Chapter V Plan for Construction of New Cold Rolling Mill Complex

1. Designing of Process

The following three preconditions are adopted in designing the process of the new cold rolling mill complex.

1) Proven technologies which are widely used in the existing steel industries and having no elements of development are to be adopted for all the equipment.
2) The initial investment cost is to be minimized in principle.
3) The future expansion plan up to 500,000 tons/year is to be taken into consideration with regard to the land space and the plant layout at the time of designing the new cold rolling mill complex. However, any civil and building work and equipment for the expansion is not included in this FS.

1.1 Production Process for Each Grade

The production process for each grade which is to be produced at the new cold rolling mill complex is shown below.

1) GH : PL → RCM → ECL → RCL → Packing
2) GS : PL → RCM → ECL → BAF → SPM → RCL → Packing
3) CH : PL → RCM → ECL → BAF → SPM → RCL → Packing

1.2 Specifications of Hot Coil

In this FS the following specifications of hot coils are used ;

1) Maximum coil weight: 25 ton
2) Weight per unit width : 20 kg/mm-width
3) Thickness: 1.6 ~ 3.6 mm

The preconditions of the thickness of hot coils corresponding to that of cold rolled products, together with the resultant number of passes required at the cold rolling mill, are shown in Table V-1-1.

Table V-1-1 Relation between Hot Coil Thickness and Cold Coil Thickness (width is 1,000mm)

Hot coil thickness (mm)	Cold coil thickness (mm)	Number of passes at cold rolling mill
1.6	0.16	5
1.8	0.22	5
2.0	0.45	4
2.5	1.12	3
3.6	1.8	3

4) Width: 650 ~ 1,300 mm
From the market survey the width of the products are found to be 650 to 1,250 mm. The maximum width of 1,300 mm is to be used considering the possibility of trimming.

1.3 Specifications of Cold Rolled Products

Specifications of cold rolled products are assumed as follows based on the market survey of GIS and CRS.

(1) Weight of product coils
GI substrates, which are expected to account for 90% of products in the new cold rolling mill complex, are purchased in the form of coils by GI manufacturers in Viet Nam. CH products are purchased in the form of both coils and sheets. Considering the proportion of GIS production in the new cold rolling mill complex, most of the products are to be delivered to the customer in the form of coils. Accordingly, all the products are presupposed to be delivered in the form of coils.(Max.weight: 12 tons)
For sheets the required cutting work is to be done at the existing coil centers, so that no cutting facility is considered in the new cold rolling mill complex. Dividing of coil for final products are to be made at RCL.

The coil weight and the proportion of the production amount for each coil weight is shown in Table V-1-2.

Table V-1-2 Coil Weight Conditions of Products

Products	Dividing at RCL	Coil weight of Products	Proportion
GIS	2	7 ~11 ton	50 % of total amount of GIS products
	4	3 ~ 6 ton	50 % of total amount of GIS products
CRS	2	7 ~12 ton	50 % of total amount of CRS products
	4	3 ~ 6 ton	50 % of total amount of CRS products

(2) Thickness
Based on the result of market survey the following thickness range is adopted.
GIS : 0.15 ~ 0.8 mm
CRS : 0.35 ~ 1.8 mm

(3) Width
Based on the result of market survey the following width range is adopted.
GIS : 650 ~ 1,250 mm
CRS : 650 ~ 1,250 mm

(4) Required quality at international standard

The required quality of the cold rolled products is to be specified item by item in the contract with the customers. One example of required quality standard specified in JIS(G3141) is shown in Table V-1-3 for reference.

Table V-1-3 Example of Required Quality at International Standard

(CRS(Commercial Quality Grade) Thickness : 0.6 mm, Width 1,000 mm)

Quality Item		Required Quality
Thickness deviation		Target thickness ±0.06 mm
Width deviation		Target width +0 mm ~ 7 mm
Shape	Warp, Wave	Maximum 12 mm
	Local edge wave	Maximum 8 mm
	Local center buckle (wave)	Maximum 6 mm

1.4 Working Hours of Each Equipment

Working hours of each equipment is shown in tableV-1-4. 24 hour continuos operation with meal back-up persons is presumed for every equipment. The figures in the table are obtained based on the real operational indices in the existing cold rolling mills in Japan.

Table V-1-4 Working Hours of Each Equipment

		PL	RCM	ECL	BAF	SPM	RCL
Yearly hours	(hours/year)	8760	8760	8760	8760	8760	8760
Time for maintenance	(hours/year)	576	480	480	360	*1	360
Yearly maintenance	(days/year)	10	10	10	5	*1	5
Monthly maintenance	(hours/year)	28	20	20	20	*1	20
Available time for working	(hours/year)	8184	6711 *2	8280	8400	897	8400
Availability	(%)	85	92	94	99	95	92
Actual working time	(hours/year)	6956	6174	7783	8316	852	7728

*1 : included in RCM

*2 : The time of 672 hours required for device exchange from RCM to SPM and vice versa is taken into consideration in addition to time for maintenance

1.5 Yield of Each Equipment

At each equipment an yield loss occurs by cutting the defective parts, sampling for inspection and trimming. Furthermore, at PL additional yield loss is expected due to the reaction between iron and hydrochloric acid. Yield loss at each equipment is shown in TableV-1-5. The figures in the table are obtained based on the real operational indices in the existing cold rolling mills in Japan.

Table V-1-5 Yield of Each Equipment

	PL	RCM	ECL	BAF	SPM	RCL
Yield (%)	98.0	99.9	98.5	100.0	99.0	98.0

2. Required Performance and Specifications of Equipment

2.1 Pickling Line (PL)

(1) Required performance

PL is to be furnished with all of the following functions ;

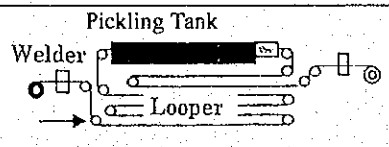
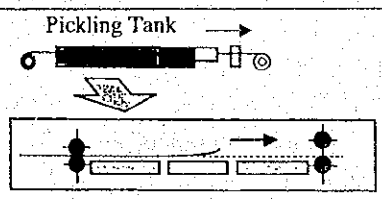
1) Descaling of hot coils
2) Trimming of coils
3) Oiling (Rust preventive oil)
4) Inspection and removing defective parts of coils
5) Cutting into specified unit weight for P/O coils
(However, processing amount of P/O at Pickling line is not considered in this FS as a result of the market survey.)

(2) Selection of process

1) PL equipment is classified into two groups, conventional type and push-pull type. The comparison between the conventional type and the push pull type is shown in Table V-2-1. In the conventional type of PL the head of the coil is welded to the tail end of the coil ahead, and thus the pickling work is made continuously. On the other hand, in PPPL the coils are proceeded to the pickling tank one by on, and thus the pickling work is made intermittently.

The push pull type pickling line (PPPL) is recommended in this FS. The criteria of the process selection are a) the number of PL constructed in the past for the production capacity planned in this FS, and b) the required initial investment cost for the equipment. For the production capacity of 220,000 tons/year PPPL type was adopted predominantly. In addition, the required initial investment cost for conventional type is expected to be three times as much as PPPL type.

Table V-2-1 Comparison between Conventional Type and Push Pull Type Pickling Line

	Conventional type	Push Pull type
Schematic image	 Welder and loopers at entry and exit required	
Threading method	Continuous	Batch
Max. Line speed (mpm)	400 (Center)	200
Rough estimation of production capacity (kton/year)	300 ~2,000	200 ~600
Rough estimation of equipment cost*1 (M US$)	30 ~50	10 ~15

*1: Production capacity: approx. 250,000 tons/year

2) With regard to the acid to be used, hydrochloric acid (HCl) is recommended. In the past

sulfuric acid (H_2SO_4) was used occasionally, however, HCl is better with regard to a) surface quality after pickling and b) pickling efficiency. In the recent years HCl is used predominantly for pickling of low carbon steel. The temperature of HCl during pickling is to be raised up to 90℃ to allow the better pickling efficiency.

3) Side trimmer is to be equipped.
4) Oiler is to be equipped.
5) Enough inspection space is to be secured for quality inspection of products.
6) Acid regeneration plant (ARP) is to be equipped for treatment of strong waste acid. The necessity of ARP was confirmed by the result of the site survey that there is not enough capacity in Viet Nam to treat the strong waste acid.

2.2 Cold Rolling Mill (CM)

(1) Required Performance

CM is to be furnished with all of the following functions ;

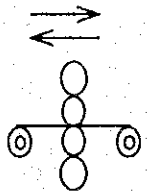
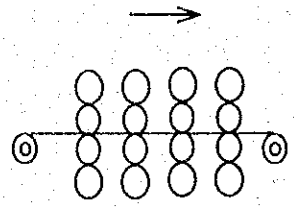
1) Production capacity
2) Control of thickness
3) Control of shape (affecting the threadability of the succeeding processes and the shape of final products)
4) Control of surface quality (affecting that of final products)

(2) Selection of Process

Cold rolling mill is classified into two groups, a reversing type and tandem type. The comparison between the reversing type and the tandem type is shown in Table V-2-2. For the reversing type, one or two stands with rolls are located in the center of the equipment and thickness of the strip is reduced by the strip being rolled forward and backward with the required number of passes. The reversing type has a relatively small production capacity. The reversing type cold rolling mill can be made a combination type rolling mill, namely it can be used as a skin-pass mill (SPM). On the other hand, for the tandem type, three to six stands with rolls are located and the rolling is made only in one direction. The tandem type has a larger production capacity.

The reversing type cold rolling mill (RCM) is recommended in this FS. The criteria of the process selection are a) the number of CM constructed in the past for the production capacity planned in this FS, and b) the required initial investment cost for the equipment. For the production capacity planned RCM has been adopted predominantly. In addition, the required initial investment cost for the tandem type is expected to be three times as much as RCM.

Table V-2-2 Comparison between Reversing Cold Rolling Mill and Tandem Cold Rolling Mill

	Reversing Cold Rolling Mill	Tandem Cold Rolling Mill
Schematic image		
Number of stands	1 ~ 2	3 ~ 6
Rough estimation of production capacity (kton/year)	100 ~ 300	500 ~ 2,000
Rough estimation of equipment cost*1 (M IUS$)	15 ~ 25	45 ~ 75

*1: Production capacity: approx. 250,000 tons/year

(3) Mill type of cold rolling mill

There are a few equipment types of cold rolling mills in operation in the world. There are three possible mill types for the cold rolling mill planned in this FS. These mill types together with their characteristics are shown in Table V-2-3. The criteria of the selection are the items listed in Table V-2-3 1) to 7).
Firstly, Senzimir type is turned down for the following reasons ;

a) An independent skin pass mill is required, resulting in an increase of the initial investment cost.
b) Senzimir type is not widely used for the low carbon steel production in the world.

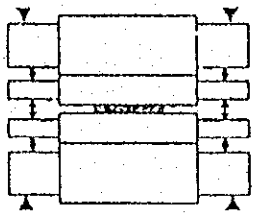
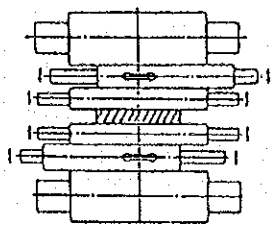
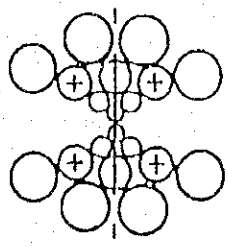
4-Hi type cold rolling mill requires less initial investment cost compared to 6-Hi type, however, considering the following disadvantages of 4-Hi type, 4-Hi type cold rolling mill is not profitable.

a) 4-Hi type mill has less capability of shape control compared to 6-Hi type mill which has the intermediate rolls, resulting in both less stability of operation and higher yield loss.
b) 4-Hi type mill has to have several different roll curves of work rolls for crown and shape control, resulting in an increase of work load at the roll shop and also an increase of cost for work rolls possessed.

Considering the above-mentioned points, 6-Hi type cold rolling mill is recommended in this FS.

Table V-2-3 Comparison of Mill Type

・Precondition: Products are CRS and GIS (maximum width 1,250 mm).

	4-Hi	6-Hi	Senzimir
Schematic image			
	WR,BUR Total 4 rolls / stand Medium WR Simple constitution	WR,IMR,BUR Total 6 rolls / stand Medium WR Simple constitution	WR,IMR,BUR Total 20 rolls / stand Smaller WR Complex constitution
1)Thickness accuracy *1	◎	◎	◎
2)Flatness controllability	○	◎	◎
3)Product quality	◎	◎	◎
4)Productivity (Work efficiency)	◎	◎	△ (High frequency of roll changing)
5)Possibility of skinpass rolling	◎	◎	× (Smaller WR)
6)Roll shop	○	◎	△ (High frequency of roll changing)
7)Major products	Low carbon steel	Low carbon steel	Special steel (Stainless steel, Electrical steel etc.)

◎: Excellent ○: Good △: Fair ×: Poor

*1:with Hydraulic screw-down cylinder, AC motor and AGC system

2.3 Electrolytic Cleaning Line (ECL)

(1) Required performance

ECL is to be furnished with all of the following functions ;

1) Removing oil adhering to the surface
(From the market study, it is revealed that ECL is necessary for processing GI substrate (Full hard)).
2) Tight winding of coils (to avoid the quality problems at BAF)
3) Removing defective parts of coils (including the removal of off-gauge parts at cold rolling mill)

(2) Selection of process

At the present moment the cleaning method which is widely used in the steel industry in the world to remove the lubricant adhered to the strip surface is the combination of the following three degreasing methods. Accordingly, the same cleaning method is recommended in this FS.

1) Chemical degreasing with alkaline
   With regard to the alkaline to be used, Ortho Sodium Silicate is recommended.
2) Mechanical degreasing with high rotating brush
3) Electrochemical degreasing with electrode
   Horizontal bath type is recommended.

2.4 Annealing Furnace

(1) Required performance:

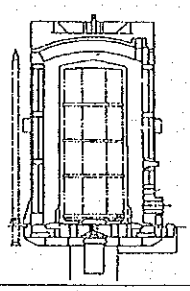
Annealing furnace is to be furnished with all of the following functions ;

1) Control of mechanical property (Recrystallization of grains)
2) Removing oil adhering to the surface

(2) Selection of process

1) Annealing furnaces are classified into two groups, box annealing furnace (BAF) and continuous annealing line (CAL). The comparison between BAF and CAL is shown in Table V-2-4.At BAF the coils are annealed in the form of coils as they are, on the other hand at CAL the coils are annealed continuously after being rewound.
   Box annealing furnace (BAF) is recommended in this FS. The criteria of the process selection are a) the number of annealing equipment constructed in the past for the production capacity planned in this FS, and b) the required initial investment cost for the equipment. For the production capacity of around 90,000 tons/year BAF type is adopted predominantly. In addition, the required initial investment cost for CAL type is expected to be three times as much as BAF type.

Table V-2-4 Comparison between BAF and CAL

	Box annealing furnace (BAF)	Continuous annealing line (CAL)
Schematic image		
Production capacity (for CRS annealing, 1,000 tons/year)	20 (for 1 unit) ～	400 ～ 1,000
Rough estimation of equipment cost*1 (M US$)	2.5 ～ 5	20 ～ 30

*1 : Production capacity: approx. 90,000 tons/year

2) BAF is classified into two groups by the atmosphere gas to be used, H2 type and the conventional type. The comparison between H_2 type BAF and the conventional type BAF is shown in Table V-2-5.

H_2 type is recommended in this FS. The criteria of the process selection are a) quality of products, b) production efficiency, c) the number of annealing equipment constructed in the past and d) the required initial investment cost for the equipment. For quality of products, H2 gas has higher reducibility than HN gas and inhibits the occurrence of temper color caused by the oxide film. In addition, H2 gas has higher heat transfer, resulting in more uniform mechanical property. For production efficiency, H2 gas, as is mentioned, has higher heat transfer, meaning higher production efficiency. As to the number of annealing furnace in operation, the H2 gas type has been getting more common in these days although the conventional type used to be common in the past. For the initial investment cost, there is no significant difference between these two types .

Table V-2-5 Comparison between H_2 Type BAF and Conventional Type BAF

		H_2 type	Conventional type
Atmospheres (vol. %)		H_2: 100%	H_2: 5%,N_2: 95%
Product quality	Tempering color	◎	○
	Property variations	◎	○
	Surface cleanliness	◎	○
Productivity		◎	○
Initial Investment cost		about same for the same production quantity	

◎: Excellent ○: Good

3) Coil Cooling Unit (CCU) is to be equipped for the prevention of rust after annealing at BAF. This equipment prevents annealed coils from rust by charging dry and cool air to the coils.

2.5 Skinpass Mill (SPM)

(1) Required performance:
SPM is to be furnished with all of the following functions ;

1) Light hardening and adding toughness to the steel
2) Elimination of yield point elongation
3) Impartation of required surface texture
4) Improvement of flatness

(2) Selection of process
As was mentioned in Cold Rolling Mill (CM) of Section 2.2 (2), one stand mill of combination type is recommended in this FS. This mill can be used both as a cold rolling mill and as a skinpass mill. The criteria of the process selection area) the number of CM constructed in the past for the production capacity planned in this FS, and b) the required initial investment cost for the equipment. Refer to Section 2.2 for detail.

2.6 Recoiling Line (RCL)

(1) Required performance
RCL is to be furnished with all of the following functions ;

1) Inspection of width, gauge and surface defects, and removing defective parts
2) Cutting coils into a specified unit weight
3) Improvement of flatness
4) Trimming of coils
5) Oiling (rust preventative coating)

(2) Selection of the process

1) A welder is to be equipped for threading of thin gauge sheet such as GI substrate.
2) Tension leveler is to be equipped for the improvement of flatness of thin gauge sheet (especially GI substrate (Full hard)).
3) Side trimmer is to be equipped.
4) Oiler is to be equipped.
5) Enough inspection space is to be secured for quality inspection of products, and thickness gauge meter is to be equipped.
6) Coil sleeve loader is to be equipped for the attachment of sleeves to products.
7) Test laboratory is to be equipped for sample testing of products.

2.7 Ancillaries

2.7.1 Water Treatment Facilities

The quantity of raw water is 90m^3/hr. It is supplied to demineralized water supply system, each equipment in the mill complex and cooling tower, and some of the raw water is used as potable water. The waste water is generated at weak acid waste water treatment system and at weak alkali waste water treatment system, and is drained through pipe to outside the mill complex. In addition, the sludge is also generated at the said water treatment systems, and taken away from the mill complex by trucks.

Basic ideas of planning facilities are as follows;

1) Industrial water supply system;
The quality of raw water is satisfactory. As the value of SS is equivalent to that of filtered water, namely less than 1 mg/litter, there is no need to have the treatment of SS such as sedimentation and filtering.
However, the residual chlorine is equivalent to that of drinking water, namely 0.8 mg/litter, which may possibly cause the corrosion of pipe and equipment. Accordingly, elimination of chlorine is taken into consideration by activated carbon absorption.

2) Machinery for cooling water system;
The water is circulated between the equipment and the cooling tower through water pump. The water temperature is to be maintained between 35℃ and 45℃. As the quantity of water is decreased by evaporation from the cooling tower, the industrial water is to be added.

3) Demineralized water supply system;
Demineralized water supply system with two beds and three towers is to be installed. The process of producing demineralized water is shown below. Resin-regenerated waste water is to be treated at the weak acid waste water treatment system.

4) Weak acid waste water treatment system;
As the waste water is mainly composed of $FeCl_2$, the water treatment of neutralization, oxidation, coagulation and sedimentation is to be installed. Dehydrated sludge is to be taken away from the mill complex by trucks.

5) Weak alkali waste water and oily waste water treatment system;
As this waste includes the impurity of small oil particles in the waste, the treatment of double pressure floatation process is to be installed. Dehydrated scum is taken away from the mill complex by trucks.

6) Others;
   a) Fire hydrant is to be installed.
   b) Sewage is to be installed.
   c) Potable water and sanitary sewage is to be installed.

2.7.2 Electric Power Receiving and Distribution Equipment

Specification of electric power receiving and distribution equipment plan for the cold rolling mill complex is shown below.

(1) Electric power receiving capacity

Electric power receiving capacity and receiving voltage is decided by demand prediction.
This demand prediction (kVA) is obtained from the total active power (kW) and reactive power (kVar) of the load in each equipment, considering available factor and power factor. This gives the total prediction value of 14.4 MVA.

(2) Voltage fluctuation measures

Voltage fluctuation at take over point must be maintained at less than 3.8%. This is the critical value to keep the lighting equipment normal (not to cause flicker), during the operation including the cold rolling mill acceleration timing. Accordingly, power condenser of 2,000kVA must be installed in the main motor line (22 kV).
After installing the power condenser, the demand prediction becomes 13.7 MVA.
Considering 10% upper allowance, the power receiving transformer capacity of 15 MVA is adopted in this FS.

(3) Electric power receiving voltage

For electric power receiving voltage in the cold rolling mill complex, there are two possibilities, namely 110 kV or 22 kV. Both cases of 110 kV or 22 kV are studied here based on maintaining the voltage fluctuation value less than 3.8% based on demand prediction.
Based on the calculations for the above Case 1 and 2 , electric power receiving voltage of 110 kV is adopted in this FS. In addition, 110 kV power receiving has advantage compared to 22 kV with regard to power failure and electric power charge.

(4) Number of electric power receiving line

Number of electric power receiving line is one due to the following reasons ;

1) Frequency of power failure is quite limited (3～4 times/year)
2) Continuous time of power failure is short (less than one hour).
3) Initial investment cost is to be minimized.

(5) Operating and monitoring of electric power receiving and distribution equipment

The operating and monitoring panel is installed in the electric power receiving and distribution station and at every operating room of each process equipment.

(6) Diesel generator for emergency

Diesel generator for emergency of about 300 kVA is to be installed to protect equipment.

(7) Electric power for construction

Electric power of about 2 MVA is required for construction of cold rolling mill complex. Electric power receiving voltage is 22 kV.

2.7.3 Roll Shop

At the roll shop grinding of the rolls used in the cold rolling mill and in the skinpass mill, namely work rolls (WR), intermediate rolls (IMR) and back-up rolls (BUR), dull finishing (flecked texture) of the rolls, inspection, disassembly and assembly of the roll chock are executed.

2.7.4 Crane

Cranes are to be equipped in the mill complex for the following purposes ;

1) Transferring the coils in the mill complex
2) Conveying the equipment and materials at the time of installation and maintenance.

For the planned cold rolling mill complex 16 cranes are to be equipped.

2.7.5 Coil Conveyor

A coil conveyor is used for transferring the coils between buildings. This conveyor is equipped with the motor in itself and supplied with electricity from outside and moves on the track. For the planned cold rolling mill complex seven conveyors in total are to be installed.

2.7.6 Equipment of Maintenance Shop

At the maintenance shop relatively small scale maintenance in the mill complex listed below is carried out.

1) Disassembly and conditioning of chocks and bearings of table rolls, bridle rolls and so on.
2) Disassembly and conditioning of hydraulic and air cylinders
3) Repair of piping

2.7.7 Equipment of Test Laboratory

The following functions are to be secured in the test laboratory.

1) Test to certify the specified quality of the products of CRS and GIS produced in the cold rolling mill complex. The tests required are tensile strength, hardness and roughness.
2) Analysis for the operation of cold rolling mill complex. The analysis required is the concentration analysis of acid, alkaline and oil.

2.7.8 Acid Regeneration Plant (ARP)

The waste acid from the pickling line is regenerated at Acid Regeneration Plant (ARP). According to the findings obtained from the site surveys of JICA Team, at the moment there is not enough capacity of strong waste acid treatment in Viet Nam. Accordingly, ARP is requested to be newly installed in this FS.

The waste acid is put into the roaster heated-up at high temperature, and the water content is taken away by evaporation. Then ferric chloride is reacted with oxygen, and the acid is dissolved thermally into ferric oxide and hydrochloric acid.

Fe_2O_3 is taken away from the roaster gas of high temperature at the cyclone. Then the gas is cooled down and HCL in the gas is absorbed in the absorption tower, giving the regenerated HCl with

18 % concentration.

2.7.9 Hydrogen Gas Generator

The hydrogen gas is used as the atmosphere gas of BAF. The site surveys of JICA Team have revealed that there is no possibility of having the enough supply of hydrogen gas from outside, which necessitates the installation of hydrogen gas generator in the mill complex. In this generator the demineralized water is electrolyzed, giving the hydrogen gas.

2.7.10 Storage Tanks for Nitrogen Gas, LPG and Heavy Oil

(1) Storage tank for nitrogen gas

The nitrogen gas is used as the purging gas at BAF. The site surveys of JICA Team have revealed the existence of enough possibility of obtaining the nitrogen gas from outside. Accordingly, a storage tank is to be installed and the gas is procured from outside and transported by tank lorries. The necessary piping is to be made from the storage tank to BAF.

(2) Storage tank for LPG

LPG is used as the fuel for BAF and ARP. A storage tank is to be installed and LPG is procured from outside and transported by tank lorries. The necessary piping is to be made from the storage tank to BAF and ARP.

(3) Storage tank for heavy oil

The heavy oil is used as the fuel for boiler for evaporating. A storage tank is to be installed and heavy oil is procured from outside and transported by tank lorries. The necessary piping to be is made from the storage tank to the boiler.

2.7.11 Air Compressor

Compressed air is used as one source of possible powers, and the air compressor needs to be installed.

2.7.12 Boiler

In the mill complex the steam is used for heating-up the equipment. The site surveys of JICA Team have revealed that there is no possibility of having the enough supply of steam from outside, which necessitates the installation of boiler within the mill complex. The necessary piping is to be made from the boiler to each equipment.

2.7.13 Devices for packing

Paper packing is to be done for the produced coils. This packing work is done manually, however the following devices are needed in the packing yard ;

1) Cutting machines of the packing materials in accordance with the coil sizes.
2) Devices for packing such as portable banding machine and so on

Packing materials such as paper, banding hoop and seal are to be procured from outside.

2.8 Consumption of Utility and Sub-Material of Each Equipment

The cold rolling mill requires various utilities and sub-materials for its operation. This is the case both for the main equipment and for the ancillaries. In this FS the utilities and sub-materials required for each ancillary is included in the main equipment which is most related to the specific ancillary. The consumption of utility and sub-material of each equipment is shown in Table V-2-6. The figures in the table are obtained based on the real operational indices in the existing cold rolling mill in Japan. The consumption of water is described in the section of water treatment.

Table V-2-6 Consumption of Utilities and Sub-Materials of Each Equipment

(per one ton product at the delivery of each equipment)

		PL	RCM	ECL	BAF	SPM	RCL
Electricity	(kwh/ton)	17	136	36	43	46	27
Vapor	(kg/ton)	30	15	40	0	15	0
LPG	(Nm3/ton)	1.3	0	0	4.5	0	0
N2 gas	(Nm3/ton)	0	0	0	2.4	0	0
H2 gas	(Nm3/ton)	0	0	0	2.4	0	0
Hydrochloric acid	(kg/ton)	4	0	0	0	0	0
Inhibitor	(kg/ton)	0.03	0	0	0	0	0
Roll	(kg/ton)	0	0.15	0	0	0.02	0
Orcho sodium silicate	(kg/ton)	0	0	0.7	0	0	0
Lubricant	(litter/ton)	0	0.7	0	0	0.2	0
Rust preventive oil	(litter/ton)	0.15	0	0	0	0	0.8

【Complement】

1) Ancillaries included in the main equipment are as follows ;

PL : Acid regeneration plant(ARP), Hot coil yard, Crane, Coil conveyor
RCM・SPM : Roll shop, Air compressor, Crane, Coil conveyor
ECL : Water treatment facilities, Boiler, Crane, Coil conveyor
BAF : H2 generator, Maintenance shop, Crane, Coil conveyor
RCL : Packing yard, Shipping yard, Test laboratory, Crane, Coil conveyor, Office

3. Specification of Electricity, Instrumentation and Process Computer

In defining equipment specification, the following three factors are very important;

(1) Proven technologies which are widely used at the existing steel industry are to be adopted.
(2) The initial investment cost is to be minimized.
(3) Equipment is to be automated with regard to the key functions such as unified quality and yield improvement. Accordingly, process computers which make the data setting to electrical equipment and instrumentation equipment are to be introduced at CRM and SPM.

3.1 Specification of Electrical Equipment

3.1.1 Power Supply Equipment

The single line diagrams for CRM and PL which describe the distribution voltage to each process equipment after power receiving at 110 kV are shown in Fig.V-3-1 and Fig.V-3-2 respectively. The voltage is transformed down to 22 KV by the transformer after power receiving at 110 kV. For CRM which has a large load capacity, power supply is made with 22 kV to minimize the power transmission loss. On the other hand, for other process equipment power supply is made with 6.6 kV. The power received at each equipment with the voltage of 6.6 kV is further transformed down to the application voltage specific to equipment such as control power, roll drive power, crane power and so on.

3.1.2 Motor Drive Device

There are two possible variable speed drive systems for mill, reel and roll which are to be driven with variable speed, namely the variable speed system of alternating current (AC) and that of direct current (DC). AC system is to be adopted in this FS as it is better in accuracy of speed control, speed response and maintainability.

Motor driving with constant speed for pump and blower is controlled by magnetic contactor.

3.1.3 Motor

Squirrel cage induction motor is to be adopted with maintainability and equipment cost taken into consideration. Voltage specification and protection system are described below.

(1) Voltage specification

Voltage specifications are as follows considering the power system and mechanical specifications.

- Motor for variable speed ----manufacturer standard
- Motor for constant speed----from the viewpoint of efficiency, low tension voltage with 380 V three phases for below 250 kW, and high tension voltage with 6.6 kV three phases for over 250 kW.

(2) Protection system

Protection system of motor is shown in Table V-3-1.

Table V-3-1 Protection System of Motor

Location	Protection system
Indoor	Totally enclosed indoor type
Outdoor	Totally enclosed outdoor type
Pickling tank	Totally enclosed Acid proof type
Alkali tank	Totally enclosed Alkali proof type
Oil cellar	Totally enclosed increased safety type

3.1.4 Master Control Device

Control by PLC(Programmable Logic Controller) and that by relay sequence are used depending on the required function after taking into consideration the timing of commissioning and function of each equipment. Classification of control method by the required function for electrical equipment is shown in Table V-3-2. Equipment is to be automated with regard to the key functions such as quality unification and yield improvement.

Table V-3-2 Classification by Control Function of Electrical Equipment

Control function	Control
Speed control of roll and tension control of strip	PLC or sequencer
Run and stop of pump and blower	Sequencer or relay logic
Emergency stop and lock switch	PLC or sequencer and relay logic(buck up)

3.1.5 Operating and Monitoring Device

Operating panel and monitoring panel are to be installed at each operating room to monitor the operation and conditions of equipment. In addition to the operating room, the operating panel is to be installed close to the equipment for efficient maintenance and commissioning.

3.2 Specification of Instrumentation Equipment

Control by DDC(Direct Digital Controller) and that by relay sequence are used depending on the required function after taking into consideration the timing of commissioning and function of each equipment. The classification of control method by the required function for instrumentation equipment is shown in Table V-3-3.

For equipment with a small number of control loops, one loop controller which can be purchased at low price is occasionally used. Equipment is to be automated with regard to the key functions such as quality unification and yield improvement.

Table V-3-3 Classification by Control Function of Instrumentation equipment

Control function	Control
Temperature and density control of liquid	DDC or one loop controller
Shut off valve circuit etc.	DDC or one loop controller and relay logic(buck up)

Specifications for gauge meters installed at CRM and RCL are described in Section V.3.2.2.

3.2.1 Operating And Monitoring Device

Operating panel and monitoring panel are to be installed at each operating room to monitor the operation and conditions of equipment. In addition to the operating room, the operating panel is to be installed close to the equipment for efficient maintenance and commissioning.

3.2.2 Specification of Gauge Meter

X-ray gauge meter and γ -ray gauge meter are to be adopted at CRM and RCL respectively with the required function and equipment cost taken into consideration. Comparison of the said two gauge meters is shown in Table V-3-4.

Table V-3-4 Comparison of Gauge Meter

Items	X-ray gauge meter	γ -ray gauge meter
Accuracy of setting	◎	◎
Response speed	◎	○
Equipment cost	High	Low
Application	On line control for AGC	For Monitoring
Application equipment	Cold rolling mill	Recoiling

◎:Excellent ○:Good

3.3 Specification of Process Computer

To improve the quality uniformity and yield, process computers which make the data setting to electrical equipment and instrumentation equipment are to be introduced at CRM and SPM. Control items of process computers are shown in Table V-3-5.

Table V-3-5 Main Control Items of Process Computer Equipment

Classification of function	Function	Main function
Setting and control	(1)Setting to AGC device	Coil No., Coil code, Strip width, Target gauge, Tension etc.
	(2)Setting to gauge meter	Coil No., Target gauge etc.
	(3)Setting to oil cellar panel	Flow pattern of rolling liquid
Tracking	Tracking in mill zone	Tracking in mill zone and rolling condition
Data logging	Actual data of constant length	Statistics control of actual data of constant length(gauge)
Input and output for operator	(1)Rolling schedule	Monitoring and revision of rolling schedule
	(2)Actual rolling time	Input of not operating time(line stop etc.)

3.4 Production Control

Considering the production capacity and number of grades, the production control such as planning and monitoring is to be made by operators.

3.5 Specification of Telecommunication Equipment

The required telephone equipment, paging equipment and broadcasting equipment are described below.

(1) Telephone equipment
The exchange machine through which communication both within the mill complex and to outside the mill complex can be made is to be installed. The required number of lines is twenty.

(2) Paging equipment
For the purpose of communication in each process equipment, paging is to be installed at operating rooms, machine sides and electrical rooms.

(3) Broadcasting equipment
For the purpose of broadcasting in the overall mill complex, a microphone and main device are to be installed in the main office and speakers at required points in the mill complex.

3.6 Erection and Wiring Work Items for Electricity, Instrumentation and Process Computer

The required works for erection and wiring are as follows ;

(1) Erection and wiring work of power receiving and distribution equipment
(2) Erection and wiring work of main equipment(electricity, instrumentation and process computer)
(3) Temporary electrical power for construction
(4) Wiring work from power station to each process equipment
(5) Miscellaneous electric work (lighting work, telecommunication equipment work etc.)

3.7 Law and Regulation

With regard to electrical work, an application is to be made for automatic fire alarm equipment and lubrication unit installed in oil cellar for motor bearing of mills. The application is to be made to, and the inspection is made by the relevant province and city fire offices.

3.8 Possibility of Domestic Procurement in Viet Nam for Electricity, Instrumentation and Process Computer Equipment.

The result of evaluation on the possibility of domestic procurement for electrical, instrumentation and process computer equipment and work material is shown in Table V-3-6. Power equipment such as high tension voltage panel, low tension voltage panel and transformer are manufactured at the moment in Viet Nam by local manufacturers, and there is a possibility of the domestic procurement with some limitation. There is no manufacturers of driving device and controller. Work materials such as cables can be procured locally in Viet Nam.

Table V-3-6 Possibility of Domestic Procurement in Viet Nam

Equipment and material	Local maker	Application equipment	Remarks
High tension voltage panel	Exist	Incidental equipment and temporary power	
Transformer	Exist	Incidental equipment and temporary power	
Low tension voltage panel	Exist	Incidental equipment and lighting panel	
Motor drive device	None	None	
Controller(PLC,DDC etc.)	None	None	
Telecommunication equipment	None	None	
Cable	Exist	Main equipment work and incident equipment work	Adoption of Cable for special high tension voltage(over 22KV) is early.
Cable rack and pipe	Exist	Main equipment work and incident equipment work	
Lighting device and trolley	None	None	

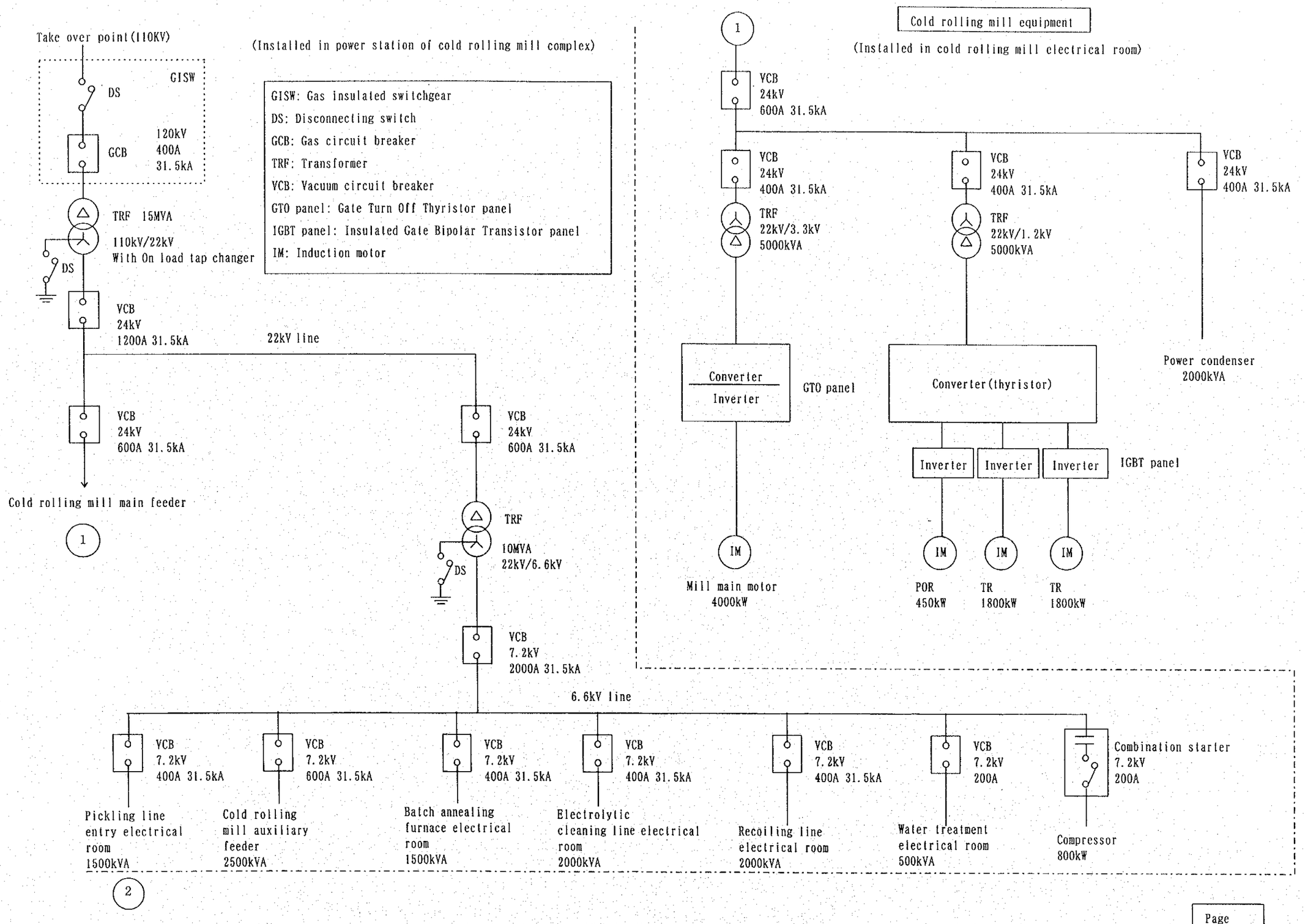


Fig. V-3-1 Single Line Diagram for Cold Rolling Mill

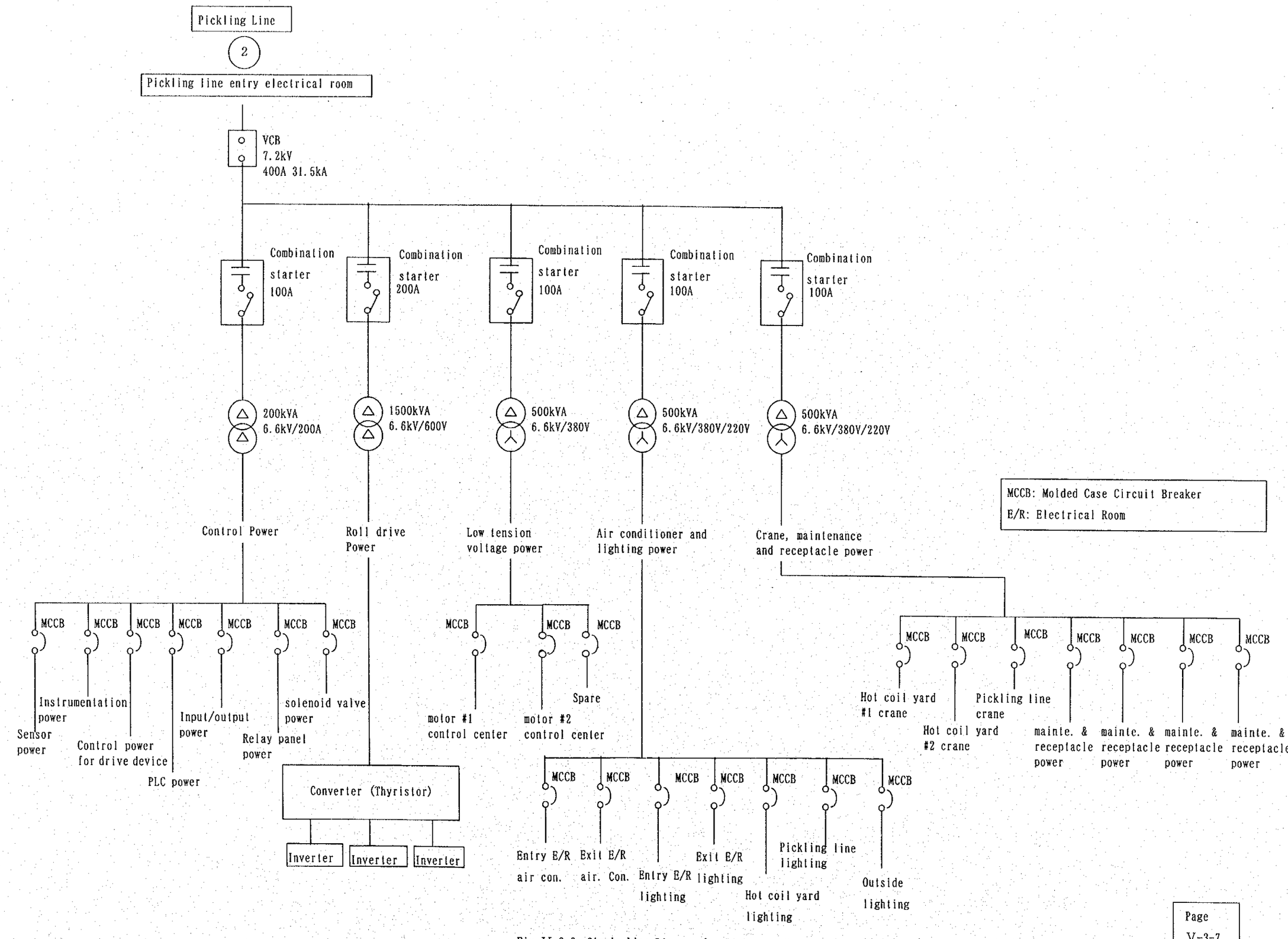


Fig. V-3-2 Single Line Diagram for Pickling Line

4. Layout

4.1 Basic Ideas for Designing Mill Complex Layout

The mill complex layout is considered for the processes defined in Chapter V.2. In addition, the material flow and the provision for future expansion are taken into consideration.

(1) Equipment to be considered

1) Production equipment:

① Push pull type pickling line
② 1 stand reversing cold rolling mill (combination line with Skinpass mill)
③ Electrolytic cleaning line
④ Box annealing furnace (and Coil cooling unit)
⑤ Recoiling line

2) Ancillaries:

① Roll shop
② Electric power receiving and distribution equipment
③ Water treatment facilities
④ Acid regeneration plant
⑤ H_2 gas generator and N_2 gas, LPG, Heavy oil storage tanks
⑥ Air compressor
⑦ Boiler
⑧ Crane
⑨ Coil conveyor
⑩ Test laboratory
⑪ Maintenance shop
⑫ Hot coil yard
⑬ Packing yard
⑭ Shipping coil yard
⑮ Office and Canteen

4.2 Recommended Mill Complex Layout

Although the future expansion plan of the cold rolling mill complex has not yet been specified, the land space is secured with the following assumptions. As a result of this consideration, the land space is set to be the size of 450 m×350 m.

1) Production capacity is to be increased from 250,000 tons/year to 500,000 tons/year.
2) New equipment to be newly installed for the expansion is one push pull type pickling, one stand reversing cold rolling mill, one continuous galvanizing line (CGL) of Nonoxidization furnace (NOF) type and one recoiling line for inspection.

The recommended mill complex layout is shown in Fig. V-4-1.

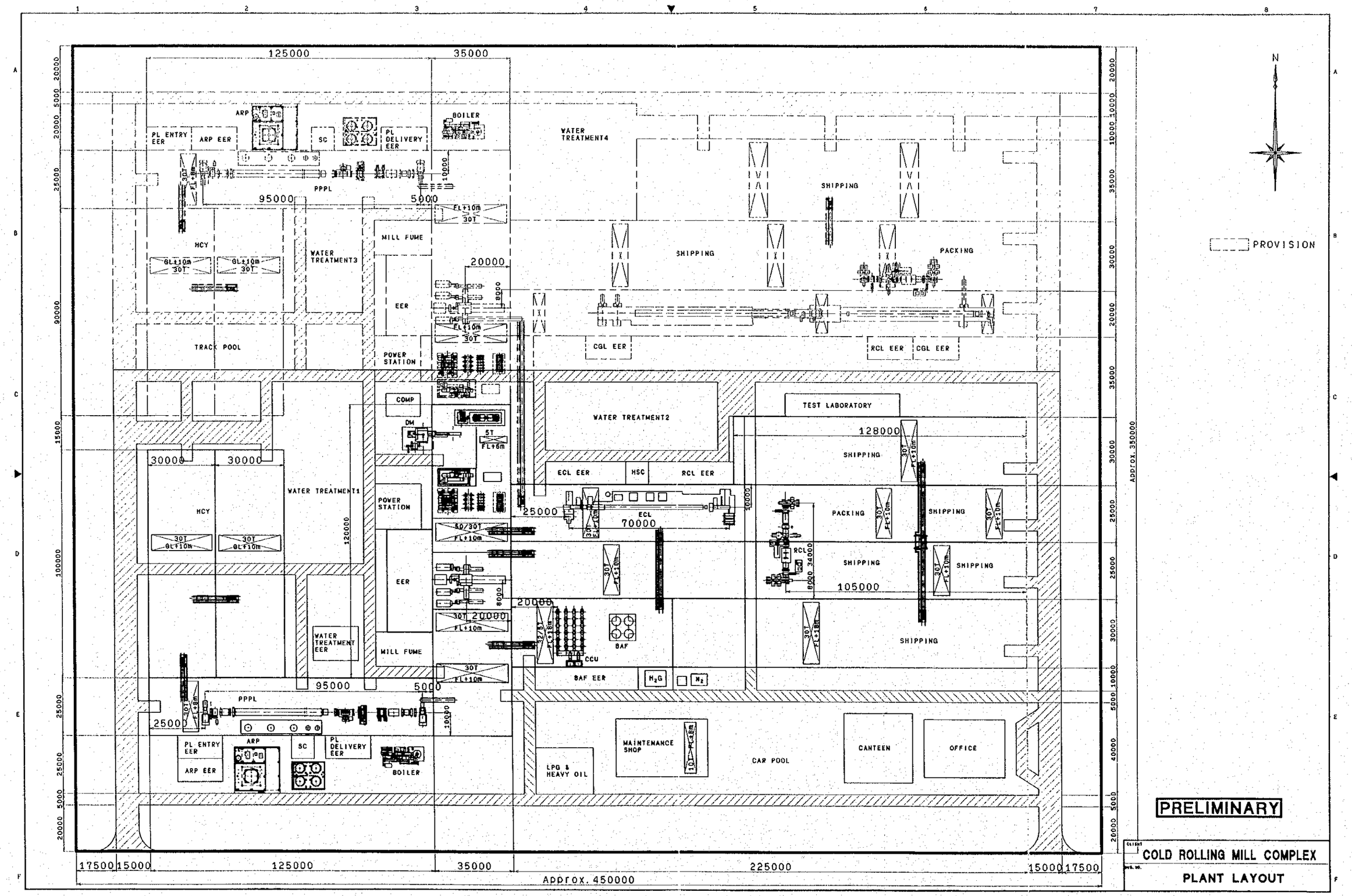


Fig. V-4-1 New Cold Rolling Mill Complex Layout

5. Specification of Civil and Building

(1) Bills of Rough Quantity for Civil and Building Work

Table V-5-1 and V-5-2 show the rough estimation of quantity for civil and building work for the new cold rolling mill complex.

Table V-5-1 Rough Estimation of Quantity for Civil Work

	Concrete Vol.	Pile	Others
PPPL YARD	6,500 m^3	–	Floor Concrete 1,800m^2
RCM・R/S YARD	8,900 m^3	–	Floor Concrete 2,500m^2
ECL・SHIPPING YARD	5,400 m^3	–	Floor Concrete 7,600m^2
RCL・SHIPPING YARD	2,500 m^3	–	Floor Concrete 5,100m^2
CCU/BAF・ SHIPPING YARD	5,900 m^3	–	Floor Concrete 5,400m^2
HOT COIL YARD	1,500 m^3	–	
WATER TREATMENT	3,900 m^3	–	
ROAD AND EXTERIOR WORK	500 m^3	–	Road Pavement 12,000m^2
Total	35,100 m^3	–	

Table V-5-2 Rough Estimation of Quantity for Building Work

MAIN BUILDING	Column No.		WIDTH (m)	LENGTH (m)	FLOOR AREA (m^2)	EAVES HIGHT (m)	STEEL (TON)
	E-W	N-S					
HOT COIL YARD1	1-4	B-O	30.0	100.0	3,000	15.0	150
HOT COIL YARD2	4-7	B-O	30.0	100.0	3,000	15.0	150
PPPL YARD	1-13	A-B	25.0	125.0	3,125	13.0	310
RCM YARD/ROLL SHOP	13-14	A-R	35.0	145.0	5,075	15.0	510
CCU/BAF YARD	14-19	C-G	30.0	55.0	1,650	23.0	250
SHIPPING YARD	19-36	C-G	30.0	170.0	5,100	15.0	510
SHIPPING YARD	14-36	G-J	25.0	225.0	5,625	15.0	560
ECL/PACKING/SHIPPING YARD	14-36	J-M	25.0	225.0	5,625	15.0	560
SHIPPING YARD	24-36	M-Q	30.0	120.0	3,600	15.0	360
TOTAL	-	-	-	-	35,800	-	3,360

SUB BUILDING	FLOOR AREA (m^2)	REMARK
EER and Operation Room (Steel structure)	4,621	
Power Station etc. (RC structure)	1,350	
Office and Canteen	4,400	
TOTAL	10,371	

(2) Drawings of Building Planning

Following figures show the building planning for the new cold rolling mill complex .

1) Fig. V-5-1 : General Plan of Building
2) Fig. V-5-2 : Elevation Plan
3) Fig. V-5-3 : Structural Plan

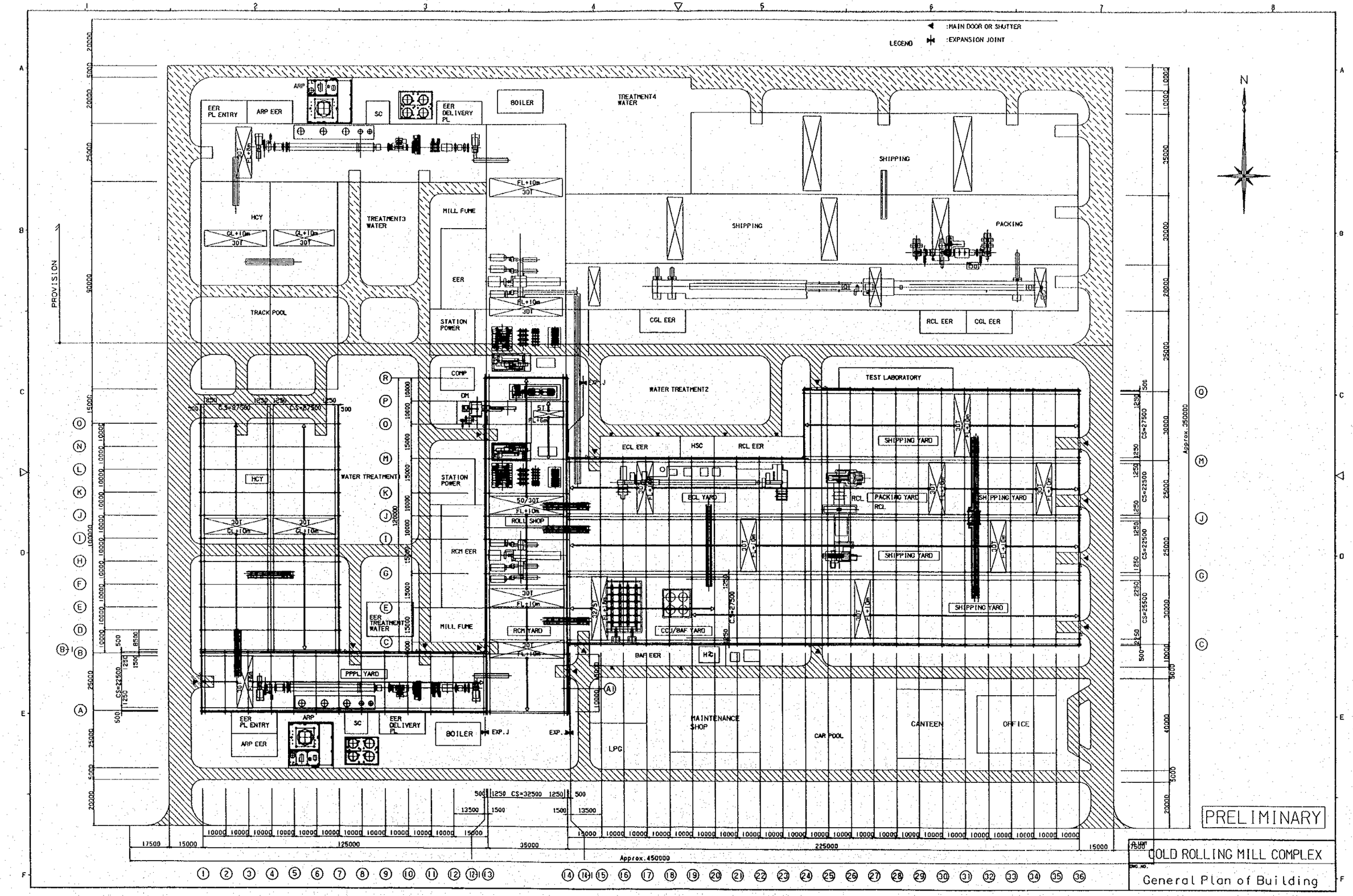


Fig.V-5-1 General Plan of Building

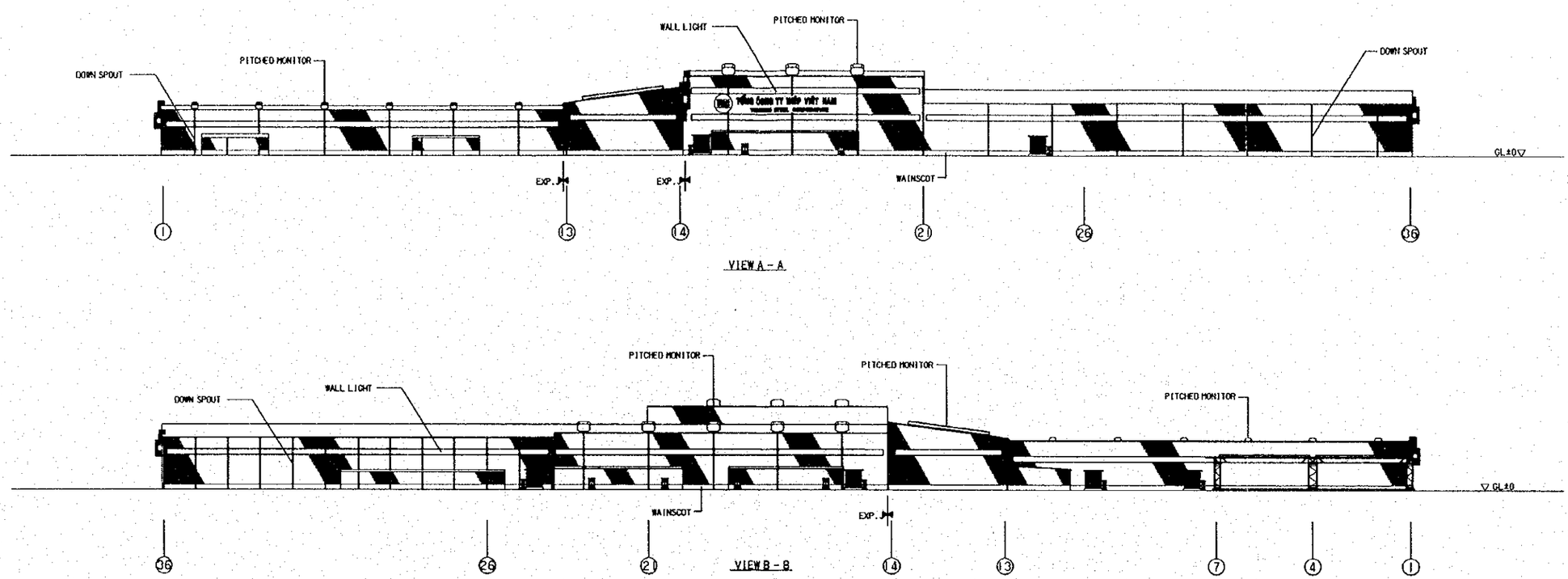
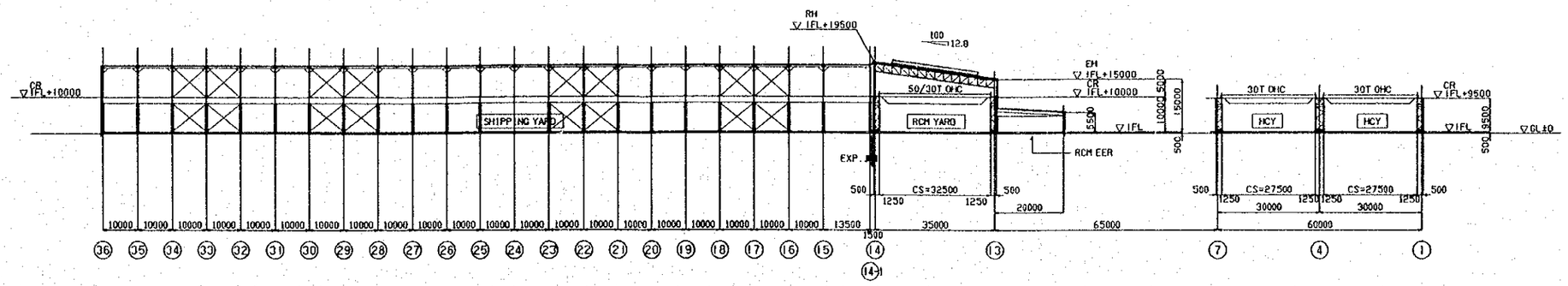
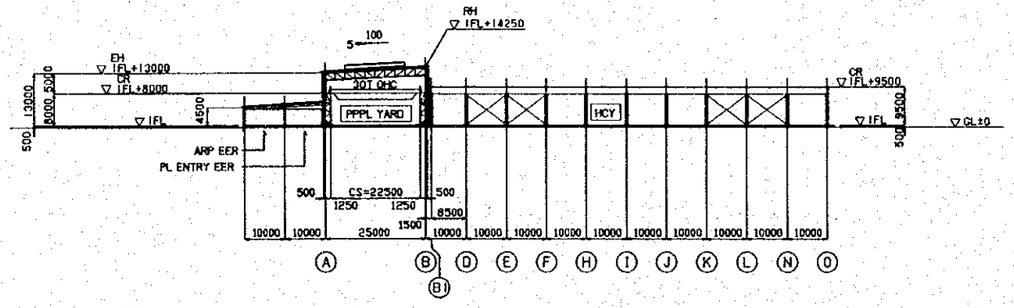


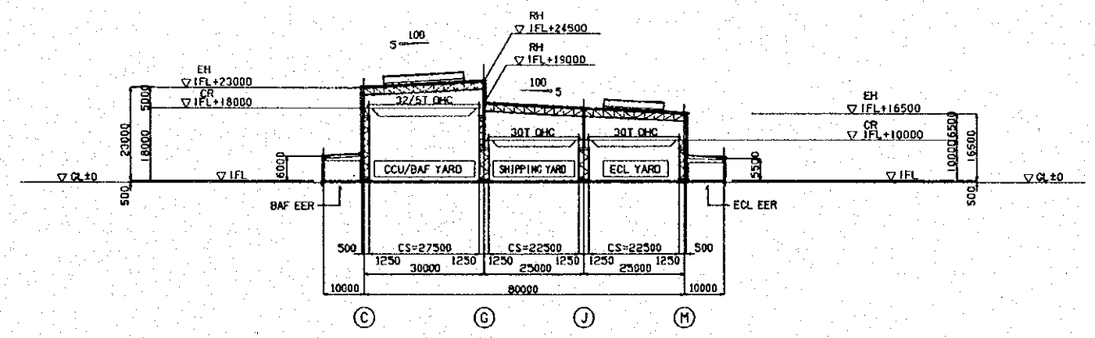
Fig.V-5-2 Elevation Plan



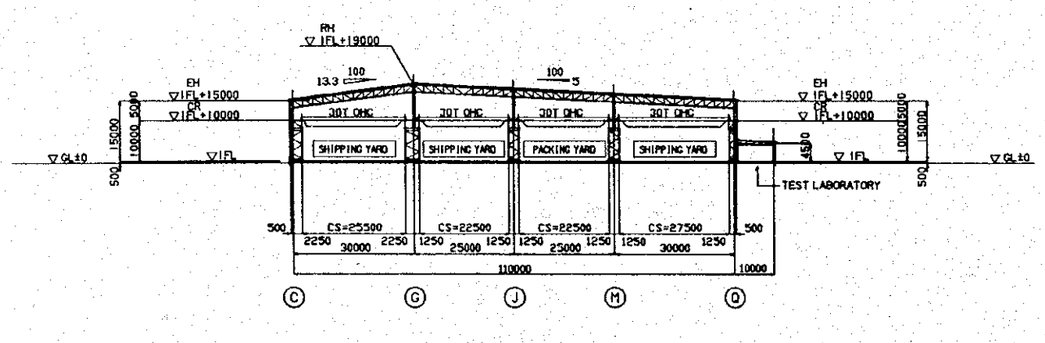
SECTION A - A



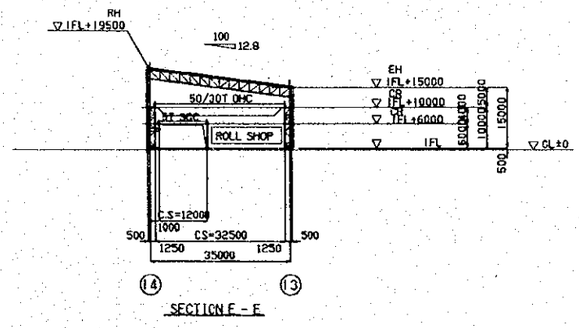
SECTION B - B



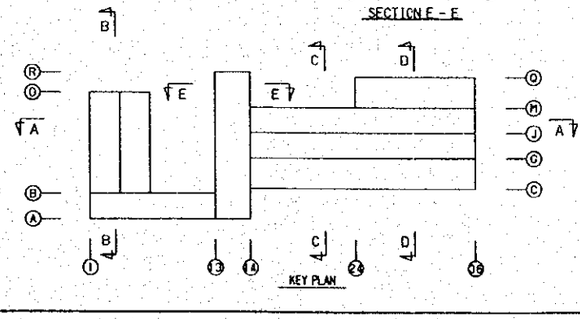
SECTION C - C



SECTION D - D



SECTION E - E



LEGEND : EXPANSION JOINT

PRELIMINARY

CLIENT
COLD ROLLING MILL COMPLEX

DWG. NO.
Structural Plan

Fig. V-5-3 Structural Plan

6. Conceptual Design of Infrastructure

6.1 Power Supply to the New CRM

(1) Design Basis

110 kV power from Phu My power plant will be received at the receiving station of CRM with overhead line and will be distributed to load of CRM

a) Basic specification of power distribution
- Receiving voltage : 110 kV ± 10%
- Maximum short circuit current : 40 kA
- Power supply capacity : 40 MVA or more
- Number of line : 1 line
- Type of distribution line : Over head line with steel tower and ACSR (Aluminum conductor steel reinforced) wire

b) Name and location of power supply substation for CRM
- 110 kV switch yard at Phu My power plant
- Approx. 2500 m from CRM

(2) Equipment consists of :

a) 110 kV switch gear with auxiliary equipment
- Number of set : 1 set
- Installed at 110 kV switch yard of Phu My power plant

b) Power distribution line
- Number of line : 1 line ,
- Length : 2500 m

6.2 Water Supply and Waste Water Discharge

6.2.1 Water supply

(1) Design basis

Water for Phu My IZ which is supplied by Ba Ria Vung Tau water company through under ground pipe line will be provided to factories through internal underground network with water pump station boosting pressure to be 0.3 MPa.

The CRM receives the water from the network to use for make-up of circulated industrial water and general purpose. Underground piping of the network will be laid under the sidewalk at the side of CRM.

(2) Equipment consists of :

a) Under ground piping with accessories 1 set

b) Metering device 1 set

6.2.2 Waste Water Drainage

(1) Design basis

Phu My IZ has two drainage networks laid under the side walk of the IZ. One is rain-water drainage and the other is waste water drainage. CRM should discharge separately both drainage to corresponding network whose underground piping will be laid under sidewalk at side of CRM. Waste water from factories of the IZ subject to the discharging standard "C "will flow to final water treatment station through the network in gravity running and will be treated to meet the discharging standard "B" of Viet Nam. The estimated water volume of waste water from CRM is approx. 60 m^3/h.

(2) Equipment consists of:

- Underground piping: 1 set
- Accessories: 1 set

6.3 Fuel

(1) Design basis

Fuel in CRM is used mainly for BAF, ARP and boiler. It is possible to use LPG, natural gas and heavy oil as fuel. In this project, LPG is adopted for fuel of BAF and APR , and heavy oil for boiler.

Reasons are as follows:

- LPG does not require any heavy investment for receiving equipment such as pipe line compared with natural gas.
- Price of heavy oil is cheaper than that of LPG and natural gas, however it seems that the combustion of heavy oil affects the quality of products such as cold coil.

LPG and heavy oil will be procured in market by CRM itself and transported with tank trucks.

(2) Equipment consists of:

- Storage equipment: 1 set

7. Manning Plan

In principle, manning plan is made based on ;

1) the organization described in V.8
2) the production with three crews of three shifts
3) the extent of automation described in V.3

Manning plan obtained with the above-mentioned principle is shown in Table V-7-1.

Table V-7-1 Manning Plan

White Collar Staffs	
Managing Director	1
Deputy Managing Director	1
Department Managers	7
Section Managers	13
Engineers	8
Foreman	16
Clerk	16
Secretary	2
Sub total	64

Blue Collar Workers				
(3 Crew 3 Shift)	(Foreman)	Skilled Worker	Un-skilled Worker	Total
PL	(1)	15	3	18
RCM	(2)	15	3	18
ECL	(1)	12	3	15
BAF	(1)	12	3	15
RCL	(1)	15	3	18
Packing	(1)	30	6	36
Crane	(1)	42	6	48
Roll Shop	(1)	15	3	18
Production control	(1)	15	3	18
Testing & quality	(1)	12	3	15
Utility	(1)	15	3	18
Inspection	(1)	12	3	15
Maintenance	(2)	48	9	57
Hot coil yard & Shipping yard	(1)	21	6	27
Sub total	(16)	279	57	336
			Grand total	400

8. Mill Management

8.1 Organization of the Mill

The following organization of the new cold rolling mill is recommended as a proposal on the basis of the main functions of the mill. However, revisions suited to the actual state at VSC should be examined in the future.

President

Vice president

Department	Main function
Production Control Department	Formation of production plans, order receipt job, procurement of hot coils, adjustment of shipping, transportation planning and control
Quality Control Department	Determination of manufacturing specifications, preparation and control of manufacturing standards, solving complaints and claims of customers, customer management
Manufacturing Department	Preparation of and compliance with operation standards, manufacturing control(production, quality, cost), primary quality judgment
Equipment Department	Maintenance and improvement of equipment, equipment control
Accounting and Purchasing Department	Budget control, cost calculation, procurement of spare parts
General Administration Department	General affairs, personnel affairs, etc.
Sales Department	Sales activity

Fig. V-8-1 Organization of Mill

8.2 Introduction of Cold Rolling Technology

8.2.1 Technical Training of Technical Staff

When the execution of the construction of the cold rolling mill complex is determined, technical staff should be appointed as soon as possible, and the technical staff should start the learning of cold rolling.

8.2.2 Technical Training of Operators

At least six months prior to the start of operation, operators who will provide the main force for each process should be appointed and they should learn the knowledge of the equipment constructed and be given an opportunity to learn actual operations for about one month.

Further, in a certain period from the stage of trial run to the start of operation, the operators should also receive training by experts who have experience with operations.

8.3 Quality Control

(1) Standards of products and specific agreements with users are to be made. They constantly require to upgrade their standards and revisions are required. So the departments concerned must be ready for these changes.

(2) It is important for the manufacturing department to meet with those users' requirements and systems capable of meeting these requirements in terms of inspection and control are to be established.

(3) Information exchanges with users are to be thoroughly carried out to know whether the users are satisfied or not. If there is any room for improvement, it must be done without delay.

9. Construction Schedule

The construction schedule of the planned cold rolling mill complex is shown in Fig.V-9-1. This schedule covers from the commencement of the civil work to that of the commercial operation, and is decided based on the past example of the construction of a cold rolling mill in South East Asia together with consideration of the scale of the mill complex planned in this FS. It is taken for granted that the land preparation and the construction of roads to the site is to be completed before this schedule. In addition, as the preparatory work before this schedule the following items are to be done ;

1) Investigation to decide the contractors for each equipment and for each work
2) Contracting
3) Detailed designing after contracting

It should be noted that the required time for detailed designing varies depending both on the content of the contract and on the capability of the contractors.

For each equipment the required time for construction and/or installation is nearly solely dependent on the content of the equipment itself. On the other hand, the construction schedule for ancillaries is decided automatically depending on the start-up of the relevant equipment. For reference, the construction schedule of the water treatment facilities is shown here as an example.