Chapter 4

PLANT SITE SELECTION

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At the initial stage of site selection in March 1997, GOFI proposed eight areas, three areas in Safaga, three areas in Suez and two areas in Alexandria. However, these areas are not appropriate for construction of the flat steel plant. During the first field survey in March, the Study Team indicated GOFI the premises of plant site selection and requested to reconsider the sites to be proposed.
After the stage-1 of the second field survey, conducted by GOFI with assistance of the Study Team, GOFI proposed three sites of Suez (Adabiya Free Zone and Bir Odeib) and Alexandria (El Dekhiela) taking into due consideration the premises of plant site.

Based on the proposal, the Study Team visited following authorities of Cairo, Suez and Alexandria, together with the personnel in charge of GOFI, to investigate the possibility of the construction of the flat steel plant at each proposed site.

Suez	:	Suez Governorate
		Red Sea Port Authority
Alexandria	:	Alexandria Governorate
		Alexandria Port Authority
		ANSDK
Other authorities	:	GAFI, GASCO, NOPWASD, etc.

Following are the result of the site selection concluded by the first and second field survey.

4-1 Conditions and Specifications of Plant Site

4-1-1 Planning and phasing

The process of selection of appropriate location of the steel plant site can be broken down into following three phases.

- 1st phase : To define the requirement of the specification and geographic condition to be satisfied by the site
- 2nd phase : To select several areas where the specific sites are to be located.
- 3rd phase : To select the most appropriate specific site for construction of the plant

During this feasibility study, field survey was made for possible two sites proposed by GOFI. The results were evaluated based on the evaluation criteria and the most suitable site was selected.

4-1-2 Importance of plant location

In constructing a steel plant with production capacity of one million ton of flat products per year, a huge amount of investment is required. Furthermore, if infrastructure necessary for a steel plant such as port facilities, road, electric power, natural gas and industrial water supply, sewage, housing etc. are constructed simultaneously, the total investment will reach to twice of the construction cost of a steel plant.

Every aspect of the plant operation activities is greatly influenced by the regional area and geographical location of the plant.

The plant site requires vast land with solid soil.

Port facilities for unloading raw materials and steel scrap, and the same for shipping products and road network are dominant conditions of the site.

Energy supply and utilities such as electric power, natural gas, industrial water and waste water sewer are also indispensable for operation of the plant.

Furthermore great impact with respect to employment and relevant city facilities can be given to the surrounding area by construction and operation of a steel plant. Operation of the plant requires expertise of management, technologies and a large number of skilled labors.

Construction of a steel plant will facilitate new relevant industry to grow. It is necessary to assure that no deterioration of environment nor bad influence to the ecosystem are generated by construction and operation of a new steel plant.

It is obvious that if all amount of investment for infrastructure are imposed on or borne by the steel plant, the project of the steel plant shall no longer be feasible. Dominant conditions to be investigated in selecting the most appropriate site include regional development plan and implementation schedule of infrastructure.

4-1-3 Outline of the flat product plant

(1) Products and products capacity

Products; Flat steel (Hot rolled, Cold rolled, Galvanized coil and sheet)

Production capacity;

1st stage : approximately 1.0 million tons per year

2nd stage : approximately 2.0 million tons per year

(2) Production process and number of employees

- Iron making : Direct reduction plant
- Steelmaking : Electric furnace and continuous slab caster
- Rolling mill : Hot strip mill, cold strip mill
- Number of employees:

  1st stage ; approximately 1,500 persons

  2nd stage ; approximately 2,000 persons

(3) Implementation schedule

1st stage : 2002~2005 year

2nd stage : after 2015

4-1-4 Specification and requirement of the plant site

(1) Land

The ideal plant site area necessary for construction of the plant is,

Initial stage : 0.8~1.0 million m^2

Future : 1.2~1.5 million m^2

The plant site area could be reduced to a certain extent according to the conditions of the specific site.

(2) Port facility

Raw material berth

- Iron ore and pellet: 20 m depth, 320 m length for 120,000 DWT vessel

- Scrap : 11 m depth, 200 m length

Products shipping berth

- Products : 7.5 m depth, 130 m length

(3) Energy, natural resources and utilities

- Electric power : 200 MW
- Natural gas : 55,000 Nm^3/hr
- Industrial water : 36,000 m^3/day (Make up water)
- Waste water sewer: 24,000 m^3/day

4-2 Site Selection History

During the 1st field survey of the feasibility study on installation of the flat products plant in March, 1997, detailed, useful information and materials on the three proposed sites nominated by GOFI was collected.

The three proposed sites are Safaga, which lies on the Red Sea coast some 600 km south of Cairo, Suez at the south entrance of Suez Canal, and Alexandria on the Mediterranean Sea coast.

According to the result of the investigation and evaluation carried out on the basis of the information and material, the specific areas in the three proposed sites designated by GOFI were found far below adequate levels in terms of the required specifications for a steel plant site.
A summary of the results of the preliminary evaluation of the three proposed site is as follows.

All the proposed sites are not directly facing the coast and are far from the existing port facilities or possible port facilities to be installed in future. A coastal site is essential to reduce material handling costs for the plant.

The natural gas supply and industrial water supply indispensable for plant operation are planned to be installed in future but completion time is uncertain at Safaga and Suez.

The specified area in Alexandria is too small to accommodate all steel plant activities.

Following the results of preliminary evaluation, the above three proposed sites were disregarded and other possible sites were investigated. Finally two areas were designated as proposed sites, the Adabiya Industrial Free Zone in Suez and El Dekhiela in Alexandria.

4-3 Proposed Site Information and Data

4-3-1 Location of steel products manufacturers and end users

The Study Team investigated the major consumers of flat products during the first and second field survey in March and June, 1997. Location of steel product manufactures, and end users represented by consumption of flat products is shown in Figure 2-1-1 and 3-2-1.

The locations of major consumers are summarized as follows :

1) Approximately 80 % of the consumers for flat products are located around the Cairo area including 10th of Ramadan City and 6th of October City.

2) Approximately 20 % of the consumers for flat products are located in the cities of Portsaid, Suez and Alexandria.

Both Alexandria and Suez are within 250 km of Cairo and experience almost the same transportation conditions.

4-3-2 Land and regional conditions

(1) Site condition (Location and area)

Location and features of the two proposed sites are summarized as follows. (Refer to Figures 4-3-1 and 2)

1) Suez

Suez is located to the east of the Nile Delta and to the north west of the Suez Gulf about 140 km east of Cairo.

The region of the Gulf of Suez qualifies as an area which attracts world-wide investment as it located on the most important line of world naval communications.

The proposed site for the steel plant site in Suez is situated in the Adabiya Industrial Free Zone which lies on the western coast of the Suez Gulf shown in Figure 4-3-1. It is about 12 km from the center of Suez City.

The Adabiya Industrial Free Zone was planned as one of the zones of the Suez Bay Coastal Area Development. The area of the proposed site is about 662,000 m^2 (excluding about 180,000 m^2 of the business center zone and surrounding public road area) and located 4-5 km from Adabiya port. The shape of the area is rectangular and

about 800 m wide and 1,000 m long. Since the industrial zone lies at the foot of the Ataqa mountains, the topography of the area is very steep for the site of a steel plant. The difference in elevation between the lowest and the highest point is about 30 m.
The proposed site is allocated as an industrial free zone for small and medium scale enterprises, and the area is divided into eight blocks and already graded. The each block is surrounded by paved road where drainage pipe, electric power and telephone cables have been already installed.

According to the Red Sea Port Authority, port facilities for steel plant use are planned for construction in Adabiya port. Details of the facilities, and the issues of how to construct and implement the project, etc., are under consideration.

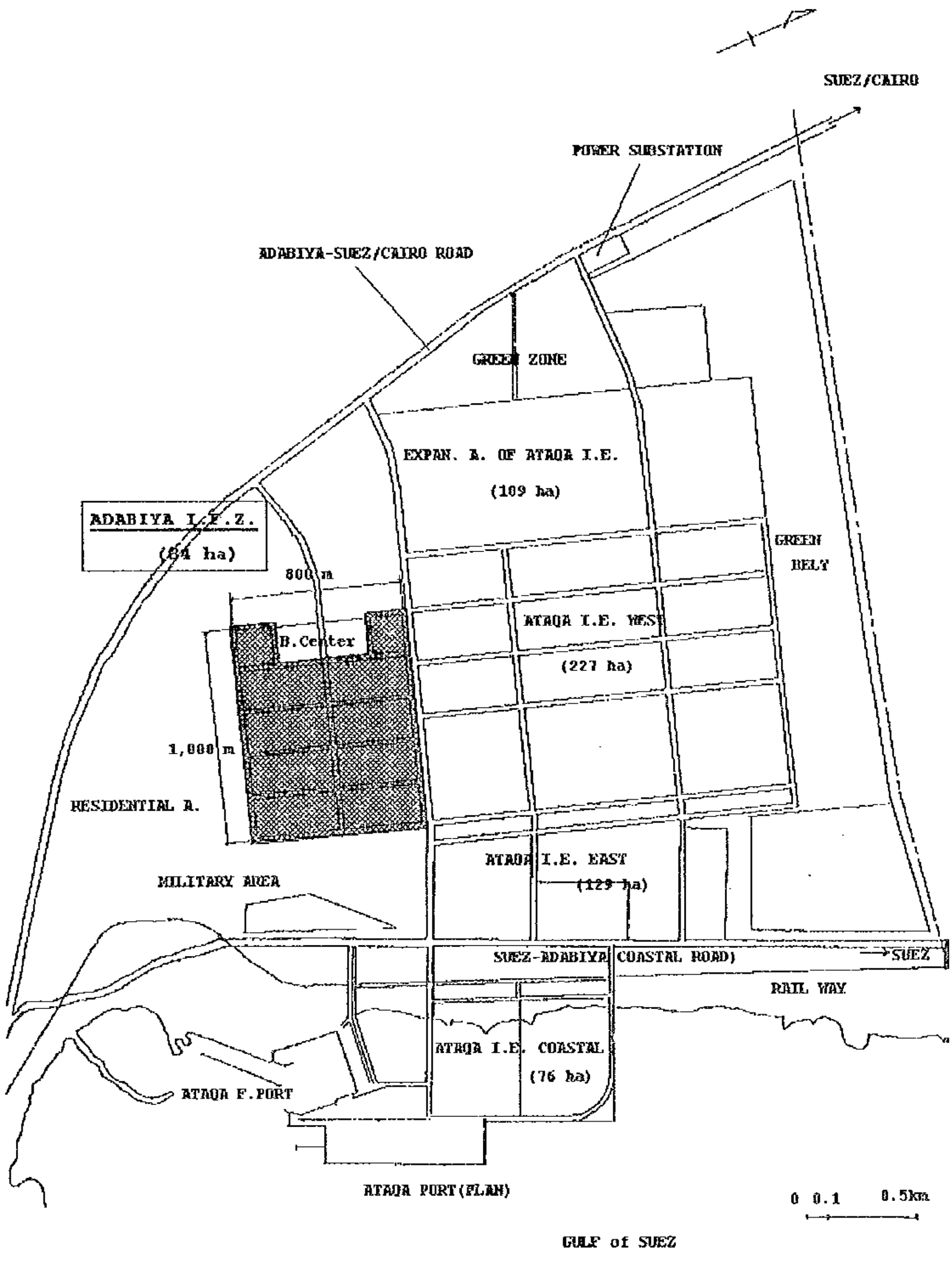
Land acquisition cost in the Suez area will be LE 30/m^2.

2) Alexandria

Alexandria, which has a population of three million and is the center of industrialization in Egypt, is located at the coast of the Mediterranean Sea.
Agriculture, chemical, steel and tourism industries are under development in this district, thus the area offers exceedingly easy access to public facilities and infrastructure such as roads, railways, port, natural gas, industrial water and electric power supply, etc. Alexandria National Iron and Steel Company (ANSDK), which is one of the biggest and most modern integrated steel plant in the Middle East, is located some 15 km west of the city of Alexandria.

The proposed site for the steel plant is located at the north west of lake Maryut and beside the ANSDK steel plant.
The proposed site, with an area of about 600,000 m^2, is faced to the El Dekhiela port and shape of the land is rectangular .
The ground level at the site is very low and seems to be reclaimed land on lake Malyut.
Since the upper layer of subsoil is silty clay of which bearing capacity is limited, a piled foundation for heavy machine and building shall be applied.

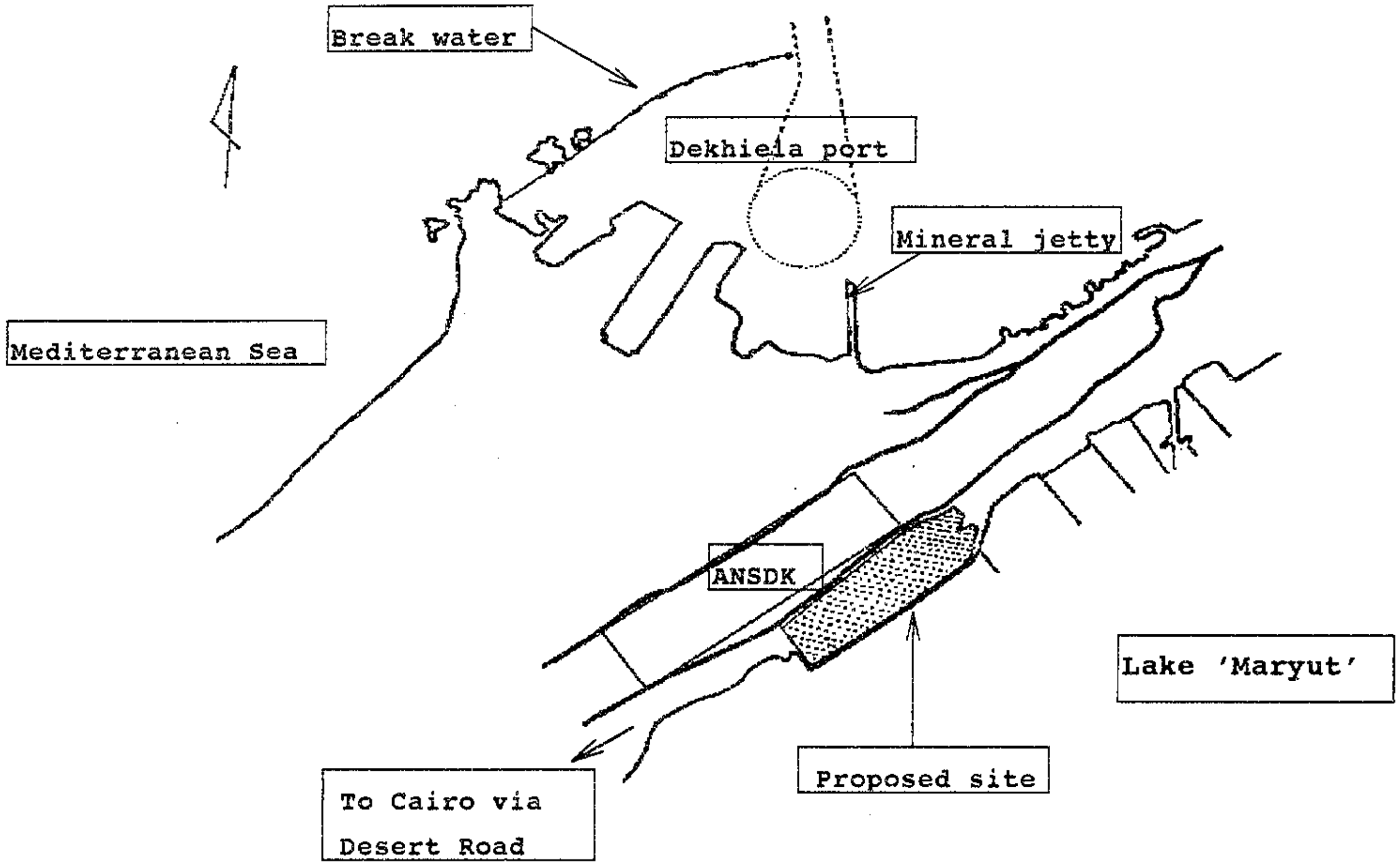
Figure 4-3-1 Location Plan (Adabiya I.F.Z.)



Source; JICA Report of the Suez bay coastal area development '93

Figure 4-3-2 Location Plan (El Dekhiela)

(Non Scale)



(2) Natural conditions

1) Meteorological conditions

Meteorological conditions are not always important factors compared with other site conditions in general, excepting any impact on port operation by storms or wind. Moderate and stable conditions are desirable from the view points of economics and the environment.

According to published data, the brief of each region is reported as follows. (See Appendix 4A-1 for details)

(a) Suez (Adabiya)

a) Temperature (°C)
- Annual mean : 22.5, max.29.0, min.16.0
- Absolute records: max.45.6, min. 0.0

b) Relative humidity(%)
- Annual mean : 67, max.73, min.58

c) Rainfall(mm)
- Annual total : 23.6

d) Number of days with rain (≥1.0 mm)
- Annual total : 5.1

e) Wind direction
- Prevailing : North

f) Seismicity *1 : Not remarkable

(b) Alexandria (El Dekhiela)

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

b) Relative humidity (%)
- Annual mean : 68, max.73, min.64

c) Rainfall(mm)
- Annual total : 168

d) Number of days with rain (≥1.0 mm)
- Annual total : 23.4

e) Wind direction
- Prevailing : Northwest

f) Seismicity *1 : the "Northern Red Sea-Gulf of Suez-Cairo-Alexandria Clysmic-Trend" zone

Remarks; *1: Refer to "The Geology of Egypt" edited by RUSHDI SAID

2) Topographical conditions

The land for the flat steel plant shall be developed as a horizontal plane in consideration of the highest flood water and sea levels, etc. For development of the land, including access roads and railway lines, it is also important that the configuration of the land (undulation, gradient, etc.) is suitable.

(a) Suez (Adabiya Industrial Free Zone)

The land designated for the flat steel plant site has already been developed based on a recommendation of a JICA report published in 1993.

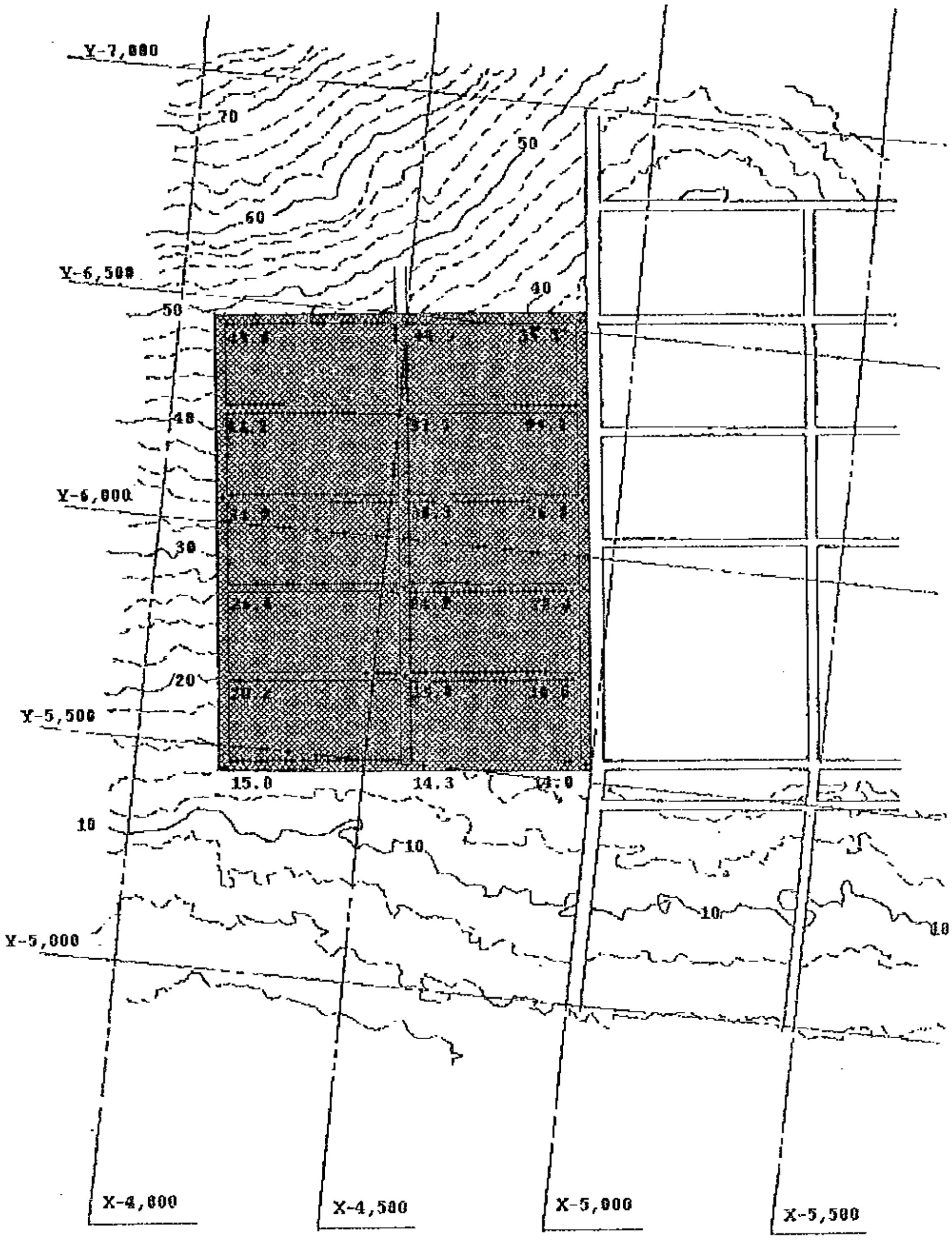
The developed ground elevation of the area varies from approximately 15 to 50 m above the sea level and the gradient is approximately 2.2 to 3.4 %. Therefore, in order to obtain one or two wide horizontal plane surfaces for the flat steel plant site, a large amount of earth work (cutting and filling) and relocation work of such facilities as roads, drainage systems, buildings etc. which have already been constructed, are required. (See Figure 4-3-3)

(b) Alexandria (El Dekhiela)

The ground elevation of the area designated for the flat steel plant site is low and a little above the water level of Lake Maryut, except the western area which has been filled to about 0.5 to 3.5 m above water level with a certain amount of steel slag and is partially utilized as a scrap storage yard. The remaining eastern area is a natural hazard (the lake). Therefore, a large amount of filling, banking and/or replacement of unsuitable material (sediment from the bed of the lake and discarded slag) with suitable filling material are necessary. In order to keep better access to the plant area from the surrounding public roads and easier construction of the foundations at the time of project execution, a finished elevation of about 4 to 5 m above the water level of the lake should be considered.

(See Figure 4-3-4)

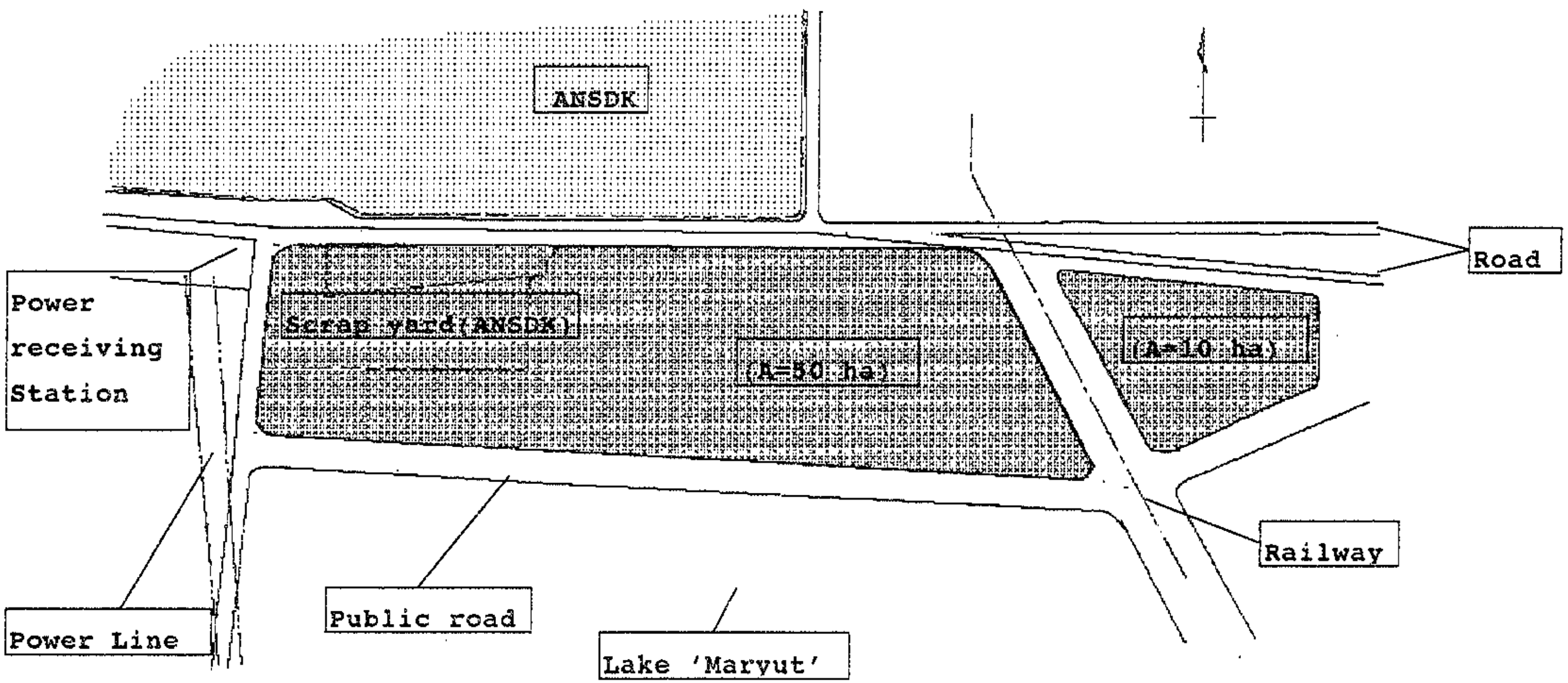
Figure 4-3-3 Topography of Adabiya I.F.Z.



Source; JICA Report of the Suez bay coastal area development '93

Figure 4-3-4 Land Location Plan (El Dekhiela)

(Non scale)



3) Soil conditions

The soil condition of the flat product plant project site is an important factor for design and construction of the various types of foundations and/or underground structures. In order to construct a rigid and stable foundation and structure for heavy equipment, and the stable stock yard bed required for storage and handling of big volumes of raw materials and finished products, a stable and stiff sand or sandy soil subsoil strata is preferable. In case soft soil layers exist, replacement with good quality soil or improvement by some means should be considered so that the problem of settlement of the foundations and structures can be minimized.

A typical soil profile of each proposed site is referred to in Figure 4-3-5.

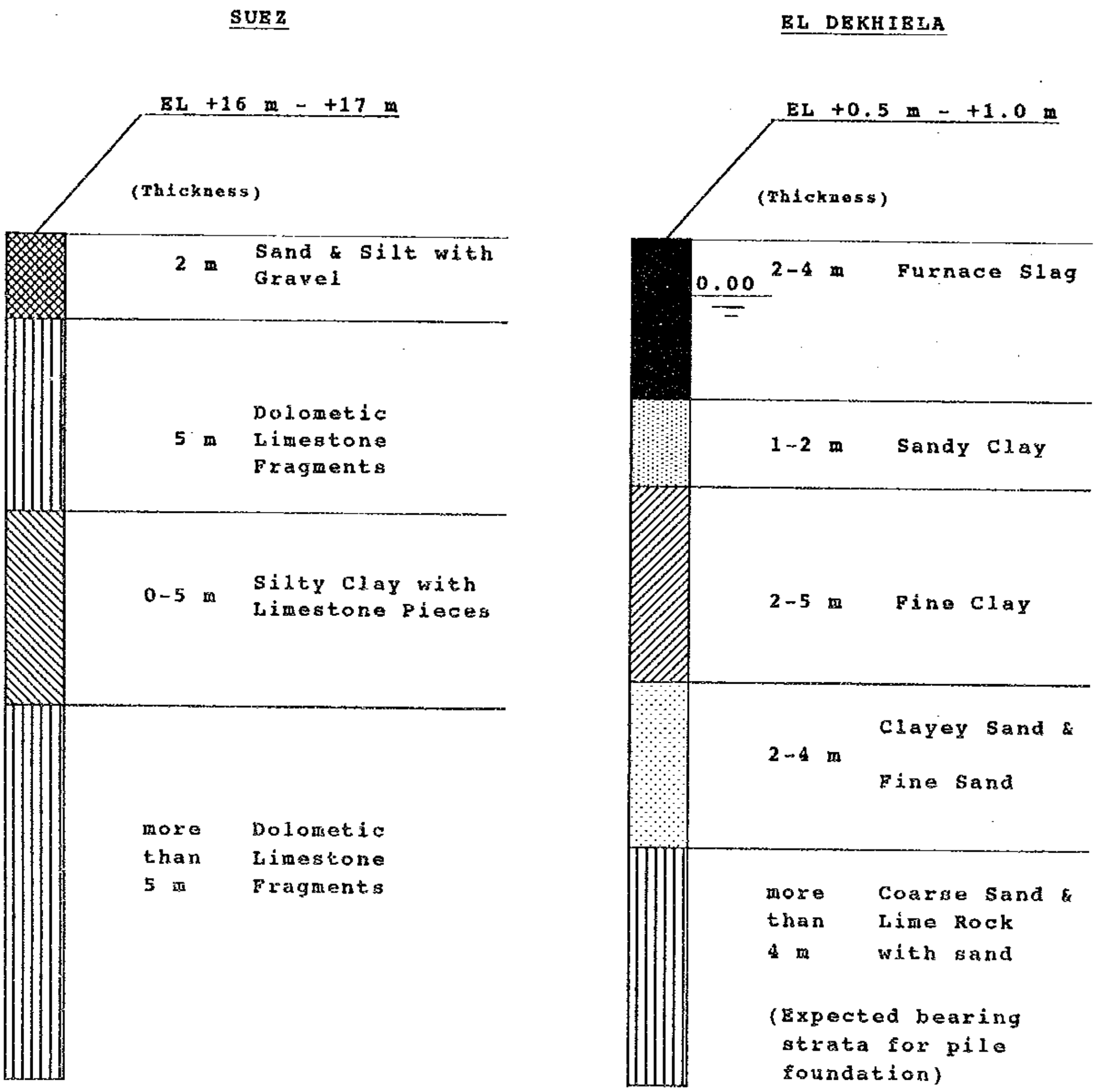
(a) Suez (Adabiya Industrial Free Zone)

According to the JICA report published in 1993, the subsoil condition of the area consists of stable layers of sand, gravel and dolometic lime stone. In addition, the N-value of each layer is more than 50, and no underground water was observed.

(b) Alexandria (El Dekhiela)

The proposed site is located behind the ANSDK steel factory along the coast of Lake Maryut. According to the soil report and the observation from the western part of the area, the soil profile is characterized by subsoil consisting of a top layer of slag 2 to 4 m thick, an under-layer of very soft sandy clay and a fine clay layer 4 to 8 m thick, and beneath this a stable and stiff sand and lime rock layer.

Figure 4-3-5 Soil Profile (Typical)



(Source;JICA Report of the Suez bay coastal area development '93)

Note: The profile represents the data of 12-borings executed at the western part of the proposed site.
(source;ANSDK)

4) Sea conditions

4) Sea conditions

Where harbor construction is required, it is essential to take such natural sea conditions as tide level, tidal current, wave height, depth and condition of the sea bed, existence of drift sand, etc. and congestion of port operations (which may be caused by or may affect an existing port and facility) into consideration. According to maritime reports and charts, the sea conditions of each area are as follows;

(a) Suez

a) Tide level

- High water level : Datum line + 1.55 m
- Mean water level : Datum line + 0.26 m
- Low water level : Datum line - 1.15 m

b) Tidal current

- Velocity (m/s) : 0.1 - 0.2
- Direction : SE and NW

c) Wave height

- Height (m) : 1.5 - 2.5
- Period (s) : 4.0

d) Others

- Sea bed condition and drift sand: N/A

(b) Alexandria

a) Tide 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

b) Tidal current

- Velocity (m/s) : 0.08 - 0.23
- Direction : E/ESE and NW/NNW

c) Wave height

- Height (m) : 0.2-0.5 from E/ESE direction and
  : 1.0 - 1.4 from NW/NNW direction
- Period (s) : 8.5 - 9.2

d) Others

- Sea bed condition and drift sand: N/A

(3) Social conditions

The Study Team investigated social conditions surrounding two proposed plant sites. Social conditions include the regional development plan, labor force, houses, incentives, laws and regulations, and supporting industries.

1) The development plan

The development plan is a comprehensive plan by the government control. The government has executed the first to third Five Year Plan (from fiscal 1982 to 1997). According to the regional development plan, the government has not been presented the development plan for Cairo and Alexandria up to this time. It seems that the government is anxious about overpopulation and increase of mass industries in these two areas.

Suez had much smaller population due to the evacuation in the war in 1967. So, the government has enlisted infrastructure plan for the development of industries in Suez since 2nd Five Year Plan (from 1988 to 1992 fiscal year) so that Suez may have one million population in 2000. Also, in 1987, Suez was set up as the pubic free zone, and its infrastructures have been gradually improved by the Development Plan of Suez Bay Coastal Area.

2) Labor force

In Egypt, the present labor market is under oversupply.

In accordance with the data of the Central Bank of Egypt and CAPMAS, the population, employment and unemployment situation are shown in Table 4-3-1. The percentages of employees by sector in 1994/95 are 53.6% in commodity sectors, 16.4% in production service sectors, and 30.0% in social service sectors. In commodity sectors, the percentage of agriculture is 31.9 %, mining and manufacturing 13.7%, and others 8.0%. Generally speaking, commodity sectors, especially in manufacturing, have the capability of absorbing new job opportunities. In Egypt, the percentage of employees in manufacturing sector is very low, and that of social service sectors is very high. These facts show that social service sectors and the agriculture sector have many surplus employees in Egypt.

The rate of employees in the total population was as low as 25% in 1996(Japan; 52%, USA; 48% in 1996). In June 1995, there were as many as 2.67 million Egyptian workers abroad. This might be attributable to less employment opportunities in Egypt.

Table 4-3-1 Population, Employment and Unemployment

unit: thousand, %

	1994/95		1995/96	
Population	58,978	---	60,236	---
Labor force	16,452	---	16,925	---
Number of employees	14,879	100.0	15,340	100.0
In commodity sectors	7,968	53.6	8,171	53.3
- Agriculture	4,744	31.9	-	-
- Mining & manufacturing	2,031	13.7	-	-
In production service sectors	2,450	16.4	2,553	16.6
In social service sectors	4,461	30.0	4,616	30.1
Number of the unemployed	1,573	---	1,585	---
Unemployment ratio %	9.6	---	9.4	---

Source: Central Bank of Egypt, CAPMAS. Notes:- not available

The expansion of employees in manufacturing sector is smaller than expected. It seems delay of privatization has caused less development of industries. The number of university graduates is yearly about 100,000 and they have been formerly admitted to be employees of social service sectors. But, the recent promotion of privatization is making it more difficult for social service sector to absorb those people.

According to CAPMAS, the population of Suez and Alexandria in 1996 is 204,000, and 3,484,000 respectively. Each of these in 2001 will be anticipated 611,000 and 3,926,000. In both cities, a new steel company, which can pay attractive wages, will be able to hire easily less than 2,000 employees necessary for project of flat product plant. In terms of the population scale, it will be easier for a new company to be located in Alexandria to employ workers than in Suez.

3) Houses

The supply of houses has been regarded as important by the government in terms of social policies. Apart from quality, houses are supplied in quantity.

According to the census in 1986, housing units in Suez, and Alexandria were 81,849, and 788,134 each. The vacant rates were 16.2% and 11.9% respectively. The vacant rate for all Egypt and all urban governorates was 16.6% and 13.2% respectively. In the 3rd Five Year Plan, growth rate in investment of social services sectors was set higher than one of the GDP total, and implemented investment of housing from 1992/93 to 1995/96 shared 32% in social services sectors. However, the number of houses built has been decreasing in these past few years because of a decline in the population growth rate.

As for future housing conditions in Suez and Alexandria, Suez may have some advantages compared with Alexandria due to social policy such as the progressive Development Plan of the Suez Bay Coastal Area.

4) Incentives, laws and regulations

The government has been constructing 12 new towns as "New Communities," away from the major cities like Cairo and Alexandria. It is said that extremely generous incentives are available to attract investment into these new towns, including good ten-year tax exemptions, cheap land prices, labor conditions, and relatively little bureaucracy. Tax holidays can be extended still further through self-financed expansion or through the creation of subsidiary companies. However, Suez is not included in New Communities.

The government established "Free Zones" in 1974 to promote and vitalize manufacturing industries located in such big cities as Cairo and Alexandria. This investment system is not so attractive as "New Communities" in terms of incentives. It was reformed as Investment Law No.8/1997. It aims to create employment opportunities and generate foreign exchange earnings through export. Companies established in free zones can operate in the same manner as a foreign country. It means that they can enjoy exemptions from some taxes and duties such as customs duties for exports and imports, general taxes, etc. But they lose these special privileges and guarantees when they deal with their own products inside Egypt. Two types of Free Zones have been established by the General Authority for Investment (GAFI). One is public free zones for a conglomerate of projects, the other is private free zones, for a single project which requires a particular location.

One of proposed sites for flat steel products plant is in the public free zone of Suez. But this project intends to sell flat products mainly in the domestic market, therefore a site in the free zone is not necessarily advantageous.

5) Supporting industries

In Egypt new communities and public free zones have been established to promote manufacturing. And investment in various sectors has been increasing in Alexandria, Suez, Nasr City, Port Said and the regions surrounding Cairo.

GAFI showed the investment data in free zones at the end of June 1996 to the Study Team. According to it, a total of 650 projects are approved, with L.E. 5,212 million in equity, and L.E. 13,816 million in investment cost. The approved numbers of the projects in free zones are 291 in Alexandria, 82 in Suez, 127 in Cairo, 126 in Port Said, 16 in Ismailia, and 8 in Damietta. The details about Alexandria and Suez are shown in Table 4-3-2.

Table 4-3-2 Free Zones Projects in Alexandria and Suez

Unit: million L.E. and % ( )

	Alexandria	Suez	Total
Approved			
1) Number of Projects**	291(45)	82(13)	650(100)
2) Equity*	1,223(23)	2,172(42)	5,212(100)
3) Investment*	3,644(26)	6,920(50)	13,816(100)
In Operation			
1) Number of Projects**	162(46)	40(11)	349(100)
2) Equity*	688(41)	90(5)	1,667(100)
3) Investment*	1,478(53)	107(4)	2,770(100)
Under Implementation			
1) Number of Projects**	129(43)	42(14)	301(100)
2) Equity*	535(16)	2,082(59)	3,545(100)
3) Investment*	2,166(20)	6,813(62)	11,046(100)

Source: GAFI

Note: Till June 30,1996. ** Number, * Price.

According to this table, there are a lot of projects in Alexandria and Suez, and many big-scale projects will concentrate in Suez in the future. Thus, it seems that industries in Alexandria and Suez will be under expansion.

The steel works generally needs a lot of commodities, which range from office supplies, construction materials, production supplies and machinery. Also in the construction stage, domestic companies will be employed as building and civil engineering contractors. In Egypt major domestic supporting companies are in Cairo, partially in Alexandria, and scarce in Suez. In the future many new companies will be located in Suez, but it may take many years for those companies to be capable and experienced suppliers to the flat steel plant.

(4) Construction requirements

For a steel works construction, a large amount of construction material, manpower, and construction equipment shall be utilized under experienced management.

It is of importance that in the area of the site the supply of resources such as materials, manpower and equipment are sufficient to meet project requirements.

The brief of the present condition of construction requirements is referred to as Appendices 4A-2 - 4A-5.

-Appendix 4A-2 Availability of Typical Construction Materials

-Appendix 4A-3 Availability of Typical Construction Man Power

-Appendix 4A-4 Availability of Typical Construction Equipment

-Appendix 4A-5 Typical Contractors for Civil and Building Work

1) Suez

Many projects in various industrial fields have been planned and implemented in consideration of the utilization of the existing port facility.

As to the present construction activity, a land development project has been completed at the southern area of the Ataqa industrial zone. The supply capabilities that construction requires seem to be sufficient as referred to in the appendices.

2) Alexandria

In this area, it is assured that the supply capabilities required for steel plant construction are sufficient, since there are similar scale steel plant construction projects(such as Direct Reduction plant, Electric Arc Furnace plant and Rolling Mill plant etc.) in existence and expansion programs have been continuously implemented during the past decade at ANSDK.

4-3-3 Transportation and port facilities

(1) Port facility

1) Adabiya port in Suez

Adabiya port of which outline is described below situated on the coast of the head of the Suez Gulf about 5 km south of Adabiya Industrial Free Zone where the proposed site of steel plant is located.

- Total number of commercial quays : 10 quays
- Total length of commercial quays : 2,140 m
- Quay depth : up to 13 m
- Port total productive area : 6.3 million t/y
- Total storage capacity cereals store : 15,000 m^2

New container quay construction work, which has total length of 1,000 m and 14.5 m depth of quay, will be launched soon.

Mineral jetty for the steel plant could be constructed at the new container quay sharing length 400 m out of 1,000 m. Detail study and confirmation about this mineral jetty would be required.

2) El Dekhiela port

El Dekhiela port is situated on the coast of Mediterranean Sea, 15 km west of Alexandria port and has a function of unloading general cargo and iron ores for the Alexandria National Iron and Steel Co. (ANSDK),and coal for the Egyptian Iron and Steel Co. (EISCO) steel works use.

- Total number of commercial quays	: 13 quays
- Total length of commercial quays	: 3,510 m
- Quay depth	: up to 20 m
- Port total productive area	: 8.4 million t/y
- Total storage capacity areas	: 869,000 m^2

The detailed information of mineral jetty in El Dekhiela port are as follows;

Berth	:Water depth 14m ,	Berth length 300m
	Water depth 20m ,	Berth length 300m
Unloader	: 1,000 t/hr x 2	
Stacker	: 1,000 t/hr x 2	
Reclamer	: 800 t/hr x 2	

(2) Road and railway

Land transportation plays a very important role in the economic development of a country. It has a major impact on production from the transport of raw materials to delivery of the final products to its target market. The steel plant should be assured the shortest possible delivery of raw materials at an economical cost with a good transportation system. Also the finished products should be delivered safely to their final destination as promptly and economically as possible.

In Egypt transportation is mainly carried out by road and railway . In freight transport, roads share over 90% and railways below 10%.

The features of land transportation in Egypt can be summarized as follows.

1) Road transport

Egypt has 45,000 km of roads, of which 17,000 km are inter-city roads in relatively fair and good condition. Cairo is connected by roads with several cities such as Alexandria, Suez, Ismailia, Port Said and other delta towns, and Aswan as far as the High Dam, and they are in reasonable condition. Paved inter-city roads increased from 8,365 km in 1981 to 18,770 km in 1995. Table 4-3-3 shows the length of paved roads.

Table 4-3-3 Length of Paved Roads in Main Governorate

Unit: km

Governorate	Width of Road (m)			Total
	- 7.5	7.5- 12	12 – double	
1) Cairo	-	338	233	571
2) Alexandria	97	-	132	229
3) Suez	60	309	378	747
4) Port Said	-	19	78	97
5) Red Sea	736	888	16	164
Total	6,692	9,885	2,193	18,770

Source: CAPMAS(As of 1995)

As for road conditions, Suez is generally good.

Egyptian road traffic means vary as shown in Table 4-3-4.

Table 4-3-4 Road Traffic (in-movement licensed vehicles)

Unit: 1,000

Type of Vehicle	Number
Passenger cars	1,306
Busses and Coaches	39
Lorries	429
Trucks	46
Motorcycles	402

Source: CAPMAS(As of 1995)

The Private sector plays a major role in land transport. Its share is 90 % against 10 % for the five public sector companies. The government is planning to privatize these public sector companies in the future.

2) Railway transport

Egypt has 5,300 km of railways which are connected to main cities. Railways transport is mainly used for passengers. Egyptian National Railways (ENR), a public sector company, monopolizes railway transport. ENR has more than 70,000 employees, and is chronically embarrassed by deficit.

Freight transportation by railway decreases reducing yearly due to high costs and handling problems in comparison with road transportation. ENR is studying its privatization and its restructuring.

ENR delivers freight transport of raw materials and products. For example, ENR carries phosphate and iron ore from the Bahariya mines in the Western Desert, and transports imported coal from Alexandria port, to EISCO located at Helwan. But most other steel mills do not use the railway to transport materials and steel products. They do not have directly connected rail lines within the works as EISCO has.

3) Domestic transportation for flat steel works

As it is difficult that ENR under restrictions will invest new lines for private steel companies, only transport by road, that is by truck, can be studied for domestic transport for flat steel works. Domestic transport for flat product plants is mainly divided into that of domestic materials such as limestone and that of flat steel products. Limestone in Egypt is plentiful in the western side of the Nile River. Excellent quality limestone for steel is produced from two mines, Beni-Khalid and Rifaie and are transported to both EISCO and ANSDK respectively. The former is located 250 km south of Cairo near Giza, and the latter is near Giza

Consumption of flat steel products by location is shown in Table 3-2-4. The Study Team learned the freight charges of main road transport from a representative private agency. These are shown as follows.

- Suez - Cairo	: 16 - 18 L.E./ton (134 km)
- Alexandria - Cairo	: 16 - 18 L.E./ton (221 km)
- Suez - 10th of Ramadan	: 18 - 20 L.E./ton (170 km)
- Alexandria - 10th of Ramadan	: 18 - 20 L.E./ton (284 km)
- Alexandria - Suez	: 20 - 21 L.E./ton (355 km)

These do not necessarily show freight charges in proportion to distance. Availability of return cargo has a big impact on freight.

Normally whether the truck can easily pick up cargo on its return has a big impact on freight. There is big movement of many kinds of goods between Cairo and Alexandria. Suez is still a city with smaller movement. Thus, for the flat steel plant, the Suez site has an advantage over Alexandria in terms of distance, but both sites are under almost equal conditions because of the availability of cargo, when trucks return from Cairo to Alexandria.

4-3-4 Water supply, sewage and waste water treatment

(1) Water supply

The flat steel plant at the 1st stage will require a large volume of fresh water as follows;

36,000 m^3/d (1,500 m^3/hr) for raw water
1,000 m^3/d for drinking water

1) Water resource

Information on water resources from Ministry of Irrigation and Water Resources is as follows;

Water intake: from canal

Case-A : -Water brought from canal to the flat steel plant directly.
- Responsibility belongs to Ministry of Irrigation and Water Resources.
- Cost of construction of water intake facilities shall be borne by the steel plant.

Case-B : - Water brought from canal via a water clarification system to the steel plant.
- Responsibility belongs to water authorities.
- The pipe line from water clarification system to the steel plant shall be borne by water authorities.
(For example, this was the case for ANSDK.)

2) Supply facilities of potable and raw water

During the site survey, information on supply facilities of potable and raw water in the two proposed sites were investigated and each location is summarized as follows:

(a) Suez

The existing water supply line (diameter of pipe line is 200 mm) has a capacity of 11,000 m^3/d and new lines (diameter of pipe lines are 800 mm/1,000 mm) will be prepared for the free zone. These lines will be constructed for drinking purpose and for light industry.

Raw water for the flat product plant is not available in Suez.
Raw water is available from Suez sweet water canal (distance between canal and proposed site is about 17 km).
According to Suez Governorate, supply facilities for the flat product plant in Suez will be prepared by Suez canal authority.

(b) Alexandria
The existing water supply line at the proposed area in Alexandria are of 700 mm of diameter used for potable water and a raw water.
Supply facilities of potable and raw water in the two proposed sites are briefly summarized as follows:

Table 4-3-5 Supply Facilities of Potable Water

Proposed sites	Pipe line	Capacity m^3/d (future)	Result
Suez	1,000 mm	11,000 (30,000)	Available
Alexandria	700 mm	30,000	Available

(Requirement for flat project: 1,000 m^3/d)

Table 4-3-6 Supply Facilities of Raw Water

Proposed sites	Pipe line	Result
Suez	Pipe line is not available	Future plan exists
Alexandria	Pipe line is Available	Available

(Requirement for flat project :36,000 m3/d)

3) Quality of raw water

The required quality of raw water for steel plant is indicated in Table 4-3-7.

Table 4-3-7 Required Quality of Raw Water for Steel Plant

Service	Quality
Direct cooling water DR (Direct reduction plant) HSM(Hot strip mill)	Chloride : < 70 mg/l Total dissolved Solid : (< 300 mg/l) (Preferable) Total hardness as $CaCO_3$: < 90 mg/l
Washing water CSM(Cold strip mill)	

(a) Suez

Raw water quality from Suez sweet water canal is indicated in Table 4-3-8. Chloride ion is much higher than the required value.

Desalination plant shall be required so that raw water quality will meet with requirements of steel plant.

Table 4-3-8 Raw Water Quality from Suez Sweet Water Canal

Items	Unit	Quality(max)
Turbidity	NTU	18
PH		8.27
Total dissolved solid	Mg/l	733 (900)
Total hardness as $CaCO_3$	Mg/l	224
Total alkalinity	Mg/l	174
Chloride	Mg/l	500
Iron	Mg/l	Nil

Source : NOPWASD

(b) Alexandria

Raw water quality which is available in Alexandria is indicated in Table 4-3-9

Chloride ion is almost same as the required value.

Desalination plant is not required and only water softener is required in Alexandria.

Table 4-3-9 Raw Water Quality Available in Alexandria

Items	Unit	Quality
Turbidity	NTU	-
PH		7.6 ~ 7.8
Total dissolved solid	Mg/l	245 ~ 344
Total hardness as $CaCO_3$	Mg/l	150 ~ 220
Total alkalinity	Mg/l	160
Chloride	Mg/l	38 ~ 67
Iron	Mg/l	0.05 ~ 0.2

Source :ANSDK,1996

4) **Unit price of water**

Unit prices of raw water and potable water are as follows:

Table 4-3-10 Unit Price of Raw Water and Potable Water

Site	Raw water (LE/m^3)	Potable water (LE/m^3)
Suez	Not yet set up	Inside city : 0.75 Out side city : 1.25 (Adabiya)
Alexandria	1.02	1.02

Source : Suez = Suez Governorate , Alexandria = ANSDK

(2) **Sewage and industrial waste water**

Disposal quantity of sewage and industrial waste water from the steel plant under study is estimated as follows:

Sewage : 1,000 m^3/d

Industrial waste water : 24,000 m^3/d (1,000 m^3/hr)

1) Law and regulation for sewage and waste water

Egyptian Environmental Law No.4 for 1994 was received from GOFI. According to the above law, standard and specification of some elements in disposal water are specified, and the following laws stipulate where the disposal water should be discharged respectively.

Egyptian Law	4 for '94	:	To the sea
Egyptian Law	48 for '84	:	To the Nile
Egyptian Law	93 for '62	:	To the sewage

2) Facilities of sewage and waste water

The facilities of sewage and waste water in two proposed sites were investigated, and facilities in each site are summarized as follows:

(a) Suez

The sewage treatment station of the capacity of 55,800 m^3/d is located beside the proposed area.

Industrial waste water will be treated here also.

The standard value of elements of waste water shall be in accordance with Egyptian Law 93 for '62.

(b) Alexandria

Industrial waste water and sewage system are available now and waste and sewage can be discharged to the sea after being treated in the steel plant.

The capacity of discharge system to the sea in ANSDK is 1,860 m^3/h and currently 170m^3/h is used, so it has enough capacity.

The discharge quality of waste water, circulation water which after being treated by water treatment station is much better than those of standard value in accordance with Law 4.

Standard and specification of some elements whenever discharging to the sea in accordance with Law 4 are indicated in chapter 8.

4-3-5 Natural resources and energy

(1) Electric power

1) Power requirement

Approximate requirement of power for the steel plant will be as follows;

- Maximum demand : 200 MW
- Power supply capacity (Back power) : 1,000 MVA

2) The power supply grid

The power supply grid supplying power to the whole country is interconnected at 500 kV, 220 kV and 132 kV.

The energy produced is transmitted from Aswan to the main consuming regions in Nag Hammadi, Alexandria and Delta.

3) The annual report of electric statistics of Egypt

Egyptian Electric Authority (EEA) has been publishing the annual report of electric statistics of Egypt for promotion of electrical energy and its growth since last year.

Important data extracted from EEA annual report are shown in tables as mentioned below;

- Table 4-3-11 : Nominal capacity and fuel used for power station during 1995/96.
- Table 4-3-12 : Substation capacities distributed over zones for 1995/96.
- Table 4-3-13 : Energy consumed in different zones.
- Table 4-3-14 : Expected projects within two years-Power plants.
- Table 4-3-15 : Expected projects within two years-The net works (Substation).
- Table 4-3-16 : EEA medium term plan for capacity addition at generation plants from 1994/95 to 2005/06.

4) Power supply to the proposed sites

(a) Suez

The following power is supplied through national grid (net work).

- Voltage level : 220 kV
- Line configuration : Double lines
- Supply power capacity : Minimum 1,531 MW
- Excess load : 690 MW
- Power failure : 0.1-0.5 second (instantaneous)/several times in month and 5-15 minutes (frequency stoppage)/2-3 year

(b) Alexandria

Refer to Figure 4-3-11.

The following power is supplied through national grid (net work).

- Voltage level : 220 kV
- Line configuration : Double lines
- Supply power capacity : Minimum 1,441 MW
- Excess load : 691 MW
- Power failure : 0.1-0.5 second (instantaneous)/several times in month and 5-15 minutes (frequency stoppage) /2-3 year

5) Summary for power supply

Power supply for both sites, Alexandria and Suez, is sufficient.

For the further detailed data, refer to Table 4-3-17.

Table 4-3-11 Nominal Capacity and Fuel Used by Power Station during 1995/1996

Power station	Installed Capacity(MW)	Fuel type	Remarks
Shoubrah	1,260	Mazout/NG	
Cairo West	350	Mazout/NG	
Cairo West	660	Mazout/NG	
Cairo South	570	Solar/NG	
Cairo South	165	Solar/NG	
Wadi Hof	100	Solar/NG	
El Tebbin	46	Solar/NG	
El Tebbin	45	Mazout	
Demitta	1,125	Solar/NG	
Talkha	283.5	Solar/NG	
New Talkaha	90	Mazout	
Talkaha 210	420	Mazout/NG	
Kafr el Dawar	440	Mazout/NG	
Mahmoudia	180	Solar/NG	
Mahmoudia	308	Solar/NG	
Damanhour 300	300	Mazout/NG	Alex
New Damanhour	195	Mazout/NG	Alex
Old Damanhour	30	Mazout	
Damanhour	153	Solar/NG	
Abu Kir	900	Mazout/NG	Alex
Siuf	113	Mazout	Alex
Siuf	200	Solar/NG	Alex
Ataka	900	Mazout/NG	Suez
Abu Soltan	600	Mazout/NG	Suez
Suez	185	Mazout	Suez
Shabab	100	Solar/NG	
Walidia	300	Mazout	
Port Said	44	Solar/NG	
Assiut	90	Mazout	

Source: EEA

Table 4-3-12 Sub-station Capacities Distributed over Zones for 1995/1996

Unit: MVA

Zone	500kV	220kV	132kV	66kV	33kV
Cairo	1,500	5,400	-	6,910	-
M.Delta	-	2,680	-	3,129	34
W.Delta	-	1,395	-	1,130	26
Alexandria	-	2,865	-	2,593	182
Canal	-	2,025	-	2,164	-
N.U.Egypt	3,035	1,115	954	621	649
S.U.Egypt	2,245	750	1,858	561	794
Total	6,780	16,230	2,812	17,108	1,685

Source: EEA

Table 4-3-13 Energy Consumed in Different Zones

Unit: Million kWh

Zone	92/93	93/94	94/95	95/96
Cairo	15,155.2	15,942.9	17,179.8	18,096.8
M.Delta	6,283.4	6,485.5	6,967.0	7,464.0
W.Delta	2,194.4	2,200.2	2,268.1	2,468.3
Canal	4,271.4	4,493.7	4,796.3	5,379.0
Alexandria	5,615.4	5,820.2	6,133.5	6,391.8
N.U.Egypt	3,702.5	3,664.0	3,687.8	4,046.9
S.U.Egypt	8,108.5	8,233.1	8,406.0	8,709.1
Total	45,330.8	46,839.6	49,438.5	52,555.9

Source: EEA

Table 4-3-14 Expected Projects within Two Years
– Power Plants

Name of project	Capacity (MW)
Assiut second extension	1 x 300
El Arish	2 x 30
El Koraimat	2 x 600
Total	1,560

Source: EEA

Table 4-3-15 Expected Projects within Two Years
– Networks (Sub-Station)

Name of Project	KV	Capacity (MVA)
500 kV Sub-station		
New Suez	500/220/11	1 x 500
220 kV Sub-station		
Loxur Shark	220/66/20	2 x 75
Zaafrana	220/22	2 x 75
Maghagha	220/66/33/11	2 x 75
Taba	500/400/22	1 x 75
	500/220/22	1 x 500
Safaga	220/66/22	2 x 75
Marsa Matrouh	220/66/11	2 x 75
Nowebaa	220/66/22	2 x 75
Sharm El Shiekh	220/66/22	2 x 75

Source: EEA

Table 4-3-16 EEA Medium Term Plan for Capacity Addition of Generation Plant from 1994/1995 to 2005/2006

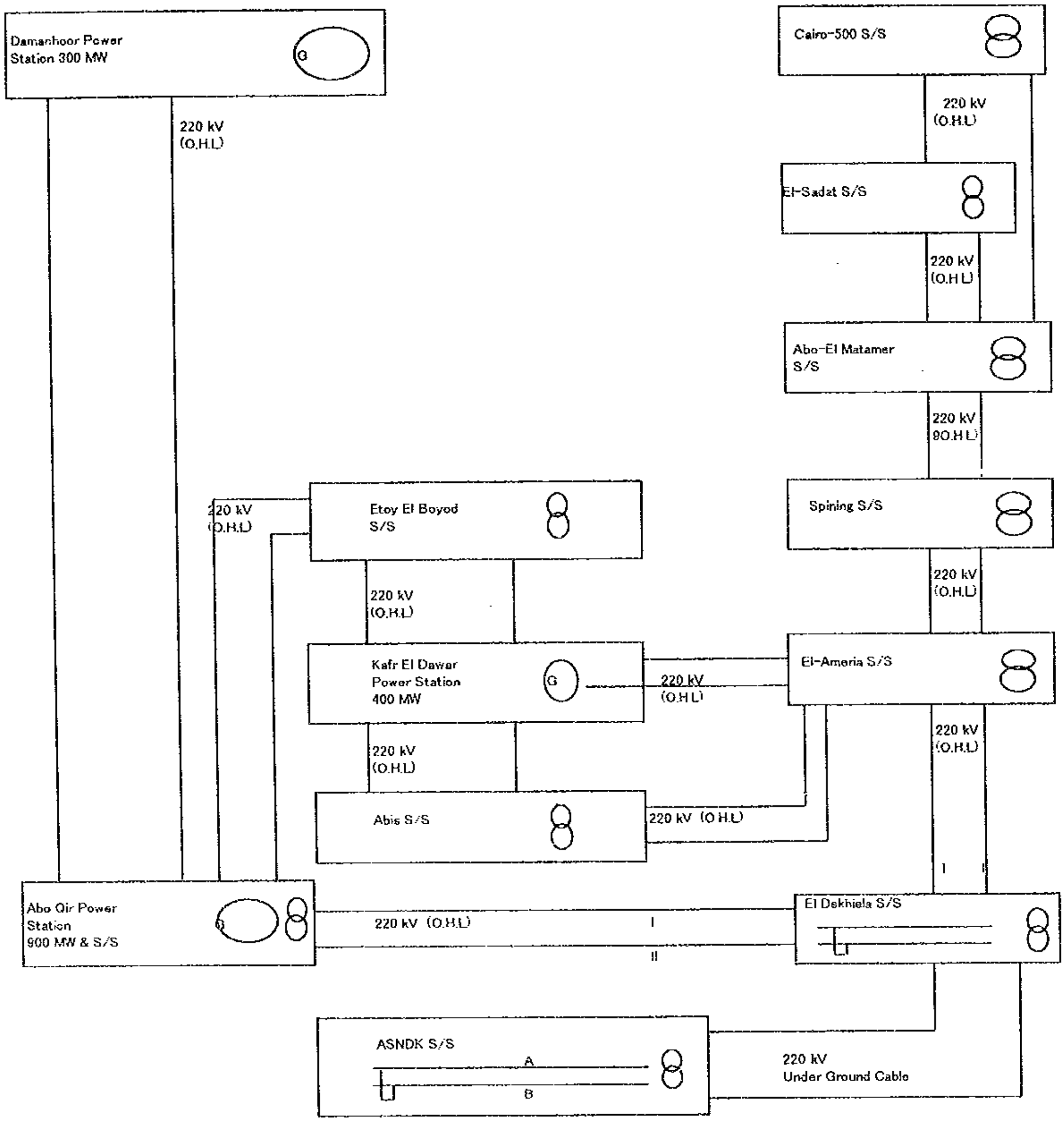
Plant	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06
Talkha Ext.	210											
Assult	2x300	300										
Cairo West								2x325				
Mahmodia C.C.		100										
Damanhour Ext.											325	
Damanhour C.C.		50										
Cairo South C.C.	165											
Kurimat			650	650								
Sidi Krir					325	325						
Ayon Mousa							325	325				
Attaka(Pumps St.)									325	325		
Cairo North G.T.												
Delta North G.T.												
Nobaria C.C.											2x300	300
Suez Gulf									325	325		325
El Tebien G.T.										2x100		
Total	975	450	650	650	325	325	325	975	650	850	925	625

Source: GOFI (JICA phase-1 report)

Table 4-3-17 Evaluation of Power Supply for Proposed Sites

No.		Description	Site: Alexandria – El Dekhiela	Site: Suez – Ataqa
1		Requirement of Power		
		a) Average maximum demand (MW)	200	200
		b) Power supply capacity (Back power) (MVA)	1000	1000
2		Existing Major Power Stations Capacity		
	2.1	Alexandria site		
		a) Damanhoor Power Station		
		* Installed capacity (MW)	300	
		* Load factor (%)	60	
		* Excess capacity (MW)	120	
		b) Kafr El Dawar Power Station		
		* Installed capacity (MW)	270	
		* Load factor (%)	30	
		* Excess capacity (MW)	189	
		c) Abo Qir Power Station		
		* Installed capacity (MW)	871	
		* Load factor (%)	56	
		* Excess capacity (MW)	382	
	2.2	Suez site		
		a) Ataqa Power Station		
		* Installed capacity (MW)		850
		* Load factor (%)		57
		* Excess capacity (MW)		365
		b) Suez Power Station		
		* Installed capacity (MW)		106
		* Load factor (%)		64
		* Excess capacity (MW)		38
		c) Abu Soltan Power Station		
		* Installed capacity (MW)		575
		* Load factor (%)		50
		* Excess capacity (MW)		287
3		Total Excess capacity (MW)	691	690
4		Distance from Substation to site (m)	Approx. 200-300	1000
5		Supply voltage level (kV)	220	220
6		Line configuration	Double line	Double line
7		Power supply condition in terms of reliability such as ;		
		-Volatge	205-220 kV	205-220 kV
		-Frequency	49.9-50.2 Hz	49.9-50.2 Hz
		-Power failure (Instantaneous)	0.1-0.5 sec.	0.1-0.5 sec.
		-Power failure (Frequency stoppage)	5-15 min/2-3year	5-15 min/2-3year
8		Result of evaluation	Sufficient	Sufficient

Figure 4-3-6 Net work feeding to El Dekhiela



(2) Natural gas

The flat steel plant under study will require about 55,000 Nm^3/hr of natural gas.

1) Back ground

During the survey, information on " An overview of Egypt's Oil and Gas Sectors " issued by American Chamber of Commerce in Egypt was received as back ground data and information. It is briefly summarized as follows:

(a) Reserves

In 1990, Egypt had known gas reserves of 12 trillion cf., including 8.5 trillion cf. of non-associated gas reserves. Current reserves of natural gas amount is estimated at 21.4 trillion cf. due to a sharp increase over 1992.

The government's objective is to discover new reserves, averaging 1.35 trillion cf. annually over the next twenty years. This will eventually maintain reserves at the current level while meeting domestic demand, which is forecast at 27 trillion cf., over the period.

(b) Production

Until 1992, natural gas production has been averaged 1.1 billion cf./d.

EGPC (Egyptian General Petroleum Corporation) has forecast that production will reach at 1.6 billion cf./d in 1996/97 at the end of the current Five - Year Plan.

Natural gas production within 1994 is indicated in Table 4-3-18.

Table 4-3-18 Natural Gas Production in Egypt

Unit : 1,000 t (In 1994)

Natural gas	Quantity
Abu Madi	2,632
Abu Qir/Naf	1,199
Abu Al-Gharadiq	547
Badreddin 1	129
Shukeir (Suez Gulf)	1,254
Badreddin 2,3	2,408
Sinai	103
Khalda	24
Abu Sinai	186
Across Gulf	246
El-Qaraa	786
TOTAL	9,514

Source:American Chamber of Commerce in Egypt

2) Natural gas supply

The following information was received from GASCO (Egyptian Natural Gas Company).

(a) Capacity of the existing supply sources

Required quantity for the steel plant is 55,000 Nm^3/hr and GASCO has enough supply sources.

(b) The existing supply pipe lines

Net work of supply line exists respectively in Alexandria and Suez.

Supply pipe line up to factory boundary shall be installed by Egyptian Natural Gas Company (GASCO).

(c) The required quality of natural gas for steel plant project

The required quality of natural gas for steel plant is indicated in Table 4-3-19

Table 4-3-19 Required Quality of Natural Gas for Steel Plant Project

Supply capacity	55,000 Nm^3/hr
Service	Feed to DRP (Direct Reduction Plant) Fuel gas
Composition	C_5+(Heavy hydro carbon):< 0.5 (mol. %) Sulfur (as H_2S) = 5 ~ 10 ppm

Sales gas analysis from GASCO was received and is indicated in Table 4-3-20
Analysis value will meet with the requirements for steel flat project.
As for H_2S content, Natural gas which is under production in Alexandria is less content and is preferable for DR plant.

Table 4-3-20 Sales Gas Analysis

Composition	Mol%
N_2	0.65 ~ 1.06
CO_2	1.87 ~ 0.45
C_1	77.51 ~ 92.00
C_2	13.37 ~ 3.69
C_3	6.02 ~ 1.65
IC_4	0.27 ~ 0.39
NC_4	0.26 ~ 0.39
IC_5	0.03 ~ 0.15
NC_5	0.03 ~ 0.15
C_6+	0.01 ~ 0.10
G.C.V(BTU/FT)	1183.00 ~1077.00

Source : GASCO

(d) Unit price of natural gas

Unit price of Natural gas is linked with international price and is the same for both proposed sites.

The unit price which will be used for Feasibility Study calculation of the steel plant, which starts in 2005, is indicated in Table 4-3-21.

Table 4-3-21 Unit Price of Natural Gas

(Unit: 0.01 US$/$Nm^3$)

Proposed site	Unit price
Suez	8.4
Alexandria	8.4

4-4 Evaluation Criteria

4-4-1 Flow of site selection

The primary selection: Compliance evaluation of dominant conditions	Based on the field survey, three proposed sites shall be screened in regard to the compliance with essential conditions as the site for construction, operation and management of the steel plant.
↓	
The secondary selection: Comparative evaluation of technical economical and social factors	Regional characteristics of sites, which passed with success the primary selection shall be compared in regard to the technical, economical and social factors.
↓	
Overall evaluation: Selection of the site	Taking the results of the compliance evaluation of dominant conditions (primary selection) and comparative evaluation of technical, economical and social factors (secondary selection) into consideration, overall evaluation shall be made to focus only one possible site and the Study Team will recommend it to Egyptian government.
↓	
Final decision of the site	Based on the above results, final decision of the plant site shall be made upon discussion with Egyptian authorities.

4-4-2 Primary selection

To evaluate compliance of proposed sites with essential conditions for the steel plant construction, compliance evaluation of dominant conditions shall be made. The compliance evaluation criteria was prepared based on the following concept.

Energies, utilities and relevant infrastructures shall meet requirements of the steel plant quantitatively and qualitatively.

The plant is assumed to start its operation in 2005. Development of energies, utilities and infrastructures shall also meet the implementation schedule.

To obtain the result of the primary selection of field survey, alphabetical signs shall be given in the column.

A: Present status gives satisfactory conditions, situations or environment. Sign "A" represents acceptable.

I : Present status is not satisfactory, but conditions, situations or environment seem to be improved in the future. Sign "I" represents insufficient but can be improved.

U: Present status is not satisfactory, conditions, situations and environment do not seem to be improved in the future. Sign "U" represents unacceptable.

Table 4-4-1 Summary of Primary Selection

Factor/Consideration	Suez	Alexandria
1. Land Utilities:		
(1) Area;		
2. Transportation and port facilities:		
(1) Iron ores berth		
(2) Berth for products and scrap		
3. Utilities		
(1) Industrial water		
(2) Natural gas		
(3) Electric power		
(4) Waste water sewer		

4-4-3 Secondary selection

This section describes about the secondary evaluation criteria.

(1) Technical evaluation

All possible proposed sites, which successfully passed through primary selection shall be evaluated with Check List for Site Selection - Technical evaluation for Secondary Selection.

Evaluation procedures are given below.

Three check boxes are prepared on each item. The first box is "importance" and the second and third boxes are "rating and scores".

An alphabetical sign based on the following criteria shall be given in the "importance" box.

The sign "importance" is classified into three categories as follows;

A: Important condition items

B: Ordinary, or good if it is furnished

C: Just for information

Alphabetical signs and evaluation scores shall be given in the "rating" box.

A: Present status gives satisfactory conditions and /or situations (score range: seven to ten points). Sign "A" represents acceptable.

I : Present status is not satisfactory, but conditions and/or situations are expected to be improved in the future (score range: five to seven points). Sign "I" represents insufficient but can be improved.

U: Present status is not satisfactory conditions, and/or situations or environment is not expected to be improved in the future (score range: five points and less). Sign "U" represents unacceptable.

Summary of Technical Evaluation shall be summarized in Table 4-4-2.

Table 4-4-2 Summary of Technical Evaluation in Secondary Selection

	Importance	Rating	Score
1. Land utilities			
1.1 Site conditions			
1.2 Supporting industries			
1.3 Construction requirement			
1.4 Manpower			
2. Transportation and port facility			
2.1 Port facility			
2.2 Road and railway			
3. Utilities			
3.1 Water supply			
3.2 Sewerage and waste water			
4. Natural resources and energy			
4.1 Natural gas			
4.2 Electric power			
5. Natural environment			
5.1 Meteorological condition			
5.2 Topographical condition			
6. Environment and pollution			

(2) Economical comparison

In the field survey including observation of the actual site, it is helpful for site selection study to collect data on energy costs, utility charges and land purchase prices. Based on these data, calculation shall be made site by site to figure out influence of the initial investment amount, and long term operation costs generated from regional differences. Then, economical comparison among candidate sites shall be carried out.

Table 4-4-3 Comparison of Total Amount of Initial Investment and Operation Costs by Site

Cost factors	Suez	Alexandria
(1) Land		
1) Acquisition of land		
2) Land preparation		
3) Slope protection		
(2) Port and port facilities		
1) Quay		
2) Port facilities		
(3) Facilities in plant		
1) Conveyer		
2) Foundation		
3) Desalination plant		
4) Softener		

(3) Social factor evaluation

Social factor shall be evaluated in accordance with Check List for Site Selection, Social factors evaluation for Secondary Selection . Qualitative evaluation shall be applied by means of alphabetical signs as "A" , "B" and "C" for importance and as signs "A" , "I" , "U" for rating. Because it is very difficult to carry out quantitative evaluation to social evaluation.

Table 4-4-4 Summary of Social Factor Evaluation

Factor consideration	Evaluation
Regional condition (1) Regional development Plan (2) Relevant Industries (3) Environmental restriction	

4-4-4 Overall evaluation

After the secondary selection of technical, economical and social factor evaluation, ranking of suitability shall decided with the overall evaluation table.

Table 4-4-5 Overall Evaluation Table

Evaluation items	Site A	Site B
1. Technical factor		
1.1 Land utilities		
(1) Site conditions	□□□□□	□□□□□
(2) Supporting industries	□□□□□	□□□□□
(3) Construction requirement	□□□□□	□□□□□
(4) Manpower	□□□□□	□□□□□
1.2 Transportation and port facilities		
(1) Port facilities	□□□□□	□□□□□
(2) Road and railway	□□□□□	□□□□□
1.3 Utilities		
(1) Water supply	□□□□□	□□□□□
(2) Sewerage and waste water	□□□□□	□□□□□
1.4 Natural resources and energy		
(1) Natural gas	□□□□□	□□□□□
(2) Electric power	□□□□□	□□□□□
1.5 Natural environment		
(1) Meteorological condition	□□□□□	□□□□□
(2) Topographical condition	□□□□□	□□□□□
(3) Soil condition	□□□□□	□□□□□
(4) Sea condition	□□□□□	□□□□□
2. Economical comparison		
3. Social factor		
4. Overall ranking		
5. Recommendation		

4-5 Results and Recommendation

The results and recommendation of the Study Team can be summarized as follow;

(1) Primary and secondary evaluation

Both proposed sites of Suez and Alexandria(El Dekhiela) are passed primary and secondary evaluation.

(2) Conclusion of the site selection

After due consideration of the features and results of the technical and economical evaluation on both sites of Suez and Alexandria, it is concluded that El-Dekhiela area of Alexandria site is more appropriate for conducting feasibility study.

Following are the briefing of the conclusion.

1) Technical evaluation

Both sites of Suez (Adabiya F.Z.) and Alexandria (El Dekhiela) are technically acceptable as the Flat Product Plant Site.

2) Economical evaluation

- Investment of the Suez site is higher by around LE 270,000,000 (US$ 80,000,000) than Alexandria site.
- Operation cost of Suez is higher by around LE 30,000,000 (US$ 9,300,000) per year than Alexandria.

3) Site condition

(a) Suez

There are some unpredictable factors surrounding Suez site such as;

- Future port availability
- Land acquisition issue under the regulation of Free Zone
- Industrial water supply and it's price

(b) Alexandria

Proposed area are owned by ANSDK, Alexandria governorate and Military of defense. All of these parties concerned have to agree to sell the land to the project.

4) Recommendation

Alexandria site (El Dekhiela) is more appropriate for conducting further feasibility study. The Study Team is to conduct further feasibility study on Alexandria (El Dekhiela) site.

The summary of evaluation of proposed site is shown in Appendix 4A-6.

4-6 Others

4-6-1 Study on Bir Odeib

In addition to the two sites of Adabiya Free Zone in Suez and El Dekhiela in Alexandria, GOFI proposed to study on Bir Odeib area 60 km south of Suez City. However, the Study Team disregarded to study on the site because of the following reason.

- Although the development plan of Bir Odeib is under consideration, any concrete development plan has not been decided.
- Construction of water pipeline for industrial water from Helwan is under consideration. However, detail plan has not been decided yet.
- There is not any construction plan of natural gas supply.
- There is not any construction plan of mineral jetty for the steel plant.

In order to conduct further study and make the feasibility study as accurate as possible, cost information such as construction cost, transportation cost and price of utilities is essential. However, under such conditions described 4.6.1 above, it is difficult to obtain any data and information necessary for financial analysis, and this analysis on Bin Odeib, if performed, would be meaningless.

Chapter 5

BASIC FLAT PRODUCT PLANT CONCEPT

Chapter 5. BASIC FLAT PRODUCT PLANT CONCEPT

5-1 Production and Products

The production plan of the new flat product plant is prepared based on the future consumption of flat products in Egypt predicted in the JICA Phase-1 report with some modifications incorporated from the results of the Phase-2 field survey described in Chapter 3.

5-1-1 Production estimate

(1) Estimation from the JICA Phase-1 Study

Consumption of flat products in Egypt was investigated through the Phase-1 JICA Feasibility Study and shown in the JICA Phase-1 report submitted in 1996. According to the report, for the case of medium growth rate, consumption of flat products in Egypt will be 1,734,000 tons per year in 2005 and reach 2,528,000 tons per year in 2015 as shown in Table 5-1-1 and Figure 5-1-1. Estimated breakdown of each product is shown in Table 5-1-2.

Although consumption for high and low growth rates were also shown in the report, the following study will be conducted based on the estimated consumption for the medium growth rate.

(2) Salable flat steel product estimate

Salable products from the new flat product plant in 2005 are estimated by rearranging the data of the Phase-1 report and by subtracting the following product item 6) and 7) from the total estimated consumption shown in Table 5-1-2.

1) Hot and cold rolled products (thickness < 3.0mm)

   Products of thickness less than 3 mm in the category, "hot & cold" were already divided into two categories by the Phase-1 report, about 50 percent for hot rolled products and 50 percent for cold rolled products.

2) Hot rolled products (thickness = 3.0-24 mm)

   Hot rolled products of thicknesses "between 3.0 and 24 mm" shall be divided into two categories, hot rolled products with thicknesses from 3.0 to 13mm and plate with thicknesses from 13 to 24 mm.

Table 5-1-1 Forecast of Flat Product Consumption in Egypt

Unit : 1,000 t/y

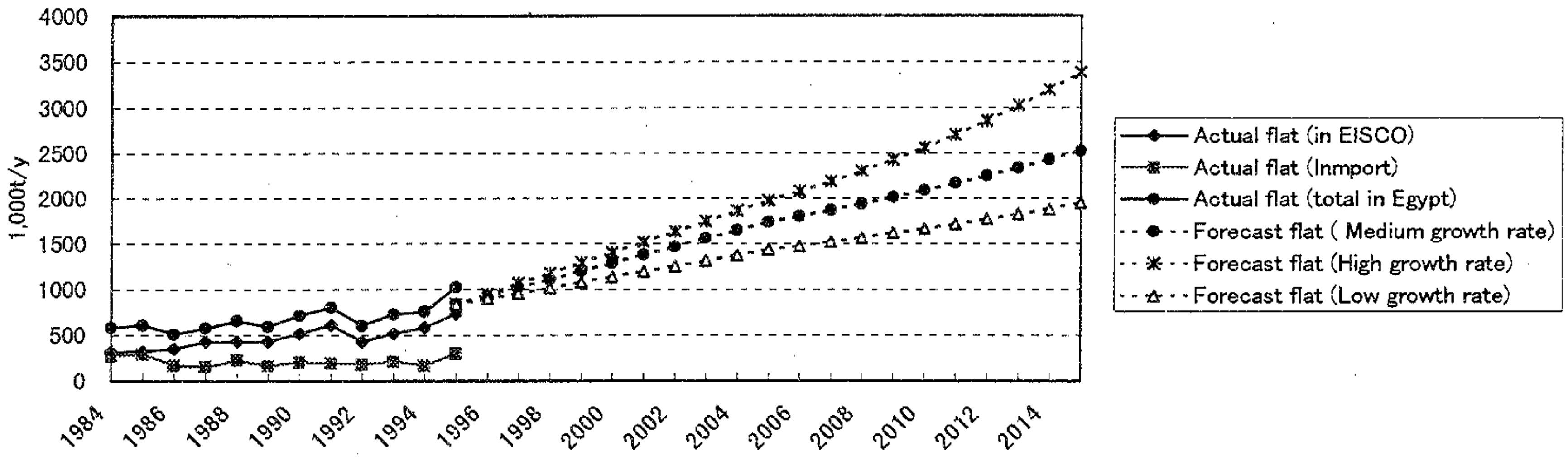
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Actual flat (in EISCO)	311	322	346	427	428	429	514	609	422	516	583	729				
Actual flat (Inmport)	271	290	167	150	229	163	201	192	182	209	171	295				
Actual flat (total in Egy	582	612	513	577	657	592	715	801	604	725	754	1024				
Forecast flat (Medium growth rate)												834	924	1014	1104	1194
Forecast flat (High growth rate)												834	948	1061	1175	1288
Forecast flat (Low growth rate)												834	893	953	1012	1071

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Actual flat (in EISCO)																
Actual flat (Inmport)																
Actual flat (total in Egy																
Forecast flat (Medium growth rate)	1284	1374	1464	1554	1644	1734	1798	1865	1936	2009	2086	2167	2251	2339	2431	2528
Forecast flat (High growth rate)	1402	1516	1629	1743	1856	1970	2073	2184	2302	2428	2562	2706	2860	3024	3199	3386
Forecast flat (Low growth rate)	1131	1190	1249	1308	1368	1427	1471	1517	1564	1612	1663	1715	1769	1825	1882	1942

Source: Actual Flat Consumption based on IISI 1997

Forecast Flat Demand based on JICA Phase-1 Report 1996

Figure 5-1-1 Forecast of Flat Product Consumption in Egy



3) TIN and TFS

Products in the category "coated" are composed of galvanized products, tinplate (including TFS), color coated products and a small amount of other products.

Demand for tinplate, which is categorized as "Cans", is estimated to be 36,281 tons per year. However, judging from the results of the Phase-2 field survey , the sum of average consumption of tinplate between 1990 and 1995 was about 45,000 tons per year. Moreover, this number seems to be unchanging until 2020 due to the increase of consumption of substitute materials.

4) Demand for metal containers

The results of the phase-2 field survey showed that the consumption of 28,346 tons per year of "metal containers" was actually used for corrugated sheet. Therefore, this amount shall be transferred to the category, "Construction"

5) Coated products

Coated products excluding "Cans" are regarded as galvanized products, color coated products and a small amount of other products. Judging from the ordinary coated product market, it is assumed that 85 % of the coated product would be galvanized products and remaining 15% would be color coated products and others.

6) Production at EISCO

It is assumed that production of flat products by EISCO will be kept at the same level as the average production during the year of 1990 to 1995.

Actual production will be as follows;

Hot rolled products

- Production : 400,000 tons/year including;
  - Hot rolled coil = 320,000 tons/year
  - Plate = 80,000 tons/year
- Nominal capacity : 600,000 tons/year

Cold rolled products

- Production : 160,000 tons/year
- Nominal capacity : 250,000 tons/year

7) Exclusions

The following products shall be excluded from the products of the new flat product plant because of the small size of the market or decreased demand.

- Hot rolled products of widths over 1,500 mm
- Hot rolled products of thicknesses over 24 mm
- Tinplate and TFS products
- Other coated sheets

8) Skinpassed coil

Fifty percent of hot rolled coil under 3 mm shall be processed by a skinpass line to correct flatness.

As a result of the adjustments described above, the demand forecast and estimated salable products were calculated and shown in Tables 5-1-3, 5-1-4 and Figure 5-1-2.

Unit : t/y

Table 5-1-2 Demand Forecast for Flat Products in 2005 (Medium growth case)

	Thickness	Width <1500mm												W>1500mm	Total
		Construction	Ship yards	W.Pipe	Gas cylinder.	Metal Cont.	Railway	Automabile	Home Appliances	Can	Furniture	Government.	Other		
Hot & Cold	t<3	6,215	12,598	317,447			1,050	24,825	136,669		104,985	8,399	99,395		711,583
Hot	t=3-24	278,695	19,737	211,633	102,801	20,997	11,179	41,918	1,380			45,983	18,574	106,684	859,581
Hot	t>24	20,144					1,079					630		24,234	46,087
Non Coated subtotal		305,054	32,335	529,080	102,801	20,997	13,308	66,743	138,049		104,985	55,012	117,969		1,486,333
Coated						28,346			13,652	36,281			38,006		116,285
Total		305,054	32,335	529,080	102,801	49,343	13,308	66,743	151,701	36,281	104,985	55,012	155,975	130,918	1,733,536

t<3mm : Hot 342,549, Cold : 369,034

Source : JICA Phase-1 Report 1996

Unit : t/y

Table 5-1-3 Demand Forecast for Flat Products in 2005 Revised by the Study Team

	Thickness	Width <1500mm												W>1500mm	Total
		Construction	Ship yards	W.Pipe	Gas cylinder.	Metal Cont.	Railway	Automabile	Home Appliances	Can	Furniture	Government.	Other		
Cold	t<3							21,686	136,669		104,985	6,299	99,395		369,034
Hot	t<3	6,215	12,598	308,728			1,050	3,138	0		0	2,100	0		333,829
Hot	t=3-13	139,348	9,869	211,633	102,801	20,997	11,179	41,918	1,380			45,983	18,574	53,342	657,023
Plate	t=13-24	139,348	9,869											53,342	202,558
Plate	t>24	20,144					1,079					630		24,234	46,087
TIN & TFS										45,000					45,000
Galvanized		24,094							11,604				32,305		68,003
Color coated		4,252							2,048				5,701		12,001
Total		333,400	32,335	520,361	102,801	20,997	13,308	66,742	151,701	45,000	104,985	55,012	155,975	130,918	1,733,535

(a) Hot Rolled Products of 3.0-24.0mm thickness are divided into 3.0-13.0mm and 13.0-24.0mm segments, over 13.0mm will be considered plate

(b) 50% of Hot Rolled Products under 3.0mm will be skinpassed coil

(c) Coated products for cans are TIN & TFS products. Consumption will be 45,000 t/y ; (the same average consumption as 1990-1995) see Table 3-1-2 Chapter 3.

(d) Coated products except tin consist of 85% galvanized and 15% color coated products

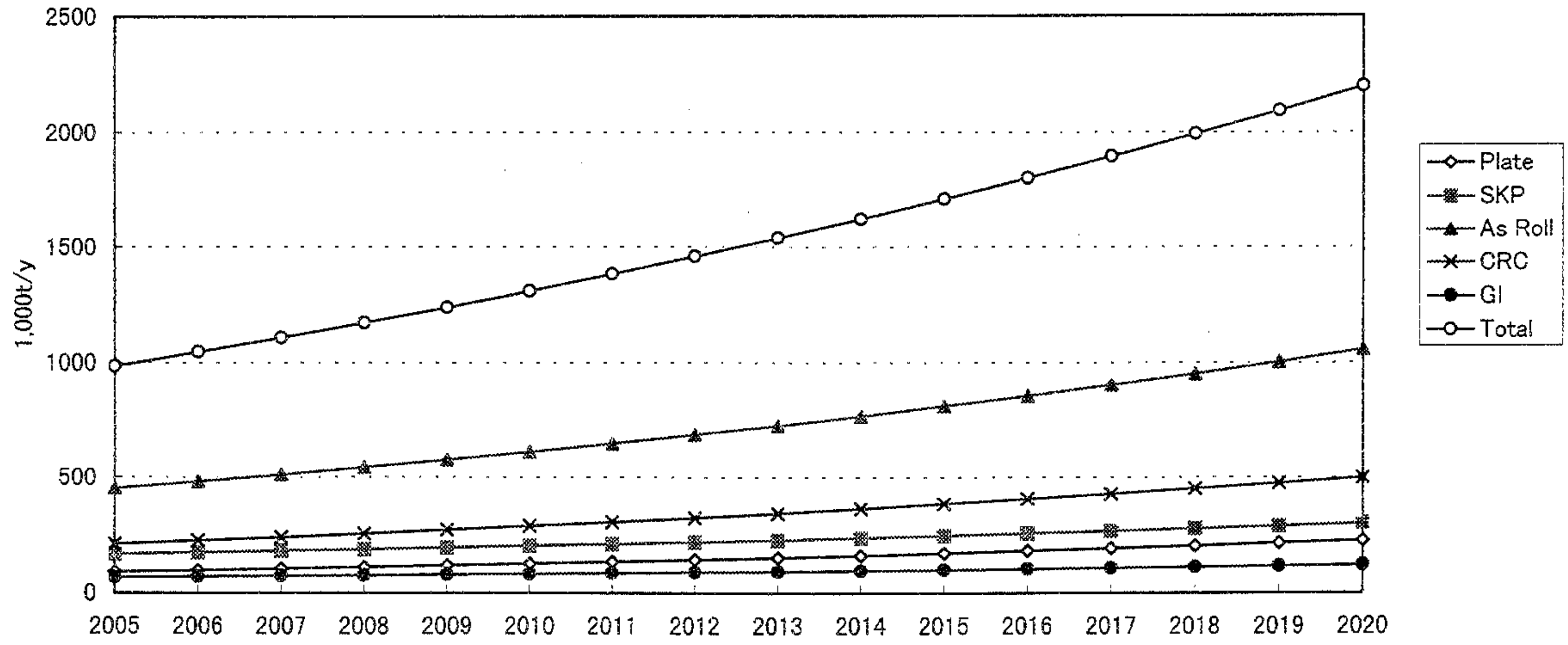
(e) Coated products for metal containers mean galvanized sheet for walls and roofing of buildings and should be categorized as "construction"

Table 5-1-4 Forecast of Salable Domestic Flat Products in the Flat Product Plant

Unit : 1,000 t/y

Demand Forecast of Flat products in Egypt										EISCO's Production			Salable Domestic Flat Products in New Flat Project						
Year	Cold	t<3	t=3-13	Plate	TIN	GI	Color	W>1500	Total	Cold	Hot	Plate	year	Plate	SKP	As Roll	CRC	GI	Total
2005	369	334	604	171	45	68	12	131	1734	160	320	80	2005	91	167	451	209	68	986
2006	384	347	627	177	45	71	12	136	1798	160	320	80	2006	97	173	480	224	71	1046
2007	398	360	651	184	45	73	13	141	1865	160	320	80	2007	104	180	511	238	73	1106
2008	413	374	676	191	45	76	13	147	1936	160	320	80	2008	111	187	543	253	76	1171
2009	429	388	702	199	45	79	14	152	2009	160	320	80	2009	119	194	577	269	79	1238
2010	446	404	730	207	45	82	15	158	2086	160	320	80	2010	127	202	612	286	82	1308
2011	464	420	759	215	45	85	15	165	2167	160	320	80	2011	135	210	649	304	85	1382
2012	482	436	789	223	45	89	16	171	2251	160	320	80	2012	143	218	687	322	89	1459
2013	501	454	820	232	45	92	16	178	2339	160	320	80	2013	152	227	727	341	92	1540
2014	521	472	853	242	45	96	17	185	2431	160	320	80	2014	162	236	769	361	96	1624
2015	542	491	888	251	45	100	18	193	2528	160	320	80	2015	171	246	813	382	100	1713
2016	564	511	923	261	45	104	18	200	2627	160	320	80	2016	181	255	858	404	104	1803
2017	586	531	960	272	45	108	19	208	2729	160	320	80	2017	192	265	905	426	108	1897
2018	610	552	998	283	45	112	20	216	2835	160	320	80	2018	203	276	954	450	112	1994
2019	634	574	1037	294	45	117	21	225	2946	160	320	80	2019	214	287	1004	474	117	2095
2020	659	596	1079	305	45	121	21	234	3061	160	320	80	2020	225	298	1057	499	121	2201

Figure 5-1-2 Forecast of Salable Domestic Flat Products
from Flat Product Plant



5-1-2 Product mix and production plan

(1) Product mix

As shown in Section 5-1-1, the products to be produced by the flat product plant shall be hot rolled coil, plate, cold rolled coil and galvanized coil. Annual production of the products to be produced is shown in Table 5-1-4.
50% of hot rolled coil of thicknesses less than 3.0 mm shall be skinpassed. Tinplate and TFS will not be produced by the flat product plant.

According to the Phase-2 field survey , most flat products are supplied to consumers in sheet form in Egypt except for pipe making company. It is assumed that hot and cold rolled coils are processed by the service center established adjacent to the major market of flat products for the convenience of customers.

(2) Sizes and specifications of products

The present size mix of flat products was investigated and reported by the JICA in Phase-1. For the time being, the average width of flat products in Egypt is rather narrow compared to the international market due to the fact that most flat products are supplied by EISCO and maximum width of the hot and cold rolled products is limited to 1,000 mm . However, it is supposed that this will be changed to wider products to improve operating efficiency and yield in the near future when the new flat plant starts production.
Therefore, it will be more appropriate to estimate the future size mix based on the international market.

Judging from the present industries in Egypt, rapid expansion of demand for high grade steel can not be expected. The mix of grade will be almost the same as at present even after the start-up of production of the new flat steel plant.
Size mix and specifications of products are estimated and shown in Tables 5-1-5, 6, 7, 8 and 9.

Table 5-1-5 Slab Size Mix

Width (mm)	Mix (%)	Remarks
650-800	(5.0)	Slitted slab
850-1,100	33.0	
1,150-1,300	36.0	
1,350-1,600	31.0	
Total	100.0	

Note 1. Average slab width = 1,195 mm

2. Slab 800 mm and under in width shall be produced from double width slab by gas cutting.

3. 5% of slabs are assumed to be surface conditioned

4. Hot charge rolling ratio is assumed to be 60%

Table 5-1-6 Hot Strip Mill Size Mix

(Unit: %)

Thickness (mm)	Width (mm)				Total
	610-799	800-1,099	1,100-1,299	1,300-1,600	
1.6- 2.9	4.0	14.0	15.0	4.0	37.0
3.0-12.9	1.0	19.0	21.0	12.0	53.0
13.0-24.0	0	0	0	10.0	10.0
Total	5.0	33.0	36.0	26.0	100.0

Note : Average = 7.0 x 1,158 mm

Table 5-1-7 Cold Strip Mill Size Mix

(Unit: %)

Thickness (mm)	Width (mm)		Total
	610-1,099	1,100-1,250	
0.4-1.0	27.5	27.5	55.0
1.0-1.6	11.0	19.0	30.0
1.6-2.5	7.5	7.5	15.0
Total	44.0	54.0	100.0

Note : Average = 1.08 x 1,028 mm

Table 5-1-8 Galvanizing Line Size Mix

(Unit: %)

Thickness (mm)	Width (mm)		Total
	610-999	1,000-1,250	
0.4-1.0	35.0	35.0	55.0
1.0-1.6	15.0	15.0	30.0
Total	50.0	50.0	15.0

Average = 0.88 x1,015 mm

Table 5-1-9 Hot Rolled Coil Specifications

(Unit: %)

Specification	Final products	
St-12,13,14	36.0	Cold rolled or Galvanized products
St-33	4.0	Hot rolled coil or plate
St-37	54.0	
St-44,50,52	6.0	
Total	100.0	

(3) Production plan and start-up production program

The production plan for the flat steel plant shall be studied taking account of the quantity of salable products and production capacity of one unit of the appropriate production process. After due consideration, the production plan was decided and is shown in Table 5-1-10 and Figure 5-1-4. Production of the plant is defined by the production of slab which will be one million tons per year from the second year after start-up of the plant. However, it will be 60% of full capacity, i.e. 600,000 tons of slab per year in the first year, 2005.

5-1-3 Material flow

Material flow is established taking into consideration the salable quantity of each product, quality demands, production capacity and yield of each process. The flow for the first year and after the third year are shown in Figures 5-1-4 and 5-1-5 respectively.

Table 5-1-10 Production Plan and Start-up Program

Product	2005	2006	2007
DRI	700,000	900,000	1,000,000
Burnt lime	24,000	40,000	40,000
Slab	600,000	1,000,000	1,000,000
Hot rolled coil (As rolled)	221,000	368,000	368,000
(Skinpassed)	104,000	173,000	173,000
Plate	58,000	97,000	97,000
Cold rolled coil	134,000	224,000	224,000
Galvanized coil	42,600	71,000	71,000
Total of flat products	560,000	933,000	933,000

5-1-4 Coil service center

The market for flat products is much more varied compared to that for re-bar. Therefore, for the convenience of the consumers the coils are normally delivered from steel plants to the service center where the coils are stocked and delivered to consumers by slitting in width or cutting in length just after receipt of an order from the end user.
It is assumed for this study, that service centers will be constructed adjacent to the major market and operated by subsidiary companies or distributers.

Reasons why the coil center are expected to be constructed outside the steel plant are as follows;

a) A short delivery time can be expected for orders of great size and grade variety

b) Some service centers are already operating adjacent to the major market and future expansion can be expected

c) The scale of the storage yard and facilities is rather small and can be updated step by step in accordance with market demand

Figure 5-1-3 Demand Forecast and Sales Plan

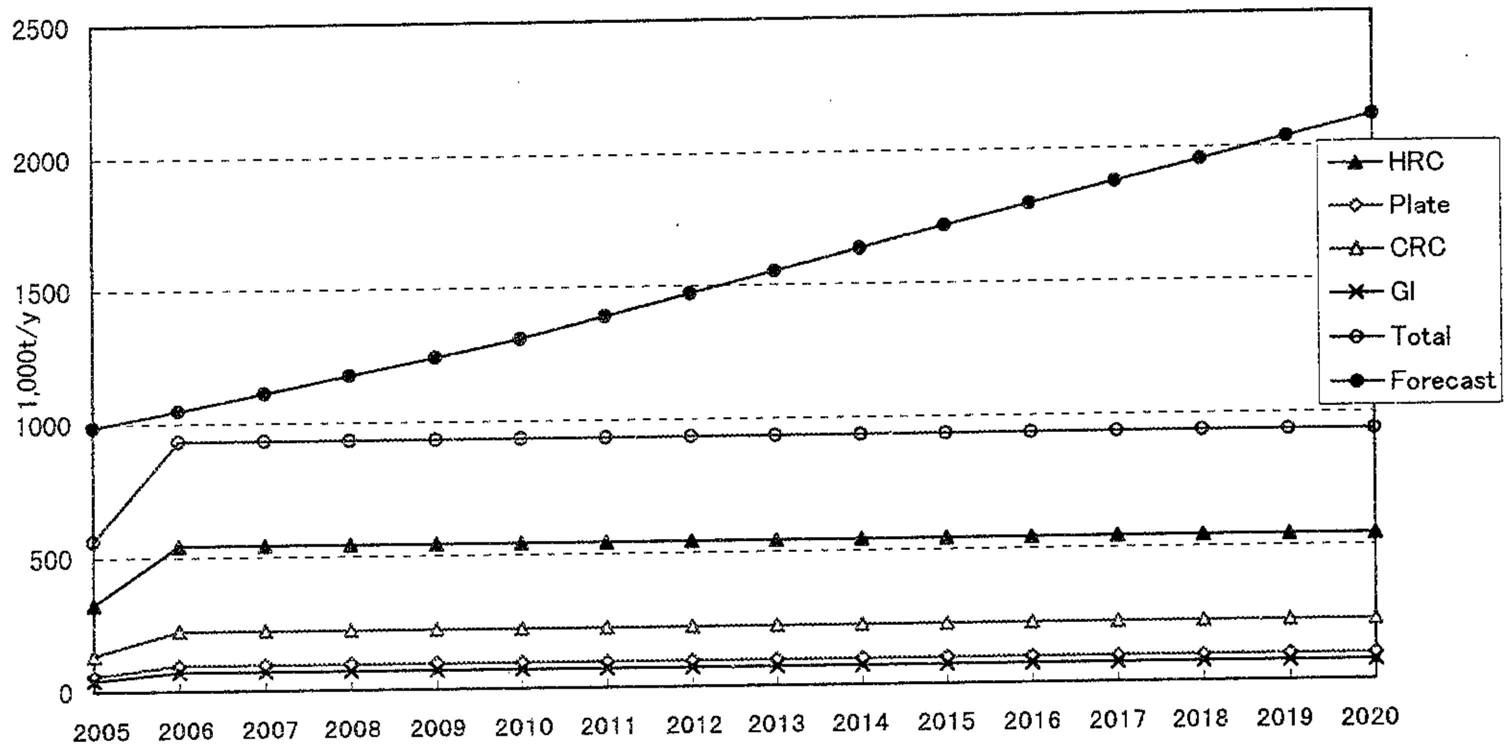
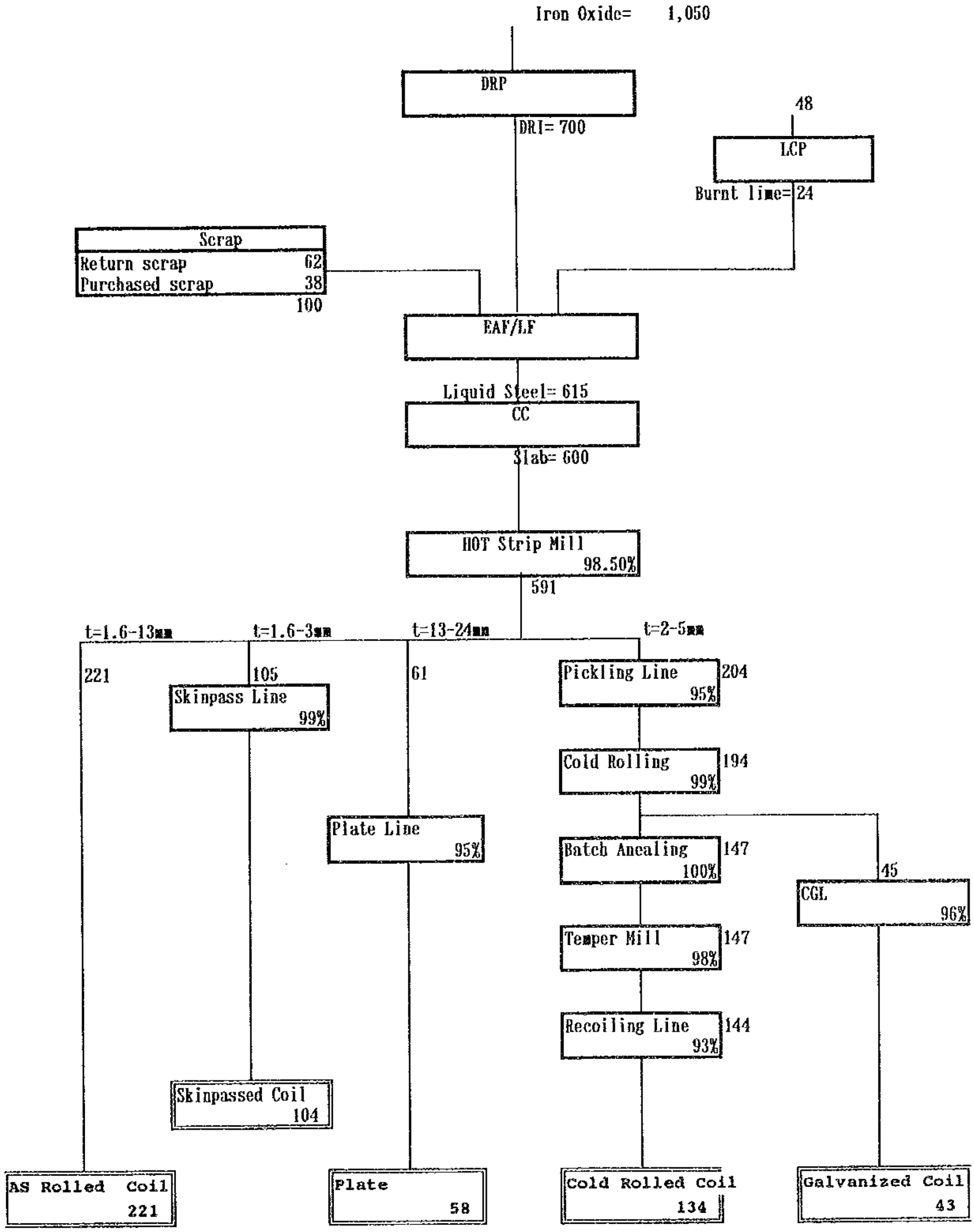


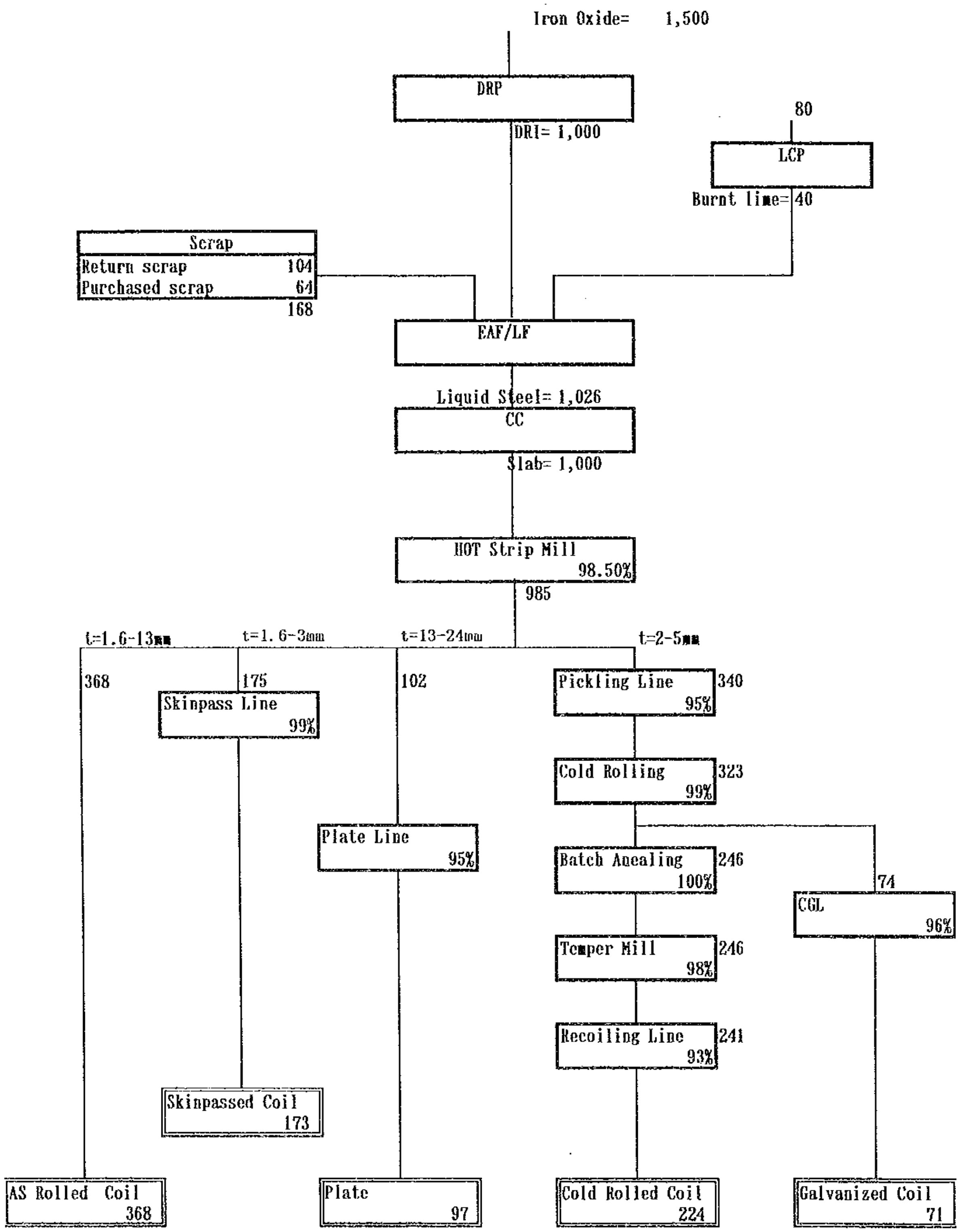
Figure 5-1-4 Material Flow sheet in 2005 (Start-up) unit : 1,000t/y



TOTAL FLAT PRODUCTS : 560 kT/Y

Figure 5-1-5 Material Flow sheet in 2007 (Full Operation)

unit : 1,000t/y



TOTAL FLAT PRODUCTS : 933 kT/Y

5-1-5 Energy balance

Energy balance of the first stage is estimated and shown in Table 5-1-11.

Table 5-1-11 Energy Balance of the First Stage

	Plant	Power balance (GW/year)	Fuel balance (10^9cal/year)
Consumption	Iron & steel making process	749	2,637
	Rolling process	142	311
	Utility & services	73	12
	Total	964	2,960
	Total as calorific value (10^9kcal/year)	2,361 (10^9kcal/year)	2,960
Purchase	Total	964	2,960
Unit energy consumption (Mcal/crude steel ton)	DR+EAF process	5,321	

Note :1kWh = 2,450 kcal

The unit energy consumption of the DR+EAF process is 5,321 Mcal per ton of crude steel. This value is almost the same level as similar operating plant in the world.

5-1-6 By-products and wastes

The basic concept of treatment method for by-products and wastes is re-use as much as possible.

Kind of by-products and wastes are;

- Scrap
- Ore, oxide and lime fine
- Mill scale
- Slag
- Sludge
- Dust

- SMP waste brick
- others

The method of re-use are;
- as raw material for this steel plant
- as raw material for outside company
- as a material of road bed and reclaiming

and the rest unable to re-use is only disposed.

Kind and quantity of by-products and wastes generated from each plants and treatment method are shown on Table 5-1-12.

Table 5-1-12 Description of By-Products and Waste

Materials	Generated from	Treatment	Quantity(t/y)
Scrap	CCM, HSM, CSM Slag yard	Return to EAF	104,000
Mill scale	CCM, HSM, CSM	Sell to cement company	14,000
EAF slag	EAF	Dispose	120,000
Oxide fines	DRP	Sell to cement company, Pelletizing plant	62,000
Lime fines	LCP		
DRP cake	DRP	Dispose	26,000
EAF dust	EAF	Dispose	20,000
SMP waste brick	EAF, CCM	Dispose	5,000
Sludge	DRP, EAF, HSM, CRM	Sell to cement company	302,000

5-2 Outline of Principal Project Facilities

The flat steel products plant will consist of the principal production plants shown in Table 5-2-1 and the auxiliary facilities shown in Table 5-2-2 respectively. Details of these plants and facilities are described in Chapter 6.

Table 5-2-1 Outline of Principal Plant

Plant	Description
1. Direct reduction plant (DRP)	– Type: Midrex process, MEGAMOD® – Number of units: One set
2. Steelmaking plant (SMP)	
2.1 Electric arc furnace (EAF)	– Type: DC (direct current) arc furnace with EBT (eccentric bottom tapping system) – Number of units: One set
2.2 Ladle furnace (LF)	– Type: AC (alternating current) of three phase type – Number of units: One set
2.3 Slab continuous casting machine (SL-CCM)	– Type: Vertical progressive bending type with multi-point unbending – Number of units: One set
3. Hot strip mill plant (HSMP)	– Type: Semi-continuous type – Number of units: One line
4. Cold strip mill plant (CSMP)	– Type: Four Hi single stand reversing mill – Number of units: One line

Table 5-2-2 Outline of Auxiliary Facilities

Facilities	Description
1. Lime calcining plant (LCP)	- Type: Shaft kiln type - Number of units: One set
2. Power and distribution facilities	
3. Utilities facilities	- Water treatment stations - Natural gas station - Production facilities for plant air, hydrogen gas and steam
4. In-works transportation facilities	
5. Analysis and inspectionfacilities	
6. Maintenance shop	
7. Administrative facilities	- Main office - Site offices for DRP, SMP, HSMP, CSMP, LCP and maintenance shop - Guard office - Canteen - Clinic - Parking lot - Other

Selection of the type of direct reduction process, electric arc furnace, continuous casting machine, hot strip mill and cold strip mill is discussed in section 5-3.

In addition to the principal production plants and auxiliary facilities mentioned above, the raw materials yard for the DRP and infrastructure such as port facilities and supplies of electric power, natural gas and water are required for operation of the flat steel products plant.
The raw materials yard and port facilities plan to utilize the existing facilities at El Dekhiela Port and the supply lines of electric power, natural gas and water are assumed to be available at the battery limit of the steel plant. Details are described in section 7-2.

5-3 Selection of Process

5-3-1 Direct reduction process

The steel making processes by the direct reduction - EAF route presently occupy the second largest share in operation throughout the world. Among direct reduction processes, the following are the representative processes industrially proven or commercially available.

Natural gas based process:

- MIDREX Process
- HYL-III Process
- FINMET (former FIOR) Process
- IRON CARBIDE Process

Coal based process:

- SL/RN Process

(1) Representative processes

1) MIDREX Process

The first MIDREX plant was built in Portland, Oregon, USA in 1969 by Midrex Division of Surface Combustion Company which had been purchased by the Midland Ross Corporation, USA. In 1974, the Korf Group purchased the division and formed Midrex Corporation. In the early 1980s, the Korf Group experienced financial difficulties and in 1983 sold Midrex to Kobe Steel.

The MIDREX Process (Figure 5-3-1) converts iron oxide pellets or lump ore to high purity direct reduced iron (DRI) or hot birquetted iron (HBI). The direct reduction of iron oxides proceeds on a continuous basis: the iron oxides are fed to the top of the shaft furnace, flow downward by gravity and are then discharged from the bottom of the shaft furnace in the form of DRI.

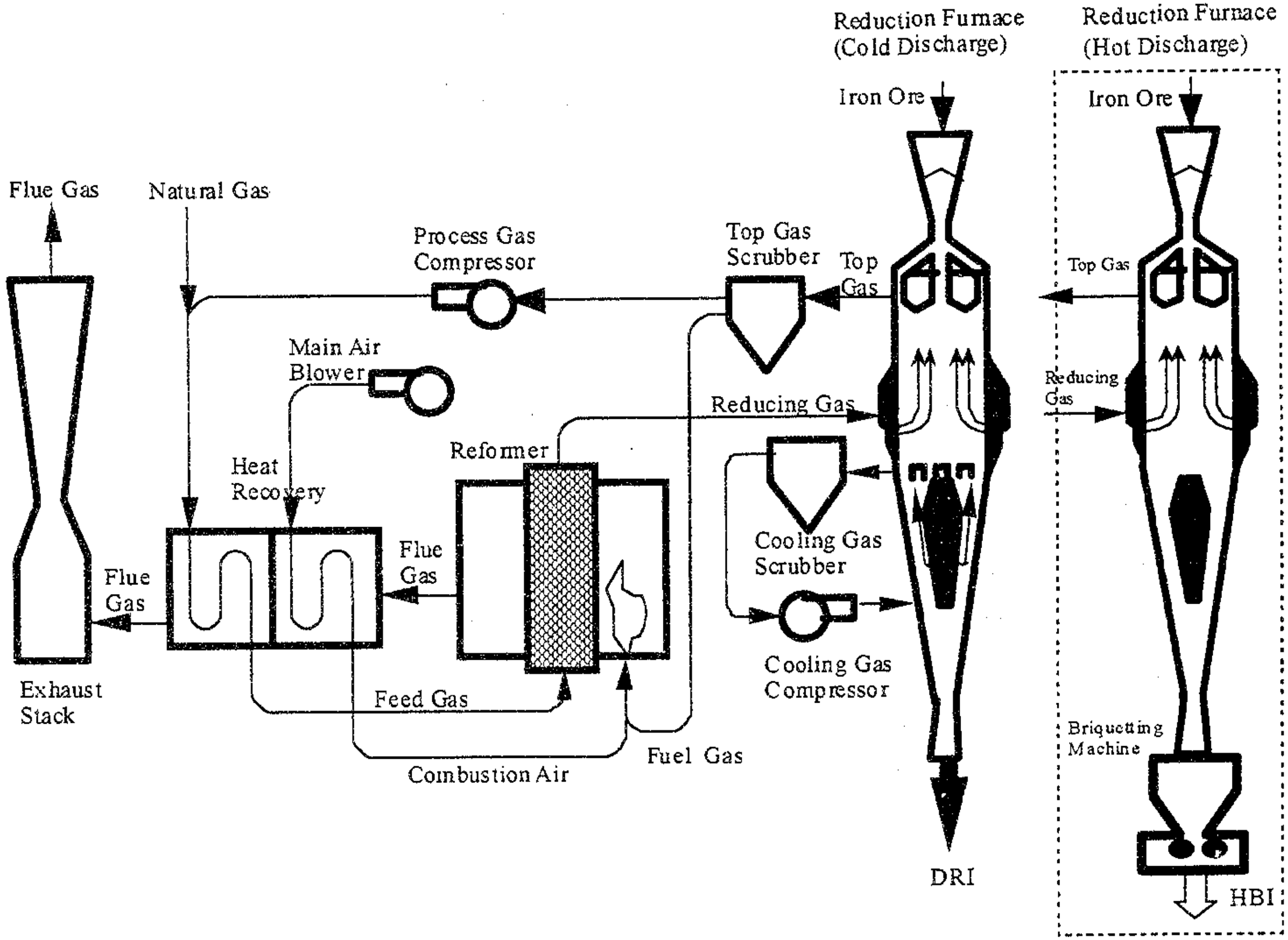
Reducing gas is generated in a stoichiometric CO_2 reformer which reformes a mixture of fresh natural gas and recycled top gas from the shaft furnace at approximately 920°C. As the reducing gas leaves the reformer in near equilibrium conditions, containing 90 to 92 % hydrogen plus carbon monoxide, the gas does not require quenching, it is fed directly to the shaft furnace where reduction takes place at bout 850°C.

Part of the shaft furnace off-gas is used to fire the reformer burners; the remainder is recirculated to the reformer. Thermal efficiency of the reformer is greatly enhanced by a comprehensive heat recuperation system. The heat exchangers recover the sensible heat from the reformer flue gas to preheat combustion air (used in the reformer burners) up to 650°C and to preheat the process gas (mixture of top gas and natural gas) fed to the reformer up to 540°C.

The DRI produced can be discharged at ambient temperature or hot briquetted. The briquettes are cooled in a quench tank or with water sprays. The shaft furnace is operated at low pressure and has a number of internal mechanical devices and flow aid devices to facilitate solid/gas contact.

A major feature of the MIDREX Process is its stable product quality. The uniform gas distribution in the shaft furnace ensures uniform product metallization even when the ore supplies change.

Figure 5-3-1 MIDREX Process Flow



2) HYL-III Process

The first HYL plant was built in 1957 in Puebla, Mexico. This technology, known as HYL-I, uses four fixed bed reactors, operated in a batch mode. In 1969, development of HYL-II, an improved batch process, was begun. Simultaneously, HYL began working on HYL-III, a continuous process using a shaft furnace. The first commercial HYL-III plant, 2m5, was started up in 1979.

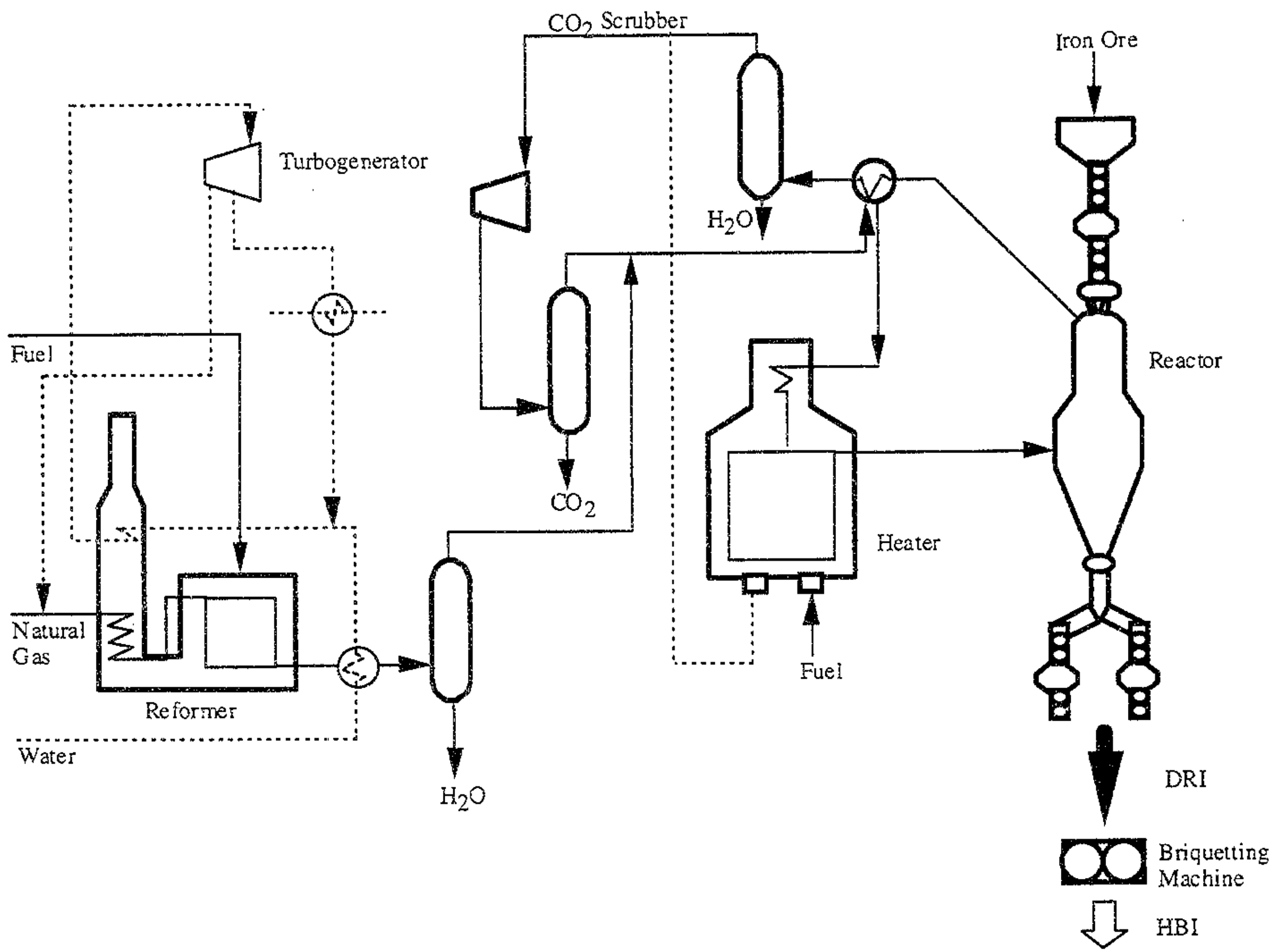
The HYL-III Process (Figure 5-3-2) reduces iron oxide pellets or lump ore in a shaft reactor. Reducing gas is generated in a steam reformer to produce the hydrogen plus carbon monoxide required as make-up for the reduction process. The reformed gas is quenched to remove excess steam, then reheated.

Reducing gases are made up of a mixture of make-up and recycling gases. The basic components of the reduction circuit, aside from the reactor, are (1) a gas heater to increase the reducing gas temperature up to 925°C, (2) a scrubbing unit for deducting, cooling and H_2O elimination from the top gas, (3) the recycle gas compressor and (4) the CO_2 removal unit. Here CO_2 is selectively eliminated from the system for a more efficient reuse of the recycle gas.

The zero kWh option uses steam turbines to produce electricity, steam for the turbines is generated using heat from the reformed gas quenching step. The shaft furnace is operated at high pressure; it has no internal mechanical devices or flow aids except for "cluster breaker" at the furnace outlet.

After CO_2 is removed, reactor off-gas is circulated to the reactor. The DRI produced can be discharged at ambient temperature or hot briquetted. The briquettes are cooled in a quench tank.

Figure 5-3-2 HYL-III Process Flow



3) FINMET (former FIOR) Process

The concept for the Fluidized Iron Ore Reduction Process (FIOR) was developed by A. D. Little and Esso Research and Engineering Co. in the 1950s. The A. G. McKee Co. acquired the rights to sub-license the FIOR technology in 1971 and sold a license to FIOR de Venezuela where the 400,000 t/y plant started up in 1976. Later, rights to the technology were sold to Davy International.

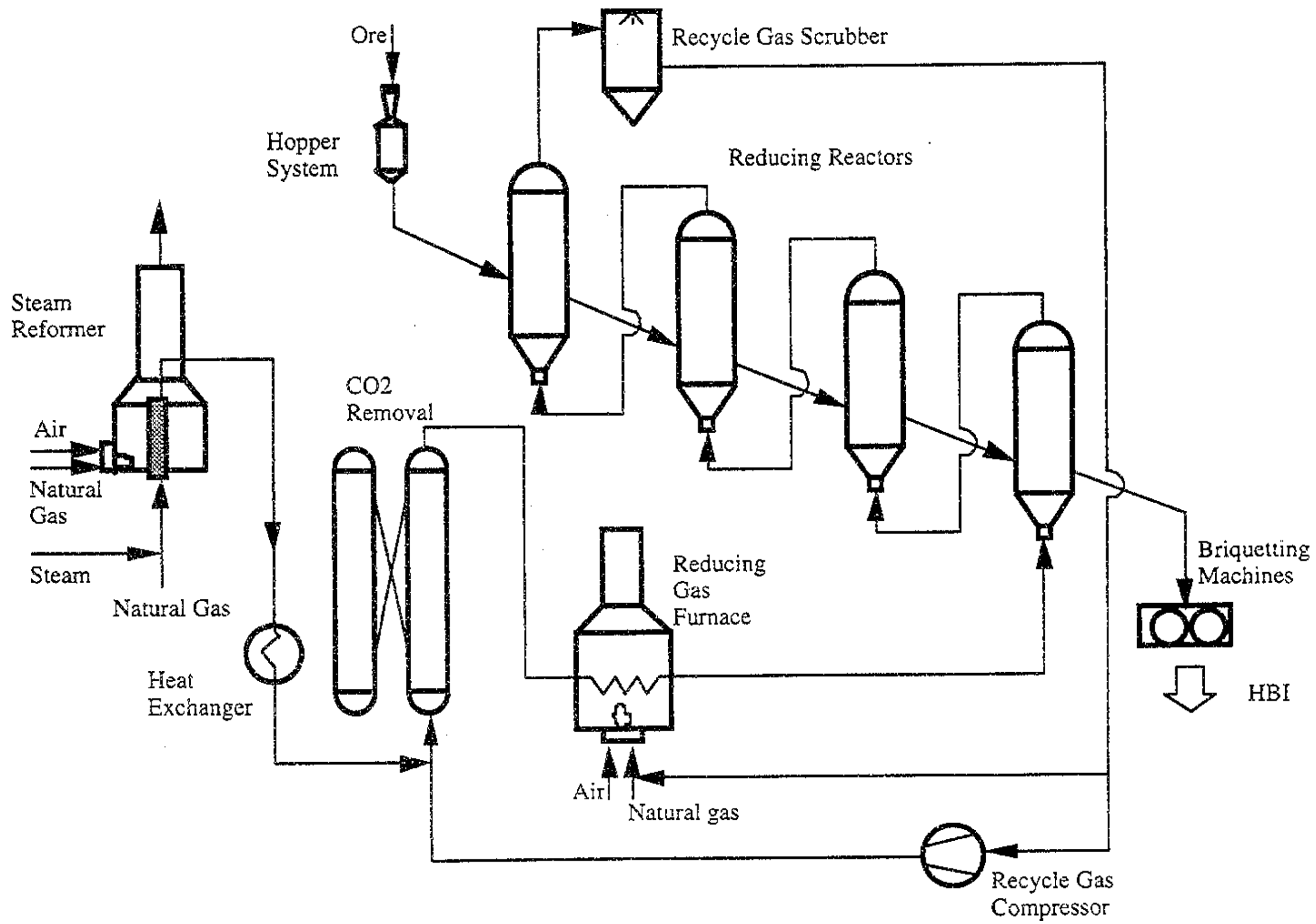
The FIOR Process (Figure 5-3-3) uses four bubbling bed fluidized reactors to reduce iron ore fines. The fines are charged to the first reactor, where they are preheated, and flow sequentially through the other three. Reducing gas is generated in a steam reformer. The product is discharged hot, briquetted, then air-cooled.

An improved version of the FIOR Process is now marketed as the FINMET Process which is often termed "FIOR II" Process. The FINMET Process is designed to correct deficiencies in the FIOR process in the area of ore preheating CO_2 removal, cyclone life, solids transfer and recycle of remet material.

The FIOR preheating reactor uses natural gas to preheat the iron ore. In the FINMET Process, this step was eliminated and the heat is provided by off-gas from the reducing reactors.

The CO_2 removal system can scrub recycle gas as well as reformed gas. In the FIOR plant, only the reformed gas is scrubbed, which limits the amounts of CO which can be used in the reducing gas. The FINMET Process will use higher percentages of CO to improve the process heat efficiencies.

Figure 5-3-3 FINMET Process Flow



4) IRON CARBIDE Process

In 1994 the first commercial Iron Carbide Process plant having a 0.3 million t/y capacity was started up in Trinidad to supply the products to Nucor, USA.

The Iron Carbide Process uses one bubbling fluidized bed reactor to reduce iron ore fines. The reactor has a series of internal baffles that create intimate contact between the ore and the gas. Hydrogen is used as the reducing gas; it is produced from natural gas by steam reforming, then shifting the gas and removing CO_2.

Iron carbide is made by a single step, gas solids reaction. Iron oxide is fed into a fluidized bed reactor at a temperature between 550°C and 600°C and a pressure of about 1.8 atmospheres. A preheated process gas containing a mixture of carbon monoxide, carbon dioxide, methane, hydrogen and water vapor, is introduced to form iron carbide. The typical chemical reaction for the process is as follows:

$$3Fe_2O_3 + 5H_2 + 2CH_4 = 2Fe_3C + 9H_2O$$

Reactor off-gas is returned to the reactor. The product is cooled in the heat exchanger that preheats incoming ore. Product is in the form of iron carbide (Fe_3C) fines which contain about six percent of carbon.

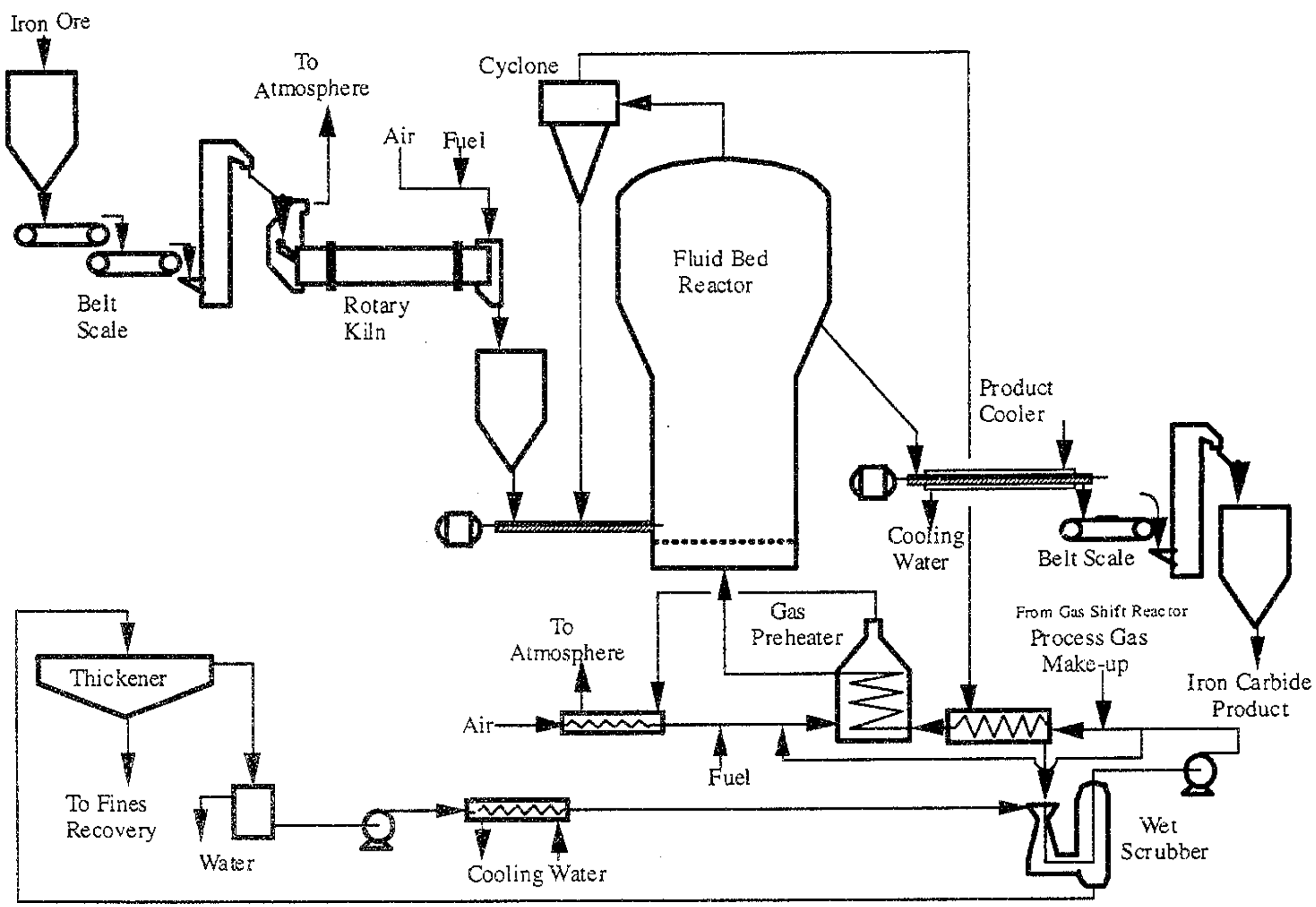
A diagram of the system for the production of iron carbide (Figure 5-3-4) reveals its essential elements.

First, the screened and classified iron or concentrates are preheated and introduced into the fluidized bed reactor, where a hot steam of a mixture of gases is forced up through the bed of ore, interacting to strip the oxygen from combination with iron (forming water), while carbonaceous gases provide one carbon atom for every three iron atoms, thus forming iron carbide - Fe_3C.

Second, the water laden off-gas (top of the reactor) is relieved of much of its dust burden in the cyclone on top of the reactor, then goes to the heat exchanger for cooling and into the scrubber where the water vapor is condensed out of the stream along with any remaining small particles of dust.

Third, the scrubbed gas, partially depleted of carbon and hydrogen, is reconstituted with make-up gas, and is re-pressurized, passed through the heat exchangers to boost the temperature, and finally pre-heated to the reactor temperature for re-entry at the bottom of the fluidized bed reactor to repeat the cycle.

Figure 5-3-4 IRON CARBIDE Process Flow



5) SL/RN Process

The SL/RN Process was developed as a combination of the Republic Steel and National Lead (RN) Processes developed between 1920 and 1930, and the Stelco and Lurgi (SL) processes developed around 1960. Between 1968 and 1984, the Highvelt Steel and Vanadium Corporation of South Africa installed 13 SL/RN kilns for pre-reduction of iron ore. In addition to the plants making DRI, there are number of plants used for production of ferroalloys.

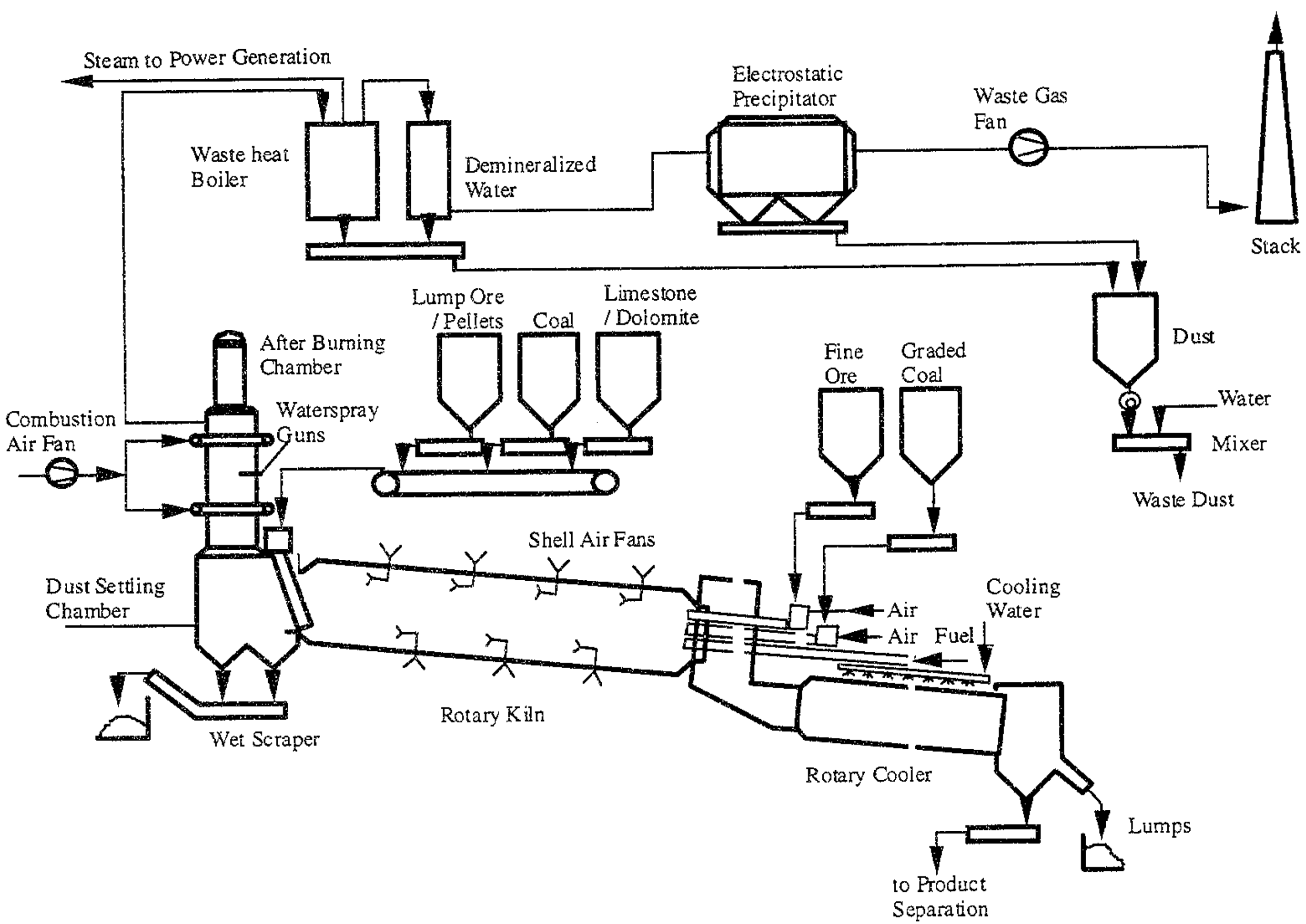
In the SL/RN Process (Figure 5-3-5) iron oxide in pellet or lump form is fed to rotary kiln. Coal is introduced at the tail end of the kiln, is gasified, and reduces the iron oxide. Air is introduced to the kiln at several places.

The product is discharged from the reactor, cooled in a rotary cooler, magnetically separated from the coal ash, and discharged in pellet or lump form. The off-gas is burned in a combustion chamber and cooled, then dust is removed. The gas can then be used to generate electricity.

In terms of the use of different reductants, the SL/RN Process is characterized by great flexibility as it can process all coals from non-coking coals such as lignite to anthracite and coke breeze.

An additional feature of the SL/RN Process is the possibility of recovering considerable amounts of energy by utilizing a waste heat boiler for production of high pressure steam for subsequent electric power generation.

Figure 5-3-5 SL/RN Process Flow



(2) **Selection of the direct reduction process**

Comparison of main features of the representative processes is given in Table 5-3-1. This study adopts the MIDREX process because of the following reasons:

1) MIDREX process has the largest number of commercial plants installed all over the world

2) MIDREX process has the largest accounts for the total capacity of production of direct reduced iron all over the world

3) MIDREX process is only one direct reduction process which was commercially installed in Egypt and has been operating about ten years in stable

Table 5-3-1 Comparison of the Representative Processes

	Gas based				Coal based
	MIDREX	HYL-III	FINMET [former FIOR]	IRON CARBIDE	SL/RN
Status	Industrial	Industrial	Industrial	Industrial	Industrial
Iron source	Pellets Lump	Pellets Lump	Fines Size:sinter feed	Fines Size: 0.1-1mm	Pellets Lump
Fuel source	Natural gas	Natural gas	Natural gas	Natural gas	Coal
Pressure (kg/cm^2)	Atomospheric	5	11 - 12	0.8	Atomospheric
Typical plant capacity ($x10^3$ tons/y)	1,000	1,000	FINMET: 1,000 FIOR: 400	320	150 - 250
Plant installed (modules)	39	13	1	1	8**
Total capacity installed ($x\ 10^3$ tons/y)	20,010	6,370	400	300	1,320**
Selective evaluation*	I The most spread process	I Less plants than MIDREX	II Few industrial plants	II Few industrial plants	II Small scale plants
Commercial operation in Egypt	Yes	No	No	No	No
Result of selection	Representative process				

*I: Representative process

II: Next representative process

**: SL/RN plants of production over 150,000 tons/y

5-3-2 Electric arc furnace

(1) Introduction

There are two types of electric arc furnace for steelmaking, the AC (alternating current) arc furnace and the DC (direct current) arc furnace.
Selection of the type of arc furnace is discussed hereunder.

(2) Differences

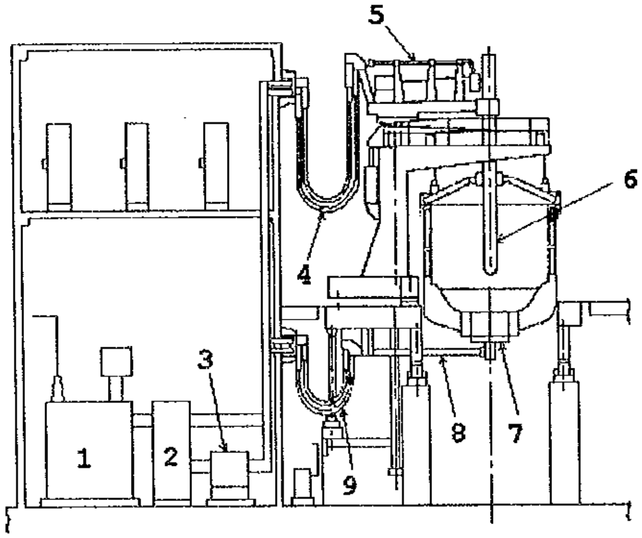
1) Major differences

The major difference between AC and DC arc furnaces is the use of alternating or direct current for generation of the arc.
In the arc furnace, scrap is melted by the arc. The arc is generated by an alternating current going to and from three graphite electrodes, through the scrap or molten steel in the AC arc furnace. In the DC arc furnace, a direct current goes from an anode electrode installed in the bottom of the furnace to a single graphite cathode electrode through the scrap or molten steel.

2) Equipment configuration differences

Figure 5-3-6 shows the equipment configuration of a DC arc furnace.

Figure 5-3-6 DC Arc Furnace Equipment Configuration



1. Transformer
2. Thyristor rectifier
3. DC Reactor
4. Water cooled cable
5. Secondary conductor
6. Graphite electrode
7. Bottom electrode
8. Secondary conductor
9. Water cooled cable

Note 1) Thyristor rectifier: To convert the power company supplied alternating current to a direct current

2) DC reactor: To minimize current increase during short circuiting

Major equipment differences of the DC arc furnace from the AC arc furnace are;

- addition of the thyristor rectifier and bottom electrode, both of which are not required in the AC arc furnace, and
- a single graphite electrode and corresponding electrode lifting device, both of which require three sets for the AC arc furnace.

(3) DC arc furnace needs

Production of steel by arc furnaces has been increasing and it is said that it will reach 40 % of the total production of all steelmaking by the end of this century.

Historically the AC arc furnace began with "UHP (Ultra High Power) operation" and development continued to scale-up furnace size and utilize oxygen gas by means of oxy-lancing and oxy-fuel burners. Furthermore, new technologies; EBT (eccentric bottom tapping), SPH (scrap pre-heating) and operation in combination with a LF (ladle furnace) were introduced along with improved operational techniques such as long arc and foamy slag operations.

Now traditional AC arc furnaces seem to have reached the final development stage. It is difficult to make further improvements and the flicker problem, which prevents scaling up of input power cannot be escaped.

The DC arc furnace has been studied and developed in Europe. In 1985, MAN-GHH constructed the first commercial DC arc furnace in the world at Nucor Steel, USA. Following the first construction of a 30 t DC arc furnace in Japan at Topy Industries in 1988, NKK constructed the largest (130 t) DC arc furnace at that time in the world at Tokyo Steel in 1989, the success of which established the DC arc furnace's reputation. After that, not only Japan but also other countries such as the USA, Korea, Taiwan, Malaysia, etc. began promoting construction of DC arc furnaces.

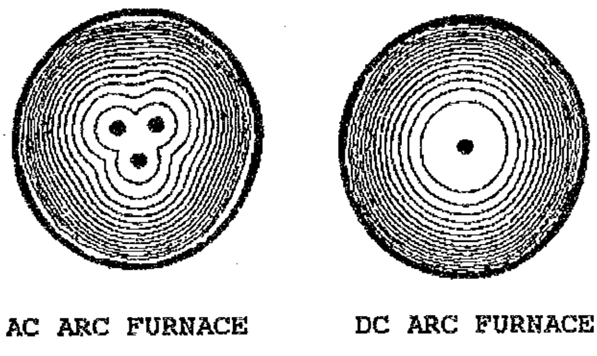
(4) Advantages of the DC arc furnace

1) Uniform melting

Uniform melting is realized thanks to the single carbon electrode, though such has been never realized in the AC arc furnace.

The melting pattern is shown in Figure 5-3-7.

Figure 5-3-7 Characteristic Melting Pattern



In the AC arc furnace, electromagnetic force acts on each arc and arc direction is always toward the furnace wall. Thus, "hot spots" appear and cause wall damage. This phenomenon is inevitable in the AC arc furnace.

Arc deflection occurs also in the DC arc furnace. Specifically, the arc is deflected by the magnetic force induced by the magnetic field formed by the secondary conductors. However, the arc deflection in the DC arc furnace can be eliminated by proper design of the bottom secondary conductor arrangement. Therefore uniform melting can be realized.

2) Strong stirring force

Strong stirring force leads to faster melting.

In the AC arc furnace, stirring force imparted to the molten steel by magnetic force is quite small due to the current flow on the surface of the molten steel.

In the DC arc furnace, current penetrates the molten steel and there is a magnetic field in the molten steel itself. The magnetic force generated by the current and this magnetic field agitates the molten steel. Strong stirring force can be created by proper design of the bottom conductor arrangement.

According to test results, the mixing time of nickel and copper components into molten steel is about 80 seconds in the DC arc furnace and more than 300 seconds in the AC arc furnace. This faster mixing time is achieved by the strong stirring force.

3) Long arc operation

Long arc operation can acquire rapid melting of charged materials. A long arc is achieved by high voltage and low current as is the nature of arc generation.

In the AC arc furnace, arc length is not longer than 400 mm. For more than 400 mm of arc length, it is necessary to select over 900 V of tap voltage. This high voltage will emphasize "hot spots" and power disturbances such as the flicker phenomenon.

In the DC arc furnace, it is possible to operate a 700 mm arc length because there are no "hot spots". Rapid melting can be achieved.

4) Heating efficiency

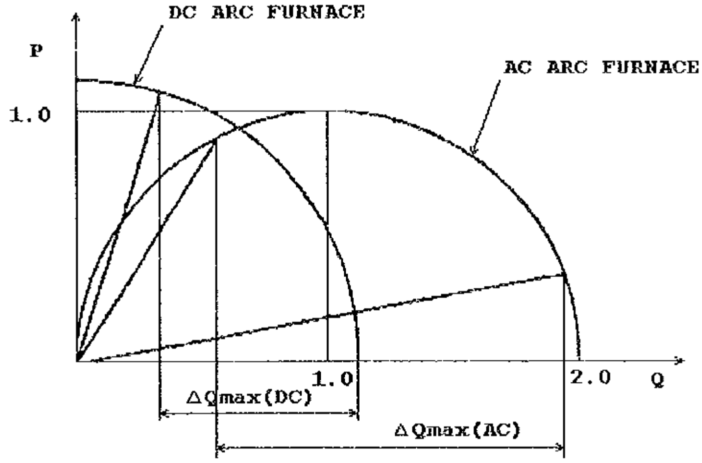
In the AC arc furnace, arc jet generation accompanies alternate changes of arc direction and the heat energy of an arc jet is not always effectively transferred to the molten steel. In the DC arc furnace, the arc jet is always from the graphite electrode to the molten steel thus concentrating its energy under the graphite electrode. Therefore the DC arc furnace has better heating efficiency.

5) Flicker level

In an arc furnace (AC and DC), the flicker level is estimated by the maximum variation of reactive power. The maximum reactive power is shown at short circuit occurrence which happens with contact between the graphite electrode and the scrap. Flicker level depends on the difference between the reactive power at short circuit formation and that for normal operation.

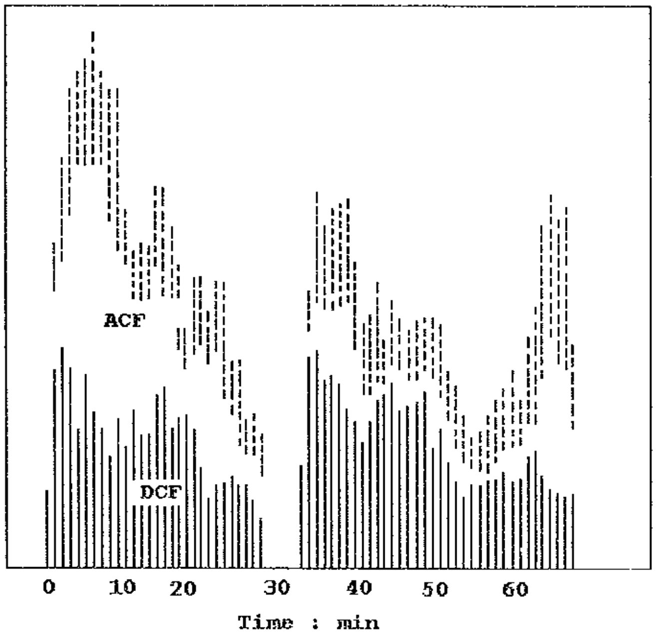
In principle, differences in flicker level between AC and DC arc furnaces are shown in Figure 5-3-8.

Figure 5-3-8 Differences in Flicker Level between AC and DC



When a short circuit occurs, the current of the AC arc furnace reaches the maximum value but in the DC arc furnace the increase of the current is limited because current is constantly controlled by the DC reactor. This is the reason why the flicker level of a DC arc furnace is less than 50 % of that for an AC arc furnace. Actual flicker values are shown in Figure 5-3-9.

Figure 5-3-9 Comparison of Flicker Level of AC and DC Furnaces



(5) Conclusion

Due to the above mentioned considerations, the DC arc furnace is more appropriate for the flat steel products plant.

5-3-3 Continuous casting machine (CCM) and hot strip mill (HSM)

There are many CCM - HSM processes in the world. In order to select most appropriate process the following combination process are studied.

- Thin Slab CCM & HSM process (TSP)
- Medium Slab CCM & HSM process (MSP)
- Conventional Slab CCM & HSM process (CVP)

(1) Characteristics of TSP, MSP and CVP

Schematic drawings of TSP, MSP and CVP are shown in Figure 5-3-10. DRI and high quality scrap will be provided as raw materials in this project.

Brief descriptions of each process are written below :

1) Thin slab CCM and HSM process (TSP)

After steelmaking, molten steel is poured into the CCM and slabs of 50 - 60 mm thickness are produced. These slabs are heated to 1,000 - 1,100 °C in a tunnel type furnace and rolled into strips of 1.6 to 13 mm thickness by a six stand finishing mill. These strips are wound into coils by a down coiler. The TSP is considered a suitable process for production of commercial grade products of four to five feet in width. Production capacity is 700,000 - 900,000 tons per year for one strand.

2) Medium slab CCM and HSM process (MSP)

After steelmaking, molten steel is poured into the CCM and medium size slabs of 90 - 150 mm thickness are produced. These slabs are heated to 1,100 - 1,200 °C by a reheating furnace and rolled approximately 30 mm by a single stand roughing mill and to 1.6 - 13 mm by a five stand finishing mill. These strips are wound into coils by a down coiler.

3) CVP

There are several types of conventional HSMs in the world. However, the coil box type mill, with one reheating furnace, one stand roughing mill, one coil box, five stand finishing mill and one down coiler, is suitable for the flat steel plant because of the small market demand.

After steelmaking, molten steel is poured into the CCM and slabs of 200 - 250 mm thickness are produced. These slabs are heated to 1,200 - 1,250 °C by a reheating furnace, rolled to approximately 30 mm by a single stand roughing mill, and wound into coils at the coil box. After the coil box, these bars in coil form are unwound and rolled into 1.6 to 13 mm strips by a five stand finishing mill. These strips are wound into coils by a down coiler.

The CVP is a very popular and completely developed process for producing high quality products.

(2) Comments on TSP, MSP and CVP

The technical features of the three processes are compared taking into consideration the actual conditions in Egypt as shown in Table 5-3-2 and 5-3-3. Following are some brief comments.

1) Raw materials

Generally scrap is used as raw material in an EAF. It is said that the quality of products produced in an EAF process is poor compared to that of a Basic Oxygen

Converter due to residual elements such as Sn, Cu, etc. In order to solve this problem, high quality raw materials are used for the flat steel plant. Normally, about 80 % DRI and 20 % scrap are used.

2) Productivity and investment cost

Each process can produce one million tons of steel per year if narrow products are excluded from the flat project. Investment cost itself is the lowest in the case of the TSP.

- TSP can be established with low investment costs
- The advantage of MSP is that an integrated steel plant with a CCM & HSM can be established with lower investment costs compared with the CVP.
- The TSP should be operated with high speed casting to keep production capacity (quality problems will occur)
- The advantage of CVP is the possibility of achieving high productivity with fewer additional facilities such as a CCM, reheating furnace, down coiler, etc. Production capacity can easily be increased to 3,000,000 tons per year, maximum.
- The construction cost of CVP is higher than the other two CCM-HSM processes, but the construction cost of HSM itself is almost same.

3) Surface quality

The Surface quality of slabs depends on slab thickness and casting speed.

- The TSP should be operated with high casting speed to keep production capacity, but high speed operation affects surface quality
- TSP and MSP can not apply slab surface conditioning to remove defects caused by irregular operation, but conditioning is necessary for high surface grade steel such as DDQ and automobile body parts.
- Even for slabs produced by the CVP, some are surface conditioned subject to surface requirements to produce high quality products.
- MSP may have the ability to produce higher quality steel than the TSP in future, but this technology is still under development at present.
- TSP and MSP are the processes which have been developed for mini-mills to produce commercial grade quality steel with low investment. They do not aim to produce high quality

A summary of slab surface quality is shown as follows :

Good : ← CVP > MSP > TSP → : Poor

4) Quality and products to be produced

Products to be produced in the flat project are summarized as follows : (details are described in Section 5.1)

- 34 % : Welded pipe (Hot Rolled Coil)
- 20 % : Construction (45% : Plate, 47% : HRC, 8% : GI)
- 20 % : Home appliance & Furniture (CRC)
- 26 % : Others

Quality demands from the above customers are not so high that the TSP, MSP and CVP can produce those products except for a small amount of high grade products such as DDQ and automobile body parts.

As plate requires a reduction ratio of approximately more than four times, the slab thickness shall be at least 100 mm to produce plates of 25 mm in thickness. Plates over 13 - 15 mm thickness can not be produced due to thin slab thickness of 50 - 60 mm in TSP.

5) Narrow products less than 800 mm

The narrow (less than 800 mm)product ratio is 5 % (see Section 5.1). In the case of the CVP, these products are made from narrow slabs which are produced by gas cutting from slabs with double width to increase CCM capacity. In the cases of the TSP and MSP, narrow hot rolled coils less than 800 mm can be produced by slitting hot rolled coils of double width. However, narrow cold rolled products less than 800mm can not be produced in the same way as narrow hot rolled coils because the maximum width of the cold rolling mill is 1,250 mm. Narrow cold rolled coils must be produced from the same size as hot rolled coil. This causes capacity reduction and technical difficulties for the TSP and MSP.

6) Small orders flexibility

Generally flat products are produced after order placement from the customer and order size (ton/order) from the customer is rather small in countries where the total market is small like Egypt. Each customer orders with their respective specifications such as thickness, width, steel grade, etc. Long products are produced without receiving orders from customers and each steel making company can produce without restrictions in scheduling.

The CVP is the better process when accepting small orders because the width of each product can be adjusted by the roughing mill. However it is difficult to adjust the width of products from TSP and MSP due to the fact that the TSP is not equipped with edging devices and the edger of the MSP is rather weak.

7) Operating costs

The TSP has the highest operating cost savings and this will be US$ 1.0-2.0/t compared with the CVP.

- Energy savings : Slabs are directly rolled by the TSP and MSP. Fuel consumption saving will be 100,000-200,000 kcal/t and rolling power savings will be 5-10 kWh/t.
- Yield improvement : TSP and MSP are direct rolling processes and the yield of hot rolled coil from molten steel will be 0.7 - 0.5 % higher than the CVP due to reduced scale and elimination of slab conditioning.
- Manpower savings : As TSP and MSP have no slab yard, manpower for a slab yard (including crane) is not necessary. Manpower savings will be 10 - 20 workers.

(3) Conclusion

The conventional CCM process is recommended

The reasons are as follows :

- A TSP can not produce plate of 13 - 24 mm in thickness.
- MSP technology is still under development at present.
- TSP and MSP are not suitable for producing narrow strip (610 - 800 mm in width) due to low productivity.
- TSP and MSP are not suitable for production of high grade steel such as DDQ(Deep Drawing Quality), EDDQ(Extra Deep Drawing Quality), automobile body parts, etc.

CCM & HSM process summary :

- Slab thickness : 210 mm
- Slab conditioning : applicable
- Max. hot rolled product width : 1,600mm *1
- Max. hot rolled product weight : 28 ton max. *2

*1 Width of hot rolled products

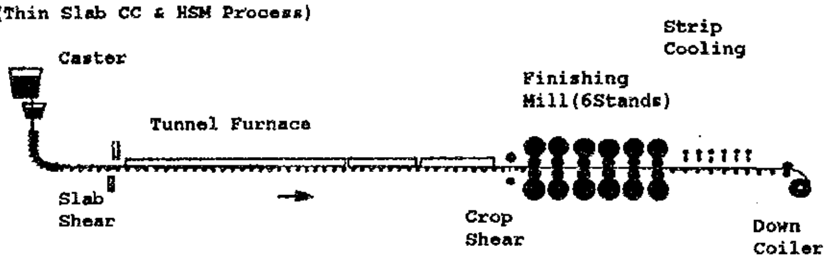
Considering market demand in Egypt, 93 % of flat products are of a width under 1,500 mm. The reason for the 1,500 mm borderline is the existing plant restriction (Maximum plate width from EISCO is 1,500mm). Generally "five feet" implies 1,524 mm in the international steel business and approximately 30 - 50 mm will be added at the hot rolling mill. Consequently the maximum width at hot rolling shall be 1,600 mm considering five feet of hot rolled product.

*2 Coil weight

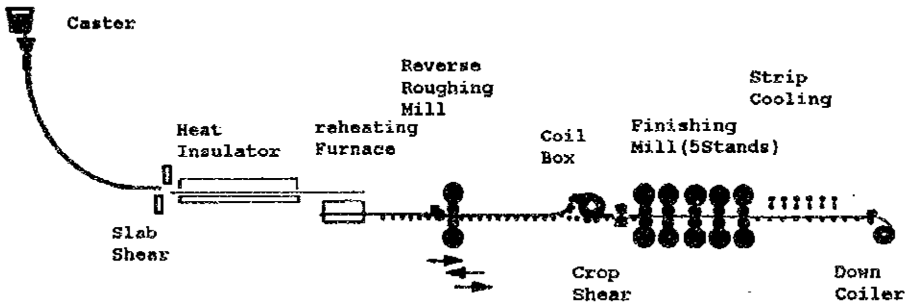
Generally 1,000 PIW (pound per inch width) is the standard of modern hot strip mills (17.8 kg/mm). In the case of 1,600 mm maximum width, weight of the hot rolled coil is 28 ton.

Figure 5-3-10 Schematic Drawing of TSP, MSP and CVP

(a) TSP (Thin Slab CC & HSM Process)



(b) MSP (Medium Slab CC & HSM Process)



(c) CVP (Conventional Slab CC & HSM Process)

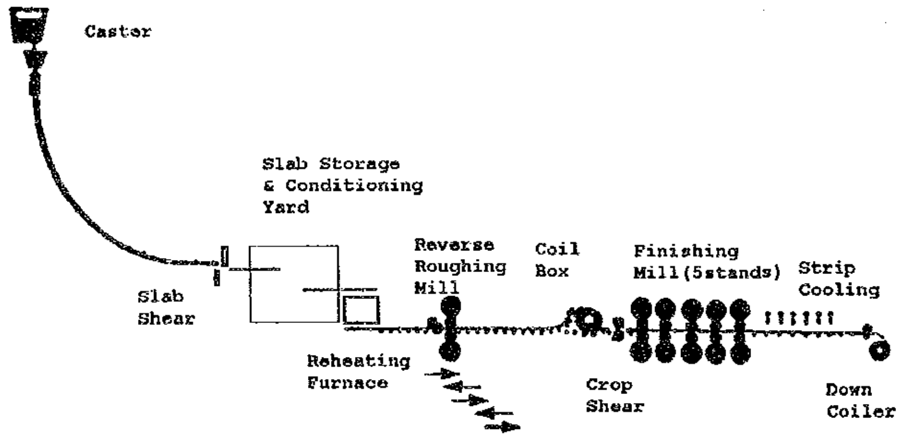


Table 5-3-2 Comparison of Specification of CCM and HSM

<table>
<tr><th></th><th>TSP</th><th>MSP</th><th>CVP</th></tr>
<tr><td>1. Products in the flat product plant</td><td colspan="3">
<table>
<tr><th>Products</th><th>Thickness</th><th>Width</th><th>Production tons per year</th></tr>
<tr><td>Hot rolled coil</td><td>1.6 − 13.0 mm</td><td>610 − 1,600 mm</td><td>approx. 370,000</td></tr>
<tr><td>Skinpassed coil</td><td>1.6 − 6.0 mm</td><td>610 − 1,600 mm</td><td>approx. 170,000</td></tr>
<tr><td>Plate</td><td>13.0 − 24.0 mm</td><td>610 − 1,600 mm</td><td>approx. 100,000</td></tr>
<tr><td>Cold rolled coil</td><td>0.4 − 2.5 mm</td><td>610 − 1,250 mm</td><td>approx. 220,000</td></tr>
<tr><td>Galvanized coil</td><td>0.4 − 1.6 mm</td><td>610 − 1,250 mm</td><td>approx. 70,000</td></tr>
</table>
</td></tr>
<tr><td>2. Main equipment</td><td>EAF ×1(DRI 90%)
Thin slab CC×1 (t=50mm) V=5mpm
HSM Tunnel Furnace×1
Finishing Mill×6std
Down Coiler×1</td><td>EAF ×1 (DRI 90%)
Midi Slab CC ×1 (t=90−150mm) V=2.5−3.5mpm
HSM WB Furnace×1
Roughing Mill×1std
Coil Box×1
Finishing Mill×5std
Down Coiler×1</td><td>EAF ×1(DRI 90%)
Conventional CC ×1 (t=210mm) Av=1.8mpm
HSM WB Furnace×1
Roughing Mill×1std
Coil Box×1
Finishing mill×5std
Down Coiler×1</td></tr>
<tr><td>3. Capacity</td><td>(one furnace) approx. 1,000,000 t/y
(two furnaces) approx. 2,000,000 t/y</td><td>(one furnace) approx. 1,000,000 t/y
(two furnaces) approx. 2,000,000 t/y</td><td>(one furnace) Over1,000,000t/y
(two furnaces) Over2,000,000t/y</td></tr>
<tr><td>4. Works in operation (Example)</td><td>Nucor (USA)
Hamboo (Korea)
POSCO (Korea)</td><td>BHP/North star (USA)
Trico (USA)</td><td>Almost integrated works adopted</td></tr>
<tr><td>5. Available products</td><td>1. Mainly commercial quality
2. not suitable for tin & automobile outer parts
3. Width > 800 mm</td><td>1. High quality is difficult due to Impossibility of slab conditioning
2. Suitable for all use (not clear in actual plant)</td><td>1. high quality possible
2. Suitable for all use.</td></tr>
<tr><td>6. Flexibility of small orders</td><td>Difficult to accept small orders due to no edger
(width can not be changed at HSM)</td><td>Difficult to accept small orders due to weak edger
(difficulty of width change at HSM)</td><td>Possible to accept small orders due to edger
(width can be changed at HSM)</td></tr>
<tr><td>7. Capital cost</td><td>Low</td><td>Middle</td><td>High</td></tr>
<tr><td>8. Operating Cost (CC & HSM)</td><td>(Yield, Energy, Manpower)
Base</td><td>Higher
Base +0.5−1.0 us$/t</td><td>Higher
Base + 1.0−2.0 us$/T</td></tr>
</table>

Table 5-3-3 Comparison of TSP, MSP and CVP (Summary)

	TSP	MSP	CVP
1. Advantage	1. Energy saving & low operating cost 2. Low initial equipment cost	1. Middle Quality (Higher than CSP) 2. Middle equipment cost between TSP & CVP 3. Equipment cost per steel ton may be the lowest	1. High quality 2. Easy to change Strip width at HSM 3. High productivity of narrow slab casting (Double width casting is possible)
2. Disadvantage	1. Difficulty of slab conditioning 2. Width adjustment at HSM is impossible. 3. Usage for Tin and Automobile is not possible 4. Can't use tapered slabs	1. Difficulty of slab conditioning 2. Under development process	1. High initial equipment cost 2. High operating cost
3. Comment	1.Strip width should be 800-1600mm 2. Kind of strip width should be minimized 3. Very useful process under 1.0 million tons per year. 4. Suitable for production of commercial products mainly for building construction in large markets such as USA etc.	1. Hot rolled coil quality is not clear (Under development) 2. Suitable for small production of medium class products in medium or large markets. 3. This technology is still under development. No good process for EGYPT flat project at present	1. Very useful process to produce narrow size (especially TMBP) and wide range of strip width 2. Best process for high quality products and high production. 3. Suitable for small production of various products in small or medium markets.

5-3-4 Cold strip mill

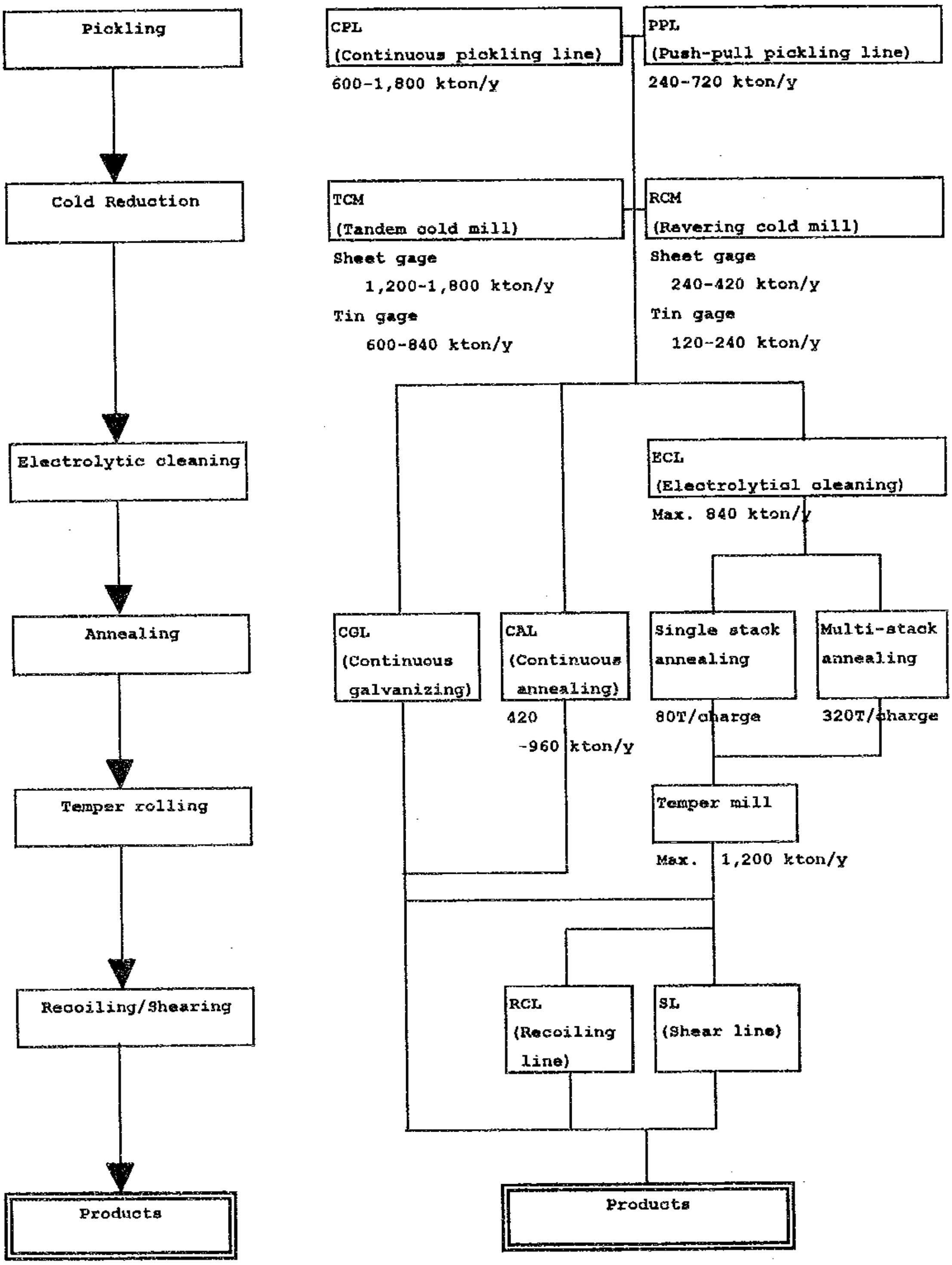
(1) Process for cold rolled and galvanized products

The process to produce cold rolled products and galvanized products, and the purpose of each process is as follows;

[Process]	[Purpose]
Pickling	The purpose of pickling is to eliminate iron oxide (scale) on the strip surface which was formed in hot rolling.
Cold Rolling	The purpose of cold rolling is to roll hot rolled strip at room temperature and to reduce thickness up to target level.
Electrolytic Cleaning	In general if annealing cold rolled strip as it is, carbide or sticky stein will remain on the strip surface and it will not only harm the surface appearance but also cause trouble in next process.
Annealing	The steel physical properties formed after hot rolled are distorted heavily by cold rolling and become hard and difficult to form. However, if heating it up to 620 - 730 °C and holding for some time, re- crystallization occurs in steel structure. As a result hardness, yield strength and tensile strength go down and it becomes easy to form.
Zinc Coating	By passing annealed strip in molten zinc, strip surfaces are covered with zinc.
Temper Rolling	The purpose of temper rolling is to improve the mechanical property of the steel after annealed and control surface roughness and shape.
Recoiling	The purpose of recoiling is to divide coils, to trim and/or to remove defects.

(2) Equipment for cold rolled products and galvanized products

The following shows some representative equipment to produce cold rolled products and galvanized products. Economical production capacity for each piece of equipment is also shown.



(3) Selection of appropriate equipment

1) Pickling process

As shown in Figure 5-3-11 there are two representative pieces of equipment, CPL (Continuous pickling line) and PPL (Push pull pickling line), for the pickling process. The CPL has very high productivity but requires high investment also. Therefore even if taking the 2nd stage into consideration the PPL shall be selected for this project.

2) Cold rolling process

As shown in Figure 5-3-11, there are two representative pieces of equipment, TCM (Cold tandem mill) and RCM (Cold reversing mill), for the cold rolling process. The TCM has very high productivity but requires high investment also and it is not appropriate for such small production as 400,000 ton/year.

Therefore the RCM shall be selected for this project. However, as the maximum production by RCM is about 350,000 ton/year, additional RCM or the alternative equipment should be considered in the 2nd stage.

3) Electrolytic cleaning process

The Electrolytic cleaning line shall not be installed because tin plate is not planned in this project and therefore such severe surface cleanliness is not required before annealing.

Instead, strip surface cleaning shall be done at the last pass of the RCM with special rolling oil.

4) Annealing process

There is some equipment for the annealing process such as CAL (Continuous annealing line), batch annealing furnace and UAS (Uniflow annealing system). CAL is applied to high production plant and requires high investment. UAS is highly automated equipment but is not suitable for this project because of equipment cost. The Batch annealing furnace has two types, one is the single stack annealing furnace and another is the multi stack annealing furnace. As this project has to produce small amounts of various kind of products, the single stack annealing furnace shall be selected. As atmosphere gas, pure hydrogen gas shall be selected due to production efficiency.

5) Temper rolling process

In general a temper mill can process 1,200,000 tons sheet gage per year and even if tin gage, 600,000 tons per year. In case of this project only 250,000 tons/year of sheet gage are expected to be processed in the 1st stage and 430,000 tons in the 2nd stage. When constructing a temper mill, it has too much production capacity. Therefore, taking the reversing mill production in the 2nd stage into account, this mill shall be designed as a combination type temper mill (which is utilized as reversing mill also in the 2nd stage).

6) Recoiling and Shearing line

One recoiling line shall be installed to cut off off-gage and/or detrimental portions and divide coils into the order weights.

With reference to the shearing line it shall not be installed because of following reasons.

- At present there are some profilers in Egypt such as Egyptian-Italian Co. that import cold rolled and galvanized coils and cut and slit them at their shops. It is more economical to utilize them.
- There are many small customers for cold rolled and galvanized products in Egypt but they are concentrated in some industrial zones. Therefore it is more cost effective to have the appropriate size of profilers zone by zone.

7) CGL

As representative continuous galvanizing lines which have been constructed in recent years, the following types of equipment are listed up.

- Wheeling type (off line annealing, Max. 100,000 t/y)
- Horizontal NOF(Non Oxygen Furnace) type
  (in line annealing, Max. 250,000 t/y)
- Vertical RT(Radiant Tube) type
  (in line annealing, Max. 400,000 t/y)
- Vertical DFF(Direct Fired Furnace) type
  (in line annealing, Max. 400,000 t/y)

The Wheeling type is a low cost line to zinc-coat with dry flux and it does not require an annealing furnace but recently it is not applied so much due to quality and efficiency,

while, recently in developed countries mainly vertical RT type and DFF type lines are preferred to construct. This is because these types have very high productivity and are suitable for extra-deep drawing quality which is requested by the automotive