CHAPTER 6

GENERAL PLANT DESCRIPTION

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6-1 Basic concept

The equipment program of the present feasibility study is primarily based on the stage I plan, in which a single blast furnace shall be used, and designed to maintain the basic production balance shown in *Fig. 4-1-1*.

For the stage II plan, in which two blast furnaces shall be used, the capacity and laout of each equipment are also studied considering, the new techniques to be introduced in the future, for maintaining the basic production balance for stage II as shown in *Fig. 4-1-3*.

The following are the outline of each facility.

(1) Preparation and reclamation of the site.

Reclamation and preparation of the site are the basis for the steelworks construction and, therefore, must be carried out prior to any other works.

The entire area of the steelworks site is approximately 643^{ha}; 606^{ha} of purchased land, and 37^{ha} of land reclaimed from the sea.

Since the positions of bank heads and berths for loading finished products (for stage II) were moved back 100^{m}, from the plan of Pre-Feasibility Study, the total area of reclaimed land was reduced by 8^{ha} compared with the area reported in the previous study. As the bank head shown in the Pre-Feasibility Study was found to sit on a deep trough, it was decided to avert this.

The total area used for the stage I is approx. 376^{ha}; mostly purchased land, and approx. 23.4^{ha} of reclaimed land.

For effective operations of the new steelworks, the ground level of the site must be high enough to prevent the site being submerged by the waves and tide from the sea in front, or by floods from the land behind.

As for the preparation of the site, a balance of earth shall be maintained, as far as possible, by preventing earth from being brought in from outside of the site.

The ground level of the site shall be as follows:

Berth area	M.L.L.W. + 4.0^{m}
Raw material yard (including coke plant area)	M.L.L.W. + 5.0^{m}
Rolling area	M.L.L.W. + 5.5^{m}
Blast furnace and steelmaking area	M.L.L.W. + 6.4^{m}

The main drainage canals shall be open in view of the probable future expansion and construction cost, and drain water from inside and around the site.

However, the drainage canals along the ore yard at the north side shall be constructed with concrete because they are also used to drain the sea water from the power station and, therefore, must be a permanent structure.

(2) Port facilities

For the construction plan of the new integrated steelworks, a large berth (23^{m} deep and 351^{m} long) was already constructed in Macajalar Bay by the P.S.C and is now in operation to receive the iron ore and limestone for the sintering plant of the P.S.C.

Under these circumstances, the new steelworks shall make use of the P.S.C's berth for receiving the iron ore and, in stage I, the berth for unloading coal, scrap and other raw materials, the dolphin for receiving crude oil, and the berth for loading finished products shall be constructed.

The plan for bank revetment shall be minimized as much as possible and those bank revetments consist of two types: the permanent banks to suit their purposes, and the temporary ones for future use.

For lighterage, a minimum water area in front of the wharfs shall be reserved for easier incoming and outgoing of the vessels which are expected in stage I.

(3) Loading and unloading facilities

As raw material unloading equipments, the newly-constructed berth for unloading raw materials shall be provided with two unloaders (capacity: 500$^{t/hr}$ each) which are used to unload coal, scrap and miscellaneous raw materials.

Since the port acceptance capacity for large vessels is estimated to be increased in stage II, the existing berth of the P.S.C shall be extended and provided with two additional large unloaders (capacity: 1800$^{t/hr}$ each).

As for product loading equipment, the berth for finished products shall have two loaders (lifting capacity: 25^{t} each) which are used to load hot coils, slabs, blooms and billets, and also to unload ferro alloy, calcium carbide, refractories, and other materials.

In stage II, the berth for finished products shall be extended and provided with two additional loaders.

The roads shall be used for the transporation of the scrap, ferro alloy, refractories and other material, all which are unloaded at the berth, and the transportation of the hot coils, slabs, blooms and billets to be shipped. For these purposes, use of necessary vehicles is being studied. Since the shipment of products and materials and the types of products to be manufactured increase in stage II, the construction of warehouses for finished products is being studied.

(4) Raw material handling facilities

The raw material handling facilities shall include the raw material yard (a stacking/reclaiming system) for acceptance and storage of iron ore, limestone, coal and other

raw materials, the sizing plant for sizing (crushing and screening) lump ore and the blending yard for blending sinter materials.

In general, the belt conveyer shall be used for the transportation of those raw materials. Based on the estimation of necessary storage space for each raw material, the storage capacity for each yard is decided as follows:

Yard	Storage capacity (Unit: t)
Raw material yard	900,000
Blending yard	90,000

In stage I, the sinter plant for exclusive use with the new integrated steelworks shall not be constructed and, therefore, the production of sinter shall be entrusted to the P.S.C. In stage II, the sinter plant exclusively used for the new integrated steelworks shall be built up so as to meet the growing demand for sintered ore.

(5) Coke oven plant and by-product plant

A coke oven must have a capacity to produce blast furnace coke (lump coke 746,000$^{t/y}$) by one battery (45 ovens × 2). Furthermore, the use of 6^{m} ovens and minimum facilities shall be planned in consideration of production quantity and work efficiency.

The by-product plant consists of the equipment to recover coke oven gas (called COG hereafter), tar, light oil and other by-products.

In stage II, the facility for ammonium sulfate shall be constructed with the capacity enough to process increasing COG.

(6) Blast furnace plant

In stage I, a single blast furnace shall produce 1,434,000^{t} of pig iron annually.

In stage II, the production shall be 2,867,000^{t} per year since one more blast furnace will be constructed.

For the achievement of these production levels, the blast furnace shall be the large blast furnace with 2,600$^{m^3}$ inner volume, 2 iron tapholes, 2 cinder notches and 30 tuyeres. For the achievement of the most stable operation, the blast furnace plant shall employ highly reliable equipment which are excellent in handling and for a long time use.

The blast furnace plant shall be provided with three hot blast stoves (blast temperature: 1,050℃), the gas cleaning equipment for treating blast furnace gas (hereinafter called BFG) and the dry-pit type slag treatment equipment.

For the hot metal handling, when converter and blast furnace production are not balanced,

the casting machine (capacity: 35,000$^{t/month}$) shall be installed to make cold pig production possible.

(7) Lime calcining plant

A calcining furnace with the capacity of 250$^{t/d}$ shall be provided for the burning of the limestone which is needed for converter operations.

If an additional converter is constructed in the future, a lime calcining furnace shall be also installed.

The calcining furnace is of the rotary kiln type and quicklime is transported directly from a storage bunker to the flux hoist equipment of a converter plant.

(8) B.O.F plant and ingot-making facilities

The B.O.F plant shall produce 1,569,000$^{t/y}$ (molten steel base) in stage I and 3,147,000$^{t/y}$ in stage II.

As a prerequisite, the molten steel that is produced in the converter is sent to the continuous casting plant.

For the achievement of the production level mentioned above, the B.O.F plant shall be provided with two converters (160$^{t/heat}$) and, as an operation method, always have one converter in operation and the other well maintained and in working order.

The B.O.F plant is designed to allow the installation of one more converter in the future and, in the final stage, to use an operation method in which two converters are in operation and the other one in operating condition and well maintained always.

For the treatment of converter waste gas, a noncombustion type treatment which recovers the waste gas shall be employed so as to save energy.

Hot metal is transported to the B.O.F plant by a torpedo car, and then poured into the hot metal ladle in the pit of the B.O.F plant.

Some hot metal is desulfurized by the torpedo car desulfurization equipment, which is installed between the blast furnace and the converter.

Flux shall be stored in the underground bunker, which is located outside the converter shop, and be brought up by means of the conveyer belt.

B.O.F slag shall be carried to the slag yard by a slag pot car on the railroad.

The ingot-making facilities shall be constructed to make steel ingots from the hot steel unsuitable for continuous casting (low temperature and insufficiently deoxidized hot steel), and to work as supporting equipment for the starting-up period of continous casters, and for emergency stops of continuous caster operation.

The ingot-making facilities are designed, as a top-pouring type, to have a maximum capacity of 6$^{heats/d}$ (approx. 25,000$^{t/month}$).

In addition to those ingot-making facilities, the molten steel transfer car for returning the hot steel shall be located between the teeming bay and the raw material bay.

(9) Continuous casting plant

In stage I, the continuous casting plant shall produce 1,200,000^{t} (slab base) of slab for hot-rolled coils and plates for a year and 300,000^{t} (bloom base) of blooms for billets for a year.

Furthermore, continuous casting shall be applied to all the molten steel which is produced by the converter.

In the stage II, the continuous casting plant shall produce 2,000,000^{t} of slabs and 1,000,000^{t} of blooms per year. As a continuous caster for slabs, two 1-strand continuous casting machines (single radius curved mold caster) which are easily manipulated shall be installed in addition to the converter facilities.

And one 4-strand continuous casting machine shall be installed as a continuous caster for blooms.

The cast slab and bloom sizes are specified as follows:

	Thickness	Width	Length
Slabs:	200 ×	(900 to 1,900) ×	(4,980 to 9,200)^{mm}
	Cross section		Length
Bloom:	200$^{\phi}$ or 250$^{\phi}$ ×		6,100 (max.)^{mm}

A machine scarfer shall be installed so that the surface quality of slabs can be maintained high and stable and the handling of slabs be made more effective.

The slabs for hot rolled coils shall be cast in multiple widths of 6 feet (6').

The secondary cutting and division of these slabs shall be performed at the slab yard.

The slabs for plates are planned to be manufactured at a maximum length of 6,100^{mm} and their secondary cutting shall be carried out by the plate maker.

In the second stage (three converters installed and two of them in service), two 1-strand continuous casting machines for slabs and one 4-strand continuous casting machine for blooms shall be installed (the installation position is a symmetrical arrangement of that of stage I).

The layout of these machines is so designed that slabs can be supplied in a hot state to the hot strip mill in the future.

(10) Hot strip mill

In stage I, the hot strip mill shall have a capacity of making C.C. slab (200^{mm} thick, 600 to 1,300^{mm} wide and 9,200^{mm} max. in length) into hot coils (1.2 to 12.7^{mm} thick, 600

to 1,250^{mm} wide, 760^{mm} inner oil diameter, and 1,800^{mm} , max. outer coil diameter) and produce 1,052,000^{t} for a year. The facilities of the hot strip mill shall include two reheating furnaces, one roughing mill, five finishing mills and two down coilers to maintain the necessary and economical production level.

Furthermore, it is taken into consideration that the production shall increase to the level of 1,721,000$^{t/y}$ in stage II and, for this reason, the installation of an additional reheating furnace, roughing mill and down coiler may be needed. In stage II, the hot strip mill shall process 226,000^{t} of sheets (1.2 to 6.35^{mm} thick, 800 to 1,250^{mm} wide and 2 to 6^{mm} long) for a year.

The hot coils shall be used for (1) hot rolled sheets and coils, (2) pipes and tubes, (3) cold rolled sheets and coils, (4) G.I sheets and (5) tin plates.

(11) Billet mill and medium section mill

150,000^{t} of billet shall be produced per year in stage I and, in stage II, 630,000^{t} of billets and 186,000^{t} of medium section be manufactured per year.

For the most effective investment in the facilities for stage I, the facilities are so designed that they can be economically rebuilt into the section mill in stage II.

In stage I, the billet mill shall turn the blooms of 200 × 200^{mm} into 150,000$^{t/y}$ of billets measuring 135 × 135^{mm} and 100 × 100^{mm} (ratio 24:76).

One reheating furnace (capacity: 45$^{t/hr}$) and one billet mill shall be installed.

In stage II, additional continuous finishing mills and finishing equipment shall be installed behind the billet mills, which are constructed in stage I, and this will be converted to medium section mill to produce 186,000^{t} of medium sections per year.

Furthermore, the new billet mill shall be constructed to turn the blooms of 200 × 200^{mm} cross-section into 630,000^{t} of billets measuring 135 × 135^{mm}, 100 × 100^{mm}, or 50 × 50^{mm} per year (ratio of these types of billets is 6:79:15).

The billet length is specified at 6^{m} for each size and the billets shall not be conditioned.

(12) Power plant and B.F. blower plant

The power plant and the blast furnace blower shall be installed in order to make effective use of the BFG, COG and LDG which are generated in the steelworks. The steam for general use of the steel work shall be supplied by means of extraction from turbine for overall efficiency of the steelworks.

For the power plant and the blast furnace blower, two units of turbine-generator-blowers shall be employed and their fuels can be either of those steelworks generated gases or heavy oil.

Those units provide the following services during normal operation (stage I):

	Turbine output	Generator output	Blower axial input
No.1 unit	40,000 kW	25,000 kW	15,000 kW
No.2 unit	40,000	40,000	* –
Total	80,000	65,000	15,000

* denotes a spare blower

One more unit shall be installed in stage II.

(13) Power receiving and distribution facilities

The power receiving and distribution facilities include a power receiving unit for overall steelworks (primary power source), a power distribution system, a telephone system and temporary power supply equipment for construction. The receiving power voltage (primary voltage) shall be 138^{kV} and the distribution voltage (secondary voltage) shall be 34.5^{kV}, taking into account the efficiency of the power consumption in the future. The 138^{kV} power receiving equipment is designed on a two circuits base so that the occurence of a complete power failure can be avoided during maintenance, inspection or other troubles. The 34.5^{kV} line system is composed of double buses so that the line will be divided into two systems of NPC power and genarating plant in the steelworks.

(14) Oxygen plant

The oxygen generators (8,500N$^{m^3/hr}$, 2 units) shall be installed to generate and supply oxygen, nitrogen and argon for use in the steelworks.

For a steady supply of oxygen, liquid oxygen equipment shall be provided so that 70% of oxygen generation can be maintained during any time of trouble with one of the oxygen producers or during periodical maintenance (for 14 days).

(15) Fuel equipment

The fuel equipment supplies the BFG, COG, LDG, heavy oil and steam to each destination as required, and the fuel distribution center shall be constructed for effective operations. For effective use of these gases, the BFG holder (100,000$^{m^3}$ × 1), the OG holder ((40,000$^{m^3}$ × 1) and the LDG holder (50,000$^{m^3}$ × 1) shall be installed so as to keep a blance between the consumption and production of those gases.

Furthermore, gas discharging stack with combustion device shall be installed respectively to cope with any sudden change of consumption and/or production of these gases.

The capacities of the BFG holder and the LDG holder are taken into consideration so that

they can be used in stage II. As for the C gas holder, an additional C gas holder shall be installed in stage II, which might be used as a spare. To the mill plant, mixture of BFG and COG gases shall be supplied for the purpose of effective and economical operations.

(16) Utilities piping system

The utilities piping system is the piping system that leads from the utility facilities to each destination of use, and is planned on aerial route.

The capacities of the main route piping are based on the demand in stage II.

(17) Water supply equipment

The water supply equipment shall deal with the taking, treating and supplying of seawater, and with the supplying of industrial water from receiving pond.

Receiving pond ($90{,}000^{m^3} \times 1$ unit) receives $53{,}000^{m^3/d}$ of industrial water per day and supply to the destinations via an elevated water tank.

The sea water shall be taken from a deep level of the sea near the coal berth jetty (intake volume: $22{,}000^{m^3/hr}$) and supplied to the power plant and oxygen plant system, and the coke plant system by pumps. The capacity of the water supply equipment is primarily designed for stage I.

However, the capacities of the industrial water pond and the seawater conduction facilities, are designed to be effective for stage II.

(18) Water recirculation facilities

The water recirculation facilities shall be installed independently at eight different points (blast furnace, coke/by-product plant, B.O.F., continuous casters, lime calcining plant, billet mill plant, hot strip mill plant and oxygen gas plant) close to each plant, considering the capacities sufficient for stage I.

The water recirculation facilities shall usually supply the water at 35°C in accordance with volume and qualities necessary for each plant. However, they are also designed to provide the water at 40°C to some equipment as B.O.F. gas recoverying equipment, lance and the dust collectors, etc.

(19) Transportation facilities

The transportation facilities are for handling raw materials, semi-finished products and such wastes as slag, sludge, scale, scrap, dust, and so on.

They shall involve railroad transportation only for such hot and heavy materials as hot metal, B.O.F. slag and ingot, and road transportation for the other products and materials.

320^t capacity torpedo casrs shall be used for the transportation of hot metal and their rail

road guage shall be 1,435[mm], condisdering the use of large-size vehicles.

Road transport vehicles, flat-topped trucks and dump trucks shall haul materials for maintenance and others, respectively.

(20) Maintenance shop

The scale of the maintenance shop shall be determined according to the necessity for normal maintenance operations.

As a general rule, special maintenance equipment (high quality or large-sized items) and spare parts shall be purchased.

The maintenance system shall be an independent centralized system, which consists of the central maintenace station and the local maintenance shops. The central maintenance station takes care of repair and maintenance of equipemnt, consisting of the plants for plating, forging, metal formaing and machining, and of the work shop for repairing machinery, vehicles, electrical/instrument equipment and civil, water facilities.

The local maintenance shops shall be established in eight different areas of main plants, to take care of inspections and maintenance.

(21) Testing and analysis equipment

The testing and analysis equipment shall be necessary items as follows:

(1) The testing and analysis equipment for raw material shall be installed for the purpose of managing the blast furnace operation, and for the by-product inspections (check and analysis of such semifinished products as ingots, slabs and billets; and the acceptance test and quality control of raw materials).

They shall be installed by the blast furnace plant.

(2) In front of the converter, the quick analysis equipment shall be installed for the purpose of inspection and quality control of finished products.

(3) In the hot strip mill, the mechanical testing machines necessary for the inspection before the products shipment and for the quality control shall be installed.

6-2 General layout

6-2-1 Space

The general layout of the greenfield steelworks shall be studied on the basis of approx. 643^{ha} of the area in Tagoloan Villanueva, Mindanao Island, which was offered by the Philippine Authorities. In the vicinity of this area, the sinter plant of P.S.C is already in operation and the sea berth are already constructed to receive raw materials. The general layout up to the production capacity of 3.0 million ton per year in satage II was mainly studied considering the reservation of space for future use.

6-2-2 General arrangement

As mentioned before, the sinter plant is already established and there is a usable coastline only in one direction at the present. Those conditions limit possible plans for the overall layout. The raw material yard shall be constructed near the P.S.C yard so as to smoothen the flow of the process starting with acceptance of raw materials and ending with shipment of finished products.

Location of main production facilities is arranged around the center of the steelworks site to shorten transportation distances. The energy supply system shall be constructed at the center of the steelworks site for effective operation and maintenance of each production facility. The plants for raw materials, coke oven, blast furnace, steelmaking, hot strip mill and billet mill are laid out for efficient operation.

6-2-3 Features of the layout

Figure 6-2-1 shows the general layout of the steelworks with the following features:

(1) Raw material

Iron ore shall be delivered mainly from the P.S.C berth by means of conveyer belts.

The raw material yard shall be constructed close to and parallel to the P.S.C yard.

Furthermore, the raw material berth (13^{m} deep and 270^{m} long) shall be constructed at the northwest of the yard to unload coal, scrap, limestone and others raw materials.

In the layout preparation, the raw material yard uses common-yard method for minimum construction costs and for effective use of yard areas. The established P.S.C berth and the new raw material berth are so designed as to reserve equivalent area of space which shall be necessary for future extention of the berth.

(2) Coke oven

The coke oven shall be installed compactly between the raw material yard and the blast furnace, simplifying the transportation routes of coal and coke.

The coke oven is so designed as to allow new installations (CDQ or desulfurization of COG) in the future.

(3) Blast furnace

The No. 1 blast furnace shall be installed close to the B.O.F plant so that hot metal can be transported directly to the converter by torpedo cars, without the shunting of locomotive. In stage II, the No. 2 blast furnace shall be newly installed next to the No. 1 blast furnace at a distance of 220m. Each facility and set of equipment is arranged in the steelworks site compactly so that construction cost can be minimized and the daily operation be made more effective and the construction and repair works made easier.

(4) B.O.F plant and continuous casting facilities

The torpedo car desulfurization equipment, which is to be installed between the blast furnace and the converter, shall be able to handle a large amount of hot metal. The locations of the B.O.F, the continuous casting plant and the lime calcining plant are arranged effectively in the steelmaking area so that quicklime can be delivered directly.

The layout takes it into consideration that the continuous casting plant can be coupled with the hot strip mill by means of roller tables in the future. The ingot making yard shall use carpouring method. The ingot storage yard shall be outside the B.O.F plant facility; a railroad transport serves up to the ingot storage yard and the trailers shall be used for the transportation between the ingot storage yard and the berth. The B.O.F slag shall be transported by the railroad, and the slabs and blooms shall be carried by trailer.

(5) Hot strip mill

The hot strip mill shall be installed as close to the steelmaking plant as possible, so that the steelmaking plant can supply hot slabs to the hot-strip mill easily in future. When the slab yard and the product finishing yard are extended in stage II, the arrangement of these facilities is designed so as to prevent the flow of the processing from becoming more complicated.

(6) Billet mill and medium section mill

The billet mill shall be installed parallel to the hot-strip mill. In stage II, the billet mill shall be reorganized to become a medium section mill by installing continuous finishing mills and finishing equipment behind the billet mill.

Since the new billet mill is to be installed parallel to the medium section mill, this arrangement shall make use of the rolling area more effectively, and make the balance of the overall facility arrangement better and let the roads run straight.

Since the bar mill etc. are estimated to be installed in future, the layout allows for as large a site behind the billet mill as possible.

(7) Auxiliary equipment

1) The power station serves both as a primary substation and is to be situated at the center of the steelworks, i.e. central to working loads.
2) The main roads are designed to smoothen the shipment of finished products. The product berth shall be constructed behind the raw material berth.
3) The railroad transportation is designed to be as small as possible and, therefore, the total length of the railroad shall be minimum.
4) Each plant shall have its own water recirculation system.
5) On consultation with the Philippine side, the central maintenance shop shall be built in the vicinity of the steelworks, not inside the site.

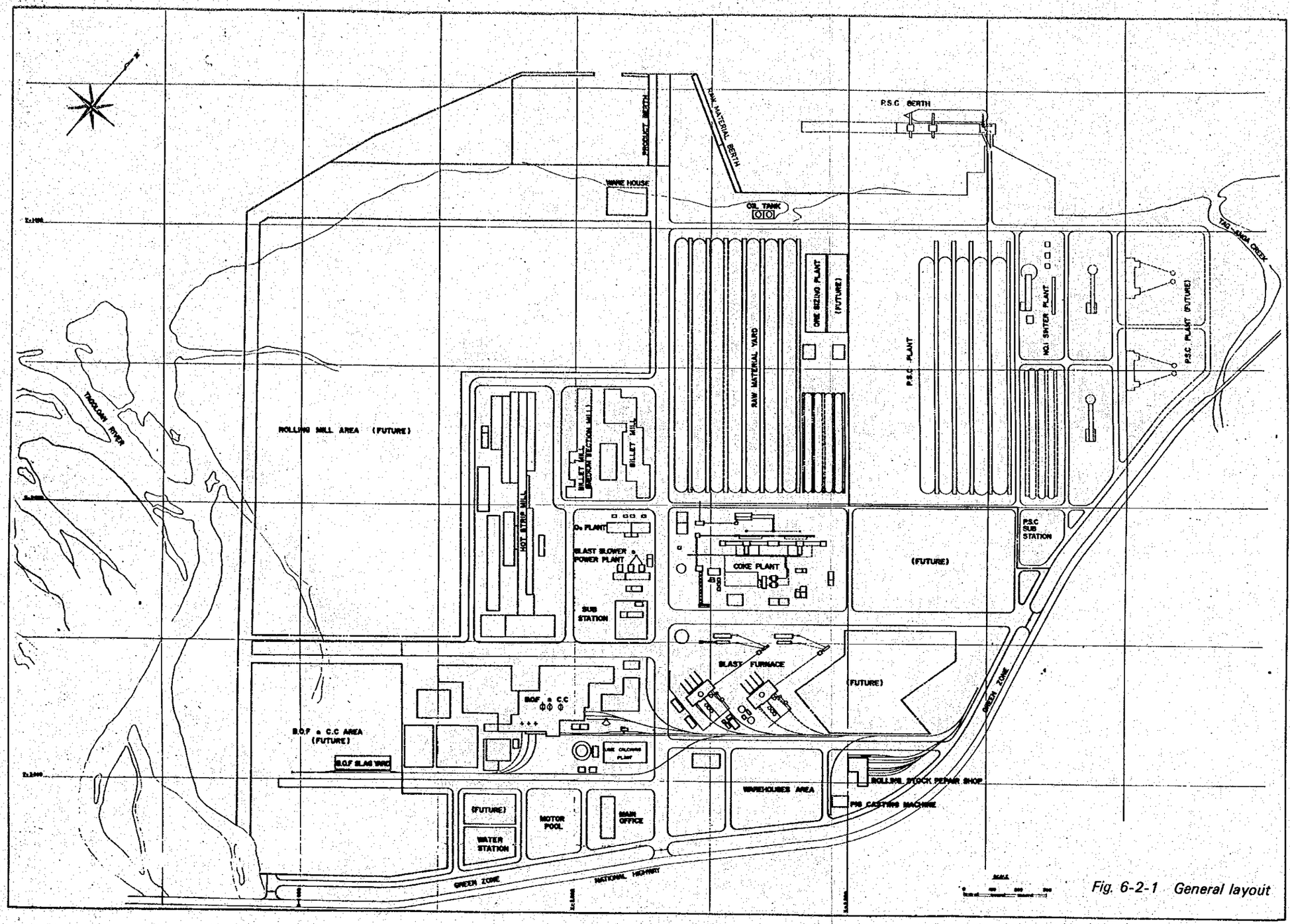

Fig. 6-2-1 General layout

6-3 Main specifications

Table 6-3-1 shows the main specifications of the individual equipment and facilities, which shall be installed or constructed in stage I and stage II.

Table 6-3-1

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
1. Preparation and reclamation of land				
Purchase land	606 ha	233.9 ha reserved for future use	——	
Prepared and reclaimed land	376.5 ha	353.1 ha for land 23.4 ha for reclaimed land		
Construction of drainage canal	1 set	Open drainage canal Length: 18,250 m		
2. Port facilities				
Raw material berth	1 set	13 m depth x 270 m length (use for ships of 50,000 D/W)		
Product berth	1 set	7 m depth x 330 m length (designed for ships of 5,000 D/W)	1 set	7 m depth x 250 m length (designed for ships of 5,000 D/W)
Crude oil berth	1 set	5 m depth x 30 m length (designed for ships of 2,000 D/W)		
Revetment	1 set	Frontal revetment, 5 m depth x 150 m length Attached revetment, 3 m depth x 330 m length Masonry revetment, 510 m length		
3. Loading and unloading facilities				
Unloader	2 units	500 t/hr Horizontal luffing crane	2 units	1,800 t/hr Rope trolley type crane
Loader	2 units	25 t rope trolley type crane	2 units	Same as left
Transportation	30 units	Tractor x 5, Trailer x 13 and others	23 units	Tractor x 4, Trailer x 12 and others
Product warehouse	——		1 set	Floor area: 15,000 m² Crane attached to ceiling
4. Raw material handling				
Raw material yard	1 set	Yard area: 135,000 m² Storage capacity: 900,000 t	1 set	Yard area: 45,000 m² Storage capacity: 300,000 t

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
		Stacker 3 units Reclaimer 3 units and others		Stacker 1 unit Reclaimer 3 units and others
Sizing equipment	1 set	Gyratory crusher 2 units Hydrocorn crusher 2 units and others	1 set	Hydrocorn crusher 2 units
Blending yard	1 set	Yard area: 12,000 m^2 Storage capacity: 90,000 t Stacker 1 unit Reclaimer 1 unit	1 set	Same as left
5. Coke/by-product plant				
Coal selection equipment	1 set	Coal blending bin 300 t/bin x 16 bins and others	1 set	Same as left
Coke oven	90 chambers	Coke chamber volume 6,000 mm (H) x 430 mm (W) x 15,800 mm (L) Effective inner volume 36.0 m^3/oven	90 chambers	Same as left
Coke transportation equipment	1 system	Conveyor belt capacity 180 t/hr	1 system	Same as left
Gas exhaust equipment	2 units 4 units	Gas exhaust equipment 52,000 Nm^3/hr Primary gas cooler 17,500 Nm^3/hr cooler	1 unit 4 units	Same as left Same as left
Gas refining equipment	1 system	Final cooler, Ammonia scrubber, Benzen scrubber } Processing capacity: 52,000 Nm^3/hr	1 system	Final cooler, Benzen scrubber } Processing capacity: 52,000 Nm^3/hr
			1 set	Ammonium sulfate making equipment 35 t/d
Biological treatment facilities	1 set	Capacity: 1,100 m^3/d	—	
6. Blast furnace equipment				
Blast furnace	1 unit	Inner volume: 2,600 m^3 Hearth diameter: 11,200 mm Furnace support: Free standing type Iron taphole x 2, Slag notch x 2, Tuyere x 30	1 unit	Same as left

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
		Charging system: Belt conveyor		
Hot blast stove	3 units	Cowper type Blast temperature: 1,050°C	3 units	Same as left
Gas cleaning equipment	1 units	Treating gas volume: 341,000 Nm^3/hr Secondary venturi type wet gas cleaner	1 units	Same as left
Transportation of furnace raw material	1 unit	Ore bunker x 8 bins Coke bunker x 6 bins, Screen x 11 Charging conveyor	1 unit	Same as left
Slag treatment equipment	1 unit	Slag pit x 3	1 unit	Same as left
Pig casting machine	1 unit	Fixed roller type Capacity: 35,000 t/month	—	
7. Lime calcining plant				
Limestone storage silo	1 unit	Storage capacity: 1,050 t	1 unit	Same as left
Calcining furnace	1 unit	Type: Rotary kiln Capacity: 350 t/d Fuel: COG	1 unit	Same as left
Product bunker	1 set	Volume: 2,700 t		
8. B.O.F plant				
Converter	2 units	Capacity: 160 t/heat	1 unit	Same as left
Lance and lance hoist rigs	2 units	Quick change type Oxygen delivery capacity: Max. 40,000 Nm^3/hr	1 unit	Same as left
Waste gas processing equipment	2 units	Type: Noncombustion type Amount of waste gas: Approx. 100,000 Nm^3/hr	1 unit	Same as left
Sub-lance equipment	2 units	Automatic probe attachment type	1 unit	Same as left
Fluxes handling equipment	1 set	Underground bunker, Belt conveyor system	1 set	Equipment level over the furnace
Torpedo car desulfurization equipment	1 unit	CaC_2 upward blowing method	1 unit	Same as left
Steel ladle	15 units	Capacity: 160 t	8 units	Same as left

Equipment and facility	Stage 1		Stage II	
	Quantity	Specifications	Quantity	Specifications
Steel ladle car	2 units	Capacity: 240 t Motor-driven self travelling type	1 unit	Same as left
Crane	15 units	Hot metal charging crane 270 t x 40 t x 1 unit Scrap charging crane 90 t x 75 t x 1 unit Steel ladle service crane 240 t/40t x 1 units Stripper crane 35 t/1unit and others	5 units	Hot metal charging crane 270 t/40t x 1 unit and others
Ingot making facilities				
Teeming car	8 units	Capacity: 250 t (Purchase in transportation facilities)	—	
Mold cooling bed	1 set	500 m^2	—	
9. Continuous casting plant & ingot making facilities				
(1)Continuous casting plant				
Continuous slab caster	2 units	Type: Low-head cruved mold type Number of strands: 1 Slab dimentions: Thickness 200 mm Width 900 ~ 1,900 mm Length 4,980~9,200 mm Casting speed: Max. 1.5 m/min.	2 units	Same as left
Continuous bloom caster	1 unit	Type: Low-head curved mold type Number of strands: 4 Bloom dimensions: 200 x 200 x 6,100 mm (L) 250 x 250 x 6,100 mm (L)	1 unit	Same as left
Molten steel handling equipment				
Ladle turret	3 units	Capacity: 240 t, 1 r.p.m.	3 units	Same as left
Tundish and tundish car	1 set	18 t Tundish x 23 units and others	1 set	Same as left

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
Cast slab/bloom delivery equipment				
Roller table	1 set	For slab: 2 units For bloom: 4 units	1 set	Same as left
Pusher	4 units	Flor slab: 15 t x 2 units For bloom: 75 t x 2 units		
Piler	2 units	Capacity: 45 t (for slabs)	2 units	Same as left
Cooling bed	4 units	For slabs: 20 m x 75 m x 2 units For bloom: 5 m x 10 m x 2 units	4 units	Same as left
Crane	29 units	Continuous caster service crane 120 t/40 t x 1 unit Slab delivery tong crane 45 t x 2 units Slab delivery lifting magnet crane 30 t x 2 units Bloom delivery lifting magnet crane 15 t x 1 unit and others	29 units	Same as left
10. Hot strip mill				
Reheating furnace	2 units	Type: Working beam type Capacity: 140 t/hr	1 unit	Same as left
Rougher				
VSB	1 unit	Motor: AC 1,000 kW x 1 unit	——	
R_1 mill	——		1 unit	Type: Reversing 4-high mill Motor: DC 4,000 kW x 1 unit
E_1 mill	——		1 unit	Type: Front edger type Motor: DC 1,000 kW x 1 unit
R_2 mill	1 unit	Type: Reversing 4-high type Motor: DC 5,500 kW x 1 unit	——	
E_2 mill	1 unit	Type: Front edgen type Motor: DC 1,000 kW x 1 unit	——	
Finishing rolling mill equipment				
Finishing mill	6 units	Type: 4-high mill	——	

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
		Motor: DC 26,500 kW x 6 units		
Coiler	2 units	Type: 3 W rapper roll type Coil inner diameter: 760 mm Coil outer diameter: Max. 1,800 mm	1 unit	Same as left
Shear	—		1 unit	Capacity: 1.2 ~ 6.35 mm thickness 2 ~ 6 m length
Crane	17 units	Material yard crane 90 t x 4 units and others Rolling yard crane 125 t/30 t x 1 unit and others	10 units	Material yard crane 90 t x 2 units and others
11. Billet mill (Stage I) Medium section mill (Stage II)				
Reheating furnace	1 unit	Type: Pusher type Capacity: 30 t/hr Fuel: Mix. gas, Crude oil (for emergency use)	—	Capacity: Improved to 45 t/hr
Rolling mill equipment				
Rougher	1 unit	Type: Reversing 3-high mill Motor: AC 2,000 kW x 1 unit	—	
Finishing mill	—		10 units	Type: Continuous 2-high mill Motor: DC 500 kW x 10 units
Steel shear	1 unit	Type: Motor-driven down cut Capacity: Max. 135 x 135 mm	—	
Frying shear	—		1 unit	Type: Motor-driven crank method
Cooling equipment (for billet mill)	1 unit	Cooling bed: Pusher type 6 m x 15 m x 1 unit Binding machine: Automatic wire binding machine x 1 unit	—	

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
Cooling finishing equipment (for medium-section mill)	——			Cooling bed: Skew roller method 12 m x 90 m x 1 unit Leveler: One-hand carry type, multi-roll leveler x 1 unit Shear: Motor-driven crank method x 1 unit Binding machine: Automatic wire binding machine x 4 units
Crane	8 units	Bloom receiving lifting magnet crane 5 t x 2 units Bloom delivery lifting magnet crane 5 t x 2 units Rolling yard crane 35 t/5 t x 1 unit Billet delivery lifting magnet crane 5 t x 1 unit and others	6 units	Medium section rolling-yard crane 7.5 t x 3 units and others
New billet mill (Stage II)				(New billet mill)
Reheating furnace	——		2 units	Type: Pusher type Capacity: 75 t/hr Fuel: Mixture gas Heavy oil (for emergency)
Rougher	——		1 unit	Type: Reversing 2-high mill Motor: DC 2,500 kW
Bloom shear	——		1 unit	Type: Motor driven down cut Capacity: Max. dimension 165Φ
Billet mill	——		6 units	Type: Continuous 2-high mill Vertical type x 3 sets Horizontal type x 3 sets Motor: DC 500 kW x 6 sets
Frying shear	——		1 unit	Type: Motor-driven crank type Capacity: Max. dimension 100Φ
Hot saw	——		1 unit	Type: Motor driven horizontal type
Binding machine	——		2 units	Type: Automatic wire binding type

Equipment and facility	Stage 1		Stage II	
	Quantity	Specifications	Quantity	Specifications
Crane	——		13 sets	Bloom receiving lifting magnet crane 10 t x 4 sets Product yard beam crane 7.5 t x 4 sets and others
12. Power generator B.F. blower equipment				
Boiler	2 units	Capacity: 185 t/hr	1 unit	Capacity: 255 t/hr
Steam turbine	2 units	Output: 40,000 kW	1 unit	Output: 60,000 kW
Generator	2 units	Output: 40,000 kW	1 unit	Output: 60,000 kW
Blower	2 units	Output: Max. 21,000 kW Normal blowing capacity: 4,050 Nm^3/min	1 unit 1 unit	Same as left Same as left
Extracted steam	2 sets	Steam volume: 30 t/hr	1 set	Same as left
13. Power receiving/ distribution facilities				
Power receiving facilities	2 units	Main transformer 50 MVA 138 kV/34.5 kV	1 unit	Main transformer 70 MVA 138 kV/34.5 kV
	29 sets	Circuit breaker equipment	11 sets	Same as left
Power distribution equipment	1 set	34.5 kV Cable length: Approx. 22,550 m 3.3 kV Cable length: Approx. 4,310 m	1 set	34.5 kV Cable length: Approx. 7,775 m
Telephone exchange equipment	1 set	Automatic exchange 500 lines	1 set	Automatic exchange 120 lines
14. Oxygen plant				
Air separation equipment	2 units	Capacity: 51,500 Nm^3/hr x 2 units	2 units	Same as left
Compressed oxygen gas delivery equipment	2 units	8,300 Nm^3/hr x 7 kg/cm^2 compressor	2 units	Same as left
	3 units	8,300 Nm^3/hr x 30.5 kg/cm^2 compressor	2 units	Same as left
Argon rectifier	1 set	Capacity: 60 Nm^3/hr	1 set	Same as left
Nitrogen gas compressor	2 units	6,700 Nm^3/hr x 9.5 kg/cm^2 compressor	1 unit	Same as left

Equipment and facility	Stage 1		Stage II	
	Quantity	Specifications	Quantity	Specifications
Liquid oxygen equipment	1 set	1,000 t liquid oxygen storage tank 3,320 Nm^3/hr liquid oxygen pump x 1 unit	1 set	Same as left
15. Fuel equipment				
B.F.G. equipment	1 unit	100,000 m^3 holder	—	
C.O.G. equipment	1 unit	40,000 m^3 holder	1 unit	30,000 m^3 holder
	4 units	6,500 Nm^3/hr blower	2 units	Same as left
Mixture gas equipment	3 units	35,000 Nm^3/hr blower	—	
L.D.G. equipment	1 unit	50,000 m^3 holder	—	
	2 units	20,000 Nm^3/hr blower	1 unit	Same as left
Heavy oil equipment	1 unit	6,000 t heavy oil tank	1 unit	Same as left
General use boiler	1 unit	Capacity: 7 t/hr	—	
16. Main piping equipment	1 unit	B.F.G. piping: 3,600 $mm\phi$ x 1,200 m C.O.G. piping: 200 ~ 1,700 $mm\phi$ x 3,900 m Mixture gas piping: 600 ~ 2,300 $mm\phi$ x 1,690 m L.D.G. piping: 1,000 ~ 2,300 $mm\phi$ x 1,650 m Blast furnace blower piping: 1,700 $mm\phi$ x 800 m	1 unit	
17. Water supply equipment				
Water receiving pond	1 pond	Volume: 90,000 m^3 Quantity of water received 53,000 m^3/d	—	Quantity of water received 93,000 m^3/d
Potable water and industrial water equipment	1 set	Amount of water treated Industrial water 2,200 m^3/hr Potable water 130 m^3/hr		Amount of water treated Industrial water 3,900 m^3/hr Potable water 210 m^3/hr
Seawater equipment	1 set	Amount of intake 22,000 m^3/hr		Amount of intake 39,000 m^3/hr
18. Water recirculation facilities				
Coke/by-product water recirculation	1 system	Amount of feed water Approx. 610 m^3/hr	1 set	Total amount of feed water Approx. 1,130 m^3/hr

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
Blast furnace water recirculation	1 system	Amount of feed water Approx. 9,400 m^3/hr	1 system	Total amount of feed water Approx. 18,200 m^3/hr
B.O.F. water recirculation	1 system	Amount of feed water Approx. 5,139 m^3/hr	1 set	Amount of feed water Approx. 7,718 m^3/hr
Continuous casting water recirculation	1 system	Amount of water conveyed Approx. 7,270 m^3/hr	1 system	Total amount of feed water Approx. 14,600 m^3/hr
Lime calcining water recirculation	1 system	Amount of feed water Approx. 490 m^3/hr	1 system	Amount of feed water Approx. 980 m^3/hr
Billet mill water ecirculation	1 system	Amount of water conveyed Approx. 980 m^3/hr	1 system	Amount of water conveyed Approx. 4,500 m^3/hr
Hot strip mill water recirculation	1 system	Amount of water conveyed Approx. 17,500 m^3/hr	1 system	Amount of water conveyed Approx. 23,900 m^3/hr
Oxygen plant water recirculation	1 system	Amount of feed water Approx. 830 m^3/hr	1 system	Same as left
19. Transportation facilities				
Railroad transportation	1 set	320 t torpedo car x 12 20 t slag pot car x 6 250 t teeming car 60 t diesel locomotive x 4 25 t diesel locomotive x 2 Railroad length x 10,000 m	1 set	Same as left 60 t diesel locomotive x 1 25 t diesel locomotive x 1 Railroad length x 1,000 m
Road transportation equipment	1 set	Flat body truck x 3, Dump truck x 26 and otehrs Road: Length approx. 17,810 m (Paved area: approx. 33,150 m^2)	1 set	Flat body truck x 2, Dump truck x 16 and others
20. Maintenance facilities				
Central office	1 set	Building area 3,000 m^2	——	
Mechanical repair shop	1 set	Building area 3,600 m^2	——	
Machine shop	1 set	Building area 3,600 m^2	——	
Structural shop	1 set	Building area 3,600 m^2	——	
Forging shop	1 set	Building area 1,000 m^2	——	

Equipment and facility	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
Electric and instrumentation repair shop	1 set	Building area 4,500 m^2	——	
Civil/construction/ waterworks repair shop	1 set	(Building: on the mechanical repair shop site)	——	
Rolling stock repair shop	1 set	Building area 5,400 m^2	——	Building (1,000 m^2) shall be added
Car repair shop	1 set	Building area 2,250 m^2	——	
Local maintenance shop	8 shops	Building area 1,000 m^2/a shop	1 shop	Building area 1,000 m^2
Warehouse	4 sets	Spare parts warehouse 6,000 m^2 Oil and grease warehouse 500 m^2 Refractories warehouse 7,500 m^2 General material warehouse 2,000 m^2		Spare parts warehouse (2,000 m^2) shall be added Oil and grease warehouse 300 m^2 Refractories warehouse 3,000 m^2 and general material warehouse shall be added
21. Testing and analysis facilities				
Raw material testing and analysis equipment	1 set	Building area 1,204 m^2 Sample preparation device x 1 set Testing analysis device x 1 set	——	Building (200 m^2) shall be added
Analysis equipment	1 set	Building area 200 m^2 Sample preparation device x 1 set Analyzer x 1 set	1 set	Sample preparation device shall be added x 1 set
Machine testing shop	1 set	Building area 1,076 m^2 Sample preparation device x 1 set Testing device x 1 set	1 set	Building (360 m^2) shall be added Same as left Same as left
22. Office	1 set	Main office 10,000 m^2 Plant security office and gate x 3, fence 4,000 m	——	Main office shall be added

6-4 Summary of consumption and generation

Table 6-4-1 shows the unit and annual consumption of raw materials, utilities and by-products in the main plants at the stage I.

Table 6-4-1 Summary of consumption and generation

Equipment	Production amount 10^3 t/y	Raw materials			Utility			Sub-products		
		Name	Unit	Annual consumption	Name	Unit	Annual consumption	Name	Original material	Annual generation
Raw material handling					Electric power	——	9.8×10^6 KWH			
					Industrial water	——	288×10^3 m^3			
Coke / by-products plant	Coke 877	Coal	1.35 t/t - coke	$1,289 \times 10^3$ t	C. O. G.	19 Nm^3/t - coke	16.6×10^6 Nm^3	C. O. G.	320 Nm^3/t - coal	380×10^6 Nm^3
					Mixture gas	852 Nm^3/t - coke	747×10^6 Nm^3	Coke breeze	11.1 %/t - coal	131×10^3 t
					Steam	93.4 kg/t - coke	81.9×10^3 t	Tar	3.5 %/t - coal	42×10^3 t
					Nitrogen	~ Nm^3/t - coke	~ $\times 10^3$ Nm^3	Light oil	1 %/t - coal	11×10^3 t
					Electric power	47.9 KWH/t - coke	42×10^6 KWH	Steam	44.9 kg/t - coke	39.4×10^3 t
					Sea water	19.3 m^3/t - coke	16.9×10^6 m^3			
					Industrial water	1.02 m^3/t - coke	894×10^3 m^3			
					Potable water	0.07 m^3/t - coke	58.4×10^3 m^3			
Blast furnace plant	Pig iron 1,434	Sinter ore	953 kg/t - pig	$1,367 \times 10^3$ t	Blowing air	1,360 Nm^3/t - pig	$1,951 \times 10^6$ Nm^3	B. F. G.	1,980 Nm^3/t - pig	$2,839 \times 10^6$ Nm^3
		Pellets	342 kg/t - pig	490×10^3 t	Heavy oil	40 kg/t - pig	57.4×10^3 t	Slag	300 kg/t - pig	430×10^3 t
		Fine ore	325 kg/t - pig	466×10^3 t	B. F. G.	660 Nm^3/t - pig	946.6×10^6 Nm^3	Skull	3 kg/t - pig	4.3×10^3 t
		Manganese	9 kg/t - pig	13×10^3 t	C. O. G.	2 Nm^3/t - pig	2.9×10^6 Nm^3	Dust	20 kg/t - pig	28.7×10^3 t
		Lime stone	40 kg/t - pig	57×10^3 t	Steam	15 kg/t - pig	21.5×10^3 t			
		Coke	520 kg/t - pig	746×10^3 t	Electric power	20 KWH/t - pig	28.7×10^6 KWH			
					Industrial water	4.1 m^3/t - pig	59×10^6 m^3			
					Potable water	15 ℓ/t - pig	21.5×10^3 m^3			
					Oxygen	3 Nm^3/t - pig	4.3×10^6 Nm^3			
					Nitrogen	23 Nm^3/t - pig	33×10^6 Nm^3			
Lime calcining plant	Quick lime stone 94	Lime stone	2.33 t/t	219.6×10^3 t	C. O. G.	322.2 Nm^3/t	30.3×10^6 Nm^3	Fine lime stone	233 kg/t	21.9×10^3 t
					Electric power	55 KWH/t	5.2×10^6 KWH	Fine quick lime	25 kg/t	2.51×10^3 t
					Potable water	20.2 ℓ/t	1.9×10^3 m^3	Sludge	40 kg/t	4.5×10^3 t
					Industrial water	3.5 m^3/t	331×10^3 m^3			
B.O.F. plant	Molten steel 1,569	Hot metal	892.5 kg/t	1.4×10^6 t	C. O. G	2 Nm^3/t	3.1×10^6 Nm^3	B. O. F. slag	120 kg/t	188.3×10^3 t
		Mold pig iron	21.5 kg/t	33.7×10^3 t	Oxygen	55 Nm^3/t	86.3×10^6 Nm^3	Ingot slag	20 kg/t	31.4×10^3 t
		Ore	20 kg/t	31.4×10^3 t	Nitrogen	9 Nm^3/t	14.1×10^6 Nm^3	Torpedo car slag	12 kg/t	8.4×10^3 t
		Quick lime	60 kg/t	94.1×10^3 t	Electric power	30 KWH/t	47×10^6 KWH			
		Lime stone	5 kg/t	7.8×10^3 t	Industrial water	0.25 m^3	390×10^3 m^3	Scrap	20 kg/t	31.4×10^3 t
		Scrap	161.3 kg/t	253.1×10^3 t	Potable water	0.05 m^3/t	80×10^3 m^3	L. D. G.	70 Nm^3/t	109.8×10^6 Nm^3
		Fluorite	3 kg/t	4.7×10^3 t						
		Alloy steel	6.8 kg/t	10.7×10^3 t						

Equipment	Production amount 10^3 t/y	Raw materials			Utility			Sub-products		
		Name	Unit	Annual consumption	Name	Unit	Annual consumption	Name	Original material	Annual generation
Continuous slab caster	Slab 1,200	Molten steel		1.25 x 10^6 t	C. O. G.	6 Nm^3/t	7.2 x 10^6 Nm^3	Scrap	41 kg/t	49.2 x 10^3 t
					Oxygen	15 Nm^3/t	18 x 10^6 Nm^3	Scale	16.5 kg/t	19.8 x 10^3 t
					Argon	0.25 Nm^3/t	300 x 10^3 Nm^3			
					L. P. G.	1.33 kg/t	1,596 t			
					Electric power	29 KWH/t	34.8 x 10^6 t KWH			
					Industrial water	1.7 m^3/t	2.1 x 10^6 m^3			
					Potable water	44 ℓ/t	52.6 x 10^3 m^3			
Continuous bloom caster	Bloom 300	Molten steel		319 x 10^3 t	C. O. G.	6 Nm^3/t	1.8 x 10^6 Nm^3	Scrap	53 kg/t	15.9 x 10^3 t
					Oxygen	2.5 Nm^3/t	0.75 x 10^6 Nm^3	Scale	7 kg/t	2.1 x 10^3 t
					Argon	0.25 Nm^3/t	75 x 10^3 Nm^3			
					L. P. G.	0.475 kg/t	142 t			
					Electric power	29 KWH/t	8.7 x 10^6 KWH			
					Industrial water	1.8 m^3/t	0.55 x 10^6 m^3			
					Potable water	53 ℓ/t	15.8 x 10^3 m^3			
Billet mill plant	Billet 150	Bloom			Mixture gas	200 Nm^3/t	30 x 10^6 Nm^3	Scrap	20 kg/t - bloom	3 x 10^3 t
					Electric power	75 KWH/t	11.3 x 10^6 KWH	Scale	20 kg/t - bloom	3 x 10^3 t
					Potable water	0.75 m^3/t	114 x 10^3 m^3			
					Industrial water	2 m^3/t	300 x 10^3 m^3			
					L. P. G.	0.04 Nm^3/t	6 x 10^3 Nm^3			
					Oxygen	1.7 Nm^3/t	255 x 10^3 Nm^3			
Hot strip mill plant	Hot coil 1,052	Slab		1,079 x 10^6 t	Mixture gas	200 Nm^3/t	210 x 10^6 Nm^3	Scrap		15 x 10^3 t
					Electric power	110 KWH/t	116 x 10^6 KWH	Scale		12 x 10^3 t
					Industrial water	4 m^3/t	4.2 x 10^6 m^3			
					Steam	12 kg/t	12.6 x 10^3 t			
					Potable water	0.2 m^3/t	210 x 10^3 m^3			
Power plant and B. F. blower plant					Heavy oil	—	3,370 t			
					L. D. G.	—	109.8 x 10^6 Nm^3			
					B. F. G.	—	972.7 x 10^6 Nm^3			
					C. O. G.	—	173.6 x 10^6 Nm^3			
					Electric power	—	42.75 x 10^6 KWH			
					Sea water	—	149.8 x 10^6 m^3			
					Pure water	—	250x 10^3 m^3			
Oxygen plant					Steam	—	9.0 x 10^3 t			
					Electric power	—	98.65 x 10^6 KWH			
					Sea water	—	15.23 x 10^6 m^3			
					Industrial water	—	0.5 x 10^6 m^3			
Product/raw material facilities					Electric power	0.5 KWH/t	0.72 x 10^6 KWH			
Water supply equipment					Electric power	—	For sea water 21.95 x 10^6 KWH			
						—	For water 4.04 x 10^6 KWH			