Section 8 Basic Oxygen Furnace Plant

Contents

1. General

1.1 General description of steelmaking plant (BOF and continuous casting)

1) The NISW is constructed for supplying large amount of steel required for domestic demand.
2) The steel making plant shall be constructed aiming at realizing high productive operation with large quantity of production.
3) The steelmaking process of the NISW is constructed by BF／BOF process from view point of raw materials and energy availability.
4) The required steel is mainly commercial grade of general use in Viet Nam, and the steel as sheet used for car outer body is not produced for the present, but there is capability of producing such grade in the future.
5) The main raw material is hot metal from blast furnace (BF) and home generated scrap. Imported and domestically generated scrap is not expectable.
6) The 220 t/heat nominal capacity basic oxygen furnaces (two out of three BOFs) produce molten steel of 4,535x10^3t/y at step-3.
7) The two conventional slab casting machines produce 3,225 x10^3t/y of slab, and one billet casting machine produces 1,095x10^3t/y of billet.
8) The casting process is totally continuous casting process without ingot making, and aims at hot direct charging to hot rolling mill as much as possible.

1.2 The construction timing and the amount of production

Table 8-1 summarizes the construction timing of steelmaking plants and amount of production.

Table 8-1 The construction timing and the amount of production

Step & Year	Step-2		Step-3	
	Formation	Production	Formation	Production
		x10^3t/y		x10^3t/y
BF	1 BF	2,266	2 BF	4,389
BOF	1/2 BOF	2,342	2/3 BOF	4,535
Slab-CCM	1 str. SL CCM x 2	2,224	1 str. SL CCM x 2 (M.L. extension)	3,225
Billet-CCM	-----	------	8 str. BT CCM	1,095

Note: ML; machine length

(1) At Step-2
  a) The two (2) BOFs are constructed (1 operation out of 2 furnaces) accompanied with the No.1 BF construction, and the amount of molten steel product is half of final stage production.
  b) Two slab CCMs with one strand each are constructed at step-2, though its machine length is shorter than that of final step to save investment cost due to limited amount of slab production.

(2) At Step-3
  a) One (1) BOF is additionally installed (2 out of 3 furnaces operation) accompanied with the No. 2 BF. construction.
  b) The machine length of two slab casters are extended accompanied with increasing of casting speed for increasing of production.
  c) The billet caster is constructed with 8 strands to produce 1,095 $x10^3$t/y of billet.

(3) In future, the area for construction of 1-str. slab caster is provided for steel grade change and more production required.

2 Preconditions

2.1 Conditions of preceding process

2.1.1 Main raw material

(1) Hot metal from blast furnaces
 – BF capacity; 3,200 m^3 x 2 (at Step-2 ; 1 BF is constructed)
 -- Table 8-2 shows the property of hot metal and cold pig iron generally required.

Table 8-2 Hot metal condition (assumption)

Item	[C]	[Si]	[Mn]	[P]	[S]	Temperature
Unit	%	x 10^{-2}%	x 10^{-2}%	x 10^{-3}%	x 10^{-3}%	℃ (hot metal)
Value (approx.)	4.0	40	35	110	35	1,550 (at BF) 1,320 (at BOF)

(2) Scrap condition

Generation	As a rule, only home scrap generated in the NISW is used. No import, no other domestic supply due to short scrap generation

2.2 Preconditions of operation

2.2.1 Product mix and process

(1) Property of flat product

Product mix of flat product is assumed and shown in Table 8-3.

a) The steel grade is mainly commercial grade general use.

b) The hot metal is treated only desulfurization in the torpedo car (TDS), not required to treat the desiliconization nor dephosphorization.

c) The BOF adopts oxygen top blowing and inert gas bottom blowing method to strengthen agitation. (CB; Combination Blowing)

d) CAS-OB(Composition Adjustment by Sealed argon bubbling with Oxygen Blowing method) is adopted for the secondary refining process, and its functions are temperature (heating) control, chemical composition adjusting, and eliminating of inclusion.

In future; Degassing (RH) equipment will be provided in the layout for de-hydrogenation of heavy plate, and decarbonization to produce ultra low carbon steel.

e) The products are supplied to domestic market, as a rule, accordingly export of the products is not planned even at final stage(Step-3).

(2) Property of non-flat product

Product mix of non flat product is assumed and shown in Table 8-4.

a) The billet is used mainly for wire rod, bar and light section for construction use.

b) Hot metal treatment process, BOF process, and secondary refining process are same as that of flat product.

c) The product (billet) is supplied to domestic rolling mills, as a rule, and export is not planned even at final stage(Step-3).

2.2.2 Main materials blending ratio and yield

Table 8-5 shows the main material blending ratio. Home scrap ratio is estimated from material balance in the NISW, and the yield is estimated from general experiences.

Table 8-5 Main materials blending ratio and yield

Item		%	
		Step-2	Step-3
1) Main material blending ratio	Hot metal ratio (+ Cold pig iron ratio)	89.1 (0.9)	89.1 (0.9)
	Scrap ratio	10.0	
2) Yield	Molten steel yield	93.0	

Table 8-3 Product mix and production process of flat product

	Product. ratio (%)	Typical steel grade (JIS)			Process	
					BOF	Continuous casting
Tensile strength / Product	Approx. %	≦30 K Low-[C] steel	40 K Low or Middle -[C] steel	≧50 K Low alloy steel	1) Hot metal treatment ·Torpedo desulfurization for required [S] level ↓ 2) BOF ·Combination blowing -Top oxygen blowing - Bottom inert gas blowing ↓ 3) Secondary refining -CAS-OB process -(RH degasser is future provision)	1) Slab caster · 1-strand Slab-CCM · Vertical bending type · Casting speed - LC steel max 2.5 mpm - MC steel max. 2.0mpm · Immersion nozzle (IN) Powder casting · Mold EMSB(Electro-magnetic brake) · Mist cooling
Hot final product	48	SPHC, SPHD, SPHE etc.	SS400, SM400 SAPH etc.	SS500, SM500 SPFH SPA-H etc.		
Heavy plate	12	———	SS400, SM400 etc.	SS500, SM500 etc.		
Cold rolled (include coated)	40	SPCC,SPCD, SPCE, SPFC etc.	SPFC	SPA-C		
Production ratio (%)	100 / 100	70 - 75	20 - 25	5		

Note; K; kg/mm^2 (tensile strength),
The production ratio in the Table is approximate value at step-3 to image the distribution of flat product.

Table 8-4 Product mix and production process of non-flat product

	Product	Product ratio %	Typical grade (JIS)	Steelmaking Process: BOF	Steelmaking Process: Continuous casting
Wire rod		Approx.		1) Hot metal treatment ·Torpedo desulfurization for required [S] level ↓ 2) BOF ·Combination blowing -Top oxygen blowing -Bottom inert gas blowing ↓ 3) Secondary refining CAS-OB process (RH degasser is future provision)	Billet caster ·8-strand BT-CCM ·Casting speed 2.5 mpm (for 150 sq.) ·Open casting or powder casting ·Mold EMS (Electro-magnetic stirrer)
	Re-bar in coil	1.5	SD295		
	Low carbon steel	22.5	SWRM8 to 22		
	High carbon steel	3.0	SWRH62 to 72		
	Cold heading steel	1.5	SWRCH10 to 50		
	Spring steel	1.5	SUP6,9		
	Low alloy steel	(0)	SCM435		
	Welding wire steel	(0)	SWRY11 to 21		
		30.0			
Bar	Re-bar	46.0	SD295 to 345		
	General structure	3.0	SS400 to 490		
	Chains	3.0	SBC300 to 490		
	Cold finish	(0)	SGD2 to 4		
	Carbon steel	3.0	S25C to S55C		
	Low alloy steel	(0)	SMn443, etc.		
		55.0			
Bar and section	Re-bar	6.0	SS400		
	Section	9.0			
		15.0			
	Total	100.0			

Remark;
The (0) marked in the steel grade column in the table shall not be produce at the final stage(step-3). They shall be produced after additional secondary refining process (degasser) is installed.

2.2.3 Material balance of raw material and product

Figure 8-1 and Figure 8-2 outline the flow of raw material and product balance in steelmaking plant from the BOF plant to the continuous casting plants for step-2 and step-3 respectively.

2.2.4 Operating condition of the BOF plant

Table 8-7 shows the operating conditions of steelmaking plant.

Table 8-6 Operating condition of BOF plant

Items		Planned value	
		Step-2	Step-3
1) Operating rate	(Total steelmaking time /calendar time)	70 %	
2) Operating time	a) Annual operating day	345 d	
	b) Monthly operating days	29 d	
	c) Scheduled maintenance		
	Annual	7 d/y	
	Monthly	12 hr x 1 time / WKS	
3) Molten steel tapped per heat	(tons)	Average 220 t/ht	
4) Steel tapped (tons)	a) Annual ton	2,342,000 t	4,535,000 t
	b) Monthly ton	195,200 t	377,900 t
	c) Daily ton	6,800 t	13,167 t
5) Steel tapped (heats)	a) Annual heats	10,645 ht	20,613 ht
	b) Monthly heats	887 ht	1,718 ht
	c) Daily heats	30.6 ht	59.2 ht
6) Steelmaking time	Tap to tap time	36 min/ht	
	Break down Charging	5 min	
	Blowing	16	
	Measuring	6	
	Tapping	5	
	Slag off	4	

Unit; x10³t/y

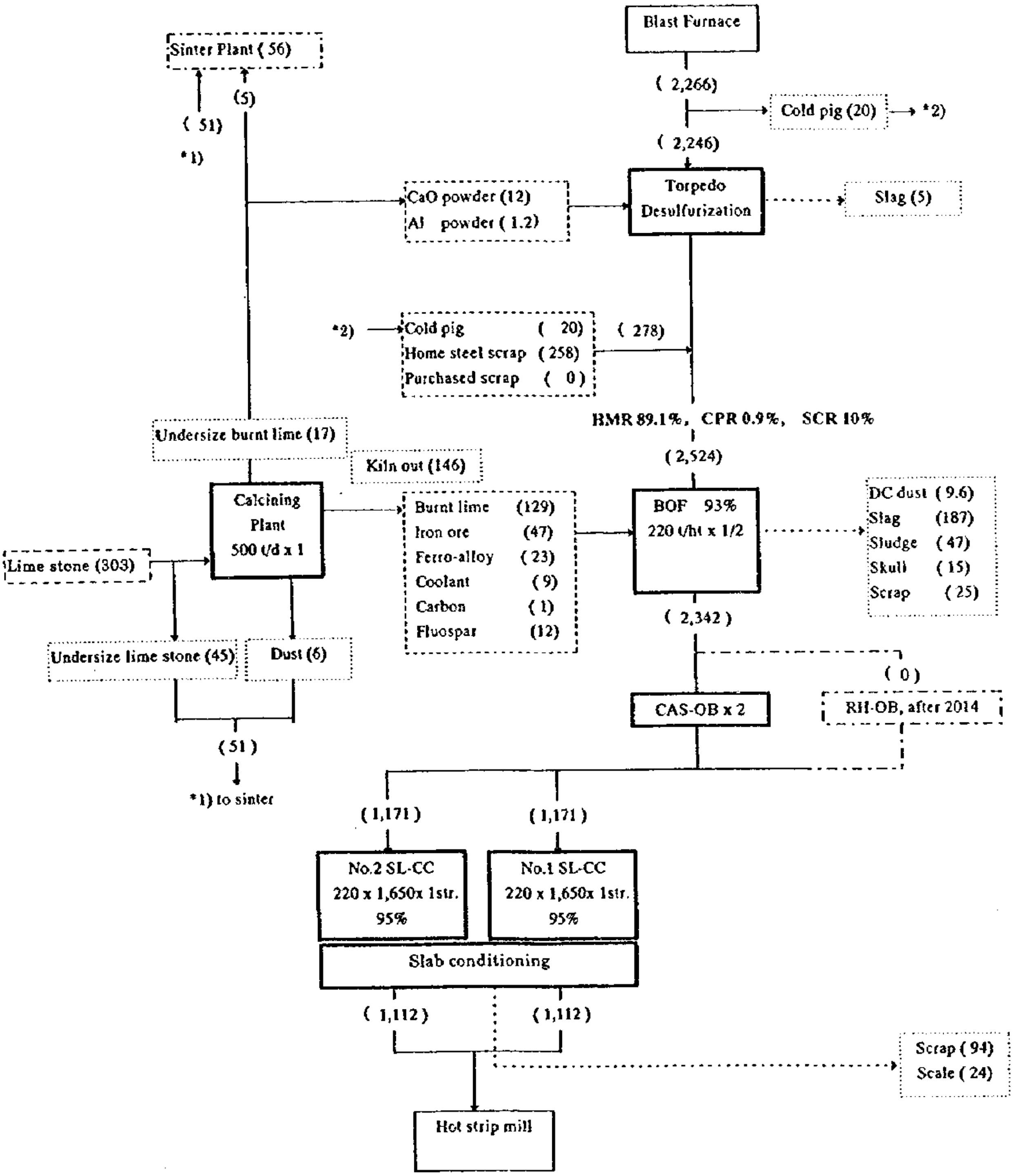


Figure 8-1 Material balance of steelmaking plant at Step 2

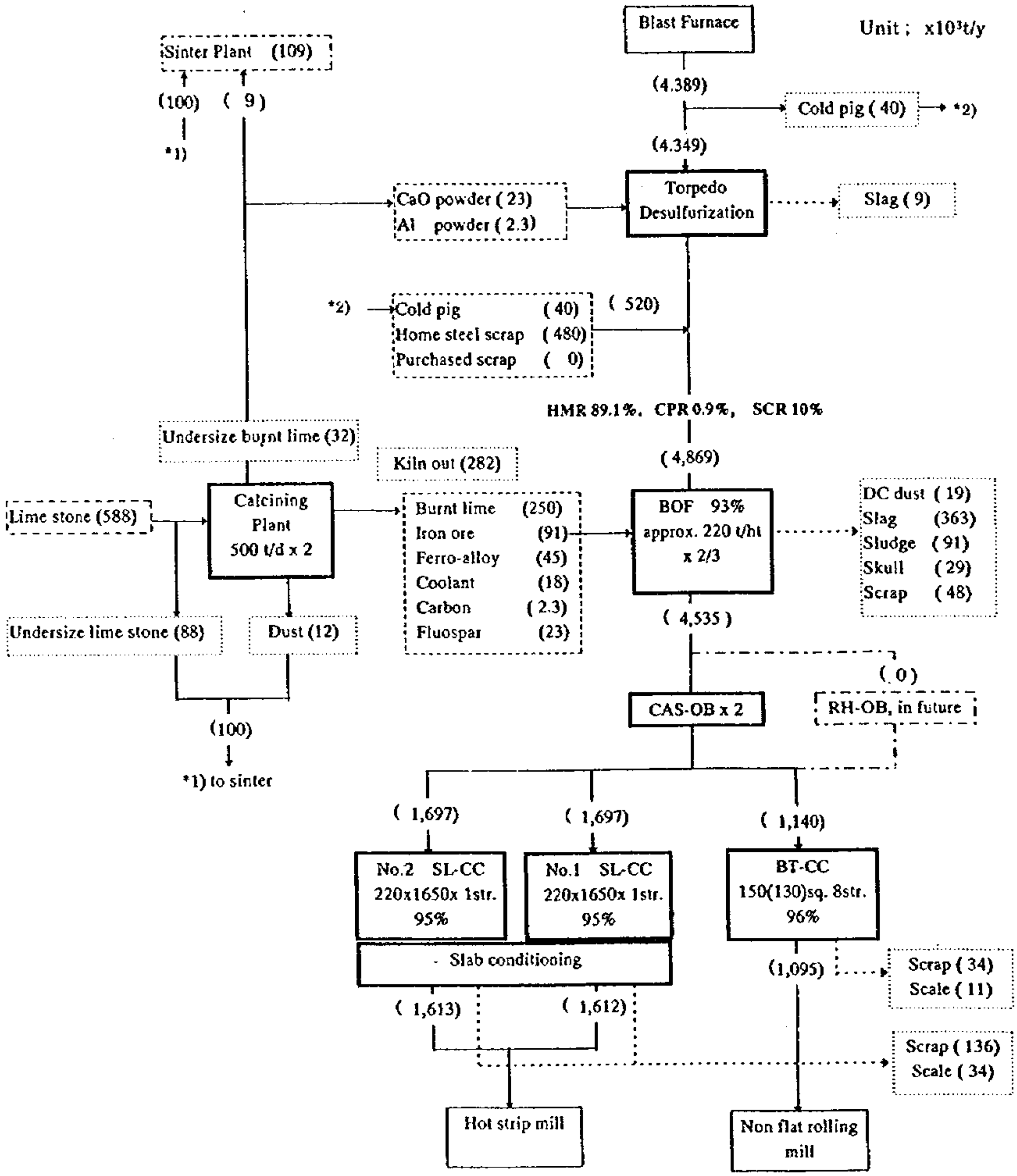


Figure 8-2 Material balance of steelmaking plant at Step 3

3. Equipment plan

3.1 Equipment specifications

Table 8-7 shows the outline equipment specification roughly studied.
Function and conception of each equipment are outlined below.

1) Hot metal handling equipment
Torpedo cars (TDC) with capacity of approx. 250 t is used to carry hot metal from BF to BOF. On the way from BF to BOF, the hot metal is desulfurized at the torpedo desulfurization (TDS) station.
2) Torpedo desulfurization equipment
As outlined in Table 8-2, the sulfur content of hot metal is expected not so high because good quality iron ore is to be imported, but the sulfur content of final product cannot be attained low enough, if it is not desulfurized.
The TDS equipment is possible to treat large amount of hot metal.
The agent of desulfurization is fine burnt lime supplied from calcining plant and aluminum dross powder for promotion of reaction.
3) Scrap handling equipment
Three scrap loading lines with weighing equipment in the scrap loading bay. Assuming maximum scrap ratio as 20 %, the capacity of scrap charging chute is estimated approx.45 t.
4) Converter equipment
Three furnaces of nominal capacity of 220 t/heat is installed at step-3 (two out of three furnaces operation).
The capacity is fixed considering the matching between BOFs and casters.
The BOF capacity is fixed a bit larger (because a bit lower working time ratio) for realizing the enough capacity of slab production by two CCMs of 1-strand high speed casters.
The converter is the type of combination blowing method with top oxygen blowing and bottom inert gas (N_2 and CO_2) blowing to strengthen agitation.
5) Oxygen blowing equipment
To attain 36 min. tap-to-tap time, the oxygen blowing equipment is designed as the average blowing time of 16 min, and the oxygen blowing rate of a lance is approx. 43,000 Nm^3/h, the maximum design condition is approx. 45,000 Nm^3/h.
6) Sub-lance equipment
The simultaneous hitting ratio by the static control is low, which can be increased by introducing a sub-lance system. The sub-lance measurement is made few minutes before blow-off, in which the temperature and carbon content of the molten steel is measured to judge the blow-off time and coolant weight.

7) Waste gas processing equipment
As a positive energy saving measure, waste gas processing equipment of non-combustive recovery type is installed.
The dust content in the waste gas after dust collection is designed in accordance with the regulations concerned. (generally less than 0.1 g/Nm^3).
The gas is recovered by switching the three-way valves to the recovery side and sending the gas into the LDG (LD gas) holder.
The low content CO (carbon mono-oxide) gas is burned and discharged from stack during non-recovery period of operation.

8) Flux handling equipment
The fluxes except the burnt lime are received by truck in the under ground bunkers, and transported into the high level bunkers via the belt conveyors, which are joined by the burnt lime conveyor.
The charging equipment is able to charge fluxes during blowing operation.

9) Ferro-alloy handling equipment
The ferro-alloy shall be received by the truck in the under ground bunkers, and transported into the high level bunkers via the belt conveyors.
After the brand and quantity of ferro-alloys are determined according to the steel grade and blow-off conditions, the ferro-alloys shall be charged into molten steel ladle during the tapping operation.

10) Molten steel transportation equipment
The tapped molten steel in the molten steel ladle is transported from converter to CAS-OB equipment (or directly casters) by molten steel ladle car, and by ladle crane.

11) Secondary refining equipment
The functions required for secondary refining process are as follows.
  a) To stabilize the quality of Al-killed steel, it is required to keep aluminum yield at high level, and to control the chemical composition of molten steel within narrow range.
  b) To supply molten steel to the different type of CCMs, the secondary refining process is required to treat as quick as possible.
  c) Quick heating up function is required to control the molten steel temperature within narrow range.

The CAS-OB method is adopted for these requirement.

Table 8-7 Equipment specification of BOF plant

Equipment	Quantity		Main specification
	Step-2	Step-3	
1 Converter equipment			
1) Converter proper	2	+1	Capacity; 220 t/ht, Tap-Tap; 36 min.
2) Furnace tilting device	2	+	Shaft mount 4-motor drive
3) Oxygen blowing system	2 sets	+1 set	Blowing O_2 rate; approx. 45,000 Nm^3/h
			Lance; quick exchangeable type 2sets/BOF
4) Bottom gas blowing equipment	2 sets	+1 set	LD-CB process (CO_2+N_2 gas blowing)
5) Sub-lance equipment	2	+1	Vertical insertion, automatic probe attaching and detaching
6) Cooling water equipment	2 sets	+1 set	For converter and lance etc.
2 Converter auxiliary equipment	2 sets	+1 set	
3 Hot metal handling equipment	2 sets	+1 set	Hot metal weighing and transfer cars Hot metal ladles, and deslagging devises
4 Scrap loading equipment	2 sets	+1 set	3 loading and weighing lines Scrap chutes; capacity approx. 45t:
5 Raw material handling equipment			
1) Burnt lime and flux handling equipment	1 set	--	Transporting to the BOFs and charging into the BOFs
2) Ferro-alloy handling equipment	1 set	--	Transporting to the BOFs and charging into the ladles
6 Waste gas treatment equip.			
1) OG equipment	2 sets	+1 set	Type; LDG recovery, closed circuit cooling water system
2) Secondary ventilation system	1 set	+1 set	Type; Bag filters approx.16,000m^3 /min & 9,000m^3/min
3) Roof dust collector	--	--	Future provision; (Type; Bag filters)
7 Secondary refining equipment			Snorkel lifting, ladle handling equipment
7.1 (CAS-OB)	1 set	+1 set	High level bunkers & ferro-alloy charging equipment
	--		O_2, Ar and N_2 gas supply equipment
7-2 RH-OB equipment (future provision)			For degassing and decarbonization
8 Molten steel handling equipment	1 set	+1 set	Molten steel ladle Ladle on line maintenance equipment and others
9 Crane	1 set	+1 set	
10 Hot metal pre-treating equipment Torpedo de-sulfurization equipment	1 set	+1 set	1 treatment station/set Agent; CaO +Aluminum powder

(continued)

Equipment	Quantity		Main specification
	Step-2	Step-3	
11 Torpedo car deslagging equipment	1 set	--	Deslagging station 2 (2 torpedo cars series operation) Bag filter type dust collector
12 Torpedo car maintenance equipment	1 set	--	Function; Cooling, demolishing, relining, and drying
13 Slag disposal equipment	1 set	--	Water and natural air cooling yard type
14 Ladle relining equipment	1 set		Function; Refractory demolishing, relining, drying, ladle transfer
15 Electrical equipment	1 set	+1 set	a) Line equipment drive and control system b) Power supply and distribution system c) Battery for emergency d) Other equipment
16 Instrumentation	1 set	+1 set	a) Instrumentation for line equip. b) Air and power source c) Other equipment d) ITV etc.
18 Process computer for BOF process control	1 set		Main function a) End point control b) Blowing pattern pre-set c) Ladle addition calculation d) Other data treating etc.
19 Water treatment	1 set		Drinking & sanitary water system, fire hydrant equipment etc.
20 Civil engineering and building	1 set		a) Foundation b) Yard c) Track
21 Building	1 set	+1 set	a) Main building b) Auxiliary building
22 Gas holder 1) Oxygen gas holder 2) Nitrogen gas holder 3) LD gas (LDG) holder	 1 set 1 1	 +1set -- --	

3.2 Equipment flow

Figure 8-3 outlines the equipment flow from the BOF to continuous casting plant.

3.3 Plant layout of steelmaking plant

Figure 8-4 shows the layout of BOF, CCM, and lime calcining plants.

3.4 Production and unit consumption of steelmaking process

Table 8-9 lists the production and unit consumption of BOF process.

3.5 Manning plan of BOF plant

The manning plan is estimated on the base of 3 shifts x 4 crews.

The organization of steelmaking plant division is assumed as follows.

<Division> <Section> <Sub-section>

- Steelmaking division
  - BOF operation
  - CC operation
    - Slab CC operation
    - Billet CC operation
  - Calcining operation
  - Machine operation (crane operation)
  - Refractory maintenance
  - Machine maintenance
  - Technical section

Machine operation, Refractory maintenance, Machine maintenance and Technical section: Supporting for ·BOF ·CC ·Calcining

Table 8-8 shows the manning plan of BOF.

Table 8-8 The manning plan of BOF plant (at Step-3 unit: persons)

BOF plant	General control	Operation		Machine operation		Refrac-tory		Mainte-nance		Technical division		Total	
Step	2 & 3	2	3	2	3	2	3	2	3	2	3	2	3
General manager	1											1	
Section manager		1		1		1		1		1		5	
Assistant manager		1		1		1		1		1		5	
Engineer		1		1		2		2		3	4	9	10
Foreman		17		5		6		4				32	
Skilled worker		95	153	25	39	64	102	19	29			203	323
Unskilled worker		41	65	11	17	27	43	8	12			87	137
Clerk	1											1	
Secretary		1		1		1		1		1		5	
Total	2	157	239	45	65	102	156	36	50	6	7	348	519

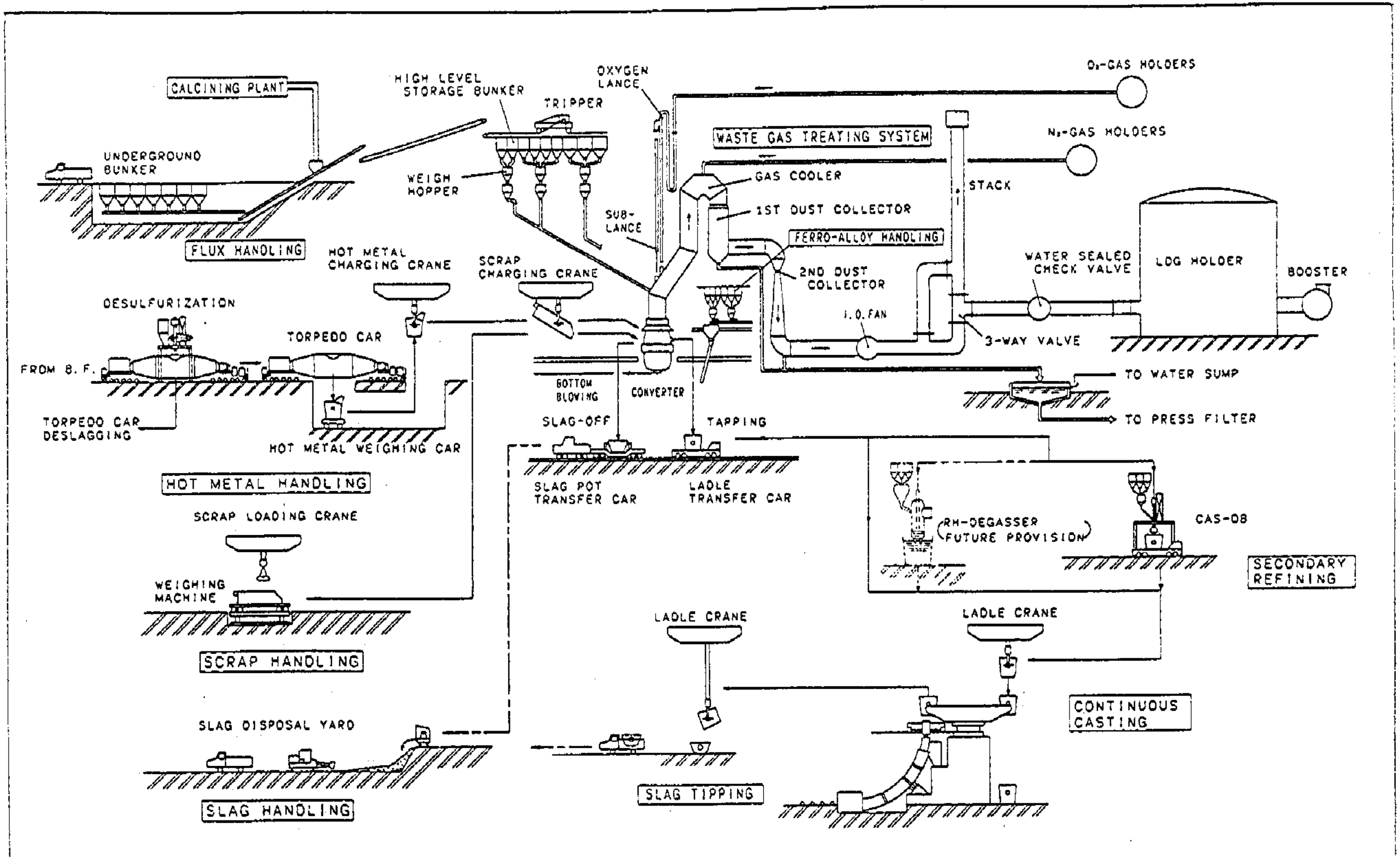


Figure 8-3 Equipment flow of steel making plant

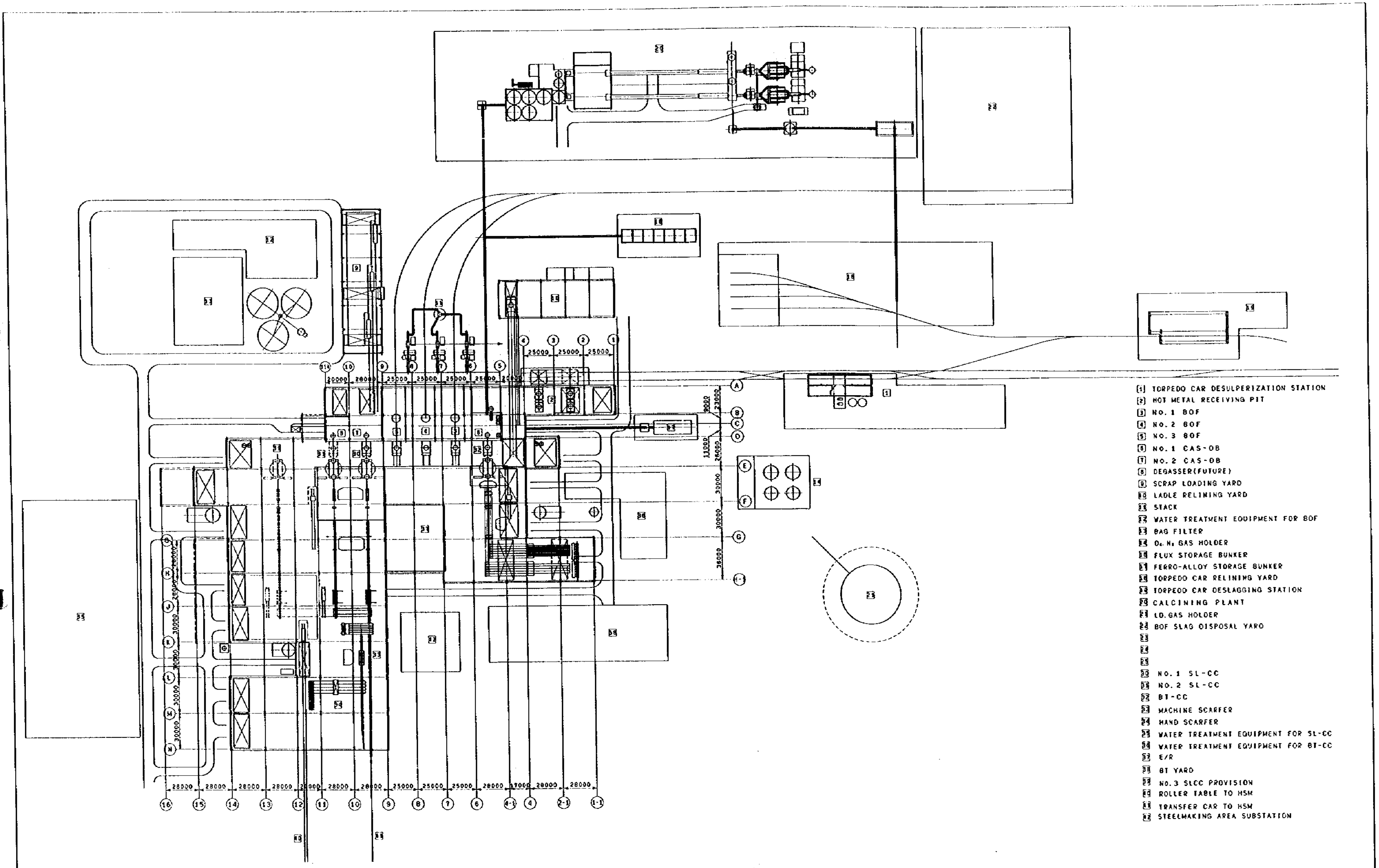


Figure 8-4 Layout of steel making plant

Table 8-9 Production and unit consumption of steelmaking process

Note: t-s; molten steel 4,535 x10^3t/y

Item	U.C		Q'ty (step-3)	Supply	Remark
	Unit		t/y		
1) Main material					
· Hot metal	kg/t-s	958.1	4,344,984	NISW	HMR 89.1%
· Cold pig iron	kg/t-s	9.7	43,990	NISW	CPR 0.9%
· Scrap	kg/t-s	107.5	487,513	NISW	SCR 10%
2) Auxiliary materials					
· Limestone	k g/t-s	(129.3)	(588,000)	D	(for calcining)
· Burnt lime		55.0	250,000	NISW	
· Dolomite		(0)	(0)	D	
· Fluorspar		5.0	22.700	Imp.	
· Iron ore		20.0	90,700	Imp.	
· Forming suppressing agent		3.0	14,000	Imp.	
3) Torpedo desulfurization					
· CaO powder		7.0	23,100	NISW	From calcining plant
· Al dross powder		0.7	2.31	Imp.	Addition with CaO
4) Ferroalloy					
· HC Fe-Mn		4.0	18,140	Imp.	
· LC Fe-Mn		2.0	9,070	Imp.	
· Si-Mn		1.0	4,540	Imp.	
· Fe-Si		1.0	4,540	Imp.	
· Si-Mn		—	—	Imp.	
· Special alloy		—	—	Imp.	
· Al, Bundle Al		2.0	9,100	Imp.	
· Pitch cokes (carbon)		0.5	2,270	Imp.	
· Coolant		4.0	18,140	Imp.	Temp. control in ladle
· Heat shield agent		3.0	13,600	Imp.	Burnt chaff

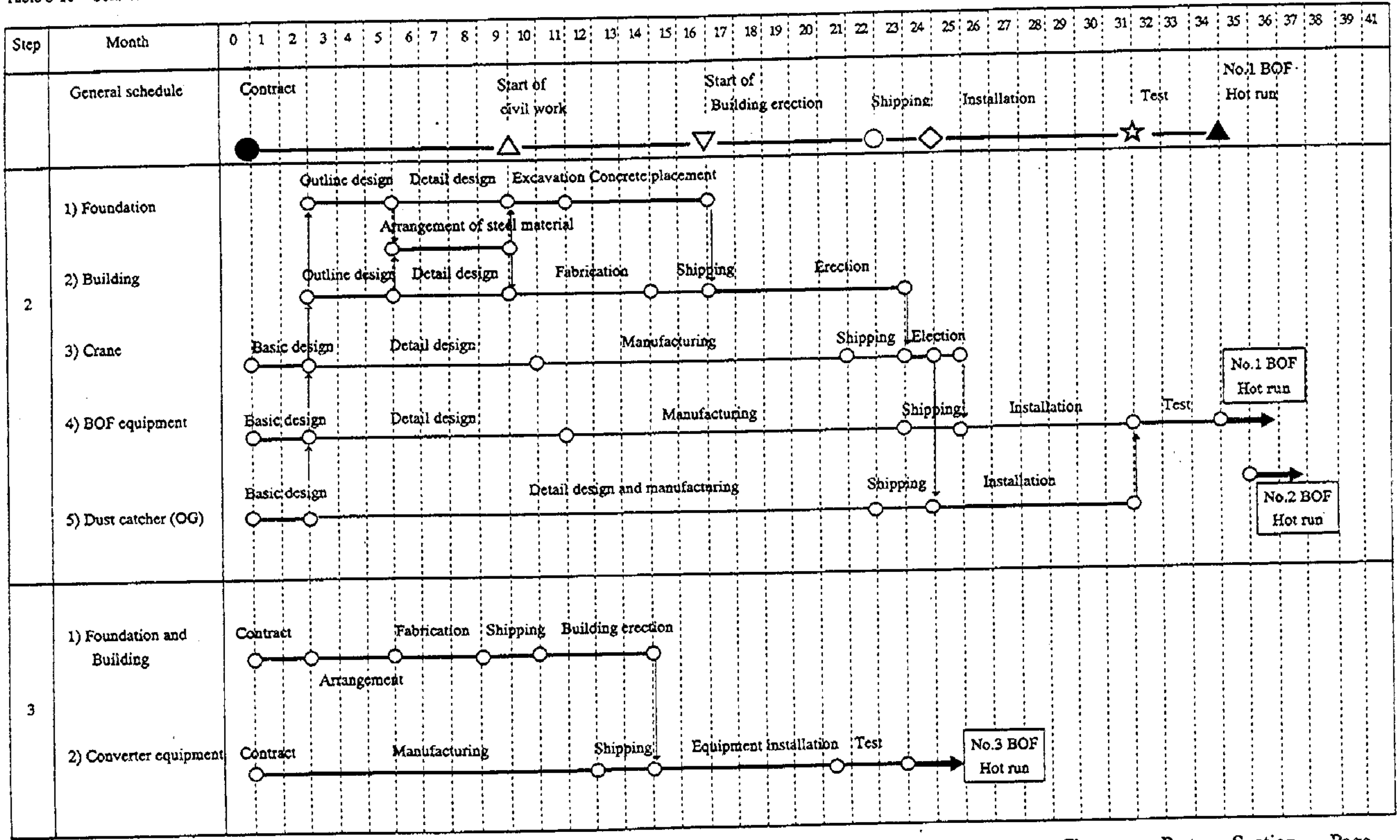
Note; D; domestic, Imp; import, pcs; pieces

Item	U.C		Q'ty	Supply	Remark
	Unit		unit/y		
5) Utility					
· O_2 gas	Nm^3/t-s	52.0	$235.8x10^6$	NISW	
· N_2 gas	Nm^3/t-s	14.0	$63.5x10^6$	NISW	
· Ar gas		0.9	$4.1x10^6$	NISW	
· Compressed air		–	–	NISW	
· Steam	kg/t-s	–	–	NISW	
· Electricity	kwh/t-s	30.0	$136.1x10^6$	NISW	
· Water	m3/t-s	0.5	$2.3 x10^6$	NISW	
6) Fuel					
· LDG	Nm^3/t-s	−90.0	$408.2x10^6$	NISW	By product
· COG	Nm^3/t-s	6.0	$27.2x10^6$	NISW	
7) Refractory					
· Torpedo car	kg/t-s	0.81	$3.7x10^6$	D/Imp	D; Shamotte brick
· TDS lance	pcs/ts	0.37	$1.7x10^6$	Imp	
· Hot metal ladle	kg/t-s	0.34	$1.5x10^6$	D/Imp	D; Shamotte brick
· Converter	kg/t-s	2.33	$10.6x10^6$	Imp.	
· Molten steel ladle	pcs/ts	1.20	$5.5x10^6$	Imp.	
· SN & Porous plug	kg/t-s	0.22	$1.0x10^6$	Imp.	Molten steel ladle
· CAS snorkel	kg/t-s	0.40	$1.8x10^6$	Imp.	
8) Measuring probe					
· Sub lance probe	pcs/ht	2.5	51,540	Imp.	
· Temperature & OXP	pcs/ht	4.0	82,500	Imp.	Free-oxygen measuring
9) Other materials					
· CAS snorkel cap	pcs/ht	1.0	20,600	Imp.	
· Calorize pipe	pcs/ht	1.5	30,920	Imp.	For slag off Skull cutting by O2

3.6 Construction schedule

Table 8-10 shows the construction schedule of BOF plant.

Table 8-10 Construction schedule of Basic oxygen furnace plant (BOF)



4. Technical explanation

4.1 Furnace capacity

The furnace capacity is estimated as follows.

1) As the average tap to tap time 36 minute is selected, which is being considered as a standard value, and considered the productivity of SL-CCM, and billet CCM.
2) The working time ratio(WTR) is approx. 70%. This is smaller than those of SL-CCM and billet CCM. The main reason is to realize the capacity of high productive slab CCMs (it is better to adopt a slightly larger BOF capacity).
3) The furnace capacity is called as follows using the relationship between the tap-to-tap time, the actual steelmaking time and the production amount.

a) Heat number: $$\frac{365 \times 1{,}440 \times 0.70}{36} = 10{,}220 \text{ heats/y}$$

b) Average heat capacity: $$\frac{4{,}535 \times 10^3 \text{t/y}}{2 \times 10{,}220 \text{ heats/y}} = 220 \text{ t/ht}$$

Section 9 Continuous Casting Plant

Contents

1. General

1) The two unit of 1-strand continuous casting machines (CCM) for slab, and one unit of 8-strands CCM for billet are installed in the steelmaking plant.
2) All of the molten steel manufactured by BOF of 220 t/heat capacity is supplied to these continuous casting machines.
3) The produced slabs are supplied to the hot strip rolling mill in the NISW, and the billets are supplied to the other rolling mills in Viet Nam.
4) The production capacity is $3,225 \times 10^3$t/y of slab and $1,095 \times 10^3$t/y of billet, and all of the product is, as a rule, consumed in domestic market.
5) The grade of flat product is mainly commercial grade steel, the steel grade such as car body sheet is not included.
6) The grade of non-flat product is mainly commercial grade steel for bars, wire rods, and light section for construction use.
7) The CC plant is planned aiming to high productive plant rather than high grade steel production.
8) The slabs from the slab CCMs are carried to Hot Rolling Mill (HRM) by the roller tables as directly as possible for saving the heat energy of slabs.
9) The conventional slab CCM／Coil Box type HSM process for flat product is adopted mainly from the following view point;
   - The flat production by purchased slab starts preceding the construction of the iron and steel making plant. Only conventional slab is purchasable in the world market at present.

2. Precondition

2.1 The plant construction basis

Table 9-1 shows the production volume required for the continuous casting machines.

Table 9-1 The construction timing and amount of product (Unit:1,000t/y)

Step	Step -2	Step -3
Slab CC	2,224	3,225
Billet CC	0	1,095
Total	2,224	4,320

2.2 Conditions of the preceding process

Table 9-2 shows the conditions of the preceding process.

Table 9-2 The operating condition of BOF

Preceding process	BOF operation	t/ht	Tap to tap time
BF---BOF---CAS-OB	2 out of 3 operation	220	36 min

2.3 Preconditions of the product

2.3.1 Slab production (Flat-product)

(1) Feature of steel grade

- The steel grade of hot final product is mainly 30 kg/mm^2 strength and 40 kg/mm^2 class, however 50 kg/mm^2 class is rather small as shown in section-8 Table 8-3.
- The steel grade of cold rolling product is mainly low carbon Al-killed steel, and ultra low carbon steel is not produced.
- The plate (thickness is less than approx.32 mm) is rolled by the hot rolling mill, and the plate mill is not constructed.
- The slab CCM is possible to adopt the modernized high speed casting method, because mainly the low carbon commercial grade steel is produced.
- The on line machine scarfing and off line manual scarfing are applied for slab conditioning.

(2) Product-mix

The product-mix of flat product is shown in Table 8-3 (described in section 8-2.2.1).

(3) Size distribution and production

Table 9-3 shows the size distribution based on the demand projection of the final products.

Table 9-3 Size distribution and amount of production

Av. Width mm	Distribution (%)	Remarks
800 (~ 899)	242 x10^{3}t/y (7.5)	
950 (~1,099)	884 (27.4)	
1,250 (~1,299)	1,496 (46.4)	
1,550 (~1,600)	603 (18.7)	
Total (%)	3,225 (100.0)	Casting average width 1,200 mm
Av. width	1,190 mm	
Slab thickness	Approx. 220 mm	
Slab length	Max. 10,400 mm	
Weight	Approx. max. 29 t	PIW 1,000

PIW: Pound per inch width

(4) Operating conditions

Table 9-4 shows the operating conditions of the slab CCM.

Table 9-4 Operating condition of slab CCM

Item		Planned value	
		Step-2	Step-3
1) Operating time	a) Annual operating day	345 d	
	b) Monthly operating days	29 d	
	c) Scheduled Maintenance	12 hr x 1 times/2wks	
	Annual Maintenance	7 d/y	
2) Operating rate	Σ Preparing and casting time / Calendar time	75% (calculated)	86 % (calculated)
3) No. of Heats to be cast by machine	Annually	10,645 ht/y	15,427 ht/y
	Monthly	887 ht/m	1,285 ht/m
	Daily.	30.6 ht/d	44.3 ht/d
Working formation	3 shift x 4 crews		

(5) Yield of process

Table 9-5 shows the yield of the slab casting operation.

Table 9-5 Yield of slab casting operation

	Yield rate
Slab casting yield (Good slab／Molten steel)	95 %

2.3.2 Billet production (Non-flat product)

(1) Feature of steel grade

- The billet is used mainly for bar, wire rod and light section of construction use, and the high production capacity billet casting machine is required.
- The capacity of BOF is a little too large for billet casting, and it is difficult to keep large lot size in general. But, it can be expected to make such large lot size and sequence casting, because the steel grade is mainly for construction use, and this plant is large billet supply center of Viet Nam.
- Steel grade requires degassing is not produced until installation of RH equipment for slab.

(2) Product mix

Product-mix and production process for non-flat product is shown in Table 8-4(described in section 8-2.2.1).

(3) Size mix and production

Table 9-6 shows the size-mix of billet in according to demand.

Table 9-6 Size-mix of billet production

Group	BT size	Length	Weight
	square mm	mm	t/BT
Wire rod	150	Max.	Max.
Bar	(130)	12,000	2.1 t/BT
Section			

(4) Operating condition

Table 9-7 shows the operating conditions of the billet CCM.

Table 9-7 Operating condition of billet CCM

Item		Planned value	
		Step-2	Step-3
1) Operating time		Same as case of slab CCM	
2) Operating rate	Σ Preparing and casting time / Calendar time		approx. 82 % (Calculated)
3) No. of Heats to be cast by machine	Annually	---	5,182 ht/y
	Monthly	---	431 ht/m
	Daily.	---	14.9 ht/d
Working formation	3 shift x 4 crews		

(5) Yield of billet casting process

Table 9-8 shows the yield of billet casting operation.

Table 9-8 Yield of billet casting operation

	Yield rate
Billet casting yield (Good billet／Molten steel)	96 %

3. Equipment plan

3.1 The formation of casting plant

(1) The slab CCMs and billet CCM are constructed in the same plant (one steel making plant) for suppressing investment cost as much as possible.
(2) The continuous slab casting plant and the hot rolling mill are located near each other, and the slabs of good quality are transferred from the casters to the hot rolling mill as directly as possible to reduce the heat loss of slabs.
(3) The two slab CCMs of 1-strand are constructed at step-2 to make sure the stable production of half in case of one slab CCM trouble at least. At step-3, the machine length of two CCMs is extended in according with the required production.
(4) The higher speed CCM requires more advanced technologies on casting operation and maintenance to keep large volume of production and high working time ratio.
(5) Such advanced technologies shall be completely transferred to NISW by the contractors.
(6) The billet CCM should be multi strand (more than 7 strands) type, considering the matching with BOF capacity (t/ht).
It requires comparatively high level operation technologies as slab CCM too.
(7) The productive capacity of slab CCMs and billet CCM are explained in 4-1 and 4-2 of Technical explanation.

3.2 Equipment specifications

3.2.1 Productivity

Table 9-9 shows the productivity balance between CCMs and BOFs.

Table 9-9 Productivity balance between CCMs and BOFs

	Productivity (t/hr)			Remark
Continuous casting machine			Ratio	Molten steel base
1) No.1 SL-CCM	Average	246	(1.5)	50 min/ht, 8-CCC, *TAT 30 min
2) No.2 SL-CCM	Average	246	(1.5)	
3) BT-CCM	Average	161	(1.0)	72 min/ht, 5-CCC, *TAT 50 min
Total	Average	656		
BOF No1 and No2	Average	733		36 min/ht,

*TAT: Turn around time (preparing time)

The total productivity of slab is three times of billet, it just fits the required amount of steel (slab is $3{,}225 \times 10^3$ t/y, billet is $1{,}095 \times 10^3$ t/y).

3.2.2 Main specifications of slab CCM

Table 9-10 shows main specifications of slab CCM.

Table 9-10 Main specification of slab CCM

		Sep-2	Sep-3
1	No. of strand x No. of CCM	1str. x 2	same as left
2	Size (T x W x L)	220x1,600x10,400mm	same as left
3	Type	Vertical bending	same as left
4	Casting speed (Max.)	Approx. 2.0mpm	Approx. 2.6
5	Machine length	Approx. 35 m	Approx. 45m

3.2.3 Main specifications of billet CCM

Table 9-11 shows the main specifications of billet CCM.

Table 9-11 Main specification of billet CCM

		Sep-2	Sep-3
1	No. of strand x No of CCM	———	8 str. x 1
2	Size ; Section		150 square (130 sq.)
	Length (unit weight)		max. 12,000 mm
3	Type		Bending type
4	Casting speed (Max.)		max. 3.5 mpm for 130 sq.
5	Machine length		approx. 18 m

3.2.4 Specification list

Table 9-12 lists the equipment specifications studied for the slab CCMs and the billet CCM.

3.3 Equipment flow

Figure 9-1 outlines the equipment flow of slab casting process.
Figure 9-2 outlines the equipment flow of billet casting process.

3.4 Plant layout of steelmaking plant

Figure 8-4 (in section 8) shows the plant layout of CCMs.
The layout has space provisions of one more slab CCM construction and slab conditioning yards for steel grade change and/or more production capacity required.

3.5 Production and unit consumption of CCM process

Table 9-13 lists the production and unit consumption of CCM process.

Table 9-12 Equipment specifications

	Equipment	Quantity		Main specification
		Step-2	Step-3	
1. Slab CCM	(1) Liquid steel handling equipment	2 sets	–	Ladle turret; Loading capacity approx. 300 t x 2 ladles
	(2) Caster proper	2 sets	–	Vertical bending type 1 strand x 2 CCM Machine length; approx. 35 m(Step-2), approx. 45 m(Step-3) Casting size; Thickness ; approx. 220 mm, Width; ; ~1,600 mm Slab length ; approx. 10,400 mm (PIW=1000) Casting speed; Max. 2.6 mpm (at step-3)
	(3) Slab delivery equipment	2 sets	–	Slab piling equipment, roller tables, strand gathering equipment etc.
	(4) Slab conditioning equipment	1 set	–	1) Automatic 4-sides scarfer 2) Chain transfer, slab turning device, etc.
	(5) Maintenance equipment 1) Tundish maintenance equipment 2) Machine maintenance equipment	 1 set 1 set	 – –	 1) Tundish tilting, refractory demolishing and relining, drying 2) Alignment mold, support roll and segment roll, spray testing
	(6) Crane equipment	1 set	–	1) Tundish maintenance, machine maintenance 2) Slab handling and others
	(7) Electrical equipment	2 sets	–	1) Power supply equipment 2) Continuous casting electrical equipment etc.
	(8) Instrumentation	2 sets	–	1)Tundish molten steel weight control 2) Mold level control 3) Secondary cooling water flow control etc.
	(9) Process computer	1 set	–	Main function; a) Production standard guidance b) Operation sequence monitor
	(10) Water treatment equipment	1 set	–	1) Clean water circulation equipment 2) Contaminated water circulating equipment 3) Machine scarfer water treatment equipment
	(11) Civil engineering and building 1) Civil engineering 2) Building	 1set 1set	 – –	 a) Foundation, b) Yard, c) Track, d) Others a) Main building, b) Auxiliary building

	Equipment	Quantity		Main specification
		Step-2	Step-3	
2. Billet CCM	(1) Liquid steel handling equipment	—	1 set	Same as slab caster
	(2) Caster proper	—	1 set	· Type; Bending mold 8-strands type · 8-strands x 1 CCM · Machine length; approx. 18 m · Casting size; Section 150 mm sq. (130 sq.) Slab length; 12,000 mm Unit weight max. 2.1 t/billet · Casting speed; Max. 3.5 mpm for 130 sq.
	(3) Billet delivery equipment	—	2 set	1) 1 set for 4-strand each 2) Billet rotating type cooling bed
	(4) Maintenance equipment	—	1 set	1) Tundish maintenance equipment 2) Machine maintenance equipment
	(5) Crane equipment	—	1set	1) Tundish maintenance, machine maintenance 2) BT handling with lifting magnet
	(6) Electrical equipment	—	1 set	1) Power supply equipment 2) Continuous casting electrical equipment etc.
	(7) Instrumentation	—	1 set	1) Tundish molten steel weight control 2) Mold level control 3) Secondary cooling water flow control etc.
	(8) Process computer	—	1 set	Main function; 1) production standard guidance 2) operation sequence monitor
	(9) Water treatment equipment	—	1 set	1) Clean water circulation equipment 2) Contaminated water circulating equipment
	(10) Civil engineering and building 1) Civil engineering 2) Building	—	 1set 1set	 a) Foundation, b) Yard, c) Track, d) Others a) Main building, b) Auxiliary building

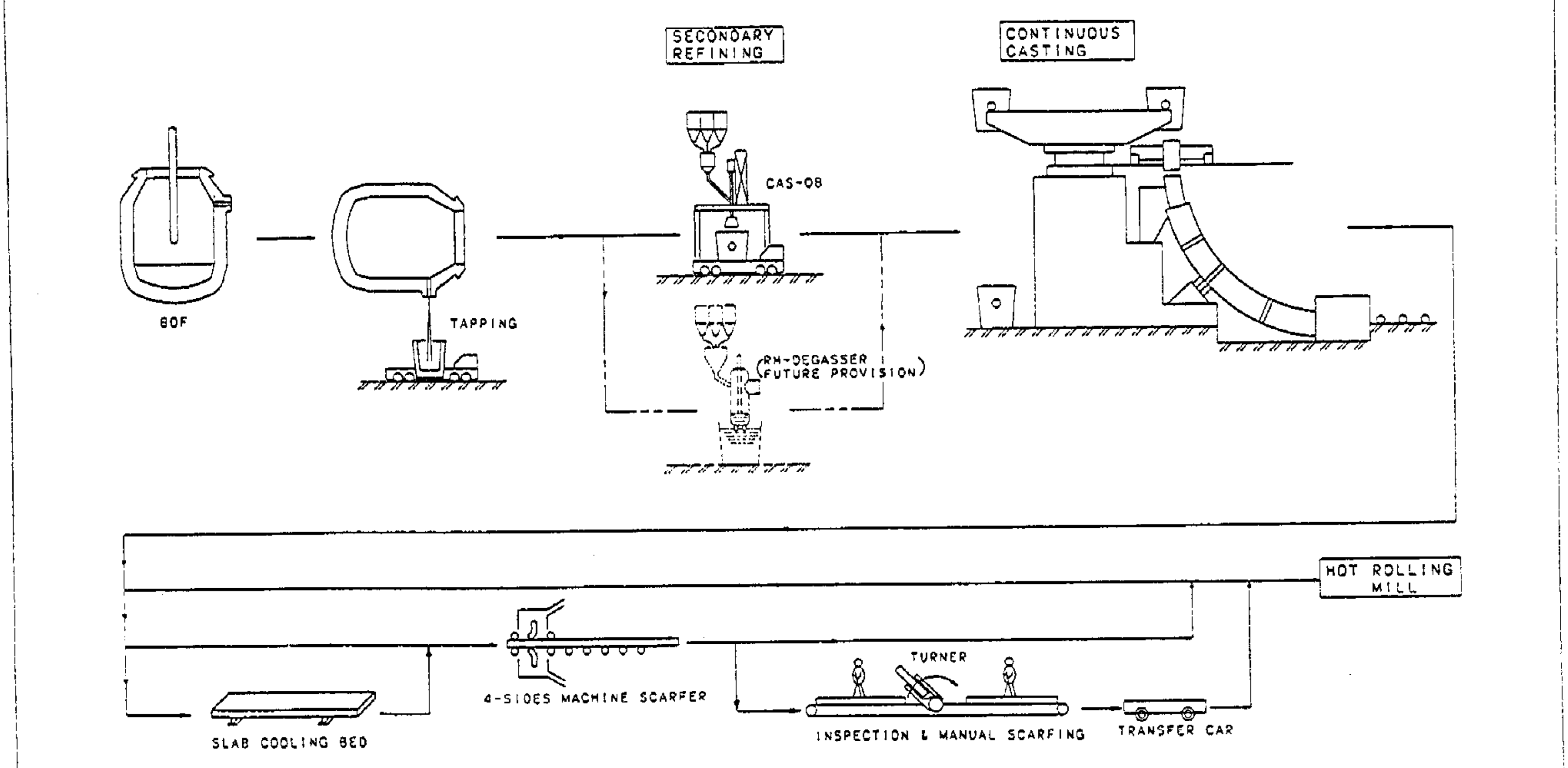


Figure 9-1 Equipment flow of slab casting process

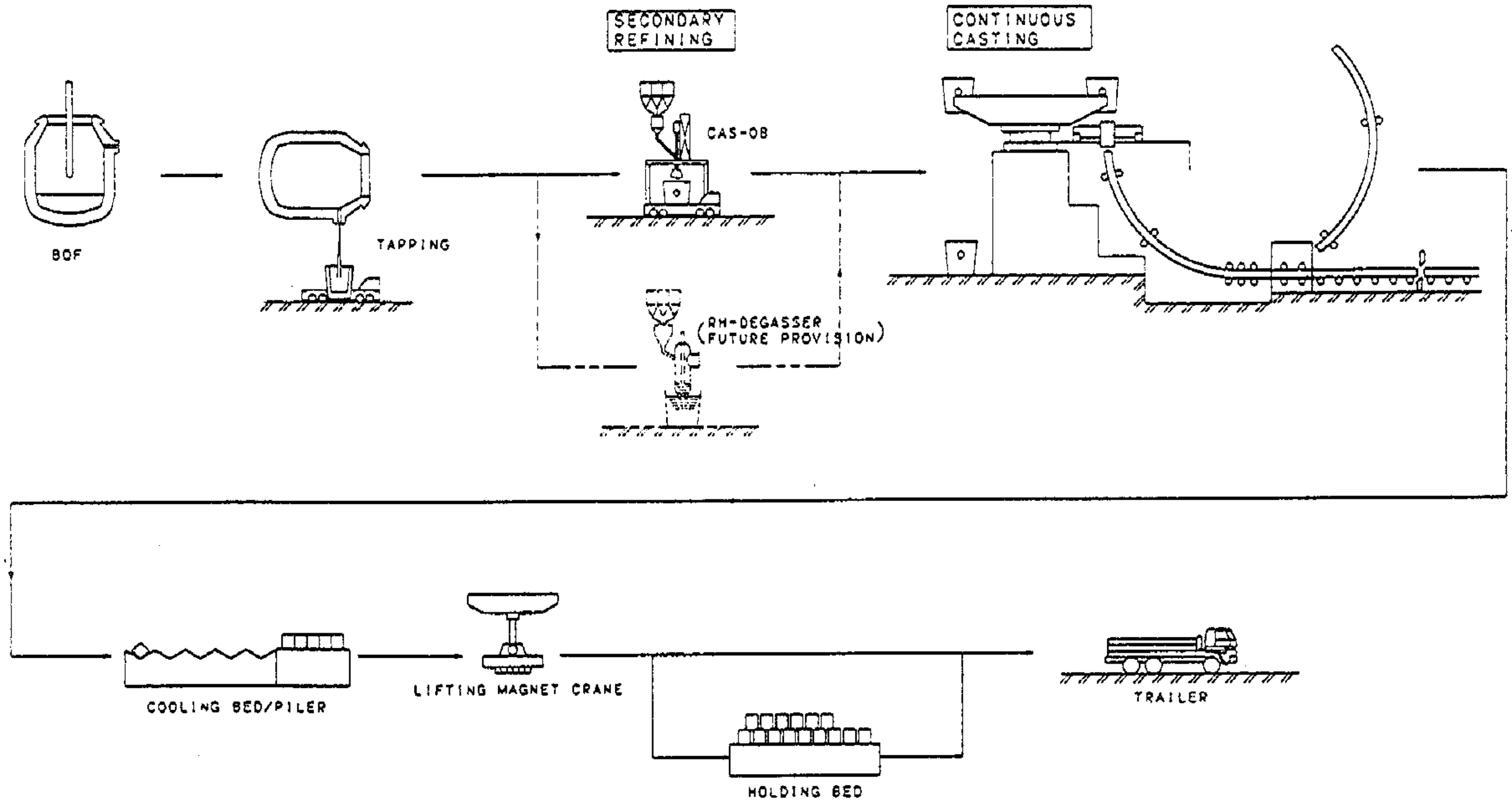


Figure 9-2 Equipment flow of billet casting process

Table 9-13 Unit consumption in CCM process

t-s: good slab = 3,225 x10^3t/y, good billet = 1,095 x10^3t/y

Item	U.C			Q'ty	Supply	Remark
	Unit	Slab	Billet	unit/y		
1) Materials						
· Powder	kg/ts	0.6	0.1	2.05 x10^6	Imp.	
· Rapeseed oil	l/ts	—	0.12	0.13 x10^6	D	
2) Utility						
· O_2 gas	Nm^3/ts	3.9	3.1	16.0 x10^6	NISW	
· N_2 gas	Nm^3/ts	0.4	0.4	1.73 x10^6	NISW	
· Ar gas	Nm^3/ts	0.1	0.1	0.43 x10^6	NISW	
· Comp. air	Nm^3/ts	—	—	—	NISW	
· Electric power	kWh/ts	24	24	103.7 x10^6	NISW	
· Industrial water	m^3/ts	0.7	0.7	3.04 x10^6	NISW	
· Soft water	m^3/ts	0.01	0.01	0.04 x10^6	NISW	
3) Fuel						
· COG	Nm^3/ts	2.4	2.4	10.4 x10^6	NISW	TD heating
· LPG	Nm^3/ts	0.3	—	1.8 x10^6	Imp.	Gas cutter
4) Refractory						
· Long nozzle etc.	kg/ts	0.03	0.03	0.13 x10^6	Imp.	
· Tundish	kg/ts	1.9	2.0	8.3 x10^6	Imp.	
· Immersion nozzle etc.	kg/ts	0.21	0	0.68 x10^6	Imp.	
5) Others	kg/ts	1.0	—	3.2 x10^6	Imp.	
· Insert Fe plate	kg/ts	0.02	0.02	0.09 x10^6	Imp.	
· Whisker	pcs/ht	3	4	67 x 10^3	Imp.	
· Thermo-couple	pcs/ht	3	3	62 x 10^3	Imp.	
· V- board						

Note: D; Domestic, Imp; Import, pcs; pieces

3.6 Manning plan of CCM plant

The manning plan is estimated on the base of 3 shifts x 4 crews.
The organization of steelmaking plant is shown in section-8.3.5.
Table 9-14 and 9-15 summarize the manning plan of slab CCM plant and billet CCM plant respectively.

Table 9-14 The manning plan of the slab CCM plant

Slab CCM plant	General control	Operation		Machine operation		Refractory		Mainte-nance		Technical division	Total	
Step	2 & 3	2	3	2	3	2	3	2	3	2 & 3	2	3
General manager												
Section manager		1									1	
Assistant manager		1		1		1		1		1	5	
Engineer		1		1		1		2		3	8	
Foreman		9				5		5			19	
Skilled worker		82	93	18	20	64	83	62	80		226	276
Unskilled worker		35	40	8	8	28	36	26	34		97	118
Clerk												
Secretary		1									1	
Total		130	146	28	30	99	126	96	122	4	357	428

Table 9-15 The manning plan of the billet CCM plant (at Step-3) (unit: persons)

Billet CCM plant	General control	Opera-tion	Machine operation	Refrac-tory	Mainte-nance	Technical division	Total
Section manager		1					1
Assistant manager		1		1	1	1	4
Engineer		1		1	1	2	5
Foreman		5					5
Skilled worker		36	14	50	36		136
Unskilled worker		16	6	22	16		60
Clerk							
Secretary		1					1
Total		61	20	74	54	3	212

3.7 Construction schedule

Table 9-16 and 9-17 show the construction schedule of slab CCM plant and billet CCM plant respectively.

Table 9-16 Construction schedule of slab CCM plant

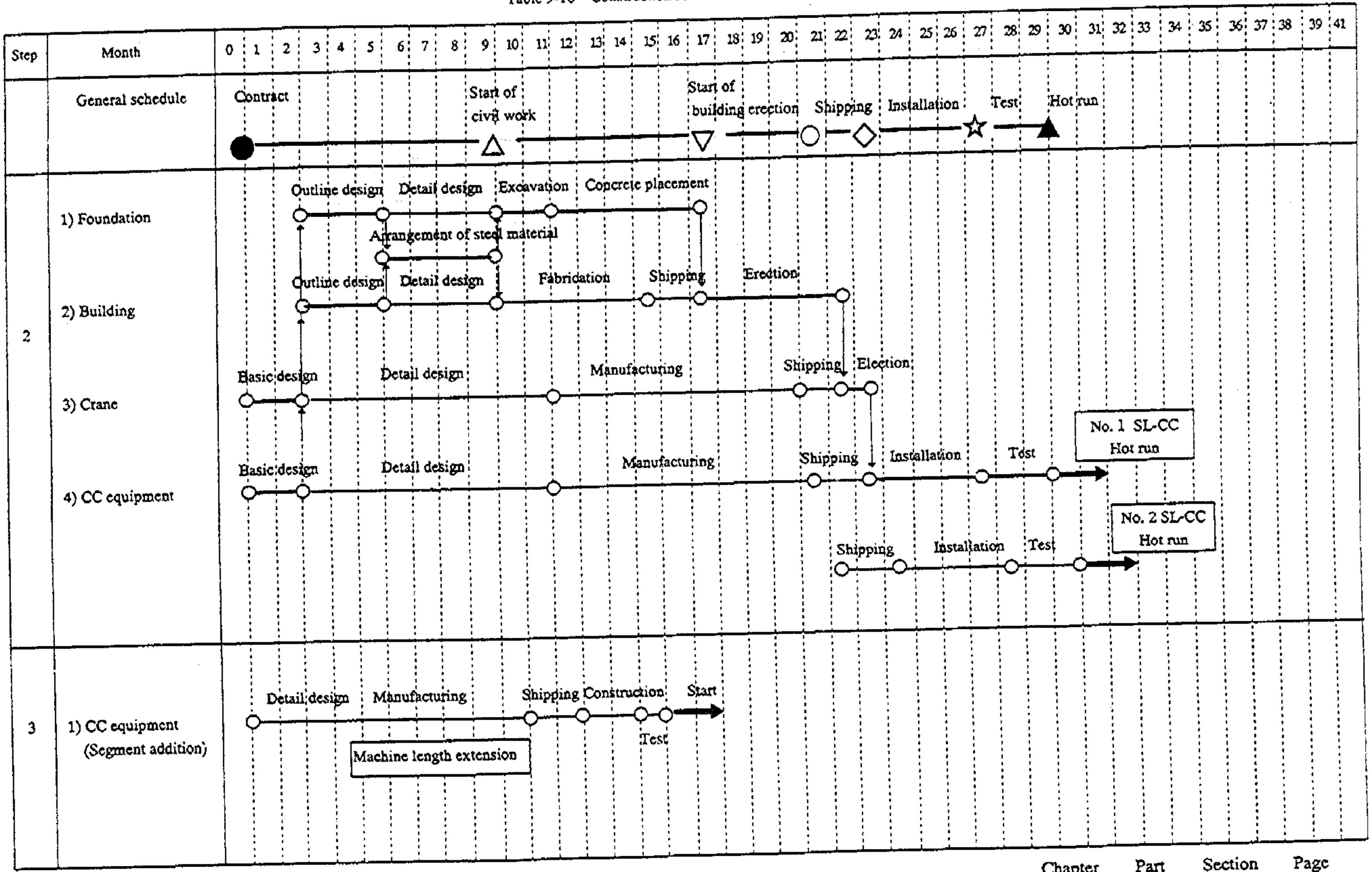
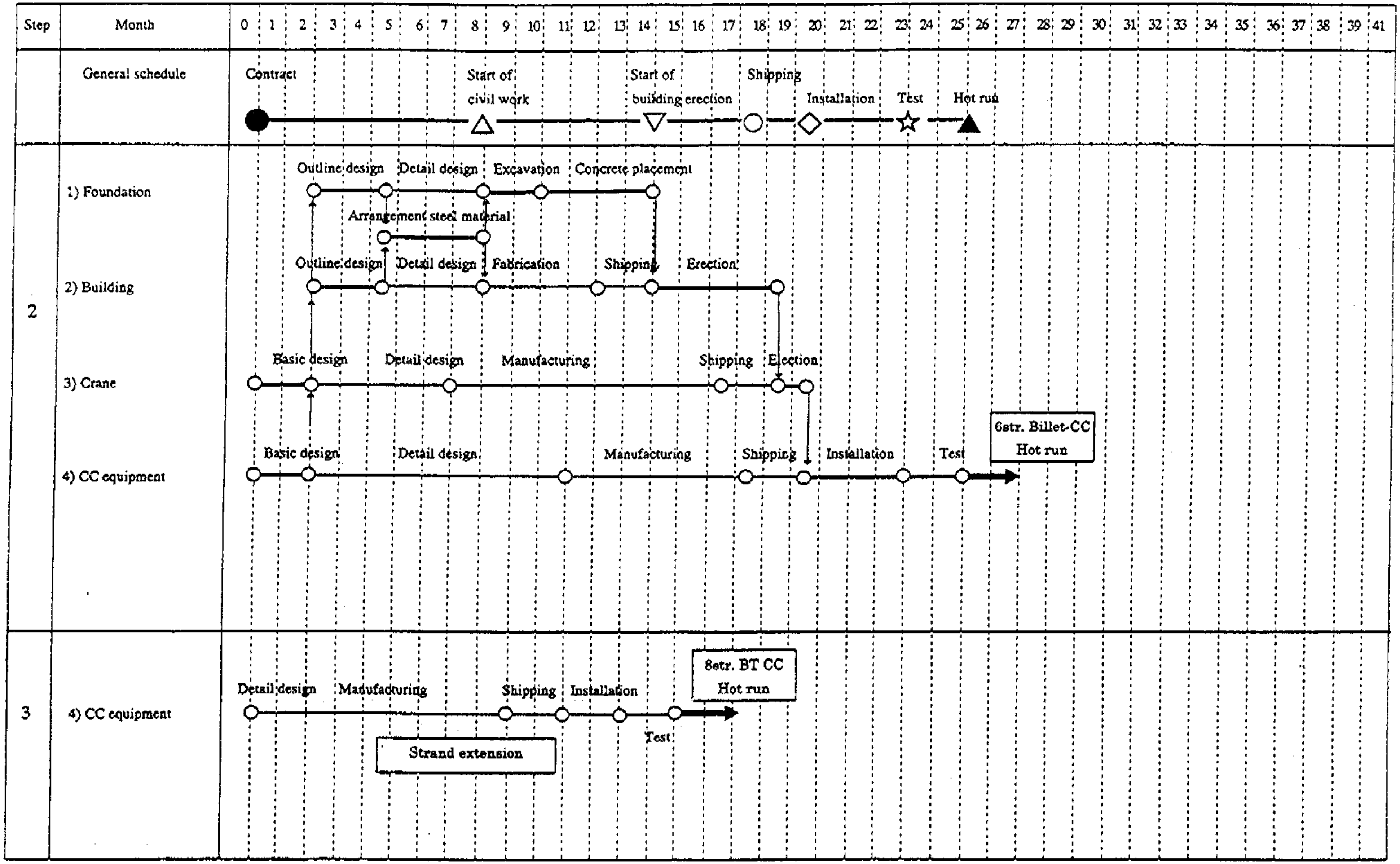


Table 9-17 Construction schedule of billet CCM plant



4. Technical explanation

4.1 Productivity of slab CCM

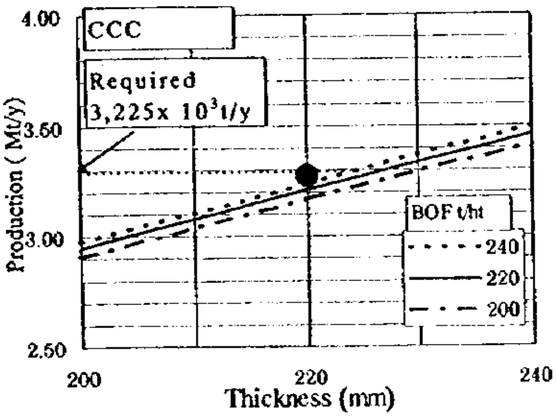


Figure 9-3 Influence of BOF capacity

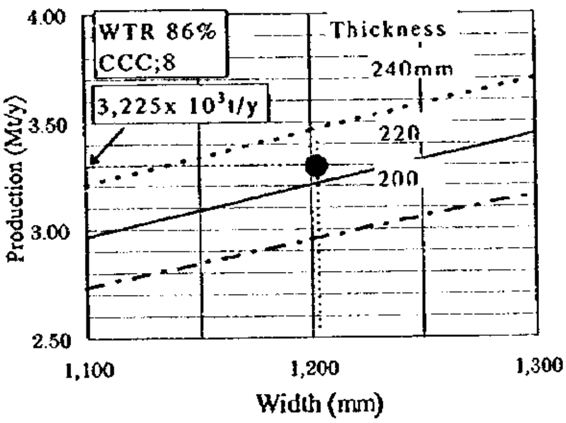


Figure 9-4 Influence of slab width

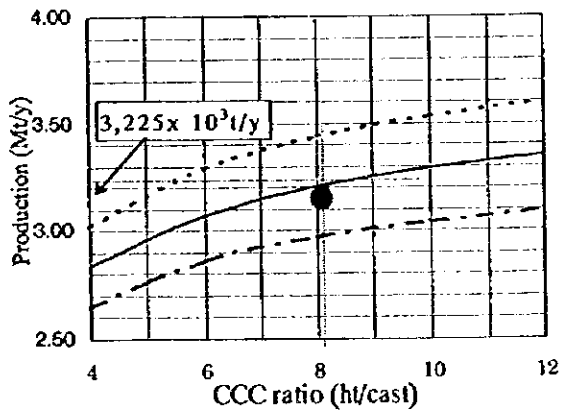


Figure 9-5 Influence of sequence casting

1) Preconditions
   - CCM type; 1strand CCM x 2 units
   - Casting speed ; Average 2.0 mpm
   - Working time ratio ; 86%

2) The influence of BOF capacity (See Figure 9-3)

   The capacity of BOF is required as large as possible.
   It shall be decided 220 t/ht.

3) The influence of slab thickness (See Figure 9-3)

   The larger slab thickness is desired for the capacity of CCM although the thinner slab thickness is desired for the capacity of HSM.
   It shall be decided approx. 220 mm.

4) The influence of slab width (See Figure 9-4)

   The larger slab width is desired for the capacity of CCM.
   The slab width shall be estimated approx.1,200mm from the demand of final product.

5) The influence of CCC ratio (See Figure 9-5)

   The CCC ratio is expected approx. 8 CCC, with the product-mix required and adoption of multi CCC technologies.

This study shows the production capacity is required amount of 3,225 x10^3t/y.

4.2 Productivity of the billet CCM

Table 9-18 shows the type and productivity of the billet CCM.

Table 9-18 The type and capacity of billet CCM

Case	Product	Strand	Vc	Casting time	CCC	Cast	Working time	WT R
	x10^3t/y		mpm	min/ht	ht/cast	cast/y	min/y	%
1	1,095	7	2.5	72	5	411	429,000	81.8
2	1,095	8	2.2	72	5	410	427,000	81.4

Either case-1 or 2 is possible to adopt, here, the 8-strands CCM shall be adopted to make sure of the productivity.

An idea of the formation of CCM;

1 ladle ⇒ 2 units of tundish ⇒ 2 units of 4 strands mold

Section 10 Hot Strip Mill Plant

Contents

1. General

1.1 The scope of facilities included in the hot strip mill plant (HSM plant)

The facilities included in the HSM plant are as follows:

(1) Process facilities

1) Hot strip mill including roll shop and slab yard (HSM)
2) Hot skinpass mill (HSPM)
3) Hot shearing line (HSHL)
4) Heavy plate cutting line (HPCL)
5) Hot slitting and recoiling line (HSRL)
6) Hot coil cooling/packing/storage yard and coil conveyor system

(2) Utility system and auxiliary facilities

1) Water treatment and re-circulation facilities including low and high pressure systems.
2) Utility supply system including steam, compressed air, oil etc.
3) Level 3 computer system for HSM plant
4) Local plant office
5) Other auxiliary facilities

Note 1: Hot strip mill (HSM) means the above (1)-1).
Hot strip mill plant (HSM plant) means the above (1) and (2).

Note 2: The more detailed equipment list is shown in Table 10-32 on page 48 - 50 of this section.

1.2 Production scale of HSM plant

The production scale of the HSM and finishing facilities has been decided as follows:

(1) Using the results of the market study shown in Table 1-1 "Steel demand projection", on page 1 of Section 1, Part 3, Chapter IV, the forecast of flat product demand classified by final production process has been prepared as shown in attached Table10-1 and 10-2.

- Table 10-1 : Forecast of flat product demand by final production process (product basis).

- Table 10-2 : Forecast of flat product demand by final production process (slab basis)

Table 10-1 and 10-2 are basically same except that the figures in Table 10-2 are converted to slab basis using the yield value of each process.

Table 10-1 and 10-2 show that the total demand of flat products is 3,510,000 t/y on a final product basis, and 3,877,000 t/y on a slab basis.

In this section the figures on slab basis will be mainly used because it is more convenient for the study of production scale.

(2) Table 10-3 prepared by using Table 10-2 shows the accessible demand for the product of each process in the case that the max. width of HSM products is 1600 mm.

- Table 10-3 : Accessible demand for each process (slab basis)

The various premises to derive Table 10-3 from Table 10-2 are explained in the remarks of Table 10-3(2/2) on page 7 of this section.

As shown in Table 10-3, the accessible demand for HSM products is theoretically 3,345,000 t/y against 3,877,000 t/y of the total demand.

This means that 532,000 t/y (3,877,000 - 3,345,000) is inaccessible by the HSM in the new integrated steelworks (NISW).

Out of the above inaccessible 532,000 t/y of products, approx. 470,000 t/y are those with a width exceeding 1600mm, and approx. 60,000 t/y are EGL products which will not be produced in NISW.

(3) Considering the above accessible amount (3,345,000 t/y), the maximum capacity of the HSM is decided to be 3,225,000 t/y (approx. 96 % of 3,345,000 t/y). The 3,225,000 t/y on a slab basis is equivalent to 3,000,000 t/y on a product basis.

Table 10-1 Forecast of flat product demand by final production process(product basis)

(unit : 1000 tpa)

Year	Total Steel	Total Flat	Flat products							W. Pipe
			Plate mill	HSM	CSM	CGL (HD-galv.)	EGL	Tin/TFS		
1996	1,300	390	58	48	65	128	11	40		40
1997										
1998										
1999										
2000	2,350	870	93	195	177	209	19	65		112
2001										
2002										
2003										
2004										
2005	4,150	1,910	239	501	454	355	33	88		240
2006										
2007										
2008										
2009										
2010	6,380	3,510	473	994	899	604	55	125		360

Table 10-2 Forecast of flat product demand by final production process(slab basis)

(unit : 1000 tpa)

Year	Total Flat	Flat products							W. Pipe (92%)
		Plate mill (90 %)	HSM (93%)	CSM (89%)	CGL (90%)	EGL (90%)	Tin/TFS (84%)		
1996	434	64	52	73	142	12	48		43
1997									
1998									
1999									
2000	964	103	210	199	232	21	77		122
2001									
2002									
2003									
2004									
2005	2,112	266	539	510	394	37	105		261
2006									
2007									
2008									
2009									
2010	3,877	526	1,069	1,010	671	61	149		391

Note : Percentage figures shown under each process are the yield value of each product against slab.

Table 10-3(1/2) Accessible demand for each process(slab basis)

(unit : 1000 tpa)

Year	Flat Total	Plate mill		HSM		CSM		CGL	EGL	ETL	W.Pipe
		Total	Accessible by HSM	Accessible for (Plate,HSM, CSM,Pipe)	Accessible for (HSM-finished)	Accessible for (CSM,CGL, ETL)	Accessible for (CSM-finished)				
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
1996	434	64	(19)	322	(49)	215	(73)	142	12	48	39
1997											
1998											
1999											
2000	964	103	(31)	769	(197)	431	(199)	232	21	77	110
2001											
2002											
2003											
2004											
2005	2,112	266	(80)	1,726	(507)	904	(510)	394	37	105	235
2006											
2007											
2008											
2009											
2010	3,877	526	(158)	3,345	(1,005)	1,830	(1,010)	671	61	149	352

Table 10-3 (2/2) Remarks on Table 10-3(1/2)

1. ①(Flat total) = ②(Plate product) + ⑤(Hot rolled product) + ⑦(Cold rolled product) + ⑧(CGL product) + ⑨(EGL product) + ⑩(ETL product) + ⑪(W.Pipe product)

2. ②(Plate) means the plate products thicker than 6 mm which are preferably produced without coiling.

3. ③(Plate product accessible by HSM) are the plate products with a width of 1600mm or less which will be accessible by the HSM to be installed in NISW.
According to our survey on the Viet Nam steel market, it seems that 30 % of plate products will be accessible by a 5-foot mill, and 60 % accessible by a 6-foot mill.

4. ⑤(HSM products accessible by a 5-foot mill) is presumed 94% of total HSM products.

5. ⑪(W.Pipes accessible by 5-foot mill) is presumed 90% of total welded pipes.

6. ④(Accessible amount by HSM) = ⑤(Accessible hot rolled product) + ⑥(Accessible amount by CSM) +③(Plate accessible by HSM) + ⑪(Accessible W.Pipe)
These figures of in column ④(Accessible by HSM) are the maximum accessible amount out of total flat products in the Viet Nam market.

7. ⑥(Accessible amount by CSM) = ⑦(Cold rolled product) + ⑧(CGL product) + ⑩(ETL product)
⑨(EGL product) is not included in ⑥ because no EGL is expected to be installed in NISW before 2010.
⑩(ETL product) is not included in ⑥ for 1996, 2000 and 2005 because no ETL is expected to be installed before 2005.

1.3 Production flow, product mix and size mix

1.3.1 Production flow and product mix

The production flows of HSM plant are attached in the following pages.

- Figure 10.1 : Production flow of HSM plant at 2nd step(2010)

- Figure 10.2 : Production flow of HSM plant at 1st step(2005).

The above production flow at 2nd step has been prepared considering the following conditions:

1) As described in item 1.2 (3) of page 2, the maximum production capacity of HSM is 3,225,000 t/y on slab basis(equivalent to 3,000,000 t/y on product basis).

2) Based on the past experiences and the survey results of Viet Nam market (table 10.2 & table 10.3), the product mix when delivered from HSM plant are presumed as follows:

Table 10.4 Product mix of hot rolled products

Product kind	Production(t/y)
a) Hot coils for CSM plant in NISW	1,000,000
b) Hot coils for P/O products(coil/sheet) (*1)	200,000
c) Hot coils for re-rolling companies	600,000 - 400,000
d) Hot coils for pipes & formed sections	300,000
e) Hot coils for coil centers	300,000 - 500,000
f) Hot rolled sheets/plates	240,000
g) Hot rolled heavy plates(*2)	120,000
h) Hot slit/recoiled coils	240,000
Total	3,000,000 (*3)

Note(*1): Some part of P/O products will be cut into sheet in HSM plant.

Note(*2): The hot rolled heavy plates are produced without coiling at down-coiler.

Note(*3): The above figures are all on product basis.

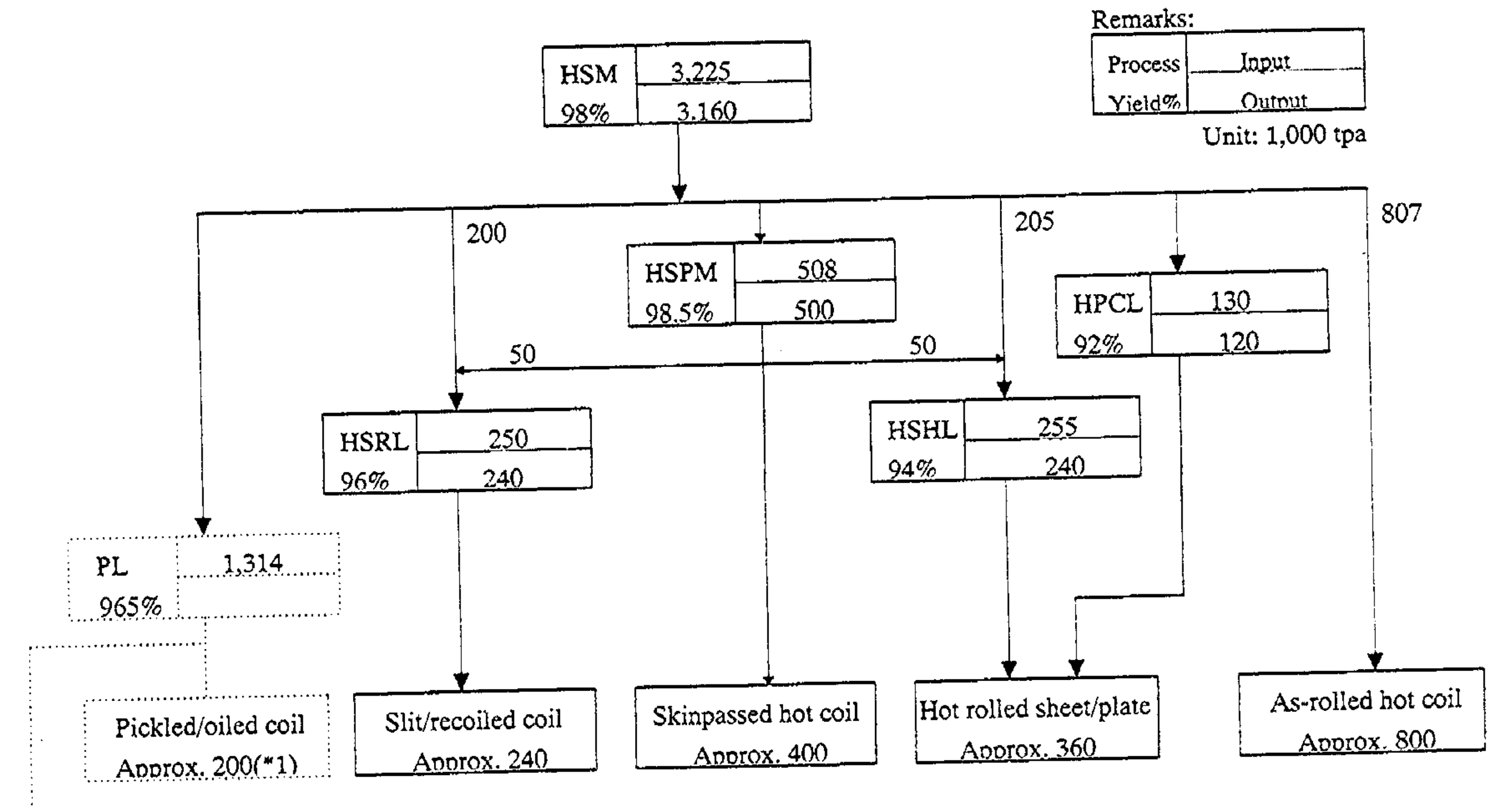


Figure 10-1 Production flow of HSM plant at Step 2 (in 2010)

Note(*1): Some part of P/O coils to be skinpassed and/or cut into sheets at HSM plant are not shown in this production flow.

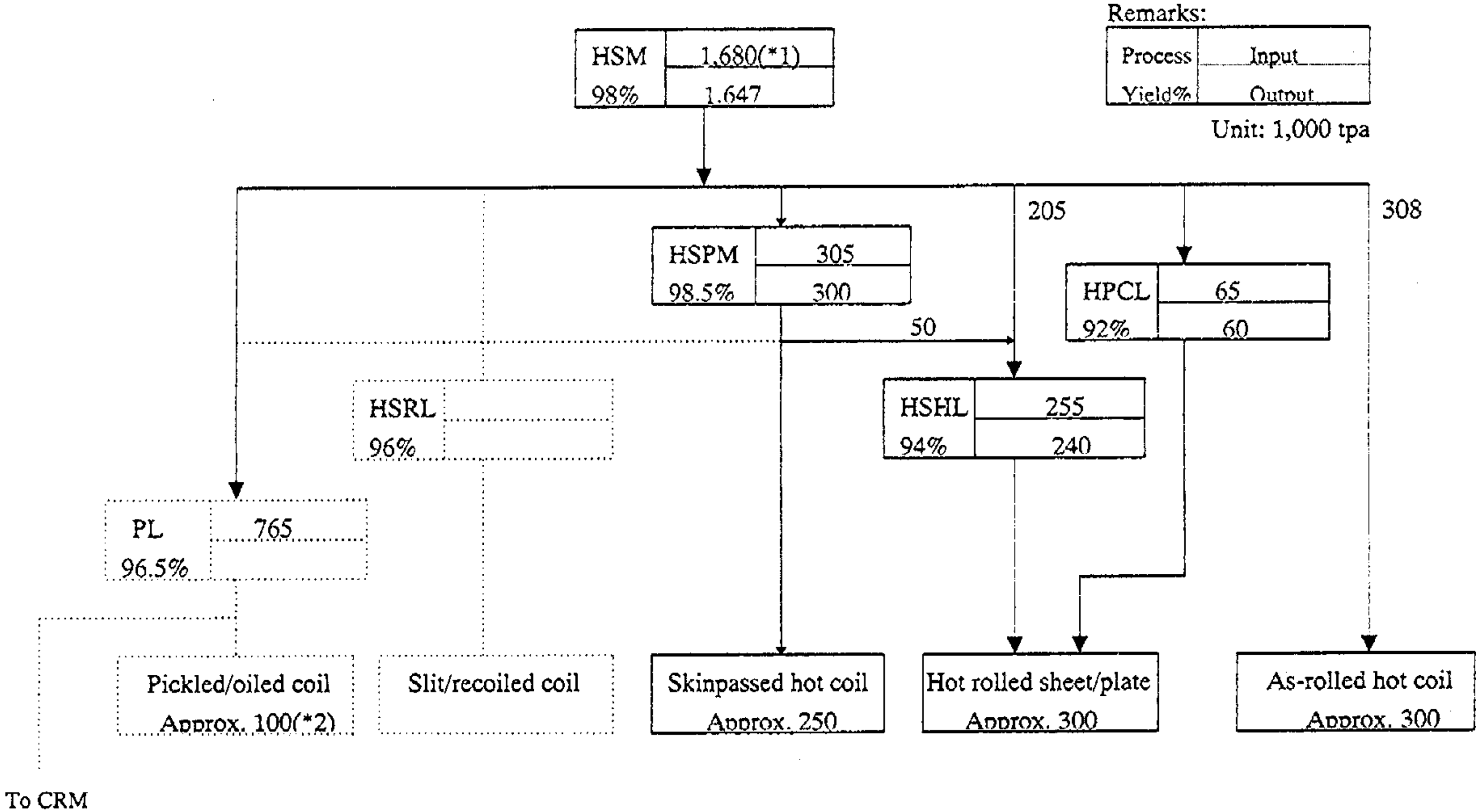


Figure 10-2 Production flow of HSM plant at Step 1 (in 2006)

Note(*1): Slabs shall be procured from international market.

Note(*2): Some part of P/O coils to be skinpassed and/or cut into sheets at HSM plant are not shown in this production flow.

1.3.2 Size mix and steel grades

It is very difficult to prepare the precise size mix of flat rolled products through the survey of the present Viet Nam market because the present consumption of flat products is too small to forecast the product sizes in the future.
Therefore the size mix of the future Viet Nam market has been prepared using some presumptions as described below.
The size mix and steel grades are used for the basic plan of facilities.

(1) Width distribution

The width distribution of flat products narrower than 1,600 mm has been prepared as shown in Table 10-5, based on the following presumptions:

1) As for the cold rolling mill, the ratio of 800mm wide products will be small compared with that in Japan because of the small consumption of tinplate.

2) As for the HSM-finished products except for the heavy plates, the width distribution will be similar to that in Japan.

3) As for the heavy plate products, the ratio of the products narrower than 1,600mm is estimated at about 30% taking account of the future plans for ship-building industry etc. in Viet Nam, while it is only 10 % in Japan.

Table 10-5 Width distribution of flat products narrower than 1600mm

Nominal width(range)	Ratio
800mm (- 899mm)	8 %
950mm (900 - 1,099mm)	27 %
1,250mm (1,100 - 1,299mm)	46 %
1,550mm (1,300 - 1,600mm)	19 %
Average product width	approx. 1,190mm

The average width of slabs charged to the HSM will be approx. 1,200mm due to 10mm edging on average at HSM.(1,190mm + 10mm)

The above width distribution is used for the calculation of the CCM production capacity.

Table 10-6 below shows the width distribution of the flat products including those wider than 1600mm. Table 10-6 has been prepared based on the similar presumptions used for Table 10-5.

Table 10-6 Width distribution of all flat products

Width range	Ratio
- 1,600 mm (5 feet)	88 %
1,600 (5 feet) - 1,900 mm (6 feet)	7 %
1,900 (6 feet) -	5 %

Note : Considering the above figures in Table 10.5, the width of HSM has been decided to be 5 feet.(Refer to item 2.2.1-(3)-1) in this section.)

(2) Thickness distribution

According to the survey on the Viet Nam market and general experiences in Japan, the thickness distribution for the hot rolled products narrower than 1,600mm is estimated as shown in Table 10-7.

Table 10-7 Thickness distribution of hot rolled products

Thickness range	Ratio
1.20 - 1.79 mm	6 %
1.80 - 5.99 mm	80 %
6.00 - 15.99 mm	10 %
16.00 - 32.00 mm	4 %

Note : The ratio of demand for products thicker than 32mm is considered very small in the Viet Nam market.

The thickness ranges and typical sizes of HSM products are shown in Table 10-8.

Table 10-8 Thickness range and typical sizes of products

	Thick. range (mm)	Typical size (Thick. x Width mm)
1 Hot coils for cold rolling	1.8 - 4.0	2.3 x 800, 2.3 x 950, 3.2 x 1,250
2 Hot-finished products(*1) (produced by coiling)	1.2 - 16.0	1.6 x 950, 2.3 x 1,250, 3.2 x 1,250, 6.0 x 1,550 etc.
3 Heavy plates (produced without coiling)	9.0 - 32.0	9 x 1,550, 13 x 1,550, 16 x 1,550, 20 x 1,550

Note *1: Hot-finished products include all products produced by the HSM in NISW except for those subject to cold rolling in NISW and those produced without coiling.

1.3.3 Steel grades

Typical steel grades for flat products are shown in Table 10-9 using JIS.

Table 10-9 Typical steel grade for flat products

Tensile strength (nominal) / Product	25 - 35 kg/mm^2 (low carbon steel)	35 - 45 kg/mm^2 (low or middle carbon steel)	45 kg/mm^2 - (low alloy steel)
Heavy plate	SS330	SS400, SM400, SMA400	SM490, SMA490,
Hot finished products	SPHC, SPHD	SS400, SM400, SAPH400,	SS490, SM490, SPFH490, SPA-H (API-5LX-60)
Cold rolled products including coated products	SPCC,SPCD SPFC35, SPB	SPFC40,	SPA-C

Note: The standard in parenthesis is not JIS.

SS: General Structural Steel, SM: Welded Structural Steel,
SMA: Atmospheric Corrosion Resisting Steel,
SPHC,SPHD: Mild Steel(Hot rolled), SPCC,SPCD: Mild Steel(Cold rolled)
SAPH: Automobile Structural Steel(Hot rolled)

SPFH: Automobile Structural Steel(Hot rolled high tensile & high formable)
SPFC: Automobile Structural Steel(Cold rolled high tensile & high formable)
SPA-H: Superior Atmospheric Corrosion Resisting Steel(Hot rolled)
SPA-C: Superior Atmospheric Corrosion Resisting Steel(Cold rolled)
SPB: Tin Mill Blackplate

According to our experiences in Japan and South East Asia, the distribution of steel grades classified by the tensile strength for the total flat products (narrower than 1600mm) in the Viet Nam market is roughly presumed as follows:

1) 25 - 35 kg/mm2 : 70 - 75 %
2) 35 - 45 kg/mm2 : 20 - 25 %
3) 50 kg/mm^2 or higher : 5 %

1.4 Basic design concepts of HSM plant

The following items have been taken into consideration as the basic design concepts of the HSM plant.

1) An important feature of the Viet Nam market is that there is only a small demand for flat products at present, but a quite rapid growth of demand is expected in the future.(cf. 1.6 million t/y at step 1, and 3.2 million t/y at step 2)

   Therefore, careful consideration has been made to allow for smooth and reasonable expansion of facilities towards step 2 of project.

   The low investment cost at 1st step is also an important condition to be achieved to make the project economically feasible.

2) The Viet Nam market requires a wide range of flat rolled products including thin gauge hot rolled products, heavy plates, cold rolled products, galvanized products, tinplate etc. with various grades of qualities.

   Considering the above items 1) and 2), the coil box type HSM has been selected as the most suitable type of HSM for VSC after considerable efforts were made for review and study regarding the types of HSM.

3) At step 1 of construction of the new integrated steel works (NISW), it is planned to install the HSM plant prior to the upstream plants such as the ironmaking plant and steelmaking plant.
   As a result of this condition, the following items need to be considered:

   a) The necessary utility supply systems such as oil, gas, compressed air, steam etc. in the HSM plant need to be provided.

   b) It is necessary to use slabs which must be purchased from the international markets until the upstream plants have been installed.

4) Direct hot charge rolling (DHCR)

The HSM and the continuous casting machine(CCM) will be planned in order to utilize the direct hot charge rolling which is widely practiced by Japanese steel mills.

The merits of DHCR are as follows:

a) Energy saving of the reheating furnace

b) Reduction in slab handling work and slab inventory

c) Reduction in production time from CCM through HSM

To utilize DHCR the following conditions are taken into design concepts:

a) Achievement of surface-defect-free slabs at CCM

b) Achievement of schedule-free rolling at HSM

c) CCM and HSM are directly connected by the roller table

d) Productivities of CCM and HSM are well compatible each other

5) Strip profile control at the finishing mill

The crown value of strip will be controlled at a preferably low level by introducing the strip profile control system at the finishing mill which has been recently developed and has become an effective technology for producing high quality flat products at Japanese HSMs and other advanced mills.

6) Hot finishing lines

a) As most flat product users in Viet Nam are considered rather small companies and in the developing stage, many companies will ask for sheets/plates or slit/divided small coils instead of the as-rolled large coils.

Therefore it is planned to provide one set of various finishing lines in the new integrated steel works to cope with the orders for sheets, plates, small coils etc.

b) In addition to the above finishing facilities to be installed in NISW, it will be necessary to have more such facilities installed at coil centers or joint venture companies to satisfy the total demand for such products.

c) It is planned to skinpass or shear the pickled and oiled products (P/O products) at the HSM finishing facilities.

2. Hot strip mill (HSM)

2.1 Selection of HSM type

The following four types of HSMs are studied and compared regarding suitability for the new integrated steelworks.

1) Compact Strip Production process using thin slab (CSP)
2) Medium thickness Slab Process (MSP)
3) Coil Box Mill using conventional slab (CBM)
4) Conventional three quarter Mill (CVM)

As a result of the study CBM has been recommended by JICA team and agreed by VSC.

The details about selection of HSM type is described in Section 4, Part 3, Chapter III.

2.2 Outline specification of HSM

Outline specification of the recommendable HSM for the new integrated steelworks is described below.

2.2.1 General

(1) Production capacity of HSM

As described in Figure 10-1 and Figure 10-2 on page 9 and 10 in this section, the required capacity of HSM on a slab basis is:

- Step 1 : 1,680,000 t/y
- Step 2 : 3,225,000 t/y

As the capacity required at Step 2 exceeds the maximum capacity of the ordinary coil box mill with single roughing stand, it will be necessary to provide one additional roughing stand at Step 2.

(2) Slabs to be charged to HSM

The recommended unit weight of slabs is 18 kg/mm (1,000 PIW) which is most widely used in the international steel industry.

Slabs need to be internationally purchased before the upstream plants such as BF, BOF etc. have been installed.
Sizes and grades of the purchased slabs are as follows:

- Thickness : Approx. 160 - 250 mm
- Width : Approx. 610 - 1,600 mm
- Length : Approx. 5,000 - 10,400 mm
- Max. weight : Approx. 29 ton
- Steel grade : Ordinary low and middle carbon steel mainly used for commercial products.
- Process : Continuous cast slabs are preferable, but Ingot cast slabs are acceptable.

More detailed specifications for slab procurement need to be prepared at later stage when necessary.

After upstream plants have been installed, slabs will be produced by the continuous casting machines to be installed at Step 2.
Sizes and grades of the slabs from the CCM are:

- Thickness : 220 mm
- Width : 610 - 1,600 mm
- Length : 4,000 - 10,400 mm
- Max. weight : 28.8 ton for 1,600mm wide slab 24.3 ton for 1,350mm wide slab
- Steel grades : Mainly low and middle carbon steel, some high carbon steel and low alloy steel.
- End use : Various end uses including tinplate, automobile material etc.

(3) Product size range of HSM

1) Product width

The maximum width of HSM products has been discussed between the VSC and JICA team, and agreed to be 1,600mm because of following reasons:

a) According to the market study the ratio of products narrower than 1,600 mm (5 feet) is about 88 %, and the ratio of those between 1,600 mm (5 feet) and 1,900 mm (6 feet) is only about 7 %. Please refer to Table 10-6 "Width distribution of flat products" on page 12 of this section.

b) The 5-foot HSM is very popular, and its construction cost is relatively low compared with the 6-foot HSM.

The minimum width is recommended to be 610 mm considering the end use of products.

2) Product thickness

According to the results of the market study, the maximum thickness of products coiled at the down-coiler is considered appropriate to be 16 mm, and that of non-coiled heavy plate products to be 32 mm.

Please refer to Table 10-7 "Thickness distribution of hot rolled products" in page 12 of this section.

3) Size ranges by product kinds

The size ranges of HSM products according to product kinds are planned as shown in Table 10-10 and 10-11.

Table 10-10 Product size range (Step 1)

Product kind/use	Thickness min. - max. (mm)	Width min. - max. (mm)	Production amount (1000 t/y)
1 As-rolled hot coil	1.6 - 16.0	610 - 1,600	300
2 Hot skinpassed coil	1.6 - 6.0	610 - 1,600	250
3 Hot rolled sheet/plate	1.6 - 13.0	610 - 1,600	240
4 Heavy plate*	9.0 - 32.0	900 - 1,600	60
5 P/O coil and sheet	1.6 - 6.0	610 - 1,350	100
6 Hot coils for TCM**	2.0 - 6.0	610 - 1,300	670

Note*): Heavy plates are produced without coiling at down-coiler
Note**): TCM stands for Tandem Cold Mill

Table 10-11 Product size range (Step 2)

Product kind/use	Thickness min. - max. (mm)	Width min. - max. (mm)	Production amount (1000 t/y)
1 As-rolled hot coil	1.2 - 16.0	610 - 1,600	800
2 Skinpassed hot coil	1.2 - 6.0	610 - 1,600	400
3 Hot rolled sheet/plate	1.2 - 13.0	610 - 1,600	240
4 Heavy plates	9.0 - 32.0	900 - 1,600	120
5 Hot slit/recoiled coil	1.2 - 9.0	610 - 1,600	240
6 P/O coil and sheet	1.2 - 6.0	610 - 1,350	200
7 Hot coils for TCM	1.8 - 6.0	610 - 1,300	1,100

(4) Operational conditions

1) Operating time and production efficiency

The annual operating time including scheduled maintenance time is described in Table 10-12.

Table 10-12 Operating time of HSM

Item	Time(hr/y)	Remarks
A. Calendar time	8,760	24 hr/d x 365 d/y
B. Scheduled maintenance	552	1) + 2)
1) Annual maintenance	(240)	24 hr/d x 10 d/y
2) Periodical maintenance	(312)	12 hr/time x 26 times/y
C. Time to work	8,208	A - B
D. Operating time	6,977	C x 85%(Operating ratio)

Required production efficiency is shown in Table 10-13.

Table 10-13 Required production efficiency of HSM

	Required production efficiency
Step 1	1,680,000 t/y ÷ 6,977hr/y = 240 t/hr
Step 2	3,225,000 t/y ÷ 6,977hr/y = 462 t/hr

The HSM is designed to satisfy the above production efficiency taking account of the product size mix.

2) Product yield and unit consumption

Product yield and unit consumption of utilities and sub-materials are described in Table10-14.

Table 10-14 Product yield and unit consumption of HSM

	Step 1	Step 2
1 Product yield	98 %	98 %
3 By-product and waste		
1) Scrap	0.8 %	0.8 %
2) Mill scale	1.2 %	1.2 %
2 Unit consumption		
1) Electricity	110 kWh/t	100 kWh/t
2) Fuel	300,000 kcal /t	200,000 kcal /t(*) 300,000 kcal /t(**)
3) Water	3 m^3/t	3 m^3/t
4) Steam	6 kg/t	6 kg/t
5) Compressed air	10 Nm^3/t	10 Nm^3/t
6) Roll	0.6 kg/t	0.6 kg/t

Note*): The 200,000 kcal/t is for the slabs from CCM in NISW assuming DHCR is utilized to 75 % of the slabs.

Note**): The 300,000 kcal/t is for the purchased slabs

The above figures are typical ones to be used for the pre-feasibility purpose.
It is necessary to make a detailed study to obtain more precise figures because operational performances depend on mill design.

2.2.2 Each facility of HSM

(1) The facility configuration of HSM is shown in Table 10-15.

Table 10-15 Facility configuration of HSM

	Step 1	Step 2
1 Slab storage yard	1 yard + outside	1 yard
2 Reheating furnace	1 furnace	3 furnaces
3 Roughing mill	1 stand	2 stands
4 Finishing mill	5 stands	6 stands
5 Down coiler	1	2
6 Roll shop	3 roll grinders	4 roll grinders

The layout of HSM is shown in Figure 10-3 in page 46 of this section.

The equipment list of HSM plant is shown in Table 10-32 in page 48 - 50.

(2) Slab storage area

The slabs are stored both inside and outside the slab yard .
The slab storage plan is shown in Table 10-16.

Table 10-16 Slab storage plan

	Step 1 Reserved stock (No. of days)	Step 2 Reserved stock (No. of days)
1 Inside slab yard	4 days	2 days
2 Outside slab yard	41 days	
Total	45 days	2 days

As the slabs need to be procured from overseas countries at Step 1, it is planned to store a reserve stock equivalent to the 45 day's slab consumption.

But at Step 2, 2 days of slab stock are considered enough because the slabs are produced and stored as necessary in the steel making shop to be constructed in the new integrated steel works.

(3) Reaheating furnace (RF)

One reheating furnace will be installed at Step 1 to reheat the slabs from room temperature to the rolling temperature(approx. 1,250℃).
This No.1 RF is an oil-fired type because the by-product gas is not available at Step 1, and will be modified to a gas-fired type at Step 2.

The No.2 and No.3 RFs will be installed at Step 2 to reheat the slabs from room temperature or warm temperature just after being cast (approx:800-850℃) by the two continuous casting machines to be installed at Step 2.
The above No.2 and No.3 RFs will be of gas-fired type because of the availability of the by-product gas from the upstream plants.

The reheating capacity of each RF will be approx. 250 t/hr against cold slabs.

(4) Roughing mill (RM)

One stand(called R2) of the RM will be installed at Step 1 to achieve 1.68 million t/y of production.

It is necessary to install the second stand(called R1) of RM at Step 2 to increase the production capacity to 3.225 million t/y because the max. production capacity of the coil box type HSM with one RM stand is considered less than 3 million t/y.

The distance between R1 and R2 will be designed as short as possible to reduce the total length of HSM.
If it is possible from view point of the mill design, the adoption of tandem reversing type RM is considered most effective to achieve the above purpose.

(5) Finishing mill (FM)

One set of coil box, crop shear and finishing scale breaker is installed in front of the finishing mill stands.

The number of FM stands will be 5 at Step 1, which will be able to produce the minimum thickness of 1.6 mm product.
The number of FM stands at Step 2 will be 6, which will be able to produce the minimum thickness of 1.2 mm product.

The FM stands will be equipped with the following functions to allow for satisfactory profile control, uniform roll wear and the high possibility for schedule-free rolling.

1) Profile control function using the pair cross system(PC-system) or the work roll shift system(WRS-system) or some other technology to fulfill the purpose.

2) Uniform roll wear function using the on-line roll grinding system(ORG-system) or WRS-system etc.

(6) Down-coiler (DC)

One down-coiler will be installed at Step 1, and an additional one at Step 2 to cope with the increased production requirement.

The products up to 16 mm are coiled by the down-coiler, but the products thicker than 16 mm are carried over to the heavy plate cutting line without coiling.

Between FM and DC, one set of strip cooling system is installed to cool the strip temperature from 800 - 900℃ to 550 - 650℃ in ordinary cases. Due to the adoption of the coil box mill, the length of the strip cooling system can be designed to be very short because the acceleration of rolling speed is not required in case of the coil box mill.

(7) Roll shop

Roll grinders and other facilities necessary for the maintenance of rolls and chocks are provided in the roll shop adjacent to the HSM yard.

The typical facilities to be provided in the roll shop are shown in Table 10-17.

Table 10-17 Main facilities of roll shop

	Step 1	Step 2
1 Roll grinder	3	4
2 Roll lathe	1	1
3 Bearing washer	1	1

3. Hot finishing facilities

3.1 General

Table 10-8 shows the configuration of the finishing facilities, which have been planned considering the product mix and the production flow of HSM plant. (Please refer to item 1.3.1 "Production flow and product mix" on page 8 in this section.)

Table 10-18 Configuration of hot finishing facilities

	Step 1		Step 2	
	No.	Capacity 1000 t/y	No	Capacity 1000 t/y
1 Hot skinpass mill	1	700	1	700
2 Hot shearing line	1	300	1	300
3 Hot plate cutting line	1	60	1	120
4 Hot slitting/recoiling line	0	0	1	240

The size range of the finishing facilities are summarized in Table 10-19. (Please refer to Table 10-10 and 10-11 on page 21 of this section.)

Table 10-19 Thickness range of finishing facilities

	Step 1 (mm)	Step 2 (mm)
1 Hot skinpass mill	1.6 - 6.0	1.2 - 6.0
2 Hot shearing line	1.6 - 13.0	1.2 - 13.0
3 Heavy plate cutting line	9.0 - 32.0	9.0 - 32.0
4 Hot slitting/recoiling line	N/A	1.2 - 9.0

The layout of the finishing facilities is shown in Figure 10-3 on page 46.

3.2 Hot skinpass mill (HSPM)

3.2.1 General

It is necessary to install one set of hot skinpass mill from Step 1 of project for the following purposes:

1) Improvement of flatness, shape and mechanical properties of hot rolled products to meet the required quality depending on the end use of the products .
2) Division of large coils into small ones to meet the customer's equipment capacity.
3) Inspection of strip surface to ensure the surface quality.

3.2.2 Operational conditions and performances

The operational conditions and performances of the HSPM are shown in Table 10-20.

Table 10-20 Operational conditions and performances

	Step 1	Step 2
1 Production		
1) Hot coil	300,000 t/y	500,000 t/y
2) P/O coil	60,000 t/y	60,000 t/y
2 Product yield	98.5 %	98.5 %
3 By-product(scrap)	1.5 %	1.5 %
4 Unit consumption		
1) Electric power	4 kWh/t	4 kWh/t
2) Roll	0.05 kg/t	0.05 kg/t
5 Working time	3,600 hr/y(*1)	5,400 hr/y(*2)
6 Production efficiency	105 t/y	105 t/y

Note: One idea to keep the necessary working hours is shown below.
*1) 16hr/d(2 shifts) x 5d/w x 50 w/y x 0.9 = 3,600 hr/y
*2) 24hr/d(3 shifts) x 5d/w x 50 w/y x 0.9 = 5,400 hr/y

3.2.3 Outline specification of HSPM

The outline specification of HSPM is shown in Table 10-21.

Table 10-21 Outline specification of HSPM

Item	Description
1 Max. coil weight	29 ton
2 Coil inside diameter	
1) Entry side	760 mm
2) Delivery side	760 mm
3 Strip thickness	1.2 -6.0 mm
4 Strip width	610 - 1,600 mm
5 Rolling speed	Approx. 300 mpm

3.3 Hot shearing line (HSHL)

3.3.1 General

Generally the demand for the sheet and plate products compared to coil products is considered higher in the Viet Nam market than that of neighboring countries at the first stage because many users of flat products are expected to use sheets/plates instead of coils for the coming decade.

At least one line of HSHL is considered necessary to be installed in the integrated steel plant from Step 1 to directly supply sheets/ plates to various customers.

In addition to this line, several hot shearing lines need to be installed at coil centers by private companies or joint venture companies to satisfy the total demand for sheets/plates in the Viet Nam market.

3.3.2 Operational conditions and performances

The operational conditions and expected performances of HSHL is shown in Table 10-22.

Table10-22 Operational conditions and performances

	Step 1/Step 2
1 Production	300,000 t/y
1) Hot rolled sheet/plate	(240,000 t/y)
2) P/O sheet	(60,000 t/y)
2 Product yield	94 %
3 By-product(scrap)	6 %
4 Unit consumption	
1) Electric power	12 kWh/t
2) Compressed air	10 Nm^3/t
5 Working time	7,380 hr(*1)
6 Production efficiency	
1) Hot rolled sheet/plate	45 t/hr(*2)
2) P/O sheet	33 t/hr(*3)

One example of operating times and production efficiencies are described below.

Note *1 : [365d/y x 24hr/d - 10d/y(annual maint.) -12hr x 26 times/y (periodical maint.)] x 0.9 = 7,380 hr

Note *2 : This t/hr is the average for those of typical sizes of hot rolled sheets/plates such as 3.2 x 4' x 8', 6.0 x 5' x 10' etc.

Note *3 : This t/hr is the average for those of typical sizes of P/O sheets such as 2.3 x 3' x 6', 3.2 x 4' x 8' etc.

3.3.3 Outline specification of HSHL

The outline specification of HSHL is shown in Table 10-23.

Table 10-23 Outline specification of HSHL

Item	Description
1 Max. coil weight	29 ton
2 Coil inside diameter	760 mm
3 Sheet/plate size	
1) Thickness	1.2 - 13 mm
2) Width	610 - 1,600 mm
3) Length	1,200 - 12,000 mm
4 Side trimmer	Rotary type with scrap chopper
5 Leveler	1 or 2 levelers
6 Shear	Cutting without line stop
7 Piler	Reject piler and prime piler
8 Max.line speed	Approx. 60 mpm

3.4 Heavy plate cutting line (HPCL)

3.4.1 General

As the demand for heavy plate products is considered high in Viet Nam, it is planned that a heavy plate cutting line be installed with the HSM.

This HPCL can manufacture plates with a thickness of 9 to 32 mm without coiling at the down-coiler.
But the maximum plate width is limited to around 1,600 mm, which is same as that of coiled products.

This line is suitable for production of plates with excellent flatness and low residual stress, which are suitable for shipbuilding, tank manufacturing etc.

3.4.2 Operational conditions and performances

The operational conditions and expected performances of HPCL is shown in Table 10-24.

Table 10-24 Operational conditions and performances of HPCL

	Step 1	Step 2
1 Production capacity (t/y)	60,000	120,000
2 Product yield (%)	92	92
3 By-product(scrap) (%)	8	8
4 Unit consumption		
1) Electric power (kWh/t)	8	8
2) Compressed air (Nm^3/t)	10	10
5 Working time (hr/y)	2,500(*1)	5,000(*2)
6 Production efficiency (t/hr)	26(*3)	26

Note *1 : [365d/y - 10d/y(annual maint.) - 26d/y(fortnightly maint.)] x 8hr/d(1 shift) x 90% = 2,512hr/y

Note *2 : [365d/y - 10d/y(annual maint.) - 26d/y(fortnightly maint.)] x 16hr/d(1 shift) x 90% = 5,024hr/y

Note *3 : Production efficiency for 13.0 x 1,500 x 6,000 mm plate (typical size)

3.4.3 Outline specification of HPCL

The outline specification of HPCL is shown in Table 10-25.

Table 10-25 Outline specification of HPCL

	Step 1	Step 2
1 Slab	Half length slab	Half length slab
2 Plate size		
1) Thickness	9.0 - 32.0 mm	9.0 - 32.0 mm
2) Width	900 - 1,600 mm	900 - 1,600 mm
3) Length	1,800 - 12,000 mm	1,800 - 12,000 mm
3 Dividing shear		
1) Gas cutting type	9.0 - 32.0 mm	19.0 - 32.0 mm
2) Mech. shear type	N/A	9.0 - 19.0 mm
4 Cooling bed	N/A	to be provided
5 Leveler	4 high x 1	4 high x 1
6 End/Side cutter	Off-line portable gas cutter	Off-line portable gas cutter

3.5 Hot slitting and recoiling line (HSRL)

3.5.1 General

One line of HSRL will be necessary because of the following reasons:

1) Relatively small companies manufacturing pipes or formed light sections may request slit or trimmed coils to be supplied by VSC because it is not practical for each company to have an HSRL in its plant.

2) Some VSC's customers will need small coils divided by an HRSL because they cannot accept as-rolled large coils on their facilities.

If a sufficient number of HSRLs are installed at coil centers or pipe manufacturers, it will be unnecessary for VSC to install an HSRL in its integrated steel plant.
According to our study it is considered appropriate to install an HSRL at Step 2 of the project in the integrated steelworks.

3.5.2 Operational conditions and performances

The operational conditions and expected performances of HSRL is shown in Table 10-26.

Table 10-26 Operational conditions and performances

	Step 2
1 Production	240,000 t/y
1) Slit coil	(192,000 t/y)
2) Recoiled coil	(48,000 t/y)
2 Product yield	96 %
3 By-products(scrap)	4 %
4 Unit consumption	
1) Electric power	4 kWh/t
5 Working time	max. 6,566 hr (*1)
6 Production efficiency	40 t/hr

Note *1: [365d/y x 24hr/d - 10d/y(annual maint.) -12hr x 26 times/y (periodical maint.)] x 0.8 = 6,566 hr

3.5.3 Outline specification of HSRL

The outline specification of HSRL is shown in Table 10-27.

Table 10-27 Outline specification of HSRL

Item	Description
1 Max. coil weight	29 ton
2 Coil inside diameter	
1) Entry side	760 mm
2) Delivery side	760 mm
3 Strip thickness	1.2 - 9.0 mm
4 Strip width	
1) Entry side	610 - 1,600 mm
2) Delivery side	150 - 1,600 mm
5 Max. line speed	Approx. 120 mpm
6 Packing facilities	Off-line semi-automatic type

Note: The functions of the HSRL are the slitting, trimming and recoiling of hot rolled coils.

3.6 Hot coil cooling yard, hot coil conveyor and product packing/storage yard

3.6.1 Hot coil cooling yard

The hot rolled coils are transported from the down-coiler to the hot coil cooling yards by the coil conveyors.
The hot coils(600℃ at the down-coiler) are naturally cooled down to 50℃ or lower about 4 days after being placed in the coil cooling yard.
The cooled coils are charged to the hot finishing facilities or transferred to the packing areas as it is.

The coil cooling areas are designed to store a number of coils equivalent to 6 day's production considering cooling time and production scheduling time.

The areas of the coil cooling yard are shown in Table 10-28.

Table 10-28 Areas of coil cooling yard

	Step 1	Step 2
1 In HSHL yard	40m x 60m	40m x 60m
2 In HSPM yard	40m x 60m	40m x 60m
3 In HSRL yard	N/A	40m x 75m

Note: Coils are stacked in two layers in the coil cooling yards.

3.6.2 Coil conveyors(CV)

Coil conveyors are provided to transport the hot coils from the down-coiler to hot finishing yards and the cold pickling yard.
The approx. lengths of the coil conveyors are shown in Table 10-29.

Table 10-29 Coil conveyor plan

	Step 1	Step 2
1 CV in HSM yard	30 m	30 m
2 CV from mill yard to CRM plant	200 m	200 m
3 CV in HSHL yard	50 m	50 m
4 CV in HSPM yard	50 m	50 m
5 CV in HSRL yard	0	50 m

3.6.3 Coil packing and storage yard

The products after processed at the finishing facilities are stored for about 4 days in the finishing yards for packing, mechanical testing etc. before they are delivered to the shipping yards closely located from the storage yards.

4. Utility and auxiliary facilities

4.1 Utility consumption

The approximate consumption of utilities at HSM plant is shown in Table 10-30.

Table 10-30 Utility consumption at HSM plant

	Consumption. (unit)	Consumption (total)	Remarks
(Step 1)			
1 Water	3 m^3/t	5.04 Mm^3/y	Make up water.
2 Electric power	113 kWh/t	190 GWh/y	HSM, HSHL etc.
3 Heavy oil(10,000kcal/kg)	300,000 kcal/t	50,400 t/y	RF,
4 Compressed air	10 Nm^3/t	16.8 MNm^3/y	Plant air etc.
5 Steam	6 kg/t	10,000 t/y	Oil heating etc.
(Step 2)			
1 Water	3 m^3/t	9.68 Mm^3/y	
2 Electric power	102 kWh/t	329 GWh/y	
4 Coke oven gas(4,800kcal/Nm^3)	* 200,000 kcal/t * 300,000 kcal/t	156 MNm^3/y	
5 Compressed air	10 Nm^3/t	32.2 MNm^3/y	Plant air etc.
6 Steam	6 kg/t	19,400 t/y	Oil heating etc.

Note*) 200,000 kcal/t for slabs from CCM, 300,000 kcal/t for purchased slabs

Other than the above utilities, small amount of nitrogen gas is used for the purging of the reheating furnace pipings, and some oxygen gas and natural gas or LPG gas are used for gas cutting of heavy plates and other purposes.

4.2 Supply system of utilities

The utility supply system is planned as shown below.

1) Water
The make up water for the HSM re-circulation system will be supplied from an outside water source.
The water re-circulation and treatment systems are incorporated in the HSM plant including scale pits, filters, cooling towers, segmentation ponds, pump systems etc.

2) Electric power
The electric power will be purchased from an electricity company. The local sub-station is not included in HSM plant.

3) Heavy oil
Heavy oil will be delivered from outside by tank lorry and stored in the tanks to be installed in HSM plant at Step 1.
The heavy oil is used as a fuel for No.1 reheating furnace.

4) Coke oven gas(COG)
COG will be generated at the upstream plants and distributed through piping to HSM plant. The COG is used as a fuel for the reheating furnaces and gas cutting of the heavy plates.

5) Liquid propane gas(LPG)
LPG(or natural gas) to be used for gas cutting of the heavy plates will be purchased from outside at Step 1.
COG will be used for the heavy plate cutting at Step 2 instead of LPG.

6) Nitrogen
Nitrogen gas is used only for purging the COG when the furnace is turned off.
The nitrogen gas is purchased in bottle at Step 1, and to be distributed through piping from the oxygen plant at Step 2.

7) Oxygen
The oxygen gas used for gas cutting of the heavy plates will be purchased in bottles from outside at Step 1, but will be distributed through piping from the oxygen plant at Step 2.

8) Compressed air
The compressed air will be generated by a small compressor at HSM plant at Step 1, but that additionally needed at Step 2 will be supplied from the central compressor.

9) Steam
The steam mainly used for heating of the oil will be generated by a small boiler at the HSM plant.

4.3 Auxiliary facilities(L/3, Local office, Local maintenance shop)

The following auxiliary facilities will be included in the scope of the HSM plant, but details need to be studied at the later stage when necessary.

4.3.1 L/3 computer system

A simple L/3 computer system will be provided out of the HSM plant to provide the production schedule and instructions .

The L/2 computer of HSM plant will receive the operating instructions from the L/3 system, and will output the operating results necessary for the production control and scheduling system.

4.3.2 Local maintenance shop

Basically necessary maintenance machines are provided in the central maintenance shop. Only a small local maintenance shop will be provided in HSM plant at Step 1 for the convenience of minor maintenance work.

4.3.3 Local office

A local office will be provided in the HSM plant at Step 1 for the use by management, engineers, operators, maintenance personnel etc.

4.3.4 Others

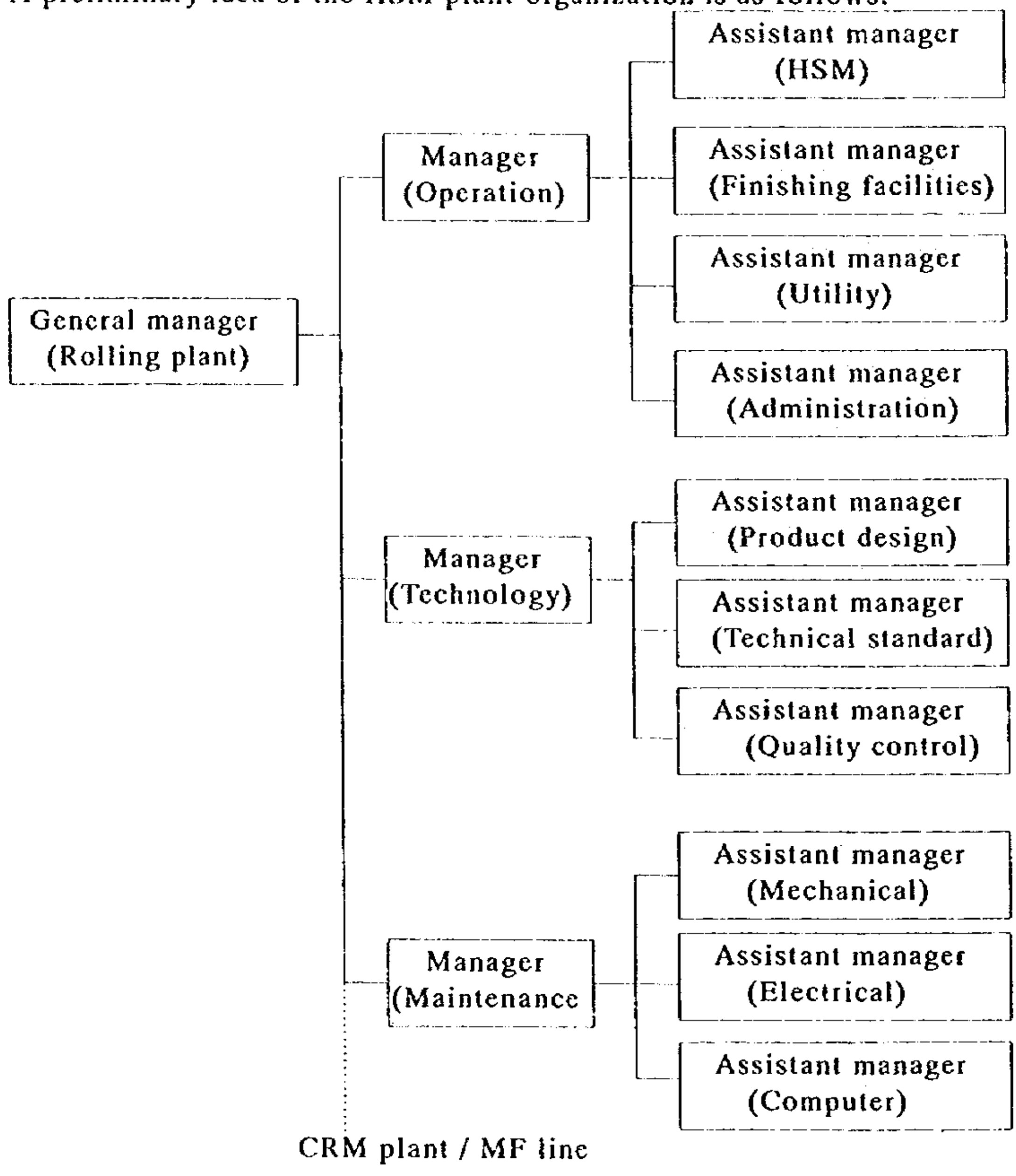
Other auxiliary facilities necessary for operation of the HSM plant are included in the scope of the HSM plant.

5. Operational management system of HSM plant

The operational management system of the HSM plant is briefly described below.

5.1 Organization and manning plan

A preliminary idea of the HSM plant organization is as follows.



A preliminary manning plan is shown in Table 10-31 just to indicate the approximate number of personnel required for HSM plant.

5.2 Quality control system

The HSM plant has the following functions for quality control system.

1) Quality design of the products including decision of steel grades, process parameters etc.

2) Preparation of technical and operational standards.

3) Inspection of products.

4) Monitoring and improvement of quality levels

The data logging system incorporated in the HSM process computer will be used for the monitoring and improvement of quality levels of the products.

Table 10-31 Manning plan of HSM plant

	Manager	Asst. Mng	Engineer	Foreman	Operator/ Technician	Total
(Step 1)						
1 Operation						
1) Management/Staff	1	4	5			
2) HSM				8	56	
3) Roll shop					28	
4) Heavy plate cutting line				1	12	
5) Hot shearing line				4	52	
6) Hot skinpass mill				4	24	
7) Hot slitting/recoiling line					0	
8) As-rolled coil					32	
9) Utility				4	24	
2 Technology						
1) Management/Staff	1	3	6			
3 Maintenance						
1) Management/Staff	1	3	6			
2) Mechanical				1	35	
3) Electrical				1	22	
4) Computer system				1	8	
Total	3	10	17	24	293	347

(Step 2)						
1 Operation						
1) Management/Staff	1	4	7			
2) HSM				8	60	
3) Roll shop					44	
4) Heavy plate cutting line				2	24	
5) Hot shearing line				4	52	
6) Hot skinpass mill				4	34	
7) Hot slitting/recoiling line					40	
8) As-rolled coil				1	36	
9) Utility				4	28	
2 Technology						
1) Management/Staff	1	3	7			
3 Maintenance						
1) Management/Staff	1	3	6			
2) Mechanical				2	40	
3) Electrical				2	27	
4) Computer system				1	9	
Total	3	10	20	28	394	455

6. General layout of the hot strip mill plant

The general layout of HSM plant is shown in Figure 10-3.

The layout is a preliminary one. The dimensions and the numbers of facilities such as cranes etc. shown in the layout are just for reference.

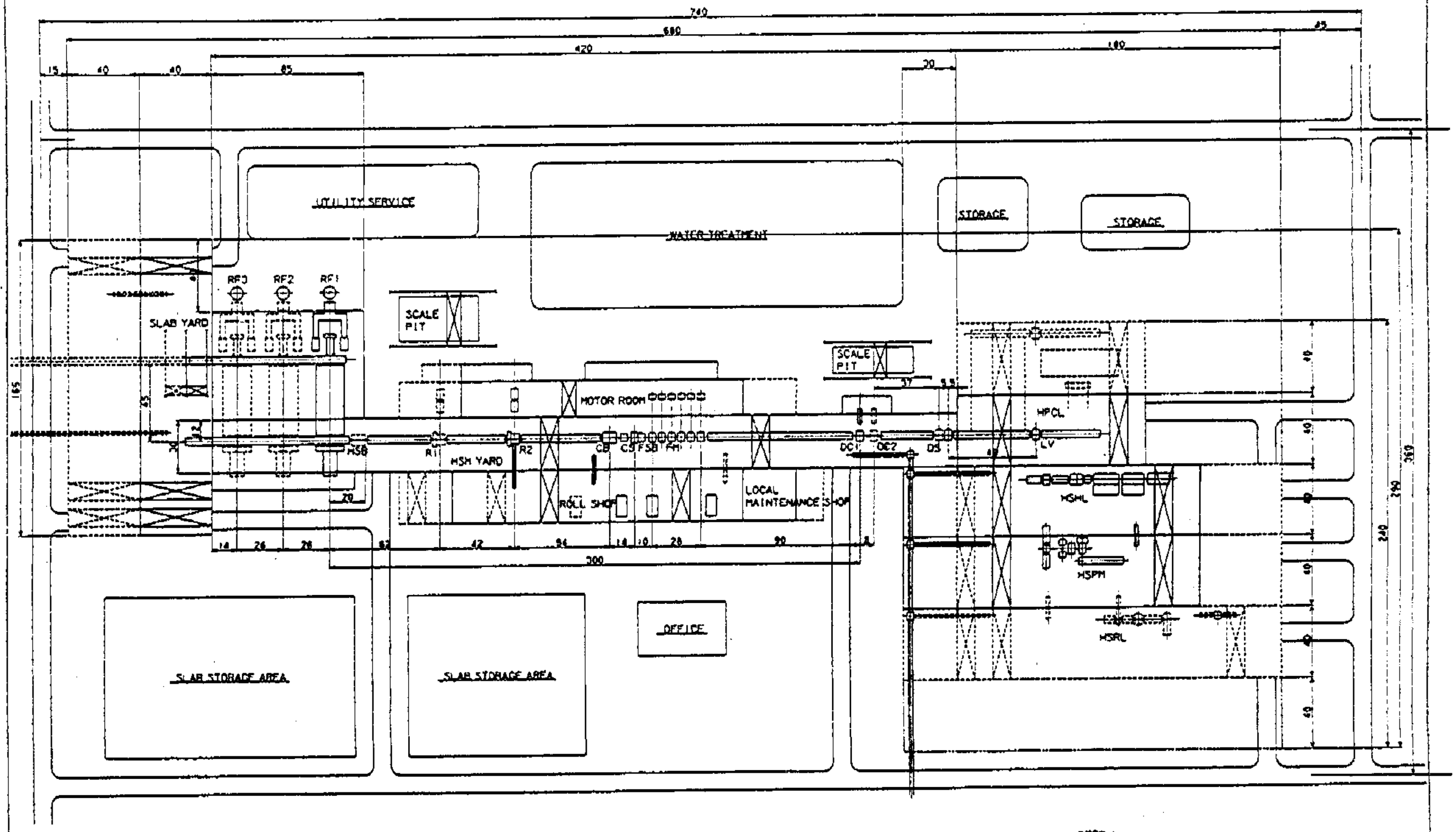


Figure 10-3 Hot strip mill plant layout

7. Equipment list of the hot strip mill plant

The equipment list of the HSM plant is shown in Table 10-32.

Table 10-32(1/3) Equipment list of HSM plant

No.	Equipmnent	Step 1		Step 2	
		Q'ty	Description	Q'ty	Description
1	Hot Strip mill	1 set	1.7 million t/y (slab basis)	1 set	3.25 million t/y (slab basis)
			Single RM coil box type HSM		Coil box type HSM with 2 RMs
1.1	Slab yard facilities	1 set	Unpiling crane for slab charging	1 set	Unpiling crane for slab charging
1.2	Reheating furnace	1	250 t/hr, WB type	3	250 t/hr, WB type
1.2.1	Slab charging facilities	1		3	
1.2.2	Furnace proper	1	Oil fired type	3	Oil fired type x 1, Gas fired type x 2
1.2.3	Slab discharging facilities	1		3	
1.3	Roughing mill	1	Reversing type with edger	2	Reversing type with edger
1.4	Finishing mill	1 set		1 set	
1.4.1	Coil box	1	1 station type	1	2 station type
1.4.2	Crop shear	1	Drum type	1	Drum type
1.4.3	Finishing scale breaker	1	Hydraulic type	1	Hydraulic type
1.4.4	Finishing mill stand	5	Hydraulic AGC, Profile control type.	6	Hydraulic AGC, Profile control type.
1.4.5	Strip cooling facilities	1 set	Laminar flow type	1 set	Laminar flow type
1.5	Down coiler	1 set	1.2 - 16.0 mm	2 set	1.2 - 16.0 mm

Table 10-32(2/3) Equipment list of HSM plant

No.	Equipmnent	Step 1		Step 2	
		Q'ty		Q'ty	
1.6	Roll shop	1 set	Roll grinder x 3	1 set	Roll grinder x 4
1.7	Crane and lifting equipment	1 set	Included	1 set	Included
2	**Hot Finishing Facilities**				
2.1	Hot skinpass mill	1	Production capacity 700,000 t/y	1	Production capacity: 700,000 t/y
2.1.1	Packing facilities		Off-line manual type		Off-line manual type
2.2	Hot shear line	1	Production capacity: 300,000 t/y	1	Production capacity: 300,000 t/y
2.2.1	Packing facilities		Off-line manual type		Off-line manual type
2.3	Heavy plate cutting line	1	Production capacity: 60,000 t/y	1	Production capacity: 120,000 t/y
2.4	Hot slitting and recoiling line	0		1	Production capacity: 240,000 t/y
2.4.1	Packing line			1	Semi-automatic type
2.5	Coil cooling yard and conveyor				
2.5.1	Coil cooling yard	1 set	2 yards	1 set	3 yards
2.5.2	Coil conveyors	1 set	Approx. 330 m	1 set	Approx. 380 m
2.6	Cranes and lifting equipment	1 set	Included	1 set	Included

Table 10-32(3/3) Equipment list of HSM plant

No.	Equipmnent	Step 1		Step 2	
		Q'ty		Q'ty	
3	Utility system & Auxiliary facilities				
3.1	Water treatment system	1 set	Filter, Cooling tower, Pond etc.	1 set	Filter, Cooling tower, Pond etc.
3.2	Water re-circulation system	1 set	Low, middle and high pressure system	1 set	Low, middle and high pressure system
3.3	Compressed air system	1 set	Plant air	1 set	Plant air
3.4	Steam generating system	1 set	For oil heating	1 set	For oil heating
3.5	Oil storage & supply system	1 set	Oil tank x 2 for No.1 RF	1 set	Oil tank x 2 for No.1 RF
3.6	Auxiliary facilities				
3.6.1	L/3 computer system	1 set	Production scheduling system	1 set	Production scheduling system
3.6.2	Local maintenance shop	1 set	Mainly just for assembling/disassembly	1 set	Mainly just for assembling/disassembly
3.6.3	Local office	1		1	
3.6.4	Others	1 set		1 set	

8. Construction

8.1 Construction schedule

The period of Step 1 construction work is estimated at 36 months from the contract to the start-up of the HSM plant as shown in the attached table.

- Table 10-33 : Construction schedule of HSM plant(Step 1)
- Table 10-34 : Construction schedule of HSM plant(Step 2)

On the other hand the period of Step 2 construction work will be approx. 28 months because of less work volume than that of Step 1.

8.2 Construction volume

It is difficult to estimate the volumes of construction work such as installation of mechanical/electrical equipment, erection of building and construction of foundation because the detailed specifications of the HSM plant have not been decided yet. Especially the design of buildings and foundations is considerably influenced by the local conditions such as climate, seismic and soil conditions etc.

Table 10-35 shows reference information for a general understanding about the scale of construction work which is obtained from experiences in the past.

Table 10-35 Construction volume of HSM plant

		Step 1 + Step 2
1	Weight of mechanical/electrical equipment(*1)	25,000 - 38,000 ton
2	Weight of buildings(*2)	7,000 - 11,000 ton
3	Concrete volume of foundation	70,000 - 110,000 m^3

(*1) Refractories of reheating furnaces are not included.
(*2) Only steel structures of plant buildings are included.

Table 10-33 Construction schedule of HSM plant (Step 1)

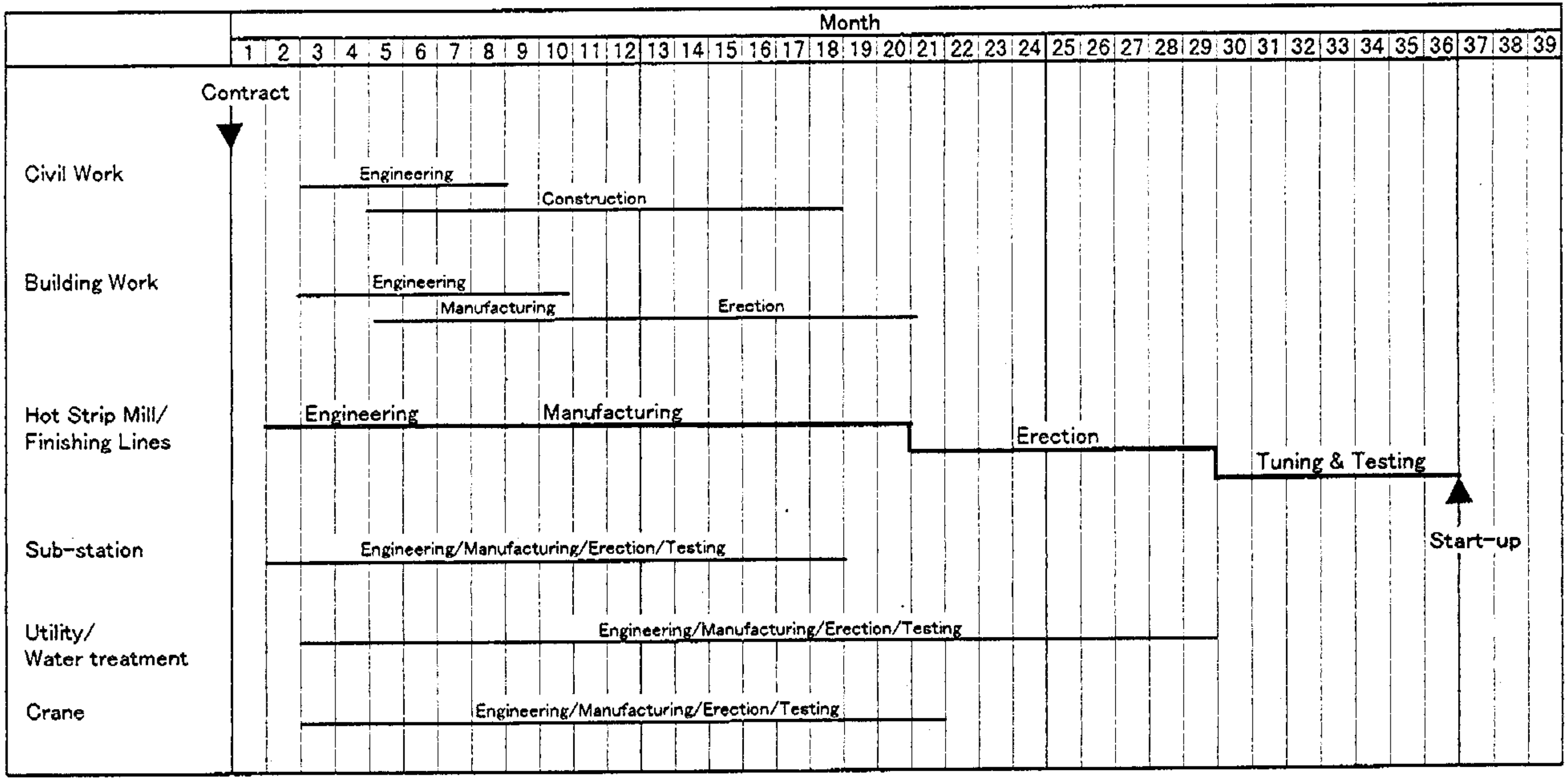
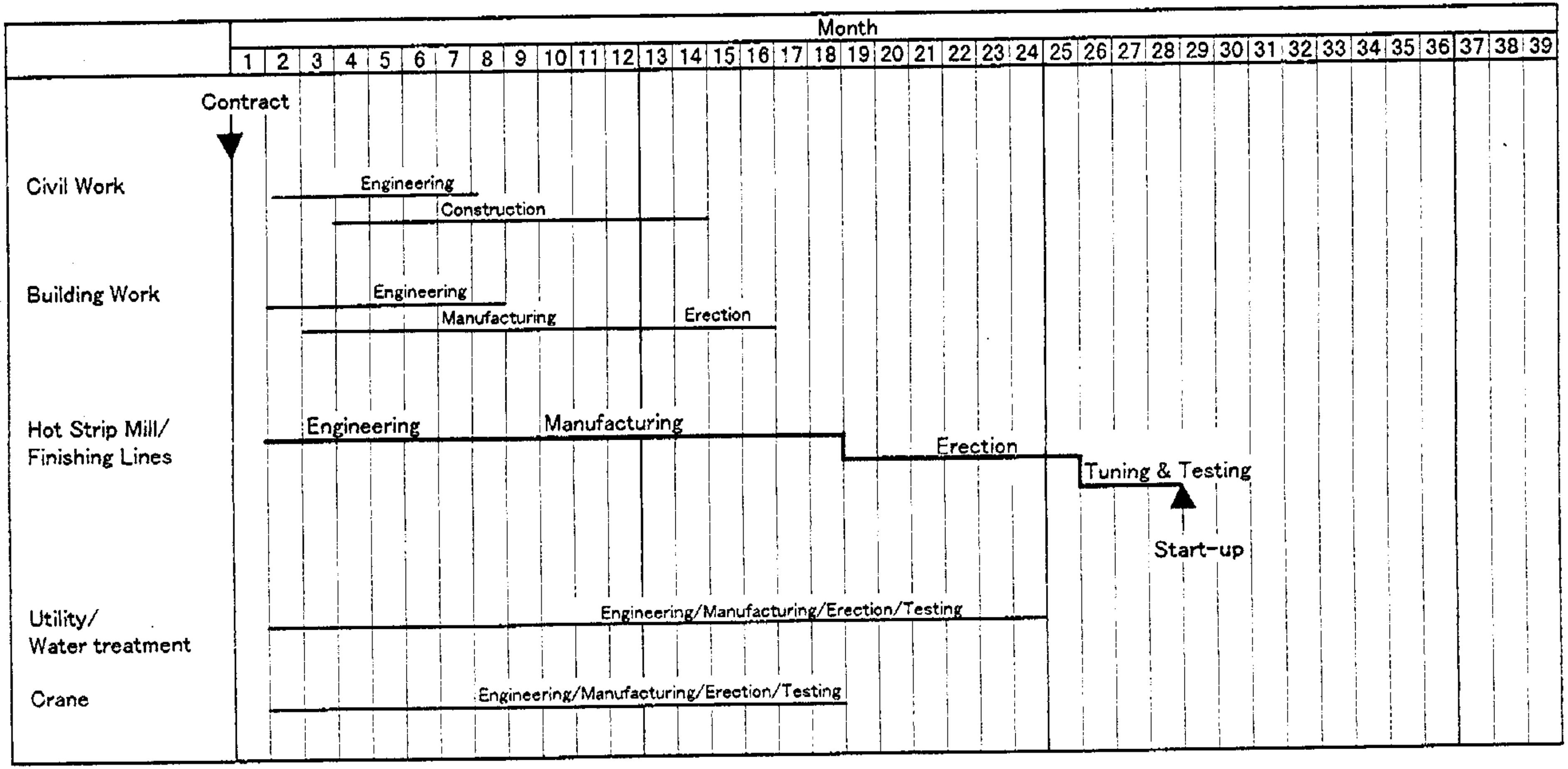


Table 10-34 Construction schedule of HSM plant (Step 2)



8.3 Construction timing of the rolling plants

It was agreed at the steering committee meeting held in September, 1997 in Viet Nam that the pre-feasibility study be carried out assuming HSM and CSM to start up approximately in the middle of 2005.
Refer to Chapter IV, Part 2, Section 7, Page 2, for the general construction schedule.

9. Summary

The important points of this section are briefly itemized below.

1) The final production capacity of HSM is decided at 3.2 million t/y in order to cover the flat product demand as much as possible.

2) The type of HSM is decided to be a coil box mill because it is considered most suitable for NISW from technical and economical viewpoints.
Generally the maximum production capacity of a coil box mill with a single roughing stand is less than 3 million t/y.
By installing two roughing stands, the capacity is increased to 3.2 million t/y.

3) The width of HSM is decided to be 5 feet because 88 % of the flat product demand can be covered by a 5-foot mill.

4) The minimum thickness of HSM products is proposed to be 1.6 mm with 5 FM stands at Step 1, and 1.2 mm with 6 FM stands at Step 2.
The minimum thickness of 1.6 mm will satisfy the almost all demands for hot rolled sheets and coils including those for CSMs.

5) The HSM is planned to facilitate the direct hot charge rolling of slabs from the CCMs to be installed at Step 2 in order to reduce the energy consumption and slab handling work.
But it is necessary to continue the procurement of some part of slabs from international markets before the upstream plants have been complete at Step 3.

6) It is planned to install one set of various finishing facilities in NISW in order to meet the wide range of orders including sheets, plates, skinpassed coils, slit coils, P/O products etc.