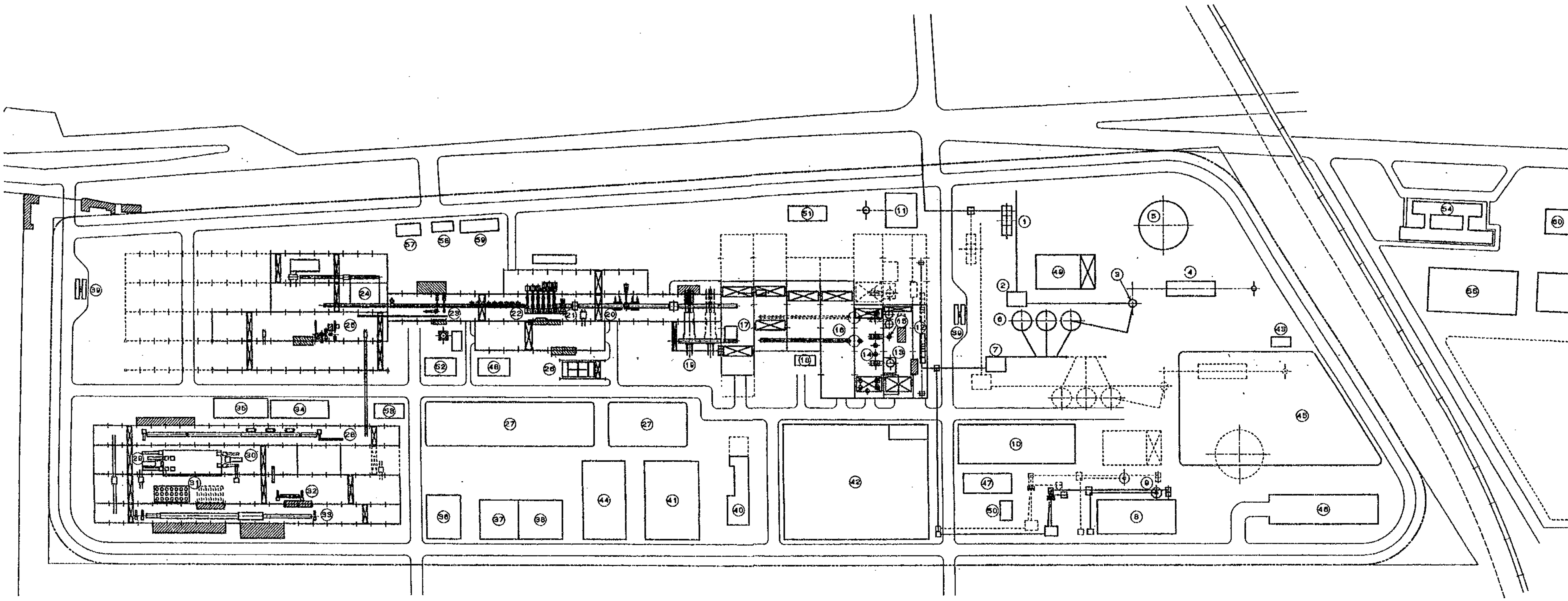
industry.
In this project, taking into consideration construction cost and capacity, cost-effective horizontal NOF type shall be selected.

5-4 Plant General Layout

The general plant layouts for the Flat Project are shown in Figures 5-4-1 and 5-4-2.

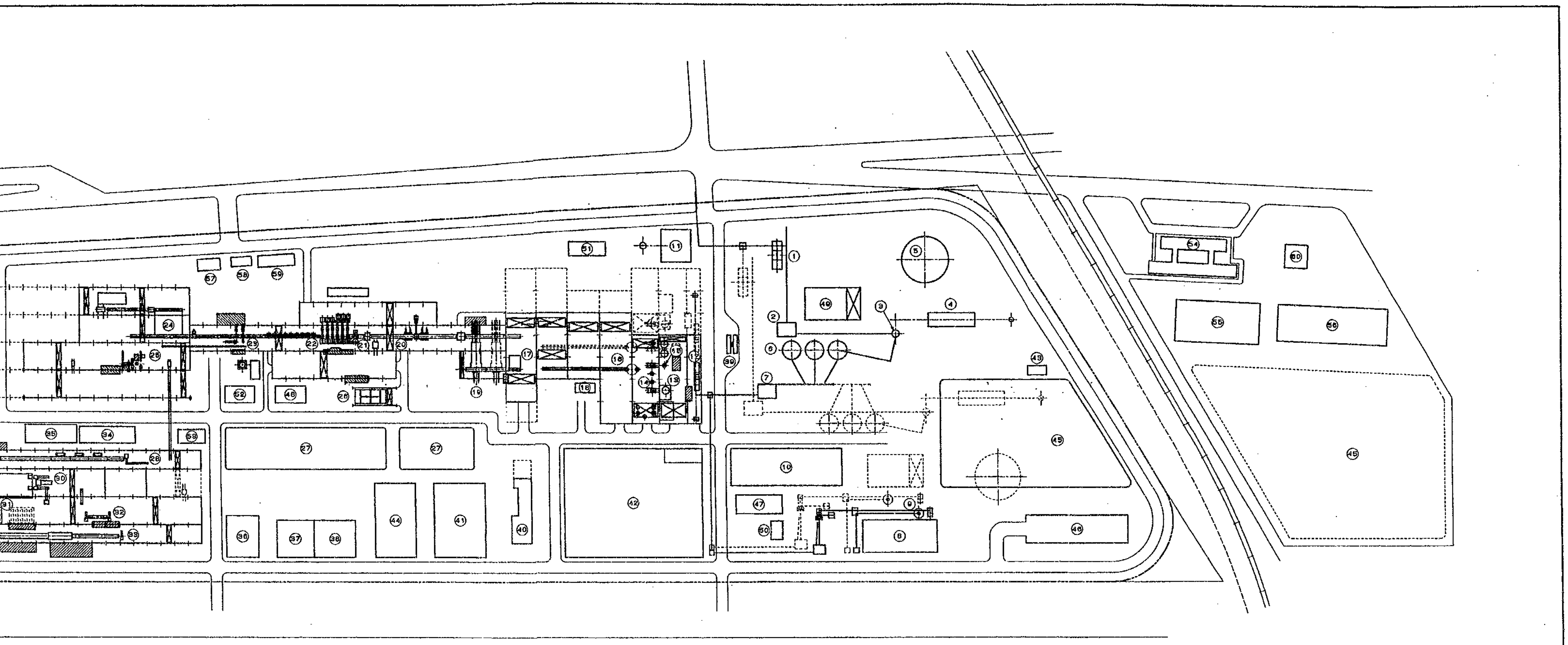
Disposition of the major production units are planned to minimize the material handling. The pellets and iron ore stock yards are next to mineral jetty, these materials are transferred by conveyor to Direct Reducing Plant (DRP). Direct reduced Iron (DRI) and burnt lime are also transferred by conveyor to Steel Making Plant (SMP). Scrap yard is located in the plant area and scrap is transferred by dumping truck to scrap bucket in SMP. SMP and Hot Strip Mill (HSM) are conveniently located. The main receiving sub-station is envisaged near the major power consumers i.e. SMP and HSM. Suitable location for debris dumping yard and sewage treatment plant are also identified in the layout. Space provision for analyses and inspection is kept. Administrative building, restaurant, maintenance shop and warehouse are placed east side across the rail way. Road weigh bridge required for weighing the incoming and outgoing trucks will be located in the plant. Adequate space provision has also been envisaged for locating facilities like plant office, first-aid, fire station, gate house, car repair shop, etc.
The requisite provisions of landscaping and greenbelts with a view to avoid adverse impact on the environment are considered. Large scale tree plantation is envisaged in addition to greenbelts around a production units and offices. Besides providing pleasant surroundings, these will help reducing dust generation and temperature as well as general noise level.



1	OXIDE PELLET STORAGE BIN	11	DUST COLLECTOR	21	COIL BOX	31	BATCH ANNEALING FURNACE	41	RAW WATER RECEIVING STATION	51	SMP OFFICE
2	OXIDE PELLET SCREEN	12	MATERIAL HANDLING SYSTEM	22	FINISHING MILL	32	RECOILING LINE	42	MAIN SUBSTATION	52	HSM OFFICE
3	REDUCTION FURNACE	13	ELECTRIC ARC FURNACE	23	DOWN COILER	33	HOT DIP GALVANIZING LINE	43	NATURAL GAS RECEIVING STATION	53	CRM OFFICE
4	REFORMER	14	LADLE TRANSFER CAR	24	PLATE LINE	34	ACID REGENERATION	44	SEWAGE TREATMENT STATION	54	MAIN OFFICE
5	CLARIFIER	15	LADLE FURNACE	25	SKINPASS MILL	35	UTILITY PLANT	45	SCRAP YARD	55	MAINTENANCE SHOP
6	DRI STORAGE BIN	16	SLAB CASTER	26	SCALE PIT FOR HSM	36	WATER TREATMENT FOR CRM	46	SLAG YARD	56	REFRACTORIES WAREHOUSE
7	DRI SCREEN	17	SLAB CONVEYOR	27	WATER TREATMENT FOR HSM	37	OIL STORE	47	ADDITIVE WAREHOUSE	57	GUARD OFFICE
8	LIME STONE STORAGE YARD	18	SCALE PIT FOR CCM	28	PICKLING LINE	38	WASTE STORE	48	LABORATORIES	58	CLINIC
9	LIME CALCINING PLANT	19	REHEATING FURNACE	29	REVERSING MILL	39	TRUCK SCALE	49	DRP OFFICE	59	FIRE FIGHTING STATION
10	WATER TREATMENT FOR SMP	20	ROUGHING MILL	30	TEMPER MILL	40	AIR COMPRESSOR ROOM	50	LCP OFFICE	60	RESTAURANT

0 50 100m

No



	STORAGE BIN	11	DUST COLLECTOR	21	COIL BOX	31	BATCH ANNEALING FURNACE	41	RAW WATER RECEIVING STATION	51	SMP OFFICE
	SCREEN	12	MATERIAL HANDLING SYSTEM	22	FINISHING MILL	32	RECOILING LINE	42	MAIN SUBSTATION	52	HSM OFFICE
	NACE	13	ELECTRIC ARC FURNACE	23	DOWN COILER	33	HOT DIP GALVANIZING LINE	43	NATURAL GAS RECEIVING STATION	53	CRM OFFICE
		14	LADLE TRANSFER CAR	24	PLATE LINE	34	ACID REGENERATION	44	SEWAGE TREATMENT STATION	54	MAIN OFFICE
		15	LADLE FURNACE	25	SKINPASS MILL	35	UTILITY PLANT	45	SCRAP YARD	55	MAINTENANCE SHOP
	IN	16	SLAB CASTER	26	SCALE PIT FOR HSM	36	WATER TREATMENT FOR CRM	46	SLAG YARD	56	REFRACTORIES WAREHOUSE
		17	SLAB CONVEYOR	27	WATER TREATMENT FOR HSM	37	OIL STORE	47	ADDITIVE WAREHOUSE	57	GUARD OFFICE
	ORAGE YARD	18	SCALE PIT FOR CCM	28	PICKLING LINE	38	WASTE STORE	48	LABORATORIES	58	CLINIC
	G PLANT	19	REHEATING FURNACE	29	REVERSING MILL	39	TRUCK SCALE	49	DRP OFFICE	59	FIRE FIGHTING STATION
	NT FOR SMP	20	ROUGHING MILL	30	TEMPER MILL	40	AIR COMPRESSOR ROOM	50	LCP OFFICE	60	RESTAURANT

Note: Future expansion plan is shown by doted lines.

Figure 5-4-1

0 50 100m

FLAT PRODUCT PROJECT OF EGYPT	
TITLE	PLANT GENERAL LAYOUT
DWG NO. EFP-PGL-001	
DATE	JUL.31.1997
SCALE	

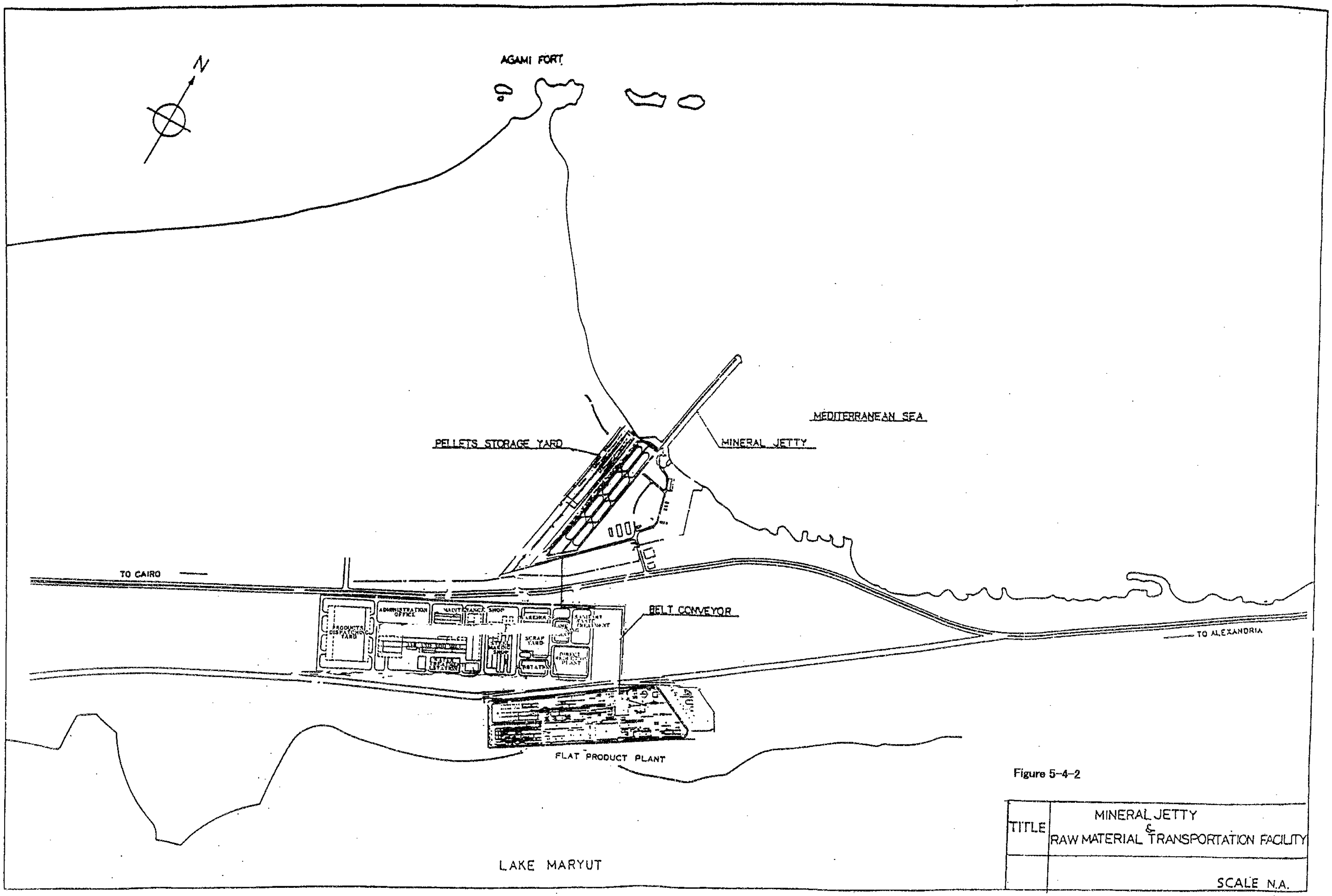


Figure 5-4-2

TITLE	MINERAL JETTY & RAW MATERIAL TRANSPORTATION FACILITY
	SCALE N.A.

5-5 Basic Design Data

The following is the basic design data and conditions to be adapted for the study.

5-5-1 General

(1) Applicable laws, regulations, codes and standards

Compliance with the relevant laws, regulations, codes and standards of the following will be considered.

- Egyptian laws, regulations, codes and standards
- International codes and standards and their equivalents
- Specific codes, association standards and/or trade names in which the general specification and the technical specification may cite, for the purpose of defining a minimum quality level for equipment, material or workmanship.

(2) Unit and language

Measurements will be made in the metric system, and the prevailing language will be English.

5-5-2 Site conditions

(1) Site location

- Northwest part of Lake Maryut.

(2) Climate

1) Ambient Temperature (°C)
   - Annual mean : 20.1, max. 24.2, min 16.3
   - Absolute records max. 40.6, min. 4.0

2) Relative Humidity (%)
   - Annual mean : 68, max. 73, min. 64

3) Rainfall (mm)

- Annual total : 168.0

4) Number of Days with rain (≥ 1.0 mm)
   - Annual total : 23.4

5) Wind
   - Prevailing direction :Spring NW to NE
     Summer NW
     Autumn N to NE
     Winter SW to NW
   - Mean scalar wind :Annual mean 9.3 knots speed

6) Earthquake
   - Compliance with the Uniform Building Code (UBC latest edition) for Zone 2A.

(3) Topographic data

The following conditions will be assumed. For details, it will be defined based on the result of subsurface soil exploration and plane survey to be done at the preparation stage of project implementation.

1) Soil conditions

A typical soil profile of subsurface soil will be referred to in Figure 4-3-5.

(a) Soil bearing capacity
   - q : 0.15 - 0.25 kg/cm^2 (EL - 1.5 m to EL - 9.5 m)
     : 1.50 - 3.00 kg/cm^2 (EL - 9.5 m to EL - 19 m)

(b) Type of subsurface soil(typical)

	Thickness (m)
- Slag (reclaimed)	: 2-4
- Sandy clay/crushed shells	: 1-2
- Very soft clay	: 4-6
- Silty clayey sand/sandy clay	: 3-4
- Stiff sandy clay/cemented sand	: 2-3

More than (EL-17 to EL-19) : cemented sand layer

(c) Groundwater level : MSL; ± 0 m

2) Site elevation

(a) Existing grade(assumption)

- Area utilized for scrap yard (70,000 m^2) :EL + 3.8 m
- Area reclaimed with slag (230,000m^2) :EL + 1.5 m
- Remaining area (300,000 m^2) :EL - 2.0 m

(b) Finished elevation (planned) :EL + 4.5 m

3) Water level

- High water level : Datum line +0.52 m
- Mean water level : Datum line +0.33 m
- Low water level : Datum line +0.11 m

(Source; The maritime report and chart)

(4) Transportation

1) Nearest port to the site

- El Dekhiela Port and
- Alexandria Port

2) Inland transportation

(a) Road service

Roads conditions around the project site are fairly good and well maintained. For the main route, refer to Table 5-5-1.

Table 5-5-1 Road Conditions between Cairo and Alexandria

Road condition			
	Length (km)	Width (m)	Remarks
Cairo/Alex (desert)	220	7.5 + 2.0	Dual carriage Way
Cairo/Alex (Agricultural)	205	7.5 to 10.5 + 2.0	Dual carriage way
Traffic safety measures; Well prepared			
Max. allowable loads on bridges; 70 tons			

(b) Railway service

- Available : by ENR service network
- Max. capacity per car : 75 tons
- Track gauge : 1,435 mm
- Required to comply with governmental regulations (special law 152/1980)

5-5-3 Utility condition

Utility condition at the each plant is as follows;

(1) Natural gas

- Supply pressure : 6.0 kg/cm^2
- Calorific value (min) : 9,000 kcal/Nm^3
  (ave) : 9,450 kcal/Nm^3
  (max) : 10,000 kcal/Nm^3

(2) Oxygen gas

- Supply pressure : 15.0 kg/cm^2
- Purity : 99.5 %

(3) Nitorogen gas

- Supply pressure : 6.0 kg/cm^2
- Purity : 99.99 %

(4) Argon gas

- Supply pressure : 6.0 kg/cm^2
- Purity : 99.9 %

(5) Hydrogen gas

- Supply pressure : 6.0 kg/cm^2
- Purity :99.999 %

(6) Plant air

- Supply pressure	: 6.0 kg/cm^2
- Dew point	: Ambient temp.
- Oil	: Oil free

(7) Steam

-Supply pressure	: 7.0 kg/cm2
-Temperature	: the saturated temperature

(8) Potable water

-Supply pressure	: 2.0 kg/cm2
-Analysis	: within standard value of potable water

(9) Make up water

-Supply pressure	: 2.0 kg/cm2
-Analysis :	
pH	: 7.6 ~ 7.8
Total hardness	: 80 mg/l as CaCO3
Chloride ion	: 38 ~ 67 mg/l
Turbidity	: <2 NTU

5-5-4 Basic data on electric power

The power distribution system of the flat steel plant is shown on the Figures 6-6-1 through 6-6-3.

The various permissible voltage levels are as follows;

(1) **Voltage to be received:** 3-phase, 220 kV, 50 Hz

(2) **Distribution voltage:**

1) AC 33kV, 3-phase, 3 wires (neutral 100 ohms resistance grounded)
2) AC 6.6 kV, 3-phase, 3 wires (neutral 10 ohms resistance grounded)
3) AC 380 V, 3-phase, 3 wires (direct grounded)

4) AC 380/220 V, 3-phase, 4 wires (direct grounded)

(3) Rated voltage for equipment

1) AC voltage

- 6.6 kV	: Motor of 200 kW and larger
- 380 V	: Motor of below 200 kW
- 380/220 V	: Lighting circuit
- 220 V	: Single-phase power outlet control circuit/Control of electro-magnetic contactor
- 24 V	: Safety hand lamp

2) DC voltage

- 750 V or less	: Main motor for rolling mill
- 440/220 V	: Variable voltage auxiliary motor
- 220 V	: Constant voltage auxiliary motor
- 110 V	: Control of circuit breaker

(4) Voltage and frequency fluctuations

1) Range of voltage fluctuation

- 220 kV	: +/- 10 %
- 33 kV	: +/- 5 %
- 6.6 kV	: +/- 5 %

2) Range of frequency fluctuation

- Normal	: 50 Hz +/- 2 %
- Abnormal	: 50 Hz +/- 3 %

(5) System short-circuit capacity

- 220 Kv	: Max. 15,000 MVA (40 kA), min. 4,000 MVA
- 33 kV	: 1,600 MVA (25 kA)

(6) The emergency power shall be supplied to the plant where it is necessary from the Substation.

5-6 Raw Materials

5-6-1 General

The raw materials required in a direct reduction process (DR) of iron oxide and an electric arc furnace (EAF) route of a steel making plant include iron ores (lump ore and oxide pellet), scrap and sub-materials such as limestone, ferro-alloys, aluminum and fluorite.

Generally, feasibility study is based on the principle that these raw materials are of local origin or production.

However, in this study, the raw materials were classified into those to be locally procured in Egypt and those to be imported, with consideration given to the present status of the resource researches and the developments being conducted in Egypt.

The deposits and occurrences of minerals in Egypt are shown in Figure 5-6-1.

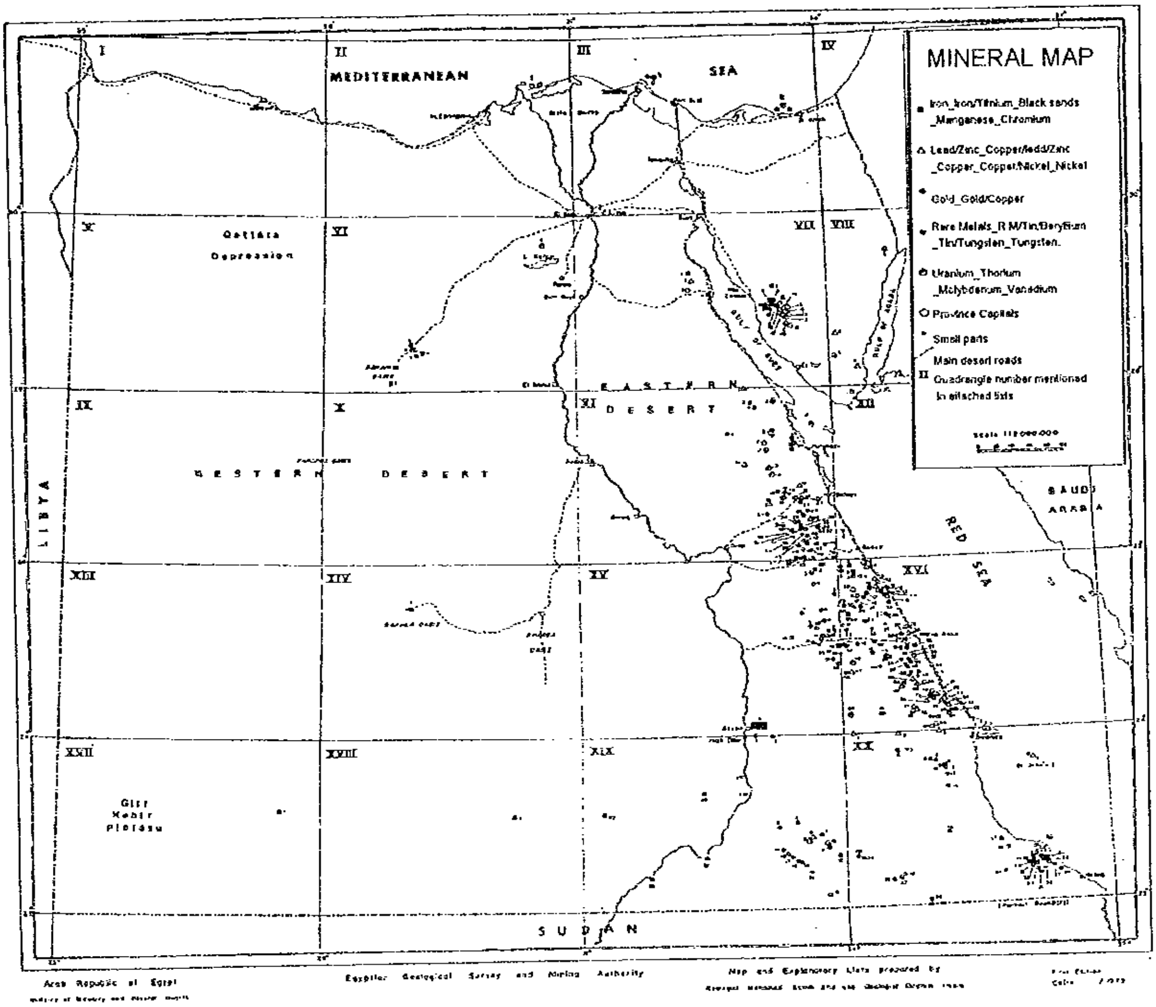
As the result of this study, the raw materials were divided into three categories as follows, depending on supply sources:

1) Domestic supply
   - (a) Limestone
   - (b) Fluorspar
   - (c) Ferro-silicon
   - (d) Aluminum (shot and bar)

2) Domestic and importation, together
   - (a) Ferro-manganese
   - (b) Refractories

3) Importation
   - (a) Iron ore and oxide pellet
   - (b) Scrap
   - (c) Graphite electrode

Figure 5-6-1 Mineral Map of Egypt



Source: Egyptian Geological Survey And Mining Authority

The required iron ores in the DR/EAF route must be of high quality (67% Fe content or more preferably). Consideration was given to the properties of iron ores and also other industrial and economic factors, and in conclusion, iron ores were selected as supply sources from other countries in this study.

Although locally produced scrap and ferro-manganese are utilized in the domestic industries, their quantities do not suffice more than that required by the existing Egypt steel industry, so it was concluded that these raw materials would be also imported.

Limestone, fluorspar, ferro-silicon and aluminum are produced in Egypt. Limestone and ferro-silicon have been exported for chemical industry and steel making use and they are the most reliable ones among the all raw materials in respect of the supply capacity.

Typical standard quantities of the raw materials required for the flat steel plant of one million tons per year production basis are shown in Table 5-6-1.

Table 5-6-1 Main Raw Materials for Flat Steel Plant

(Unit: tons/y)

Raw Materials		Quantity	Remarks
Iron ores	Lump ore	300,000	Mixing ratio of lump ore and pellets will be 20% and 80%, respectively
	Oxide pellets	1,200,000	
Scrap		170,000	Return scrap = 104,000 t/y Purchased scrap = 64,000 t/y
Limestone		80,000	
Ferro-alloys	Ferromanganese	3,500	
	Ferrosilicon	200	
Aluminum		600	
Fluorite		500	

5-6-2 Iron ores

(1) Characteristics of iron ores for DR process

Raw materials for the DR process considered in the Study are iron ores, namely lump ore and oxide pellets. The quality requirements of iron ores suitable for the process are in general as follows:

1) Chemical composition

Since the gangues can not be separated from the iron ores in DR process, it is obvious that a particularly strong demand must be placed upon the chemical composition of iron ores. This is based on the fact that in most cases direct reduced iron (DRI) is supposed to substitute steel scrap in EAF as well as the condition of this study. The main principal requirements concerning chemical composition of iron ores are as follows:

Total Fe (iron)	: 67 % or more (preferably)
P (phosphorus)	: 0.03 % or less
S (sulfur)	: 0.025 % or less
$(SiO_2 + Al_2O_3)/Fe \times 100$	: 5 % or less

When raw materials containing high proportion of gangues are fed into EAF, a large volume of slag will be produced, thus leading to an adverse influence on steel making efficiency and to an increase in unit consumption of electric power. To avoid these inconveniences, iron ores with less gangues must be used.

Most recent operational experiences with DR/EAF route indicate that up to 5 % of slag to iron ratio, or $(Si0_2+Al_2O_3)/Fe \times 100$, are considered to be permissible.

It is well known that P and S are harmful for the quality of steel, thus contents of such elements in raw materials are restricted within certain limitations.

2) Physical properties

General main requirements concerning physical properties are as follows:

(a) Particle size:

Pellets: 9 - 16 mm, as main size fraction

Lump ore: 10 -35 mm, as main size fraction

(b) Cold crushing strength: 250 kg/pellet

(2) Supply source

1) Iron ore resources in Egypt

The deposit and occurrence of iron ore in Egypt have been reported by the General Organization For Industrialization (GOFI) and the Egyptian Geological Survey And Mining Authority (EGSMA) and some local organizations.

(a) Deposit of the Eastern Desert

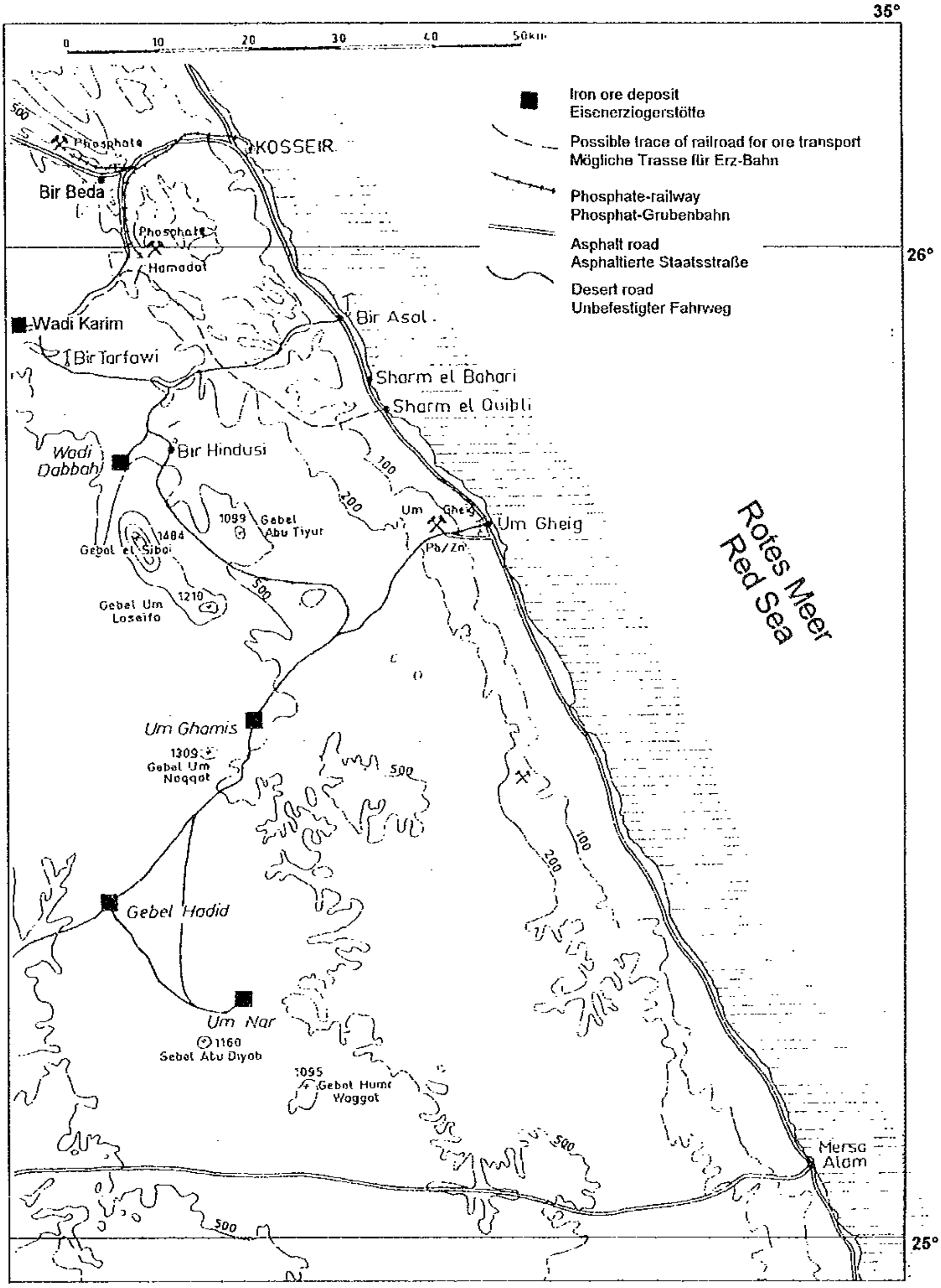
The major iron ore deposits are located in the eastern desert. The area map of the main deposits are shown in Figure 5-6-2 and the summarized data are given in Table 5-6-2.

(b) New Discovered Deposit

Recently, the Ministry of Industry and Mineral Resources announced the new discoveries of iron ore reserves in the South East Aswan areas. Expected and confirmed iron ore geological reserves are 483 and 173 million tons, respectively. However, the qualities have not evaluated to satisfy the required quality level of the DR grade iron ore. However, in future, domestic iron ores which have sufficient quality to sustain the DR/EAF route iron and steel making operations may be discovered and developed.

The areas of the reserves are shown in Figure 5-6-3 and summery of the reported data of the mines is given in Table 5-6-3.

Figure 5-6-2 Map of Iron Ore Deposits of Eastern Desert



Source: The Iron Ore Deposits of The Eastern-Desert

By Eng. ANWAR H.BISHAY/ EGSMA.

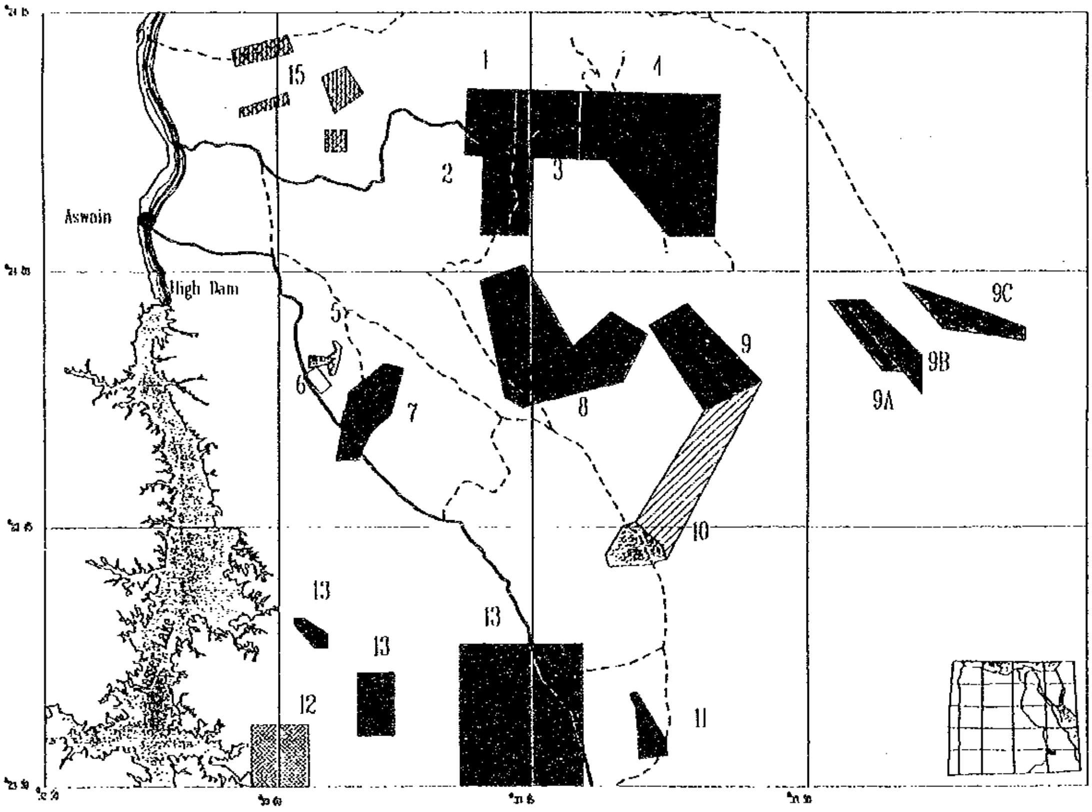
Table 5-6-2 Summary of Mines Data in Eastern Desert

Area Name of Reserves (*1)		Chemical Composition (wt %)							
Deposit	(m.- tons)	Fe	SiO2	Al2O3	CaO+MgO	P	Mn	TiO2	S
Wadi Karim		42 - 45	23 - 24.5	1.6	9.5	0.29	0.10 - 0.19		
Wadi Dabbah		35 - 39.5	31 - 34	1.7	8.7	0.56	0.10 - 0.19		
Um Ghamis		41 - 46	26 - 29	2.6	7.4	0.39	0.10 - 0.19		
Gebel El Hadid		45.5	26.60	1.3	6.2	0.19	0.03 - 0.10		
Um Nar		40.5-45.5	27.5 - 32	0.8	4.5	0.22	0.03 - 0.10		
Total	33								
Average		42.55	28.02	1.60	7.26	0.33	0.03 - 0.12	0.11	(very small)

Souece: The Iron Ore Deposits of The Eastern-Desert By Eng. ANWAR H. BISHAY / EGSMA

Note: (*1) Minable ore reserves excluding Um Nar

Figure 5-6-3 Area Map of Reserves in South East Aswan



Source: GOFI(June 23,1997)

- 1-North of Aweirsha
- 2-South of Awairsha
- 3-Um Hoqban
- 4-Wadi Allawi
- 10-East of Um Hebal
- 5 Km 21 Aswan-Allagi Road
- 6-Km 23 Aswan-Allagi Road
- 7-Km 29 Aswan-Aliagi Road
- 8-Middle and north of wadi Al Arab
- 9-East of wadi Al Arab
- 9A and 9B-East and west of Dabaa
- 9C-Wadi Al Kabsh
- 10-East of Um Hebal
- 11-North of Barqat Tokham
- 12-End of Khor Rahmi
- 13-Areas under Exploration
- 14-Areas Highly Promising under exploration
- 15-Old mines of Iron and Steel Company

Table 5-6-3 Summary of Table Mines Data in South East Aswan

Sample No.	Area Name of Deposit		Reserves (*1) (m.- tons)	Calculated Fe %	Chemical Composition (wt %) Fe_2O_3	SiO_2	Al_2O_3	P_2O_5	MnO	Mn	MgO	CaO	SO_3	S	TiO_2	Na_2O	K_2O	Cl-	L.O.I.
1	Aweirsha																		
	North of Aweirsh	(without intercalations)	14	60.90	87.07	5.54		0.99	0.29		0.58	2.94							
a	North of Aweirsh	(with intercalations)	16	46.20	66.06	14.15		2.97	0.30				0.170						
b	North of Aweirsh	(with intercalations)	12	45.97	65.72	14.63		2.05	0.01				0.040						
2	South of Aweirsh	(without intercalations)	12	60.98	87.18	5.41		0.91	0.29		0.57	2.96							
3	Um Hoqban	(with intercalations)	13	46.79	66.89	11.94		1.54	0.52				0.380						
	Um Hoqban	(without intercalations)		60.86	87.01	5.46		0.94	0.29		0.58	3.03							
4	Allawi	(with intercalations)	34	45.51	65.06	17.58		2.23	0.40				0.290						
	Allawi	(without intercalations)		61.00	87.21	5.52		0.97	0.29		0.59	2.99							
5	KM 21 Aswan-Allaqi Road		3	47.42	67.80	7.67		0.70											
6	KM 23 Aswan-Allaqi Road		12	50.39	72.04	8.70		0.75											
7	KM 29 Aswan-Allaqi Road		9	51.34	73.40	14.75		0.56											
8	Middle and North of Wadi Al Arab		10	51.46	73.58	10.34		0.58											
9	East of Wadi Al Arab		88	49.60	70.92	6.49		0.36											
A	East and west of Dabaa		75																
B	East and west of Dabaa																		
C	Wadi Al kabsh		30																
10	East of Um Hebal		64	56.56	80.86	13.70		0.80											
A1	East of Um Hebal			50.79	72.61	7.60	2.41	1.20	1.85		0.67	3.73			0.35	0.15	0.10	0.86	8.58
1/1	East of Um Hebal			56.49	80.76	5.60	1.46	0.98	0.73		0.23	2.93			0.16	0.03	0.01	0.70	6.55
1/2	East of Um Hebal			53.86	77.00	2.07	1.40	1.57	1.70		0.50	5.00			0.09	0.03	0.11	0.90	9.10
2/3	East of Um Hebal			54.56	78.01	5.05	1.40	1.54	0.70		0.39	5.60			0.14	0.02	0.06	0.61	5.55
2/4	East of Um Hebal			58.82	84.10	2.30	1.54	0.87	0.70		0.40	2.60			0.10	0.03	0.06	0.21	5.52
3/5	East of Um Hebal			54.56	78.00	2.20	1.30	2.14	0.54		0.35	7.00			0.10	0.03	0.06	0.81	6.29
4/7	East of Um Hebal			58.76	84.01	4.18	1.15	0.96	0.80		0.46	2.90			0.10	0.02	0.05	0.21	3.66
4/8	East of Um Hebal			56.30	80.50	5.20	1.30	1.95	0.50		0.56	6.00			0.15	0.03	0.06	0.60	3.86
11	Barqat Tokham		7	52.84	75.55	8.27		1.61											
12	Khor Rahmi		11	48.75	69.70	10.60		1.00											
	Total		483																
	Average			53.36	76.29	8.12	1.50	1.26	0.62		0.49	3.97	0.22		0.15	0.04	0.06	0.61	6.14

Source: GOFI (June 23, 1997)

Note: (*1) Geologically estimated ore reserves

(c) Production of iron oxide pellet

Planning of benefitiation and agglomeration has been studying by the Ministry of Industry and Mineral Wealth based on the Aswan iron ores. However, there is no iron oxide pellet of local production up to now.

(d) Statistic data of iron ores

Statistic data concerning iron ores in Egypt were collected from the Central Agency For Public Mobilization and Statistics (CAPMAS). There are some dispersion in the data, which would be attributable to lack of original data and information. Summary of the data are given for reference in the tables attached hereinafter. (Table 5-6-4 and Table 5-6-5)

Table 5-6-4 Summary of Statistic Data of Lump Ore in Egypt

Description	Unit	Year									
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 (*1)
1) Domestic production	t/y		2,112	2,562	2,400	2,132	2,287	2,229	2,877	2,690	
2) Import (External trade)	t/y			545,694	1,065,879	987,150	1,391,972	1,045,732	599,049	639,228	333,696
3) Main foreign suppliers (Country)											
(1) (Arab Emarat Country)	t/y										61,030
(2) (Austraria)	t/y				81,470						
(3) (Brazil)	t/y			422,534	489,893	387,242	690,657	751,787	599,049	395,998	272,666
(4) (France)	t/y				27,154						
(5) (Germany, Rep. of)	t/y				2		31				
(6) (India)	t/y									80	
(7) (Italy)	t/y							3			
(8) (Malaya)	t/y				16,316		32,977				
(9) (Netherland)	t/y			41				224			
(10) (Norway)	t/y					121,545	19,643				
(11) (Singapore)	t/y				16,500						
(12) (Shily)	t/y						62,301				
(13) (Sweden)	t/y			123,098	407,232		364,385	229,287		243,150	
(14) (Trinidad Tobago)	t/y					17,638					
(15) (U.K.)	t/y					122,316	69,000	64,431			
(16) (U.S.A.)	t/y					268,141	120,857				
(17) (Venezuera)	t/y				27,292	70,269	32,123				
(18) (Yogoslavia)	t/y				10						
(18) (imported from Suez poet))	t/y			21	10						
4) Price											
(1) Domestic market price	LE/t		4	4	6	6	8	9	8	9	
(2) Import price (CIF) --- Average	$/t			48	51	73	56	47	41	49	62

Source: CAPMAS, 1997 March

Note (*1): From January (1) to October (10)

Table 5-6-5 Summary of Statistic Data of Oxide Pellet in Egypt

Description	Unit	Year									
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996(*1)
1) Domestic production	t/y										
2) Import (External trade)	t/y			545,673					514,626		410,070
3) Main suppliers (Country)											
(1) (Belgim)	t/y								101		
(2) (Brazil)	t/y			422,534					263,484		272,570
(3) (Netherlands)	t/y			41							
(4) (Spain)	t/y								3		
(5) (Sweden)	t/y			123,098					132,830		137,500
(6) (U.S.A.)	t/y								118,208		
4) Price											
(1) Domestic market price	LE/t										
(2) Import price (CIF) --- Average	$/t			48					39		57

Source: CAPMAS, 1997 March

Note (*1): From January (1) to October (10)

2) Foreign iron ores sources

The DR grade iron ores of major existing mines or suppliers in the world, which are being fed into DR plants and tested at a laboratory scale, are listed in Table 5-5-6. They have been evaluated with respect to the suitability for DR and free market availability to a DR plant.

Table 5-6-6 DR Grade Iron Ores of Major Existing Mines

Country	Brand Name	
	Pellets	Lump Ores
Bahrain	GIIC	
Brazil	CVRD Samarco	Ferteco MBR (Mutuca)
Chili	CMP	
India	Kudremukh	
Peru	Hierro Peru	
Sweden	LKAB	

(3) Selection of Supply Sources

The Egyptian Iron and Steel Co. (EISCO), who has a blast furnace route steel making plant, has been using iron ores of the Aswan Ore Mining and the Bahario Ore Mining, however, the total Fe content of the iron ores is 45 % and 53 %, respectively.

The Alexandria National Iron and Steel Co. (ANSDK), who is only one steel works in Egypt that has a DR/EAF process route steel making plant, has been using the imported iron ores

from Brazil, Sweden and some other suppliers.
Supply sources had been studied from both of domestic and foreign iron ores sources and it was difficult, in view point of the quality, to have a realistic outlook for the use of domestic iron ores as supply sources for this study.
Accordingly, this study adopted the assumption that iron ores would be imported.

(4) Transportation

There are two main factors affecting the transportation cost (freight rates) for receivers of heavy and large bulk cargoes such as iron ores.
One is whether a large scale receiving port for large bulk cargo with unloaders is available.
General required sea water depth in low tide (LTWD) for an iron ores vessel is as follows;

Type of vessel	Capacity	LTWD
a) Cape size	125,000 ton and more	16 – 20 m
b) Panamax	Less than 80,000 ton	10 – 16 m

The other is location of a receiver's unloading port. Freight rates vary depending upon whether a loading port of following or return cargo is located near or distant from an unloading port of iron ores, and whether chances to find succeeding or return cargoes are frequent or not.

Vessel size and freight rate adopted to this study are based on the actual data of ANSDK because of similarity of the conditions of the selected plant site and the port.
However, an optimum vessel size and freight rate may be studied in detail at the time of preparing for an eventual supply contract of iron ores.

5-6-3 Steel scrap

(1) Scrap supply in Egypt

Statistics on the amount of steel scrap generated domestically in Egypt are not available from CAPMAS (Central Agency for Public Mobilization and Statistics), however, according to ANSDK (Alexandria National Iron and Steel Co.), it is estimated that 150 - 200 thousand t/y is generated.
This amount of scrap is not sufficient for the Egyptian steel industry when considering that ANSDK already imports scrap of approximately 100 thousand t/y as shown in Table 5-6-10.

The scrap required for the flat products plant at the first stage of one million t/y is approximately 170 thousand t/y consisting of home scrap of 106 thousand t/y and out-sourced scrap of 64 thousand t/y. Therefore 64 thousand t/y scrap should be imported.

According to CAPMAS, imported scrap consists of as little as approximately 100 thousand t/y including alloy and stainless steel as shown in Table 5-6-7.
Comparing the imported quantity of carbon steel scrap (excluding alloy and stainless steel) of 82,064 t in 1994, 92,163 t in 1995 and 57,145 t in 1996 shown in Table 5-6-7 with the ANSDK imported scrap in ANSDK of 113,440 t in 1994, 84,900 t in 1995 and 104,880 t in 1996 shown in Table 5-6-10, the CAPMAS figures are rather lower than those of ANSDK. This discrepancy might be caused by the statistical method.

Table 5-6-7 Imported Scrap in Egypt

Unit: t

Kinds of scrap	1994	1995	1996
(1) Waste & scrap of stainless steel	123	2	144
(2) Waste & scrap of other Alloy steel	23,479	5,327	36,940
(3) Waste & scrap of tinned Iron or steel	1,632		250
(4) Waste & scrap of cast Iron	480	5,065	3,649
(5) Turnings & milling waste sawdust filing & trimming	144		
(6) Other ferrous waste & scrap	78,016	85,832	53,246
(7) Remelting scrap Ingots	1,792	1,166	
Total =(1)+(2)+(3)+(4)+(5)+(6)+(7)	105,666	97,492	94,229
Total =(3)+(4)+(5)+(6)+(7)	82,064	92,163	57,145

Source: CAPMAS

Scrap is imported from Europe and the CIS. The origin of imported carbon steel scrap is shown, for example, in "Other ferrous waste and scrap", in Table 5-6-8.

The price of imported scrap is different depending on country of origin and imported quantity as shown in Table 5-6-9, for example, in "Other ferrous waste scrap" in 1996.

Table 5-6-8 Origin of Imported Scrap in Egypt

(On "Other ferrous waste and scrap") Unit: t/y

Origin Country	1994	1995	1996
Republic of Iraq			1
Yemen Arab Republic		4,503	3,240
Republic of Lebanon	6,249	1,768	477
Rumania	12,988	7,856	13,054
Russian Federation	169		3,299
Republic of Ukraina			26,769
Republic of Belarus	532	520	632
Republic of Bosnia and Hercegovina			1
Italy		150	2,535
Federal Republic of Germany	90		42
France			50
Kingdom of Jordan		40	
Turkey	9,347	3,081	
United Kingdom		64,996	
Gabon		2,850	
Libyan Arab Republic	547		
Bulgaria	999		
Switzerland	45,616		
Singapore	149		
Uganda	20		
Foreign Ship Supply	1,038	60	3,135
Passengers Dutiable Luggage by Ship			12
Investment Authority (Free Area)	700		
Other Free Areas	50		
Total	78,494	85,824	53,246

Source: CAPMAS

Table 5-6-9 Price of Imported Scrap in Egypt

(In "Other ferrous waste and scrap" in 1996)

Origin country	Value (US$)	Quantity (t)	Unit price (US$/t)
Republic of Iraq	901	1	901.0
Yemen Arab Republic	504,432	3,240	155.7
Republic of Lebanon	49,297	477	103.3
Rumania	2,197,783	13,054	168.4
Russian Federation	545,090	3,299	165.2
Republic of Ukraina	1,479,332	26,769	55.3
Republic of Belarus	68,453	632	108.3
Republic of Bosnia and Hercegovina	712	1	712.0
Italy	397,315	2,535	156.7
Federal Republic of Germany	10,209	42	243.1
France	9,011	50	180.2
Foreign Ship Supply	541,439	3,135	172.7
Passengers Dutiable Luggage by Ship	1,325	12	110.4
Total	5,805,229	53,246	109.0

Source: CAPMAS

(2) ANSDK scrap procurement

ANSDK, the biggest scrap consumer in Egypt, purchased scrap from the local market and foreign suppliers as shown in Table 5-6-10. In addition, 40,000 - 50,000 t of home scrap is consumed every year.

The main sources are Europe and the CIS for imported scrap, Russia and India for imported pig iron and the Egyptian Iron and Steel Co. (EISCO) for domestic pig iron.

Domestic scrap is transported by trucks of 20 t capacity and imported scrap is transported by vessels of 5,000 - 20,000 t capacity.

Table 5-6-10 ANSDK Scrap Procurement

Unit: t

	1994	1995	1996
Domestic			
1) Scrap	128,220	168,400	200,370
2) Pig iron	36,870	8,710	0
Imported			
1) Scrap	113,440	84,900	104,880
2) Pig iron	133,820	95,870	104,920
Total			
1) Scrap	241,660	253,300	305,250
2) Pig iron	170,690	104,580	104,920

Source: ANSDK

(3) Scrap quality

According to the information provided by ANSDK, the quality of scrap and pig iron is shown in Table 5-6-11.

Table 5-6-11 ANSDK Scrap Quality

	Domestic scrap (Heavy)	Import scrap	Pig iron
C content (%)			3.5 min.
P content (%)			0.35 max.
S content (%)			0.05 max.
Cu content (%)	0.2 max.	0.2 max.	
Ni content (%)	0.01 max.	0.01 max.	0.1 max.
Cr content (%)	0.01 max.	0.01 max.	0.1 max.
Thickness (mm)	3 min.	6 min.	
Width (mm)	500	500	
Length (mm)	1,200 max.	1,200 max.	

Source: ANSDK

5-6-4 Principal sub-materials

(1) Limestone

Burnt lime is consumed in the electric arc furnace after being calcined from limestone. The limestone required for the flat steel products plant of 1,000,000 t/y is approximately 80,000 t/y. This total is available in the local market.

1) Limestone deposits

In accordance with literature (*1) published by EGSMA (Egyptian Geological Survey and Mining Authority), Egypt has many limestone deposits of commercial potential at key sites suitable for exploitation for local use or export to any part of the world. Most promising limestone deposits are located in the Nile Valley, Canal Governorates, Western Alexandria and the Sinai.

For example, chemical analysis of Nile Valley limestone deposits is shown in Table 5-6-12.

Table 5-6-12 Chemical Analysis of Nile Valley Limestone Deposits

Location	CaO %	MgO %	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	Al_2O_3+Fe_2O_3 %	L.O.I %	SO_3 %	P_2O_5 %	R_2O_3 %
Wanina	55.36	0.32	0.04	0.32	0.08		44.22	0.1		
Sidi Saleh	55.46	0.29	0.11	0.32	0.42		44.16	0.11		
Hammamia	55.29	0.30	0.007	0.29	0.027		44.19	0.11		
Khashaba	55.24	0.3	0.003	0.33	0.06		44.16	0.11		
Beni Khalid	54.71	0.50		0.22	0.12		43.78	0.17		
Zawiet Sultan	55.34	0.41		0.13	0.04		43.02	0.13		
Tuna El Gebel	54.83	0.54	0.1	0.48	0.14		43.61	0.12		
Gebel El Gir	46.76	0.73	3.37	6.91	1.60		38.38			
Kom Ombo	44.69	1.36	2.01	8.80	0.98		39.10	0.13	0.24	1.73
Sharama	46.60	1.27	1.40	7.66	1.05		38.75	0.74		
Wadi Sannur	55-65	0.04-0.05								
Helwan area										
G. El Abiad	51.23	0.97		3.1		1.78				

Location	CaO %	MgO %	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	Al_2O_3+Fe_2O_3 %	L.O.I %	SO_3 %	P_2O_5 %	R_2O_3 %
Shag El Tebbin	50.33–51.0			2.63–4.29		0.88–1.93				
G. El Mowasla	53.5	0.5		2.1–7.2		1.3–2.25				
G. El Rifai	51.24–55.00	0.62–2.81		1.01–1.72		0.23–0.85				
Batn El Baqara	49.7–52.7	0.66–2.98		1.47–3.47		1.8–4.05				
Athar El Nabi	50.95–53.05	0.52–0.70		1.59–6.8		2.04–2.25				
Gebel Degla	53.53–54.51	0.63–1.14		1.05–1.56		0.60–2.04				
Gebel Tura	50.12–53.86	0.56–1.97		2.24–18.8		0.27–1.94				
Helwan	47.65–55.03	0.4–3.86		0.50–5.44		0.12–3.32				
Unit I	44.68–51.52	0.57–2.06	1.01–2.05	3.36–8.16	0.61–1.06		34.71–40.97	0.12–1.74		
Unit II	32.72–37.82	0.54–2.32	4.81–7.71	18.80–30.90	1.93–3.56		22.45–32.01	0.14–3.16		
Unit III	46.59–51.12	0.50–1.86	1.05–1.86	4.10–7.05	0.48–0.84		37.81–40.53	0.07–0.32		

Source: GOFI based on literature published by EGSMA

Limestone from Wanina, Sidi Saleh, Hammamia, Khashaba, Beni Khalid, Zawiet Sultan and Tuna El Gebel will be suitable for steelmaking processes in view of the chemical properties (However, use of limestone for steelmaking is not determined only by chemical composition. Other properties, for example compression strength, should be also considered).

*1 "Limestone and Dolomite in Egypt",
A Commodity Package, Minerals, Petroleum and Groundwater Assessment Program, USAID Project 263-0105, Cairo, Egypt, January 1986

2) Production of limestone in Egypt

Limestone production for industrial use in Egypt is 600 - 900 thousand t/y as shown in Table 5-6-13. Egypt is blessed with abundant limestone reserves as described and does not need to import limestone.

Table 5-6-13 Production of Limestone in Egypt

Unit: t

Year	Production
1987/88	689,574
1988/89	704,083
1989/90	779,248
1990/91	749,421
1991/92	718,119
1992/93	891,074
1993/94	
1994/95	652,631

Source: CAPMAS

3) ANSDK Limestone procurement

The quantity of ANSDK purchased limestone is shown in Table 5-6-14. ANSDK purchases limestone from Quarico and Roda both of which are located in Giza.

Table 5-6-14 Quantity of ANSDK Purchased Limestone

Year	Quantity (t)
1994	127,550
1995	117,660
1996	103,770

Source: ANSDK

4) EISCO limestone sources

EISCO has used limestone from its own quarry located in Beni-Khalid 250 km south to Cairo.

5) Limestone quality

According to the information provided by ANSDK, the quality of the limestone is as follows;

CaO: 48 % minimum

SiO_2: 3 % maximum

P_2O_5 : 0.1 % maximum

S: 0.08 % maximum

(2) Ferro-manganese

Ferro-manganese is consumed in the electric arc furnace for alloying. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 3,500 t/y. Ferro-manganese would be available in local market but its use depends on capacity of the local supply and its use in all steelmaking processes.

1) Present situation in Egypt

Production of ferro-manganese started, in 1994 in Egypt. Production was 23,857 t in 94/95, 26,630 t in 95/96. However, ferro-manganese is still imported. Tables 5-6-15 and 5-6-16 show the amounts and origins of imported ferro-manganese respectively.

Comparing the imported quantity of ferro-manganese of 16,002 t in 1994, 8,396 t in 1995 and 12,013 t in 1996 shown in Table 5-6-15 with the ANSDK imported ferro-manganese of 17,020 t in 1994, 19,000 t in 1995 and 15,000 t in 1996 shown in Table 5-6-17, the CAPMAS data is lower than that of ANSDK. This discrepancy might be caused by the statistical method.

Table 5-6-15 Imported Ferro-manganese in Egypt

	Fe-Mn C % > 2 (t)	Fe-Mn C % < 2 (t)	Fe-Mn (t)	Total (t)	Value (US$)	Unit price (US$/t)
1989			7,962	7,962	5,417,828	680
1990			17,844	17,844	10,894,866	611
1991			26,260	26,260	17,232,741	656
1992			15,472	15,472	8,082,186	522
1993			22,774	22,774	11,588,926	509
1994	7,757	8,245		16,002	7,578,531	474
1995	5,151	3,245		8,396	5,024,776	598
1996	5,508	6,505		12,013	7,824,103	651

Source: CAPMAS

Unit: t

Country	Fe-Mn C % > 2			Fe-Mn C % < 2		
	1994	1995	1996	1994	199	1996
France			2,502	5,024		
South Africa		21	3,006		3,006	4,307
Austria		21				
United Kingdom	3,006	3,004		1,059		
F. R. of Germany		2,048		42	75	2,014
Switzerland	730	15		2,001		
EEC		42				
Malaysia	4,021					
Spain				78	123	165
USA				40		19
Russian Federation					21	
THAILAND					21	
CANADA					0	
Total	7,757	5,151	5,508	8,245	3,245	6,505

Source: CAPMAS

2) ANSDK ferro-manganese procurement

The quantity of ANSDK purchased ferro-manganese is shown in Table 5-6-17. At present ANSDK imports ferro-manganese from France, Germany and South Africa.

Table 5-6-17 Quantity of ANSDK Purchased Ferro-manganese

	Quantity (t)
1994	17,020
1995	19,000
1996	15,000

Source: ANSDK

(3) Ferro-silicon

Ferro-silicon of 75 % Si content is consumed in the electric arc furnace for alloying. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 200 t/y which will be procured from local supplies.

will be procured from local supplies.

1) Present situation in Egypt

Ferro-silicon is produced in Egypt and some is exported. The following tables show the production of ferro-silicon of 75 % Si content and the import/export of ferro-silicon respectively.

Table 5-6-18 Production of Ferro-silicon (Si 75 %) in Egypt

Unit: t

Year	Production
1987/88	7,806
1988/89	6,907
1989/90	7,922
1990/91	7,596
1991/92	6,725
1992/93	7,246
1993/94	6,955
1994/95	4,214
1995/96	7,199

Source: CAPMAS

Table 5-6-19 Import/Export of Ferro-silicon (Si % > 55) in Egypt

	Export		Import	
	Q'ty (t)	Value (LE)	Q'ty (t)	Value (US$)
1994			99	199,050
1995	37,591	24,732,232	3,041	1,931,618
1996	24,511	18,377,465	182	232,710

Source: CAPMAS

Table 5-6-20 Import/Export of Ferro-silicon (Si % < 55) in Egypt

	Export		Import	
	Q'ty (t)	Value (LE)	Q'ty (t)	Value (US$)
1994	2,616	1,364,528	281	206,224
1995	3,750	1,758,789	938	1,394,409
1996	1,780	788,574	1,051	1,154,267

Source: CAPMAS

2) ANSDK ferro-silicon procurement

The quantity of ANSDK purchased ferro-silicon is shown in Table 5-6-21. ANSDK purchases ferro-silicon from KIMA in Aswan and EFACO in Edfo near Aswan.

Table 5-6-21 Quantity of ANSDK Purchased Ferro-Silicon

Year	Quantity (t)
1994	3,350
1995	6,380
1996	4,800

Source: ANSDK

3) Ferro-silicon quality

According to the information provided by ANSDK, the quality of Ferro-silicon is as follows;

Si : 68 % minimum
C : 0.2 % maximum
P : 0.05 % maximum
S : 0.02 % maximum

(4) Aluminum

Aluminum is consumed in the electric arc furnace for de-oxidation. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 600 t/y which will be procured from local supplies.

1) Present situation in Egypt

Aluminum used for steelmaking is available from local supplies. Table 5-6-22 shows production and unit price of aluminum in Egypt.

Table 5-6-22 Production and Price of Aluminum in Egypt

Year	Production (t)	Value (1,000 LE)	Unit price (1,000 LE/t)
1987/88	173,460	617,373	3.6
1988/89	180,931	808,652	4.5
1989/90	179,167	674,727	3.8
1990/91	177,707	748,905	4.2
1991/92	177,838	743,550	4.2
1992/93	178,477	789,243	4.4
1993/94	180,236	799,035	4.4
1994/95	181,061	1,137,809	6.3
1995/96	179,774	1,167,622	6.5

Source: CAPMAS

2) ANSDK aluminum procurement

The quantity of ANSDK purchased aluminum are shown in Table 5-6-23. ANSDK purchases aluminum from ECW in Alexandria.

Table 5-6-23 Quantity of ANSDK Purchased Aluminum

Year	Quantity (t)
1994	164
1995	73
1996	115

Source: ANSDK

3) Aluminum quality

According to the information provided by ANSDK, the quality of the aluminum is shown as follows;

Weight of piece : 5 kg

Al : 99.9 %

(5) Fluorspar

Fluorspar is one of the additives sometimes used in the electric arc furnace to improve the fluidity of slag. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 500 t/y which will be procured from local supplies.

1) Present situation in Egypt

Fluorspar used for steelmaking is available from local supplies. Table 5-6-24 shows production and unit price of fluorspar in Egypt.

Table 5-6-24 Production and Price of Fluorspar in Egypt

Year	Production (t)	Value (1,000 LE)	Unit price (LE/t)
1987/88	1,849	311	168
1988/89	1,611	268	166
1989/90	1,249	225	180
1990/91	1,526	351	230
1991/92	981	232	236
1992/93	521	120	230
1993/94	514	141	274
1994/95			
1995/96			

Source: CAPMAS

(6) Graphite electrodes

Graphite electrodes are used in the electric arc furnace. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 2,500 t/y. Electrodes for ultra high power use are not available in Egypt.

1) ANSDK Graphite electrode procurement

Table 5-6-25 shows the quantity of ANSDK purchased electrode. Electrodes are imported from Europe and Japan.

Table 5-6-25 Quantity of ANSDK Purchased Electrode

Year	Quantity (t)
1994	4,820
1995	4,120
1996	4,110

Source: ANSDK

(7) Refractories

Refractories for steelmaking is used for high temperature furnace and ladle. This requirement for the flat steel products plant of 1,000,000 t/y is approximately 5,000 t/y. Some kinds and quantities of refractories for steelmaking will be purchased in the local market.

1) Present situation in Egypt

Production of refractories for industrial use in Egypt is shown in Table 5-6-26.

Table 5-6-26 Production and Price of Refractories in Egypt

Year	Production (t)	Value (1,000 LE)	Unit price (LE/t)
1987/88	164,521	35,458	216
1988/89	181,113	50,968	281
1989/90	168,633	47,218	280
1990/91	156,050	55,859	358
1991/92	147,911	64,705	437
1992/93	115,044	55,646	484
1993/94	131,850	60,937	462
1994/95	115,000	49,850	433
1995/96	111,702	57,169	512

Source: CAPMAS

There is a refractories manufacturer in Cairo, The Egyptian Co. for Refractories which is the largest producer in the Middle East, North Africa, Mediterranean and Gulf areas, and has an 80 % share for the Egyptian market. It has already supplied gunning and fettling materials for steelmaking and will supply some kinds and quantities of refractories for steelmaking use at international prices.

2) ANSDK Refractories procurement

Table 5-6-27 shows the quantity of ANSDK purchased refractories. Refractories brick is imported from Europe.

Table 5-6-27 Quantity of ANSDK Purchased Refractories

	Quantity (t)
1994	20,490
1995	25,840
1996	28,710

Source: ANSDK

Chapter 6

FACILITY PLAN

Chapter 6. FACILITY PLAN

This chapter describes the facilities which are required for the start-up of the flat product plant in 2005 (1st stage), and annual production capacity is one million tons as shown in section 5-1-1.

6-1 Direct Reduction Plant

6-1-1 Outline

(1) Basic plan of DRP

Basic plan of the direct reduction plant (DRP) for the flat steel plant is to adopt the MIDREX Megamod® of gas based direct reduction plant.

(2) Production and products

1) Production capacity

Production capacity of the DRP is 1,000,000 ton of direct reduced iron per year.

2) Product specification

The expected main specifications of the direct reduced iron are as follows:

(a) Fe Total	:	90 - 94	wt %
(b) Fe Metallic	:	83 - 89	wt %
(c) Metallization	:	92 - 95	wt %
(d) Carbon content	:	1.0 - 2.5	wt %

(3) Scope of facilities

DRP comprises of the following facilities:-

1) Reduction system
2) Reforming system
3) Process gas system
4) Heat recovery system
5) Seal gas and purge gas system
6) Emergency inert gas system

7) Water system
8) Fire fighting system
9) Dust collection system

6-1-2 Basic design

(1) Raw materials

The design basis of the raw materials for DRP is 1,500,000 ton per year of iron oxide feed mixture of lump ore and oxide pellet.
Typical standard mixing ratio of the raw materials is as follows:

1) Lump ore :20 - 30 wt %
2) Oxide pellets :80 - 70 wt %

(2) Operation

1) Operation shift
Daily operation shift is three shifts operation by four crews.

2) Operation hours
Annual operation hour is 7,500 hours, which is determined based on the consideration of the annual production schedule of the flat steel plant.

(3) Unit consumption

The following are the expected unit consumption (per ton of product) based on the MIDREX Megamod® plant:

1) Iron oxide : 1.5 t
2) Natural gas : 2.5 Gcal(LHV)
3) Electricity : 125 kwh
4) Water : 1.5 m^3

6-1-3 Production plan

(1) Rated production plan

Rated annual production plan is 1,000,000 tons of direct reduced iron per 7,500 hours.

(2) Start-up production plan

At the initial stage of plant start-up, the facilities will be checked through the production operation and operators may not be familiar with operation and maintenance works of the plant. Therefore, production capacity will be gradually increased from the initial start-up and be reached to the full production scale.
Production schedule will be as follows:

1) The 1st year : 70 % of the annual rated capacity
2) The 2nd year : 90 % of the annual rated capacity
3) After the 2nd year : 100 % of the annual rated capacity

6-1-4 Process and equipment description

Process and equipment of the main systems of DRP is described hereinafter.

(1) Reduction system

The reduction furnace is the patented MIDREX Shaft Furnace with a 6.65 meter diameter. Iron ores enter the Shaft Furnace through the upper dynamic seal leg and are then uniformly distributed on the stock line by means of a plurality of symmetrical feed pipes.

The iron ores are reduced to metallic iron in the reduction zone (upper portion of the furnace) by contact with hot gases containing hydrogen and carbon monoxide, which flow counter current to the descending iron oxide. Uniform reducing gas flow is assured by special designed inlet ports (tuyeres).
Below the reduction zone, the furnace contains burden feeders which ensure a uniform velocity of material flow through the furnace.

In the lower portion of the MIDREX Shaft Furnace, the direct reduced iron (DRI) is cooled by re-circulated cooling gas to near ambient temperature.
The DRI leaves from the shaft furnace through the bottom gas seal leg which operates in the

same manner as the upper seal leg. The vibrating discharge feeder is used to control the rate of product discharge from the shaft furnace. Product is discharged onto the product discharge conveyor. The product discharge system conveys the DRI from the discharge feeder to the DRI product silos.

(2) Reforming system

The MIDREX Reformer is a refractory-lined, gas-tight steel structure which contains vertically suspended heat resistant alloy tubes filled with catalyst and arranged in the fire box in six parallel rows. For ease of installation and future expansion, the reformer is constructed of modules called "bays".
The reformer tubes are supported at the roof and expand downward through the floor of the reformer. The bottom of each tube is sealed with a flexible expansion seal to prevent air infiltration into the combustion zone of the reformer.

A preheated mixture of scrubbed and compressed process gas and natural gas enters the bottom of each reformer tube and flows upward through the static catalyst bed. The natural gas is stoichiometrically reformed with carbon dioxide and water contained in the process gas stream to produce a hot hydrogen and carbon monoxide containing gas.
The reformed gas exiting from three headers (each tied into two rows of reformer tubes) is collected into a single refractory lined duct that supplies the reducing gas directly to the bustle of the reduction shaft furnace.

Heat for the reformer is supplied by the main burners which are located on the bottom of the reformer box between tube rows and between the outside tube rows and the reformer wall. The fuel for main burner combustion is a mixture of natural gas and excess spent reducing gas which has been cleaned and cooled in the top gas scrubber to produce top gas fuel.

The required air for combustion of the main burner fuel mixture is supplied by the main air blower. Natural gas fired auxiliary burners serves to maintain reformer box temperature when the Plant is in an idle mode of operation so as to minimize both restart time and thermal cycling of the reformer tubes.

Flue gas is withdrawn from the reformer box in two flue gas headers arranged along the upper parts of both longitudinal walls of the reformer. To ensure uniform heat distribution along the reformer length, each reformer bay has a separate flue gas port to each of the flue gas headers.
These flue gas ports are located in the side wall sections of every bay directly below the

reformer roof. The flue gas headers are refractory lined and expansion joints are provided between the single sections of the headers to compensate for thermal expansion. Also, to permit thermal expansion, the reformer structure is anchored at its center and allowed to expand freely in either direction. A series of sliding plates allow the columns to move horizontally in an uninhibited fashion.

Finally via the flue gas header, the flue gas exiting the reformer box flows to the heat recovery system where the waste heat is recovered.

(3) Process gas system

The process gas system consists of a direct contact water scrubber and compressors necessary to clean, cool, and compress the spent reducing gas exiting the shaft furnace.

The spent reducing gas exits the shaft furnace and first enters the top gas scrubber. Inside the scrubber the gas passes through two distinct processing zones:

1) The gas first flows through the venturi portion of the scrubber where the hot gas is rapidly cooled and particulate matter is wetted and removed;
2) Warm gas is then split into two streams that pass through two parallel packed beds and two sets of spin vanes (for water droplet removal) within the scrubber. Additional gas cooling takes place within the packed beds and excess water vapor condenses.

After scrubbing and cooling, approximately two-thirds of the clean top gas (now process gas) flows to the inlets of the process gas compressors.
The process gas is subsequently mixed with preheated natural gas before entering the feed gas pre-heater. The preheated feed gas is then passed through the reformer tubes filled with catalyst where the reforming reactions take place with a sufficient supply of energy from the reformer's main burners, both to heat the gases to the temperature required for reduction and to supply the heat required by the reforming reactions.

The remaining one-third of the cleaned top gas (now top gas fuel) is mixed with a small amount of natural gas to become the fuel mixture for the reformer main burners. The fuel then passes through a mist eliminator to remove water droplets before entering in the top gas fuel pre-heater.
Reformed process gas exiting the reformer (now reformed gas) is usually too hot for direct injection to the reduction shaft furnace as bustle gas. Therefore, tempering or cooling of the hot reformed gas is required to obtain the proper temperature.

The reformed gas cooler performs the function of cooling a small slip stream of reformed gas which is then mixed with the remainder of hot reformed gas to obtain a bustle gas of proper temperature. This reformed gas cooler is a packed bed, direct contact cooler which uses a spray of process water as the coolant.

(4) Heat recovery system

The flue gas from the reformer is used to preheat the reformer main combustion air, the feed gas stream, the main burner fuel and the process natural gas. The total benefit of the heat recovery system is an increase in reformer capacity and a reduction in the net plant energy consumption by approximately 25 - 30 percent from the first generation MIDREX Plant designed in 1969. The system consists of combustion air recuperators, feed gas pre-heaters, top gas fuel pre-heaters, process natural gas pre-heaters, and a fan and an ejector stack.

The ejector stack is a forced draft (venturi type) flue gas stack that induces the hot flue gas to flow from the reformer through the heat recovery system. A fan is used to create the required suction to cause flow of the hot reformer flue gas by creating a venturi effect within the stack. The combustion air recuperators are U-bundle type heat exchangers which are arranged within the refractory-lined reformer flue gas ducts. The recuperators are designed to preheat the combustion air to about 675 °C in two stages.

The natural gas is preheated to 370 °C, then mixed with the process gas (feed gas) heating it to over 100 °C. The feed gas pre-heaters finish heating the process gas and natural gas mixture to approximately 400 °C in the first pass and to a final temperature of 580 °C after the second pass. The feed gas pre-heaters are U-bundle type heat exchangers which are suspended in the refractory lined reformer flue gas ducts situated downstream from the combustion air recuperators.

The top gas fuel pre-heaters are also U-bundle type heat exchangers which are suspended in the refractory lined reformer flue gas ducts situated downstream from the natural gas pre-heaters. The top gas fuel pre-heaters are designed to preheat the main burner fuel to approximately 290 °C.

6-1-5 Organization and personnel

Table 6-1-1 shows the organization and personnel plan of the DRP of the flat product plant.

Table 6-1-1 Organization and Personnel for DR Plant

Description	Per Day	Per Shift(*1)	Total
Section Manager	1	0	1
Assistant Section Manager	1	0	1
Process & Operations / Engineer	2	0	2
Water Treatment / Engineer	1	0	1
Shift Foreman	0	1	4
Control Room Operators	0	4	16
Field Operators	0	8	32
Material Handling Supervisors	1	0	1
Material Handling Operator	0	0	0
Process/Laboratory Technician	0	1	4
Total	6	14	62

Note 1. (*1) : Three shifts by four crews per day.

6-1-6 Drawing and equipment list

(1) General layout

Refer to Figure 6-1-1

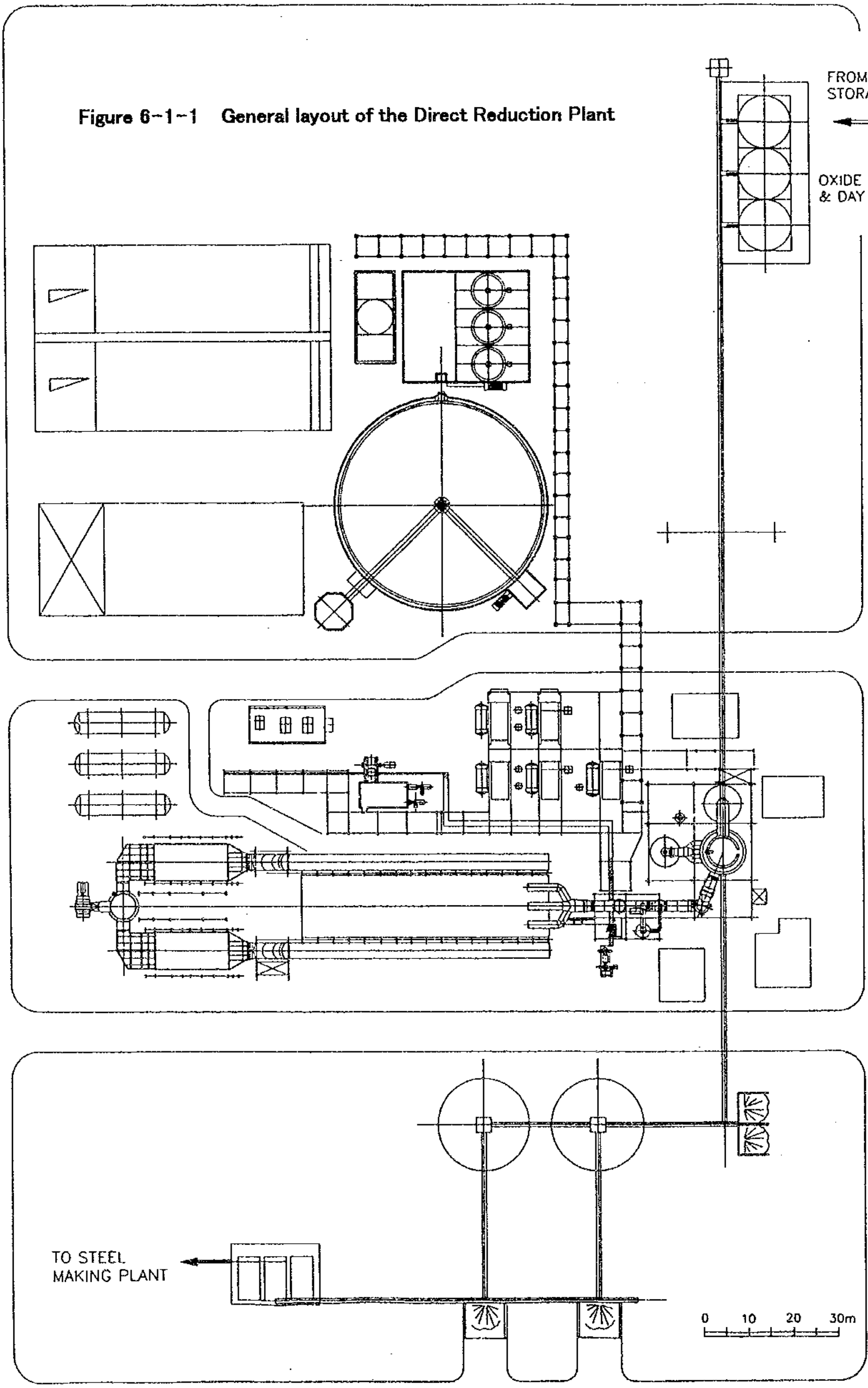
(2) Equipment list

Refer to Appendix 6A-1-1

(3) Drawings

Refer to Appendix 6A-1-2

Figure 6-1-1 General layout of the Direct Reduction Plant



6-2 Steelmaking Plant

6-2-1 Outline

(1) Basic concept

The steelmaking Plant (SMP) consists of one 160 t DC EAF (DC Electric Arc Furnace), one 160 t LF (Ladle Furnace), one, one strand SL-CCM (Slab Continuous Casting Machine), and auxiliary facilities to produce slab for flat products. The main raw materials for the EAF are scrap and DRI (Direct Reduced Iron).

(2) Production and products

1) Production

The production amount of the SMP is shown in Table 6-2-1.

Table 6-2-1 SMP Production

Unit: t/y

Item	SMP
Molten Steel	1,026,000
Slab	1,000,000

2) Products and steel grades

Products and steel grades from the SMP are shown in Table 6-2-2.

Table 6-2-2 Products and Steel Grades

Item	SMP
Products	Slab: 210 mm thicknessx x 800 - 1,600 mm width x 5,000 - 10,900 mm length x 28.0 t weight
Steel grade	DIN st 12, 13, 14 :36 % St 33 : 4 % st 37 :54 % st 44,50,52 : 6 %

(3) Facilities

1)	Handling facilities	: 1 lot
2)	Electric arc furnace facilities	: DC type 160 t x 1 unit
3)	Fume extraction system (FES)	: 1 unit
4)	Ladle furnace facilities	: 160 t x 1 unit
5)	Cranes and jib cranes facilities	: 1 lot
6)	Electrical equipment, computer system and instrumentation	: 1 lot
7)	Slab caster facilities	: 1 strand x 1 unit
8)	Spareparts and consumables	: 1 lot

6-2-2 Basic design

(1) General

1) Main raw materials

Considering the DRI production of 1,000,000 t/y in the direct reduction plant (DRP), the DRI/Scrap ratio is as shown in Table 6-2-3.

Table 6-2-3 EAF DRI/Scrap Ratio

Unit: %

Material	Ratio
DRI	86.3
Scrap	13.7

2) Operation shift

Operation is in three shifts by four crews.

3) Operation

One 160 t EAF operates with a 70 min. tap-to-tap time along with one LF operation for eight sequential casting operations with a 57 min/heat casting time for one strand SL-CCM.

4) Annual operation days

Annual operating time is 310 days.

Annual non-operating hours including preventive maintenance and unexpected shut-downs are shown in Table 6-2-4.

Table 6-2-4 Non-operating Hours

Items	Hours	% *1
(1) Periodical maintenance	16 hr x 1 time/w = 832 hr	9.5
(2) Mechanical maintenance	96 hr x 2 time/y = 192 hr	2.2
(3) Refractory & electrical maintenance	144 hr x 1 time/2y = 72 hr	0.8
(4) Total scheduled maintenance = (1)+(2)+(3)	1,096 hr	12.5
(5) Un-expected shut-down	224 hr	2.6
(6) Total non-operating hours = (4)+(5)	1,320 hr = 55 days	15.1

*1 : Percentage for 365 days

5) Plant capacity

Plant capacity is determined based on total consideration of annual slab production, annual operating time, tap-to-tap time and casting time, transformer capacity, slab weight, slab yield, etc.

Molten steel;

160 t/ht x 310 d/y x 20.7 ht/d = 1,026,000 t/y

Slab;

1,026,000 t/y x 97.5 % = 1,000,000 t/y

(2) EAF equipment and operating factors

1) Type : DC arc furnace with EBT
2) Heat capacity : 160 t/ht (excluding 20 t hot heel)
3) Transformer capacity : 133 MVA
4) DRI/scrap ratio : 86.3/13.7
5) Oxygen consumption : 30 Nm^3/t-MS
6) Electrical power consumption : 542 kWh/t-MS

7) Heats/day: 20.7 ht/d

8) Tap-to-time:

Tapping time	: 3	min.
Fettling time	: 6	min.
Charging time	: 2	min.
Melting/refining time	: 59	min. *1
Tap-to-tap time	: 70	min.

Note *1: Each heat shall be subjected to LF treatment after EAF tapping.

(3) LF equipment and operating factors

1) Type : AC, three phase type
2) Ladle capacity : 160 t/ht
3) Transformer capacity : 23 MVA
4) Electrical power consumption : 25 kWh/t-MS
5) Heats/day : 20.7 ht/d
6) Operating time : 20 - 40 min/ht

(4) CCM equipment and operating factors

1) Machine type: Vertical progressive bending type with multi-point unbending.
2) Slab size:
   - Thickness : 210 mm
   - Width : 800 - 1,600 mm, average 1,200 mm
   - Length : 5,000 - 10,900 mm
   - Weight : 28.0 t (PIW = 1,000)
3) Casting speed:
   - Maximum : 2.0 m/min.
   - Average : 1.4 m/min.
4) Casting time : 57 min./ht
5) Sequence casting: 8 heats

6-2-3 Production plan

(1) Rated production

Table 6-2-5 SMP Production Plan

Unit: t/year

Product	Annual production	Monthly production	Daily production
Molten steel	1,026,000	85,500	3,310
Slab	1,000,000	83,330	3,226

(2) Start-up production

At the beginning of start-up, installed equipment is checked through the production operation, and operators are familiar with the equipment and its operation. Production is gradually increased to reach full production one year following start-up.

First year

Molten steel	:	615,400 t
Slab	:	600,000 t

Subsequent years

Molten steel	:	1,026,000 t
Slab	:	1,000,000 t

(3) Material balance

Figure 6-2-1 shows the material balance at full production.

(4) Unit consumption, by-products and waste

Table 6-2-6 shows unit consumption of materials, refractories, utilities, by-products and waste.

Figure 6-2-1 SMP Material Balance at Full Production

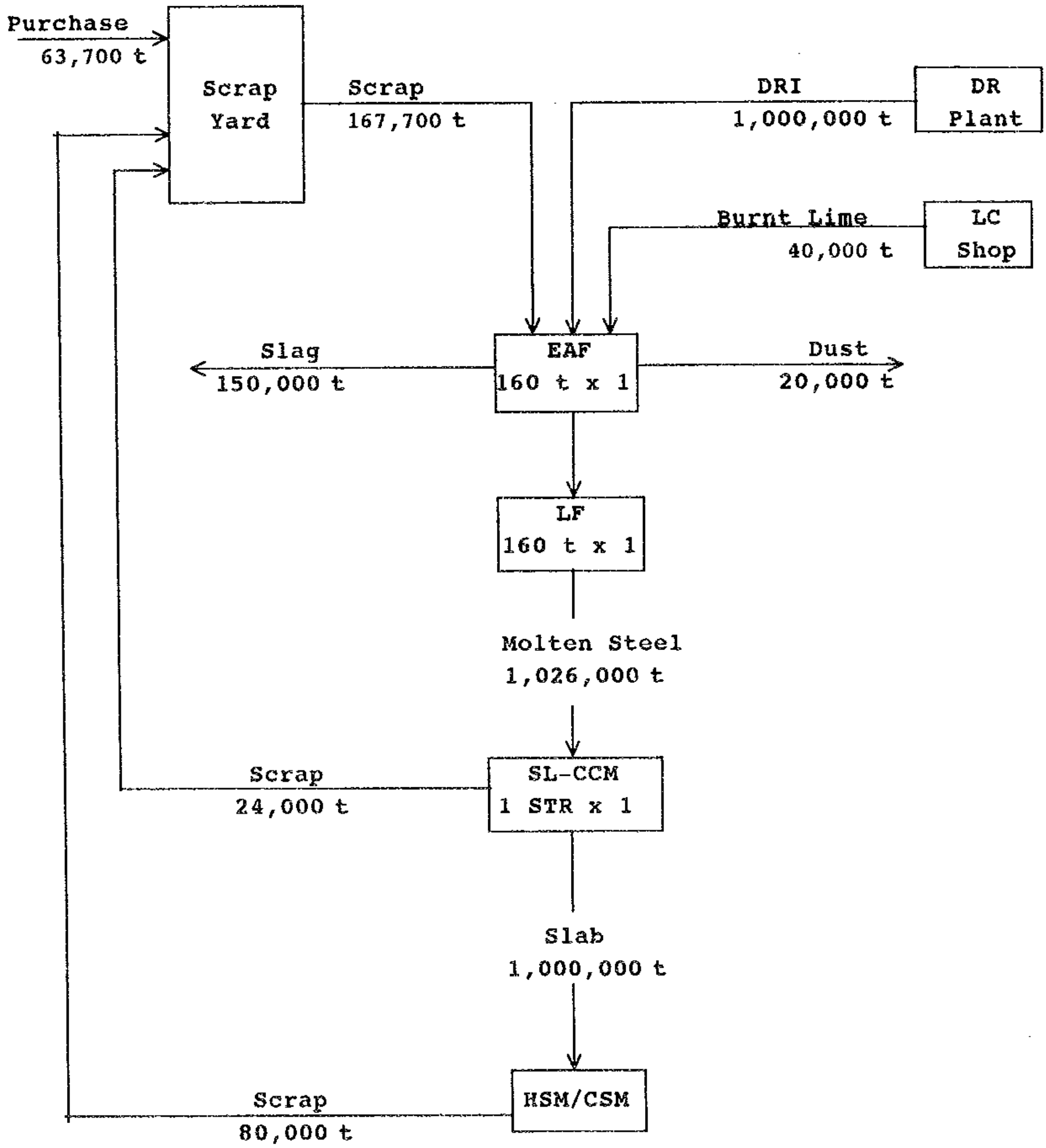


Table 6-2-6 Unit Consumption, By-products and Waste

Item	Unit consumption	Materials Required		
		Per year	Per month	Per day
1 DRI	1,000.0 kg/t-SL	1,000,000 t	83,330 t	3,226 t
2 Scrap	167.7 kg/t-SL	167,700 t	13,980 t	541 t
3 Burnt Lime	40.0 kg/t-SL	40,000 t	3,330 t	129 t
4 Fluorspar	0.5 kg/t-SL	500 t	42 t	1.6 t
5 HC/Fe-Mn	1.7 kg/t-SL	1,700 t	140 t	5.5 t
6 MC/Fe-Mn	0.8 kg/t-SL	800 t	67 t	2.6 t
7 Fe-Si	0.2 kg/t-SL	200 t	17 t	0.6 t
8 Fe-Nb	0.1 kg/t-SL	100 t	8 t	0.3 t
9 Al	0.6 kg/t-SL	600 t	50 t	1.9 t
10 Fe-Cr	0.4 kg/t-SL	400 t	33 t	1.3 t
11 Coke Lum/Breeze	35.0 kg/t-SL	35,000 t	2,920 t	113 t
12 Furnace Brick	0.8 kg/t-SL	800 t	67 t	2.6 t
13 Fettling Materials	7.0 kg/t-SL	7,000 t	580 t	23 t
14 Ladle Brick	2.8 kg/t-SL	2,800 t	230 t	9.0 t
15 Electrode	1.8 kg/t-SL	1,800 t	150 t	5.8 t
16 Tundish Brick	1.4 kg/t-SL	1,400 t	120 t	4.5 t
17 Slag	150 kg/t-SL	150,000 t	12,500 t	484 t
18 Dust	20 kg/t-SL	20,000 t	1,670 t	65 t
19 Scrap from CCM	24.0 kg/t-SL	24,000 t	2,000 t	77 t
20 Waste Brick from EAF *1	4.0 kg/t-SL	4,000 t	330 t	13 t
21 Waste Brick from CCM	1.0 kg/t-SL	1,000 t	80 t	3.2 t
22 Scale	1.0 kg/t-SL	1,000 t	80 t	3.2 t
23 Electric power for EAF *2	607 kWh/t-SL	607,000 MWh	50,583 MWh	1,958 MWh
24 Electric power for CCM	10 kWh/t-SL	10,000 MWh	833 MWh	32 MWh
25 Make-up Water for EAF *3	0.8 m3/t-SL	800,000 m3	66,700 m3	2,581 m3
26 Make-up Water for CCM	1.0 m3/t-SL	1,000,000 m3	83,300 m3	3,226 m3
27 Compressed Air for EAF *3	13.0 Nm3/t-SL	13,000,000 Nm3	1,083,000 Nm3	41,935 Nm3
28 Compressed Air for CCM	29.0 Nm3/t-SL	29,000,000 Nm3	2,417,000 Nm3	93,548 Nm3
29 Natural Gas for EAF	0.8 Nm3/t-SL	800,000 Nm3	66,700 Nm3	2,581 Nm3
30 Natural Gas for CCM	3.2 Nm3/t-SL	3,200,000 Nm3	266,700 Nm3	10,323 Nm3
31 Oxygen Gas for EAF	30.0 Nm3/t-SL	30,000,000 Nm3	2,500,000 Nm3	96,774 Nm3
32 Oxygen Gas for CCM	2.0 Nm3/t-SL	2,000,000 Nm3	167,000 Nm3	6,452 Nm3
33 Nitrogen Gas for EAF	4.0 Nm3/t-SL	4,000,000 Nm3	333,000 Nm3	12,903 Nm3
34 Argon Gas for EAF *3	0.2 Nm3/t-SL	200,000 Nm3	17,000 Nm3	645 Nm3
35 Argon Gas for CCM	0.5 Nm3/t-SL	500,000 Nm3	42,000 Nm3	1,613 Nm3

Note *1 including ladle
*2 including LF and auxiliary
*3 including LF

SL Annual Production 1,000,000 t
Operating days 310 d/y

6-2-4 Process and equipment description

(1) Scrap charging

After being loaded on dump trucks by scrap loaders at the open scrap yard and weighed at a weighing station, scrap is transported to the EAF aisle, and dumped directly into a scrap bucket placed in the pit.
Scrap in the scrap bucket is charged into the furnace by the scrap charging crane.

This scrap bucket is of the clam shell type.
Capacity of the scrap charging crane is 110/30 t. The main hoist is to lift the scrap bucket with scrap, and the auxiliary hoist is to be used for miscellaneous work.

Concerning the scrap loader, the dump trucks and weighing station, see the transportation facilities described in another section.

(2) DRI and burnt lime charging

DRI (Direct Reduced Iron) produced in the DRP (Direct Reduction Plant) and burnt lime produced in the LCP (Lime Calcining Plant) are transported by belt conveyor to storage hoppers in the DRI aisle. This transfer is automatically and remotely controlled.
DRI and burnt lime stored in the storage hoppers are continuously fed to the EAF by belt conveyor and chute. This operation is automatically and remotely controlled in accordance with the melting program.

The DRI/lime storage system has junction houses, conveyors, storage hoppers and trippers to distribute DRI and burnt lime into the storage hoppers.
The DRI/lime charging system has such facilities as weighing feeders equipped under the storage hoppers, and DRI/lime conveyor.

(3) Melting

In the EAF, scrap charged by the scrap bucket and continuously fed DRI are melted in accordance with the melting process program by electric power with the help of oxygen lancing as well as carbon injection to achieve rapid melting and the generation of foamy slag. After melting at the target temperature and achieving the desired composition of molten steel, the heat is tapped through the EBT (eccentric bottom tapping system) into the ladle lying on the ladle transfer car, leaving about 20 t hot heel in the furnace. After melting of the scrap and DRI, ferro-alloys can be added by means of an automatic additive charging system into the EAF if necessary.

The EAF is of the 160 t/heat DC type with a 133 MVA transformer to produce each heat in 70 min.

(4) Ladle furnace operation

After tapping is completed the heat is transferred to the LF station, located in the ladle aisle, by the ladle crane. Burnt lime and ferro-alloys are added to the ladle during tapping. Before receiving molten steel from the EAF, ladles are heated by natural gas fired burner.
At the LF station, the molten steel is subjected to metallurgical treatment for adjustment of the temperature and composition by electric power, alloy addition and inert gas bubbling through porous plug on the bottom of the ladle.
The heat is then transferred by the ladle crane to the SL-CCM and cast into slabs.
The LF station is also utilized for adjustment of operating time between the EAF and SL-CCM.

The LF is of the 160 t/heat AC type with a 23 MVA transformer to treat each heat within 40 min.

(5) Additives storage and charging

An additive storage system is installed in the DRI aisle. Additives are transported from the additive warehouse by dump truck and stored in storage hoppers through a dumping hopper, conveyors and a tripper. Additives thus stored are fed by means of an automatic additive charging system into the EAF before tapping, the ladle during tapping and the LF treatment.

(6) Continuous casting operation

After LF treatment, the heat is transferred by the ladle crane to the SL-CCM turret. The molten steel in the ladle is cast into slab through the pre-heated tundish with a slide gate on a tundish car, and water cooled mold. For casting, a tundish nozzle control system, mold width change system, shrouding system and mold oscillation system are applied.

The cast slab is water-cooled in a cooling chamber, and withdrawn by withdrawal unit. Slab is discharged after cutting to the determined length by a torch cut-off device. For discharging, deburring equipment and marking equipment are provided.

6-2-5 Organization and personnel

Table 6-2-7 shows the organization and personnel.

6-2-6 Drawing and equipment list

(1) General layout

Refer to Figure 6-2-2.

(2) Equipment list

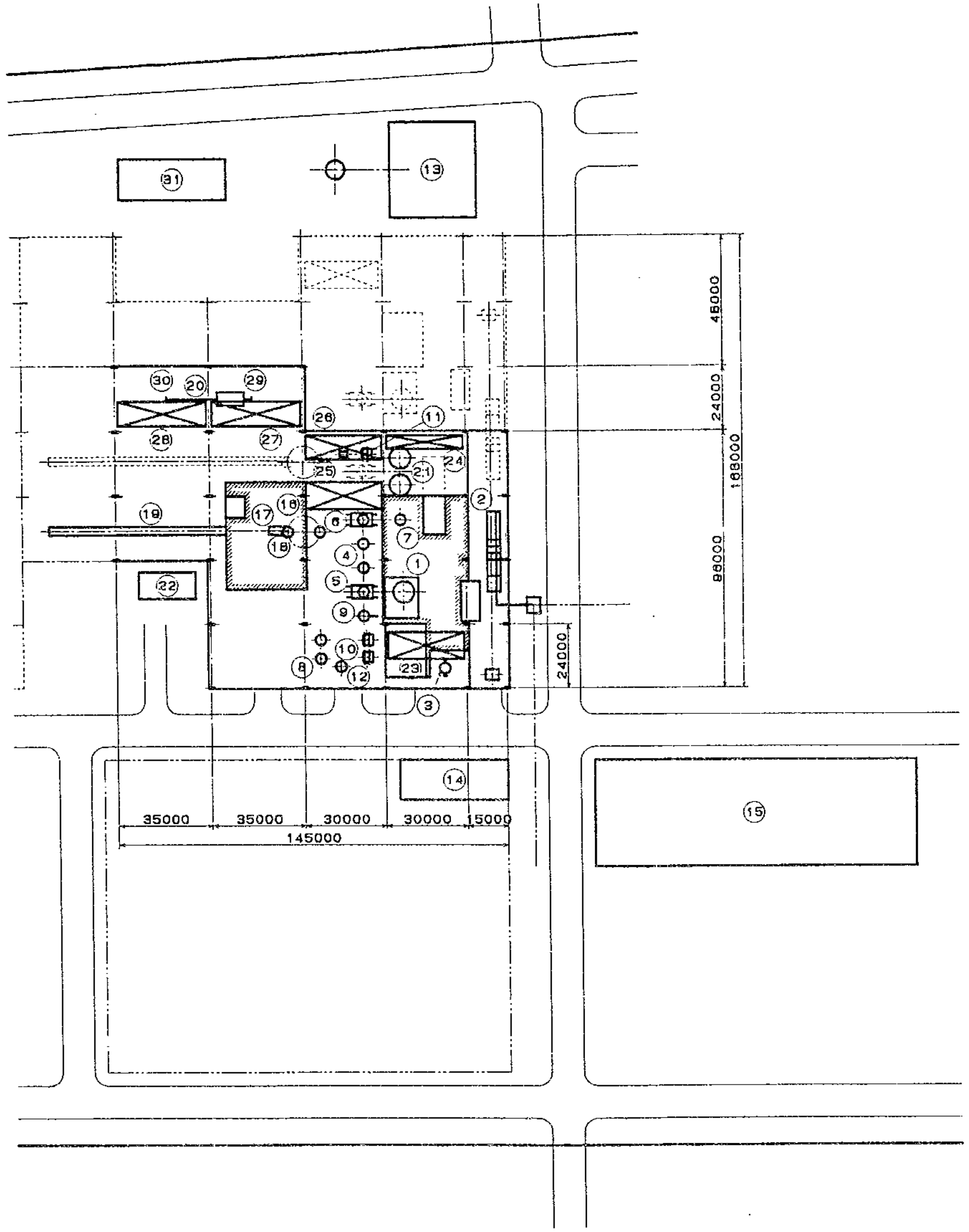
Refer to Appendix 6A-2-1.

(3) Drawings

Refer to Appendix 6A-2-2.

Table 6-2-7 SMP Organization and Personnel

Section Manager	Asst. Section Manager	Engineer	Foreman	Asst. Foreman	Worker	Remarks
				1 x 4	2 x 4	Raw material handling
	EAF		EAF/LF operation	1 x 4	4 x 4	EAF operation
	1 x 1	1 x 1	1 x 4		1 x 4	Scheduling
				1 x 4	2 x 4	LF operation
			Crane/Day work	1 x 4	7 x 4	EAF crane operation
			1 x 4		2 x 4 + 2	CCM crane operation
				1 x 1	2 x 1	Supplies control
				1 x 1	3 x 1	Additives control
SMP				1 x 1	6 x 1 +1	Minor repair work
1 x 1						
			CCM operation	1 x 4	3 x 4 +3	CCM operation (& relief)
			1 x 4		2 x 4	Slab cutter
				1 x 1	10 x 1	Mold/segment repair work
	CCM				2 x 1	Supplies control
	1 x 1	1 x 1				
			Refractories	1 x 1	4 x 1	Furnace
			1 x 4	1 x 4	5 x 4	Ladle preparation
				1 x 4	6 x 4	Tundish preparation
				1 x 4	3 x 4	Ladle relining
					1 x 1	Clerical work
1	2	3	16	37	174	Total 233



NO	EQUIPMENT
1	ELECTRIC ARC FURNACE
2	MATERIAL HANDLING SYSTEM
3	SCRAP BUCKET
4	LADLE
5	LADLE TRANSFER CAR FOR EAF
6	LADLE TRANSFER CAR FOR LF
7	LADLE FURNACE
8	LADLE RELINING STATION
9	LADLE DRYER
10	PREPARATION STATION
11	LADLE DIGOUT STATION
12	SLAG POT
13	DUST COLLECTOR
14	SMP SUBSTATION
15	WATER TREATMENT FOR SMP
16	LADLE TURRET
17	TUNDISH
18	SLAB CASTER
19	RUNOUT TABLE
20	SEGMENT TRANSFER CAR
21	EAF ROOF STAND
22	SCALE PIT
23	SCRAP CHARGING CRANE
24	SERVICE CRANE
25	LADLE CRANE
26	LADLE SERVICE CRANE
27	TUNDISH HANDLING CRANE
28	SEGMENT HANDLING CRANE
29	TUNDISH YARD
30	MOULD/SEGMENT YARD
31	SMP OFFICE

Figure 6-2-2 General Layout of Steelmaking Plant

FLAT PRODUCT PROJECT OF EGYPT			
TITLE	SMP GENERAL LAYOUT		
DWG NO. EFP-SMP-001			
DATE	JUL.31.1997	SCALE	1/1000

6-3 Hot Strip Mill Plant

6-3-1 Outline

(1) Basic concept of the HSMP

The Hot Strip Mill Plant (HSMP) shall consist of a slab reheating furnace, roughing mill, finishing mill, down coiler, skinpass line (SKL) and plate finishing line (PFL), and produce hot rolled coil and plate.

It is assumed that hot rolled coil is processed into sheets and slitted coil at the service centers located near the customers (see Section 5-1-4).

Production capacity shall be set at approximately one million tons per year.

(2) Production and products

The products of the hot strip mill shall be hot rolled coil and hot rolled plate.

The product mix and specifications are shown in Tables 5-1-6 and 5-1-9 of Section 5-1, respectively.

(3) Scope of the facilities

The HSMP shall consist of the following main facilities.

Hot strip mill (HSM)
- Reheating furnace
- Roughing mill
- Finishing mill
- Down coiler

Hot rolled coil & plate finishing line
- Skinpass line (SKL)
- Plate finishing line (PFL)

6-3-2 Basic design

(1) Design concept

1) Slab

Thickness	: 210 mm nominal 140 mm min. for returned slab
Width	: 650 - 1,600 mm (Slabs of 650 - 800 mm width are produced by dividing double width slabs)
Length	: 5,000 - 10,900 mm
Weight	: 28 ton max.

- Slab conditioning	: 5 % of total slab
- Hot charged rolling ratio	: 60 %

2) Product size and weight

- Hot rolled coil

Thickness	: 1.60 - 13.0 mm
Width	: 610-1,600 mm
Coil weight	: 28 ton max.
Specific weight	: 17.8 kg/mm max. (PIW = 1,000)
Coil diameter	: 1300 - 1,900 mm
Bore diameter	: 762 mm (normal)

- Hot rolled plate

Thickness	: 13.0 - 24.0 mm
Width	: 1,300 - 1,600 mm
Length	: 5,000 - 15,000 mm
Plate weight	: 4.5 ton max.

(2) Capacity of hot strip mill

1) Hot strip mill rolling hours

Available rolling hours are estimated using the effective rolling hour ratio and maintenance schedule decided by the Study Team as shown in Tables 6-3-1 and 6-3-2.

- Calendar hours : 24 hr x 365 days = 8,760 hr
- Scheduled maintenance hours : 714 hr
- Available rolling hours : 8,046 hr x 0.85 = 6,839 hr

Back-up roll changing is scheduled in the maintenance periods.

Table 6-3-1 Effective Rolling Hour Ratio

Item	HSM (%)
Effective rolling hours ratio	85.0
Operational shut down	
Roll change	5.0
Miss roll	2.0
Equipment Shut Down	
Mechanical	4.0
Electrical	2.0
Other shut down	2.0
Shut down total	15.0

Table 6-3-2 Maintenance Schedule

Item	HSM
Major repair	192 hr (8 days per year)
Minor repair	120 hr (5 days per year)
Periodical repair	402 hr (16 hours per 2 weeks)
Total	714 hr

2) Estimated hot strip mill rolling rate

The rolling rate of the equipment (Reheating furnace, roughing mill and finishing mill) is shown in Table 6-3-3. The rolling rate of a hot strip mill is decided by reheating furnace capacity when the rolling rate is low.

In this flat project, reheating furnace capacity is set at 150 t/hr to satisfy the planning requirements for one million tons per year production.

Table 6-3-3 Estimated Hot Strip Mill Rolling Rate

Strip		Slab				Furnace	R mill		F mill		HSM
t	W	t	W	L	Weight	(t/hr)	Sec	t/hr	sec	t/hr	t/hr
2.3	750	210	750	10.9	13.5	150	180	270	140	347	150
3.8	750	210	750	10.9	13.5	150	180	270	120	404	150
6.0	750	210	750	10.9	13.5	150	180	270	110	441	150
2.3	1050	210	1050	10.9	18.9	150	180	377	140	485	150
3.8	1050	210	1050	10.9	18.9	150	180	377	120	566	150
6.0	1050	210	1050	10.9	18.9	150	180	377	110	617	150
2.3	1300	210	1300	10.9	23.4	150	180	467	140	601	150
3.8	1300	210	1300	10.9	23.4	150	180	467	120	701	150
6.0	1300	210	1300	10.9	234.	150	180	467	110	764	150
3.8	1500	210	1500	10.1	28.0	150	180	538	120	807	150
6.0	1500	210	1500	10.1	28.0	150	180	538	110	880	150
10.0	1500	210	1500	10.1	28.0	150	170	570	140	692	150

3) Estimated hot strip mill production capacity

Production capacity of the hot strip mill is calculated as follows ;

6,839 (hr/y) x 150 (t/hr) = 1,026,000 t/y

4) Estimated skinpass line production capacity

The estimated production capacity of the skinpass line is shown in Table 6-3-4. Capacity of the SKP is to be over 500,000 t/y at full operation. Working hours are decided according to required production.

Table 6-3-4 Skinpass Line Capacity

Item	Capacity (Average)
Average size	Thickness : 2.3 mm Width : 1,240 mm Coil Weight : 22.3 ton Coil Length : 1,000 m/Coil
Rolling rate (t/hr)	Rolling Speed : 100 mpm Rolling Rate(t/hr) : 135 t/hr
Operation	Necessary working hours : 170,000(t/y)/135(t/hr) = 1,260 hr/y → One shift operation will be enough.

5) Estimated plate finishing line production capacity

The estimated production capacity of the plate finishing line is shown in Table 6-3-5. Capacity is decided by gas cutting manpower according to required production.

Table 6-3-5 Plate Finishing Line Capacity

Item	Capacity (Average)
Average size	Thickness : 20.0 mm Width : 1,450 mm Length : 9,000 mm Weight : 2.0 ton
Operation & Capacity	Capacity of Plate Finishing Line is decided by gas cutting capacity (15t/hr with 1 gas cutting area). - Required production : 97,000 t/y - Necessary working hours : 97,000 t/y/15 t/hr = 6,470 hr/y → 4 crew three shift operation

5) Necessary stock yard area

The necessary stock yard area is shown in Table 6-3-6.

Table 6-3-6 Necessary Stock Yard Area for Hot Strip Mill Plant

Yard	Production (335 days/y)	Stock days	Capacity (t/m^2)	Necessary area
Slab yard	1,000,000 t/y = 2,990 t/day	5	5	3,000 m^2 = 30 m x 100 m (Plus 600 m^2 for Slab Conditioning yard)
Coil cooling Yard for SKL	180,000 t/y = 540 t/day	5	5	540 m^2 = 25 m x 22 m
As rolled Coil Yard	363,000 t/y = 1,080 t/day	15	5	3,240 m^2 = 25 m x 130 m (open space)
Skinpassed coil Yard	178,000 t/y = 530 t/day	15	3	2,650 m^2 = 25 m x 106 m (open space)
Cooling yard for Plate	102,000 t/y = 300 t/day	3	2	450 m^2 = 25 m x 18 m
Plate yard	97,000 t/y = 290 t/day	15	2	2,180 m^2 = 25 m x 87 m (open space)
Hot rolled coil yard for CRMP	440,000 t/y = 1,310 t/day	15	5	3,900 m^2 = 25 m x 156 m (open space)

6-3-3 Production plan

- Material flow/balance are shown in Figures 5-1-4 and 5-1-5 of Chapter 5.
- Product yield is shown in Table 6-3-7.
- The learning curve after start-up is shown in Table 5-1-10 of Chapter 5.

Table 6-3-7 Hot Strip Mill(HSM) and Skinpass Line(SKL) Yield

(%)

Line	Yield	
HSM	Yield	98.5
	Scale loss	1.0
	Miss roll	0.2
	Crop loss	0.3
SKL	Yield	99.0
	Scrap loss	1.0
PFL	Yield	95.0
	Scrap loss	5.0

6-3-4 Process and equipment description

The 1,600 mm Hot strip mill is designed to be arranged in a compact configuration consisting of one slab reheating furnace, one roughing mill with one attached edger, one coil box, one flying crop shear, five finishing stands, one down coiler, one skinpass mill, one plate finishing line and one roll shop.

The general layout of the HSMP is shown in Figure 6-3-1.

(1) Slab yard and slab charging

After slab continuous casting, slabs are transferred by over head crane and stocked in the slab yard. Approximately 60 % of slabs go to the reheating furnace within 12 hours at a temperature of 500-600 °C according to the hot rolling schedule (so-called Hot Charged Rolling : HCR). Approximately 5 - 10 % of slabs are surface conditioned to remove surface defects by manual scarfing. Other slabs and surface conditioned slabs are stocked in the slab yard for one to ten days until the hot rolling schedule is arranged. The average storage time of slabs is estimated to be 3.5 days.

The slabs are moved on the entry slab conveyer by manual over head crane. At the end of conveyer the slab transfer crane lifts the slabs and moves to the furnace entry table.
The slabs positioned on the table are transferred to the slab charging position and automatically stop at the proper position. The slab charger pushes the slabs into the walking beam type reheating furnace.

(2) Reheating furnace and slab discharging

By the walking beam mechanism, the slabs are automatically moved toward the end of the furnace, and are heated to the required temperature under computer control in each zone. The burners of the furnace are fired by natural gas.

Once the slabs are heated to the proper temperature for rolling, they are extracted from the delivery end of the reheating furnace and loaded onto the furnace delivery table by the slab extractor.

The stroke of the extractor is automatically set by the computer control system considering slab width and position. Therefore every slab is automatically positioned in the center of the mill line table.

(3) Roughing mill area

The extracted slab is descaled through an hydraulic scale breaker (HSB) by means of high pressure water on the top and bottom surfaces , transferred by roller table to the roughing mill entry side.
The entry side guide forcefullly centers the slab before it enters the first pass of the edger. Forced centering will be effective in reducing the camber of the transfered bar. The slab is rolled by the roughing mill through the standard five passes by reversing operation.
High pressure descaling headers are also provided at the entry and delivery sides of the roughing mill.
The attached vertical edger reduces the slab width at every odd numbered pass.

Width reduction per pass is limited by the following conditions. When the slab is thick, motor power and roll bite angle will become critical. When the slab thins, slab width buckling will be critical. As the overall width reduction becomes larger, fish tailing as well as width drop at the head and tail ends becomes larger. Consequently, product yield losses become higher. According to the experience of an ordinary mill, the appropriate overall width change from slab to coil will be 50 mm maximum.

At roll changing, roughing mill work rolls are pulled out by hydraulic cylinder and new work rolls pushed into the mill stand automatically. Used work rolls are moved to the roll shop by over head crane and roll transfer car.

(4) Coil box

The coil box is a key component of a compact hot strip mill for the following reasons.

The coil box

- reduces the distance between the roughing mill and finishing mill by coiling the transfered bar
- saves radiated heat loss from the transfered bar surface by coiling
- changes the tail end of the transfered bar coming out of the roughing mill to head end and keeps a uniform temperature throughout total bar length
- can be a buffer for production with coiling and uncoiling at the same time by adopting No.2 cradle rolls.

As a result of the above mentioned features, the coil box has the following advantages.

- Thinner strip can be rolled with fewer finishing stands.
- Reducing furnace skid marks by self soaking in coil form.
- Saving mill power by constant speed rolling (Acceleration power is not necessary).
- Isothermal rolling by constant speed rolling.
- Saving total initial investment costs.
- Saving operational costs.

At the final pass of the roughing mill, usually the 5th pass, the front of the transfered bar reaches the coil box, while the rear is still being rolled in the roughing mill. Simultaneous operation is achieved.

The coil box is used for all products other than bars thicker than 35 mm.
The coil box no-use mode is available for thicker products where the bar runs through the coil box without coiling.

(5) Crop shear

The head of the transfered bar is automatically cut by a crop shear during uncoiling. A curved knife is provided to shape the head for smooth threading into the finishing mill.
The tail is cut by an oppositely curved knife for better yield.

Two crop buckets are located at the bottom of the crop pit. A changeover gate operated by cylinder is provided for bucket selection. The crop bucket is transported by overhead crane.

Crop shear drums are retracted as a pair from the shear frame by means of hydraulic cylinder in a similar manner to mill roll changing. Knife changing and gap adjustment can be carried out using the spare pair of drums, which saves mill shutdown time.

(6) Finishing mill

The head end of the bar goes into the finishing scale breaker (FSB) for final descaling, then fed into the finishing mill.

Roll gap and rolling speed for all finishing stands are set automatically by the computer control system.

The main motors from F-1 to F-5 are identical AC drives of higher response speed control.

The roll gap setting is regulated by means of hydraulic cylinder, the so called, push-up cylinder.

Hydraulic cylinders for automatic gauge control (AGC)are provided for all stands. A motor driven screw down mechanism is not employed. The cylinder stroke covers work roll diameter change and roll gap setting, backup roll diameter compensation is carried out by means of step plate adjustment at the time of backup roll changing.

A powerful work roll bending system and work roll shifting system are provided for the F1 to F5 finishing stands for strip profile control and schedule free rolling.

Low inertia loopers are provided between the stands F-1 to F-5 aiming for high response of finishing mill speed control at high speed AGC for better strip thickness and width.

Another important factor is the work roll changing mechanism. A pair of top and bottom work rolls is pushed out by motor operated ram located on the drive side, and changed to a new pair by the side shifter at the mill front. The new pair is pulled into the mill. Connection or disconnection of hoses is not necessary for work roll changing. Allowable time for the finisher work roll change of all stands is 10 minutes.

Backup roll assembly is designed for interchangeability with all mills.

(7) Run-out table and strip cooling

Strip from the finishing mill is fed to the down coiler through the run-out table. The run-out table is so designed to feed thin gauge strip without any problems. A Strip cooling system is provided at the run-out table, siphon type pipe laminar for the top headers and spray type headers for the bottom. Three vernier banks are provided for higher controllability of strip coiling temperature. There are a total of eight banks. Sweep sprays (side sprays) are provided. Run-out table speed is automatically adjusted to have leading speed before the strip enters the down coiler and lag speed after the tail exits the finishing mill.

(8) Down coiler

A hydraulic type side guideis provided at the entry to the down coiler which controls coil telescope. The head of the strip is fed into the down coiler through pinch rolls. A hydraulic down coiler is provided. Automatic jumping control by hydraulics can produce high quality hot rolled coil. A plug-in type mandrel is provided with a double expanding function. Coiling speed, pinch roll gap and pressure, and wrapper roll gap and pressure are automatically set by the coiler setup program. For thicker gauge or harder materials, a pressure roll is provided at the entry side of the pinch roll for returning tension to the strip after the tail leaves the finishing mill.

The coil tail stops at a designated position automatically. Then a coil stripper car transports the coil to the walking beam type coil conveyor with horizontal coil-eye.
A Coil banding machine is located at the coil conveyor. A Coil weigher is located next to the banding machine. A coil marking device is also located on the coil conveyor. Coils are lifted by overhead crane and transferred to the coil yard for cooling and storage.

A coil inspection line is provided for inspection of the coil surface immediately after coiling. For example, when the tail is chewed up in the finishing mill, the coil surface of the next coil must be inspected to decide if a work roll change is necessary.

(9) Roll shop

The roll shop to grind and maintain the mill rolls, chocks and bearings is located adjacent to the mill bay and a roll transfer car carries mill rolls to and from the mill bay and the roll shop.

(10) Hot skinpass line

The skinpass line processes hot rolled coil to correct the shape and to improve the mechanical qualities. Also, coils are divided for weight adjustment before sale.

Coils from the HSM are transported by means of coil conveyors and piled in the cooling area for approximately three days to be cooled to room temperature. After this, the cooled coils are transferred to the skinpass line by over head crane and go to the coil car, pay off reel, skinpass mill and tension reel.

After the skinpass mill, coils are bundled and painted automatically. Finished coils are stocked in the coil yard before delivery to customers.

(11) Plate Finishing Line

After the finishing mill, hot rolled plates over 13 mm in thickness go to the plate finishing line through the hot leveler. Hot rolled plate is cut to 30 m lengths by dividing shear and cooled to 600 °C at the plate cooling bed. These 30m length plates are moved by crane with magnetic lifting device to the plate stock yard. After cooling, these plates are shape improved by cold leveler and cut to length by semi-automatic gas cutter according to customer requirements. These plates are stored at the plate stock yard before delivery to customers.

(12) Coil and Plate Stock Yard

The coil cooling yard for the skinpass line has the capacity for five days stock of hot rolled coil. Hot rolled coil and plate are stocked before delivery at inside and open space coil yards with a capacity of 15 days stock of hot rolled coil & plate.

6-3-5 Organization and personnel

Organization and personnel is shown in Table 6-3-8.

Table 6-3-8 Organization and Personnel of Hot Rolling Mill Plant

SM	ASM	Engineer	Foreman	Assistant foreman	Worker	Remarks
1	Hot strip mill 1 x 1		1 x 4	1 x 4	3 x 4	Crane & Slab yard
				1 x 4	4 x 4	Furnace & Roughing
				1 x 4	3 x 4	Finishing Mill
				1 x 4	3 x 4	Down Coiler
				(16)	(52)	
	Hot coil finishing		1 x 1	1 x 4	5 x 1	Roll Assembling
				1 x 4	4 x 4	Roll Grinding
	1 x 1	2 x 1	1 x 1	1 x 4	3 x 4 4 x 1	Crane & Coil yard
				1 x 4	4 x 4	Plate Finishing
				1 x 1	4 x 1	Skinpass line
				1 x 1	4 x 1	Delivery
			(2)	(18)	(61)	
1	2	2	6	34	113	Total 158

6-3-6 Drawings and Equipment List

(1) General Layout

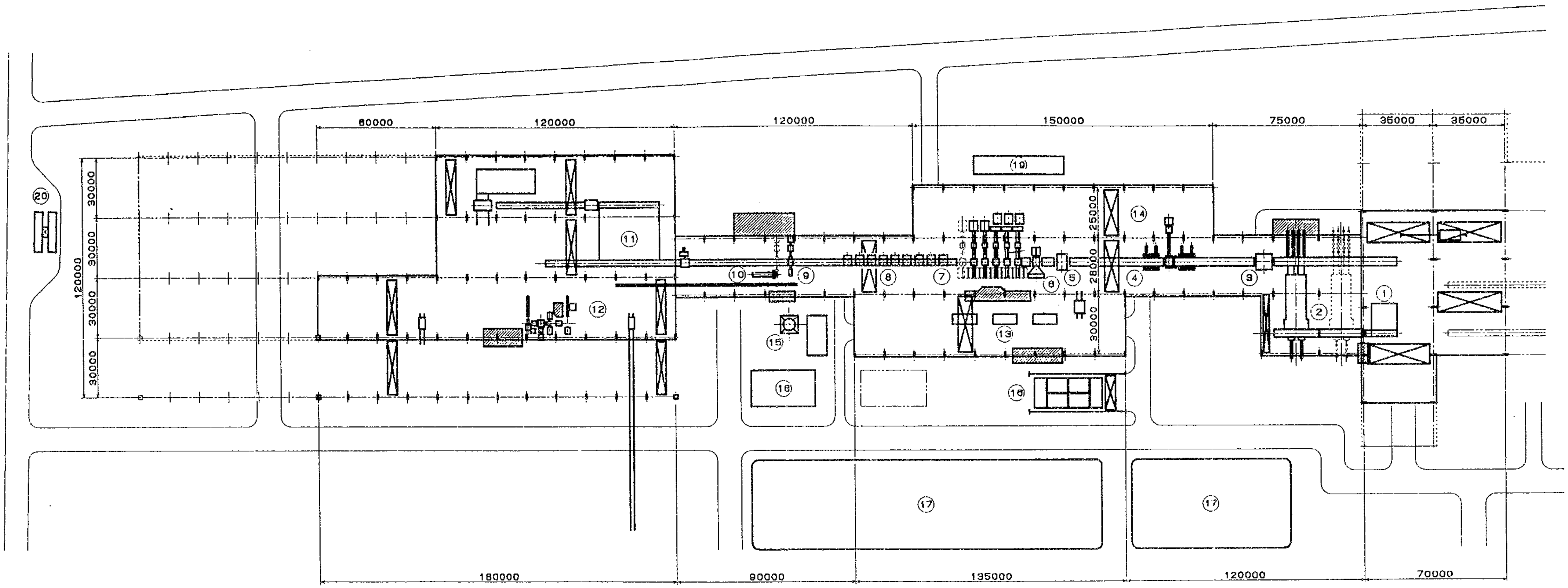
Refer to Figure 6-3-1

(2) Equipment List

Refer to Appendix 6A-3-1

(3) Drawings

Refer to Appendix 6A-3-2



1	SLAB CONVEYOR	6	CROP SHEAR	11	PLATE LINE	16	SCALE PIT
2	REHEATING FURNACE	7	FINISHING MILL	12	SKINPASS MILL	17	WATER TREATMENT
3	HYDRAULIC SCALE BREAKER	8	RUNOUT COOLING	13	ROLL SHOP	18	HSM OFFICE
4	ROUGHING MILL	9	DOWN COILER	14	MOTOR ROOM	19	HSM SUBSTATION
5	COIL BOX	10	COIL INSPECTION	15	RUN OUT WATER PIT	20	TRUCK SCALE

Figure 6-3-1 General Layout of Hot Strip Mill Plant

FLAT PRODUCT PROJECT OF EGYPT			
TITLE	HSM GENERAL LAYOUT		
DWG NO. EFP-HSM-001			
DATE	JUL.31.1997	SCALE	1/1000

6-4 Cold Strip Mill

6-4-1 Outline

(1) Basic concept of the cold rolling mill

Cold strip mill plant (CSMP) shall consist of pickling line, cold rolling mill, batch annealing furnaces, temper mill, continuous galvanizing line and recoil line, and produce cold rolled coils and galvanized coils.
Capacity will be set at approximately 295,000 tons of products per year.

(2) Production and products

Cold rolled products will be the following;

Cold rolled coil : 224,000 ton/year (Approx. 76 %)
Galvanized coil : 71,000 ton/year (Approx. 24 %)

Product flow in CSMP is described as below.

As shown in Figure 6-4-1, hot rolled coils are carried into the entry coil yard of the pickling line(CPL) in the first bay in CSMP by a coil transfer car. The coils are unwound and processed from right to left in the CPL on the drawing and consequently scale on the strip surface is removed. The coils processed in the CPL are next carried to the second bay by a cart. In the second bay the coils are cold-rolled by the reversing cold mill(RCM) and strip thickness is reduced to target. After that the coils are carried to the third bay by a coil conveyor and there turned up-end. In the third bay the coils are piled up and annealed in the single stack annealing furnaces(BA). After annealed, the coils are turned down-end again and carried to the second bay again by a coil conveyor. In the second bay the coils are temper-rolled and consequently mechanical property, shape and surface texture are improved. After that the coils are carried to the third bay again and processed in the recoil line (RCL). In the RCL, some coils are re-inspected and detrimental defects are removed. Some coils are trimmed and/or slit. Some coils are divided to meet the customer's requirement. At the exit of RCL there is a coil stock yard for cold rolled products.

The coils for galvanized products are carried from the exit of RCM to the fourth bay directly by a cart. In the fourth bay the coils are processed from left to right in the continuous galvanizing line(CGL) on the drawing. In CGL the coils are alkaline cleaned, annealed and coated with zinc. Products coils are stored at the exit of CGL.

(3) Scope of the facilities

Cold strip mill plant shall consist of the following facilities.

- Push-pull pickling line (PPL)
- Reversing cold mill (RCM)
- Single stack annealing furnaces (BA)
- Temper mill (TM)
- Recoil line (RCL)
- Continuous galvanizing line (CGL)

6-4-2 Basic Design

(1) Materials

1) Materials for cold rolled products

(a) Strip thickness

As shown in the result of field survey (Refer to Table 3-2-6), there is no demand for extremely thin gauge in Egypt, and minimum gauge requirement is 0.5 mm and maximum gauge is 3.0 mm. With reference to the gauge beyond 2.5 mm, in Japan it is preferred to do with a pickled coil. Therefore recommended thickness range will be as follows;

$$0.5 \text{ mm} \leq \text{thickness} \leq 2.5 \text{ mm}$$

(b) Strip width

From the result of field survey (refer to Table 3-2-6), there are very few demands for wider strip over 1,250 mm in Egypt.

Wider cold rolled strip over 1,250 mm is usually used for exposed panel of passenger cars. At present, although some assembling lines for passenger cars exist in Egypt also, in any case the scale of production is small and as for exposed panels all materials are imported. Taking the economical base of the press line capacity into consideration, this tendency will continue for a while in Egypt. Therefore the recommended width range will be as follows;

610mm ≤ width ≤ 1,250mm

(c) Mechanical property

As shown in Figure 3-2-2, home appliances and metal furniture occupy the majority as the end use of cold rolled products.

Usually commercial grade quality (St 12) is applied to almost all of them but in this project drawing quality (St 13) and deep drawing quality (St 14) products shall be also produced, aiming the order for special parts of home appliances and inner parts of automobiles.

Mechanical property : St 12

: St 13

: St 14

2) Materials for galvanized products

(a) Strip thickness

As shown in the result of field survey (refer to Table 3-2-6), the minimum gauge requirement is 0.3 mm and the maximum gauge is 1.5 mm. Considering the end use and specification of RCM, the following thickness range will be appropriate.

0.4 mm ≤ thickness ≤ 1.6 mm

(b) Strip width

In the result of the field survey, the maximum width requirement is 1,300 mm, but this is used for corrugated sheets for construction, and as far as the Egyptian market is concerned, 1,250 mm wide of strip is applicable for this use. Therefore the same width range as cold rolled products will be appropriate.

610 mm ≤ width ≤ 1,250 mm

(c) Mechanical property

From the result of the field survey the major use of galvanized products is for construction. Large amounts of galvanized coils are formed or fabricated to corrugate sheet, expand metal, small flange, etc. In case of such uses so severe formability is not required and so, if commercial quality and drawing quality products are produced, it will be sufficient.

Mechanical property : St12

: St13

3) Summary table

Materials to be handled in CSMP are summarized in Table 6-4-1.

Table 6-4-1 Materials to be Handled in Cold Strip Mill Plant

Items	PPL	RCM	BA	TM	CGL
Entry strip	Hot rolled Coil	Pickled coil	Cold rolled Coil	Cold rolled coil	Cold rolled coil
- Thickness	2.0-5.0 mm	2.0-5.0 mm	0.5-2.5 mm	0.5-2.5 mm	0.4-1.6 mm
- Width	610-1,250 mm	610-1,250 mm	610-1,250 mm	610-1,250 mm	610-1,250 mm
- I. Diameter	762 mm	762 mm	610 mm	610 mm	610 mm
- O. Diameter	1,900 mm max.	1,900 mm	1,900 mm max.	1,900 mm max.	1,900 mm max.
- Weight	22 ton max.	22 ton max.	22 ton max.	22 ton max.	22 ton max.
Exit strip	Pickled coil	Cold rolled coil	Cold rolled coil	Cold rolled coil	Cold rolled coil
- Thickness	2.0-5.0 mm	0.4-2.5 mm	0.5-2.5 mm	0.5-2.5 mm	0.4-1.6 mm
- Width	610-1,250 mm	610-1,250 mm	610-1,250 mm	610-1,250 mm	610-1,250 mm
- I. Diameter	762 mm	610 mm	610 mm	610 mm	610 mm
- O. Diameter	1,900 mm	1,900 mm	1,900 mm max.	1,900 mm max.	1,900 mm max.
- Weight	22 ton max.	22 ton max.	22 ton max.	22 ton max.	22 ton max.

(2) Production capacity of cold strip mill plant

1) Rolling hours of CSMP

Rolling hours are estimated as follows;

- Calendar hours : 24 hours x 365 days
  = 8,760 hours/y
- Scheduled maintenance hours : 714 hours/y
- Available working hours : 8,046 hours/y
- Running ratio : 85 %
- Net working hours : 8,046 x 0.85
  = 6,839 hours/y

2) Required annealing furnace number

(a) Production

263,000 ton/year (Actual requirement x 1.07)

(b) Product mix

Table 6-4-2 Annealed Coil Product mix

Grade	Production (ton/year)	Rate (%)
DIN 1623 - St12	197,000	75
DIN 1623 - St13	40,000	15
DIN 1623 - St14	26,000	10
Total	263,000	100

(c) Annealing method

H_2 100 % single stack annealing

(d) Reference charge in the furnace

76.8 ton for four coil stack

(Average coil weight : 19.2 ton/coil)

(e) Average outputs and processing times

Table 6-4-3 Average Output and Processing Times

Grade	Furnace outputs (ton/h)	Heating time (hours)	Cooling time (hours)	Charge /purge time (hours)
St12	4.2	17.5	20	2
St13	3.3	22.5	26	2
St14	2.7	27.5	26	2

(f) Average heating capacity

3.830 ton/hours

(g) Average heating hours

20.5 hours/charge

(h) Average cooling hours

21.5 hours/charge

(i) Hours for each base

43.55 hours/charge

(j) Operation hours

- Calendar hours	: 8,760 hours
- Yearly maintenance hours	: 336 hours
- Weekly maintenance hours	: 416 hours
- Available operation hours	: 8,008 hours

(k) Base to furnace ratio

Base hours/furnace hours = 2.172

(l) Productivity requirement

Assuming working efficiency as 90 %;

263,000/8,008/0.9 = 36.49 tons/hour

(m) Number of required heating furnaces

36.49/3.830 = 9.53 ----- 10 furnaces

(n) Number of required bases

9.53 x 2.172 = 20.7 ----- 21 bases

(o) Installed equipment

- Heating furnaces	: 10
- Cooling covers	: 11
- Base number	: 21

3) Estimated production capacity of CSMP

Estimated production capacity of pickling line, cold reverse mill, batch annealing furnaces, temper mill and CGL are summarized in Table 6-4-4.

Table 6-4-4 Estimated Production Capacity of Cold Strip Mill Plant

Items	PPL	RCM	BA	TM	CGL
Production	340,000 t/y	323,000 t/y	246,000 t/y	246,000 t/y	74,000 t/y
Average strip size	3.0 x 1,000 mm	Entry : 3.0 x 1,000 mm Exit : 1.0 x 1,000 mm	1.0 x 1,000 mm	1.0 x 1,000 mm	0.9 x 1,000 mm
Line speed	Max. 90 mpm	Max. 1,200 mpm	(21 bases)	Max. 1,000 mpm	Max. 90 mpm
Estimated average ton/h	55 ton/hour	55 ton/hour	1.8 ton/hour per one base	100 ton/hour	15 ton/hour
Estimated capacity	55 x 6,839 =376,000 t/y	55 x 6,839 =376,000 t/y	1.8 x 21 x 7,207 =272,000 t/y	100 x 6,839 =684,000 t/y	15 x 6,839 =103,000 t/y
Operating shifts/crews	3 shifts /4 crews	3 shifts /4 crews	3 shifts /4 crews	2 shifts /2 crews	3 shifts /3 crews

Note: Temper mill has much surplus capacity and so it will be designed as combination mill in preparation for future shortage of cold rolling capacity.

4) Necessary area of coil stock yards

Necessary area of the coil stock yards is shown in Table 6-4-5.

Table 6-4-5 Necessary Area of Coil Stock Yards of Cold Strip Mill Plant

Stock yard	Monthly production (ton/year)	Stock days (days)	Required area per coil (ton/m²)	Necessary area (m²)
Entry of PPL	340,000	1	4.5	270
Entry of RCM	323,000	1	4.5	250
Entry of BA	246,000	3	4.5	570
Entry of temper mill	246,000	3.5	4.5	670
Entry of RCL	241,000	2	4.5	370
RCL stock yard	241,000	15	2.5	3,100
Entry of CGL	71,000	6	4.5	350
CGL stock yard	71,000	15	2.5	960
Total				6,540

6-4-3 Production plan

- Material flow/balance are shown in Figure 5-1-4 and Figure 5-1-5 of Chapter 5.
- Yield of products is shown in Table 6-4-6.
- Learning curve after start-up is shown in Table 5-1-10 of Chapter 5.

Table 6-4-6 Cold Rolling Mill and Finishing Line Yield

Equipment	Contents	Yield (%)
PPL	Yield of PPL	95.0
	Scale loss	0.5
	Side trimmer	2.0
	Crop loss	2.5
RCM	Yield of RCM	99.0
BA	Yield of BA	100.0
TM	Yield of TM	98.0
RCL	Yield of RCL	93.0
	Side trimmer	2.0
	Scrap	5.0
CGL	Yield of CGL	96.0
	Scrap	7.0

Note: CGL yield includes "coated zincweight".

6-4-4 Process and equipment description

General layout of the cold strip mill plant is shown in Figure 6-4-1.

A cold strip mill plant of 1,250 mm width is designed to be arranged as a compact configuration.

(1) Pickling line

The line will function in accordance with the following line data.

Capacity	: 376,000 ton/year
Type	: Push-pull type
Material	: Hot rolled low carbon steel
Line speed	: 10 - 90 mpm (DC variable)
Strip thickness	: 2.0 - 5.0 mm
Strip width	: 610 - 1,250 mm
Pickling agents	: Hydrochloric acid (HCl) 18 % by weight

(2) Acid regeneration plant

Type : Spray roaster type

This process provides thermal decomposition of iron chloride including treatment of concentrated pickle liquor and produces iron oxide. Waste pickling liquor drawn from pickling process is concentrated by a venturi scrubber type preconcentrater. Concentrated waste pickle liquor is atomized at the top of the roaster and falls through the hot gases. The liquor evaporates and then reacts according to following reactions :

$$2\,FeCl_2 + 2\,H_2O + 1/2\,O_2 \rightarrow Fe_2O_3 + 4\,HCl$$
$$2\,FeCl_3 + 3\,H_2O \rightarrow Fe_2O_3 + 6\,HCl$$

(3) Cold rolling mill

Cold rolling mill shall roll pickled low carbon steel coils in accordance with the following line data.

Capacity	: 376,000 ton/year
Type	: Single stand reversing cold reduction mill(RCM)
Material	: Pickled, hot rolled low carbon steel
Rolling speed	: 0 - 450/1,200 mpm
Roll force	: Hydraulic pushing up
Strip thickness	: 2.0 - 5.0 mm (Entry)
	: 0.4 - 2.5 mm (Delivery)
Strip width	: 610 - 1,250 mm

A hydraulic roll positioning device shall control roll gap to reduce strip thickness and achieve aimed thickness manually or automatically.
A roll changing device shall be provided to change top and bottom work roll assemblies at the same time. It shall be done automatically but back up roll changing shall be done by manual operation.

(4) Batch annealing furnaces

A 100 % hydrogen batch annealing furnaces for 263,000 ton/year cold rolled strip shall be provided.

Capacity	: 272,000 ton/year
Type	: 100 % hydrogen single stack annealing furnace
Material	: Cold rolled low carbon steel
Heating furnace number	: 10 heating furnaces
Cooling cover number	: 11 units
Base number	: 21 units
Strip thickness	: 0.4 - 2.5 mm
Strip width	: 610 - 1,250 mm

The strip stretched and hardened by reversing cold mill is not suitable for any forming or drawing. In order to get the proper characteristics of ductility, yield elongation, softness and drawability, coils are heat-treated at a temperature between 620 °C and 730 °C in the heating furnace and after that cooled to approximately 100 °C in the cooling cover.

(5) Temper mill

The Temper mill shall be installed to improve the quality of the coils by making approx. 0.5 to 2.0 % extension on strip at normal room temperature.
This temper mill shall be designed as a combination mill because in the future, if the requirement for cold rolled products is highly increased, it can supplement the shortage of cold rolling capacity instead of the reversing cold mill.

Capacity	: 680,000 ton/year (Temper rolling only)
Type	: 4-Hi combination mill (Wet rolling)
Material	: Annealed, cold rolled low carbon steel
Rolling speed	: 1,000 mpm
Strip thickness	: 0.4 - 2.5 mm
Strip width	: 610 - 1,250 mm

The maintenance work for the rolls and chocks of the reversing cold mill and the temper mill shall be performed at the roll shop.
The roll shop consist of the following areas.

- Refurbishing/washing area
- Assembling area
- Roll grinder
- Shot blast machine

(6) Continuous galvanizing line

The line is composed of three sections and two horizontal loopers:

- Entry section
- Entry looper
- Center process section
- Delivery looper
- Delivery section

Two loop cars (entry and delivery) are used to keep the line speed of the process section constant while coils are charged/discharged at entry/delivery section.
The process section consists of cleaning equipment, furnace equipment, zinc coating equipment and chemical treatment equipment.

Capacity	: 100,000 ton/year
Type	: Non oxygen horizontal furnace
Material	: Cold rolled low carbon steel
Line speed	: Max. 90 mpm
Strip thickness	: 0.4 - 1.6 mm
Strip width	: 610 - 1,250 mm

The strip cleaning equipment includes all the units necessary to enable proper and complete removal of the residues from the strip handled in a cold rolling mill.

Furnace equipment consists of a non-oxygen furnace, soaking zone and cooling zone and the strip is heat-treated at a temperature between 620 °C and 730 °C in the furnace to get the proper characteristics of ductility, yield elongation, softness and drawability.

The zinc coating equipment consists of an induction zinc pot, a gas wiping equipment and cooling zones. The strip coming from the annealing furnace is dipped into zinc pot, and after passed through the zinc pot, molten zinc on the strip surface is wiped by blowing compressed cold air on it. The zinc weight is controlled automatically by the feed back from a coating weight gauge in accordance with the line speed and coating weight setting. After the coating equipment, there is a temper mill and a tension leveler ,and there mechanical property and the strip shape are controlled. Following is equipment, a horizontal spray header type chemical treatment equipment shall be installed.

(7) Recoil line

In order to remove detrimental defects, to divide coils into requested length and/or to trim edges, a recoil line shall be installed.

Capacity	: 300,000 ton/year
Line speed	: Max. 300 mpm
Material	: Annealed, cold rolled low carbon steel and galvanized steel
Strip thickness	: 0.4 - 2.5 mm
Strip width	: 610 - 1,250 mm

6-4-5 Organization and personnel

The organization and personnel for CSMP is shown in Table 6-4-7.

Table 6-4-7 Cold Strip Mill Organization and Personnel

Equipment	Section manager	Asst. section manager	Engineer	Foreman	Asst. foreman	Worker
Pickling line	1	CPL &	2	1 x 1	1 x 4	6 x 4
Cold rolling mill		Rolling		1 x 1	1 x 4	4 x 4
Temper mill		1		1 x 1	1 x 2	4 x 2
Roll shop					1 x 4	4 x 4
(Sub total)		(1)	(2)	(3)	(14)	(64)
Batch annealing		Cold coil	2	1 x 1	1 x 4	4 x 4
Galvanizing line		Finishing		1 x 1	1 x 3	6 x 3
Recoi line		1		1 x 1	1 x 4	3 x 4
Crane & coil yard				1 x 1	1 x 4	9 x 4
Waste w. treatment						1 x 4
(Sub total)		(1)	(2)	(4)	(15)	(86)
Total	1	2	4	7	29	150
Grand total	193					

6-4-6 Drawing and equipment list

(1) General layout

Refer to Figure 6-4-1.

(2) Equipment list

Refer to Appendix 6A-4-1.

(3) Drawings

Refer to Appendix 6A-4-2 to 6A-4-7.

NO	EQUIPMENT
1	PICKLING LINE
2	REVERSING MILL
3	TEMPER MILL
4	BATCH ANNEALING FURNACE
5	RECOILING LINE
6	HOT DIP GALVANIZING LINE
7	MOTOR ROOM
8	ROLL SHOP
9	ACID REGENERATION PLANT
10	UTILITY PLANT
11	WATER TREATMENT
12	CRM OFFICE

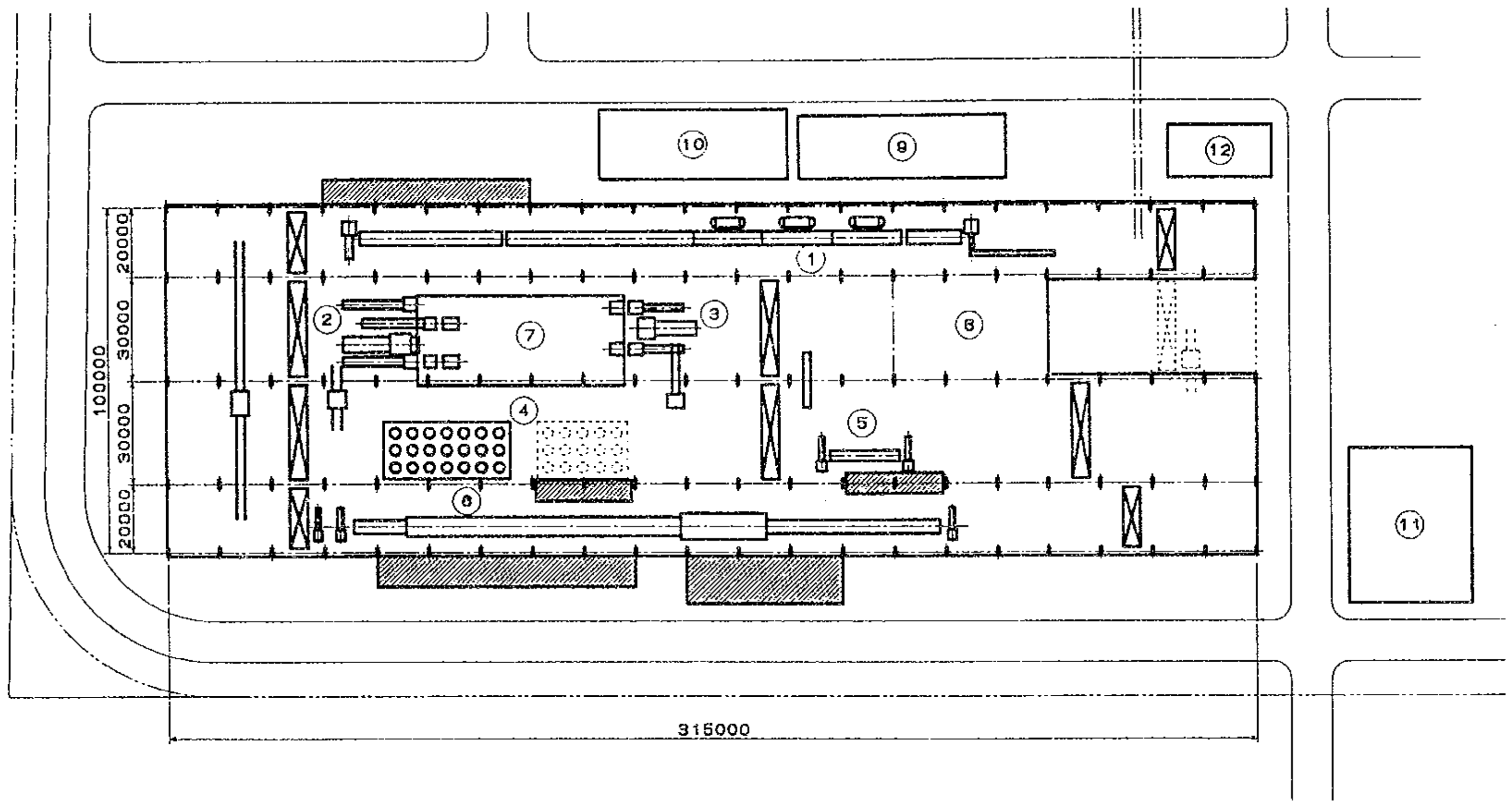


Figure 6-4-1 General Layout of Cold Rolling Mill

FLAT PRODUCT PROJECT OF EGYPT			
TITLE	CRM GENERAL LAYOUT		
DWG NO. EFP-CRM-001			
DATE	JUL.31.1997	SCALE	1/1000

6-5 Lime Calcining Plant

6-5-1 Outline

A lime calcining plant will be constructed to deliver burnt lime to the steelmaking plant. The burnt lime is a very active material and it hydrates easily to calcium hydroxide when exposed to moisture. The calcium hydroxide creates a problem in not making a suitable slag in the electric arc furnace. The lime calcining plant will, therefore, be located nearby the steelmaking plant to supply the required amount of burnt lime.

6-5-2 Basic design

- Annual production	: 52,800 tons (330 d/y x 24 h/d)
- Daily production	: 160 tons/day on average (24 h/d)
- Hourly production	: 6.67 tons/h on average
- Product quality	
Residual CO_2	: Max. 3%
Reactivity	: Min. 350 mlit (4 N - HCl, 50 g, 10 min)
Size	: 40 - 5 mm
- Limestone size	: 50 - 20 mm
- Kiln fuel	: Natural gas

6-5-3 Production plan

(1) Production

The requirement of the steelmaking plant for burnt lime will be 24,000 t/y in 2005 and 40,000 t/y after that. However, burnt lime will be produced at the nominal capacity of 52,800 t/y from 2006 and the surplus burnt lime will be sold in the domestic market.

(2) Raw material (limestone)

Limestone abundantly produced in the country will be used as the raw material in the plant. Consumption of raw material will be 2.0 tons per ton of burnt lime. Fines of limestone expected to be about 10%.

(3) Utility unit consumption

The average unit consumption of utility is expected to be as follows when the lime calcining plant is operated.

- Electricity : 50 kWh/t
- Natural gas : 100 Nm^3/t
- Water : 0.02 m^3/t
- Compressed air : 55 Nm^3/t

6-5-4 Description of process and equipment

Limestone, raw material for lime calcining plant, is stock piled in the open-air limestone storage yard and transferred by dump truck to the receiving hopper. From the hopper, the limestone is transported by conveyor to the lime storage bin and stored there. The capacity of the lime storage bin is about three days' consumption.

Limestone discharged from the bin is screened by 20 mm mesh to remove stone less than 20 mm and charged by conveyor into the weigh hopper on the top of the lime kiln.

Limestone is preheated, calcined and cooled in the lime kiln. Heated in the kiln, limestone is calcined to burnt lime by the following reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

Lime kiln consists of two towers, which are used for calcining and regenerating, alternately. The cycle of each kiln is about 120 cycles/day. The kiln can be divided to preheating zone, calcining zone and cooling zone from the top. Limestone undergoes the above reaction as it descends in the kiln.

Supporting equipment for the kiln are to be installed:
blower for combustion air, natural gas combustion system, hydraulic equipment, dust catcher, etc.

Burnt lime is discharged from the kiln to the conveyor and after weighing, transferred to the product screen. The screen separates the burnt lime to + 40 mm and - 5 mm and lumps of + 40 mm are crushed by jaw crusher and returned to the product screen. Fines of - 5 mm are briquetted by the briquetting machine and stocked in the product bin. Burnt lime of 5 - 40 mm is sent by conveyor directly to the product bin. The product bin can hold about two days' consumption of burnt lime.

Burnt lime discharged by the vibrating feeder from the product bin is, after weighing, transferred by belt conveyors to the steelmaking plant.

Dust collecting facilities are installed at certain places in the raw material facilities, lime kiln and product facilities where dust tends to occur. After being collected by the dust collector, product dust is briquetted and sent to the product bin.

6-5-5 Organization and personnel

The organization and personnel to operate the plant is charted below.

Table 6-5-1 Lime Calcining Plant Organization and Personnel

SM	ASM	Engineer	Foreman	A.Foreman	Worker	Remarks
	1	1	1 x 4	1 x 4	3 x 4	Shift Crew
				1 x 1	4 x 1	Day Crew
	1	1	4	5	16	Total 27

6-5-6 Drawing and Equipment List

(1) General Layout

Refer to Figure 6-5-1.

(2) Equipment List

Refer to Appendix 6A-5-1.

(3) Drawing

Refer to Appendix 6A-5-2.

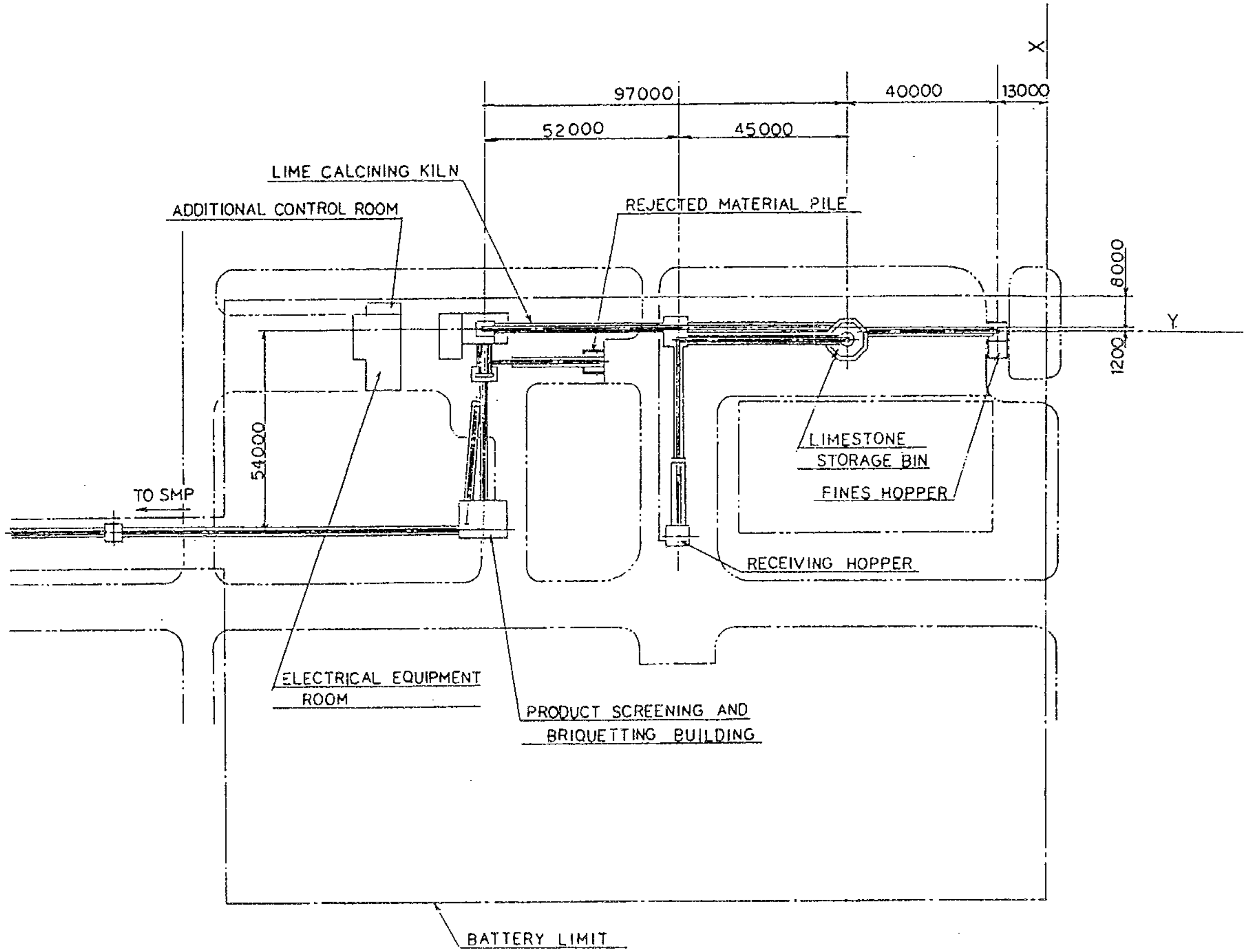


Figure 6-5-1 General Layout of Lime Calcining Plant

KOBELCO | KOBE STEEL, LTD.
ENGINEERING & MACHINERY DIVISION

TITLE: LIME CALCINING PLANT GENERAL LAYOUT (PLAN)

SCALE: 1/1000

REV. NO.	REVISION NOTE	DESIGNED	CHECKED	APPROVED	REVIEWED
D		19			
C		19			
B		19			
A		19			
0		1997	H.M.		

ENGINEERING DEPARTMENT

ISSUED BY | O. NO. | T. NO. 2 –

JOB NO.	AREA	DRAWING NO.	REV.
		D 6-52	0

6-6 Power and Distribution Facilities

6-6-1 Outline

(1) Substation in the plant shall mean the station receiving two incoming 220 kV power which is supplied by Egyptian Electrical Authority (EEA) through under ground cables from substation at El Dekhiela and stepping it down to 33 kV and 6.6 kV. Electrical equipment of the plant will take power at 33 kV or 6.6 kV from substation.

(2) 220/33 kV transformer will be installed separately for the loads which generally do not generate flicker (clean load) and for the loads which is generating flicker (dirty load).

- Clean loads : DRP, Slab CCM, HSMP, CSMP and Utility
- Dirty loads : EAF and LF

(3) High harmonic filters (H.H.F) and static flicker compensator (S.F.C) will be installed on EAF & LF bus side.

(4) Diesel generators will be installed in the substation and will supply emergency power to each plant by 6.6 kV and 0.4/0.23 kV.

6-6-2 Basic design

(1) Estimation of the demand power

The estimated demand power for the flat steel plant in full production is shown on Table 6-6-1.

(2) 220/33 kV transformers

The capacity of the transformers are selected to be 160 MVA with one unit for EAF and LF and 80/110 MVA with two units for DRP, Slab CCM, HRMP, CSMP and other loads.
160 MVA transformer has no spare transformer from view point of economy and its enough capacity.
One of the two 80/110 MVA transformers will be spare and will
have some surplus capacity.

(3) Emergency power

Two diesel generator sets will be installed for emergency power supply purpose.
Emergency power supply voltage will be 6.6 kV and 0.4/0.23 kV, and will be supplied to each shop whenever necessary.

(4) Supervisory and control room

The supervisory and control panels will be installed in the air conditioned room.

(5) 220 kV incoming cables

The 220 kV incoming cables will be supplied by EEA through under ground up to gas insulated switchgears (G.I.S) of 220 kV incoming panels in the substation.

(6) Electrical common requirement

1) Illumination levels for lighting
The illumination level will be as shown on attached Table 6-6-2.

2) Fire alarm system
This facility will be installed in supervisory room to monitor substation building and fire alarm signal from this system shall be sent to the centralized monitoring of the steel plant.

3) The following electrical equipment will be included.

(a) AC and DC motors
(b) Intercommunication system such as paging system and inter-plant telephone.
(c) Ventilating and cooling units
(d) UPS
(e) Cables and wires

6-6-3 Description of power distribution system

(1) 220 kV system

1) Gas insulated switchgears
The gas insulated switchgears (GIS) will be installed indoor in the substation.
The GIS will be equipped with receiving units, metering outfit (MOF), double main bus bars and single feeder bus bar, bus tie units, transformer feeder units and other auxiliary

devices.

2) 220/33 kV power transformers

The transformers will be installed at transformer yard beside the GIS room.

The transformer for the load which is generating flicker, will be of capacity 160 MVA ONAN, oil immersed type, suitable for outdoor use and will be have on-load tap changer.

The transformers for the loads which generally do not generate flicker, will be of capacity 80/110 MVA at ONAN/ONAF, oil immersed type, suitable for outdoor use and will have on-load tap changer.

(2) 33 kV system

1) 33 kV switchgears

The 33 kV switchgears will be installed at 33 kV switchgear room in the substation.

The 33 kV switchgears will consist of two groups, one for the furnace load and the other for non-furnace load.

The 33 kV switchgears will contain neutral grounding resistor (NGR), main panel, feeder panels (including spare feeders), GPT panels, LA and SA panels and auxiliary panel.

2) Flicker and power factor compensator (FPC)

The FPC will be installed at FPC yard in the substation.

The FPC will have high impedance transformer, thyristor equipment, auxiliary control panel and thyristor control panel for flicker compensator, filters (2nd, 4th, 5th and 6th harmonic filters) and FPC supervisory panel.

The third harmonic filter will be connected to each feeder of EAF & LF.

(3) 6.6 kV system

1) 33/6/6 kV transformers

33/6.6 kV transformer will be suitable for outdoor use and installed at transformer yard beside 6.6 kV switchgears room for connecting to 6.6 kV loads.

Transformer will be of oil immersed type having 20/24 MVA capacity at ONAN/ONAF.

Each plant section will have one number of 33/6.6 kV transformer for connecting to 6.6 kV loads.

2) 6.6 kV switchgears

6.6 kV switchgears will be installed at 6.6 kV switchgears room in the substation. The 6.6 kV switchgears will be comprise of NGR panel, main panel, bus tie panel, feeder panel, GPT panel and LA panel.

3) Static capacitor unit

Static capacitors will be installed at transformer yard beside the 6.6 kV switchgears room and will be suitable for outdoor use, oil immersed self cooled type having series reactor and discharge coil.

(4) Supervisory and control room

Control room will be provided on 2nd floor of 33 kV switchgear room.

The supervisory and control panel will be installed in the control room and will have meters, control switches, indication lamps and etc.

(5) Diesel generator

1) The diesel generator sets will be installed at the D/G yard in the substation.
2) The diesel generator sets will consist of diesel engines, generators, auxiliary transformer for station service, control panel, 6.6 kV distribution panels, starting system, cooling system and fuel system.
3) The station service 6.6/0.4 kV transformer will be installed at diesel generator yard. The transformer will be type of oil immersed type, outdoor use and will have the capacity of 500 kVA at ONAN and will be provided with accessories.

6-6-4 Organization and personnel

Organization and manpower for maintenance are shown on the Table 9-2-1 and 9-2-2.

6-6-5 Drawing and equipment list

(1) Layout of substation

Refer to Figure 6-6-4

(2) Equipment list

Refer to Appendix 6A-6-1.

Table 6-6-1 Estimated Power Demand for Flat Product Plant

Department	Production 1,000t/year	Operation hour/year	Power consumption kWh/t	Power consumption GWh/year	Average Load MW	Load factor	Maximum demand MW
DR Plant	1,000	7,500	130.0	130	17.3	0.9	19.3
LCP	40	7,500	50.0	2	0.27	0.9	0.3
EAF & LF and other	1,000	7,440	607.0	607.0	81.6	0.58	140.7
CCM	1,000	7,440	10.0	10	1.3	0.7	1.9
HSM	985	8,000	101.5	100.0	12.5	0.6	20.8
Skinpass mill	178	2,000	1.5	0.3	0.13	0.7	0.2
Plate	97	2,000	2	0.2	0.10	0.7	0.14
Pickling line	323	8,000	8.42	2.7	0.34	0.8	0.42
Cold rolling mill	320	8,000	75.8	24.3	3.0	0.7	4.3
CGL	71	8,000	45	3.2	0.40	0.8	0.50
Batch annealing	246	8,000	20	4.9	0.62	0.8	0.77
Temper mill	241	5,300	20.4	4.9	0.93	0.8	1.2
Recoiling line	224	5,300	5.4	1.2	0.23	0.8	0.3
Utilities & services		8,000		73	20	0.9	22.2
Total				963.7	138.8		213.0

Note : The number for each power consumption shows only the consumption by each department

Table 6-6-2 Illumination Levels

(Unit: Lx)

Facility	Level	Facility	level
1. Offices and rest rooms		3. Rolling mill plant	
Conference room	330	Mill yard	110
Gen. adm. Office	550	Finishing yard	110
Computer room	550	Roll shop	150
Stairway, corridor	70	Oil cellar	110
Dinning & rest room	220	Slab yard	110
Locker room	110	Operation & control room	330
2. Iron and steel plant		4. Utilities	
Operation floor, above	150	Pump room	110
Operation floor, under	70	Compressor room	110
Ingot & mold yard	150	Generator room	220
Management room	330	Control room	330
Instrument room	330	Electric room	150
Raw material stockyard	110	5. Others	
Inside plant buildings	110	Maintenance shop	150
Outdoor periphery of plant	30	warehouse	110
		Outdoor products yard	10
Conveyor,equipment	110	Roads	4
Conveyor,corridor	30		

Figure 6-6-1 Single Line Diagram 220kV and 33KV System

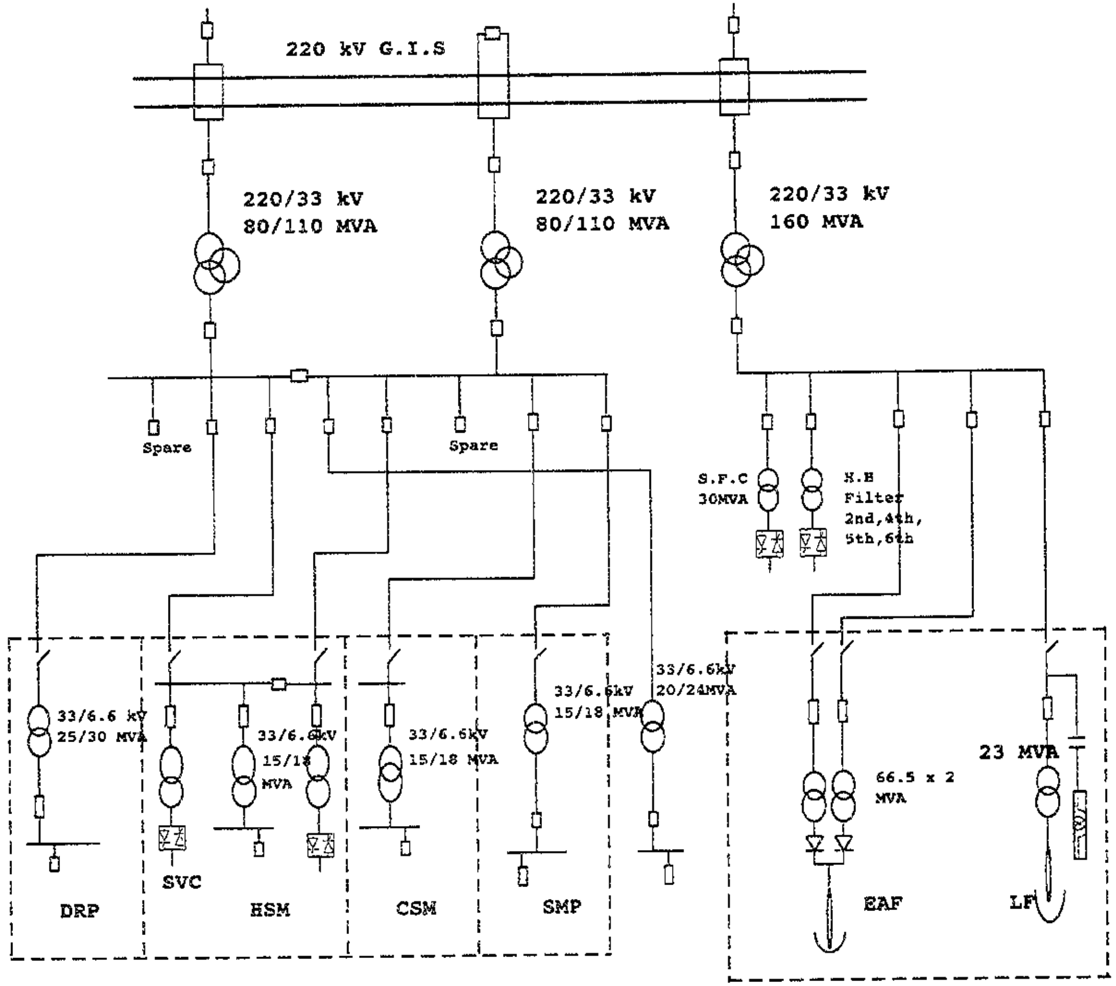


Figure 6-6-2 Single Line Diagram 6.6KV System

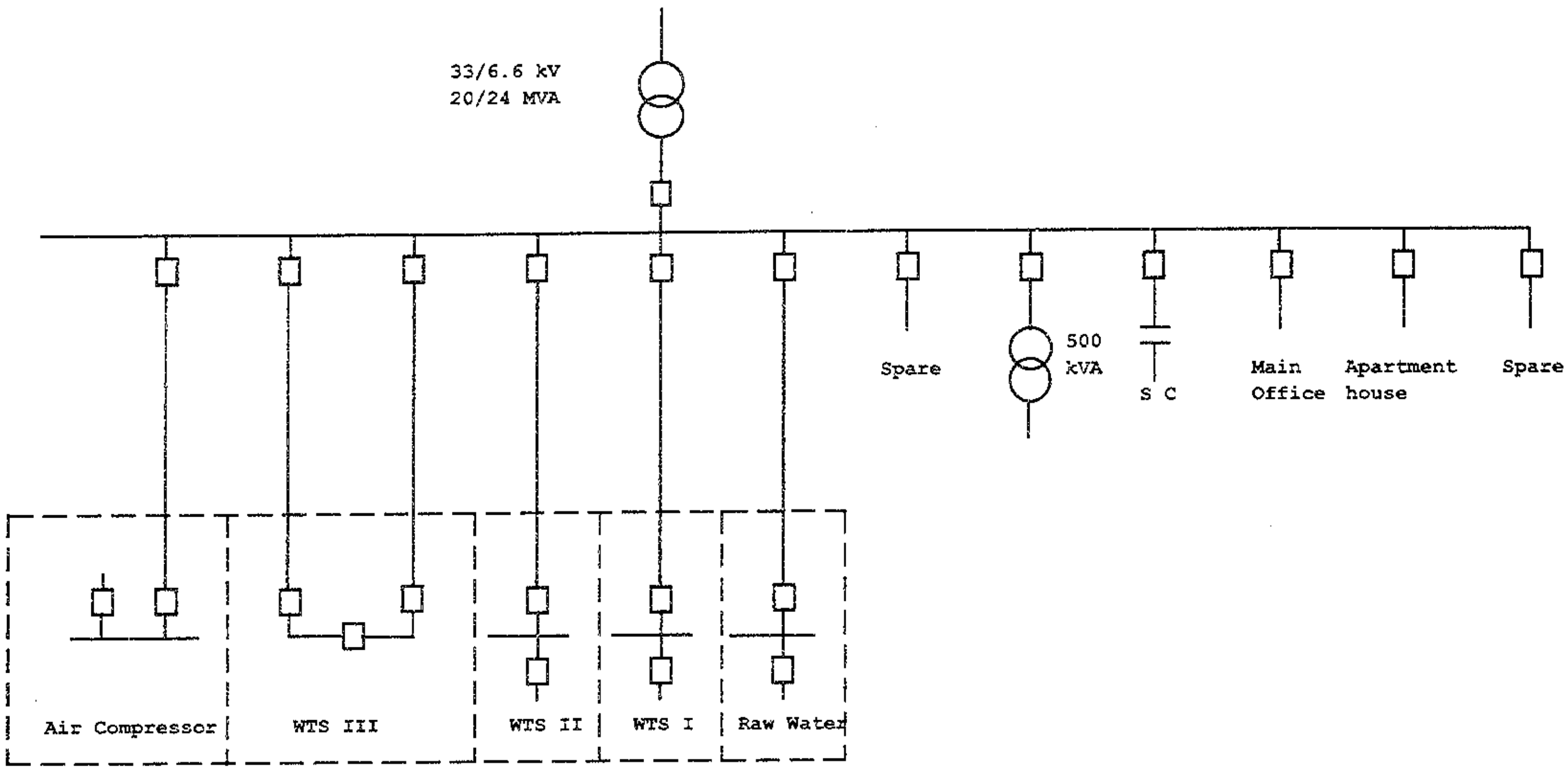


Figure 6-6-3 Single Line Diagram for Emergency Power supply

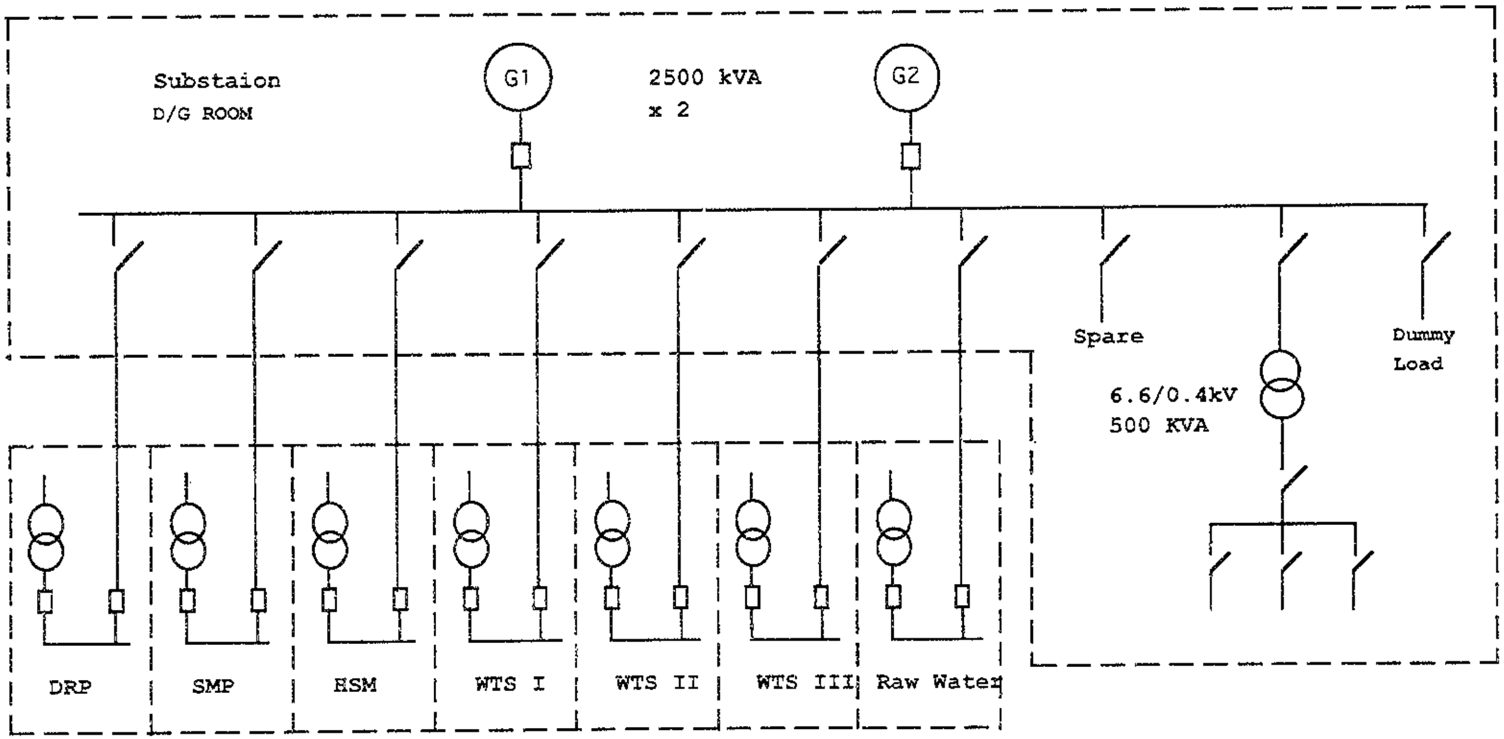


Figure 6-6-4 Layout of Substation for the flat Product plant

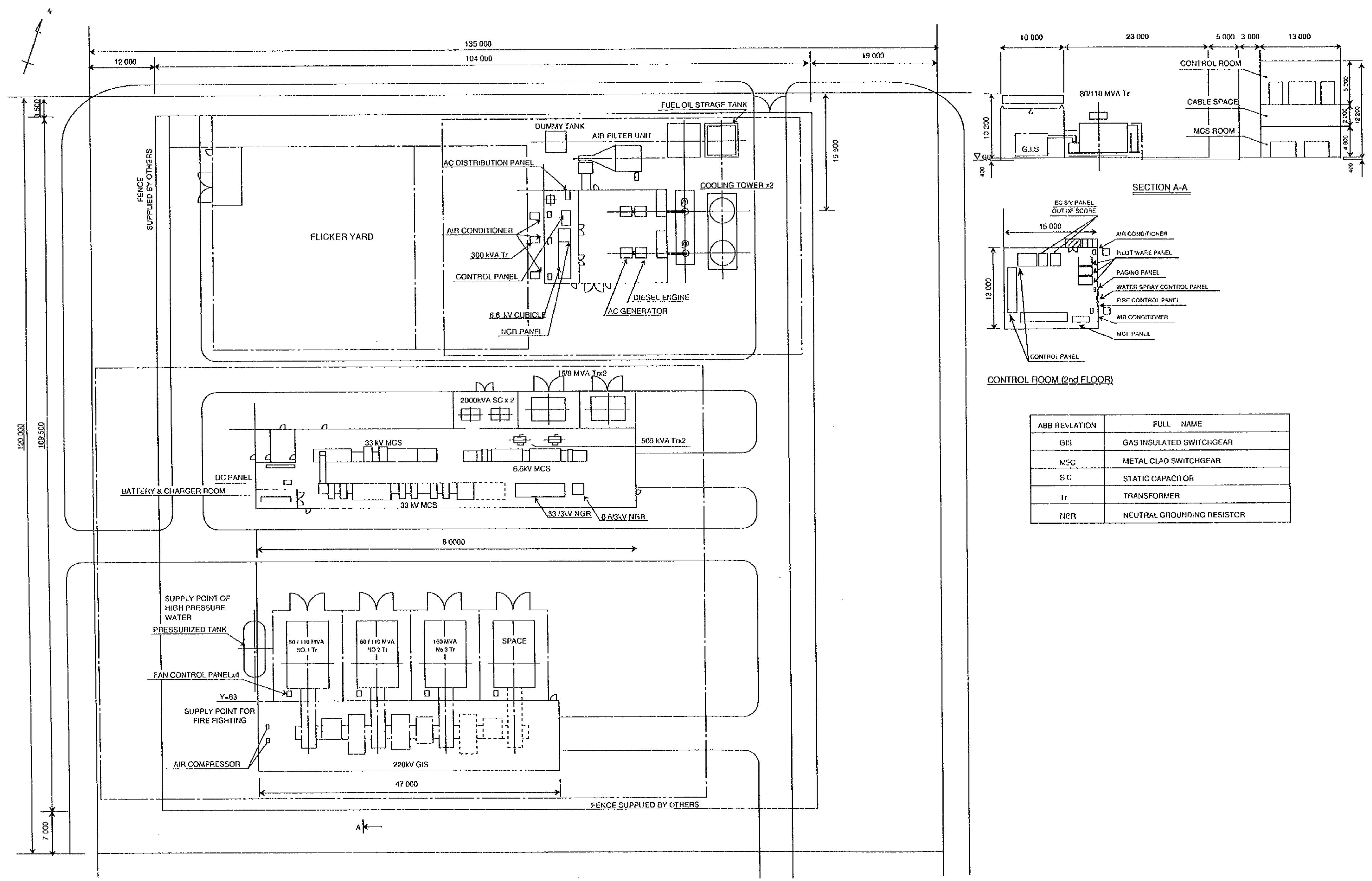


ABB REVLATION	FULL NAME
GIS	GAS INSULATED SWITCHGEAR
MSC	METAL CLAD SWITCHGEAR
S C	STATIC CAPACITOR
Tr	TRANSFORMER
NGR	NEUTRAL GROUNDING RESISTOR