduce its investment.

3) Basically, machine radius is standardized at 8 metres to make even the level of casting floor, thereby improving working and safety condition on the casting floor. In particular, of both billet-2 and billet-3 casters, all equipment but mold are the same, which improves interchangeability of parts and enables cut of stock of spares.

4) Transfer lines of billet-2 and billet-3 casters are linked directly with new bar mills. As this enables hot charge or warm charge of billets, energy saving can be expected. At the same time, it has merit in simplifying transportation of cast billets.

Lists of mechanical and electric equipment of all the casters are given in Table 7.6.9 and Table 7.6.10.

(3) Design condition of water treatment facilities

Table 7.6.11 shows design condition of water treatment facilities in each step.

(4) Technical explanation

1) Determination of the number of strands

The number of strands is determined by taking into consideration casting speed, casting time, tap to tap time, etc. based on steel production, steel weight per heat, quality of blooms or billets, frequency of casting troubles and others.

As regards casting time in particular, the following were given attention. Namely, for the bloom-1 and billet-1 casters operated by batch casting, the time must be 80 minutes or less to prevent troubles caused by drop of temperature during casting. Especially, in the billet-1 caster which casts small billets in size of 100 mm sq., frequency of casting troubles such as nozzle choking and breakout is high and the casting time is planned as short as possible.

On the other hand, in billet-2 and billet-3 casters, both operated by sequential casting, the casting time is planned to be close to the tap to tap time of BOFs (50 minutes) to permit sequential casting of a number of heats.

As a result, casting time and the number of strands are determined as shown in Table 7.6.7.

Table 7.6.7 Casting time and No. of strands

Item	Bloom-1	Billet-1	Billet-2	Billet-3
Casting time (min.)	70	73	62	53
No. of strand	3	8	6	6

As the billet-1 caster is determined as 8-strand, conventional one-body tundish would have a length of about 9 metres and there is risk of deformation and uneven flow of molten steel through different nozzles, which is undesirable for this caster with small mold of 100 mm sq. To overcome this problem, though there remains a disadvantage of necessity of double nozzle ladles, two-tundish system is to be employed giving priority to stable operation.

2) Machine radius

Machine radius is generally determined by considering factors such as casting speed, billet or bloom size, and quality level. In particular, unbending strain caused by unbending of a strand has an effect on surface quality as well as internal quality of billets or blooms, and the machine radius must be determined very carefully. In the bloom-1 caster which casts blooms of 300 x 400 mm, if one point unbending is used, the machine radius has to be as large as 10-15 metres and the height of building is inevitably high, increasing capital investment. For this reason two point unbending is adopted and machine radius could be reduced to R1 = 8 m and R2 = 16 m.

As for the billet-2 and billet-3 casters also, their machine radius is determined to be 8 metres from same consideration. In those cases, however, as strand is of small size, unbending strain can be held within permissible tolerance with one point unbending.

3) High grade steel

In deciding the machine radius which forms the basis of casters, full consideration was given to satisfy the need of casting high steel grades. Therefore, in case when production of high grade steels is required

in future, it is not necessary to remodel the casters completely. As a matter of course, however, it is necessary to make additional investment for shrouding of liquid steel between a ladle and a tundish, use of tundish sliding nozzles, and electromagnetic stirrer, and it may be necessary to use ladle metallurgy for some steel grades.

4) Distribution of liquid steel

In the 2nd step of 2.15 million-tonne scale, it is necessary to distribute liquid steel tapped from two BOFs well-timedly to 4 units of casters and teeming yard, totalling five places. In order to study the condition of such liquid steel distribution, a simple simulation was conducted. An example is shown in Fig. 7.6.1. Though it resulted in a very tight scheduling, it was confirmed that with full functioning of high degree technical control, production control and field operation control, it should be possible to cast required steel.

In the 2nd step there is still 14% of steel for ingot casting, but when it is considered that the casters are all small cross section machines which tend to have frequent casting troubles, to leave the matter as it is considered desirable for ensuring smooth production. In other words, should any caster be put out of operation due to trouble, if ingot casting is available, liquid steel planned to be cast by such caster can be cast by teeming, thus minimizing loss of production.

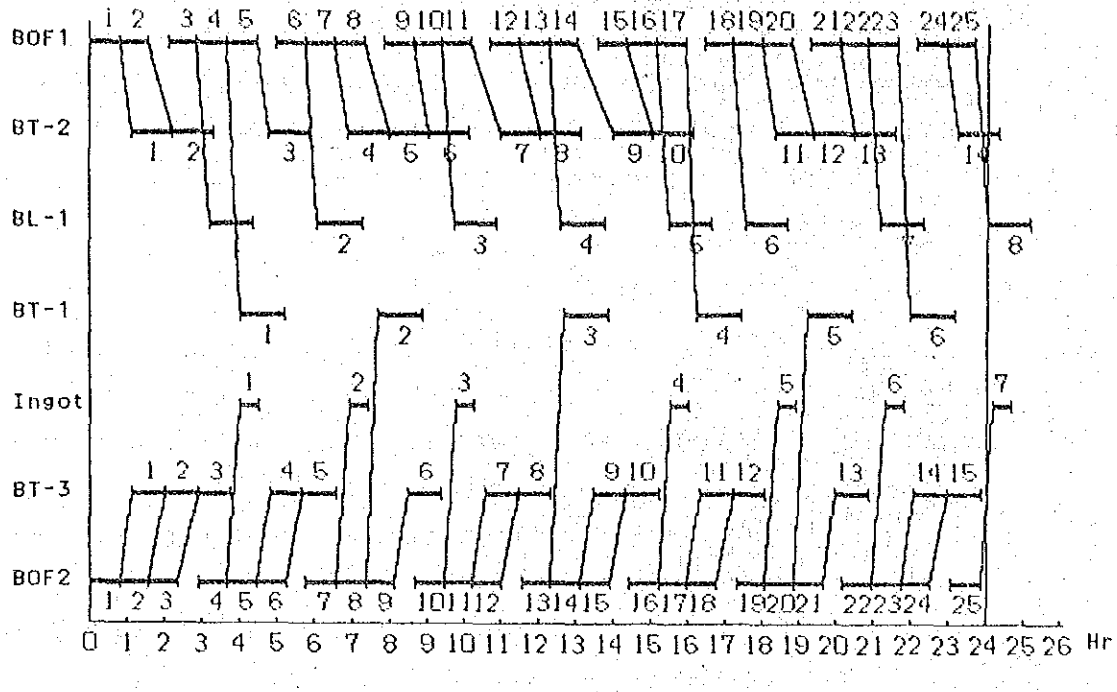
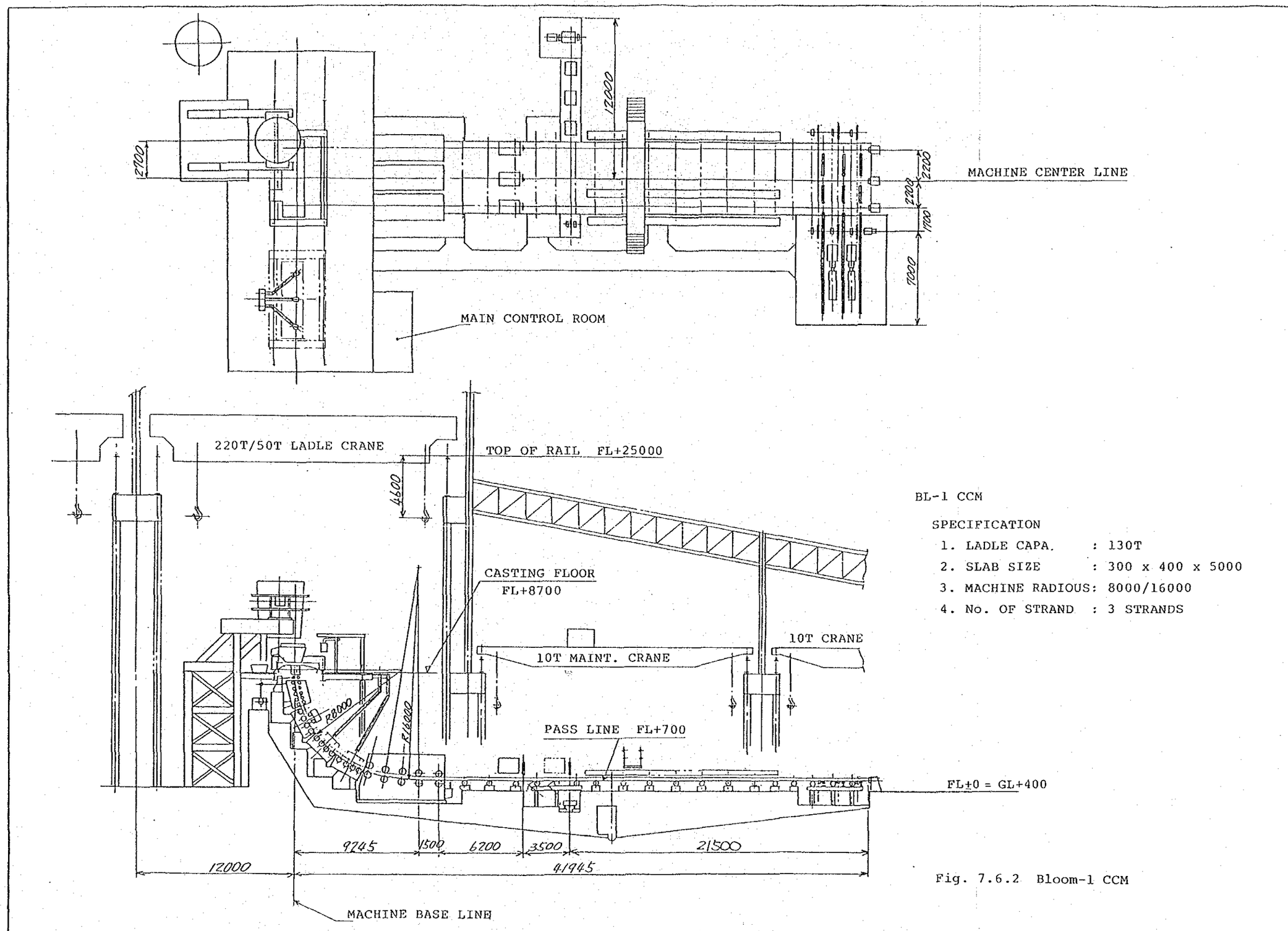


Fig. 7.6.1 An example of simulation for distribution of liquid steel

Table 7.6.8 Main specifications of casters

Item \ Caster	Bloom-1	Billet-1	Billet-2	Billet-3
Ladle handling	Ladle stand	Ladle stand	Ladle turret	Ladle turret
Tundish car	1	1	2	2
Machine type	Curved mold	Curved mold	Curved mold	Curved mold
Machine radius	8 m, 16 m	8 m	8 m	8 m
Unbending points	2	1	1	1
No. of strands	3	8	6	6
Mould size	300 mm x 400 mm	100 mmSQ	150 mmSQ	180 mmSQ
Cruising casting speed	0.7 m/min	3.0 m/min	2.1 m/min	1.7 m/min
Casting time	70 min	73 min	62 min	53 min
Cutting device	Torch	Shear	Torch	Torch
Discharge equipment	Roller table, Transfer, Cooling bed	Roller table, Transfer, Cooling bed	Roller table, Transfer	Roller table, Transfer

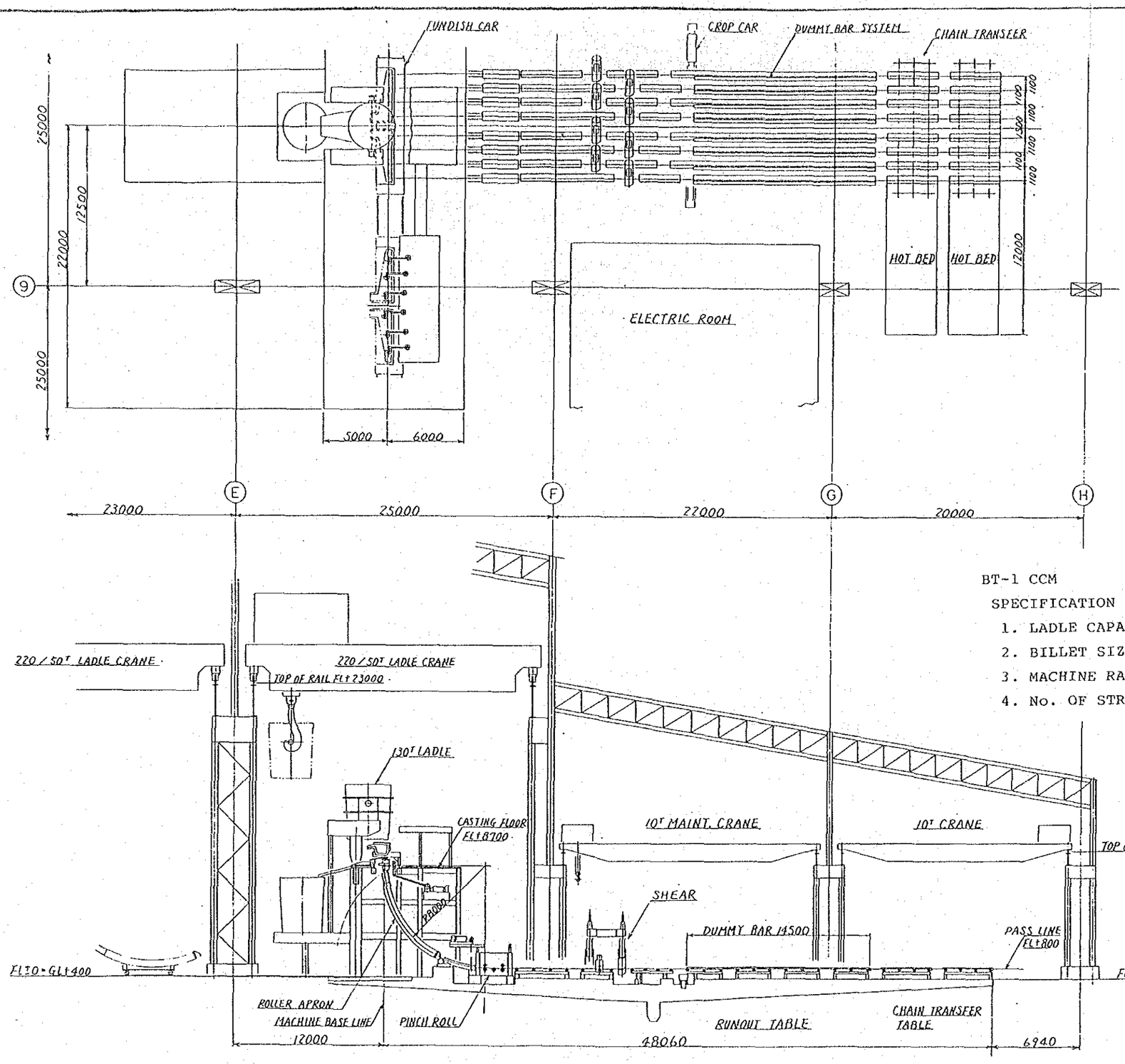


BL-1 CCM

SPECIFICATION

1. LADLE CAPA. : 130T
2. SLAB SIZE : 300 x 400 x 5000
3. MACHINE RADIOUS: 8000/16000
4. No. OF STRAND : 3 STRANDS

Fig. 7.6.2 Bloom-1 CCM

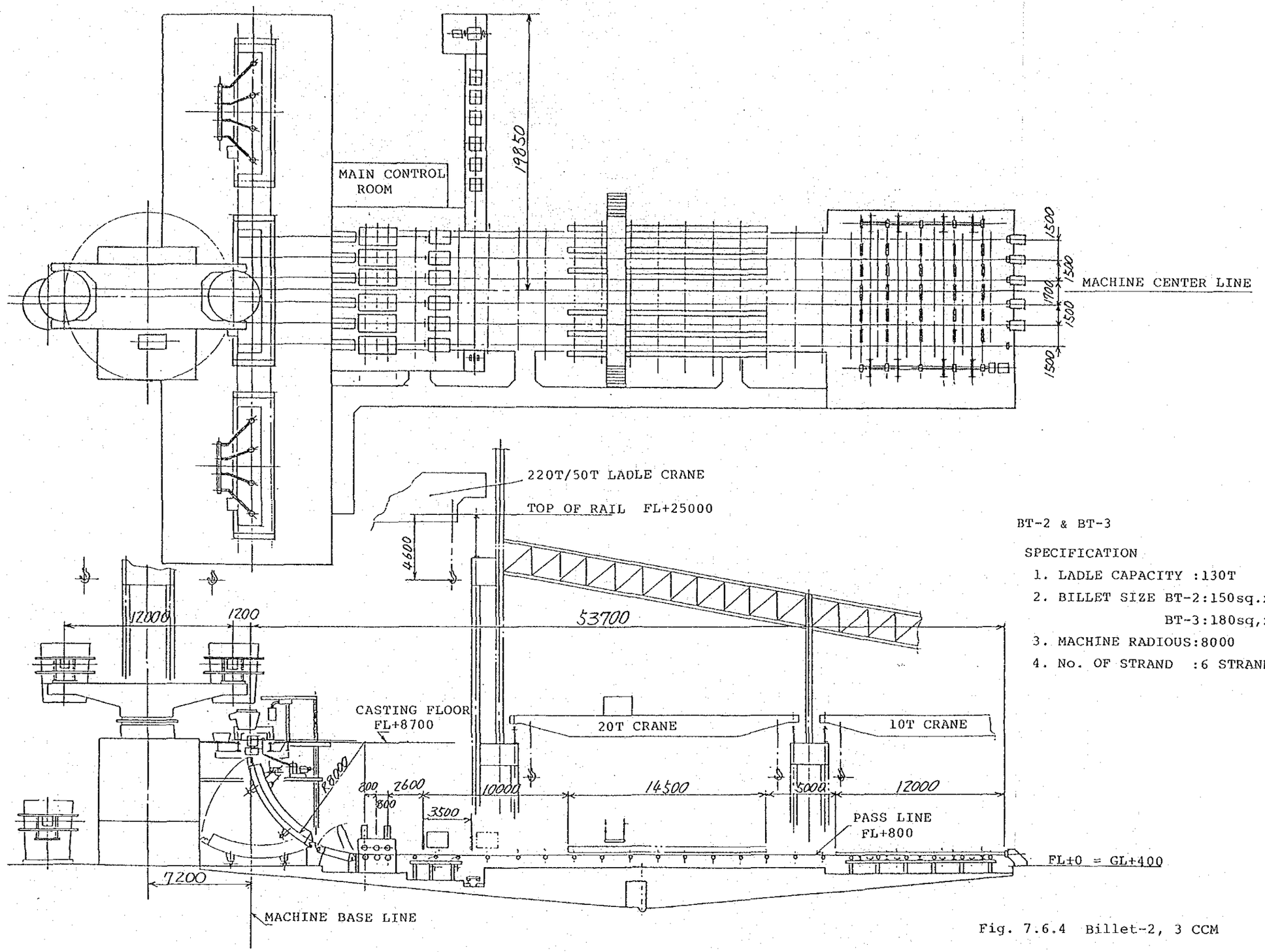


BT-1 CCM

SPECIFICATION

1. LADLE CAPACITY :130T
2. BILLET SIZE :100sq. x 3500--4000
3. MACHINE RADIOUS:8000
4. No. OF STRAND : 8 STRANDS

Fig. 7.6.3 Billet-1 CCM



BT-2 & BT-3

SPECIFICATION

1. LADLE CAPACITY :130T
2. BILLET SIZE BT-2:150sq.x12000
   BT-3:180sq,x12000
3. MACHINE RADIOUS:8000
4. No. OF STRAND :6 STRANDS

Fig. 7.6.4 Billet-2, 3 CCM

Table 7.6.9 Equipment list for casters (Mechanical)

1. Step 1 (1 MT/Y)

Item	Description	Q'ty	Remarks
1.	Rinsing station	2	
1.1	Jib crane	2	Capacity 3 T
1.2	Lifting magnet	2	Capacity 300 kg
1.3	Scrap bin	2	
1.4	Exhaust fan	2	
1.5	Auxiliaries	2 set	
2.	Crane		
2.1	Ladle crane (A)	1	220 T / 50 T
2.2	Maintenance crane	1	10 T
2.3	Ditto	1	20 T
2.4	Ditto	2	30 T
2.5	Billet/Bloom handling crane	2	10 T
3.	Ladle transfer car	2	
4.	Bloom - 1 CCM		
4.1	Steel structure	1	
4.2	Tundish	1	Capacity 30 T
4.3	Tundish cover	1	
4.4	Tundish car	1	
4.5	Tundish prebeater	1	
4.6	Slag box	1	
4.7	Mold	3	
4.8	Rape seed oil supplier	1	
4.9	Pendant box	3	
4.10	Osaillator	3	50 - 200 cpm
4.11	1st segment	3	
4.12	Common degments	3 sets	
4.13	Segment support	3	

(continued)

Item	Description	Q'ty	Remarks
4.14	Segment changing guide	3	
4.15	Pinch roll	3	
4.16	Torch cutter	3	
4.17	Torch approach roller table	3	
4.18	Torch roller table	3	
4.19	Torch runout table	3	
4.20	Crop handling	1	
4.21	Discharge roller table	3	
4.22	Chain transfer	1	
4.23	Pusher	1	
4.24	Cooling bed	1	
4.25	End stop	3	
4.26	Dummy bar	3	
4.27	Dummy bar receiver	3	
4.28	Steam exhaust	1	
4.29	Hydraulic unit	1	
4.30	Lulvication system	1	
4.31	Spares		
4.31.1	Tundish	6	
4.31.2	Tundish cover	6	
4.31.3	Mold	6	
4.31.4	1st segment	6	
4.31.5	Dummy bar head	3	
4.31.6	Dummy bar links	1	
4.31.7	Others	1 set	
5.	Billet - 1 CCM		
5.1	Steel structure	1	
5.2	Tundish	1 set	
5.3	Tundish cover	1 set	
5.4	Tundish car	1	
5.5	Tundish preheater	1	
5.6	Slag box	1	

(continued)

Item	Description	Q'ty	Remarks
5.7	Mold	3	
5.8	Rape seed oil supplier	1	
5.9	Pendant box	8	
5.10	Oscillator	8	
5.11	Roller apron	8	
5.12	Pinch roll	8	
5.13	Cutting shear	8	
5.14	Approach roller table	8	
5.15	Intermediate roller table	8	
5.16	Crop handling	1	
5.17	Dischange roller table	8	
5.18	Chain transfer	1	
5.19	Pusher	1	
5.20	Colling bed	2	
5.21	End stop	8	
5.22	Dummy bar	8	
5.23	Dummy bar receiver	8	
5.24	Steam exhaust	1	
5.25	Hydraulic unit	1	
5.26	Lulvication system	1	
5.27	Spares		
5.28	Tundish	5	
5.29	Tundish cover	5	
5.30	Mold	10	
5.31	Top part of roller apron	10	
5.32	Dummy bar head	10	
5.33	Dummy bar links	4	
5.34	Others	1 set	

(continued)

Item	Description	Q'ty	Remarks
6.	Tundish yard		
6.1	Tundish tilting device	1	For BL-1 Tundish
6.2	Ditto	1	For BT-1 Tundish
6.3	Tundish skull punch	2	
6.4	Tundish drying	1	For BL-1 Tundish
6.5	Ditto	1	For BT-1 Tundish
6.6	Tundish repain platform	1 set	
6.7	Tundish lifting beam	1	For BL-1 Tundish
6.8	Ditto	1	For BT-1 Tundish
6.9	Auxiliaries	1 set	
7.	Mold roller apron yard		
7.1	Mold tilting device	1	For BL-1 Mold
7.2	Ditto	2	For BT-1 Mold
7.3	Mold storage stand	10	For BL-1 Mold
7.4	Ditto	20	For BT-1 Mold
7.5	Mold 1st segment alignment stand	2	
7.6	1st segment alignment stand	2	
7.7	Mold assembly stand	1	
7.8	Ditto	1	
7.9	1st segment stand	6	
7.10	Auxiliaries	1 set	

(continued)

2. Step 2 (2.15 MT/Y) (additional)

Item	Description	Q'ty	Remarks
1.	Rinsing station	1	
1.1	Jib crane	1	Capacity 3 T
1.2	Lifting magnet	1	Capacity 300 kg
1.3	Scrap bin	1	
1.4	Exhaust bar	1	
1.5	Auxiliaries	1 set	
2.	Crane		
2.1	Ladle crane (A)	1	220 T / 5 T
2.2	Billet/Bloom handling crane		10 T
3.	Ladle transfer car	1	
4.	Billet - 2, - 3 CCM		
4.1	Steel strugture	2	
4.2	Ladle turret	2	
4.3	Tundish	4	
4.4	Tundish cover	4	
4.5	Tundish car	4	
4.6	Tundish proheater	4	
4.7	Slag box	4	
4.8	Mold	12	6 x 150 mmSQ 6 x 180 mmSQ
4.9	Rape seed oil supplier	2	
4.10	Pendant box	12	
4.11	Oscillator	12	
4.12	Segment (1)	12	50 - 200 cpm
4.13	Segment (2)	12	Ditto
4.14	Segment support	12	
4.15	Segment removal winch	2	
4.16	Pinch roll	12	
4.17	Torch cutter	12	

(continued)

Item	Description	Q'ty	Remarks
4.18	Torch approach roller table	12	
4.19	Torch roller table	12	
4.20	Torch runout table	12	
4.21	Crop handling	1	
4.22	Discharge roller table	12	
4.23	Chain transfer	2	
4.24	End stop	12	
4.25	Dummy bar	12	
4.26	Dummy bar receiver	12	
4.27	Steam exhaust	2	
4.28	Hydraulic unit	2	
4.29	Lulvication system	2	
4.30	Spares		For BT-2,-3 CCM
4.30.1	Tundish	14	
4.30.2	Tundish cover	14	
4.30.3	Mold	20	10 x 150 mmSQ 10 x 150 mmSQ
4.30.4	Dummy bar head	12	
4.30.5	Dummy bar links	2	
4.30.6	Others	1 set	
5.	Tundish yard		For BT-2,-3 CCM Tundish
5.1	Tundish tilting device	2	
5.2	Tundish skull punch	2	
5.3	Tundish drying	2	
5.4	Tundish repair platform	1 set	
6.	Mold roller apron yard		For BT-2,-3 CCM
6.1	Mold tilting device	3	
6.2	Mold storage stand	30	
6.3	Mold assembly stand	2	

(continued)

Item	Description	Q'ty	Remarks
7.	Spares		
7.1	Tundish	2	For BL-1 CCM
7.2	Tundish cover	2	For BL-1 CCM
7.3	Tundish	2	For BT-1 CCM
7.4	Tundish cover	2	For BT-1 CCM

Table 7.6.10 Equipment list for casters (Electrical)

Note: * 1 set covers Bloom-1 CCM and Billet-1 CCM
** 1 set covers Billet-2 and -3 CCMs

Item	Description	Quantity	
		1 million ton	2.15 million ton
1	High tension panel	1 set*	1 set**
2	Transformer	1 set	1 set
3	A C motor	1 set	1 set
4	D C motor	1 set	1 set
5	D C control panel	1 set	1 set
6	A C motor control center	1 set	1 set
7	Programmable logic controller and relay panel	1 set	1 set
8	Operater's control station	1 set	1 set
9	Instrumentation	1 set	1 set
10	Level control system	1 set	1 set
11	Detecting apparatus	1 set	1 set
12	Lighting facilities	1 set	1 set
13	Air conditioner in electrical room and operation room	1 set	1 set
14	Communication system	1 set	1 set
15	Wiring materials	1 set	1 set
16	Wiring work	1 set	1 set
17	Welding receptacle for maintenance	1 set	1 set
18	Fire alarm system	1 set	1 set

Table 7.6.11 Design condition of water treatment facility for casters

1. Step 1 (1 MT/Y)

Bloom-1 CCM and Billet-1 CCM		
1. Indirect cooling water system		
(1) Flow rate:		
	Mold	1,026 m^3/h
	Machine closed	102 m^3/h
	Total	1,128 m^3/h
(2) Temperature:		
	Inlet	45°C
	Supply	35°C
	Wet bulb	27°C
(3) Supply pressure:		3 Kg/cm^2G
2. Direct cooling water system		
(1) Flow rate:		
	Spray	264 m^3/h
	Machine open	318 m^3/h
	Total	582 m^3/h
(2) Temperature:		
	Inlet	60°C
	Supply	45°C
	Wet bulb	27°C
(3) Supply pressure:		3 Kg/cm^2G
3. Emergency water		164 m^3/Total

(continued)

2. Step 2 (2.15 MT/Y) (additional)

Billet-2 CCM and Billet-3 CCM		
1. Indirect cooling water system		
(1) Flow rate:		
	Mold	1,296 m^3/h
	Machine closed	108 m^3/h
	Total	1,404 m^3/h
(2) Temperature:		
	Inlet	45°C
	Supply	35°C
	Wet bulb	27°C
(3) Supply pressure:		3 Kg/cm^2G
2. Direct cooling water system		
(1) Flow rate:		
	Spray	360 m^3/h
	Machine open	612 m^3/h
	Total	972 m^3/h
(2) Temperature:		
	Inlet	60°C
	Supply	45°C
	Wet bulb	27°C
(3) Supply pressure		3 Kg/cm^2G

7-6-4. Ingot casting

(1) Layout

Casting platform for top pouring is located at the south end of the teeming and ladle preparation bay and there are three tracks of casting line in the bay. Steel cast in molds mounted on wagons is transferred on the line to the stripping yard about 100 metres to the south of the teeming bay and, after stripped from ingots, transferred to soaking pits.

(2) Specifications of facilities

Main specifications of facilities and equipment list are shown in Table 7.6.12 and Table 7.6.13, respectively.

Table 7.6.12 Main specifications of ingot casting facility

Ingot weight	5.0 T
No. of Ingots/Heat	26 Ingots/Heat
No. of Wagon/Train	5 * Existing molds and wagons are used.
No. of teeming tracks	3
Stripper crane	12 T x 1
Mold cleaner	1

Table 7.6.13 Equipment list for ingot casting

1. Step 1 (1 MT/Y)

Item	Description	Q'ty	Remarks
1.	Teeming platform	2	
2.	Ladle		
2.1	Ladle for casters and ingot casting	14	Capacity 130T
2.2	Emergency ladle for casters	4	
3.	Slag pot for casters and ingot casting	12	
4.	Sliding nozzle		
4.1	Hydraulic unit for ingot casting	1	on ladle crane
4.2	Hydraulic unit for ladle preparation	1	on the ground
4.3	Sliding nozzle cassette	21	
5.	Ladle preparation stand	3	
6.	Ladle drying station	3	
7.	Ladle relining station	1	Pit type
8.	Cranes		
8.1	Ladle crane	1	220T/50T
8.2	Service crane	1	90T/30T
8.3	Stripper crane	1	12T
8.4	Mold crane	1	15T
8.5	Jib crane	4	2T
9.	Locomdite	1	Diesel
10.	Forklift	4	3T
11.	Mold cleaner	1	Gentry type

(3) Operational data

Yield and unit consumption of refractories and energy for ingot casting are shown in Table 7.6.14.

Table 7.6.14 Yield and unit consumption for ingot casting

Item		Value
1. Casting yield		
(good ingot/molten steel)	%	97.0
2. Refractories for ladle		
High grade fire clay brick	Kg/T	4.6
Sliding nozzle (High alumina)	Kg/T	0.6 (Double Nozzles)
3. Utilities		
Electric power	KwH/T	2.0
C.O.G.	Nm^3 /T	2.0
Oxygen gas	Nm^3 /T	0.1
4. Mold	Kg/T	22.0
Stool plate	Kg/T	3.5

(continued)

2. Step 2 (2,15 MT/Y) (additional)

Item	Description	Q'ty	Remarks
1.	Ladle		
1.1	Ladle for casters	14	Capacity 130T
1.2	Emergency ladle	4	
2.	Slay pot for caster	16	
3.	Sliding nozzle		
3.1	Hydraulic unit for ladle preparation	1	
3.2	Sliding nozzle cassette	21	
4.	Ladle preparation stand	3	
5.	Ladle drying station	3	
6.	Ladle relining station	1	
7.	Jib crane	4	2T
8.	Fork lift	4	3T

7-7. Rolling

7-7-1. Outline of the modernization plan for rolling mills

On the condition that existing rolling mills are to be utilized after improvement as far as possible, No.1 bar mill (annual capacity 600,000 T) and No.2 bar mill (annual capacity 700,000 T) are installed to meet increased crude steel production.

Along with shift to BOF steelmaking shop, improvement of facilities required to satisfy the condition resulting from adoption of CC process is implemented.

Of existing rolling mills, blooming mill, billet mill, heavy structural mill and merchant and bar mill are to be utilized after remodelling to meet the condition in the 1st and 2nd steps. But light structural mill is to be closed in the 1st step and sheet mill is utilized in the 1st step only and closed in the 2nd step. The sheet mill is old and it is difficult to modernize it by remodelling and also estimate its remaining life. Therefore the mill is excluded from the production plan in the 2nd step.

7-7-2. Product mix

It is stated in Chapter 3 that in view of the forecast of steel demand in India, bars and other non-flat products are most suitable as product mix after expansion under the modernization of IISCO BURNPUR Works.

Product mix of existing heavy structural mill, merchant and bar mill is assumed to be kept as it is and also it is assumed their production can be expanded.

Product mix of bar mills newly installed is determined on the basis of actual production of round and deformed bars in India and BURNPUR Works.

Reflecting the above, product mix of each rolling mill is set as follows:

Heavy structural mill:	250,000 T
Squares	78,000 T
Flats	1,000
Channels, angles, joists	112,000
Rails	16,000
Special sections	43,000
Merchant & bar mill:	250,000 T
Plain round	102,000 T
Deformed bars	62,000
Angles	53,000
Flats	33,000

No.1 and No.2 bar and section mills:

Mill	Size of Products (mm)	Quantity of product Unit : x 10^3 T (ratio %)				
		10-12	14-22	25-38	40-80	Total
No.1 Bar and section mill	10-32	180 (30)	300 (50)	120 (20)	---	600
No.2 Bar and section mill	20-80	---	210 (30)	370 (53)	120 (17)	700
Total	10-80	180 (14)	510 (39)	490 (38)	120 (9)	1,300

cf: 1 Production of bar & deformed bar in India (1981/82)

Size (mm)	8-10	12-22	25-80	100 & above
Ratio (%)	15	43	41	1

(by National Council of Applied Economic Research)

2 Production of bar & deformed bar in BURNPUR works (1985/86)

Size (mm)	8-10	12-22	25-36	40-60
Ratio (%)	--	40	52	8

Sheet mill:	100,000 T
Black sheet:	70,000 T
Galvanized sheet:	30,000 T

7-7-3. Modernization plan of rolling department

(1) Blooming mill

Facilities modernization plan for blooming mill is shown in "Blooming mill" in Table 7.7.1.

In line with adoption of CC in steelmaking process, the soaking pits near mill line are removed and a bloom reheating furnace is installed. Also for improvement of quality and yield, reduction of unit fuel consumption and maintenance of facilities (decrease of scale), instrumentation of soaking pits is modernized.

For the rolling mill, thyrister converter for main motor is introduced and feed roller and roller table are remodelled to reduce troubles in rolling operation.

As fuel, power and material (ingot and bloom) conditions are much improved by the modernization, annual working hours increases to 5,500 hours and it becomes possible to process 448,000 T from ingot (120 T/h) and 282,000 T from cast bloom (160 T/h).

(2) Billet mill

Facilities modernization plan for billet mill is shown in "Billet mill" in Table 7.7.1.

Major project is introduction of thyrister converter for main motor.

As points to be improved, there may be cited installation of roller twister between stands, improvement of gauge stopper and of skids on cooling bed, but they are considered not related with the modernization plan and are to be treated as routine improvement plan items.

Production of billet mill is about 300,000 T at present. But net utilization rate of the mill is only 32% or so, and its steel shortage reaches 4,400 hours a year. If steel is available, billet production of 474,000 T should be possible even with present rolling rate of 105 T/h.

(3) Heavy structural mill

Facilities modernization plan for heavy structural mill is shown in "Heavy structural mill" in Table 7.7.1.

Replacement of reheating furnaces and introduction of thyrister converter for main motor are major projects. Also replacement of hydraulic pressure unit is performed to stabilize operation.

As to the finishing line, straightener is moved inside roller table behind cooling bed to rationalize straightening operation.

In addition to the above, improvement of roll bearing and installation of tilter is included, but they should be made as daily facilities improvement and not waiting the modernization plan.

After the modernization, conditions concerning fuel, heating capacity, steel shortage and waiting for blooms from blooming mill are improved. This enables reduction of idle time (reaching 36.5% at present) and increases annual working hours to 5,500 hours, making it possible to produce 250,000 T with production rate of 46 T/h.

(4) Merchant and bar mill

Facilities modernization plan for merchant and bar mill is shown in "Merchant and bar mill" in Table 7.7.1.

Combustion control of the reheating furnace is modified from present manual operation to automatic control system for temperature, gas flow, air flow and pressure of furnace atmosphere to improve heating efficiency, and weigher is installed at the charging side of the furnace.

Thyrister converter is used for DC mill motor only and a new desk is installed. Auxiliary motor is kept as it is.

Improvement items includes, in addition, improvement of entering guides (to roller type) of each stand and replacement of skids in the reheating furnace, but these should be dealt with as normal repair and improvement.

Incidentally the merchant and bar mill, after the modernization, is planned to be fed with billets whose size is standardized in 100 mm square. Consideration should be paid in future improvement to enable rolling of larger billets.

With improvement of fuel, power and material conditions and operation personnel being placed in all shifts after the modernization, working hours increase to 5,500 hours and production of 250,000 T is possible.

(5) Sheet mill

Facilities modernization plan for sheet mill is shown in "Sheet mill" in Table 7.7.1.

Improvement of combustion control system of the reheating furnace is taken up and it is only for the 1st step.

(6) No.1 bar & section mill

1) Outline of production

a) Product mix: Steel grade - Mild carbon steel (JIS SS & SD)

Size - Round bar 10-32 mm ø (Incl. deformed bar D10-D32)

- Angles L 25 - L 40

b) Operation condition:

Operation time (A)	- 8,760 h/Y
Roll rotating time (B)	- 6,000 h/Y
Availability (B/A)	- 68.5 %
Average productivity (C)	- 100 T/h
Annual production (BxC)	- 600,000 T/Y

2) Outline of No.1 bar and section mill

Outline of facilities of No.1 bar and section mill is shown in "No.1 bar & section mill" in Table 7.7.1.

a) Layout

No.1 bar & section mill is full continuous rolling mill and its finishing line is divided into bar finishing line and section finishing line, both forming continuous line.

Across the mill yard, there are separate product yards for bars and sections, and finished products shipped directly from the mill.

Roll shop exclusively used for this mill is set up in the rolling yard.

Also considering hot charge of billets, the entire mill is planned to be as close as possible to the CC plant.

The layout of the mill is shown in Fig. 7.7.2.

b) Billet yard

Though the mill produces mainly products of small size, it is contemplated to use billets of large size, 150 mm sq. x 10 m (unit weight being about 1,700 kg) to improve yield and productivity.

With a view of improving product quality and saving energy consumption, in principle, hot billets from the CC plant are directly fed into the reheating furnace (hot charge), by roller table to minimize heat loss of billets. But cold billets are always stocked at billet yard and used either when the CC plant is not operated or when output of the mill exceeds supply of cast billets.

c) Reheating furnace

Reheating furnace is of walking hearth type and has capacity of 120 T/h to ensure average rolling efficiency of 100 T/h. With hot charge as well as waste heat recovery by recuperater and proper control of furnace temperature, unit fuel consumption is 270 x 10^3 kcal/T when rolling production is as planned, resulting in a big energy-saving.

In addition, improved combustion control reduces sweating or excessive scaling in the reheating furnace and improves yield.

d) Rolling equipment

The mill is of tandem arrangement, with roughing train and finishing train comprising alternate horizontal and vertical roll stands and intermediate train comprising horizontal stands only. This is because both bars and sections are rolled on the mill, and when rolling sections, only horizontal stands are used of finishing train.

Each roll stand of roughing train (9 stands), intermediate train (6 stands) and finishing train (4 stands) is driven by individual motor, and roll changing device is of stand changing type to reduce roll change time.

In addition, when small size bars, 10-16 ϕ and D10-D16, are rolled, "Split rolling" is adopted. This aims at reducing the number of roll stands, thereby decreasing initial investment, improving unit power consumption and production rate.

In the split rolling, No.18 and No.19 stands roll two strands concurrently, but other stands roll one strand.

As indicated by the maximum finishing rolling speed of 25 m/sec (when 10 ø or D10 is rolled), high speed rolling is employed to increase efficiency.

Flying shear behind roughing train and snip shear behind intermediate train are installed to prevent occurrence of "misroll" by cropping defective foremost end of material to be rolled and cut off cobbles when misroll occurred, and dividing shear behind finishing train cuts rolled products to optimum cut lengths to obtain the maximum yield within the limit of effective length of cooling bed.

e) Finishing process facilities

Cooling bed is of rake type and has high speed transfer device to meet the maximum rolling speed of 25 m/sec. In addition, stopper is installed at the delivery end of cooling bed to align the ends of products and improve yield. Because handling differs between bars and sections, finishing process is separated for bars and sections.

Bars are cut to specified lengths by cold shear behind cooling bed and automatically bundled and weighed. Sections are straightened in multiple lengths to increase production rate and cut to ordered lengths and processed through piling, automatic bundling and weighing.

f) Electric equipment

Main motors are all DC motors, and one stand is driven by one motor individually. Each DC motor is supplied power from an independent variable voltage generator. This DC generator with variable voltage is static Leonard system with thyrister (Thyrister Leonard) and provides good response, and besides, it is small, requiring small area for installation, and needs almost no maintenance.

This individual power source and individual drive system provides excellent response to impact drop and enables accurate speed control.

In addition to main motors, DC motors are employed for auxiliary motors which require speed control of high accuracy.

This individual power source and individual drive system provides excellent response to impact drop and enables accurate speed control.

In addition to main motors, DC motors are employed for auxiliary motors which require speed control of high accuracy.

g) Production of high grade steel

High grade steels such as carbon steel and low alloy steel can be produced by adding billet inspection and conditioning facilities, ultrasonic detector, magnetic particle detector, shot blasting machine, and chipping tools.

The reheating furnace, of walking hearth type, is provided with automatic combustion equipment for less decarbonization, fewer surface defects, and more uniform heating.

The rolling mills, of integrated continuous rolling type with one strand for fewer rolling defects, are installed in alternate arrangement of horizontal mill and vertical mill. The cooling bed is of rake type for less bending.

All the electrical equipment are of quick-response type for stable operation of the rolling mills.

All those enable production of high grade steels excellent in surface quality, dimensional accuracy and mechanical properties.

For 10 to 16 mm ø, one-strand rolling not split rolling is employed.

h) Technical explanation on "SPLIT ROLLING"

i) What is split rolling?

The size of concrete reinforcing bar ranges widely from D10 to D51 in Japan. Among those above, smaller sizes i.e. D16 and under represent around half of the total production amount. There have been problems of low productivity and high electric power consumption because of many passes for the production of such smaller sized concrete reinforcing bars.

"Split rolling" has successfully solved these problems above. Split Rolling is an outstanding equipment of high productivity, high efficiency and very effective in energy saving for production of smaller sized concrete reinforcing bars.

Split Rolling (hereinafter referred to as SR) has advantages,

(i) High productivity
(ii) Low electric power consumption
(iii) Low investment cost owing to less necessary number of roll stands (Two roll stands can be reduced compared with conventional design, in general.)

Furthermore, below mentioned advantages can be expected in addition.

Product yield increase, because of possibility to adopt large section billets

Drastic energy saving by hot direct charging of billet under a good connection with continuous caster operation, owing to the similar productivity regardless of the product size differences.

ii) An example of Split Rolling

(a) Specification

Type	: Knife notching - split roller
Knife material	: High speed tool steel
Knife clearance adjustment	: Constant pass line, wedge type
Knife operation	: Hydraulic cylinder operated
Split roller diameter	: 200 mm
Split roller material	: Alloy tool steel
Split roller cooling	: Water spray
Shifting device	: Hydraulic cylinder operated
Split speed	: Approx. 21 m/sec. Equivalent to finishing speed: 27 m/sec.
Product size range	: D10 to D16

(b) Feature

Compared with a conventional single strand rolling, SR drastically contributes to reduce electric power consumption and reduce necessary number of roll stands and ultimately reduces both production cost and investment cost.

In addition to the abovementioned features, it has increased the finishing speed to improve the productivity particularly on smaller sized products, with driven split rollers.

(1) A couple of split rollers are installed at different planes each set on the driving side and the operation side, respectively. The driving side split rollers bend the rolled stock upward and the operation side ones downward. The pinch rollers installed just behind those units apply tension to split the rolled stock completely. Such device enables high speed rolling of even smaller sized products in a stable condition.

Fig. 7.7.1 shows schematically the principle of SR unit.

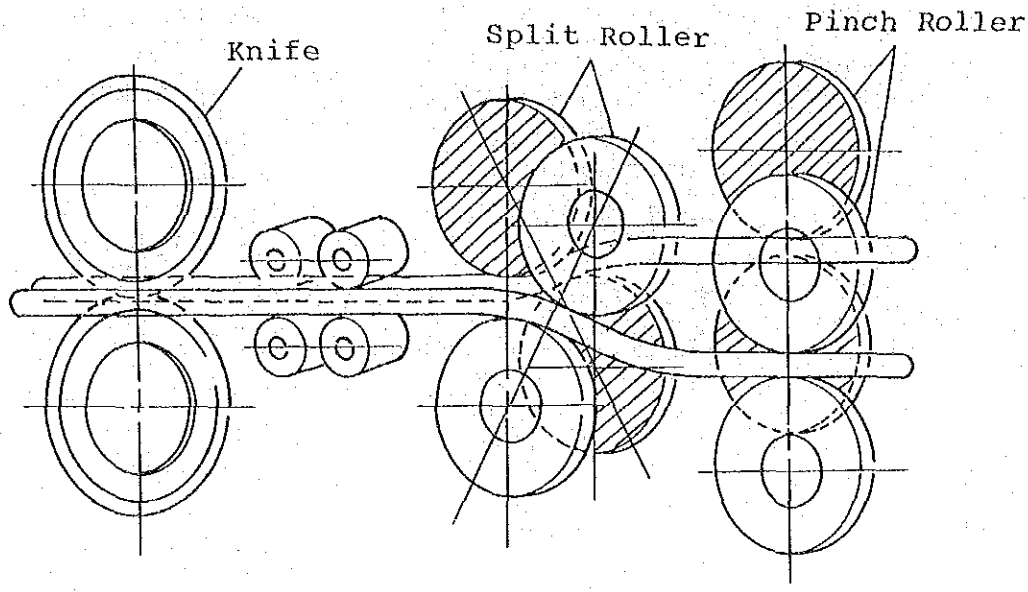


Fig. 7.7.1 SR unit mechanism

(2) A notching on the front end of a rolled stock by operating the driven disc knives with a hydraulic cylinder located just in front of the split rollers enables a smooth splitting operation, well avoiding abnormal cooling at the front end not affecting the shape of the front end of a rolled stock.

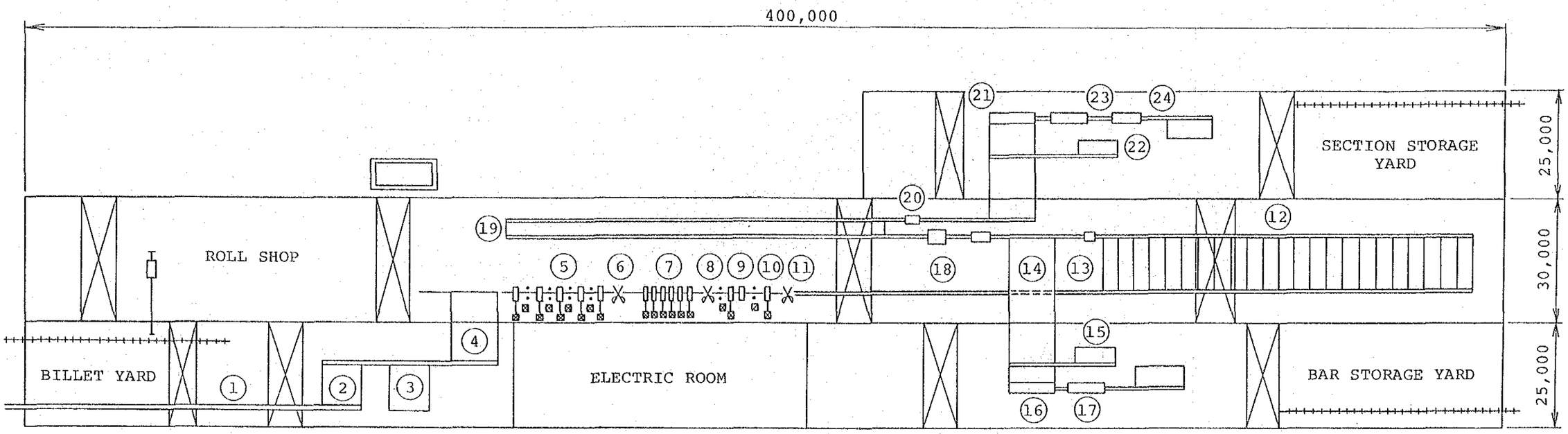
Also less clearance between the knives continuously enables notching even when the previous roll grooves are worn out to some extent, because it is effective for better split shapes.

(3) Each of split rollers and pinch rollers is equipped with a device for clearance adjustment, to easily correspond the different sizes of rolled stocks as well as size variation due to the roll groove abrasions.

Each of rollers is fixed with only one bolt for easy and prompt replacement on line.

(4) Knives and rollers are all water spray cooled at points of contact with a rolled stock for longer service lives.

(5) A hydraulically operated shift device promptly retracts the split roller unit off line when single strand rolling is needed and the unit is not necessary.



GENERAL SPECIFICATION

○ TYPE OF MILL	FULL CONTINUOUS TYPE
	SPLIT ROLLING FOR 10 TO 16 mm DIA. BARS
○ PRODUCTION CAPACITY	600,000 T/Y
○ BILLET	150 x 150 x 10,000 (APPROX. 1,700 Kg/PIECE)
○ STEEL GRADE	ORDINARY CARBON STEEL
○ PRODUCTS	ROUND & DEFORMED BAR: 10 TO 32 mm DIA.
	EQUAL ANGLES : 25 x 25 TO 40 x 40 mm
○ ROLLING SPEED	APPROX. 25 m/sec AT 10 mm DIA. BARS
	12.5 m/sec AT 30 x 30 mm EQUAL ANGLES
	10 m/sec AT 40 x 40 mm EQUAL ANGLES
○ REHEATING FURNACE	120 T/H WALKING HEARTH TYPE

NO.	EQUIPMENT NAME	NO.	EQUIPMENT NAME
①	TRANSFER ROLLER TABLE	⑬	COLD SHEAR
②	HOT BILLET RECEIVING TABLE	⑭	TRANSFER TABLE
③	COLD BILLET RECEIVING TABLE	⑮	IRREGULAR BAR TAKE-OUT TABLE
④	REHEATING FURNACE	⑯	AUTOMATIC BINDING MACHINE
⑤	ROUGHING TRAIN (9 STANDS)	⑰	WEIGHING MACHINE
⑥	FLYING SHEAR	⑱	STRAIGHTENING MACHINE
⑦	INTERMEDIATE TRAIN (6 STANDS)	⑲	TRANSFER TABLE
⑧	SNIP SHEAR	⑳	COLD SHEAR
⑨	FINISHING TRAIN (4 STANDS)	㉑	PILING MACHINE
⑩	SPLITLING UNIT	㉒	IRREGULAR SECTION TAKE-OUT TABLE
⑪	DIVIDING SHEAR	㉓	AUTOMATIC BINDING MACHINE
⑫	COOLING BED	㉔	WEIGHING MACHINE

Fig. 7.7.2 No.1 Bar & section mill

(7) No.2 bar & section mill

1) Outline of production

a) Product mix: Steel grade - Mild carbon steel

Size
- Round bar 20-80 mm ø (Incl. deformed bar D22-D38)
- Square bar 40-80 mm sq
- Angles L 40- L 80
- Channels © [50-[75

b) Operation condition:

Operation time (A)	- 8,750 h/Y
Roll rotating time (B)	- 6,000 h/Y
Availablility (B/A)	- 68.5%
Average productivity (C)	- 120 T/h
Annual production (BxC)	- 700,000 T/Y

2) Outline of No.2 bar and section mill

Outline of facilities of No.2 bar and section mill is shown in "No.2 bar & section mill" in Table 7.7.1.

a) Layout

No.2 bar & section mill is one-strand full continuous rolling mill and its finishing line, though divided into bar line and section line, is also continuous.

As the mill serves as product yard also, it has separate product yards for bars and sections, from which the products are shipped directly.

For energy saving, in principle, billets are hot charged to reheating furnace, and the mill as a whole is built as close as possible to the CC plant. The layout of the mill is shown in Fig. 7.7.3.

b) Billet yard

Billets of 180 mm sq x 10 m (unit weight being about 2,500 kg) are used to produce large bars up to 80 mm ø, but the minimum percentage reduction is 6.4, which is high enough to refine cast grain structure. Also as the unit weight is big, yield of large sized bars is high.

To ensure smooth and efficient hot charge of billets into the reheating furnace, hot billets are transferred by roller table from the finishing yard of the CC plant.

When production rate of the CC plant and that of this mill do not match well, cold billets have to be used and are always in stock at billet yard.

c) Reheating furnace

To heat billets of large section efficiently, the reheating furnace is of walking beam type. In consideration of the fact that heating capacity is a factor to determine production rate of large sizes, the reheating capacity is fixed to be 150 T/h.

The furnace is equipped with recuperater and combustion control system, and together with the hot charge, this improves unit fuel consumption to as low as 270 x 10^3 kcal/T. At the same time, proper control of furnace atmosphere temperature enables decrease of scale loss in the furnace, improving yield.

d) Rolling equipment

The mill is of tandem arrangement, and as both bars and sections are rolled, No.1 through No.8 stands of roughing train and four stands of finishing train are horizontal and vertical alternately and

Nos.9 & 10 stands of roughing train and four stands of intermediate train are horizontal.

When rolling sections, the vertical roll stands of finishing train form dummy passes.

As large billets are rolled on this mill, if only horizontal rolls are used in all stands, there may occur operational and qualitative problems caused by twisting of a rolled stock. With the alternate horizontal and vertical roll stands in roughing and finishing trains, the problems can be obviated considerably.

All of 18 roll stands are driven by independent DC motors, and roll changing time is shortened by use of stand changing system.

The maximum finishing rolling speed is about 15 m/sec. when rolling 20 mm ø and average rolling rate is 120 T/h.

To prevent occurrence of misroll by reason of fractured end of a rolled stock, a flying shear is installed behind the roughing train to crop such end and a snip shear is installed behind the intermediate train to deal with troubles such as cobble.

Dividing shear installed behind the finishing train cuts a rolled stock within the limit of effective length of cooling bed in sizes from uncut to 10 equal lengths.

e) Finishing process facilities

The cooling bed is of rake type and perfect round rolled products can be obtained.

Cold shear installed at the delivery side of cooling bed cuts both bars and sections to ordered lengths. After the cold shear, finishing process is divided into bar line and section line.

At the finishing process, bars pass through transfer-automatic bundling-weighing and sections pass through straightening-piling-automatic bundling-weighing.

f) Electric equipment

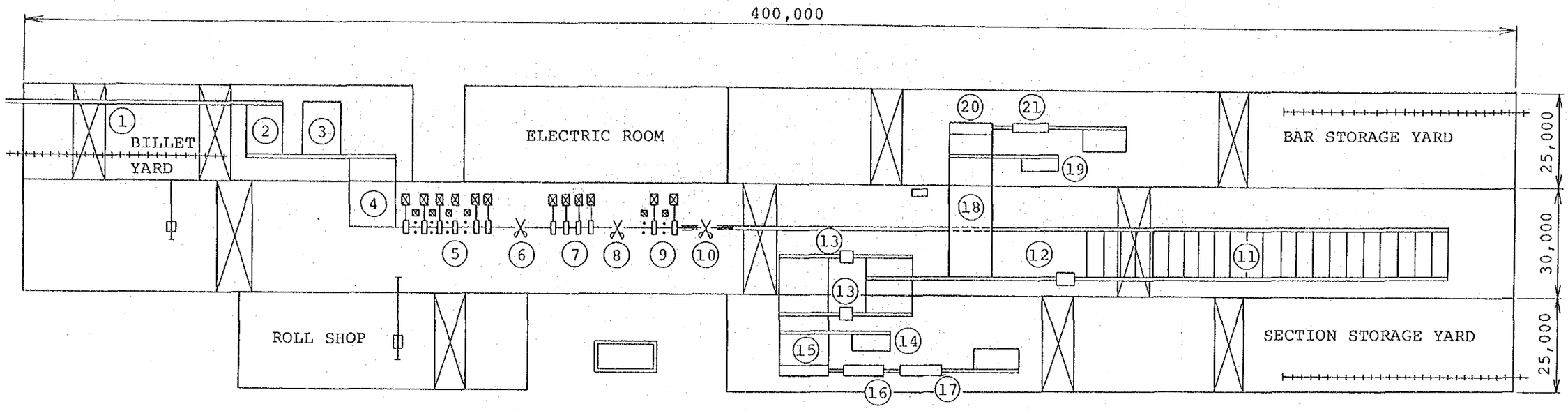
Main motors are all DC motors, and for all main motors, individual power and driving system with Thyrister Leonard system is adopted. This enables rapid speed recovery and control against impact drop. Also, compared with mercury-arc rectifier, this thryster Leonard system is lower in cost and superior in response and besides, needs almost no maintenance.

DC motors are employed also as auxilary motors of which accurate speed control is required.

g) Production of high grade steel

The reheating furnace is of walking beam type for uniform heating; the one-strand rolling mills are in alternate arrangement of horizontal mill and vertical mill for less twist of rolling stock; the cooling bed is of rake type for effective cooling and less bending; and the electrical equipment is of quick-response type for stable operation of the rolling mills.

All these enable production of high grade steels such as carbon steel and low alloy steel by installing ultrasonic detector, magnetic particle detector, shot blast machine, and chipping tools in the billet yard.



GENERAL SPECIFICATIONS

- PRODUCTION CAPACITY 700,000 T/Y
- BILLET 180 x 180 x 10,000 mm
  (APPROX. 2,500 Kg/PIECE)
- STEEL GRADE ORDINARY CARBON STEEL
- PRODUCTS ROUND & DEFERMED BARS: 20 TO 80 mm DIA.
  SQUARE BARS : 40 TO 80 mm SQ
  EQUAL ANGLES : 40 x 40 TO 80 x 80 mm
  CHANNELS : 50 x 25 TO 75 x 40 mm
- NUMBER OF STRANDS 1 (ONE)
- ROLLING SPEED APPROX. 15 m/sec AT 20 mm DIA. BARS
  10 m/sec AT 50 x 50 mm EQUAL ANGLES
  8 m/sec AT 60 x 60 mm EQUAL ANGLES
  6 m/sec AT 80 x 80 mm EQUAL ANGLES
  8 m/sec AT 50 x 25 mm CHANNELS
  6 m/sec AT 75 x 40 mm CHANNELS
- REHEATING FURNACE 150 T/h WALKING BEAM TYPE

No.	EQUIPMENT NAME	No.	EQUIPMENT NAME
①	TRANSFER ROLLER TABLE	⑫	COLD SHEAR
②	HOT BILLET RECEIVING TABLE	⑬	STRAIGHTENING MACHINE
③	COLD BILLET RECEIVING TABLE	⑭	IRREGULAR SECTION TAKE-OUT TABLE
④	REHEATING FURNACE	⑮	PILING MACHINE
⑤	ROUGHING TRAIN (10 STANDS)	⑯	BINDING MACHINE
⑥	FLYING SHEAR	⑰	WEIGHING MACHINE
⑦	INTERMEDIATE TRAIN (4 STANDS)	⑱	TRANSFER TABLE
⑧	SNIP SHEAR	⑲	IRREGULAR BAR TAKE-OUT TABLE
⑨	FINISHING TRAIN (4 STANDS)	⑳	BINDING MACHINE
⑩	DIVIDING SHEAR	㉑	WEIGHING MACHINE
⑪	COOLING BED		

Fig. 7.7.3 No.2 Bar & section mill

Table 7.7.1 Modernization of rolling department

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Blooming mill				
Soaking pit combustion control system	1 set	Instrumentation for control system of temperature, gas flow, air flow, pressure of atmosphere		
Bloom reheating furnace	1 unit	Top/Bottom fired 4 zone Walking beam type Effective length of furnace: 20,000 mm Width of furnace: 6,800 mm Burner: Nozzle mix type Recuperater Combustion control system 100 T/h		
Main-drive motor	2 units	Thyrister converter for main motor 6600HP x 1 and Ilgner Shear motor 700HP x 1 and Ilgner		
Mill feed roller	1 set	Motor drive		
Roller table	1 set	Replacement fo roller table between 500T shear and billet mill		
Billet mill				
Main-drive motor	6 units	Thyrister converter for roughing mill 800HP x 2 and Ilgners and intermediate mill 600HP x 4 and Ilgners		

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Heavy structural mill				
Replacement of reheating furnace	2 units	Top fired 1 zone pusher type Length of furnace: 7,500 mm Width of furnace : 6,700 mm Recuperater : channel type Combustion control system		
Main-drive motor	2 units	Thyrister converter for main motor 6,700HP x 1 , 6,000HP x 1 and Ilgners.		
Straightener	1 unit	Relocation of straightener		
Auxilialy equipment	1 set	Replacement hydraulic pressure unit for spindle and spindle balance (750 psi)		
Merchant and bar mill				
Reheating furnace combustion control system	1 set	Instrumentation for control system of temperature, gas flow, air flow, pressure of atmosphere. Modification of recuperater		
Main-drive motor	16 units	Thyrister converter for main motor 250/500/500HP x 1 #1 & #2 stand 250/500/500HP x 7 #3 ~ #9 stand 300/600/600HP x 2 #10, #12 stand 300/600/600HP x 2 #11, #13 stand 75/150/150HP x 4 E1 ~ E4 stand		
Sheet mill				
Reheating furnace combustion control system	1 set	Instrumentation for control system of temperature, gas flow, air flow, pressure of atmosphere.		

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
No.1 Bar & section mill				
Billet receiving equipment	1 set	Consisting of Transfer roller table: one (1) Hot billet receiving table: one (1) Cold billet receiving table: one (1)		
Reheatig furnace	1 unit	Type: Walking hearth type Capacity: 120 T/h Including Combustion control equipment		
Billet charging & discharging equipment	1 set			
Roughing mill stand	9 stands	Horizontal-vertical alternative arrangement Horizontal stand: five (5) Vertical stand : four (4) Including Driving equipment such as reduction gear, pinion stand and spindle		
Intermediate mill stand	6 stands	Horizontal arrangement Horizontal stand: six (6) Including Driving equipment		
Finishing mill stand	4 stands	Horizontl-vertical alternative arrangement		

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
		Horizontal stand: two (2) Vertical stand : two (2) Splitting unit for split rolling : one (1) Including Driving equipment		
Mill guide & guiding equipment	1 set			
Roll	1 set			
Shear	3 units	Consisting of Flying shear behind roughing train: one (1) Snip shear behind intermediate train: one (1) Dividing shear behind finishing train: one (1)		
Cooling bed	1 unit	Type: Rake type Including Run-in roller table equipped with high speed run-in trough: one (1) Run-out roller table: one (1)		
Cold shear	2 units	Type: Down cut type Including Gauge stopper: Two (2)		
Bar finishing equipment	1 set	Consisting of Transfer table: one (1) Irregular bar take-out table: one (1)		

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
		Automatic binding machine: one (1) Weighing machine: one (1)		
Section finishing equipment	1 set	Consisting of Straightening machine: one (1) Transfer table: one (1) Piling machine: one (1) Irregular section take-out table : one (1) Automatic binding machine: one (1) Weighing machine: one (1)		
Lubrication & hydraulic system	1 set	Consisting of Lubrication oil circulation system Grease system Hydraulic system		
Electrical equipment	1 set	Including Electric power supply equipment DC main mill motor: nineteen (19) total 14,000 KW Auxiliary motor Control equipment		
Water treatment system	1 set	Consisting of Direct cooling water treatment system Indirect cooling water treatment system		
Roll shop equipment	1 set	Including Roll lathe Electro discharging machine		

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Overhead travelling crane	10 units			
Other ancilarly equipment	1 set			
No.2 Bar & section mill				
Billet receiving equipment			1 set	Consisting of Transfer roller table : one (1) Hot billet receiving table : one (1) Cold billet receiving table : one (1)
Reheating furnace			1 unit	Type: Walking beam type Capacity: 150 T/h Including Combustion control equipment
Billet charging & Discharging equipment			1 set	
Roughing mill stand			10 stands	Horizontal-vertical arrangement Horizontal stand: six (6) Vertical stand : four (4) Including Driving equipment such as reduction gear, pinion stand and spindle

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Intermediate mill stand			4 stands	Horizontal arrangement Horizontal stand: four (4) Including Driving equipment
Finishing mill stand			4 stands	Horizontal-vertical alternative arrangement Horizontal stand: two (2) Vertical stand : two (2) Including Driving equipment
Mill guide & guiding equipment			1 set	
Roll			1 set	
Shear			3 units	Consisting of Flying shear behind roughing train: one (1) Snip shear behind intermediate train: one (1) Dividing shear behind finishing train: one (1)
Cooling bed			1 unit	Type: Rake type Including Run-in roller table : one (1) Run-out roller talbe: one (1)
Cold shear			1 unit	Type: Down cut type Including Gauge stopper: one (1)

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Bar finishing equipment			1 set	Consisting of Transfer table: one (1) Irregular bar take-out table: one (1) Binding machine: one (1) Weighing machine: one(1)
Section finishing equipment			1 set	Consisting of Straightening machine: two (2) Irregular section take-out table: one (1) Piling machine: one (1) Binding machine: one (1) Weighing machine: one (1)
Lubrication & hydraulic system			1 set	Consisting of Lubrication oil circulation system Grease system Hydraulic system
Electrical equipment			1 set	Including Electric power supply equipment DC main mill motor: eighteen (18) total 15,000 KW Auxiliary motor Control equipment
Water treatment system			1 set	Consisting of Direct cooling water treatment system Indirect cooling water treatment system

(continued)

Equipment and facility	Step 1		Step 2	
	Quantity	Specifications	Quantity	Specifications
Roll shop equipment			1 set	Indluding Roll lathe Electro discharging machine
Overhead travelling crane			10 units	
Other ancilary equipment			1 set	

7-7-4. Operational statistics after modernization

Operational statistics (yield and unit energy consumption) for rolling department after the modernization are shown in Table 7.7.2.

Table 7.7.2 Operational Statistics after Modernization

	Yield (%)		Power (kWh/T)		Fuel ($x10^3$ kcal/T)	
	Present	Modernized	Present	Modernized	Present	Modernized
Blooming mill			25.7	24.5	897	600
Ingot	91	92				
Bloom	-	99				
Billet mill	94.5	94.5	27.5	26	-	-
Heavy structural mill	88.5	90.5	124.6	118	616	400
Merchant & bar mill	95.8	97.0	63.5	60	566	400
Sheet mill	78.8	78.8	200	200	1572	1400
No.1 bar & section mill		97.5		90		350/ 270
No.2 bar & section mill		97.5		90		270

7-8. Maintenance

7-8-1. Premiss for the modernization

Step 1 (Crude steel production one million T/Y)

For 1st step, the existing facilities will be used more effectively, but no new investment for facilities in the maintenance department is made.

Mainely, the efforts will be made to improve the maintenance system, such as its organization and personnel, to build the foundation for programmed maintenance system.

Step 2 (Crude steel production 2.15 million T/Y)

For 2nd step, maintenance and repair shops will be centralized and new investment is made for facilities of maintenance.

The organization and personnel as re-organized in the 1st step will be further reviewed to complete the maintenance system befitting the 2nd step operation.

(1) Prime materials to be used

Estimated consumption and supply sources of prime materials used in the maintenance and repair shops in the 2nd step are as shown in Table 7.8.1.

Table 7.8.1 Prime materials to be used

(Unit: T/Y)

Description	Estimated consumption of prime material to be used			
	Produced in the Works	Supplied from KULTI	Supplied from outside	Total
Steel casting	1,000	4,000	---	4,000
Iron casting (excl. ingot mold)	1,000	2,500	---	3,500
Non-ferrous casting	20	280	---	300
Forgings	1,000	---	500	1,500
Steel structure	4,300	---	500	4,800
Total	6,320	6,780	1,000	14,100

- The amount of cast iron produced at BURNPUR Works is kept at the present level. Therefore, increase in demand for cast iron is supplemented by the increased production capacity of 2.15 million T/Y at KULTI. Incidentally, it is desirable from the viewpoint of rationalization that production of cast iron in PURNPUR Works is gradually decreased and substituted by supply from foundries at KULTI in future.
- Non-ferrous castings will be treated same as cast iron above.
- As regards forging, the capacity of the Works is to be increased to 1,000 T/Y.
- The Works' capacity to manufacture steel structure will be increased.

(2) Facilities of maintenance & repair shops

Maintenance facilities should be of scale necessary for normal maintenance work. Manufacture of high quality goods, large sized goods and other special goods is to be ordered outside. In this respect, consideration must be given how to satisfy the requirement not only in West Bengal State where BURNPUR and CALCUTTA are located but in India as a whole.

1) Examples of spares to be manufactured
   a. Machining and repair/assembly of spares and re-usable items
   b. Welding and plate/structural framework
   c. General forgings
   d. Some iron castings/non-ferrous castings

2) Examples of spares not to be manufactured

a. Steel castings
b. Most of iron castings/non-ferrous castings
c. Large forgings
d. High precision parts requiring high technology in the manufacture such as:
   Bevel gear, spindle, locomotive parts, vehicle parts, turbo-generator parts, etc.
e. Goods which cannot be manufactured economically by the Works itself
f. Most of electric parts and instrument parts
g. Standard articles
h. Parts using rubber and high polymer materials

(3) Maintenance & repair shops listed below may, if properly maintained, satisfy the requirement without investment for modernization, and therefore are excluded from the present modernization plan.

Casting & pattern shop
Locomotive repair shop
Wagon repair shop
Vehicle repair shop

(4) Scope of maintenance & repair works

Maintenance system is to be independent and centralised organization to control of maintenance and repair department, besides performing important jobs by utilizing various maintenance facilities and personnel.

1) In principle, repair of equipment is carried out in the Works.
2) Repair of reheating furnaces, excluding overall reconstruction, is done by the Works' personnel.
3) Track maintenance for railways in the compound of the Works and those under control of the Works is done by the Works' personnel.

4) Except partial repair, repair of structures and buildings is done by sub-contractors.

As mentioned in the following proposal for modernization in 7-8-2, each operation department is also responsible for some maintenance functions.

7-8-2. Proposal for modernization

(1) Organization

Present maintenance organization may be divided basically to central maintenance sections and area maintenance sections.

After the modernization, the Maintenance division will consist of central maintenance sections mainly to engage in overall maintenance of the Works, manufacture of general parts and repair of equipment such as machining, welding and plate/structural framework, casting and forging, besides other maintenance work.

Area maintenance sections belong to major operation sections and perform daily inspection, besides small repair work at area repair shop of each major production unit and maintenance of parts peculiar to each unit for re-use over and over again.

Hereinafter, the present organization of Maintenance department and that after the modernization are shown separately. (See Tables 7.8.2 and 7.8.3.)

Characteristics of the organization after modernization are as follows:

1) Maintenance system

Basically, mixed maintenance system is employed.

Table 7.8.2 Organization (Present)

	Asst.GM	Ch.Supdt Ch.Eng'r	Supdt	Mgr	Other Mgr	S/V worker	After modernization
Deputy general manager		Refractories					
	Mechanical	C & OR	Iron	Mechanical maint (BF)			to BF
				M.M. (Coke oven & CHP)			to Coal/Coke
			SMS & crane	M.M. (Steel making)			to SM
				M.M. (Crane)			to each Div.
			Rolling mill	M.M. (Blooming, Billet, Bar)			to RM
				M.M. (Heavy & light structural)			to RM
				M.M. (General servicing)			to each Div.
			Capital repair	M.M.			
				Electrical M.			
		Mech. shops	Mech. shops	Light maintenance shop			
				Heavy maintenance shop			
			Services	Disel service			
				Eearth moving equipment			
			Civil maintenance				
	Power & electrical	CEE	Electrical maintenance	Electrical maint. (Melting shop)			to SM
				E.M. (Rolling mills)			to RM
				E.M. (Heavy drive & distribution)			
				E.M. (Crane inspection)			
			E.M.	E.M. (Coke oven)			to Coal/Coke
				E.M. (BF)			to BF
				E.M. (Power distribution)			to Energy
			E.M.	Diesel services			to Energy
				Central repairings			to Energy
		CPE	Generator				to Energy
			Boilers				to Energy
		Planning					
	approx. 300					approx 8200	

Total 8500

Table 7.8.3 Re-organization (Step 2)

		Dept.Mgr	Section Mgr	Eng'r/ Staff	S/V, Worken
Gen.Mgr of maintenance div.	Dy.G.M.		Office staff (1)	0/6	--
		Maintenance technology	Mechanical (2)	11/3	17
			Electrical (2)	7/2	
	Dy.G.M.	Maintenance & repair shop		0/2	--
			Machine shop (1)	1/0	516
			Repair & assembly shop (1)	1/0	
			Forging shop (1)	1/0	252
			Casting shop (1)	1/0	99
			Structural shop (1)	1/0	242
			Loco./Wagon repair shop (1)	1/0	226
			Vehicle repair shop (1)	1/0	
		Repair & construction	Mechanical (1)	0/2	233
			Electrical (1)		81
		Electrical maintenance	Electrical maintenance (1)	8/2	206
			Electrical repair shop (1) (including diesel/vehicle) vehicle)		
			Instrument maintenance (1)		86
	Dy.G.M.	Civil	Parmanent way (1)	2/1	153
			Iron (1)		97
			Steet (1)		74
		Refractories	Refractories (2)	3/1	853
1	3	6	22	38/19	3135

Total : 3224

2) Simplification of the executive class

Present 9-grade system is revised to 4-grade. Namely,

General manager of Maintenance division
Deputy general manager of Maintenance division
Department manager
Section manager

3) Establishment of Maintenance technology department

The objective of establishment of Maintenance technology department is modernization and rationalization of maintenance work by actively promoting the work as listed below. This department in a grouply manner conducts a very important role in a modern steel plant and its typical duties are :

- Promotion of maintenance engineering
  This department performs technological activities that modify the effect of maintenance by improving maintenance method and control standards. Namely, such activities include establishment and revision of maintenance standards, guidance and assistance, analysis of causes for troubles and appraisal to the effect of maintenance.
- Implementation of optimum maintenance planning
  Optimum interval of repair, optimum method to replace parts, optimum number of maintenance personnel and optimum interval of inspection are planned to minimize the total of loss from deterioration of equipment and maintenance cost.
- Development and improvement of machining and control technologies
- Promotion for rationalization of facilities in maintenance system
  For example, strengthening of preventive maintenance system for critical facilities

- Purchasing plan for spares and control of their use
- Technical assistance for facilities maintenance
- Planning of training programme

4) Transfer of area maintenance sections

Area maintenance sections are to be transferred to respective operation departments so that they perform maintenance work under the control of operation divisions.

Namely, Maintenance depts. are to be established in the following divisions to engage in daily inspection, simple repair, and maintenance and repair of parts which are peculiar to specific plants for re-use over and over again.

Coal/Coke
Iron-making -- Iron ore/Sinter
Blast furnace
Steelmaking/Continuous casting
Rolling mills
Energy

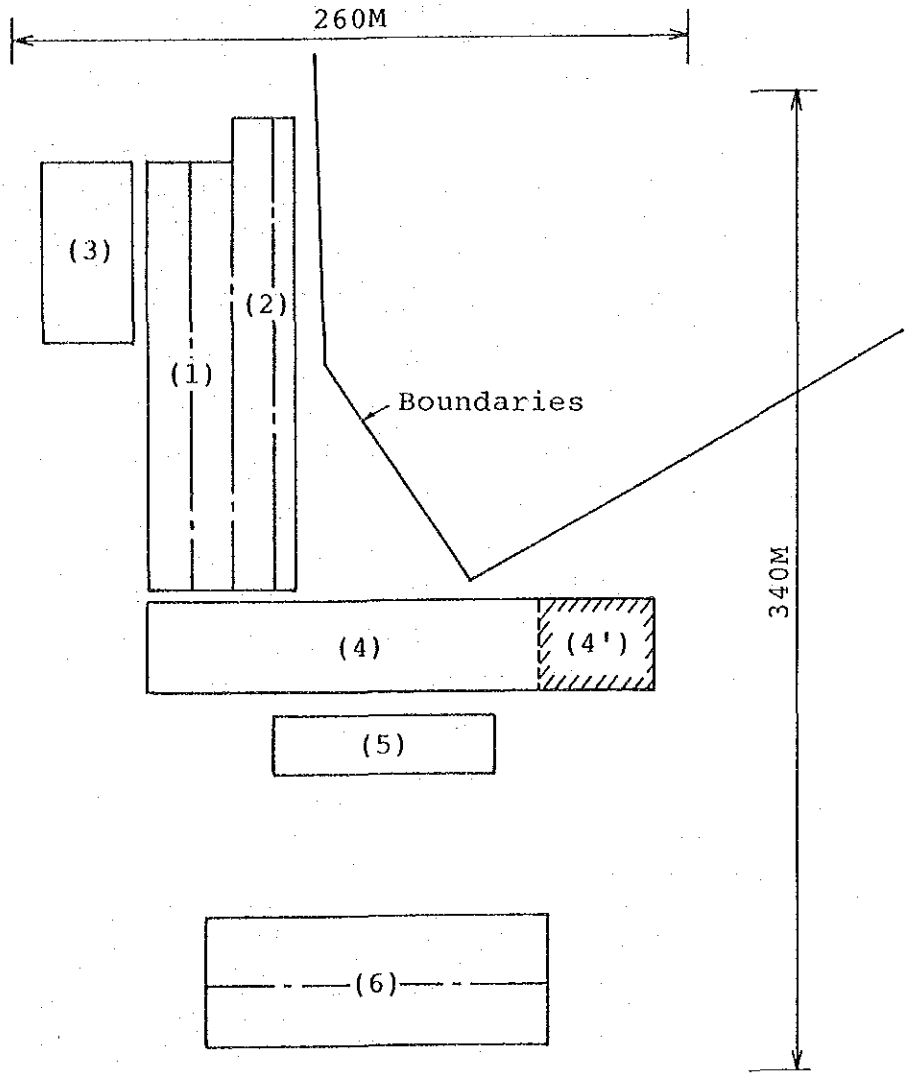
5) Expansion of Repair & construction dept.

Main jobs of this dept. are various repairs such as major repairs and periodical repairs, actions in case of breakdown and back-up in construction jobs. Also it engages in maintenance & repair of large equipment in Repair & assembly shop and welding and plate/ structural shop.

Therefore, its group organization is subject to change according to the number, scale and urgency of the work. In other words, it is a dept. which is managed as a kind of task force.

(2) Modernization of Maintenance & repair shops

The new shops should be installed for manufacture of parts and repair of mechanical, electric, instrument and other facilities, nearby the existing Heavy maintenance area. (Fig. 7.8.1.)



(1) Machine shop (Existing)
(2) Machine shop and repair & assembly shop (Existing electric repair shop)
(3) Repair & assembly shop (New)
(4) Welding and plate/structural shop (Existing)
(4') Ditto (New)
(5) Forging shop (New)
(6) Electric repair shop (New)

Fig. 7.8.1 Layout of maintenance & repair shop

Shops to be modernized are:

Machine shop
Repair & assembly shop
Welding and plate/structural shop
Forging shop
Electric repair shop

Main projects in the modernization plan for each of the above shops are:

1) Machine shop and Repair & assembly shop

- Replacement of obsolete machine tools
- Existing electric repair shop to be utilized as Machine shop and Repair & assembly shop for small Items, whereas the new Electric repair shop has to be built separately.
- Machine tools in Light maintenance area to be shifted to the above deversified shop.
- Repair & assembly shop and Blacksmith shop now in Heavy maintenance area are to be removed and on the same site, Repair & assembly shop (60 m x 30 m) for large equipment has to be built. In addition, new equipment to be introduced.

2) Welding and plate/structural shop

- Existing building has to be extended 40 m and work being done at Light maintenance area should be carried-out in the extended part of the building.
- New equipment to be introduced.

3) Forging shop

- Forging shop (75 m x 20 m) to be built adjacent to the Welding and plate/structural shop.
- Various facilities in present Forging shop and Blacksmith shop to be put together in the new Forging shop.
- Replacement of heating furnace and introduction of new equipment such as manipulator should to be planned.

4) Electric repair shop

- New Electric repair shops (120 m x 25 m, 120 m x 20 m) to be built adjacent to existing Steelmaking shop.
- Facilities in existing Electric repair shop to be moved to the new shop, and at the same time, obsolete facilities to be replaced.
- Steam cleaner for washing of motors & parts, testing panel & instruments, drying oven for drying of motors & parts, binding equipment, etc. to be introduced.

Table 7.8.4 Specification of equipment/machinery

Item	Specifications	
	Present	Rationalization
Machine shop, repair & assembly shop	Building area: 5,300 m²	Building area: 10,300 m² Diversion { : 4,400 m² : 4,100 m² New : 1,800 m² Crane: Diversion { : 15T x 1 : 3T x 1 : 7.5T x 2 New { : 20/5T x 1 : 10T x 1
	Machine tools: • Lathe - 51 • Milling machine - 7 • Drilling machine - 9 • Boring machine - 7 • Grinding machine - 20 • Planer/plano miller - 6 • Shaper - 6 • Slotting machine - 4 • Others - 7	Machine tools 15-Renewal 4- do 2- do 2- do 3- do 3- do 1- do 0- do 1- do } Existing machine tools are to be used after modernization.
	Facilities: • Hydraulic press - 2	Facilities: Diversion : Induction bearing heater - 1 Dynamic balancing machine- 2
Welding and plate/structural shop	Building area: 4,700 m²	Building area: 5,600 m² New : 1,300 m² Diversion : 4,700 m²

(continued)

Item	Specifications	
	Present	Retionalization
	Facilities ° Automatic welding unit - 4 ° Automatic gas cutting unit - 1 ° Dynamic balancing machine machine- 1 ° Bending machine - 1 • Shearing machine - 1 • Hydrualic press - 2 • Cold saw - 1 • Furnace - 2	Crane: Diversion : 20T x 1 New : 20T x 1 Facilities } Diversion New : Automatic welding unit - 2 Tig welder - 2 Flame hardening unit- 1 High speed cutter - 2 Pipe bending machine- 2
Forging shop	Building area: 820 m²	Building area: 1,500 m²(New)
	Facilities: Pneumatic hammer - 5 Furnace - 5	Crane: New : 5T x 1 3T x 1 Facilities: - Diversion - Renewal New : Manipulator 2T x 3 Furnace for heat Treatment 5T x 1 3T x 1

(continued)

Item	Specifications	
	Present	Rationalization
Electric repair shop	Building area: 4,400 m²	Building area: 5,400 m² (New)
		Crane: New: 10T x 1 5T x 2 3T x 1
	Facilities:	Facilities:
	◦ Machine shop	
	Drilling machine - 3	1 - Renewal } Existing machine tools are to be used after modernization.
	Lathe - 2	
	Grinding machine - 1	
	Shaper - 2	1 - Renewal } Existing machine tools are to be used after modernization.
	Milling machine - 1	
	• Winding shop	} Diversion
	Motor coil making machine - 3	} Diversion
	Automatic contacter coil making machine - 2	} Diversion
	Hand driven contracter coil making machine - 2	} Diversion
	Magnet coil winding turn talbe - 1	} Diversion
	• Control panel repair	} Diversion
		New:
		Steam cleaner - 1
		Coil winding machine and coil changing/winding tools - 1
		Testing panel for testing of motor/parts - 1
		Motor generator for testing DC motor - 1
		Drying oven - 1

7-9. Utilities

7-9-1. Power generating facilities

7-9-1-1. Outline

At present the Works owns power generating facilities of 60 MW, but because of gas balance and steam balance, its utilization rate is forced to be as low as about 12 MW.

On the other hand, purchased power reaches about 17 MW, but the lines of power companies are weak and request for load restriction is made frequently, with a considerable effect on production activities.

Though it is expected that gas balance and steam balance will be improved by the modernization plan, but as shown in Table 7.9.1, power bought from DVC will increase to 33 MW in the 1st step and 66 MW in the 2nd step, worse than present.

Table 7.9.1 Electricity balance

Present		Step 1		Step 2	
Generation MW	Buying from DVC MW	Generation MW	Buying from DVC MW	Generation MW	Buying from DVC MW
12	18	31	33	54	66

Under such circumstance, a plan for power generation is prerequisite to ensure stable supply of electricity, one of basic factors for production activities.

Under the plan, combined cycle type power generating facilities which utilize by-product gas and improve self-supply rate are adopted.

Heat rate of the combined cycle type is 2,000 kcal/kWh, and improvement of efficiency a little more than three times as that of existing power generating facilities whose heat rate is 6,489 kcal/kWh can be expected. (See Fig. 7.9.1.)

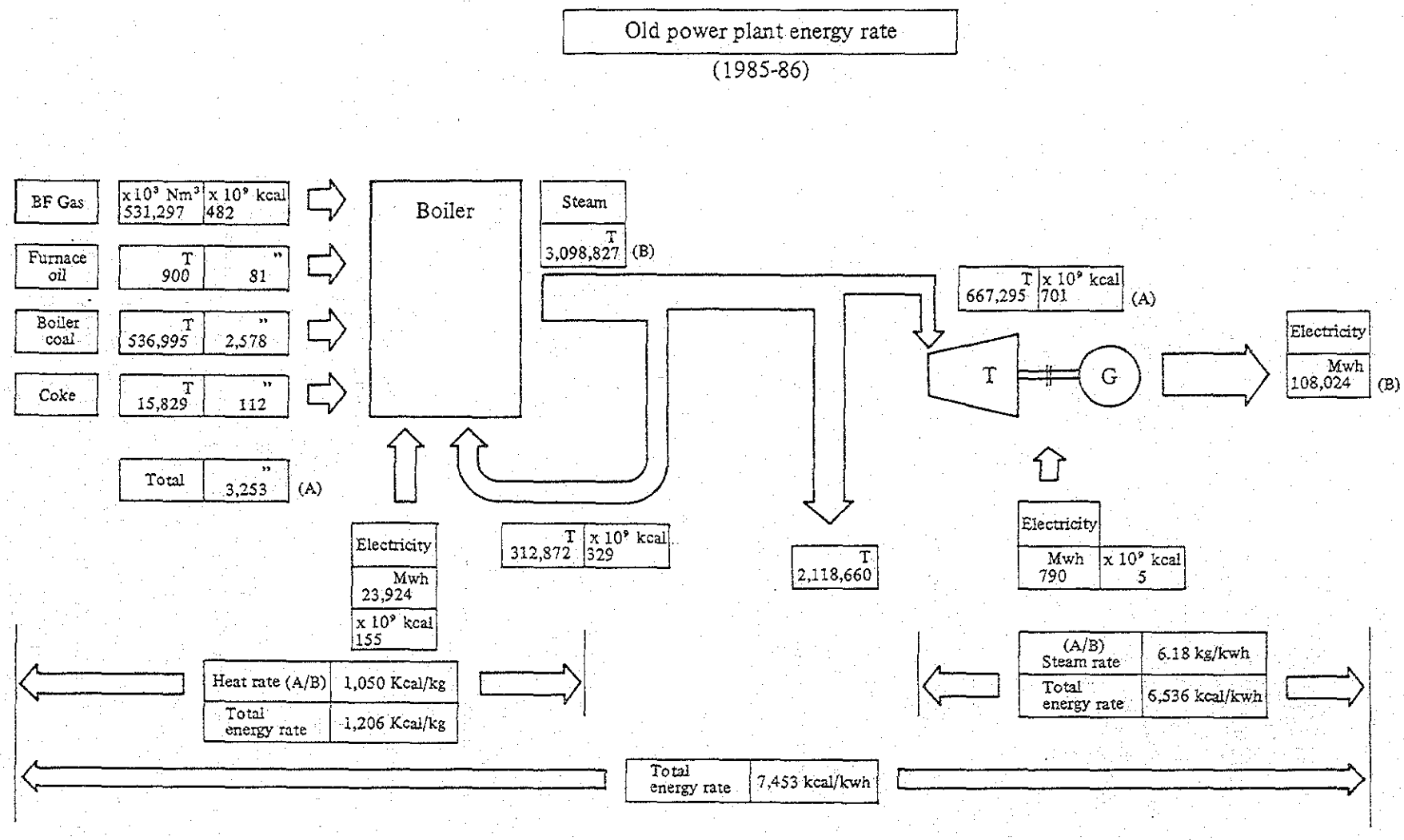


Fig. 7.9.1 Old power plant heat rate

This new power plant consists of gas compressor, generator, gas turbine, steam turbine and waste heat boiler.

7-9-1-2. Premiss for the study

Based on the gas balance in the 1st step, a 50 MW power plant will do, but in view of increased power demand in the 2nd step, it is planned that one unit of 60 MW power plant is installed in the 1st step and another unit installed in the 2nd step.

Incidentally, existing facilities are kept and operated when the new plant is under periodical inspection (about 30 days). But it may be considered also that they are closed depending on supply capacity of power companies.

(1) Determination of power plant capacity

As explained in 7-9-2, from the gas balance in the 2nd step, power generation is calculated to be 118,926 kWh/h. Therefore, the scale of the new power plant is set to be 120,000 kW.

To continue stable operation, periodical inspection in every two years is necessary, and considering loss of power generation during the inspection, 2 units of 60 MW power plants are to be built.

Construction plan calls for one unit of 60 MW plant in the 1st step and another 60 MW unit in the 2nd step.

Energy required for power generation consists of blast furnace gas (BFG), coke oven gas (COG) and basic oxygen furnace gas (LDG), and the power plant is characterized by non-use of purchased energy.

(2) Operation condition of power plant

1) Cooling water: Kind : Recirculated water
Temperature : 32 ^{O}C

2) Fuel: Mixed gas of BFG, COG and LDG

3) Air condition: Max. 40 ^{o}C
Relative humidity 100%

7-9-1-3. Specifications of facilities

(1) Specifications of major equipment

As shown in Table 7.9.2

(2) Power plant flow

As shown in Fig. 7.9.2

(3) Layout

As shown in Fig. 7.9.3

7-9-1-4. Supplementary explanation

(1) Use of coal tar

It is planned to use coal tar as fuel for the existing boilers, and the related facilities are incorporated.

(2) Gas volume required for operation of one 60 MW unit

Energy required for generating 60 MWh is $120,000 \times 10^{3}$kcal and if such amount of energy is available, it will do.

Calculating energy generated of each gas to be

BFG	1.56×10^{9}kcal/kT
COG	1.65×10^{9}kcal/kT
LDG	0.16×10^{9}kcal/kT

and considering the balance with the consumption, operation of blast furnaces, coke ovens and basic oxygen furnaces is planned.

(3) Actual examples of combined cycle power plants

The following are some examples of combined cycle power plants using by-product gas in Japan.

15,000 kW	60Hg	BFG	1965
34,000 kW	60Hg	COG	1970
16,000 kW	50Hg	BFG	1982
12,900 kW	60Hg	{BFG / COG}	1987

87,400 kW 50Hg {BFG / COG / LDG} 1986 *Output of gas turbine (Output of steam turbine not included)

7-9-2. Power receiving and distributing facilities

7-9-2-1. Outline

Power receiving and distributing facilities are the facilities that distribute purchased power and generated power to each electric room, but there are several problems in the existing power system, and for its modernization, a plan is made to solve the problems and enable stable supply of power.

7-9-2-2. Facilities plan

(1) Present problems and measures to cope with them

Present power system of power companies has such problems as

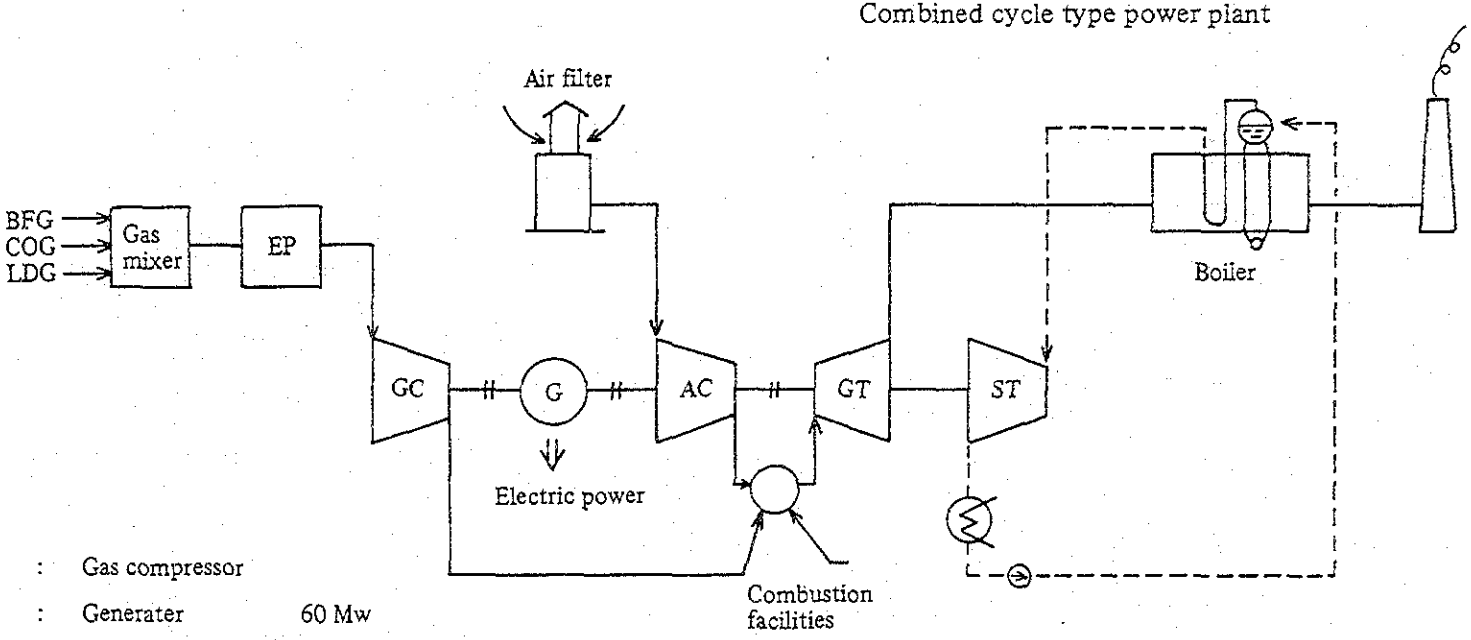
1) It is not adequate, and so power restriction occurs frequently, giving a considerable effect on production activities, and
2) Power equipment is short in short-circuit capacity.

Table 7.9.2 Equipment specifications (Power plant)

Equipment	Quantity		Specifications
	Step 1	Step 2	
1) Gas turbine	1 unit	1 unit	36.6 MW 3,000 rpm Mix gas
2) Steam turbine	1 unit	1 unit	23.4 MW 3,000 rpm
3) Generator	1 unit	1 unit	60.0 MW 11 kv
4) Boiler	1 unit	1 unit	68.6 T/h (H.P.S.) 11.8 T/h (L.P.S.)
5) Air filter	1 unit	1 unit	
6) EP	1 unit	1 unit	
7) Electrical equipment	1 set	1 set	
8) Cooling water equipment	1 set	1 set	9,000 T/h
9) Building			
Machine room	2,000 m²	2,000 m²	20 m x 50 m x 2
Electric room	1,200 m²		20 m x 20 m x 3

New power plant

Combined cycle type power plant



GC	:	Gas compressor	
G	:	Generater	60 Mw
AC	:	Air compressor	
GT	:	Gas turbine	36.6 Mw
ST	:	Steam turbine	23.4 Mw

Specific heat rate 1,900 kcal/kwh

Fig. 7.9.2 Power plant flow

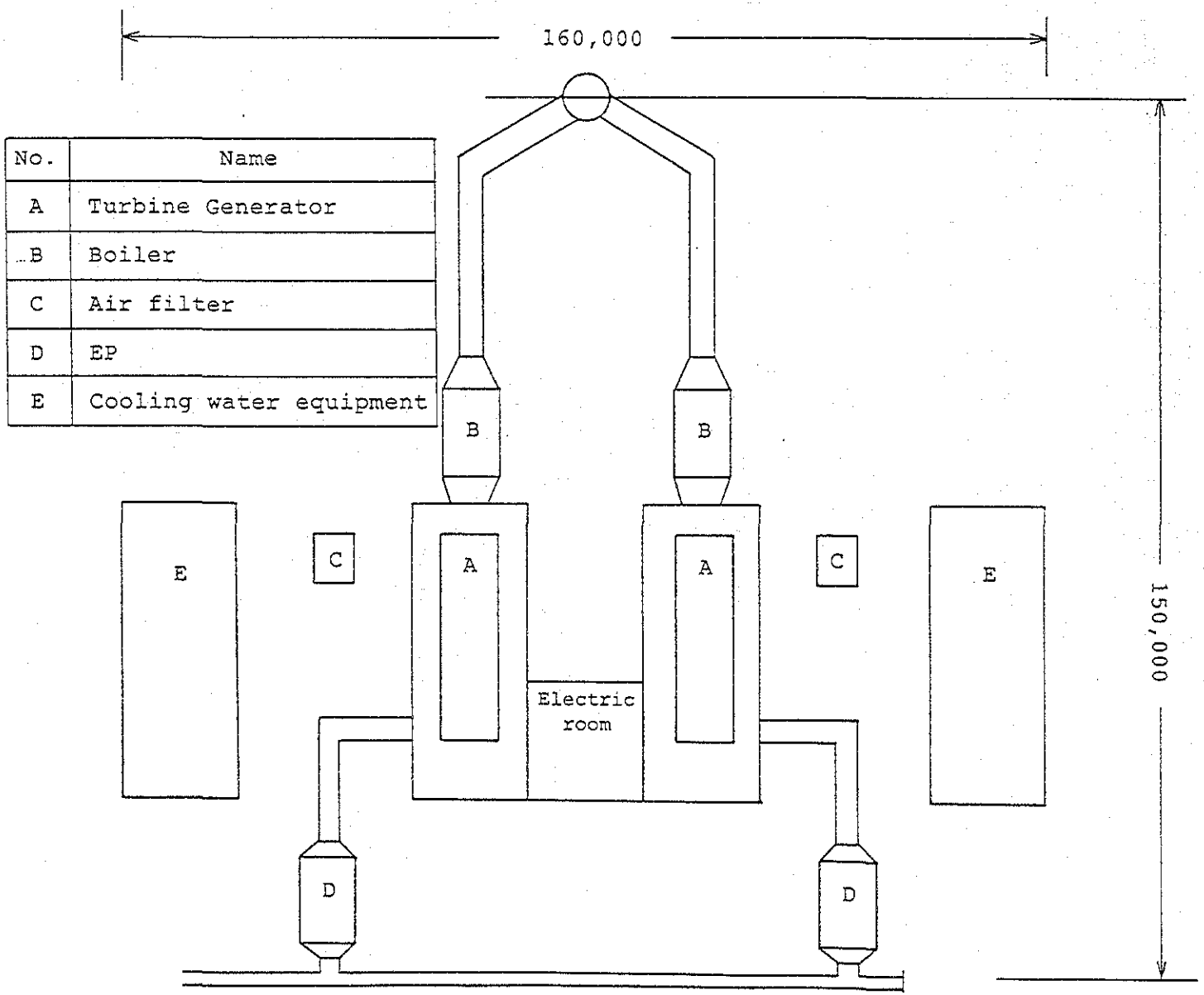


Fig. 7.9.3 Power plant layout

To overcome the problems, it is planned to take measures such as

1) Installation of new power plants and
2) Voltage of power received is raised to 132 kV rating and power at 132 kV from new power plants is connected to it, and transformer with high impedance adopted.

(2) Capacity of equipment

The capacity is determined by taking into consideration the maximum consumption based on Table 7.9.3.

(3) Power system

Both 132 kV and 11 kV busses are of double bus type so that load may be separated for purchased power and generated power.

Isolated circuit breakers are AB breaker shown in Fig. 7.9.5.

11 kV feeders are of 2-circuit type and always operated in parallel. Also pilot wire relay which can provide section protection is employed.

(4) Distribution line

11 kV distribution lines are all direct buried cables.

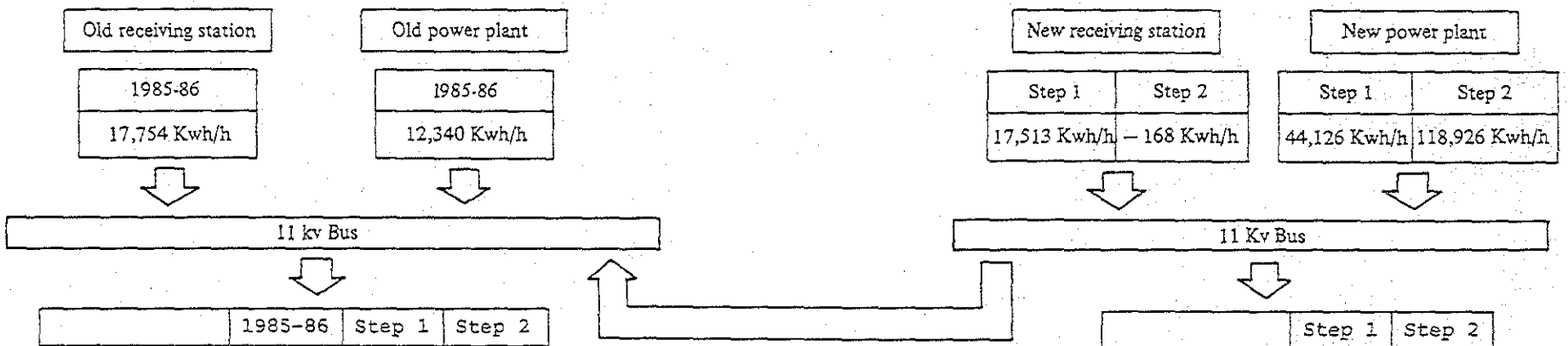
(5) Specifications of main equipment

As shown in Table 7.9.4

(6) Layout of receiving station

As shown in Fig. 7.9.4

Table 7.9.3 Electricity balance



	1985-86	Step 1	Step 2
	Kwh/h	Kwh/h	Kwh/h
Coke oven	2,330	4,102	3,143
Blast furnace	3,930	----	----
S.M.S.	1,156	----	----
Blooming mill	1,422	2,139	1,706
Hy. str. mill	1,682	3,385	3,385
Billet mill	906	1,372	754
Lt. str. mill	406	----	----
M & R mill	994	1,715	1,715
Sheet mill	1,536	2,296	----
Water supply	2,288	1,460	2,101
Old power plant	2,821	777	722
Balst furance blower	1,100	----	----
Others	9,513	3,939	6,707
Total	30,094	21,185	20,233

	Step 1	Step 2
	Kwh/h	Kwh/h
Sinter	7,487	15,692
Coke oven	----	4,693
Blast furnace	4,675	9,292
Converter	3,549	7,636
C C	554	2,118
New bar mill	2,610	13,356
Blast furnace blower	13,185	27,626
Oxygen plant	6,849	14,726
Ingot making	118	67
Lime kilm	987	2,130
New power plant	440	1,189
Total	40,454	98,525

Table 7.9.4 Equipment specifications

Equipment	Quantity		Specifications
	Step 1	Step 2	
1) Receiving station			
11kv Metal enclosed switch gear	29 units	3 units	11kv, VCB
Building			
11kv Switch gear room	390 m²		1F 13 m x 30 m
Control room	390 m²		2F 13 m x 30 m
2) Distributing equipment	1 set	1 set	Directly buried cable type

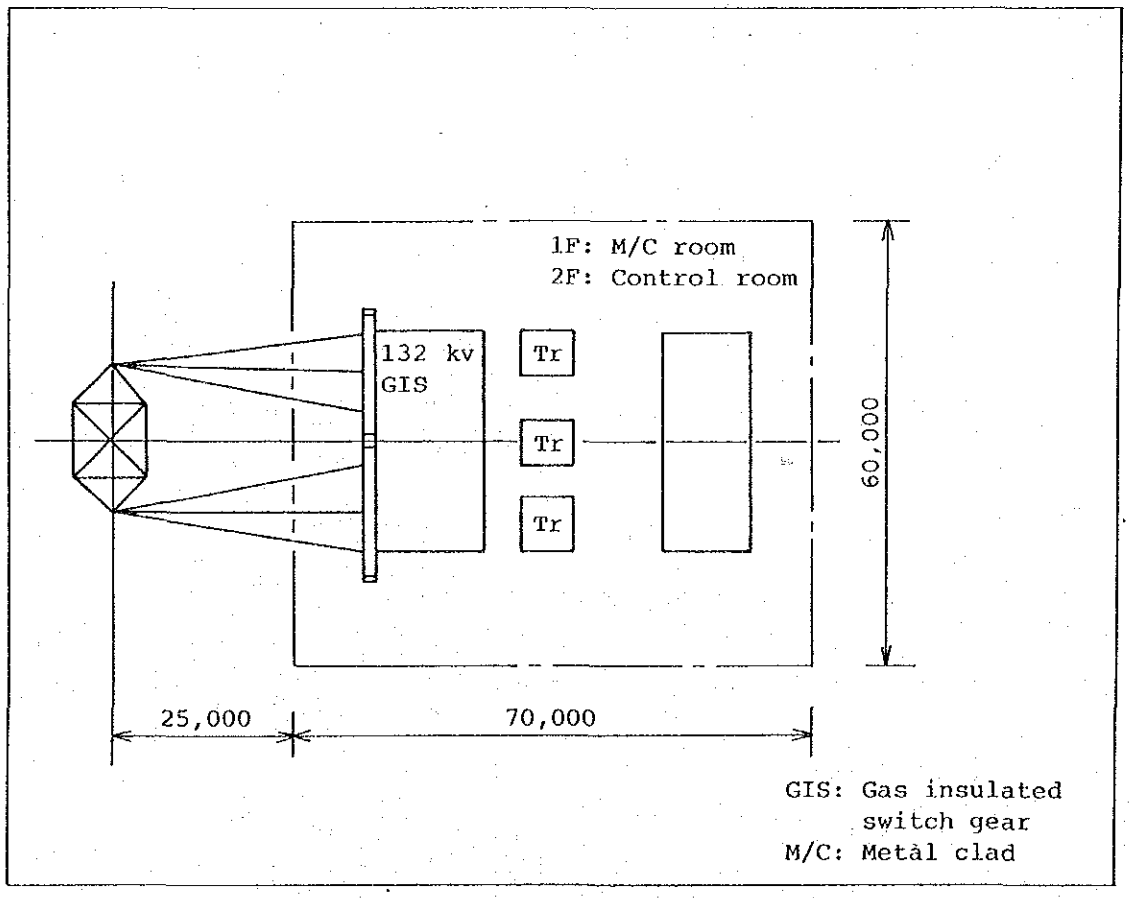


Fig. 7.9.4 Receiving station layout

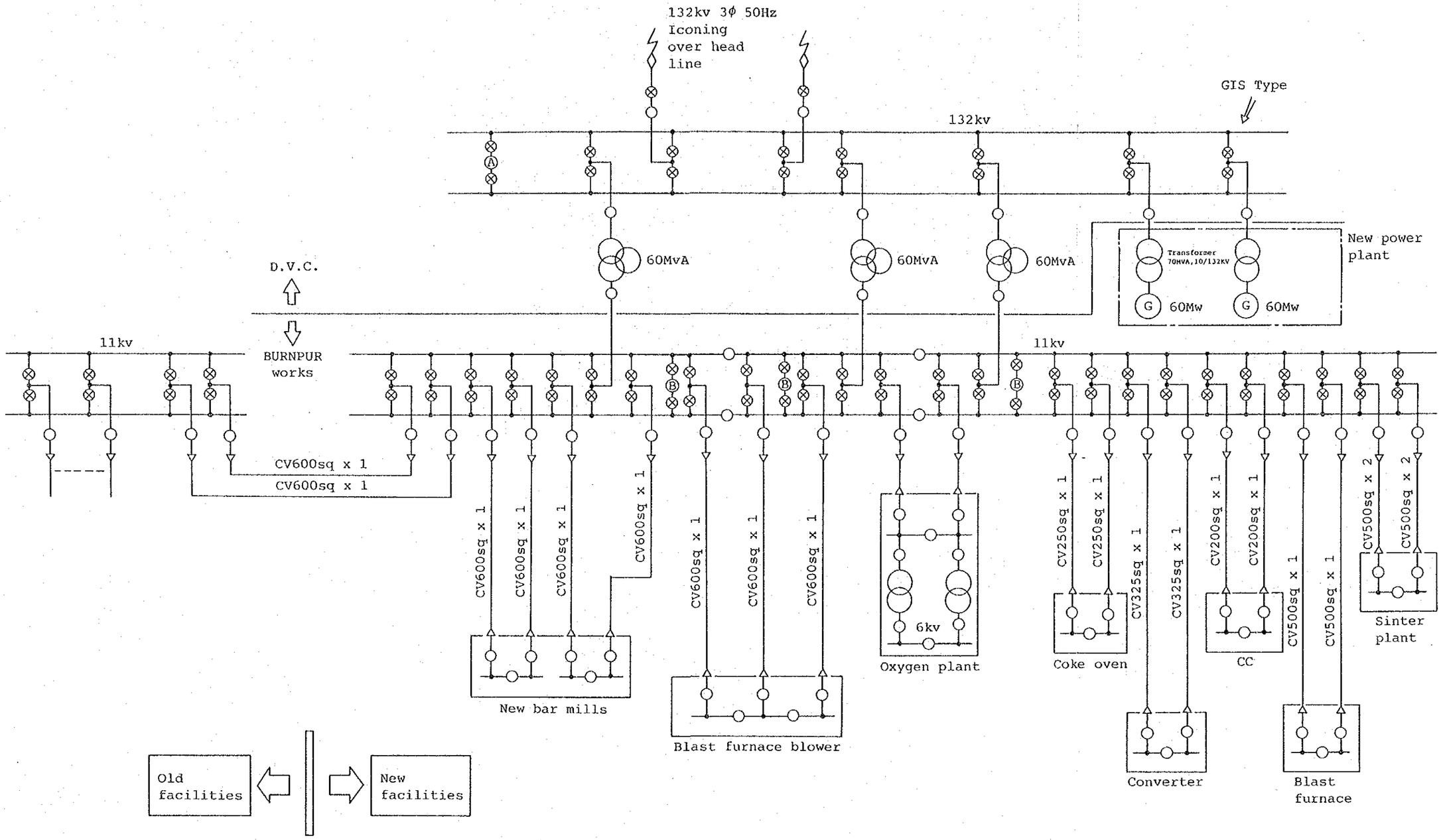


Fig. 7.9.5 Power distribution system diagram

7-9-3. Gas supply facilities

7-9-3-1. Outline

Gas supply facilities consist of gas holder, flare stack, blower, demand and supply control equipment and piping.

7-9-3-2. Premiss for the plan

To utilize by-product gasses effectively, gas supply facilities are planned as follows:

(1) Gas pressure

BFG & COG: The present pressure is 250 mm Aq, but the site calls for gas supply in broad area, and the pressure at the new site is 650 mm Aq.

Mixed gas : 250 mm Aq at the present site as before and 1,000 mm Aq at the new site

LDG : 1,000 mm Aq

(2) Mixed gas calory

All mixed gas to be 3,000 kcal, and existing mixers to be remodelled.

(3) Gas holder

BFG holder : As existing 56,600 m^3 holder cannot absorb fluctuation, one new 60,000 m^3 unit is to be constructed.

COG holder : COG being short, one new 80,000 m^3 unit is to be constructed to have the total capacity of 100,000 m^3 for adjustment of balance.

(4) Flare stack

BFG flare stack: Capacity to be a half of gas generated.

COG flare stack: 20,000 m^3 as it is used in emergency of COG blower trip.

(5) Blower

Mixed gas blower: Planned for sintering plant and new bar mills

COG blower : Planned for supply from existing area

(6) Demand & supply control equipment

Utility control centre is planned to perform demand and supply adjustement, monitoring and control of all of power, steam, power generation, O_2, N_2, air and gas supplies at one place.

(7) Piping

All pipings for gas, steam, tar, O_2, N_2, and air are to be planned.

7-9-3-3. Facilities plan

(1) Specifications of main equipment

As shown in Table 7.9.6

(2) Gas flow

As shown in Fig. 7.9.6 and Fig. 7.9.7

Table 7.9.5 Fuel balance

		1985 - 86					Step 1					Step 2				
		BFG 907 Kcal/Nm³	COG 3,957 Kcal/Nm³	Furnace oil 9,000 Kcal/kg	Coal Tar 8,000 Kcal/kg	Boiler coal 4,800 Kcal/kg	BFG 800 Kcal/Nm³	COG 4,000 Kcal/Nm³	LDG 2,300 Kcal/Nm³	Coal Tar 8,000 Kcal/kg	Boiler coal 4,800 Kcal/kg	BFG 800 Kcal/Nm³	COG (4,000) (4,500) Kcal/Nm³	LDG 2,300 Kcal/Nm³	Coal Tar 8,000 Kcal/kg	Boiler coal 4,800 Kcal/kg
		Nm³/h	Nm³/h	kg/h	kg/h	T/h	Nm³/h	Nm³/h	Nm³/h	kg/h	T/h	Nm³/h	Nm³/h	Nm³/h	kg/h	T/h
Old	Coke oven	45,816	17,017				54,762	13,558		3,799		56,856	5,882			
	Blast furnace	86,496														
	Steel melting shop	1,165	12,217	1,487	3,040											
	Blooming mill	60,181	171				14,934	6,571				12,642	3,703			
	Heavy structural mill	2,961	302	580			4,459	1,962				5,488	1,608			
	Sheet mill	2,562	1,026	957			6,243	2,747								
	Merchant mill	542	123	834			4,459	1,962				5,488	1,608			
	Power plant	60,650				61				3,799	16				7,991	7
	Others	7,610	5,313	619				1,466					2,127			
New	Sinter						2,997	1,318				7,727	2,263			
	Coke oven											89,843	8,662			
	Blast furnace						86,301	1,199				175,799	10,297			
	Converter							591					1,165			
	Ingot making shop							118					62			
	C C							249					806			
	Bar mill						3,058	1,346				19,264	5,642			
	Lime kiln							3,860					7,625			
	Power plant						74,499	2,804	8,281			116,619	25,329	17,816		
	(KULTI plant)							2,185					2,000			
Con-sump-tion	Total (A)	267,983	36,170	4,477	3,040	61	251,712	41,936	8,281	3,799	16	489,726	78,779	17,816	7,991	7
Gener-ation	Old plant	267,983	36,170	---	3,040	--	---	41,936	---	3,799	--	---	30,300	---	2,696	--
	New plant	---	---	---	---	--	251,712	---	8,281	---	--	489,726	48,479	17,816	5,295	--
	Total (B)	267,983	36,170			--	251,712	41,936	8,281	3,799	--	489,726	78,779	17,816	7,991	--
	(B) - (A)	0	0		0		0	0	0	0		0	0	0	0	

Table 7.9.6 Equipment specifications (gas)

Equipment	Quantity		Specifications
	Step 1	Step 2	
1) BF gas holder	1 unit		Capacity: 60,000 m^3 Pressure: 650 mmAq 38.4 x 63.5 m, 1,140T
2) CO gas holder	1 unit		Capacity: 80,000 m^3 Pressure: 650 mmAq 42.7ϕ x 66,0m, 1,290T
3) BF gas flare stack	1 unit		Discharge capacity: Max. 225,000 Nm^3/h Height: 35m
4) CO gas flare stack	1 unit		Discharge capacity: Max. 20,000 Nm^3/h Height: 60m
5) CO gas blower	2 units		Capacity: 20,000 Nm^3/h Delivery pressure: 650 mmAq Motor capacity: 100kw
6) M gas blower	2 units		Capacity: 40,000 Nm^3/h Delivery pressure: 1,000 mmAq Motor capacity: 200kw
7) LD gas blower	2 units		Capacity: 20,000 Nm^3/h Delivery pressure: 1,000 mmAq Motor capacity: 100kq
8) Gas mixer			
BFG-COG mixer	1 unit		Capacity: 20,000 Nm^3/h Delivery calorie: 3,000 Kcal/Nm^3
BFG-COG mixer	1 unit		Capacity: 30,000 Nm^3/h Delivery calorie: 3,000 Kcal/Nm^3
9) Telemeter' Tele-control equipment	1 set	1 set	
10) Piping	1 set	1 set	BFG, COG, LDG, MG, O_2, N_2, Air steam line

(Continued)

Equipment	Quantity		Specifications
	Step 1	Step 2	
11) Building office	900 m²		1F: Utility supply section office 2F: Utility control center 30m x 30m
Electric room	400 m²		20m x 20m

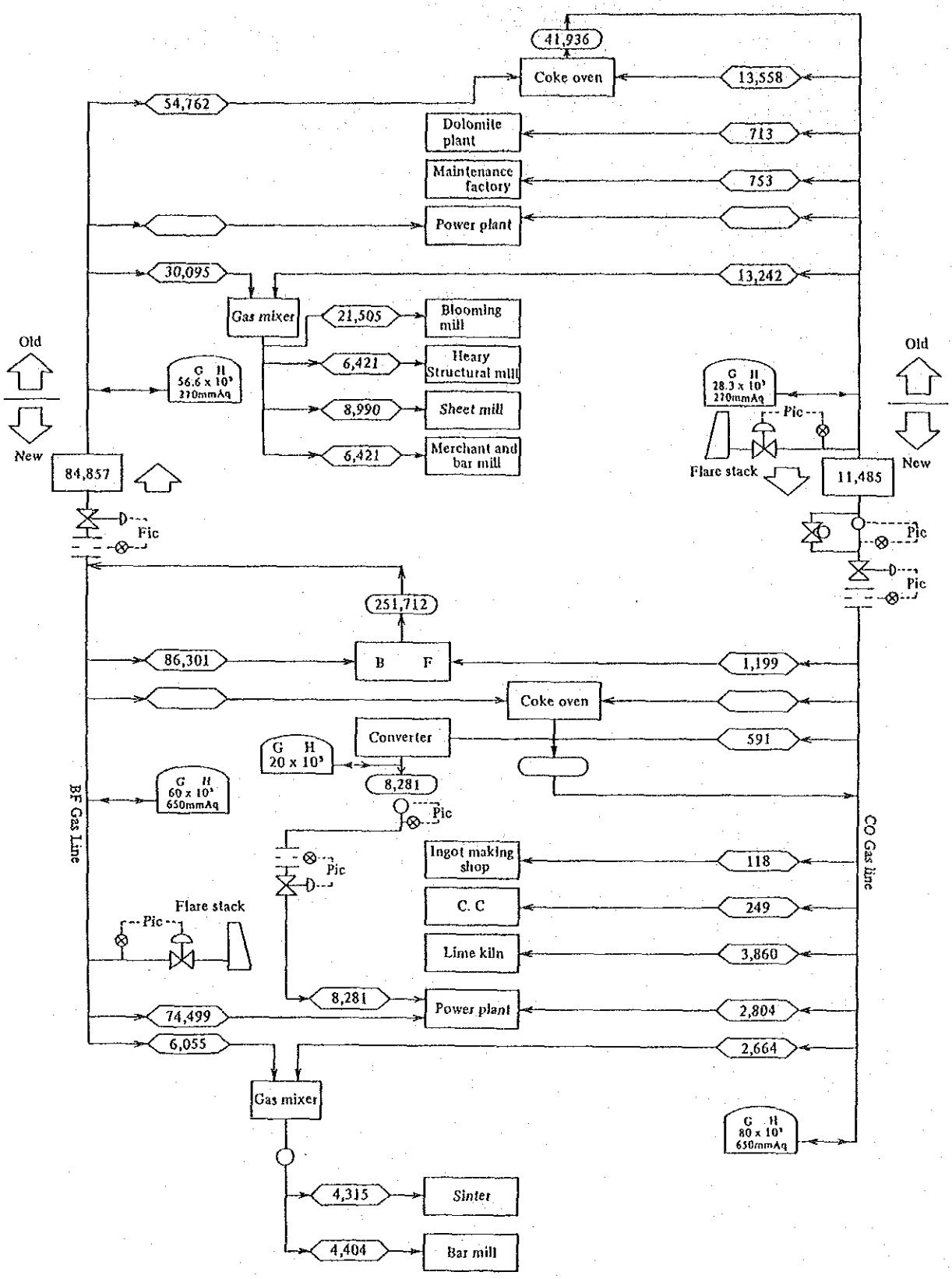


Fig. 7.9.6 Gas flow (Step 1)

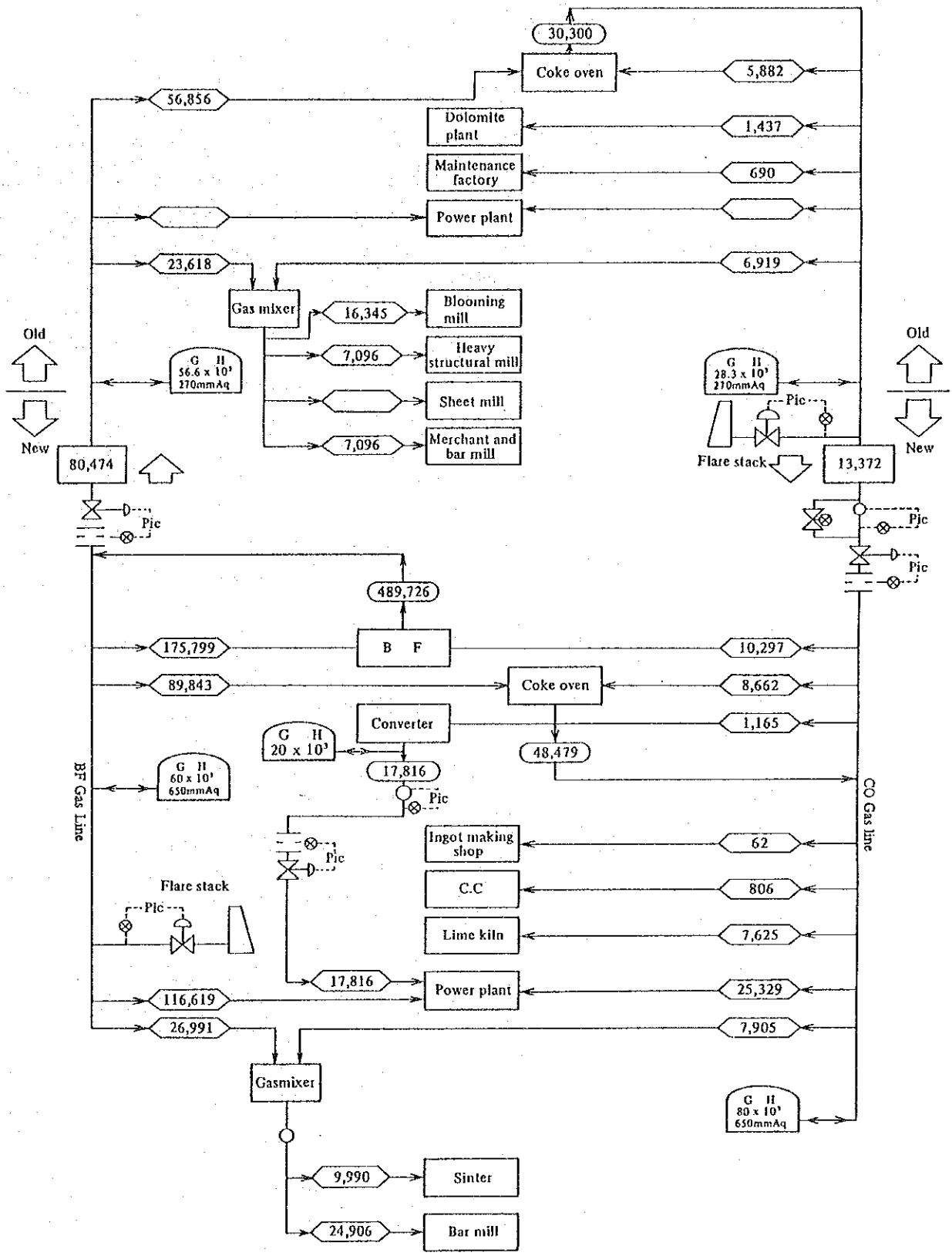


Fig. 7.9.7 Gas flow (Step 2)

7-9-4. Steam supply facilities

7-9-4-1. Outline

As steam consumption decreases drastically as a result of shutdown of steam turbine blowers and construction of the new power plants, boilers No.1 through No.12 are closed and general steam requirement in the Works is to be met by A and B boilers.

7-9-4-2. Facilities plan

(1) Piping facilities are planned as shown in Table 7.9.7.

Table 7.9.7 Steam balance

	Step 1	Step 2
Coke oven	70.0 T/h	61.2 T/h
Dolomite	0.25	0.6
Blast furnace	5.5	11.6
Sheet mill	3.4	-----
Heavy structural mill	3.7	3.7
Merchant & rod mill	4.6	4.6
A, B boiler	9.2	8.2
Loss	4.4	3.9
Total	101.0	93.8

(2) Construction expenses for pipings are included those for gas supply facilities.

7-9-5. Oxygen facilities

7-9-5-1. Outline

Oxygen plant is the facilities that produce and supply oxygen gas and nitrogen gas used in BOFs and CCs and consists of air separator, oxygen gas compressor, nitrogen gas compressor and others.

7-9-5-2. Facilities plan

The facilities are planned separately for the 1st step and the 2nd step and include a spare plant to meet the condition of trouble and periodical repair of the plant in the 1st step.

The capacity of the facilities is determined by taking into consideration the maximum consumption on the basis of O_2, N_2, air flow and balance in Table 7.9.9.

(1) Quality and capacity

Gas quality and capacity are shown in Table 7.9.8.

Table 7.9.8 Quality and capacity of each gas

	Purity (%)	Pressure (kg/cm^2)	Capacity (Nm^3/h)		Remarks
			Step 1	Step 2	
Oxygen gas	99.5	25.0	10,600	21,200	
Nitrogen gas	99.99	25.0	2,300	4,600	$O_2 \leqq 100$ ppm
Air	---	7.0	5,300	10,600	

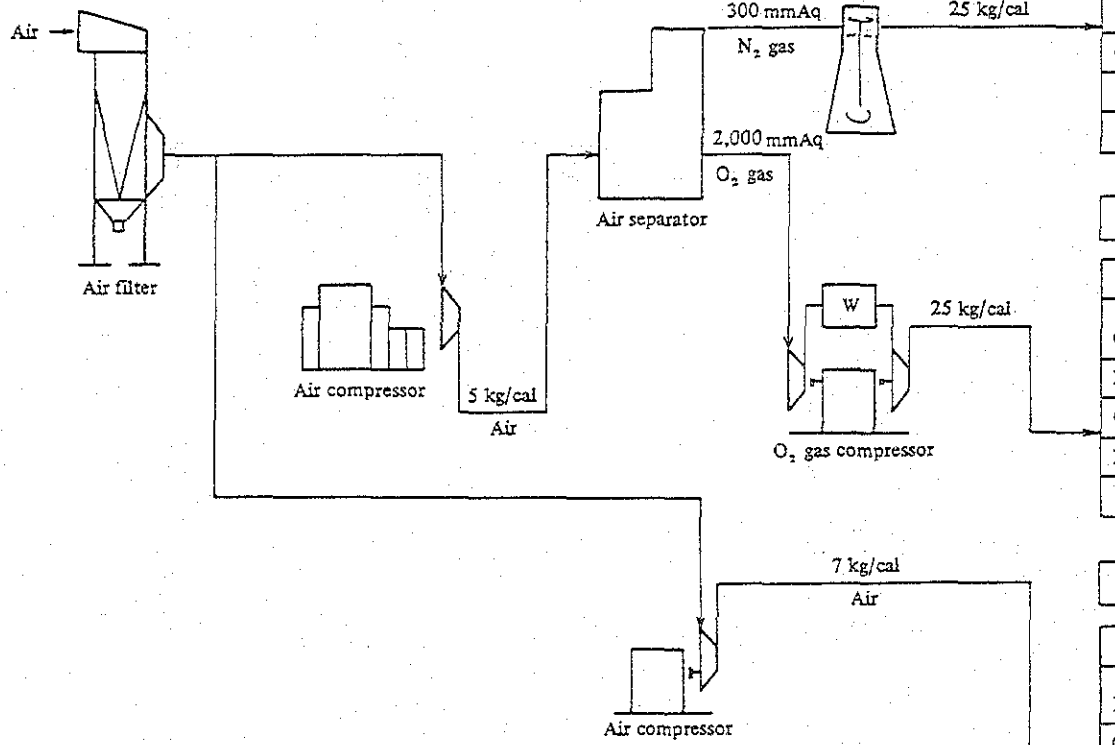
(2) Equipment list and specifications of equipment

As shown in Table 7.9.10

(3) Layout

As shown in Fig. 7.9.8

Table. 7.9.9 O_2 , N_2 , Air flow and balance



N_2

	Step 1	Step 2
	Nm^3/h	Nm^3/h
Coke oven	38	68
Blast furnace	599	1,256
Converter	1,065	2,290
C C	22	85
Loss	26	55
Total	1,750	3,754

O_2

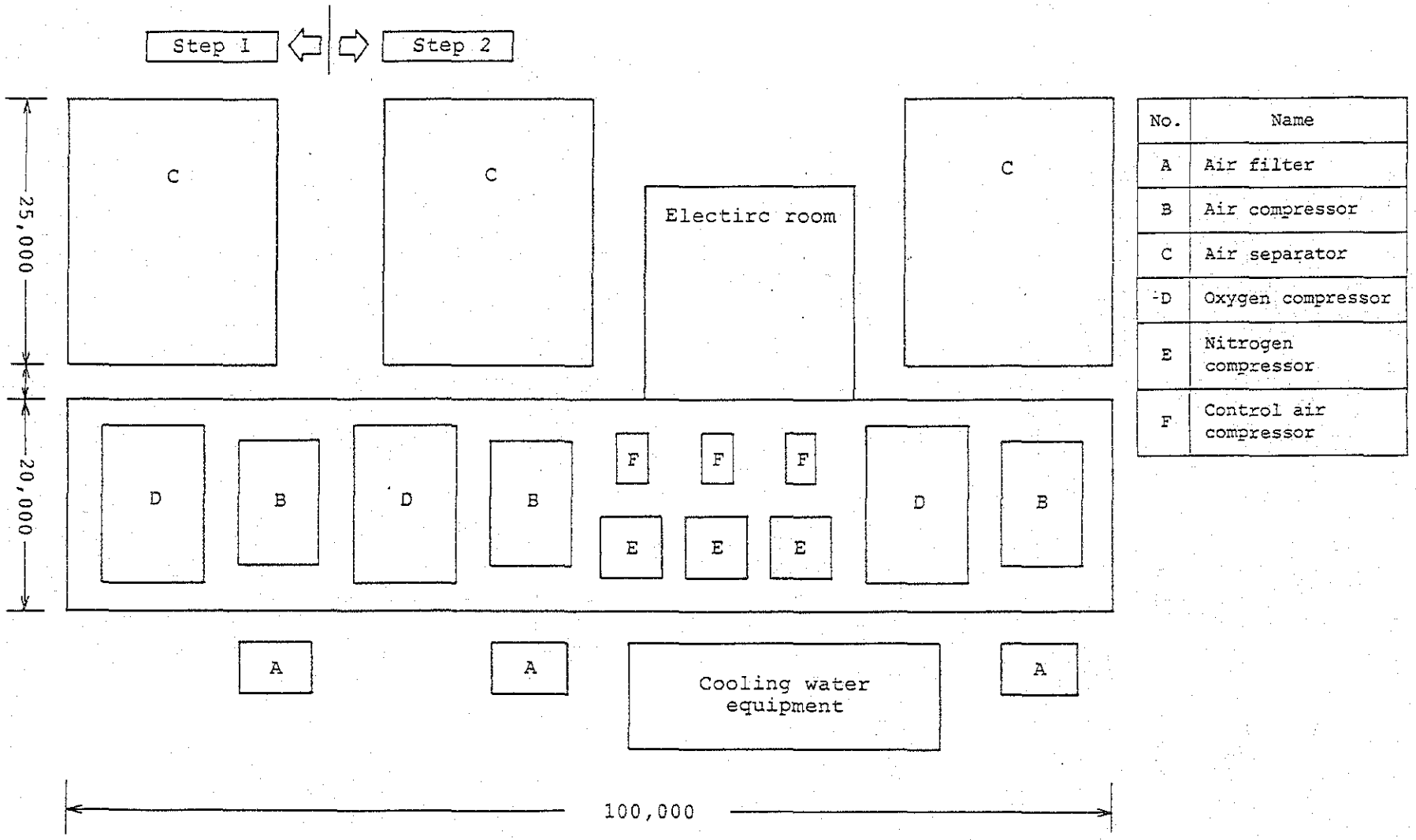
	Step 1	Step 2
	Nm^3/h	Nm^3/h
Converter	7,808	16,798
Ingot making shop	6	3
C C	54	186
Loss	118	255
Total	7,986	17,242

Air

	Step 1	Step 2
	Nm^3/h	Nm^3/h
Lime kiln	23	49
Coke oven	760	1,366
Blast furnace	2,397	5,023
Converter	592	1,273
C C	388	1,627
Loss	62	140
Total	4,222	9,478

Table 7.9.10 Equipment specifications (Oxygen plant)

Equipment	Quantity		Specifications
	Step 1	Step 2	
1) Air filter	2 units	1 unit	Type: Bag filter Capacity:. 79,000 Nm^3/h
2) Air compressor	2 units	1 unit	59,000 Nm^3/h x 5.0 kg/cm^2 Turbo type Motor capacity 5,950 kw
3) Air separator	2 units	1 unit	GO_2 10,600 Nm^3/h x 99.5% O_2 x 2,000 mmAq GN_2 5,000 Nm^3/h x 99.99% N_2 x 300 mmAq
4) Oxgen gas compressor	2 units	1 unit	10,600 Nm^3/h x 25.0 kg/cm^2 Turbo type Motor capacity 1,910 kw
5) Nitrogen gas compressor	2 units	1 unit	2,300 Nm^3/h x 25.0 kg/cm^2 Reciprocating type Motor capacity 450 kw
6) Control air compressor	2 units	1 unit	5,300 Nm^3/h x 7.0 kg/cm^2 Turbo type Motor capacity 650 kw
7) Cooling water equipment	2 units	1 unit	Close circuit type 900 T/h
8) Electrical equipment	1 set	1 set	
9) Building compressor			
Compressor room	1,500m^2	500m^2	20m x 75m, 20m x 25m
Electric room	400m^2		20m x 20m
10) Ceiling crane	1 unit		30 T



No.	Name
A	Air filter
B	Air compressor
C	Air separator
D	Oxygen compressor
E	Nitrogen compressor
F	Control air compressor

Fig. 7.9.8 Oxygen plant layout

7-9-6. Water supply facilities

7-9-6-1. Outline

As regards water supply facilities in conjunction with the modernization plan, there are two main problems, namely,

(1) Pump capacity of No.2 River side pump house will become insufficient.

(See Table 7.9.11 Water Balance)

(2) Removal of sewage disposal plant which will hinder construction of new plants.

The modernization of water supply facilities lies mainly in those two points, and also installation of water piping instrumentation facilities required for the modernization is planned.

7-9-6-2. Facilities plan

(1) Basic matters

1) Pump houses are planned to be monitored and controlled from the utility control centre.
(No.1 & No.2 River side pump houses, No.1 & No.2 Reservoir pump houses.)

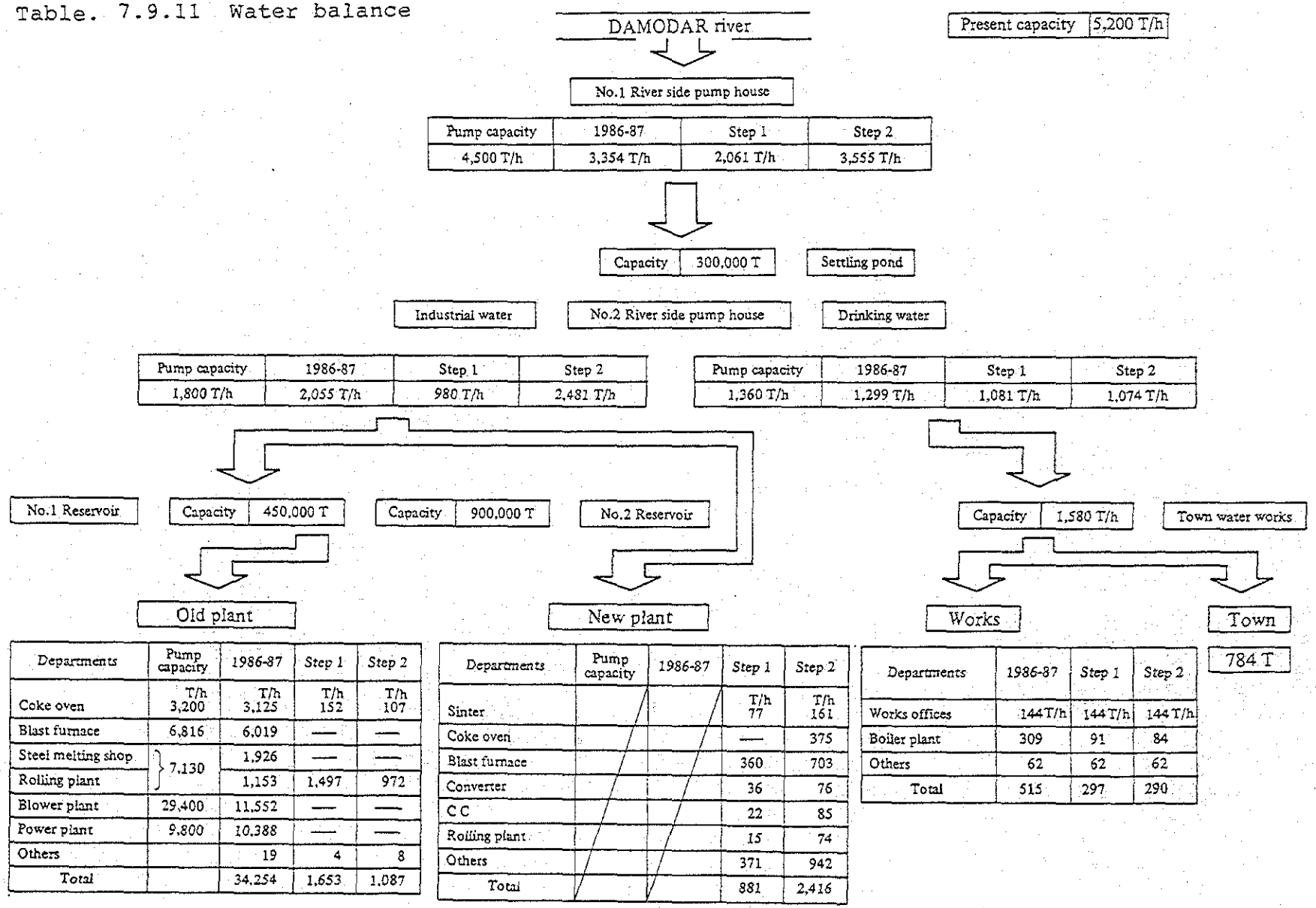
2) To new plants, clean water is supplied directly from No.2 River side pump house.

3) Sewage disposal plant is to have capacity to treat living sewage of 10,000 persons and be of underground type from environmental consideration.

4) Quality of make-up water is to be as it is.

5) All projects for water supply facilities are planned in the 1st step.

Table. 7.9.11 Water balance



Departments	Pump capacity	1986-87	Step 1	Step 2
	T/h	T/h	T/h	T/h
Coke oven	3,200	3,125	152	107
Blast furnace	6,816	6,019	—	—
Steel melting shop	7,130	1,926	—	—
Rolling plant		1,153	1,497	972
Blower plant	29,400	11,552	—	—
Power plant	9,800	10,388	—	—
Others		19	4	8
Total		34,254	1,653	1,087

Departments	Pump capacity	1986-87	Step 1	Step 2
			T/h	T/h
Sinter			77	161
Coke oven			—	375
Blast furnace			360	703
Converter			36	76
CC			22	85
Rolling plant			15	74
Others			371	942
Total			881	2,416

Departments	1986-87	Step 1	Step 2
Works offices	144 T/h	144 T/h	144 T/h
Boiler plant	309	91	84
Others	62	62	62
Total	515	297	290

(2) Equipment list and specifications of equipment

As shown in Table 7.9.12

(3) Water supply system

As shown in Fig. 7.9.9

Table 7.9.12 Equipment specifications (Water supply)

Equipment	Quantity	Specifications
1) No.2 River Side pump house		
· Pump	2 units	2,500 m^3/h x 98 m
· Electrical equipment	1 set	
· Building		
Machine room	300 m^2	15m x 20m
Electric room	400 m^2	20m x 20m
2) Piping	1 set	No.2 River side pump house to works
		Sinter line
		Converter line
		No.11 Coke oven line
		New blast furnace line
		CC line
		Rolling mill line
		Power plant line
		Oxygen plant line
3) Telemeter. Tele-control equipment	1 set	
4) Sewage disposal plant	1 unit	Capacity: 1,800 m^3/D
		Under ground type
		Building: 800 m^2 (20m x 40m)
		Electrical equipment

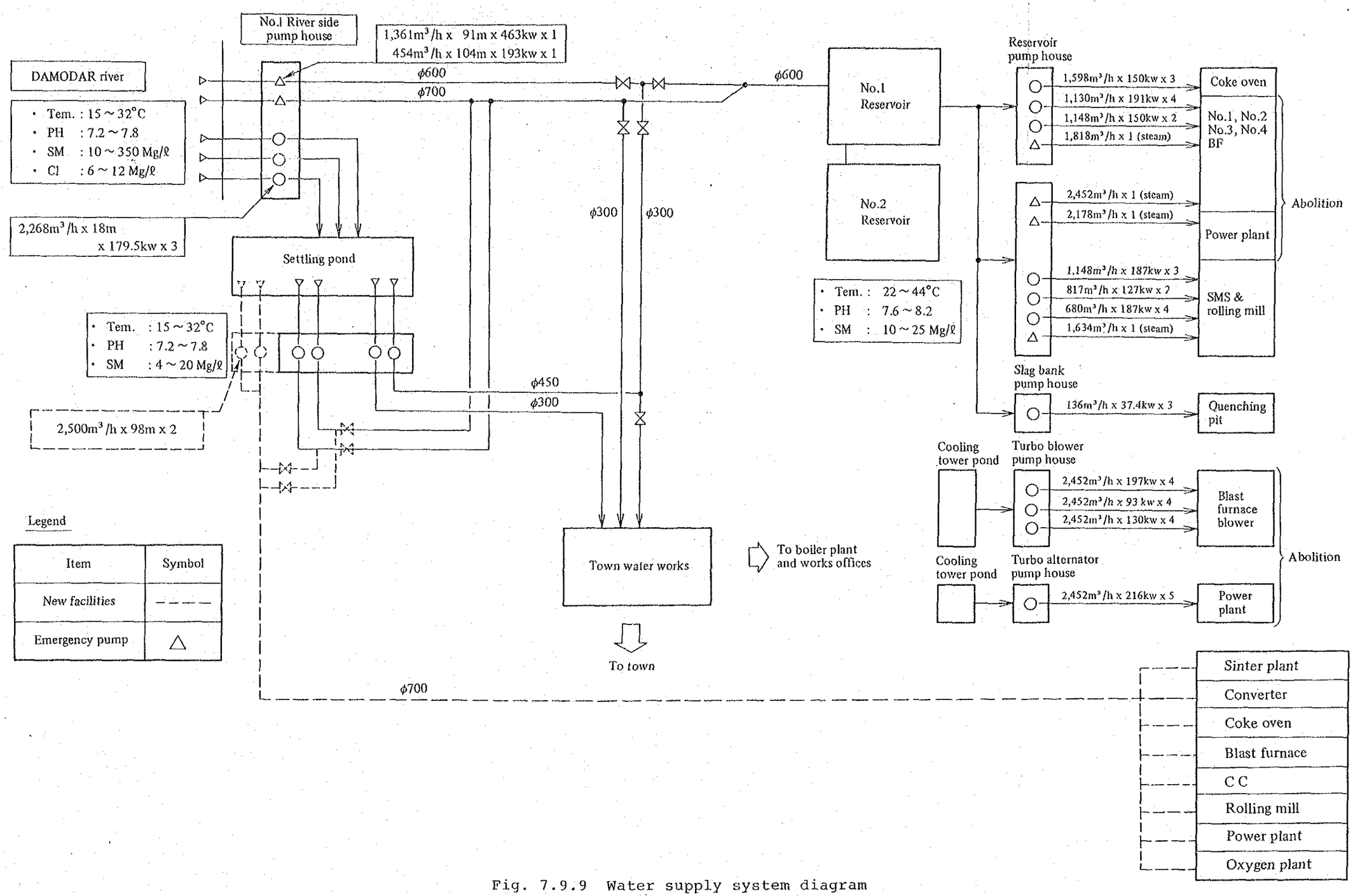


Fig. 7.9.9 Water supply system diagram

7-9-7. Air blast facilities for blast furnace

7-9-7-1. Outline

This plant is the facilities that blow air into the new blast furnaces and consists of blowers and motors.

7-9-7-2. Premiss for the plan

As existing blowers cannot be utilized due to insufficient capacity, low efficiency and obsolescence, new ones are to be constructed.

For blast furnace blowers, a spare blower is required to ensure stable operation of the furnaces, and two units are installed in the 1st step and another one in the 2nd step.

(1) Determination of capacity of the facilities

1) Capacity of blowers

Blast condition is assumed by calculating blast air volume and pressure based on blast furnace volume and furnace top pressure and considering resistance in pipe arrangement between the blower and hot stove.

Required axial input of the blower is planned to be 19,500 kW to give a surplus after it is calculated on the following conditions:

Temperature of blast air at the inlet	: 40 ^{o}C
Relative humidity of blast air	: 100%
Blast pressure at the outlet	: 3.2 kg/cm^{2}
Air volume at the outlet	: 3,900 Nm^{3}/min
Heat insulating efficiency of blower	: 85%

2) Adoption of motor driven blower

For the following reasons, motor driven blower is to be adopted.

- Low maintenance cost
- Less maintenance personnel
- Easy operation
- Possibility to start in short time
- Others

(2) Operation condition of facilities

1) Cooling water: Kind - Recirculated water
Temperature - 32 ^{o}C max.

2) Air: Temperature - 40 ^{o}C
Relative humidity - 100%

(3) Normal operation

Usually the operation is monitored and controlled from Utility control centre.

7-9-7-3. Facilities plan

(1) Specifications of main equipment

As shown in Table 7.9.13

(2) Blast furnace blower flow

As shown in Fig. 7.9.10

(3) Layout

As shown in Fig. 7.9.11

Table 7.9.13 Equipment specifications (Blower)

Equipment	Quantity		Specifications
	Step 1	Step 2	
1) Air filter	2 units	1 unit	Type: Bag filter Capacity: 3,900 Nm^3/h
2) Blower	2 units	1 unit	Maximum blast volume: 3,900 Nm^3/min Maximum blast pressure: 3.2 kg/cm^2 Normal blast volume: 3,150 Nm^3/min Normal blast pressure: 2.8 kg/cm^2 Motor capacity: 19,500 kw
3) Blow-off silencer	2 units	1 unit	Capacity: 3,900 Nm^3/h
4) Cooling water equipment	2 units	1 unit	Closed circuit type 300 T/h
5) Electrical equipment	1 set	1 set	
6) Telemeter. Telecotrol equipment	1 set	1 set	
7) Building			
Compressor room	658 m^2	182 m^2	14m x 47m, 14m x 13m
Electric room	420 m^2		14m x 30m
8) Ceiling crane	1 unit		30 T

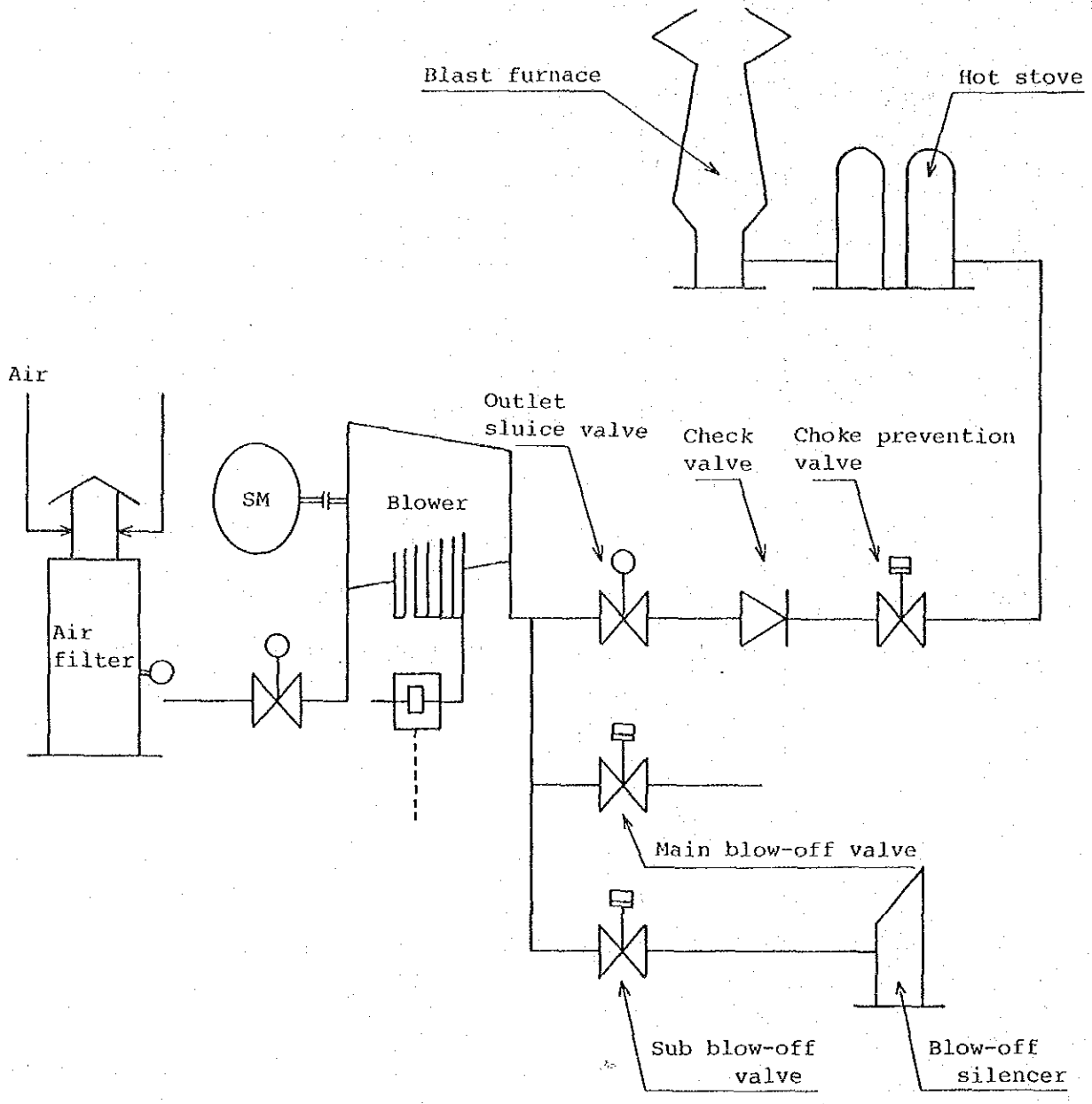
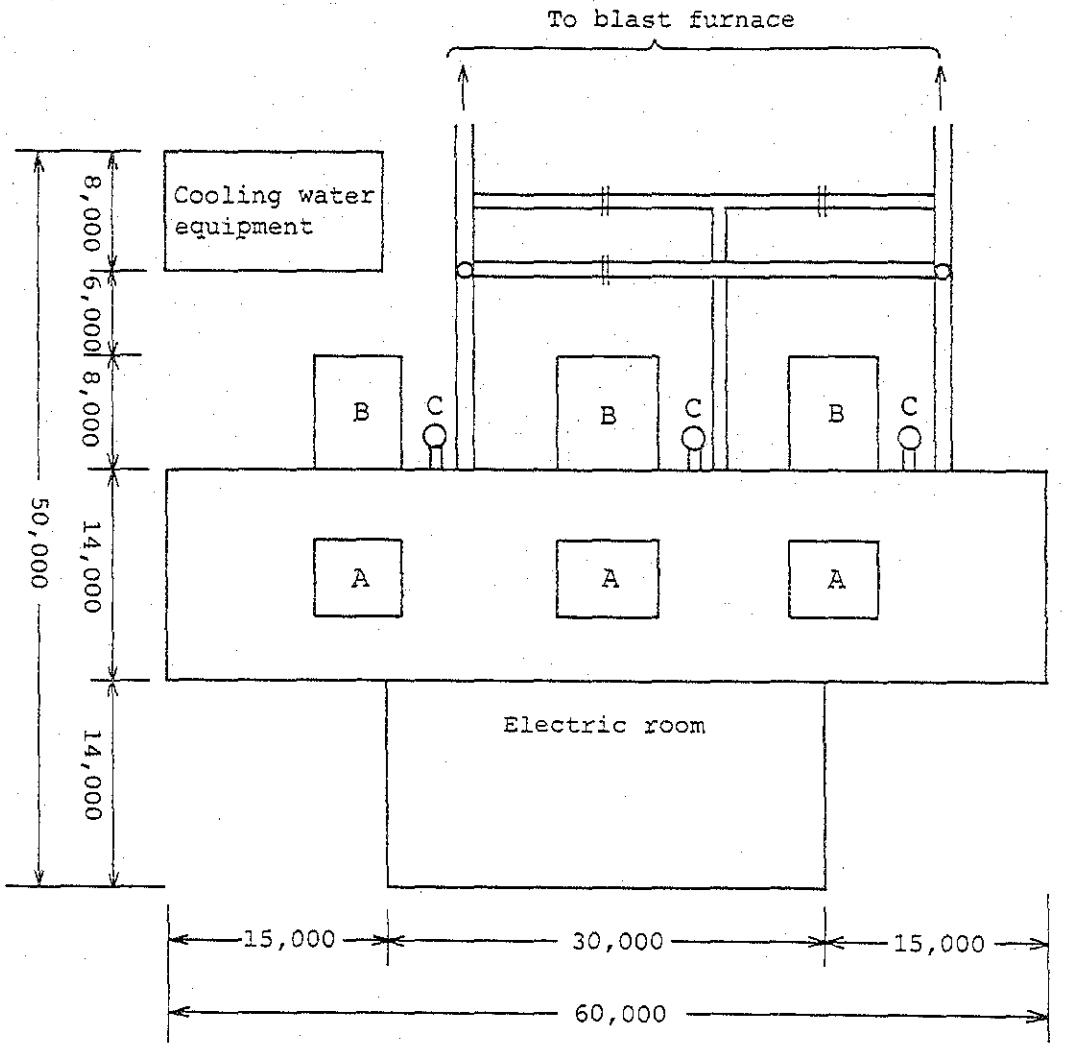


Fig. 7.9.10 Blast furnace blower flow



No.	Name
A	Blower and motor
B	Air filter
C	Blow-off silencer

Fig. 7.9.11 Blast furnace blower layout

Table 7.9.14 Energy balance (Step 1)

Unit : 10^9 Kcal

		Energy consumption											Energy generation									Net energy
	Products	Coal Kcal/kg 7,600	Boiler cpal Kcal/kg 4,800	Coke Kcal/kg 7,100	Tar Kcal/kg 8,000	Gas Kcal/Nm³ -----			Steam Kcal/kg 1,050	Electri -city Kcal/kwh 2,000	Oxygen Kcal/Nm³ 1,727	Total (A)	Coke Kcal/kg 7,100	Tar Kcal/kg 8,000	Gas Kcal/Nm³ ----			Steam Kcal/kg 1,050	Electri-city Kcal/kwh 2,000	Oxygen Kcal/Nm³ 1,727	Total (B)	(A)-(B)
Coke oven	KT/Y 990	10,116				860			643	72		11,691	7,031	266	1,469						8,766	2,925
Sinter	1,344			859		67				108		1,034										1,034
Blast furnace	1,050			4,771		647			51	82		5,551			1,764						1,764	3,787
Converter	1,036					21				62	118	201			167						167	34
C C	485					9				10	1	20										20
Blooming mill	756					335				37		372										372
Billet mill	453									24		24										24
H.S. mill	250					100			34	59		193										193
L.S. mill	-----																					
Merchant and bar mill	250					100			42	30		172										172
New bar and section mill	254					69				46		115										115
Sheet mill	100					140			32	40		212										212
Blast blower										231		231										231
Old power plant				662		266			84			1,012						928			928	84
Oxygen plant										120		120								120	120	0
Others						279			42	151	1	473										473
New power plant						773				8		781							773		773	8
Total		10,116	662	5,630	266	3,400			928	1,080	120	22,202	7,031	266	3,400			928	773	120	12,518	9,684
Purchasing energy		10,116	662							307			1,041									11,085
Selling energy																						1,401

Table 7.9.15 Energy balance (step 2)

Unit : 10^9 Kcal

Products		Energy consumption											Energy generation									Net energy
		Coal Kcal/kg 7,600	Boiler coal Kcal/kg 4,800	Coke Kcal/kg 7,100	Tar Kcal/kg 8,000	Gas Kcal/Nm³ 860			Steam Kcal/kg 1,050	Electri-city Kcal/kwh 2,000	Oxygen Kcal/Nm³ 1,727	Total (A)	Coke Kcal/kg 7,100	Tar Kcal/kg 8,000	Gas Kcal/Nm³ ----			Steam Kcal/kg 1,050	Electri-city Kcal/kwh 2,000	Oxygen Kcal/Nm³ 1,727	Total (B)	(A)-(B)
Coke oven	KT/Y 1,798	18,194				1,568			563	137		20,462	12,773	560	2,973						16,306	4,156
Sinter	2,816			1,669		141				225		2,035										2,035
Blast furnace	2,200			9,202		1,639			106	163		11,110			3,432						2,432	7,678
Converter	2,230					45				134	254	433			359						359	74
C C	1,855					31				37	3	71										71
Blooming mill	603					230				30		260										260
Billet mill	250									13		13										13
H.S. mill	250					100			34	59		193										193
L.S. mill	-----																					
Merchant and bar mill	250					100			42	30		172										172
New bar and section mill	1,300					351				234		585										585
Sheet mill	-----																					
Blast blower										484		484										484
Old power plant			302		560				76	13		951						862			862	89
Oxygen plant										258		258								261	261	Δ 3
Others						475			41	243	4	763										763
New power plant						2,084				21		2,105							2,081		2,081	24
Total		18,194	302	10,871	560	6,764			862	2,081	261	39,895	12,773	560	6,764			862	2,081	261	23,301	16,594
Purchasing energy		18,194	302																			18,496
Selling energy													1,902									1,902

7-10. Civil and building work

7-10-1. Outline

Civil and building work projects under the modernization plan for BURNPUR Works are roughly divided into land reclamation, foundation and building work for plant facilities, and other appurtenant work including boundary fencing and drainage facilities.

Not to mention land reclamation, civil and building work for facilities of a steel plant is very difficult jobs as it is big in scale and complicated involving construction of foundations for very heavy facilities and complex foundations, complicated coordination among various facilities, and large sized buildings. Therefore, contractors for this civil and building work must have sufficient experience and ability to perform construction of facilities of a steel plant.

According to the information obtained during the field study, there are several construction companies in India who it is said have experience and ability to construct a steel plant. Therefore, in this feasibility study for the modernization of BURNPUR Works, it is assumed that the work of land reclamation and civil and building work of plant facilities are carried out by Indian construction companies. It is assumed also that construction method, materials and standards as used in India at present are applied in this project.

7-10-2. Land reclamation

(1) Present condition of BURNPUR Works

1) Site area

Site area of IISCO BURNPUR Works is about 5,300,000 square metres including township (excluding the township outside Works' property line) and roughly divided as follows:

a) Site of existing plants	2,600,000 m^2
b) Dumping site	1,100,000
c) Greenery	1,100,000
d) Township	500,000

2) Ground level

According to "Reference Data, Present Status and Modernization of Burnpur Steel Works", the ground level of existing plant area is described to be from M.S.L. (Mean sea level) +129.6 m to 132.6 m.

According to "General Layout Pattern for Modernization of Burnpur Steel Works of IISCO for Production of Steel of 1.0 MT/YR" (Drawing No. PSL/833 dated 21-12-85) and as a result of field survey, the ground level of area filled with blast furnace slag, coal dust, broken bricks and other wastes from existing plants is considered from about M.S.L.+120 m to +145 m.

The ground level of greenery around the dumping site in the compound of BURNPUR Works is about M.S.L. +110 m in the south and about M.S.L. +130 m in the north.

Fig. 7.10.1 shows rough contour of the above ground levels by level.

3) Transportation

Raw materials and products to and from the Works are generally transported by rail. Raw materials are

brought into the Works through North yard and HIRAPUR exchange yard. On the other hand, delivery of products from the Works is through West yard and HIRAPUR exchange yard.

(2) Layout of the modernization of BURNPUR Works

1) Site area available for modernization

The site for construction of new facilities required for the modernization is limited to the dumping site filled with wastes of the Works and greenery in the compound of BURNPUR Works.

The total area of the dumping site and greenery is, as already mentioned, about 2,200,000 m^2. However, if limitation by reason of complicated boundaries and underground coal reserve is taken into consideration, the area available is considered to range from about 1,500,000 m^2 to 1,800,000 m^2 at most out of the total of 2,200,000 m^2.

2) Production scale

Production scale with new facilities after the modernization is planned on condition that generally about 1,500,000 m^2 site is required for steel production of one million T/Y.

Therefore, from the above available area, increase in production is assumed to be 1.0-1.2 million T/Y. In this feasibility study, it is assumed in the plan that production scale can be increased by about 1 million T/Y by new facilities after the modernization.

3) Facilities and their layout

Main new facilities are shown in Table 7.10.1 along with the present status. Their layout is shown in Fig. 7.10.2.

Table 7.10.1 Main new facilities

	Present	After Modernization	
		Step 1	Step 2
Coke oven & by-product plant			
	72 ovens x 1 →	68 ovens x 1	68 ovens x 1
	78 ovens x 2 →	78 ovens x 2 →	78 ovens x 1
	(78 ovens x 1) under rebuilding		92 ovens x 1
Sinter plant		210 m² x 1 →	210 m² x 2
Blast furnace			
	500 m³ x 2 → ×	2,250 m³x 1 →	2250 m³ x 2
	1170 m³ x 2 → ×		
Steel making shop			
	Bessemer converters → ×	130 TLD x 2	130 TLD x 3
	Open hearth furnace → ×		
Lime calcining shop	→	120,000 T/Y →	258,000 T/Y
Continuous casting machine			
		Bloom CC x 1 →	Bloom CC x 1
		Billet CC x 1 →	Billet CC x 3
Rolling mill plant			
Blooming mill	→	→	→
Heavy structural mill	→	→	→
Light structural mill	→	×	
Merchant & bar mill	→	→	→
Sheet bar & billet mill	→	→	→
Hand sheet mill	→	→	×
Galvanizing plant	→	→	→
		Bar & section mill x 1 →	Bar & section mill x 2

4) Layout plan for facilities

a) Premiss of layout plan

In planning the layout of facilities of BURNPUR Works to be modernized, the following conditions are considered.

(i) As existing railway networks, especially in the Iron-making area, are very congested, and so transportation of raw materials to new facilities is by new railway tracks laid from the DAMODAR station. The new tracks up to the compound of the Works are to be laid by a third party other than IISCO. Of the raw materials, however, coal is to be transported by ropeway from CHASNALLA mine to BURNPUR Works as is.

(ii) Products from new facilities are delivered via West yard and HIRAPUR exchange yard as is.

(iii) The ground level of the northwestern part of BURNPUR Works where existing facilities stand is assumed to be M.S.L. +130 m.

(iv) No inclination is given to the tracks for hot metal cars between blast furnaces and BOFs to ensure safety in the transportation.

(v) Under any circumstances new facilities are to be installed in the compound of BURNPUR Works.

(vi) In principle, any new structures are not to be built at area where coal reserves are likely to exist.

b) Layout of new facilities

Based on the above premiss, main new facilities are planned as follows:

(i) Ore yard is installed at the southwestern site of BURNPUR Works that is closer to the DAMODAR station.

(ii) Existing coal yard is used and a new yard is prepared at the site.

(iii) Rolling mills are built in the area close to existing rolling mills.

(iv) The new steelmaking shop and CC plant are to be built to the southwest of the new rolling mills, considering the location of the new rolling mills and the topography of the reclaimed land.

(v) Blast furnaces shop is to be constructed considering hot metal transfer to the steelmaking shop, delivery of raw materials from the sinter plant and coke oven plant, locations of existing slag granulation plant and slag pit.

(vi) The sinter plant is to be built adjacent to ore yard, and the coke ovens built considering the position of the sinter plant and blast furnace shop.

(vii) Power plant and power receiving/distributing facilities are to be built between the existing plant area and the newly built plant area, by taking into consideration the fact that power from DVC is supplied from the existing plant area and also power distribution to the new plant area.

(3) Land reclamation plan

1) Ground level of area of land reclamation

Based on the above layout plan for facilities, ground level of area of land reclamation is so planned that adequate land area necessary for construction of the new facilities can be obtained with the least earth work.

Ground level of the site for steelmaking/CC facilities is to be M.S.L. +130 m, same as the existing plant, as it is planned that the BOFs receive hot metal from not only new blast furnaces but also existing blast furnaces.

As the steelmaking/CC plant area and the blast furnace shop area are connected by hot metal transfer line, ground level of the site for new blast furnace facilities is set at M.S.L. +130 m, same as that of the steelmaking/CC plant area.

Ground level of the rolling mill area also is set at M.S.L. +130 m considering relation between CC plant and rolling mills.

As regards the coke oven plant and sinter plant areas, the present ground level of the site alotted to those areas is about M.S.L. +145 m and with a view of reducing earth work, the ground level is set at M.S.L. +135 m.

Ground level of ore yard is planned at M.S.L. + 125 m considering the ground level of greenery outside the compound of BURNPUR Works and delivery of raw material (iron ore) from the DAMODAR station.

The sites other than the above are planned at proper ground levels considering necessary earth work, ground levels of adjacent sites for other facilities and that of greenery.

2) Consideration of existing facilities to land reclamation

Those existing facilities presently in operation that obstruct land reclamation work are to be removed or moved before start of land reclamation so as to ensure smooth operation of the Works.

7-10-3. Premiss of civil and building work plan

(1) Environmental conditions

As the conditions such as wind, rain, temperature, seismics, topography, soil and others are discussed in 5-9-2, bearing capacity of soil will be discussed here.

For the bearing capacity, the following allowable bearing values also are applied.

(i)	Existing plant area	20 T/m^2
(ii)	Planned area for expansion (dumping area)	
	Improved soil area	25 T/m^2
	Unimproved soil area	10 T/m^2

(2) Planned ground level

Planned ground level of area of main new facilities is set as stated below based on the above mentioned land reclamation plan.

(i)	Existing plant area	M.S.L.+130 m
(ii)	Sinter plant area	M.S.L.+135 m
(iii)	Coke oven plant area	M.S.L.+135 m
(iv)	Blast furnace shop area	M.S.L.+130 m
(v)	Lime calcining plant area	M.S.L.+130 m
(vi)	Steelmaking shop/CC plant area	M.S.L.+130 m
(vii)	Rolling mill area	M.S.L.+130 m
(viii)	Utilities area (Power plant, power receiving/distributing facilities, oxygen plant & gas holders)	M.S.L.+130 m
(ix)	Ore yard	M.S.L.+125 m
(x)	By-product chemicals plant area (Benzene, toluene, xylene & tar)	M.S.L.+120 m

(3) Type of foundation

According to the above soil investigation report, soil of existing plant area in general has allowable bearing value not less than 20 T/m^2 and is suited for direct foundation.

On the other hand, filled up layer of the area where most of new facilities are to be built, according to the about soil investigation report, contains various sizes and shapes of steel scrap, ingot and waste and its bearing capacity for direct foundation as footing for heavy equipment and structures of a steel plant is inadequate.

However it is difficult to apply pile foundation for the heavy equipment and structures. This is because buried steel scrap, ingot and waste may hinder driving of pile foundation and also because it is difficult to know where those are buried.

Therefore it is more practical to improve the filled up layer from ground service by proper soil improvement method and then apply direct foundation to the filled up layer.

For the above reasons direct foundation is applied to foundations of new facilities.

(4) Type of building

Type of building is classified into two types. One is steel structural construction and the other is reinforced concrete construction.

Plant building is of steel structural construction and its roof and wall are planned to be corrugated galvanized sheets.

Buildings other than plant building, for example office, control room, electric room, etc., are planned to be of reinforced concrete construction.

In any case Indian custom as well as information obtained during field survey is taken into consideration.

7-10-4. Estimate condition of cost of civil and building work

(1) Estimate conditions

The following conditions are considered for estimation of cost of civil and building work.

(i) In accordance with instruction of SAIL and IISCO, all materials, labour, equipment and others are assumed available within India.

(ii) Civil and building work is assumed to be contracted, implemented and completed by Indian contractor within the construction period based on the construction schedule separately indicated.

(iii) Unit cost of civil and building work is in principle set on the basis of information given in "Reference Data - Present Status and Modernization of Burnpur Works."

However, for unit cost on which no information was available at the time of field survey, it was assumed based on experiences in Japan.

(iv) The above cost studied is to include expenses and profit.

(v) No provision was made for escalation of unit cost.

(vi) Unforeseen cost required for removal of buried obstructions is not to be included in the cost of civil and building work.

(vii) Dumping area for surplus earth resulting from civil and building work is assumed available free of cost and close to BURNPUR Works.

(2) Scope of the estimate

(i) The estimate is to be confined to civil and building work in the compound of BURNPUR Works.

(ii) Civil and building work outside the Works, for example construction of any new access roads to BURNPUR Works, shunting yard for raw materials transportation, a township and others, is to be excluded from this cost estimate.

(iii) Furnitures such as desk, chair and locker are to be outside of the scope of estimate.

(iv) Any new buildings for management such as replacement of existing office for General Manager are not considered necessary and are excluded from this cost estimate.

(v) Temporary constructions required only for this civil and building work are included in this scope of estimate.

(vi) No engineering fee whatsoever is to be included in the civil and building work.

7-10-5. Quantity of excavation work and materials used in civil and building work

The quantity of main construction works are estimated roughly as follows:

	Excavation (m^3)	Concrete (m^3)	Reinforced steel (T)	Steel structure (T)
Land reclamation	7,500,000	-	-	-
Sintering facilities	274,000	92,300	7,480	7,390
Coke oven facilities	186,000	87,300	8,350	1,120
Blast furnace facilities	203,000	64,400	5,460	3,440
Lime calcining facilities	51,000	10,000	1,000	550
Steelmaking facilities	83,000	20,000	840	11,200
Continuous casting facilities	164,000	25,000	1,600	8,000
Rolling mill facilities	247,000	55,000	4,050	6,220
Maintenance facilities	8,000	3,900	210	1,200
Utilities facilities	95,000	25,000	2,220	1,430
Total	1,311,000	382,900	31,210	40,550

The above is the quantity of construction works related to equipment and steel structural constructions. It is assumed that roughly about 10% of the above quantity (excluding the quantity of steel structure) is to be added as the quantity for reinforced concrete constructions and boundary fences.

As mentioned in Introduction in Chapter 1, the present feasibility study had to be made in a very limited time. The above quantity was very roughly estimated on the basis of soil condition and topographical data obtained during field survey in such limited time.

In particular, almost no data are available of soil data of the area where new facilities are to be constructed. In addition, the topography shown in "General Layout Pattern for Modernization of Burnpur Works of IISCO for Production of Steel of 1.0 MT/YR" does not reflect the present topographical condition.

Therefore at the time of implementation of the work, it is imperative to make over again soil investigation and topographical survey of the site planned for new facilities and confirm soil data and topographical data. It is expected that as a result of such investigation and survey, the above quantity and construction cost may be revised and made closer to practical and accurate one.

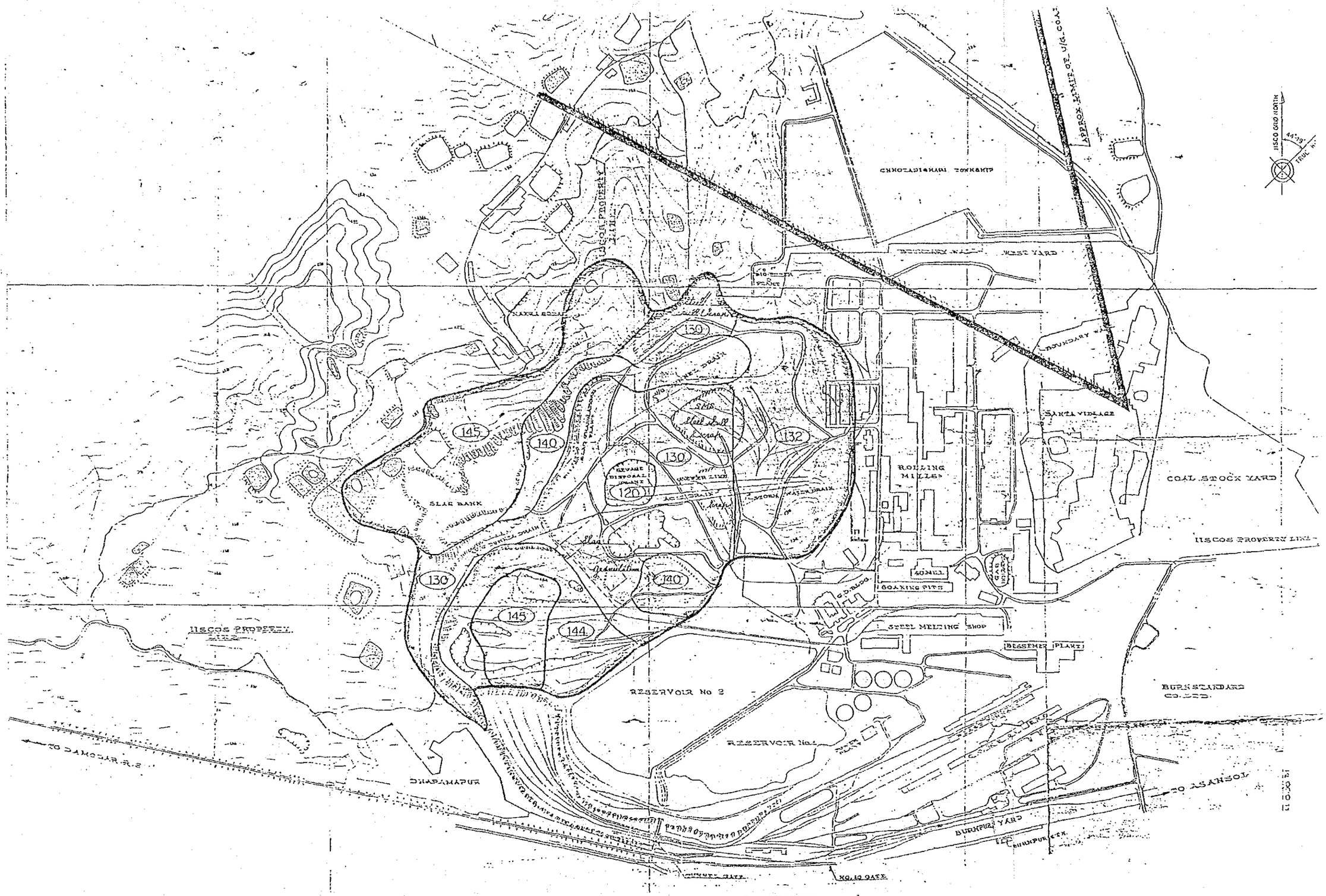


Fig. 7.10.1 Topographic map of BURNPUR works

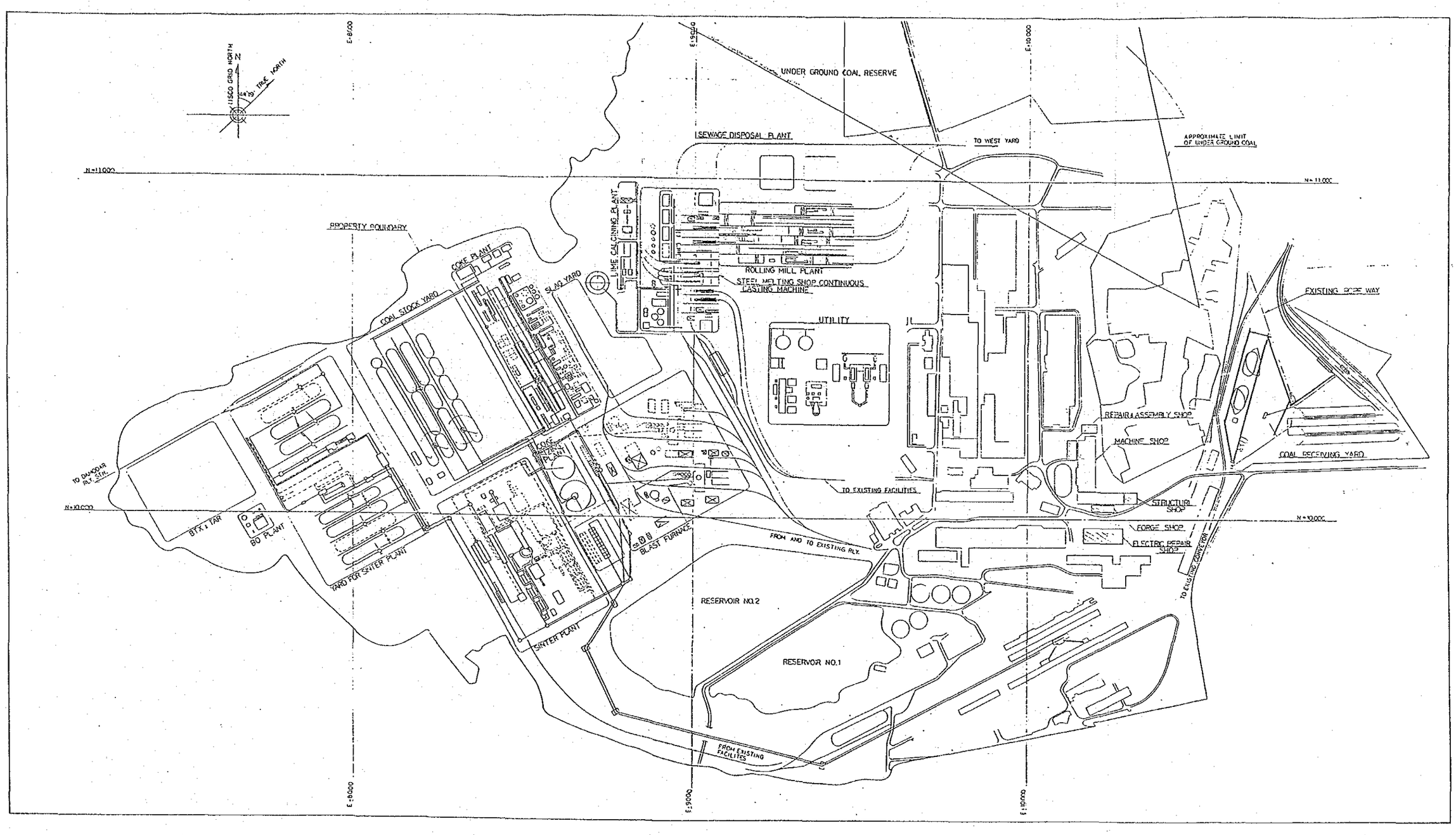


Fig. 7.10.2 General layout of BURNPUR works

7-11. Summary of the modernization plan and technical premises for financial analysis

The major part of technical premises for financial analysis discussed in detail in Chapter 8 are those discussed in detail in Chapter 7 Modernization plan.

In the following are given the items and Chapters which deal with them.

(1)	Of the investment amount,	
	Land reclamation and civil & building work	(7-10)
	Machinery & equipment, installation and vehicles	(7-2 - 7-9)
	Environmental measures	(7-1-4, 7-2 - 7-9)
	Education & training, operation guidance	(7-1-9, 7-2 - 7-9)
	Startup preparation, operation preparation	(7-2 - 7-9)
(2)	Construction schedule	(7-1-5, 7-2 - 7-10)
(3)	Production plan	(7-1-6, 7-2 - 7-7)
(4)	Material flow and material balance	(7-1-7, 7-2 - 7-7)
(5)	Energy flow and energy balance	(7-9)
(6)	Yield and unit consumptions	(7-2 - 7-9)
(7)	Personnel	(7-1-8, 7-2 - 7-9)
(8)	Education and training	(7-1-9, 7-2 - 7-9)
(9)	Repair cost	(6-3 & 7-8)
(10)	Effect of the report	(7-1-5)

Chapter 8

Financial analysis

Contents

8. Financial analysis

8-1. Estimate of investment

8-1-1. Basic idea for estimating investment

(1) Domestic and import purchasing

1) Land reclamation and civil & building work : 100% purchased at home

2) Various materials for the above : -"-

3) Machinery & equipment : Determined in view of possibility of purchasing in India and other conditions

4) Vehicle & spares : Same as 3) above

5) Erection work : Same as 3) above

6) Marine transport : Assumed 100% transported by foreign bottoms

(2) Bases of estimation

1) Time of estimation

Domestic portion : July 1986

Imported portion : December 1986

2) Currency and exchange rate

a. Currency used

Domestic portion : Indian Rupees

Imported portion : Yen (Converted into Rs.)

b. Exchange rate : 1 Rs. = ¥13.25 (July 1986)

(3) Effect of price fluctuation

The investment in this study is prices at the time of estimation in (2) above and any effect of price fluctuation at the time of construction is not incorporated.

(4) Customs imposed on imported goods

Though the investment is considerable, in principle, the existing enterprise cannot enjoy tax incentive. Consequently in this study, fairly high 55% duties are imposed on imported goods.

8-1-2. The amount of investment

(1) The total investment amount (Unit: Rs. in Lakhs)

	Domestic	Imported	Total	% Composition
1st step	79,624	49,529	129,153	(53)
2nd step	76,428	39,285	115,713	(47)
Total	156,052	88,814	244,866	(100)
%	(64)	(36)	(100)	

The breakdown of the total investment amount by step and item is shown in Tables 8.1.1, 8.1.2 and 8.1.3. And the detail by facilities is given at the end of Chapter.

(2) % composition by item of the total investment (1st and 2nd steps)

The top four items account for close to about 80% of the the total.

1) Machinery & equipment	107,048	Rs. in Lakhs	43.7%
2) Customs duties	36,222	-"-	14.8%
3) Civil & building work	28,975	-"-	11.8%*
4) Erection work	16,895	-"-	6.9%

Note: * Includes land reclamation.

Of the above, attention should be paid particularly to the high percentage of customs duties.

(3) Direct construction cost (Unit: Rs. in Lakhs)

	Domestic	Imported	Total	% Composition
1st step	49,318	38,115	87,433	(52)
2nd step	49,785	30,267	80,052	(48)
Total	99,103	68,382	167,485	(100)
%	(59)	(41)	(100)	

The breakdown of direct construction cost by step and facilities is shown in Tables 8-1-4, 8-1-5 and 8-1-6.