FEASIBILITY STUDY REPORT

ON

EL DIKHEILA INTEGRATED STEEL MILL PROJECT IN EGYPT

AUGUST, 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

Following the request of the Egyptian Government, the Japanese Government has entrusted the Japan International cooperation Agency to carry out a feasibility study on the El Dikheila integrated steel works project.

With the cooperation of the Japanese Government authorities concerned and the Japan Iron and Steel Federation, JICA organized and dispatched to Egypt a Feasibility Study Team comprising 17 specialists led by Mr. Shizuo Kishida (Executive Director, JICA) to conduct a field survey from March 1 to March 18, 1979. The purpose of this team was to make a survey on the existing steel industry and its related industries in Egypt in order to confirm the feasibility of the new steel works project planned by the Egyptian Government at El Dikheila near Alexandria.

The team discussed with the Special Committee formed under the leadership of the Egyptian Ministry of Industry and with the counterparts including the staff of this committee. The team visited and discussed with the various ministries concerned, four State steel plants and State construction companies in this connection. A field survey was conducted at El Dikheila, the planned site of the new works.

Upon its return to Japan the team prepared an interim report comprising studies on marketing, production process, production equipment, necessary personnel, construction cost, production cost, and financing and submitted it to the Egyptian Government.

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JICA despatched the second team consisting of 6 experts from June 18 to June 27, 1979 in order to discuss the above report with Egyptian Counterparts.

Based upon the agreement (Memorandum) reached between the two parties during the stay in Egypt of the second team, this report has been formulated by modifying and adding to the said report.

I hope this report will prove to be useful for further development of the steel industry in Arab Republic of Egypt and contribute to its economic growth.

I wish to express my deep appreciation for the cooperation and assistance kindly extended by the officials concerned of the Egyptian Government and Egyptian Embassy Staff in Japan.

August , 1979.

Shinsaku Hogen
President
Japan International
Cooperation Agency

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Electricity	Hidehiko Ohki	" " "	Assistant General Manager, Design Dept.
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Transportation	Tsunehiro Motobayashi	NIPPON KOKAN K.K.	Manager, Export Dept.

ACTIVITES OF SURVEY MISSION

Date	Place	Contents
March 3	Embassy of Japan to Arab Republic of Egypt	Courtesy visit and previous arrangement for survey
	Cairo Office of JICA	Previous arrangement for survey
	IMC	Wrap-up meeting
March 4	General Organization for Industrialization (GOFI)	Courtesy visit
	Ministry of Electricity (MOE)	" "
	Cairo Office of Bank of Tokyo	Survey on investment law and accounting system in Egypt
	Erection & Industrial Services Co.	Survey of the Company
	SPECO	" " " "
	Arab Contractors Co.	" " " "
	IMC	Discussion on Distribution System of Bars
March 5	National Planning Institute	Courtesy visit
	Ministry of Petroleum	" "
	Ministry of Planning	" "
	Ministry of Housing (MOH)	" "
	Delta Steel Co.	Survey of the works
	Ministry of Economy and Economic Cooperation (MEEC)	Courtesy visit
	IMC	Discussion on transportation
March 6	Alexandria Water General Authority	Survey on plan of water-supply to the new steel works
	Alexandria Ministry of Electricity	Survey on outline of electricity in Alexandria
	Alexandria Training Center	Courtesy visit
	El Dekheila	Inspection of the place where the new steel works are to be constructed
March 7	Egyptian Copper Works Co.	Survey of the works
	Alexandria Power Station	Survey on electricity
	Abu Qir Fertilizing Co.	Survey of the works

Date	Place	Contents
March 10	Egyptian Refractory Co.	Survey of the works
	Steel Structure Plant Co. (STEELCO)	" " " "
	Egyptian Iron & Steel Co. (Helwan)	" " " "
March 11	National Metals Co.	Survey of the works
	IMC	Discussion on civil engineering and construction
	MOE	Survey on electricity
	Distribution Bureau	Survey on distribution system of bars
	MEEC	Survey on taxation
	Cairo Branch of Penta Ocean Co.	Survey on the actual situation of construction works
	IMC	Discussion on transportation
March 12	Distribution Bureau	Survey on import and distribution of bars
	MOH	Survey on demand of bars
	Construction site of Otsuka Pharmaceutical Co., Ltd. (Kajima Corporation)	Survey on procurement of materials in Egypt and ability of Egyptian contractors
	IMC	Discussion on transportation
March 13	IMC	Study on the new Alexandria port project
	Cairo Western Power Plant	Survey of the works operation
	GOFI	Survey on electrical standard
March 14	Youssef Nabih & Co.	Survey on tax system and accounting law
	Distribution Bureau	Survey on expansion plan of Delta Steel and distribution mechanism
	MOE	Survey on electricity
	MOH	Survey on civil works cost
	Nasr Phosphate Co.	Survey on fluorite
March 15	IMC	Wrap-up meeting
March 16	IMC	Preparation of Memorandum

MEMBER OF REPORTING MISSION ON DRAFT REPORT

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Hidehiko Ohki	NIPPON KOKAN K.K.	Assistant General Manager Design Dept.

ACTIVITES OF REPORTING MISSION

Date	Place	Contents
June 19	Embassy of Japan to Arab Republic of Egypt	Courtesy visit and previous arrangement for reporting of the draft refort
	Cairo Office of JICA	Previous arrangement for reporting of the draft report
June 20	IMC	Questions and answers on the draft report
June 21	"	" " " " " " "
June 23	"	" " " " " " "
	Ministry of Electricity	Survey on actual conditions of electricity
	Steel Structure Co.	Survey on local manufacturing ability
June 24	IMC	Question and answers on the draft report
June 25	IMC	Preparation of Memorandum

EGYPTIAN COUNTERPART

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Member

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Eng. M. HELMY	-	Electrical Eng.
Eng. MOUNIR FAHMY	-	Erector Mech. Equip.
Mr. M. SAMIR	-	Economics

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A P P E N D I X

CHAPTER 1

Chapter 1 Introduction

1.1 This Report has been prepared on the basis of the understanding reached in the memorandum of May 16, 1979 and the memorandum of June 25, 1979 signed between the Egyptian Special Committee which has been designated by the Government of the Arab Republic of Egypt to act as the promoter of this integrated steel mill project and the JICA Feasibility Study Mission which has been entrusted by the Japanese Government to carry out the feasibility study.

The main concept of this project contemplated by the Government of the Arab Republic of Egypt is to construct and operate the integrated steel works producing 723,000 tons per year of rods and bars by using the route of the direct reduction process-electric furnace at El Dikheila near Alexandria. Financial analysis and sensitivity analysis on the fluctuation of the important factors have been made to assess technical and economic feasibility of the project based upon a detailed investigation and study of the following points:

- Domestic market analysis of steel products, in particular rods and bars, in Egypt;
- Site conditions of El Dikheila;
- Most effective and economical equipment program;
- Estimation of construction cost;
- Assumption of production cost;
- Organization of the company, manpower requirement, training and technical assistance plan.

In view of the results of the above financial analysis and technical evaluation, we believe that this integrated steel works project proves feasible. We hope this report will help the Government of the Arab Republic of Egypt to make final decision on this project.

CHAPTER 2

Chapter 2 Summary

2.1 Market Study

Steel consumption in Egypt, which is currently about 1.2 million tons, will reach nearly 10 million tons, as a result of rapid growth. Per capita crude steel consumption, which is at present about 38 Kg, will be 187 Kg in year 2000.

Bars and rods consumption, which is at present about 630 thousand tons per year, occupies around half of total steel consumption. Although bars and rods are most important items in steel products, A.R.E. is currently forced to import around 400 thousand tons of bars and rods annually, because of limited domestic supply which is at present around 240 thousand tons per year.

Projection of bars and rods demand from 1983 to 1992 is shown on Table 2.1-1.

Table 2.1-1 Projection of bars and rods demand

	1983	'85	'87	'89	'92
Demand of Bars and Rods	920	1,105	1,322	1,574	2,034

Since annual growth rate of demand is projected as high as 9.3%, and substantial expansion of domestic supply is not expected, import will grow rapidly as a result of expanding demand-supply gap, as things stand.

Therefore, realization of this project will benefit national economy not only by the development of steel industry, technology transfer, utilization of domestic natural resources, expansion of employment opportunity, but also by foreign currency saving through import substitution.

Detailed study on the possibility of export shows us that this project will have sufficient possibility of exporting to surrounding Arab countries, provided that the Project have sufficient international competitiveness.

2.2 Concept of Production Program

2.2.1 Production Program

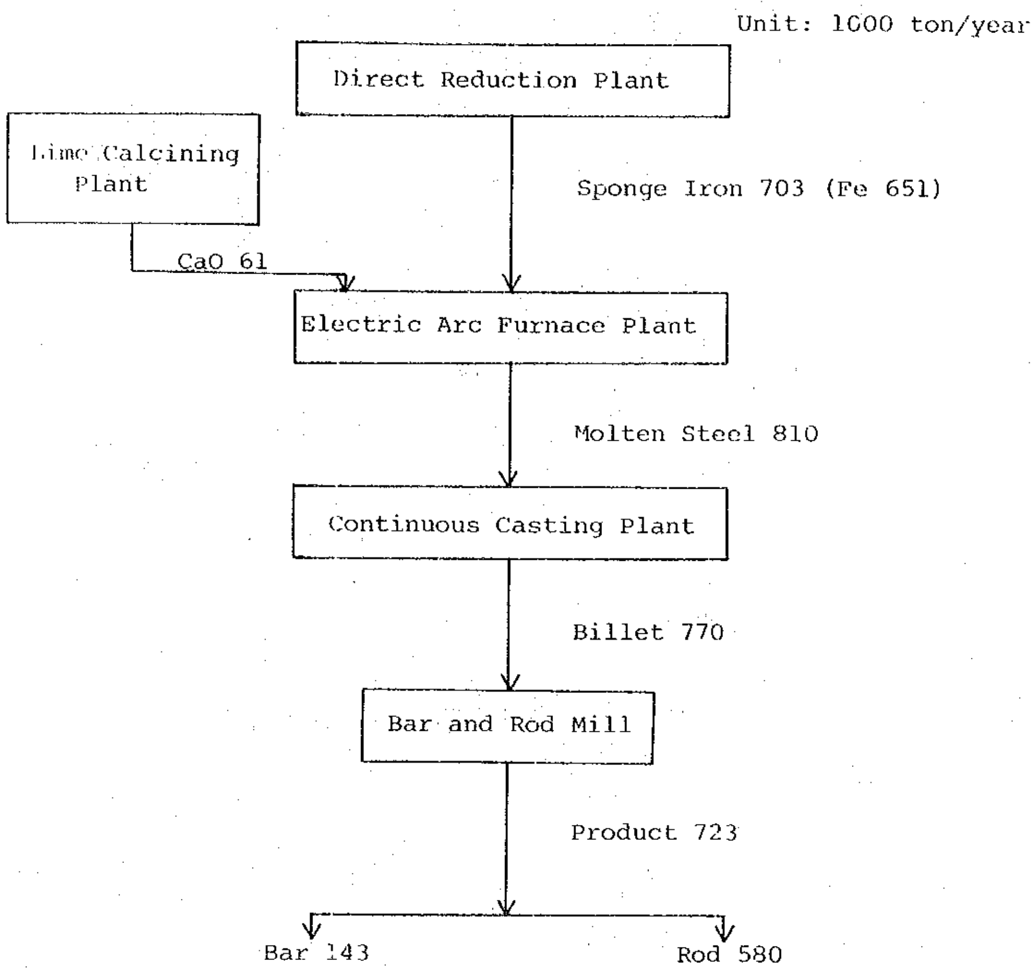
In this project, Direct Reduction - Electric Arc Furnace Route was adopted and consideration was given to the project based cn the program to produce 723,000 tons of the finished products of Bar and Rod per annum. Production Program for each project year after commencement of operation shall be shown in Table 2.2-1 and Production Flow after the full production having been achieved shall be shown in Fig. 2.2-1.

Table 2.2-1 Production Program

Unit: 1,000

Project year / Plant	1st year	2nd year	3rd year	4th year
Sponge iron	336.78	685.39	712.96	715.00
Billet	375.00	731.10	770.00	770.00
Bar & rod products	231.20	600.85	723.00	723.00

Fig. 2.2-1 Production Flow



2.2.2 Production Program

It was planned to start operation of Steelmaking Plant 3 months before starting operation of D.R. plant and Bar and Rod Mill. Until D.R. plant starts operation, Steelmaking plant shall be operated with all scrap charge.

a. From the time of starting operation, D.R. plant shall be operated with the 3 shift/4 crew system.

b. Steelmaking plant shall be operated with the one shift system for the first 3 months after starting operation, two shift system for the next 3 months and 3 shift/4 crew system from the 7th month after the start up.

c. Bar and Rod Mill shall be operated with the one shift system for the first 2 months after starting operation, two shift system for the next 2 months and 3 shift/4 crew system from the 5th month after start up.

d. For the first 2 project years, the steelmaking capacity is greater than the rolling capacity and, as a result of it, 110,000 t/Y of billets in the 1st year and 74,000 t/y in the 2nd year, 184,000 tons shall be produced for sale.

2.2.3 Expansion Plan

The Double Capacity Expansion Plan requested by Special Committee and Alternative Expansion Plan

(1,200,000 t of steel/Y) studied by JICA F/S team were compared and considered in terms of the demand forecast, effiency of investment, the state of raw material purchase, location of works etc.

As a result of it, it would be recommended that the scale of the expansion plan for this project in the future should be 1,200,000 ton per year of molten steel basis.

2.3 Study on Procurement of Raw Materials

Study on procurement of required raw materials is made on the basis of the production plan. In selection of supply sources, the following points are taken into consideration:

- The project is to make use of all raw materials available in the domestic markets.
- While due consideration is given to the location of El Dikheila plant site with respect to raw materials to be imported, a basic concept of "diversification of supply sources" is incorporated into the study to lessen the risks in procurement of main raw materials.

Not only in Egypt but also in the neighbouring countries there are various plans to produce raw materials, some of which the project will use. However, these are excluded from the study due to many unknown factors. Prices and supply and demand positions are summarized in Table 5.5-1 and 5.5-2.

Summary of the study is as follows:

2.3.1 Iron Ore

Two sources of pellets and three sources of lump ore were first selected as candidates with appropriate quality for direct reduction process. Then in consideration of ocean freight, the study chooses pellets produced by Cia. Vale do Rio Doce (Brazil) and Luossavaara- Kiirunavaara AB (Sweden) or the like and lump ore produced by Hamersley Iron Pty. Ltd. (Australia) or the like. And ocean freight rates are calculated both on the Ore-Oil and Ore-Bulk-Oil carriers basis in accordance with Egyptian requests and 100,000 to 160,000 DWT vessels are selected as basic ship size.

2.3.2 Steel Scrap

There can be various sources of steel scrap, but the study is made on the premise that the U.S.A., the largest scrap exporter, should be the main supplier with Australia and the Middle East as complementary sources. Study on ocean transportation is made on the basis of general purpose cargo vessels of 20,000 to 25,000 DWT and the discharging rate of 2,000 tonnes per day. It goes without saying that a berth for exclusive use and related facilities are essential to low cost and stable procurement of steel scrap. It is extremely difficult to appraise the price level, but the study is made based on actual prices of recent 6 months from East Coast of the U.S.A.

2.3.3 Ferro Manganese

In the study all of the required quantities are to be imported. Ferro Manganese is amply available in Europe and can be procured there. However, in view of the tendency that the price fluctuate to a large extent depending on the demand and supply position, in order to achieve stable procurement in terms of both price and quantity, it is necessary to diversify the supply sources and at the same time to conclude long term contracts for some part of the required quantities.

2.3.4 Fluorspar

It seems that some portion of required quantity can be covered by domestic production. But in the study all of the required quantity are to be imported from the countries on the Mediteranean Sea because there is uncertainty in the stable supply and quality of the domestic production.

2.3.5 Raw Materials from Domestic Markets

Raw materials from the domestic markets are ferro silicon, limestone, aluminium and coke breeze. They are currently being produced and there will be no problem in procurement of them, including their qualities. The prices taken up in the study are current domestic market prices.

2.3.6 Graphite Electrode

The demand and supply position of UHP20, which is to be adopted in the project, will be tight. Its price has jumped up by US$1,000 compared to just a year ago and it is foreseen that this price level will be kept.

The study assumed purchase of electrodes on the basis of 80% Japanese and 20% European/American considering a smooth procurement.

2.4 Concept of Facilities

2.4.1. Location and access

The proposed site for the Steel Plant is located at EL DIKHEILA area, about 15 km west of Alexandria City. El Dikheila are is a narrow and long strip of land between the Mediterranean Sea and Lake Maryut, and has several excellent conditions for a steel plant site as follows:

1) Acceptability of raw materials through the port facilities to be constructed at the Dikheila Bay.

2) Availability of natural gas as main fuel which is produced off-shore Abu Qir, about 45 km north of the site.

3) Availability of sufficient water, due to its proximity to the branch of the Nile.

4) Easiness of constructing heavy structures due to good soil conditions and non-earthquake zone.

5) Good living environment due to favorable climatic conditions.

6) Availability of labor force due to proximity to Alexandria, and no necessity to build living accommodations for this project.

7) Proximity to the market for the steel products and good connection to the existing road and railway.

Among these conditions, the most decisive one would be that the site is located near seashore.

Limestone in the site is exposed on the surface of the stratum looking like mountains and showing a conspicuous undulation as a result of disorderly mining of limestone during a long period.

Considering the access to the site, the ground level of the site is planned to be M.S.L. + 7.0m. In this case, it becomes necessary to execute land reclamation on a large scale prior to construction Steel Plant.

It is recommended to use soil and sand generating from this land reclamation for the other related construction works such as construction of break-water, raw material stock yards, etc.

Since the layer of limestone composing the stratum of the site has a high compressive strength, it is possible to expect that the stratum has enough bearing capacity as the foundation to support heavy structures. For these parts of the site where cementation has not sufficiently advanced, and where the stratum of limestone was once mined and has been reclaimed, it is necessary to take some measures.

As to the map of the location, access planning of the surrounding area, and the meteorological data, refer to 6.1.

2.4.2 General Layout

The site of this project has a width of 500 m to the south and north and has a length of about 2,200 m to the east and west and the area is adja-cent to the planned new port of El Dikheila and the raw material yard.

Taking into consideration the ground level of the site and its surrounding area, access of roads, railway, to the site, two alternative general layouts were prepared relating to 2 cases of the final output of steel; one is 1,200,000 t/y and the other is 1,600,000 t/y (DWG. No. 6-02-01 and DWG. No. 6-02-02).

In designing the layout of a steel plant generally, it is necessary to consider how to minimize the handling cost throughout all processes from receipt of raw materials up to shipment of products.

In view of this, all plants are laid out in a straight line from the east to the west and Steel Making Plant and Bar & Rod Mill are directly connected with electric transfer cars.

Judging from the smooth material flow and minimum investment cost of shifting from stage I to stage II, 1,200,000 t/y capacity plant would be the most suitable plan.

When compared with the above case, in the case of 1,600,000 t/y capacity plant, it is difficult to combine most suitable production scale of both steelmaking plant and bar and rod mill. Since the latter case has the disadvantage in view of the transportation cost, land reclamation cost, investment cost to shift to stage II, it can be judged worse choice as a whole.

2.4.3 Direct Reduction Plant

2.4.3.1 Selection of process

Among the various types of D.R. processes, which use natural gas and are currently marketed worldwide, Midrex and HYL are most widely used in commercial production scale.

Therefore, comparison is made between these 2 types, and Midrex process is chosen as the most suitable D.R. process.

Comparison between Midrex and HYL is shown as follows:

a. Quality of Sponge iron

   Sponge iron produced by the Midrex process would be more advantageous with a high percentage of metallization, and adjustable carbon content, too.

b. Raw material

   Different from HYL, it is possible for Midrex to use oxide pellet of wider variety and lump iron ore as raw material.

c. Total energy consumption is less in Midrex process than in HYL process.

2.4.3.2 Facilities

The Plant capacity is planned as 600,000 t/y nominal capacity which can attain production target of 703,000 t/y with 117% capacity utilization.

Since the sulphur content of natural gas to be used is comparatively high, it is planned to install the desulphurizing equipment of the Stretford type.

The planned operation factor are as follows:

a.	Plant Capacity:	703,000 t/y
	(Nominal):	(600,000 t/y)
	Total Fe of Sponge Iron:	92.7%
	Metallization Nominal:	93% (Range 92 - 95%)
	Carbon Content, Nominal:	1.5% (Changeable range 0.8 - 2.7%)
b.	Plant Availability:	312.5 day/y
	(Expected):	(333.3 day/y)

2.4.4 Steelmaking Plant (Including Continuous Casting)

2.4.4.1 Capacity of EAF and C.C.

The capacity of EAF (t/heat) shall be planned in consideration of the relationship with C.C. machines in the next process. In this plan, importance is attached to the operational efficiency of the steel making process and the following capacity is selected to allow easier operation.

EAF	70 t/heat x 4 furnaces
C.C.	4 strands x 3 machines

2.4.4.2 Premises of operation

a. EAF

Annual Production	:	810,000 t/y
Plant Availability	:	300 day/y
Productivity	:	9.64 heat/day
Molten Steel Yield	:	93.0%

b. C.C.

Annual Production	:	770,000 t/y
Plant Availability	:	330 day/y
Productivity	:	12.9 heat/day
Billet Yield	:	95.0%

2.4.4.3 Operation flow

Sponge iron coming from the product hopper of D.R. plant shall be continuously charged into EAF and scrap coming from Scrap yard shall be charged into EAF with Bucket. Molten steel tapped from EAF shall be poured into steel ladle arranged under the furnace and the ladle shall be hung up with crane, set into ladle slewing tower of C.C. to pour molten steel into tundish of C.C. process.

Billet produced in C.C. shall be tentatively kept on billet cooling bed located in the down stream of C.C. and then transferred as either warm billet or cold billet to bar & rod mill.

2.4.4.5 Characteristic of EAF

Taking the availability of refractory in Egypt into consideration, it is decided to set the cooling ratio of the furnace wall at about 60% and the ceiling at about 70% to minimize consumption of refractories.

2.4.5 Lime Calcining Plant

In order to produce 61,000 t/y of burnt lime consumed in EAF in a year, lime calcining plant of shaft type is selected.

The capacity of lime calcining plant is determined to be 180 t/day. The operational factors are as follows:

Annual Production:	61,000 t/y
Plant Availability:	330 day/y
Yield:	45% (Product/before washing Limestone)
Daily Production:	150 - 220 t/day

2.4.6 Bar and Rod Mill

2.4.6.1 With the production capacity at Stage I being as high as 723,000 t/y (product), this mill can be ranked as one of the largest among modern mills in the world. To minimize the capital cost, the combination mill was selected, in which one 140t/h reheating furnace, one roughing strand, one intermediate strand serve for bar and rod lines. As finishing line, one bar line and two rod lines are provided.

Also due consideration is paid to enable the future expansion to 1,200,000 t/y of molten steel by adding one reheating furnace, one roughing strand, one intermediate strand and one bar finishing line.

2.4.6.2 Production program

Based on the product mix proposed in the market study, rolling productivity in each product size was calculated to decide production capacity and operational mode of rolling mill. The rolling schedule at start-up is also prepared.

Rolling productivity by size is shown on Table 6.7.4 and the averaged rolling productivity by year on Table 6.7.5. Table 6.7.7 shows the rolling schedule at start-up.

2.4.6.3 Additive Study

(1) The product mix consisting of large amount of small-sized bars and rods is studied. The results show that the rolling capacity of the above product mix decreases by 10% than that of the original product mix.

(2) As an alternative for combination type mill, separate mill is examined. Though production capacity increases and aimed production is achieved in 3 shift/3 crew system, investment cost increases by 40%.

2.4.7 Electric power

2.4.7.1 Characteristics of electric power

Since the steel plant planned by this project is an intergrated steel mill with D.R. plant, EAF and C.C. as its central facilities, the power consumption of EAF only acconts for about 700 KWH/Ton and total consumption of power per ton of product is about 1,000 KWH which is much greater than 500 - 600 KWH per ton of product consumed by an integrated steel mill of the blast furnace route. Electric power required in the Stage I shall be as follows:

Electric power consumption of entire plant	:	850,000 MWH/Y
Maximum electric power	:	150,000 KW
Maximum electric capacity	:	180,000 KVA

In addition, 4 units of 70 ton EAF adopted in this project would cause the problem of voltage fluctuation. This problem could be neglected at present where existing maximum furnace capacity is only 25 tons in Egypt.

It is necessary, therefore, to consider about the countermeasure against the voltage fluctuation and installation of compensator.

In an emergency it is necessary to protect the power system susceptible to damages by means of emergency power supply system.

All electric power of this project, except for the emergency power supply system, shall be supplied by E.E.A. (Egyptian Electricity Authority).

Compared with the existing steelmaking plants in Egypt, the level of electric power consumption needed for this project is much larger in scale. Also the construction cost of the compensator for solving the problem of voltage fluctuatuon depends in a great deal on the capacity of the power source. Such being the case, it is recommended to study the expansion of power supply to make this project feasible.

2.4.7.2 Condition of power source

As the results of the study of the present state of power supply in Egypt, it is found that electric power needed for this project is too large to expect guaranteed power supply by existing power plants only.

It is essential to operate the power plant of 110 MW x 3 units in KAFRELDAWAR and 150 KW x 4 units in Abu Qir both planned by E.E.A currently to be constructed in Alexandria area prior to operation of this project.

As for power transmission system, the plan to construct El Dikheila substation in the southwest of this project site is under way based on the sponge iron project previously planned. This substation is prearranged to receive power from AMERIA substation and Abu Qir Power Plant with 220 KV double circuits. The power receiving system of this substation is optimal one jointing with the principal Egyptian power systems. It is recommended, therefore, that the construction of this power transmission system is completed prior to operation of this project in the same way as the case of power plants. In regard to the power receiving method of this project, however, it is needed to adjust a part of the existing construction plan of El Dikheila Substation.

As to the power receiving method from El Dikheila Substation to this project, it is expected that E.E.A. will consider the matter and make a plan. Accordingly, the following comment shall be presented as a JICA suggestion. It is recommended to receive power with 220 KV double circuits judging from the results of consideration about the maximum electric power required for this project and about the problem of the countermeasure for voltage fluctuation.

In addition, it is recommended that the cable capacity of each circuit should satisfy maximum 180 MVA. Feeders of 66 KV and 11 KV currently under planning can be utilized effectively as tentative power sources for the peripheral facilities and construction works for this project.

2.4.7.3 In-plant Electric facilities

Based upon the abovementioned characteristics of electric power and conditions of power supply, plans are worked out and specifications are prepared as to the flicker compensator, power receiving and distributing facilities, communication facilities, illumination facilities, tentative power source facilities for construction works, and emregency power supply system.

2.4.8 Oxygen Plant

The volume of oxygen gas and nitrogen gas needed for this project is 380 Nm^3/h (on average) and 322 Nm^3/h (on average) respectively and they are mainly consumed in steelmaking plant.

A plant is planned for producing each 400 Nm^3/H of oxygen gas and nitrogen gas. Each gas is compressed up to the designated pressure and distributed to the necessary paints.

2.4.9 Utility Facilities

2.4.9.1 Industrial water facilities

All the water used in the works shall be supplied by Alexandria Water Authority. As shown on Table 6.10-1, the quality of this water is considered to be used as drinking water.

Water supplied by main pipe shall be separated into 2 systems of industrial water and drinking water in the works. Industrial water shall be principally used as cooling water for various facilities and its planned consumption volume shall be 725 m^3/h on average.

The industrial water facilities shall be composed of water receiving and reserving facilities, indirect cooling water facilities, and direct cooling water facilities with the following main function respectively.

- Water receiving and reserving facilities:

  Industrial water shall be treated so as to be under 75 ppm in hardness and then reserved in a water tank of 6,000 m^3 capacity.

Indirect cooling water facilities:

After temperature control in water cooling tower, the water shall be fed to each facilities as cooling water.

Direct cooling water facilities:

After removal of scale, oil and suspendid soild with high rate filters, temperature control in water cooling tower, the water shall be reused as direct cooling water.

Head tank facilities:

Water feeding facilities for emergency

Capacity: 50 m^3

Drinking water will be used 12.5 m^3/h on an average. After being received and treated for sterilization and disinfection, the drinking water shall be transfered to the head tank and distributed.

Among waste water generated in the works, rain water shall be treated by natural filteration and waste living water shall be drained out of the works compound after being completely treated in the sewage treatment plant. The quality of the waste water after sewage treatment is shown on Table 6.10-2.

2.4.9.2 Natural gas facilities

Required quantity of natural gas is 43,130 Nm^3/h, for which 45,000 Nm^3/h supply capacity is planned. This natural gas shall be supplied through pipe line from Abu Qir located about 45 km northeast of El Dikheila. The feed pressure at the battery limit shall be 9 ∿ 11 kg/cm^2. After fine dust having been removed through filters, the supplied gas shall be sent to each facility with the pressure of 7 kg/cm^2. The natural gas used in D.R. plant shall be desulphurized so that the content of H_2S is to be under 1 ppm.

2.4.9.3 Compressed air facilities

Required quantity of compressed air is 5,670 Nm^3/h, for which 3 units of air compressors each with the capacity of 3,000 Nm^3/h shall be equipped.
2 units operate while 1 unit stands by.

The compressed air shall be mainly used for driving air cylinders in steelmaking plant and rolling mill. In addition, another compressed air facility used solely in D.R. plant shall be required.

2.4.10 Intra-Transportation

In order to execute production activity of the works, handling and transportation of an enormous quantity of materials become necessary.
Pricipal transportation necessary in the works is as follows:

1) Storage and handling of raw materials
2) Conveying of semi-products and products in the works
3) Conveying of generated waste and residual.

According to our estimate, the quantity of the above items amounts to 1,500,000 t/y. Analysis was conducted with each item needing handling and transportation and, based on the results, study is made on machines and apparatus such as trailers, roads, railways, etc.

2.4.11 Maintenance Shop

2.4.11.1 Maintenance system

This works adopts the centralized maintenance system, in which the mechanical, electrical, and instrument maintenances are based on the 3-shift system to be able to meet the immediate demand for trouble and accident.

a. Scheduled preventive maintenance is fully adopted.

b. Specified inspection team is arranged for each plant, which determines the repair cycle from the inspection results.

c. Coordinating force is established to enable statistical processing of repair data, to reduce the number of troubles and required spare parts.

2.4.11.2 Maintenance shop

Maintenance shop is provided within the works to cover about 30% of total maintenance requirement.

This maintenance shop will include the following equipment:

a. Machine shop

b. Overhaul and assembly shop

c. Steel frame shop

d. Electric repair shop

e. Instrument repair shop

f. Car repair shop

2.4.12 Analysis and inspection facilities

2.4.12.1 Analysis

To carry out analyses on sponge iron, raw materials for EAF, the X-ray quantometer, (C.S.) determination and various gas analyzer are planned. To minimize the time required for analysis, the sample is transported through the air tube provided between the laboratory and steelmaking section.

2.4.12.2 Inspection

To guarantee the product quality, the inspection facilities are planned. Equipment list is shown in Fig.6.13.3.

2.4.13 Warehouse & Shipping Facilities

Based on the results of investigation conducted as to the present shipment of bar & rod products in Egypt, delivery of products in this project are assumed to be made on vehicle ex-warehouse of this works. Though shipment of product are mostly made by trucks or tailers, consideration is given to the railway shipment.

In accordance with Agreement dated March 16, 1979, it was planned that the mill end warehouse shall keep stock for 5 days and the shipping warehouse for 16 days and the product warehouses as a whole for 21 days in total, based on the production capacity. However, it should be pointed out that 21 days storage capacity is not sufficient if we assume distribution condition existing as it is. Therefore, it is necessary to review and improve the domestic distribution mechanism of the products.

2.5 Implementation Plan

The construction schedule of this project shall cover 50 months ranging from the month of Basic Engineering being started up to the month of all production facilities operation being commenced.

It is planned in this project that steelmaking plant shall go ahead of the other facilities. The reasons are as follos:

1) Different from other principal equipment, the steelmaking operation greatly depends upon the skillfulness of operators, and thus their training must be given the prime concern.

2) Due to tight supply-demand balance for billets in Egypt, there are shortages of 100,000 t/y for National Metal and 10,000 t/y for Delta Steel.

Construction schedule of the principal facilities is shown on Table 7.1-1.

In implementing this project, it is necessary that the various facilities, which are out of the Scope of Work, such as water, electric power, gas, port, roads, railways, etc. can be completed and provided timely. As for the schedule and necessary quantity, etc., detailed description will be made in 7.2.

For reference in case of delay of construction schedule by one year, please refer to Table 7.3-1.

2.6 Estimation of Personnel Requirement, Organization Training and Technical Assistance Plan

2.6.1 Organization

In view of the fact that this project is producing round bar only and, in addition, distribution of the product is under the control of the Ministry of Housing, the organization of the head office was planned so as to minimize the size of organization and is located in the plant site. However, a liason office shall be established in Cairo for keeping contact with governmental organization.

The proposed organization is shown on Table 2.6-1.

Table 2.6-1

- Chairman — Managing Director / Board
  - General Affairs Dept.
  - Finance Dept.
  - Purchasing Dept.
  - Sales Dept.
  - Cairo Office
  - General work Manager
    - Production Dept.
    - Maintenenace and Utilities Dept.
    - Producting & Technological Management Dept.
    - Purchasing & Transportation Dept.
    - Budget & Cost Dept.
    - General Administration Dept.

2.6.2 Personnel requirement

Personnel required both in the head office and the Works is shown on Table 2.6-2.

Personnel required with 4 crew system shall be allocated to work operating under the 3-shift system.

Table 2.6-2

	Head Office	Works	Total
Manager	4	6	10
Superintendent	7	19	26
Ass't Superintendent	7	47	54
Engineer		73	73
Office Staff	18	135	153
Worker		1,485	1,485
Total	36	1,765	1,801

2.6.3 Training plan

A training methods includes

1) Training by means of the handling and operation manuals which will be submitted at the construction phase by the manufacturers concerned,

2) Abroad training,

3) Training through technical assistance after start-up operation.

Abroad training will, for the most part, consist substantially of observation because of linguistic and custom problems and as the company which will receive the trainees are conducting its own commercial production, and therefore such training will be less effective for its cost. The proposed plan covers the training of the personnel above the managing staff of the respective divisions. It is recommended that the training be performed at the works owned by the company technically assisted by an adequate steelmaking company overseas and that it be kept continued for a period ranging from the no-load test run during construction until stable operation will have been achieved.

2.6.4 Proposal for technical assistance plan

The facilities and equipment projected are of the world's highest levels at the present time and their commissioning plan is also of a high level. In order that these plans be satisfactorily accomplished, it is proposed that the Owner receive not only technological and technical assistance but also overall management assistance from a foreign steelmaking company having good experience and competent staff.

Our proposed technical assistance plan comprises as follows:

1) Period: 1.5 years before and 6 years after commercial operation.

2) Technical assistance staff.

Year	1	2	3	4	5	6	7	8
Staff	15	70	140	131	93	89	53	42

2.7 Estimation of Capital Cost

Based upon the international price level as of March, 1979, two cases on estimation of capital cost of this project with escalation and without escalation are figured out. Calculation of capital cost is based upon the following premises.

a. Machine and apparatus : Import

b. On-site construction works : Domestic

c. Material for construction works :

The principal construction materials such as cement, concrete reinforcing bar, etc. shall be imported. Gravel, sand, common brick, etc. are assumed to be available in the domestic market.

d. Customs duty : All imported machines apparatus and materials shall be duty free.

e. Spare parts : The purchasing all spare parts for one year except consumption goods such as refractory, etc. are included in the capital cost.

f. Price escalation rates :

The following price escalation rates specified in memorandum of June 25, 1979 are adopted.

	1979	1980	1981 onwards
Egypt	15%	12%	9%
World wide	7%	7%	7%

The capital cost are figured out based upon the above premises.

(Unit: US$1000)

Currency \ Calculation	Without escalation	With escalation
Foreign	438,689	534,515
Local	99,458	137,505
Total	538,147	672,020

2.8 Estimation of Production of Cost

Determination of production cost includes

- Estimation based on the prevailing price levels as of March, 1979,
- Estimation based on the prevailing price levels as of March, 1979, with consideration given to inflation and import duty on raw materials, and
- Estimation of the case where import duty on raw materials are exempted with reference to the above. The method of calculation adopted is the process cost system. The classification of processes includes lime calcination, direct reduction furnace, electric arc furnace, continuous casting, and bar & rod mill, which are the manufacturing sector. In addition to manufacturing sector, the auxiliary section and the plant management section are established.

Table 2.8-1 shows the results of calculation on the basis that the year in which commercial operation of the steelmaking plant starts is the first.

Starting from the low availability of each plant in the first year the production costs become lower as the plant availability increases. It still lowers from the third year due to the blend of the lump ore (30%). From the fourth year on the production cost becomes stable.

Table 2.8-1 Production Cost Forecast

(In U.S.$/ton)

Calculation basis / Year / Product	Based on Prevailing Price Level as of March, 1979				Escalation Case							
					Import Duty Imposed				Import Duty Exempted			
	1	2	3	4	1	2	3	4	1	2	3	4
Sponge iron	96.6	94.1	89.8	88.9	147.3	143.8	137.0	135.7	138.6	135.1	129.0	127.9
Molten steel	191.3	181.0	179.1	178.6	289.9	275.5	272.5	271.5	274.3	260.2	257.5	256.8
Billet	211.8	197.4	195.2	194.6	319.3	299.0	295.5	294.7	303.6	283.6	280.4	279.7
Bar and Rod	254.4	226.0	221.6	221.0	379.9	340.0	333.5	332.6	364.3	324.6	318.4	317.6

2.9 Financial Analysis

Financial analysis is made for the Base Case and the Escalation Case in order to examine financial feasibility and investment efficiency of the project.

In the Base Case, study is made on the assumption that import duty is exempted on raw materials. In the first year comes a deficit of U.S.$68,000,000. Profit and loss are almost balanced in the third year when the full production is achieved. A surplus of U.S.$13,000,000 comes in the fourth year, a surplus of U.S.$48,000,000 in the eight year, and thereafter surplus gradually increases. The invested capital efficiency analysis by the discounted cash flow method (DCF) results that the internal rate of return on equity (ROE) is 12.49% and the internal rate of return on investment (ROI) is 9.21%. These rates are not necessarily satisfactory.

In the Escalation Case, study is made for the two cases where import duty on raw materials is imposed and exempted. In the case with import duty imposed, the profitability is very low; a deficit of U.S. $14,500,000 comes even in the fourth year, and the year when the deficit turns into a surplus is the sixth year after start-up. Even if no dividend is distributed, the accumulated deficit becomes zero in the as late as 13th year after start-up. ROE becomes 6.12% and ROI 5.70%, the latter falling considerably short of the weighted average interest rate of 7.9% on the long-term loans. This shows that this case is definitely infeasible. If the import duty is exempted on raw materials about U.S.$15/ton cost reduction can be achieved. The year when deficit turns into surplus is the fourth year. If no dividend is disbributed, the year when accumulated deficit becomes zero is the tenth year. ROE is 9.46% and ROI 7.53%, turning somewhat favorably when compared with the Escalation Case with import duty imposed. But it is hard to say that the case is feasible.

In orfer that the project may be judged financially feasible, it is desirable that ROE should be 15% or more and ROI 10% or more. The following study deals with both the sales price aspect and cost aspect to secure the satisfactory level of IRR.

The study of the satisfactory sales price level necessary to secure the above mentioned requirements (ROE 15% or more and ROI 10% or more)and the viability of the price level has resulted as follows:

a) In the Base Case, when the current sales price of U.S.$350/ton is raised to U.S.$362/ton, requirements above can be met. The sales price of U.S.$362/ton seems viable judging from the gradually escalating trend of bar and rod price in the past. (See Fig. 35-1, Chapter 3.)

b) In the Escalation Case where import duty is imposed, the current sales price of U.S.$468 /ton has to be raised to U.S.$518/ton resulting the annual price escalation rate of 8.2% instead of 6%.

c) In the Escalation Case where import duty is exempted, the sales price has to be U.S.$502/ ton. This means the annual price escalation of 7.5%.

These annual sales price escalation rates of 8.2% (item b) and 7.5% (item c) can be considered viable like in the case with item a) when judging them from the past bar and rod sales price evolution.

By revising assumptions for the cost accounting, the above mentioned requirements can also be met. Controllable factors include the prices of natural gas, electricity and water, rent of land, import duty or raw materials, and extension of the period of corporate tax holiday from 5 to 8 years. But the following two conditions are examined here. The price of natural gas used in this feasibility study is set at a very high level (See paragraph 10.1.12), of this price is replaced by the incentive rate prevailing as of March, 1979, the cost of natural gas per ton of product becomes U.S. $35/ton lower from U.S.$46/ton to U.S.$11/ton in the Escalation Case.

Also, if raw materials are exempted from import duty, the cost becomes lower by U.S.$15/ton (See paragraph 10.2.3). Therefore, if we put the two conditions together the cost decreases by U.S.$50/ton, and assuming that sales price escalation is 6% as established initially, 15.22% ROE and 10.79% ROI can be secured. Also, if we apply these two conditions to the Base Case, 17.19% ROE and 16.63% ROI are obtained

As was mentioned above, 6% or more of the price escalation is possible, judging from the past price trend. However, considering that the objective of the project is to supply consturction material for low cost housing at the prices as low as possible, we propose to Egyptian Government to adopt the policy of supplying natural gas at lowest possible price, and granting import duty exemption for raw materials of this project, in order to make this project financially feasible, rather than resorting simply to higher sales prices.

From this viewpoint, the result of financial analysis based on incentive natural gas price and import duty exemption for raw materials, is presented in Table 11.39 through 11.48 as "JICA's recommended Case."

CHAPTER 3

Chapter 3 Market Study

3.1 Prospect of Egyptian Steel Industry

In January 1979, UNIDO made studies for drawing up a master plan for the Egyptian steel industry for the future. The study report gives an outlook on the growth of the steel industry in Egypt up to year 2000; it forecasts a possible growth of demands on all basic steel products including non-flat and flat products as well as tubular products and proposes an expansion plan for production facilities, its basic direction and implementation schedule to satisfy the forecasted demand.

According to the UNIDO report, consumption of steel products and per capita consumption in terms of crude steel in Egypt up to year 2000 are forecasted as shown in Table 3.1-1 below.

Table 3.1-1 Forecast of Steel Consumption in Egypt

	1983	1987	1991	1995	2000
Consumption of steel products (in 1,000 tons)	2,100	3,100	4,450	6,300	9,560
Per capita consumption in crude steel (in kgs)	61	82	107	138	187

The forecast was made based on the fairly high growth rate of GDP averaging 8% annually during the period, but the 187 kgs per capita steel consumption in crude steel in 2000 is only on a par with the 1975 levels of consumption in developing countries such as Hongkong (138kgs), Iraq (181), Israel (221), Gabon (208), Argentina (172) and Venezuela (196). As the levels in industrialized nations are generally in the range of 500 to 600 kgs/person or more, it would take many years beyond 2000 before Egypt reaches the level of industrialized nations even if its economy grows at such high pace. In that sense, the progress up to 2000 should be deemed only as the initial stage.

At present, Egypt consumes about one million tons of steel products annually, more than 50% of which come from abroad. This means a large outflow of foreign exchanges, but also means that there is a vast potential for industralization. Furthermore, Egyptian steel consumption is growing rapidly, and increase of domestic supply to catch up with it would not only save foreign funds by substitution of import but also bring a substantial benefit to the national economy through industrial development and increased employment opportunity.

Table 3.1-2 shows a breakdown of future steel consumption by kind of product. Steel bar and rod is the most important product items accounting for about 40% of the total in 1991 though it is noted that the share of bar and rod will show a gradual decline from about 50% at present. Current domestic supply of bar and rod is only 250,000 tons or less, and more than a half of the demand has to be met by the import. It is estimated that the outflow of foreign exchange by the import amounts to 90 million U.S. dollars (63.0 million LE) or more. (300,000 x US$300 = US$90,000,000)

Table 3.1-2 Forecast of Steel Demand by Kind of Product - UNIDO (in 1,000 tons)

	1983	1987	1991
Bar & Rod	950	1,310	1,750
	(45.2%)	(42.2%)	(39.2%)
Section	420	630	890
Plate	190	300	470
Hot Rolled Coil	540	860	1,340
Total	2,100	3,100	4,450

Note: Figures in parentheses are shares of Bar and Rod in the total tonnages.

The main demand sector of bar and rod is construction. Atkins' report shows that bar and rod are 100 per cent used in construction. (Atkins' Final Report P. 18, Table 1.6) Though it is not clear from the report how the use in the construction is divided between "building" and "civil engineering", it may be analogized from the actual condition in Japan that the "building" accounts for more than 80%.

Together with food, housing is the foundation of good life of the people, and the Egyptian government has taken various measures for stabilization of prices and quantities of supply of cement and steel bar and rod which comprise basic materials of housing construction. However, the facts that much cannot be expected for an increase in supply of bar and rod from existing domestic mills including Hadisolb and that their demand itself is fast expanding resulted in aggravation of shortage of the steel products. For this reason, it is an urgent necessity to fill the gap, and the Egyptian government has given the first priority to this project among many projects.

The UNIDO report, from the same point of view, placed emphasis on the increase of capacity to supply bar and rod and proposed as a new investment plan the construction of a steel mill specializing in bar and rod by the route of direct reduction - electric furnace.

Among the kinds of products other than bar and rod, steel sheets come next in importance. According to the Atkins report, their main demand at present comes from fabrication, machinery and electrical machinery industries. As the automotive industry progresses in Egypt in future, the consumption in this sector will certainly increase.

Steel plate is now used by fabrication and construction industries, and as the shipbuilding industry develops in future, the demand on plate from the sector will rise.

Steel shapes and sections other than round bar and rod are consumed mainly in fabrication, transportation, machinery and construction sectors. Use of large structural steels for construction is almost nonexistent.

Those kinds of steel products other than bar and rod account for about a half of the total steel demand at present, but they will increase their weight gradually in future and will come to occupy about 60% of the total market by the early 1990's. The products are produced at Hadisolb, but it will become necessary to increase the supply by constructing a new mill. For demand and supply balance of steel products by kind in future, refer to Table 3.1-3 which is quoted from the master plan made by UNIDO.

Table 3.1-3 Supply-Demand Balance

(1,000 tons)

	'83					'87					'91				
	E	N	S	D	S-D	E	N	S	D	S-D	E	N	S	D	S-D
Bar & rod	395	544	939	950	Δ11	375	1,270	1,645	1,310	335	375	1,480	1,855	1,750	105
Section	420	-	420	420	0	425	300	725	630	95	425	490	915	890	25
Cold forming	40					40					40				
H.R.C.	700	-	700	540	160	700	1,134	1,834	860	974	700	1,908	2,608	1,340	1,268
Plate	72	-	72	190	Δ118	72	-	72	300	Δ226	72	350	422	470	Δ48
C.R.C	260	-	260	432	Δ172	260	558	818	688	130	260	937	1,197	1,072	125
Tin	-	-	-	73	Δ73	-	150	150	116	34	-	250	250	180	70
G.I.S	-	-	-			-		79	79	0	-		158	158	0
(Pipes) Butt weld	100	-	100			100					100				
ERW	20	-	20			20	120	140			20	192	212		
UOE	-	-	-			-					-	120	120		
Spiral	30	-	30			30					30				

E = Existing capacity N = New capacity S = Supply
D = Demand S-D = Balance

(UNIDO Report)

3.2 Existing Mills and Their Capacities

3.2.1 Existing Mill Capacities for Reinforcing Concrete Bar

Existing and expected capacities for reinforcing concrete bar (rebar) at the existing mills are as shown in Table 3.2-1. At Copper Works, the capacity was assumed to increase to 100,000 tons a year by 1985 through construction of an electric arc furnace and an oxygen plant as well as remodelling of rolling mills.

Table 3.2-1 Rated Production Capacities for Rebar at Existing Mills (Tons/year)

	Up to 1983	1984	1985-1992
National metal	215,000	215,000	200,000
Delta Steel Mill	70,000	70,000	70,000
Copper Works	70,000	85,000	100,000
Hadisolb	-	-	5,000
Private sector mills	5,000	5,000	10,000
Total	360,000	375,000	385,000

Capacities at Delta Steel were assumed not to change.

At Hadisolb, production of bar and rod is possible at its light section mill, but it was assumed that their future production would be mainly light sections with only nominal production of bar and rod.

There are about 14 mills in private sector and their aggregate capacity to produce rebar is assumed to be about 20,000 tons. However, because of limitation in supply of re-rolling materials and in the markets for their products, actual rebar production at those mills amounts to 5,000 tons or so a year and it was assumed their production would be 10,000 tons at the maximum.

3.2.2 Production at Existing Mills and Operating Rate

Production at the existing mills in past years is shown in Table 3.2-2. Prior to 1976, annual production level never reached 220,000 tons, but it jumped to 240,000-ton level in 1977 and 1978. In the past five years, the operating rate averaged about 62%, but it averaged 68% in the two years of 1977 and 1978. Based on the above trend in the past, the operating rate was expected to improve somewhat in future years to 70%.

Table 3.2-2 Local Production of R.C. Bars

(ton)

Year	Steel 37 kg										Sub-total	Steel 52 kg							Sub-total	Total
	6	8	10	13	16	19	22	25	28	32/38		13	16	19	22	25	28	32/38		
1967/68	2,700	15,800	39,600	63,000	27,900	16,400	8,600	11,200	-	-	185,200	1,100	3,200	2,800	3,100	11,600	-	-	21,800	207,000
1968/69	3,600	18,600	67,000	53,900	20,200	17,500	8,900	12,100	-	-	201,800	900	1,600	3,100	100	7,500	-	-	13,200	215,000
1970	-	16,600	36,500	40,900	21,000	23,800	4,100	8,400	-	-	151,300	7,500	10,600	15,100	9,700	8,500	-	-	51,400	202,700
1971	-	20,100	28,000	24,800	22,600	23,000	7,000	12,700	-	-	138,200	6,700	12,500	13,100	11,800	18,200	1,500	-	63,800	202,000
1972	-	22,300	19,600	44,800	22,900	21,400	10,100	10,700	200	300	152,300	6,300	15,700	16,300	10,400	7,500	7,600	-	63,800	216,100
1973	-	23,000	31,000	36,000	49,000	15,000	5,000	8,000	-	1,000	168,000	7,000	11,000	9,000	5,000	18,000	-	1,000	51,000	219,000
1974	-	21,000	28,000	40,000	43,000	27,000	8,000	7,000	1,000	1,000	176,000	10,000	9,000	7,000	6,000	7,000	1,000	1,000	41,000	217,000
1975	-	19,000	30,000	30,000	38,000	29,000	6,000	12,000	2,000	2,000	168,000	3,000	6,000	10,000	6,000	10,000	1,000	3,000	39,000	207,000
1976	-	18,000	24,000	37,000	37,000	29,000	16,000	21,000	-	-	182,000	4,000	3,000	4,000	5,000	10,000	1,000	2,000	29,000	211,000
1977	-	16,000	11,000	55,000	58,000	26,000	15,000	19,000	1,000	1,000	202,000	3,000	7,000	7,000	7,000	12,000	3,000	3,000	42,000	244,000
1978	-	6,000	25,000	64,000	30,000	38,000	19,000	15,000	1,000	2,000	20,000	3,000	6,000	8,000	9,000	10,000	3,000	8,000	47,000	247,000

(Source: SC)

3.2.3 Forecast of Production at the Existing Mills

Based on the premise in the preceding paragraph, actual production at the existing mills in the years 1983 through 1992 was forecasted as shown in Table 3.2-3.

Table 3.2-3 Forecast of Production Up to 1992 (in 1,000 metric tons)

1983	'84	'85	'86	'87	'88	'89	'90	'91	'92
250	260	270	270	270	270	270	270	270	270

3.2.4 Product Mix of the Existing Mills

Size structure of the products of the existing mills in 1977 and 1978 is as shown in Table 3.2-4. In order to see change in the size structure from that in the past years, comparison of the average size structure in 1977 and 1978 with that in the years 1972 through 1976 was made. It shows that sizes 8mm and 10mm decreased their weight while sizes 13mm and 32mm and over increased. According to interviews with the officials of public sector mills, the shift of weight from the 8 and 10mm sizes to the 13mm size resulted from their measure to increase productivity through specialization in the production of those sizes which have better production efficiency. Therefore, the average size structure of the 1977 and 1978 production was used to forecast the size structure in the existing mills in future.

Table 3.2-4 Size Structure of Existing Mills-Bar & Rod

Ton

	6m/m	8	10	13	16	19	22	25	28	32∼	Total
1977	-	16,000 (6.6)	11,000 (4.5)	58,000 (23.9)	65,000 (26.6)	33,000 (13.5)	22,000 (9.0)	31,000 (12.7)	4,000 (1.6)	4,000 (1.6)	244,000 (100.0)
1978	-	6,000 (2.4)	25,000 (10.1)	67,000 (27.2)	36,000 (14.7)	46,000 (18.6)	28,000 (11.3)	25,000 (10.1)	4,000 (1.6)	10,000 (4.0)	247,000 (100.0)
Total		22,000 (4.5)	36,000 (7.3)	125,000 (25.5)	101,000 (20.6)	79,000 (16.0)	50,000 (10.2)	56,000 (11.4)	8,000 (1.6)	14,000 (2.9)	491,000 (100.0)
1972 ∼ 1976 Average		20,660 (9.6)	26,520 (12.4)	43,620 (20.4)	46,920 (21.9)	33,540 (15.7)	15,500 (7.2)	22,240 (10.4)	2,760 (1.3)	2,260 (1.1)	214,020 (100.0)

As regards grade of the steel, it was calculated from Table 3.2-2 that, in the average of the 1977 and 1978 production, 52 kg steel accounts for 18% of the total and 37 kg steel 83%. In the average of the past five years, the 52 kg accounts for 17.6% and the 37 kg 82%, and there is not much change in this regards. 52kg steel is all deformed (rib) bar and 37 kg steel is all plain bar. As for the sizes 10mm and under, they are often sold in coil form. (In the Memorandum, it is specified that, of the 13mm product from a new mill, only 20% is to be shipped in coil form; that all the sizes, 10mm and under, will be in coil and that the sizes. 16mm and over, will be in straight bar form.) It is expected, however, that because of easy handling and increasing use of uncoiler, the product in coil form will increase.

3.3 Import and Consumption

3.3.1 Import Trend

Import of bar and rod in the years 1968 through 1978 is shown in Table 3.3-1. Imported bar and rod are limited to the sizes 19mm and under and to the 37 kg grade. With growth of the demand, annual

Table 3.3-1 Imported Quantity of R.C. Bars St. 38 from 1968 - 1978

Tons

Years	6mm	8mm	10mm	12mm	16mm	19mm	Total
1968	21,400	9,300	1,5200	5,400	2,300	-	53,600
1969	8,800	1,500	7,900	6,300	1,100	-	25,600
1970	32,300	9,800	22,300	31,700	9,400	2,000	107,500
1971	12,300	4,700	18,400	26,800	8,300	7,000	77,500
1972	4,900	21,000	58,600	25,400	16,500	4,500	130,900
1973	14,000	19,700	19,800	11,500	1,200	-	66,200
1974	32,800	28,000	26,300	43,000	2,400	-	132,500
1975	49,000	83,400	51,800	58,500	22,900	3,000	268,600
1976	40,100	70,800	96,100	52,300	6,800	-	266,100
1977	29,000	47,000	76,000	21,000	4,000	-	177,000
1978	2,000	-	9,000	30,000	33,000	1,000	75,000

(Source: SC)

tonnages of the import showed a rapid increase, especially after 1976. As to sizes, 6mm and 8mm account for almost 50%. This is because the domestic public sector mills shifted their production to the heavier sizes so as to improve the productivity as already mentioned. Although it is observed from the Table that the import dropped substantially in 1977 and 1978, it is considered that considerable tonnages were not included in the figures due to statistical reasons. One of the reason would be that, in recent years, imports not passing through Distribution Bureau are increasing but they are not included in the statistics. Also, it is suspected that free contribution from Japan (34,000 tons in 1978) is not included. If those tonnages are included, the import in both 1977 and 1978 would show a marked increase over 1976. By deducting domestic production from the estimated total domestic consumption of 507,000 tons and 564,000 tons, respectively, in 1977 and 1978, the import in the two years is estimated to be 263,000 tons and 317,000 tons, respectively.

3.3.2 Consumption

Consumption of bar and rod is estimated by domestic production plus import. Table 3.3-2 shows trend of production, import and consumption of the product in the years 1968 through 1978.

Table 3.3-2 Production, Import, Consumption of Bar and Rod

(1,000 tons)

	Production			Import			Consumption			
	$37kg/mm^2$	$52kg/mm^2$	Total	$37kg/mm^2$	$52kg/mm^2$	Total	$37kg/mm^2$	$52kg/mm^2$	Total	%Growth over past year
1968	21.8	185.2	207	53.6	-	53.6	75.4	185.2	260.6	
69	13.2	201.8	215	25.6	-	25.6	38.8	201.8	240.6	-7.6
70	51.4	151.3	202.7	107.5	-	107.5	158.9	151.3	310.2	28.8
71	63.8	138.2	202	77.5	-	77.5	141.3	138.2	279.5	-9.9
72	63.8	152.3	216.1	130.9	-	130.9	194.7	152.3	347	24.2
73	51	168	219	66.2	-	66.2	117.2	168	285.2	-17.8
74	41	176	217	132.5	-	132.5	173.5	176	349.5	22.5
75	39	168	207	268.6	-	268.6	307.6	168	475.6	36.1
76	29	182	211	266.1	-	266.1	295.1	182	477.1	0.3
77*	42	202	244	263	-	263	305	202	507	
78*	47	200	247	317	-	317	364	200	564	

* Estimate

During the 8-year period from 1968 to 1976, the consumption showed an increase of 83%, or an annual growth rate of 7.9%, but the year-to-year growth rate showed wide fluctuations. In 1969, 1971 and 1973, the growth was minus, and especially 1973 showed a marked decline. On the contrary, in 1970, 1972, 1974 and 1975, the consumption showed very high growth rates over 20%. Especially, it increased 36.1% in 1975.

On the other hand, the production during the same period from 1968 to 1976 showed an annual growth rate of only 1.9%. In 1977, it showed an increase of 15.6% over the preceding year, but in 1978, only 1.2% over 1977. Judging from the past performance of operating rate as already mentioned, the production of 247,000 tons in 1978 may be considered to be the figure approaching the maximum attainable. In regard possible future expansion of production capacity of existing mill, much is not expected, as shown on Table 3.2-3.

Therefore, should the matter be left as it stands now, the gap between consumption and production, namely, required import, could not be narrowed rapidly and it would be a urgent need to increase domestic production by new investment in production facilities. But, however fast the expansion may proceed, it would be after 1983 when the new facilities could be commissioned and until then the import would have to increase further.

Concerning the grade of steel, a bit over 60% of the present consumption of bar and rod is $37kg/mm^2$ steel, but as it is likely that the consumption of $52kg/mm^2$ steel bar and rod will be promoted in future, it is considered that the 50-50 breakdown of production between the 37 kg and 52 kg grades at the new mill as agreed in the Memorandum is fairly in line with the expected market needs.

Analysis of consumption sectors of bar and rod in Egypt was made in the sectoral analysis of Atkins report. (See Atkins' Final Report, Chapter 1.3 Market forecast: Sectoral analysis, pp. 11-28, Annex) According to this report, reinforcing concrete bar is 100% consumed in the construction sector, of which more than 80% is assumed to be used in housing and other building constructions.

3.4 Forecast of Demand and Supply of Bar and Rod

3.4.1 Methods for Demand Forecasting

In forecasting demand of bar and rod, several methods were employed for test and comparison.

a) Correlation with GDP

The result shows a high correlation coefficient and the data used are good and reliable.

b) Correlation with housing production

The result gives a fairly high correlation, but satisfactory data on future housing production are not available.

c) Correlation with cement consumption

Correlation is comparatively high but reliability of future cement production forecast is not certain.

d) Cross-sectional analysis

This is an effective method, but it is difficult to set up a cross-sectional pattern for Egypt which is convincing. (For details, sea Atkins' report and UNIDO report)

e) Time series analysis

Judging from the condition in the past, the time series analysis cannot be considered effective. (For details, see UNIDO report, Capter 2)

f) Sectoral analysis

This method was extensively used in the Atkins' report. Maybe this is the first time that the sectoral analysis was employed for the forecast of steel consumption in Egypt, which is certainly worthy of praise, but the forecasted figures are considered to be rather too low. Although the analysis also gives valuable informations on sectoral consumption of bar and rod in Egypt, it is difficult to adopt the forecasted figures by this reason.

In the present study, while due consideration is given to the results of analysis in various reports available, examination was made mainly on the forecast made from the macro economic analysis based on the correlation with GDP.

3.4.2 Result of Forecast

The result of forecast is shown in Table 3.4-1. Annual growth rate of GDP in future years was assumed to be 8%, same as used in ISC and UNIDO reports. Though a higher growth rate is used in the new 5-year economic plan from 1978 to 1982, this study took a realistic view-point and adopted the 8%, considering it would have a higher probability.

Table 3.4-1 Forecast of Demand on Bar and Rod up to 1992

	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92
Demand on bar rod (in 1000 tons)	624	690	761	837	920	1,009	1,105	1,209	1,322	1,443	1,574	1,716	1,869	2,034
GDP (in million LE, at 1965 price)	4,543	4,907	5,299	5,723	6,181	6,676	7,210	7,787	8,410	9,082	9,809	10,594	11,441	12,356

The reason why the correlation with GDP was adopted finally is that in case of Egypt, there is a high correlativity between the consumption of bar and rod and GDP in the past and that highly reliable data are available for a comparatively long range of time.

Demand on bar and rod is expected to reach 920,000 tons in 1983 when the mill under the present project is commissioned. This is an increase of 63% over the estimated consumption of 564,000 tons in 1978. The figure of 2,034,000 tons forecasted for 1992 is 3.6 times of the 1978 figure and 2.2 times of the 1983 figure. Annual growth rate during the ten years from 1982 to 1992 is 9.3%. This is considerably higher than the realized annual growth rate of 7.9% during the eight years from 1968 to 1976, however, the latter corresponds to the slower growth rate of GDP which is only 6.1%. For reference, the growth rates of GDP in 1974 and after are: 8.2% for 1974, 8.9% for 1975, 9.4% for 1976.
In view of the fast growth of economy in recent years, the 8% annual growth rate would not necessarily be considered too high.

In Fig.3.4-1 are shown the forecasts of the ISC, Atkins', IECO and UNIDO reports. The forecast in the present report is almost in line with the UNIDO report. Also, there is not much difference between the present forecast and the GOFI forecast, but the GOFI is a little higher in 1982 and almost same in 1985, but in 1991, the present JICA forecast is slightly higher than the GOFI. Atkins' and IECO forecasts, though based on different methods, are almost same and in this figure the IECO is represented by the Atkins'. At any rate, the forecasts of Atkins and IECO are lowest among all the forecasts shown and the difference with the JICA amounts to 120,000 tons in 1983, 195,000 tons in 1987 and 317,000 tons in 1991. (See Annex-3-1 for comparison in detail)

3.4.3 Forecast of Demand and Supply

Table 3.4-2 shows possible demand/supply balance for bar and rod in future, based on the growth of demand as given in the preceding paragraph. On the supply side, it is expected that the new mill will be started up in the latter part of 1983 and reach full production (723,000 tons in terms of

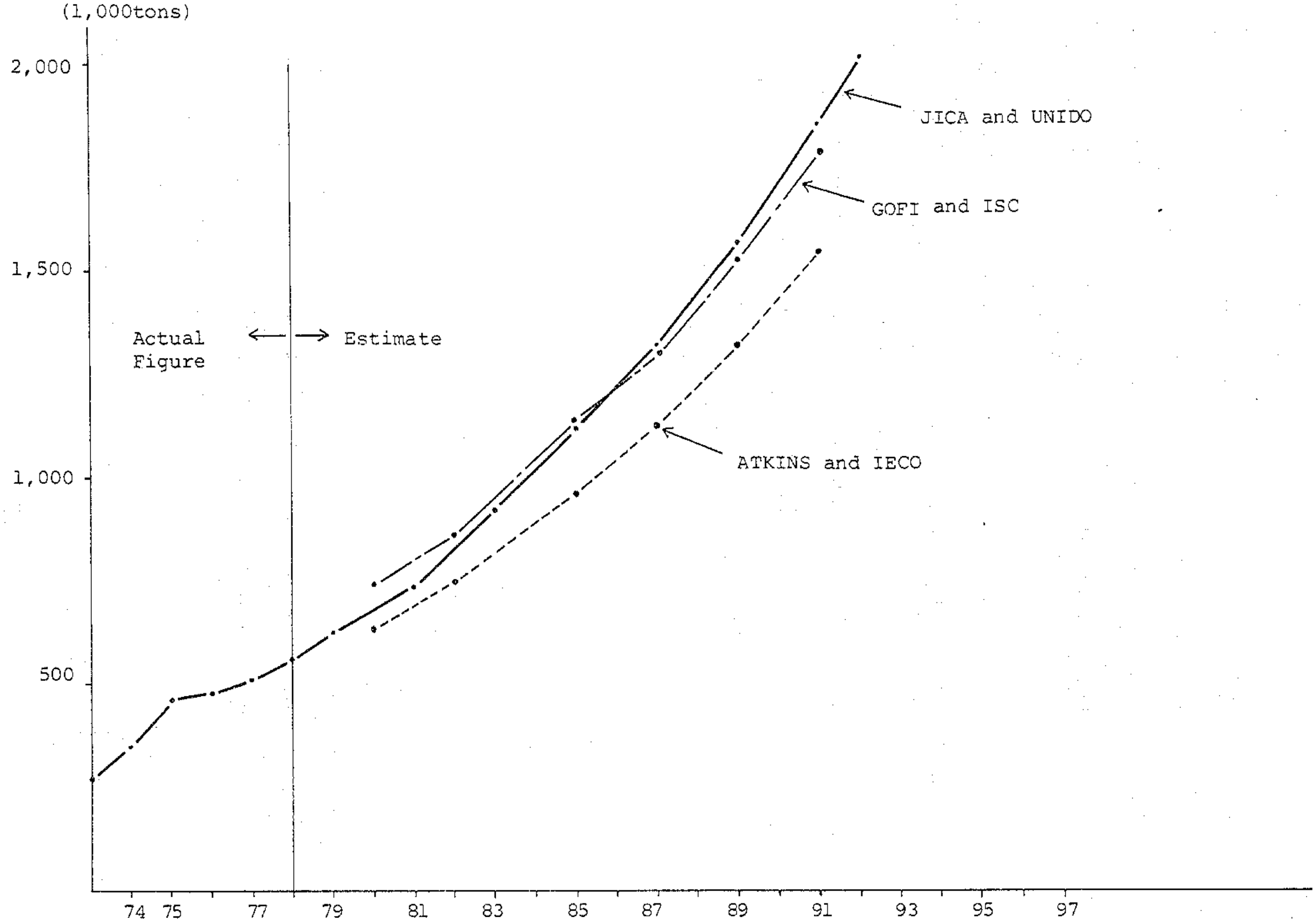


Fig.3.4-1 Comparison of Projections

Table 3.4-2 Demand-Supply Projection

	Demand	Supply			Demand-supply gap (necessary import)
		Existing mill	New mill	Total	
79	624	250	-	250	374
80	690	250	-	250	440
81	761	250	-	250	511
82	837	250	-	250	587
83	920	250	83	333	587
84	1,009	260	520	780	229
85	1,105	270	710	980	125
86	1,209	270	723	993	216
87	1,322	270	723	993	329
88	1,443	270	723	993	450
89	1,574	270	723	993	581
90	1,716	270	723	993	723
91	1,869	270	723	993	876
92	2,034	270	723	993	1,041

(1,000 tons)

finished products) in 1986 and that production at the existing mills will be as shown in Table 3.2-3.

The demand/supply balance is shown by a graph in Fig.3.4-2. It can be easily seen that the supply is still short of about 216,000 tons in 1986, necessitating importation of that much. Domestic supply of about 993,000 tons at that point will not increase until the second phase project is

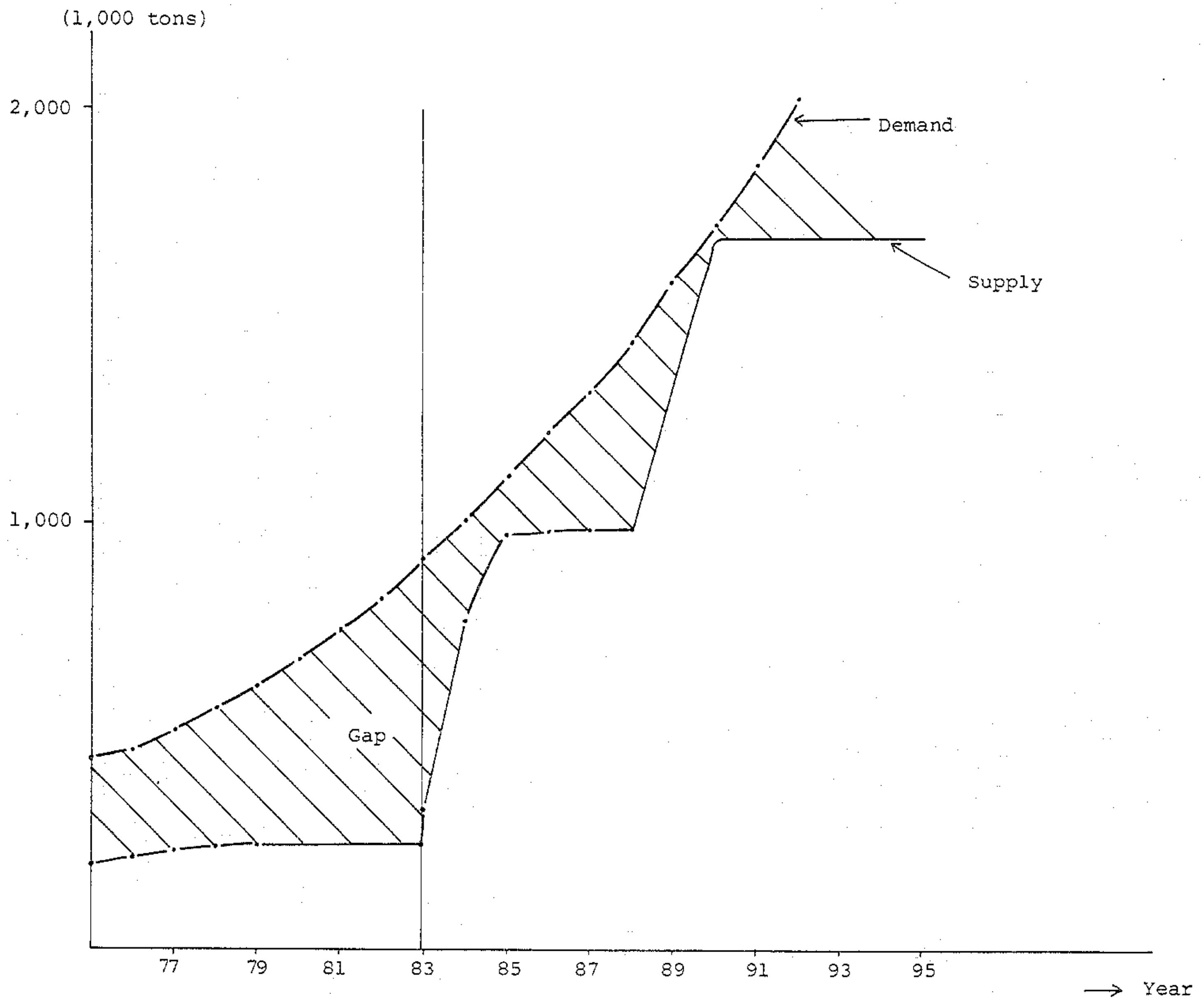


Fig.3.4-2 Demand-Supply Projection

completed and the gap between demand and supply will continue to increase year after year. Therefore, it is desirable to commence the second phase project at an earliest possible date.

It is specified in the Memorandum between JICA-Special Committee that the second phase project will involve doubling the production scale of the first-phase project. Consequently, upon completion of the second phase, the total production capacity should rise to 723,000 tons x 2 + 270,000 tons = 1,716,000 tons. As the demand reaches that level in 1990, the year should be made the target for completion of the second phase project. In order to hit the target, it would be necessary to commence the construction in 1987 and, in turn, to draw up a plan in 1985 or earlier, if the construction is assumed to take about three years. Though many indefinite factors are involved, further growth of the demand after 1991 should be taken care of by another plan as suggested in the UNIDO report.

3.4.4 Size Breakdown

Size structure of the production under this project must be decided on the basis of the forecast of size structure of future domestic consumption of bar and rod. For the size structure of future domestic consumption, the average of the past five years was to be taken. Unfortunately, however, the consumptions in 1977 and 1978 are not available and the data of 1972 through 1976 were used. Table 3.4-3 shows changes of the size structure in each year and the average size structure during the 1972-1976 period. It can be seen that 65% of the total is accounted for by sizes 13mm and under.

The average size structure in Table 3.4-3 was applied to obtain the size breakdown in each year of the forecast, which is shown in Table 3.4-4.

On the other hand, the size structure of future domestic production was estimated on the basis of the figures in Table 3.2-4. Table 3.4-2 shows both the average of the 1977 and 1978 structreu as the latest data and the average of the structure in years 1972 through 1976. It can be seen from the table that the size structure in the production of the three public sector mills showed marked changes among sizes of 8mm, 10mm, 13mm and 32mm and over, in 1977 and 1978. The decrease of weights of the 8mm and 10mm sizes and the increase of the 13mm size are considered to reveal a trend of production towards the high productivity sizes. Therefore,

Table 3.4-3 Size Structure of Domestic Consumption-Bar & Rod (EGPT)

(Ton)

	6mm	8	10	13	16	19	22	25	28	32∿	Total
1972	4,900 (1.4)	43,300 (12.5)	78,200 (22.5)	76,500 (22.1)	55,100 (15.9)	42,200 (12.2)	20,500 (5.9)	18,200 (5.2)	7,800 (0.1)	300 (0.1)	347,000
73	14,000 (4.9)	42,700 (15.0)	50,800 (17.8)	54,500 (19.1)	61,200 (21.5)	24,000 (8.4)	10,000 (3.5)	26,000 (9.1)	-	2,000 (0.7)	285,200
74	32,800 (9.4)	49,000 (14.0)	54,300 (15.5)	93,000 (26.6)	54,400 (15.6)	34,000 (9.7)	14,000 (4.0)	14,000 (4.0)	2,000 (0.6)	2,000 (0.6)	349,500
75	49,000 (10.3)	102,400 (21.5)	81,800 (17.2)	91,500 (19.2)	66,900 (14.2)	42,000 (8.8)	12,000 (2.5)	22,000 (4.6)	3,000 (0.6)	5,000 (1.1)	475,600
76	40,100 (8.4)	88,800 (18.6)	120,100 (25.2)	93,300 (19.6)	46,800 (9.8)	33,000 (6.9)	21,000 (4.4)	31,000 (6.5)	1,000 (0.2)	2,000 (0.4)	477,100
Total	140,800 (7.3)	326,200 (16.9)	385,200 (19.9)	408,800 (21.1)	284,400 (14.7)	175,200 (9.1)	77,500 (4.0)	111,200 (5.7)	13,800 (0.7)	11,300 (0.6)	1,934,400

←—— 65.2% ——×—— 34.8% ——→

Note: Consumption = Domestic production + Import

Table 3.4-4 Size Breakdown of Future Demand
(1977 - 92)

(1,000 tons)

	Total	6mm	8	10	13	16	19	22	25	28	32~
1977	507	37	86	101	107	75	46	20	29	4	2
78	564	41	95	112	119	83	51	23	32	5	3
79	624	46	105	124	132	92	57	25	36	4	3
80	690	50	117	137	146	101	63	28	39	5	4
81	761	56	129	151	161	112	69	30	43	5	5
82	837	61	141	167	177	123	76	33	48	6	5
83	920	67	155	183	195	135	84	37	52	6	6
84	1,009	74	171	201	213	148	92	40	58	6	6
85	1,105	81	187	220	233	162	101	44	63	7	7
86	1,209	88	204	241	256	178	110	48	69	8	7
87	1,322	97	223	263	280	194	120	53	75	9	8
88	1,443	105	244	287	305	212	131	58	82	10	9
89	1,574	115	266	313	333	231	143	63	90	11	9
90	1,716	125	290	341	363	252	156	156	69	98	10
91	1,869	136	316	372	394	275	170	75	107	13	11
92	2,034	148	344	405	430	299	185	81	116	14	12

the average of the 1977 and 1978 size structure was used to estimate future porduction by size of bar and rod by the existing domestic mills, which is shown in Table 3.4-5.

Demand and supply balance of bar and rod in each size was calculated as follows:

Demand in each size-production by existing mills in each size = Demand-Supply gap in each size. The result is shown in Table 3.4-6.

Size breakdown of the production of the new mill under the present project was decided with priority being place on the sizes which would enable the new mill to realize most efficient production. The reason lies in that the higher production the new mill achieves, the bigger the decrease of the import and the saving of foreign exchange would be. The saving is expected to more than offset a possible increase of payment in foreign currency for the extras for smaller sizes which would have to be imported in bigger tonnages.

Table 3.4-5 Size Breakdown of Future Production by Existing Mills

(1,000 tons)

	Existing mill Total	6mm	8	10	13	16	19	22	25	28	32∿
1977	244	-	16	11	58	65	33	22	31	4	4
78	247	-	6	25	67	36	46	28	25	4	10
79	250	-	11	22	64	52	40	25	29	4	3
80	250	-	11	21	64	52	40	25	29	4	4
81	250	-	11	20	64	52	40	25	29	4	5
82	250	-	11	20	64	52	40	25	29	4	5
83	250	-	11	19	64	52	40	25	29	4	6
84	260	-	12	21	66	53	42	26	30	4	6
85	270	-	12	21	69	56	43	27	31	4	7
86	270	-	12	21	69	56	43	27	31	4	7
87	270	-	12	20	69	56	43	27	31	4	8
88	270	-									
89	270	-									
90	270	-									
91	270	-									
92	270	-	12	20	69	56	43	27	31	4	8

Table 3.4-6 Size Breakdown of Demand-Supply Gap

(1,000 tons)

	(1) Total demand	(2) Existing total	(1)-(2)	6mm	8	10	13	16	19	22	25	28	32~
1977	507	244	263	37	70	90	49	10	13	-2	-2	-	-2
78	564	247	317	41	89	87	52	47	5	-5	7	1	-7
79	624	250	374	46	94	102	68	40	17	-	7	-	-
80	690	250	440	50	106	116	82	49	23	3	10	1	-
81	761	250	511	56	118	131	97	60	29	5	14	1	-
82	837	250	587	61	130	147	113	71	36	8	19	2	-
83	920	250	670	67	144	164	131	83	44	12	23	2	-
84	1,009	260	749	74	159	180	147	95	50	14	28	2	-
85	1,105	270	835	81	175	199	164	106	58	17	32	3	-
86	1,209	270	939	88	192	220	187	122	67	21	38	4	-
87	1,322	270	1,052	97	211	243	211	138	77	26	44	5	-
88	1,443	270	1,173	105	232	267	236	156	88	31	51	6	1
89	1,574	270	1,304	115	254	293	264	175	100	36	59	7	1
90	1,716	270	1,446	125	278	321	294	196	113	42	67	8	2
91	1,869	270	1,599	136	304	352	325	219	127	48	76	9	3
92	2,034	270	1,764	148	332	385	361	243	142	54	85	10	4

From such viewpoints, the product mix of the new mill was decided as shown in Table 3.4-7. Production will be concentrated mainly among sizes, 10mm, 13mm, 25mm, 28mm and 32mm and over. As already mentioned, this product mix is based on the forecasts of demand and production from the existing mills of the product by size.

As a result of such product mix of the new mill, the import of the product will have the size structure as shown in Table 3.4-8.

It is fully conceivable that the above product mix of the new mill may undergo changes because of unexpected shifts in the size structure of the demand in future. As the size structure given in Table 3.4-3 was estimated on the basis of the trend in the past, it is of course possible that actual structure pattern may turn out quite different from that given in the table. However, the new mill will be able to cope with such changes in size structure with ease.

The product mix of the new mill will consist of 50% of 37 kg/mm^2 grade and 50% of 52 kg/mm^2, according to the Memorandum dated March 16, 1979, but it is also possible to alter the grade breakdown in line with changes in the demand pattern in future.

Table 3.4-7 Product Mix of The New Mill

(1,000 tons)

	(1) Total demand	(2) Existing mill Total	(1) - (2)	6mm	8	10	13	16	19	22	25	28	32∿	Total
1977	507	250	257											
78	564	250	314											
79	624	250	374											
80	690	250	440											
81	761	250	511											
82	837	250	587											
83	920	250	670	-	-	-	46	-	-	12	23	2	-	83
84	1,009	260	749	-	99	180	147	-	50	14	28	2	-	520
85	1,105	270	835	62	175	199	164	-	58	17	32	3	-	710
86	1,209	270	939	-	173	220	187	13	67	21	38	4	-	723
87	1,322	270	1,052	-	126	243	211	-	68	26	44	5	-	
88	1,443	270	1,173	-	77	267	236	-	54	31	51	6	1	
89	1,574	270	1,304	-	23	293	264	-	40	36	59	7	1	
90	1,716	270	1,446	-	-	286	294	-	24	42	67	8	2	
91	1,869	270	1,599	-	-	255	325	-	7	48	76	9	3	
92	2,034	270	1,764	-	-	209	361	-	-	54	85	10	4	723

Table 3.4-8 Size Structure of Import
(After the Operation of New Mill)

(1,000 tons)

	(1) Total demand	(2) Existing mill Total	(1) - (2)	6mm	8	10	13	16	19	22	25	28	32~	Total
1977	507	244	263	37	70	90	49	10	13	-2	-2	-	-2	263
78	564	247	317	41	89	87	52	47	5	-5	7	1	-7	317
79	624	250	374	46	94	102	68	40	17	-	7	-	-	374
80	690		440	50	106	116	82	49	23	3	10	1	-	440
81	761		511	56	118	131	97	60	29	5	14	1	-	511
82	837		587	61	130	147	113	71	36	8	19	2	-	587
83	920	250	670	67	144	164	85	83	44	-	-	-	-	587
84	1,009	260	749	74	60	-	-	95	-	-	-	-	-	229
85	1,105	270	835	19	-	-	-	106	-	-	-	-	-	125
86	1,209		939	88	19	-	-	109	-	-	-	-	-	216
87	1,322		1,052	97	85	-	-	138	9	-	-	-	-	329
88	1,443		1,173	105	155	-	-	156	34	-	-	-	-	450
89	1,574		1,340	115	231	-	-	175	60	-	-	-	-	581
90	1,716		1,446	125	278	35	-	196	89	-	-	-	-	723
91	1,869		1,599	136	304	97	-	219	120	-	-	-	-	876
92	2,034	270	1,764	148	332	176	-	243	142	-	-	-	-	1,041

3.4.5 Reference data relating to demand forecast

1. RC-BAR demand forecast based on cement consumption

(1) Cement consumption on and after 1971 is as follows:

(Unit: 1000 tons)

1971	'72	'73	'74	'75	'76
2,933	2,952	3,029	3,071	3,717	4,135

Source: Bog Allen & Hamilton Management Consultant

Correlations between these data and RC-BAR consumption and the future RC-BAR demand based on the future cement demand (furnished by SC) are as follows:

	Cement consumption	RC-BAR consumption
1978	5,050	600
1979	5,500	664
1980	6,000	734
1981	6,570	815
1982	7,230	909
1983	8,000	1,018
1984	8,790	1,130
1985	9,660	1,254
1986	10,620	1,390
1987	11,650	1,536
1988	12,760	1,694

(Unit: 1,000 tons)

(2) Data restriction

Results in 1977 and the data for cement demand in 1989 onwards were not available.

2. Forecast based on correlation with housing production

(1) Results of housing production from 1968 through 1976 are as follows: (Price in 1970)

(Unit: Million LE)

1968	'69	'70	'71	'72	'73	'74	'75	'76
112.9	115.3	118.0	120.2	121.1	124.0	127.1	130.0	159.2

Source: Ministry of Planning

Correlation between past housing production and RC-BAR consumption and the future RC-BAR demand forecast based on the housing production planning data by the new 5-year plan are as follows:

	Housing Production	RC-BAR Consumption
1978	160.0	488
1979	176.0	567
1980	194.0	655
1981	214.0	752
1982	236.0	860

(Unit: 1,000 tons)

Source: New Five-Year Plan

(2) Data restriction

Reliable data on the housing production prospect after 1982 onward are not available.

As deflators of values in the 5-year plan are unavailable, values which are not deflated are used.

3. Time series extension

For reference, forecast by time series extension is given below:

1979	1982	'85	'88	'91	'92
536	677	732	1,080	1,365	1,476

(Unit: 1,000 tons)

3.5 Distribution Channel and Price of Bar and Rod

Distribution of reinforcing concrete bar (rebar) in Egypt is under governmental control in both of price and distribution channel. Products of the four public sector mills which account for almost all of the domestic supply, excepting a small part of second grade products amounting to only 1 to 2% of the total supply, are distributed through Distribution Bureau under the jurisdiction of Ministry of Housing. This reflects the government's policy to ensure stable price and supply of the product because the rebar is a basic material for construction of housing. Through the discussion with the Egyptian government officials, it became clear that it is the intention of the Egyptian government to distribute all the products of the new mill through the Distribution Bureau as long as the domestic supply falls short of the domestic demand. Namely, while the domestic supply fails to meet the demand, the government will keep all the rebar produced under its control, but once the domestic production exceeds the demand, the government will lift the control and the rebar will be left to free market mechanism.

According to the forecast of demand/supply balance mentioned above, it is unlikely that the domestic production exceeds the demand before 1992 and the present study was based on the assumption that the present governmental control would continue to exist for the time being.

The Egyptian government raised domestic prices of rebar twice since May 1978; i.e., in July 1978 and January 1979. As a result, the present domestic prices are as shown in Table 3.5-1. At present, there are two tiers of the domestic prices. One is the price of domestically produced rebar which is shown in the table.

Table 3.5-1 Domestic Prices of Rebar

(Unit: LE/ton)

Size (mm ∅)	37kg/mm²			52kg/mm²		
	Base price	Additional rate	Total price	Base price	Additional rate	Total price
17.25,incl.	195	-	195	210	-	210
16	195	2	197	210	2	212
13	195	6	201	210	6	216
10	195	12	207	210	12	222
8	195	19	214	210	19	229
6	195	25	220	210	25	235

Note: Domestic selling prices of imported rebar are obtained by adding LE100/ton on the above prices.

The other is the domestic selling prices of imported rebar which are obtained by adding LE100 on the prices of domestically produced product. Therefore, taking the base sizes of 17 - 25mm as example, the imported rebar of 37kg grade is LE 295. After deduction of handling charge, import duties and freight, the price would come to US$284, which is almost same as the international price level prevailed at the time of the last Egyptian price hike in January 1979 (F.O.B. Antwerp, US$280). It is considered that the Egyptian government's policy is, by adopting such two-tier pricing system, to promote supply of housing to low-income families and development of infrastructures, on the one hand, and, for satisfying the other demands, to supply the products at the prices as close as possible to the international prices, on the other hand. Such price policy is, therefore, considered to be in line with the intention to bring gradually, the domestic market prices of bar and rod to the levels as near as possible to the international markets. In addition to the measure, the government allows direct import, i.e., import not passing through the Distribution Bureau, for the projects having own foreign funds and the import through this route is thought to have increased substantially, though the actual information on such import could not be obtained. At any rate, it may be said that with those measures, the domestic market prices of bar and rod are now much closer to the international prices than before.

In doing the feasibility study of the present project, it was requested by the Egyptian government that prices closer to actual landed price without import duties be used as the selling prices of the product of the mill under the project and the Memorandum of March 16, 1979, also includes such agreement.

In accordance with the agreement, the selling price for the present feasibility study was set as follows, based on the latest F.O.B. Antwerp price. (See Fig.3.5-1 for FOB Antwerp price)

$$\underset{310}{\underline{\text{F.O.B. Antwerp price}}} + \underset{6}{\underline{\text{Size Extras}}} + \underset{25}{\underline{\text{Freight}}} + \underset{9}{\underline{\text{Handling Charge}}} = \underset{350\ (\text{US\$})}{\underline{\text{Selling Price}}}$$

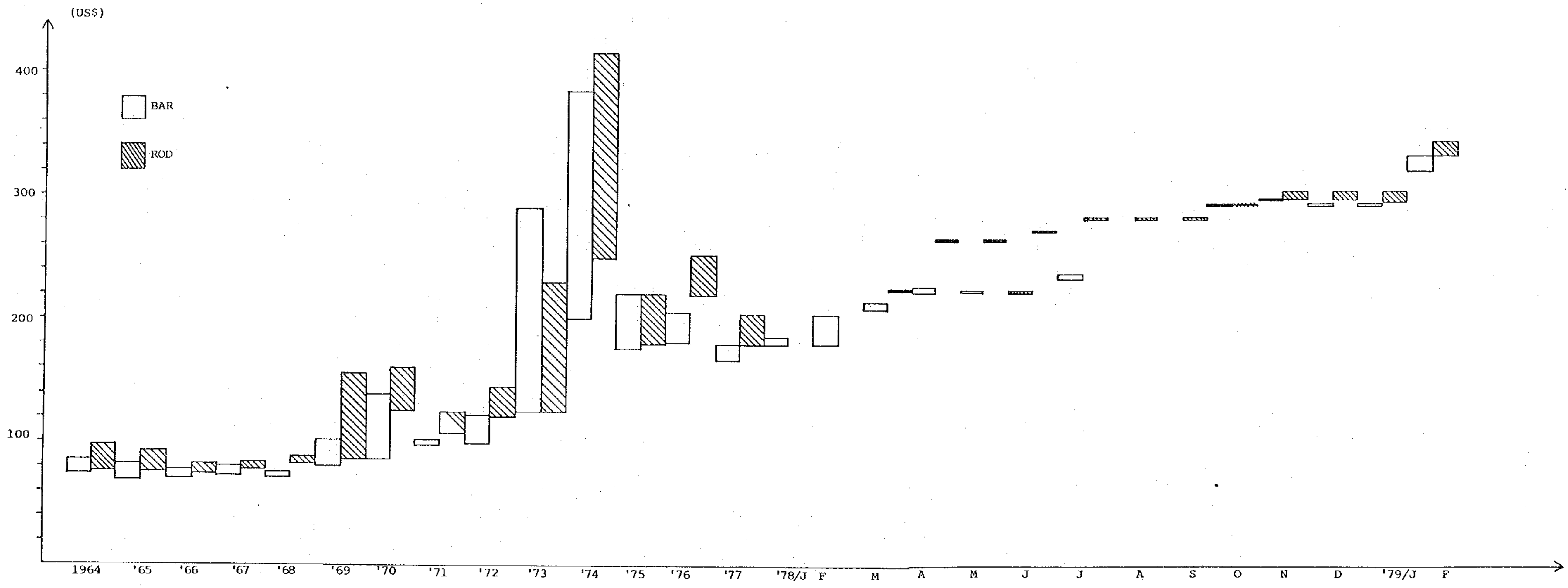


Fig.3.5-1 Continental Steel Export Market Price-Bar & Rod
(F.O.B. Antwerp. Dollars Per Metric Ton)

It is the fact of life that the price of bar and rod fluctuates violently on the international markets, and when there are excessive capacities in the exporting countries, the product is often exported at prices considerably lower than the domestic prices in the exporting countries. Therefore, the above selling price has been set on the understanding that a tariff barrier is always in effect to such an extent as that the product under the present project may remain competitive with imports even when the international market price is extremely low.

The policy of the Egyptian government to gradually abolish the controls in both aspects of price and quantity as the domestic production increases and transfer to a free market system is considered to be correct basically, but it should be pointed out that exposing the young domestic steel industry still in an immature state to a severe competition on the international markets would prevent a healthy growth of the industry and, on the contrary, might retard the growth of it as an internationally competitive industry. The right policy would be to open the domestic market in line with the progress of maturity of the domestic industry.

In that sense, therefore, the best policy would be to protect the new project by tariff barrier until it reaches maturity and becomes truely competetive.

3.6 Possibility of Export

Expansion of the production facilities should be carried out in line with increase in the demand so as to ensure a balance between demand and supply. However, while the demand generally increases continuously, the supply increases step-wise because the production facilities have to be of an economically and technically selected scale and the capacity of such facilities is added to the supply only when the expansion project is completed. As a result, even if the expansion is planned to maintain a demand and supply balance, it is inevitable that there occurs surplus of supply for some time after new facilities come into existense.

According to supply-demand forecast (3.4), it is expected that up to 1980's, demand on bar and rod will always exceed their supply in Egypt and that it is most unlikely for Egypt to have a surplus capacity for export of the products.

However, if it can have such capacity by some means, the products may find the export market easily because bar and rod are extensively used in many sectors including housing and other buildings, civil engineering works, industrial machinery and transportation equipment, etc. It is obvious the bar and rod are among the most promising products when it is considered that many Arab nations around Egypt are investing heavily not only in exploitation of oil and gas but also in the development of industries to support national economics after the oil industry and of the infrastructure of the economies, all of which would certainly expand the market for the bar and rod.

3.6.1 Bar and Rod Market in Arab Nations

When the present condition and future prospect of the international steel demand and supply balance is considered, it is clear that Egypt will have to face a fierce international competition in its export drive if it tries to enter the market. The fact that Egypt is geographically located near Europe implies that it is subject to aggressive export attacks from the steel exporting nations there. Despite of the fact, however, the export opportunity for Egypt is considered to be great. For, in view of the strong cultural and religious bond, it is considered, the Arab world can be the biggest and best export market for Egypt.

Table 3.6-1 shows consumption, production, import and self-sufficiency rate of all steel products in the Arab nations (excluding Egypt) in 1976 and 1977. (Unless otherwise specifically mentioned, the Arab nations as used in Section 3.6 will include; Saudi Arabia, Algeria, Libya, Morocco, Tunisia, Jordan, Lebanon, Sudan, North Yemen and South Yemen, Syria, Bahrain, U.A.E., Iraq, Kuwait, Qatar and Oman.)

Those nations consumed about 8 million metric tons and 7.25 million tons, respectively, of steel in 1976 and 1977, of which only about 690,000 and 740,000 tons were produced domestically, with self-sufficiency rate being 8.6% and 10.2%, respectively.

At the same time, their production capacity of rolled steel products totalled about 1,770,000 tons in 1976 and about 1,850,000 tons in 1977. But the actual production of steel products was only 690,000 tons and 740,000 tons, respectively, which shows that the operating rate of the production facilities was as low as 40%. Production capacity and operating rate of the Arab nations are as shown in Table 3.6-2.

Even if it is assumed that the total production capacity could be utilized in full, the production would satisfy only 23% to 26% of the total requirements. In view of the technical level and other inhibiting factors, it is difficult to expect that the operating rate will increase rapidly from the present level.

Table 3.6-1 Steel Products Demand and Supply, and Self-Supply Rate in Arab Nations

(Unit: 1,000 metric tons)

	Consumption (A)	Production (B)	Import (C)	Self-support rate (B/A)
1976	7,990	690	7,300	8.6%
1977	7,250	740	6,510*	10.2%

Note: Export 30,000 tons deducted.

Table 3.6-2 Production Capacity and Operating Rate of Steel Products in Arab Nations

(Unit: 1,000 metric tons)

	Capacity (A)	Production (B)	Operating rate (B/A)
1976	1,775	690	39%
1977	1,850	740	40%

Demand and supply of steel bar and rod in Arab nations in the period of 1974 through 1977 are shown in Table 3.6-3. (See Annex 3-2 for details of each nation.) During the period, the self-sufficiency rate in the Arab nations as a whole was less than 10%, or about 6% to 8%. Major part of the consumption was satisfied by the import from other countries consisting mainly of the exporting countries in Europe.

Table 3.6-3 Bar and Rod Demand and Supply in Arab Nations

(Unit: 1,000 metric tons)

	Consumption	Capacity	Production	Import*
1974	2,615	615	201	2,414
1975	2,452	615	202	2,250
1976	3,841	619	226	3,615
1977	3,114	674	250	2,864

Note: Import from U.S.S.R.
The import from U.S.S.R. was about 700,000 tons in 1974 and 1975. As no figures were available for the 1976 and 1977 import, it was assumed that about 500,000 tons was imported, which was included in the above import figures.

Even if a 100 percent operating rate of the capacity could be realized, the production would amount to 620,000 to 670,000 tons and the self-sufficiency rate would be only about 16% to 25%. Regions from which the Arab nations import bar and rod are shown in Table 3.6-4.

Table 3.6-4 Main Exporters of Bar & Rod to Arab Countries

(Unit: 1,000 metric ton)

1976

Exporting countries / Importing countries	Total import	EC 9		Other Europe		Total Europe		Eastern Europe	
			%		%		%		%
Saudi Arabia	764.75	77.42	10.1	1.43	0.2	78.86	10.3	-	-
Algeria	222.59	136.26	61.2	36.86	16.6	173.12	77.8	19.20	8.6
Morocco	261.89	115.23	44.0	10.70	4.1	125.93	48.1	124.60	47.6
Iran	268.55	58.34	21.7	-	-	58.34	21.7	11.00	4.1
Jordan	37.00	9.01	24.4	0.06	0.2	9.07	24.6	5.94	16.1
Lebanon	11.38	4.48	39.4	-	-	4.48	39.4	6.60	58.0
Syria	249,36	105.44	42.3	45.72	18.3	151.16	60.6	20.59	8.3
Libia	373.47	299.15	80.1	25.35	6.8	324.50	86.9	8.00	2.1
Sudan	15.86	15.50	97.7	-	-	15.50	97.7	-	-
Tunisia	15.21	13.81	90.8	1.30	8.5	15.11	99.3	-	-
Kuwait	483.89	15.29	3.2	0.20	0.0	15.49	3.2	0.47	0.1
Bahrain	36.27	6.04	16.7	-	-	6.04	16.7	-	-

1977

Exporting countries / Importing countries	Total import	EC 9		Other Europe		Total Europe		Eastern Europe	
			%		%		%		%
Saudi Arabia	640.34	100.53	15.7	5.06	0.8	105.59	16.5	-	-
Algeria	427.71	251.19	58.7	168.92	39.5	420.11	98.2	6.86	1.6
Morocco	326.34	85.25	26.1	240.28	73.6	325.53	99.7	0.47	0.1
Iran	89.37	45.57	51.0	6.87	7.7	52.44	58.7	4.55	5.1
Jordan	14.45	8.63	59.7	-	-	8.63	59.7	4.77	33.0
Lebanon	35.91	30.67	85.4	0.01	0.0	30.68	85.4	5.00	13.9
Syria	152.06	98.43	64.7	15.83	10.4	114.26	75.1	37.58	24.7
Libia	218.09	201.04	92.2	14.47	6.6	215.51	98.8	2.47	1.1
Sudan	37.37	25.72	68.8	-	-	25.72	68.8	-	-
Tunisia	51.55	40.85	79.2	10.70	20.8	51.55	100.0	-	-
Kuwait	145.77	14.35	9.8	2.08	1.4	16.43	11.2	0.59	0.4
Bahrain	20.53	4.33	21.1	0.09	0.4	4.42	21.5	-	-

Table 3.6-5 shows future capacity for production of bar and rod and forecast of their production in the Arab nations. The future capacity was obtained from informations about expansion plans contained in various publications generally available. Production was estimated by applying the past operating rates of the capacity after some revision.

According to the table, the production capacity of bar and rod in the Arab nations would be about 1,600,000 tons in 1980 and about 3,970,000 tons in 1985, with the production being about 870,000 tons and 2,680,000 tons, respectively. Supposing there will be no increase in the consumption in these nations from the level in 1977, the production would represent the self-sufficiency rate of only about 28% in 1980 and 86% in 1985. If the production could be maintained at 100% of the capacity, it would be possible to attain full self-sufficiency in 1985. However, in practice, it is extremely difficult to maintain the 100% operating rate of the capacity, and it cannot be expected that the Arab nations as a whole will become a net exporting region.

Table 3.6-5 Future Production Capacity and Production Projection of Bar & Rod

(1,000 ton)

	1980		1985	
	Production capacity	Production	Production capacity	Production
Saudi Arabia	65	40	945	600
Algeria	40	40	940	600
Libia	17	10	367	320
Morocco	60	36	60	36
Tunisia	165	116	350	240
Jordan	50	30	50	30
Lebanon	280	–	280	140
Sudan	60	12	60	12
N. Yemen	–	–	–	–
S. Yemen	–	–	–	–
Syria	20	10	80	56
Bahrain	–	–	–	–
U. A. E.	35	18	35	18
Iraq	400	200	400	280
Kuwait	–	–	–	–
Qatar	400	350	400	350
Oman	–	–	–	–
Total	1,592	862	3,967	2,682

It can be safely said that even if the consumption would keep the level at 1977 through the 1980's and all the expansion plans were carried out as programmed, the Arab nations would have to depend heavily on the import still in 1985.

The main expansion projects for bar and rod in the Arab nations are listed in Table 3.6-6.

Table 3.6-6 Main Expansion Projects for Bar and Rods in Arab Nations

Nation	Project	Expected capacity (1,000 tons)
Saudi Arabia	Expansion of Jeddh Merchant Bar Works	100
	Integrated Steel Works	800
Algeria	Integrated Steel Works	900
Libya	MISRATA Project	350
Morocco	SONASID Project	400
Tunisia	Expansion of El Foulaladh	185
Syria	Expansion project	60
Iraq	Greenfield project at Khor Al Zubair	400
Qatar	Qatal Steel Co.	400

3.6.2 Future Demand and Prospect of Export

As already mentioned, the Arab nations as a whole cannot achieve the self-sufficiency of bar and rod by 1985 even if it is assumed that the consumption of bar & rod would be kept at the level of 1977 and that the expansion projects were carried out as programmed.

However, it is impractical to expect that the consumption is kept at the 1977 level.

Increased steel demand is expected from such policy of the nations as development of the new well and the downstream oil industry for increasing added value of oil as well as of industries to support national economies after the oil industry. In addition, the demand will also increase by growth of population and per capita consumption in line with rise in living standard of the people and by activities in the development of infrastructure of the economics. Thus, the demand for bar and rod can be expected to increase at relatively faster pace than in the past.

Fig. 3.6-1 shows projections of consumption of bar and rod in the Arab nations by extrapolating the trend in the years, 1974 through 1977, to 1980 and 1985. The results are considered to be a most conservative forecast. Based on the forecast, the demand in the Arab nations as a whole still exceed the production in 1985 as also shown in Table 3.6-7, necessitating import of about 3,000,000 tons. This suggests that the necessity of import will persist through the 1980's.

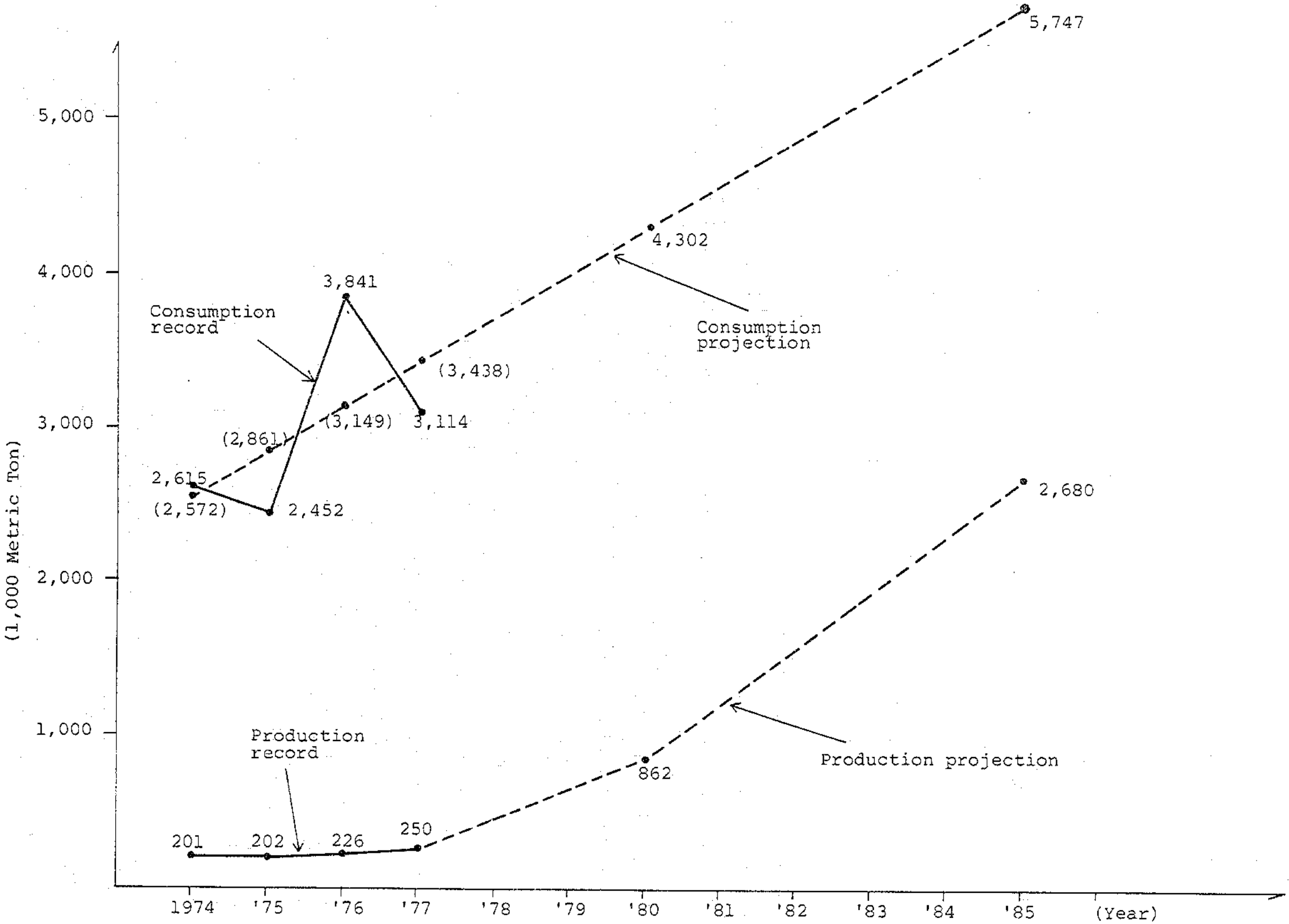


Fig.3.6-1 Consumption and Production Projection of Bar & Rod in Arab Countries

Table 3.6-7 Demand and Production of Bar and Rod in Arab Nations in 1980 and 1985

(Unit: 1,000 metric tons)

	Consumption (A)	Production (B)	Gap (A-B)
1980	4,302	862	3,440
1985	5,747	2,682	3,065

Above examination revealed that it would be impossible for the nations as a whole to achieve self-sufficiency by 1985 and that attainment of such self-sufficiency is unlikely during the 1980's.

It is also unlikely that all the expansion projects in the Arab nations would be completed in the scale and timing as programmed, and it is more likely there would be a fair degree of delay. It would be more reasonable to think that such condition would make the self-sufficiency more difficult to achieve.

There would exist continuing necessity of the import throughout the period. If the project under the present study proves to be competitive in the international market, there would exist the possibility of Egyptian export of bar and rod to the Arab nations continuously throughout the 1980's.

(ANNEX 3-1)

Comparison of Bar and Rod Demand Forecast

(Unit: 1,000 metric ton)

	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92
JICA	624	690	761	837	920	1,009	1,105	1,209	1,322	1,443	1,574	1,716	1,869	2,034
GOFI-ISC*	665	730	805	885	975	1,070	1,180							
ATKINS		642		754			959		1,127		1,321		1,552	
IECO	550	600	657	723	800	879	956	1,041	1,130	1,225				
UNIDO					950				1,310				1,750	
GOFI		743		873			1,110		1,304		1,531		1,798	

* Preliminary report, Integrated Steel Plant Project A.R.E. March 1977

ANNEX 3 - 2

Bar and Rod
Demand and Supply in Arab Nations

	1974					1975					1976					1977				
	Capa-city	Pro-duc-tion	Import	Ex-port	ASC	Capa-city	Pro-duc-tion	Import	Ex-port	ASC	Capa-city	Pro-duc-tion	Import	Ex-port	ASC	Capa-city	Pro-duc-tion	Import	Ex-port	ASC
Saudi Arabia	45	22	310		332	45	22	377		399	45	22	765		787	45	22	640		662
Algeria	40	35	343		378	40	35	290		325	40	44	223		267	40	40	428		468
Libia	17	10	412		422	17	10	386		396	17	10	373		383	17	10	218		228
Morocco	-	-	130		130	-	-	206		206	-	-	262		262	-	-	326		326
Tunisia	165	100	22		122	165	100	15		115	165	110	15		125	165	110	52		162
Jordan	50	25	16		41	50	25	17		42	50	30	37		67	50	30	14		44
Lebanon	280	-	75		75	280	-	45		45	280	-	11		11	280	-	36		36
Sudan	18	9	19		28	18	10	18		28	22	10	16		26	22	10	37		47
N. Yemen	-	-	-		-	-	-	1		1	-	-	4		4	-	-	4		4
S. Yemen	-	-	-		-	-	-	-		-	-	-	-		-	-	-	2		2
Syria	-	-	241		241	-	-	102		102	-	-	249		249	20	10	152		162
Bahrain	-	-	8		8	-	-	8		8	-	-	36		36	-	-	21		21
U. A. E.	-	-	27		27	-	-	90		90	-	-	323		323	35	18	174		192
Iraq	-	-	602		602	-	-	551		551	-	-	269		269	-	-	89		89
Kuwait	-	-	165		165	-	-	94		94	-	-	484		484	-	-	146		146
Qatar	-	-	37		37	-	-	45		45	-	-	44		44	-	-	21		21
Oman	-	-	7		7	-	-	5		5	-	-	4		4	-	-	4		4
Total	615	201	2414	-	2615	615	202	2250	-	2452	619	226	3615	-	3841	674	250	2864	-	3114

ASC: Apparent Steel Consumption

CHAPTER 4

Chapter 4 Production Program

4.1 Production Criteria

This project is to construct an integrated steel plant of direct reduction (DR) - electric arc furnace (EAF) route, which is planned to produce steel bars. Application field of the product includes principally the reinforcing bars whose supply-demand balance (refer to Chapter 3) is the tightest in Egyptian material market.

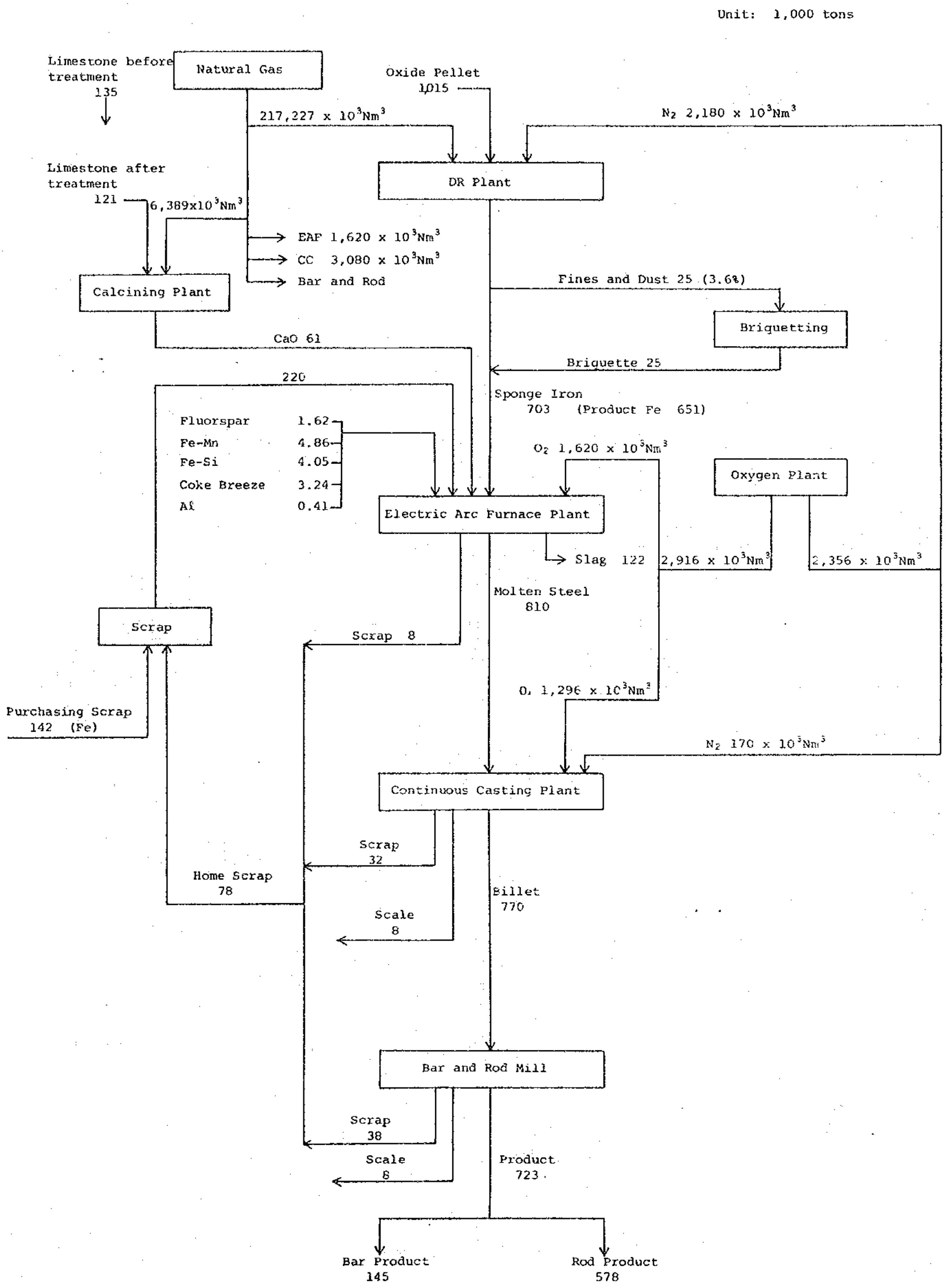
Initially, Egyptian Government requested the feasibility study on the steel plant of annual production of 600,000 t on crude steel basis and 550,000 t on product basis. After the discussion of JICA mission on March in Egypt, it was decided to enlarge the plant scale to annual 810,000 t on crude steel basis and 723,000 t on product basis in view of accelerated growth forecasted for the steel bar demand.

The direct reduction plant to be employed in this works, which is estimated as one of the largest capacity plants with actual operation record, has the nominal annual production capacity of 600,000 t.

After the stable operation is reached through operation activities, production increase up to 120% is anticipated. By incorporating four 70 t/heat EAFs as steelmaking equipment and three 4-strand billet continuous casting machines (CC machine) to cast billet, annual molten steel production of 810,000 t and 770,000 t billet production are expected. For the rolling, the bar and rod combination mill enabling the production of 723,000 t/y round bar is planned.

Fig. 4 - 1 shows the basic production balance and material balance (required raw material, products, by-products).

Fig.4-1 MATERIAL FLOW



4.2 Start-up Production Program

4.2.1 Construction program for principal equipment

Chapter 7 details the construction program.
In this project, the steelmaking plant start-up is advanced by three months to that of DR plant and the bar and rod mill.

Surplus billet the balance is reached between the bar and rod mill production and steelmaking production is planned to be sold for National Metal, Delta Steel, and other steel mills.

4.2.2 Start-up production program

4.2.2.1 DR plant

From the start-up, the 3-shift production is made. At 12th month after the start of commercial production, full production is made. During the period of 23 months after the operation start, only oxide pellet is used. From 24th month on, operation on the basis of 70%-oxide pellet and 30%-iron ore is started.

4.2.2.2 Steelmaking plant

For three months after the operation start, 1-shift operation is adopted, and for the subsequent three months, 2-shift operation. From 7th month on, 3-shift operation is made. Full production is planned from the 22nd month.

4.2.2.3 Bar and rod mill

The mill operation start is planned three months later than that of steelmaking plant. For two months after the operation start, 1-shift system is adopted, and for the subsequent two months, 2-shift operation. 3-shift operation is planned from the 5th month on.

It is also planned to start the annual 723,000 tons of production from the 22nd month.

4.2.2.4 Table 4-2 shows the start-up production program and Table 4-3 the billet balance.

a. Table 4-1 Start-up Production Program

a) Steelmaking Plant

Plant (Year / Shift / Month)		1st Year													2nd Year					3rd Year
		One Shift			Two Shift			Three Shift						Total	Three Shift				Total	Three Shift
Plant		1	2	3	4	5	6	7	8	9	10	11	12		1∿3	4∿6	7∿9	10∿12		1∿12
Molten Steel	T/M	7	10.5	14	21	28	35	42	42	42	46.2	50.4	54.2	392.3	176.4	189	201.6	202.5	769.5	810
	Heats/D	4	6	8	12	16	20	24	24	24	26.4	28.8	31.0	560.4	33.6	36	38.4	38.57	10.993	11.572
Billet	T/M	6.6	10	13.3	19.9	26.6	33.2	39.9	39.9	39.9	43.9	47.9	51.5	375.0	167.6	179.5	191.5	192.5	731.1	770

→ 100%

b) Direct Reduction Plant (Three Shift Work from Start-up)

Plant (Year / Month)		1st Year													2nd Year					3rd Year
Plant		1	2	3	4	5	6	7	8	9	10	11	12	Total	1∿3	4∿6	7∿9	10∿12	Total	1∿12
Sponge Iron	T/M	-	-	-	29.3	29.3	32.2	35.1	38.1	41.0	41.0	41.0	49.78	336.78	158.14	175.75	175.75	175.75	685.39	712.96

→ 100%

→ Pellet 70%, Iron ore 30%

Sponge TF 92.7% → Sponge TF 91%

c) Bar and Rod Plant

Plant (Year / Shift / Month)	1st Year													2nd Year					3rd Year
				One Shift		Two Shift		Three Shift					Total	Three Shift				Total	Three Shift
Plant	1	2	3	4	5	6	7	8	9	10	11	12		1∿3	4∿6	7∿9	10∿12		1∿12
Bar and Rod	-	-	-	5.1	6.8	17.0	23.8	30.6	35.7	35.7	35.7	40.8	231.2	127.5	142.8	158.1	172.45	600.85	723

→ 100%

Table 4-2 Billet Balance Sheet

Unit: 1,000

	1st Year				2nd Year				3rd Year
	1 ∿ 3	4 ∿ 6	7 ∿ 9	10 ∿ 12	1 ∿ 3	4 ∿ 6	7 ∿ 9	10 ∿ 12	1 ∿ 12
Production of Billet	29.9	79.7	119.7	143.3	167.6	179.5	191.5	192.5	770
Billet to be Used by Rolling	-	30.7	95.9	119.4	135.6	151.9	168.2	183.5	770
Balance	29.9	49.0	23.8	23.9/126.6	32.0	27.6	23.3	9.0/91.9	0
Billet for Sale	25.0	45.0	20.0	20.0/110.0	26.0	25.0	23.0	2/74	0
Billet in Works	4.9	8.9	12.7	16.6	22.6	25.2	25.5	32.5	32.5

4.3 Production Yield and Unit Consumption Rates

Table 4-3 shows the production yield and unit consumption rates of major equipment employed in this project.

Table 4-3 Production Yield and Unit Consumption Rates

Plant	Item	Calculation	Yield Figures	Remarks
Direct Reduction	Oxide Pellets Ratio	Oxide pellets / Sponge iron	1.444 t/t of S.P.	Total Fe 92.6%
		Oxide pellets (70%) + iron ore (30%) / Sponge iron	1.436 t/t of S.P.	Total Fe 91.0%
	Natural Gas	Natural gas / Sponge iron	309.0 Nm^3/t of S.P.	
	Nitrogen	Nitrogen / Sponge iron	3.1 Nm^3/t of S.P.	
	Power	Power / Sponge iron	135 KWH/t of S.P.	
	Make-up Water	Water / Sponge iron	1.5 m^3/t of S.P.	
Electric Arc Furnace	Sponge iron	Sponge iron (Fe) / Charged prin. raw materials (Fe)	74.7%	
	Scrap	Scrap (Fe) / Charged prin. raw materials (Fe)	25.3%	
	Molten steel yield	Molten Steel / Charged prin. raw materials (Fe)	93%	

Plant	Item	Calculation	Yield Figures	Remarks
Electric Arc Furance	Power	$\frac{\text{Power}}{\text{Molten steel}}$	700 KWH/t of steel	
	Burnt Lime	$\frac{\text{Burnt lime}}{\text{Molten steel}}$	75 kg/t of steel	
	Ferro-Alloy	$\frac{\text{Ferro-alloy}}{\text{Molten steel}}$	Fe-Mn 6.0 kg/t of steel Fe-Si 5.0 kg/t of steel	
	Oxygen	$\frac{\text{Oxygen}}{\text{Molten steel}}$	3 Nm^3/t of steel	
	Natural Gas	$\frac{\text{Natural gas}}{\text{Molten steel}}$	2 Nm^3/t of steel	
	Make-up Water	$\frac{\text{Water}}{\text{Molten steel}}$	3.4 m^3/t of steel	
	Brick and Refractory	$\frac{\text{Brick and fefractory}}{\text{Molten steel}}$	22.5 kg/t of steel	Furnace and ladle
Continuous Costing	Billets	$\frac{\text{Billets}}{\text{Molten steel}}$	95%	
	Power	$\frac{\text{Power}}{\text{Billets}}$	20 KWH/t of billet	
	Oxygen	$\frac{\text{Oxygen}}{\text{Billets}}$	1.6 Nm^3/t of billet	
	Nitrogen	$\frac{\text{Nitrogen}}{\text{Billets}}$	0.22 Nm^3/t of billet	
	Make-up Water	$\frac{\text{Water}}{\text{Billets}}$	0.5 m^3/t of billet	

Plant	Item	Calculation	Yield Figures	Remarks
Lime Calcining	Burnt Lime	$\frac{\text{Burnt lime}}{\text{Limestone before water treatment}}$	45%	
	Natural Gas	$\frac{\text{Natural gas}}{\text{Burnt lime}}$	105 Nm^3/t of burnt lime	
	Power	$\frac{\text{Power}}{\text{Burnt lime}}$	55 KWH/t of burnt lime	
	Make-up Water	$\frac{\text{Water}}{\text{Burnt lime}}$	1 m^3/t of burnt lime	
Bar and Rod	Products	$\frac{\text{Products}}{\text{Billets}}$	94%	Bar: 92% Rod: 95%
	Natural Gas	$\frac{\text{Natural gas}}{\text{Products}}$	35 Nm^3/t of products	
	Power	$\frac{\text{Power}}{\text{Products}}$	125 KWH/t of products	
	Make-up Water	$\frac{\text{Water}}{\text{Products}}$	1.3 m^3/t of products	