JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF INDUSTRY
THE ARAB REPUBLIC OF EGYPT

# Revised Feasibility Study
# of
# The Expansion Project
# of
# The El Dikheila Iron and Steel Works
# in
# The Arab Republic of Egypt

## FINAL REPORT
## (SUMMARY)

October 1995

NKK Corporation
in association with
Kobe Steel,Ltd.

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# 1. INTRODUCTION

## 1.1. Background of the Study

Egypt achieved high economic growth from the middle of 1970s to early 1980s and keeps 2-3% growth under the 5-year economic and social development plan. With the main object of decentralization of industries and population regionally, the plan promotes urban development while it aims at greening desert areas, and this caused increase of steel demand. However, the domestic capacity of steel supply is limited and the steel demand and supply gap shows a sign of steady increase and can be filled only by import of a large quantity of foreign steel.

In January 1979, the Government of the Arab Republic of Egypt, for the purpose of decreasing import of steel and saving foreign currencies, contemplated a plan to construct in El Dikheila area on the west of Alexandria an integrated steelworks based on direct reduction (DR) process and asked the Government of Japan to provide technical cooperation for its feasibility study. The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, carried out such feasibility study (F/S) concerning the construction of El Dikheila Iron and Steel Works in March 1979 and submitted a F/S report to the Government of Egypt in August the same year.

Based on the report, the Government of Egypt consulted with the World Bank Group and decided to implement the project as a joint venture business under the Law No. 43, 1974. A consortium (Nippon Kokan, Kobe Steel and Toyo Menka) was designated as technical partner and the

construction of El Dikheila Works with World Bank loan and Yen loan was decided. The construction was commenced in 1983 and the Works was completed as an integrated steelworks with startup of SMP (steelmaking plant) in May, BMP (bar mill plant) in July and DRP (direct reduction plant) in November 1986 and RMP (rod mill plant) in April 1987. Its product mix includes bar and rod with production capacity of 745,000 t/y in total.

The Government of Egypt planned to expand the Works to cover persisting shortage of steel products, especially rebars, and requested Japan's cooperation again in the F/S for the expansion project of El Dikheila Works.

In response to the request of the Government of Egypt, JICA conducted the F/S from 1987 to 1988 including field survey, planning of facilities' expansion, and economic analysis, and reported the expansion plan to the Government of Egypt and ANSDK.

In 1992, the Government of Egypt requested the Government of Japan to promote the expansion project in order to improve the imbalance between consumption and production of steel products, especially rebar.

In response to the request of the Government of Egypt, the Government of Japan decided to conduct the feasibility study update on the expansion project of El Dikheila Iron and Steel Works in Eqypt.

The study has been undertaken by JICA. An agreement was made on November 19, 1992 between Egypt and JICA setting forth the scope of work with regard to the study.

In accordance with that agreement, the JICA's study mission visited Egypt from March 6 to March 23, 1993 to conduct field surveys for the study.

With the backdrop as above, this F/S is to conduct market research and update the technical, financial and economic analyses of the expansion project of the Works and the results of the study are compiled in this report.

## 1.2. Scope of the Study

The scope of this study is summarized in the following.

1) To study the background and related conditions of the project

   a) General economic situation of Egypt

   b) Present situation and policies on iron and steel industry in Egypt (including policies regarding steel prices and distribution)

   c) Relevant law and regulations

   d) Comparative advantage of ANSDK

   e) Other relevant information

2) To conduct demand and supply analysis

   a) Domestic demand of rebars and other products

   b) Domestic supply of rebars and other products

3) To study the existing system of El Dikheila Iron and Steel Works

   a) Existing works' facilities and the operating performance

   b) Performance of the infrastructure such as port facilities, gas supply, electricity, water, and transportation facilities

c) Status of the procurement of raw materials

d) Finanial status and profitability of ANSDK

e) Existing engineering services, management and training arrangement in ANSDK

4) To study raw materials for the expansion project

a) Availability of iron ore, pellets, steel scrap, and direct reduced iron

b) Availability of other materials such as limestone, refractories, and other additives

5) To study the expansion facilities and the availability of infrastructure

a) Plant site and layout for the expansion

b) Various options of technologies for the expansion

c) Prospective products or product mix and production capacity

d) Availability of appropriate infrasturcture facilities such as gas, power, water, port services and transportation

e) Conceptual design for the expansion facilities

6) To make an implementation plan for the project

a) Implementation schedule of the project

b) Procurement of construction mateirals necessary for the expansion of the works

c) Additionally required manpower and organizational function

d) Construction costs and production costs for the expansion of the works

7) To conduct the financial and economic analysis for the expansion project

a) Total required funds

b) Fund plan

c) Financing

d) Production costs

e) Balance sheet

f) Profit and loss statement

g) Financial statements

h) Internal return rate

i) Sensitivity analysis

In making the implementation plan for the expansion and finanial analysis, consideration has been given to the following.

· Study on the outlook of future steel demand & supply by

taking into consideration the third 5-year economic and social development plan beginning in 1993 F.Y.

- Detailed study on product mix and material flow at the stage of expansion

- Confirmation of land required for the expansion project and the most effective layout

- Consideration to the facilities and operating method for energy saving, and yield and quality improvement

- Consideration for maximum effect of capital investment

- Suggestions for drawing up a plan of the optimum construction method and ensuring safety when the expansion is carries out while the existing plants are kept in operation.

- Actual status of technical assistance to the operation and technology transfer

## 1.3. Process of Execution of the Study

### 1.3.1. Field survey

For the purpose of making the F/S for the expansion project of El Dikheila Works, the field survey was conducted mainly in Cairo and Alexandria for 18 days from March 6 to March 23, 1993 as shown in Table 1-1.

In order to investigate whether the expansion project is feasible technically, financially and economically, and to plan product mix, production and also the most suitable facilities, studies were made on general economic condition, steel policy including price and sales channel, steel demand and supply condition in Egypt, and the existing facilities and their operational condition of the Works. For the study, the mission vistied not only El Dikheila Works but also relevant governmental offices such as Ministry of Industry, Ministry of Housing and Utilities, Ministry of Finance, Metallurgicl Industries Corporation, General Authorities for Investment, General Organization for Industrialization, Electric Power Agency, and other steel mills, related industries, steel-consuming industries, financial institutions, etc.

As shown in Table 1-2, the team members consisted of 8 persons including the leader and experts in the fields of DR, steelmaking, rolling, utilities & infrastructure, policies for iron and steel industries, market research, economic and finanial analyses, and in addition, experts joined the team for the analysis work in Japan.

A list of officials and other persons whom the members of the team had the pleasure of seeing and having discussion during the field survey is given in Table 1-3.

### 1.3.2. Analysis work in Japan

Based on the findings of the field survey, the mission engaged in analysis work in Japan, which included compilation of data on the economic condition and other relevant matters in Egypt forming the background of the project, study on the present condition and outlook of steel demand and supply in Egypt and the availability of raw materials forming the premises for the expansion projet, and also formation of the expansion plan and related facilities plan, construction schedule and operation plan. It included financial and economic analyses also. The result of such work is compiled in this report.

In addition, in preparing the report, the mission met two counterparts of Egypt, who visited Japan from March 28 to Arpil 9, 1993 and had consultation with them. At the same time, JICA provided them with opportunities to visit similar or related steel mills in Japan.

### 1.3.3. Explanation of the report

To give an explanation to the draft final report, JICA dispatched a mission to Egypt during the period of July 30 to August 11, 1993, and the mission discussed with Egypt. The mission visited ANSDK and Metallurgical Industries Corporation and gave detailed explanation to the report and it was agreed that the final report will be submitted by the end of October 1993. Schedule of the report explanation mission and a list of menbers are as shown in Table 1-4 and 1-5, also the matters agreed between the both parties in preparation of the final report were put down in the minutes of meeting. (See page 1-23/1-27.)
The minutes of Meeting is attached.

## 2. STEEL DEMAND AND SUPPLY

### 2.1 Steel Demand and Supply

The steel demand in Egypt has been stagnant for these several years.
The following tables show the steel demand forecasted by both microscopic and macroscopic methods using the third 5-year plan.

Forecast of Steel Demand in Egypt

(Unit: 1,000 t)

| Fiscal Year | 1991 | 1997 | 2002 |
|---|---|---|---|
| Long Products | 2,352 | 3,390 | 5,000 |
| · Bars and Rods | 2,174 | 3,140 | 4,610 |
| · Others | 178 | 250 | 390 |
| Flat Products | 622 | 850 | 1,310 |
| TOTAL | 2,974 | 4,240 | 6,310 |

(Note) Excluding pipes and wires

On the other hand, the steel production is forecasted based on the forecast of production capacity prepared by MIC as shown in the following table.

Forecast of Steel Production in Egypt

(Unit: 1,000 t)

| Fiscal Year | 1991 | 1997 | 2002 |
|---|---|---|---|
| Long Products | 2,016 | 2,056 | 2,170 |
| · Bars and Rods | 1,863 | 1,878 | 1,992 |
| · Others | 153 | 178 | 178 |
| Flat Products | 475 | 594 | 594 |
| TOTAL | 2,491 | 2,650 | 2,764 |

(Note) Production capacity multiplied by the present capacity utilization rate

As derived from the above, the supply-demand balance will be as shown in the following table.

The supply shortage of the total steel will expand from 483,000 tons in 1991 to 1,590,000 tons in 1997 and 3,546,000 tons in 2002.

Steel Supply and Demand Balance

(Unit : 1,000 t)

| Fiscal Year | 1991 | | | 1997 | | | 2002 | | |
|---|---|---|---|---|---|---|---|---|---|
| | D | P | P-D | D | P | P-D | D | P | P-D |
| Long Products | 2,352 | 2,016 | -336 | 3,390 | 2,056 | -1,334 | 5,000 | 2,170 | -2,830 |
| · Bars and Rods | 2,174 | 1,863 | -331 | 3,140 | 1,878 | -1,262 | 4,610 | 1,992 | -2,618 |
| · Others | 178 | 153 | -25 | 250 | 178 | -72 | 390 | 178 | -212 |
| Flat Products | 626 | 475 | -147 | 850 | 594 | -256 | 6,310 | 2,764 | -3,546 |
| TOTAL | 2,974 | 2,491 | -483 | 4,240 | 2,650 | -1,590 | 6,310 | 2,764 | -3,546 |

(Note) D: demand; P: production; P-D: Gap between supply and demand
Import and export are not considered into the above gap.
Pipes and wires are excluded.

The supply shortage of bars will be the largest: 1,262,000 tons in 1997, though import and export are out of account.

The supply shortage of other steel products than bars will not be in the scale sufficient for installing a new mill, which would be possible after the year 2000.

If the indirect demand is taken into consideration, there might be a possibility for installing a new flat mill even in 1997. However, it would confront the difficulties in meeting severe requirements in various aspects including quality, since the users are only limited machinery industries which can purchase flat products from overseas sources under the free market economy in Egypt.

On the contrary, in the case of bars it will be practically feasible to install a new rolling mill, since there are numerous users and a sellers' market is expected in future in Egypt.

As it is possibly expected that the demand for welded pipes might increase in the market, mainly for construction application, there might be a room for studying the possibility of a new mill for welded pipes of such general use. The hot coils for the materials of welded pipes will be procured rather easily from international sources.

## 2.2 Steel Price and Distribution

The policy for steel price and distribution has been greatly changed recently in Egypt.
It was an epoch-making event on the steel price policy that Cement Sales Office was closed in July 1992 in line with the adoption of thorough market price mechanism and abolishment of control prices. Then, steel companies in the public sector are able to decide prices of their products depending on the supply-demand conditions in the market with some exceptions.

In the meanwhile, the import duty of steel products, which had been imported by the Ministry of Housing, was 5%. Such import mechanism of steel caused the inflow of a large quantity of steel products at a dumping price around the time of collapse of COMECON, which made a very serious impact on the Egyptian steel industry which had been under restructuring. In order to get out of such a serious situation, the Government of Egypt discontinued the exclusive import of steel products by the Ministry of Housing for achieving the thorough market economy on the one hand, and raised the import duty up to 20% for protecting the domestic steel industry on the other hand.

The present price of rebars in Egypt is around L.E. 1,100/t on an average. As the market price mechanism has been functioning currently to an almost thorough extent in Egypt, the steel price is determined in accordance with the supply-demand condition of steel products. Due to the raising of import duties, the price level of import steel is presently not so seriously affecting the steel industry of Egypt as was in the past.

The market economy will prevail furthermore in Egypt, where the steel price will be determined especially by reflecting the market condition. The fundamental factors for affecting the steel price are firstly the supply-demand condition in the domestic market, secondly the same in the international market, and then the changes of foreign exchange rate.

It is difficult to grasp in its reality as well as to forecast not only the supply-demand condition in the domestic steel market but also the trend of the national economy as the basis for the steel demand. Especially, the view of the future prospect is difficult to be fixed when the available statistics and data are limited like in Egypt. Furthermore, forecasting the worldwide steel demand and supply is accompanied by complexity due to many related factors, and forecasting the exchange rate is very difficult due to its speculative aspect. However, it is certain that the steel price in Egypt will follow the trend in the changes in wholesale prices.

## 3. RAW MATERIALS

### 3.1. Premises

Matters considered in preparing the report are as given below.

1) A study has been made mainly about the present supply source of raw materials to ANSDK to find out whether or not required raw materials can be obtained stably after the expasion of ANSDK.

2) Raw materials which can be obtained domestically will be continuously purchased after the expansion.

### 3.2. Iron Ore

As pellet and lump iron ore having the quality suited for direct reduction process are in limited supply, they have to be purchased overseas after the ANSDK expansion.

As supply sources of DR grade pellet, LKAB (Sweden), CVRD (Brazil) and SAMARCO (Brazil) are considered to be alike.

However, as the worldwide supply of DR grade pellet is showing tendency to become tight, it is considered necessary to study medium- or long-term purchasing contracts or diversification of supply sources in order to ensure stable supply of the pellet.

### 3.3. Steel Scrap and HBI

1) Present scrap conditions in EGYPT

The supply of steel scrap to the steel industry

(mainly mini-mills) in Egypt is about 200,000 t/y according to ANSDK and import scrap has gradually increased from 1988 when ANSDK started normal operation as shown in Table 3-1.

Table 3-1 Import scrap

Unit : t/y

| Year | Import Scrap |
|---|---|
| 1984/85 | 2,197 |
| 1985/86 | 1,539 |
| 1986/87 | 1,992 |
| 1987/88 | 11,772 |
| 1988/89 | 34,029 |
| 1989/90 | 196,652 |
| 1990/91 | 115,507 |
| 1991/92 | 109,818 |

2) Scrap procurement in ANSDK

Table 3-2 shows the purchased scrap in ANSDK for the past 5 years. Of the purchased scrap, the domestic scrap is about 150,000-200,000 t/y. After the expansion, scrap of 753,900 t/y including home scrap of 65,300 t/y will be required and scrap of about 500,000 t/y should be imported considering that the procurement of more than 200,000 t/y would not be expected in local market. ANSDK should try to purchase cheaper scrap.

Table 3-2 Scrap Procurement in ANSDK

Unit : 1,000 t/y

| Year | Domestic Scrap | Import Scrap | Home Scrap | Total |
|---|---|---|---|---|
| 1988 | 221.6 | 0 | 28.3 | 249.9 |
| 1989 | 206.2 | 26.5 | 47.1 | 279.8 |
| 1990 | 178.4 | 221.8 | 41.6 | 441.8 |
| 1991 | 132.0 | 210.3 | 34.4 | 376.7 |
| 1992 | 152.4 | 147.6 | 39.3 | 339.3 |

Source: ANSDK
Note: Pig iron is included in purchased scrap.

3) HBI procurement in ANSDK

In order to increase the production, ANSDK began to use import HBI in 1990 as shown in Table 3-3.

Table 3-3 HBI Procurement in ANSDK

Unit : t/y

| Year | Import HBI |
|---|---|
| 1990 | 89,900 |
| 1991 | 173,200 |
| 1992 | 132,400 |

Source: ANSDK

## 3.4. Limestone

Limestone is abundantly available in Egypt and it is fully possible for ANSDK to obtain limestone domestically in future as at present.

Burnt lime is produced by its own lime calcining plant. As the facilities are designed with margin, they will produce required amount of burnt lime after the expansion.

### 3.5. Electrode

Electrodes are not produced in Egypt at present and all the requirement is imported. After the expansion of ANSDK also, the electrodes will have to be imported.

### 3.6. Refractories

At present, ANSDK imports a large part of refractories from developed countries and after the expansion, ANSDK will basically import a large part of the requirement.

# 4. PRESENT CONDITIONS OF EL DIKHEILA IRON AND STEEL WORKS

## 4.1. Outline of the Works

El Dikheila Iron and Steel Works is located about 15 km west of Alexandria City and was constructed with a plan to produce about 745,000 tons of bar and rod a year. Outline of major production facilities of the Works is given below.

| Facilities | Description | Capacity | Start-up |
|---|---|---|---|
| DR plant | 600,000 t/y x 1 | DRI 716,000 t/y | Nov. 1986 |
| SMP<br>· EAF<br><br>· CCM | 70 t/heat x 4<br><br>4-strand CCM x 3 | Liquid steel<br>840,000 t/y<br>Billet<br>798,000 t/y | May 1986 |
| Bar mill plant | One complete set | Bar 425,000 t/y | Jul. 1986 |
| Rod mill plant | One complete set | Bar 320,000 t/y | Apr. 1987 |

In addition to the above, the Works has a lime calcining plant, power receiving and distributing facilities, oxygen plant, water treatment plant, compressedd air plant, analysis and inspection facilities, maintenance shop, warehouse and in-works transportation facilities, administration office, and other auxiliary facilities and has adequate functions as an integrated steel mill.

## 4.2. Production

Since the start-up of SMP in May 1986, the production has increased year by year and reached 1,034,000 t/y in 1992.

## 4.3. Management

At present, ANSDK is managed by about 2,400 Egyptians and 9 Japanese staff.

The management system is well functioning under the great efforts of ANSDK's top management and personnel in accordance with the Japanese type of management and operation and the Works is smoothly operated without any problem for environmental control and safety to increase the production year by year.

# 5. EXPANSION PLAN

## 5.1. Basic Policy of Expansion Plan

### 5.1.1. Product mix and production

In the F/S conducted by JICA from 1987 to 1988, increase of steel grades in addition to the production of rebars was studied considering the market conditions in Egypt, economic point of view, layout of El Dikheila Iron and Steel Works, operational conditions of the Works, etc.
After all the study, the expansion of rebar production was recommended.
In this F/S, the same subjects as the above have been investigated and studied for updating. The results are as follows:

As stated in CHAPTER 3, the consumption of steel products in Egypt has increased year by year, and will reach 6.3 million t/y in 2002. Especially, the consumption of bar products will reach 4.6 million t/y. On the other hand, the production of bars in Egypt is now about 1.9 million t/y and will be 2.0 million t/y in 2002. The discrepancy between consumption and supply of bar products has been very large historically in Egypt in spite of the expansion of the production capacity in Egyptian steel mills. Though the imbalance between consumption and supply of steel products has been compensated by imported products, this imbalance will further increase.

The prices of bar products are now at considerable levels and this situation will continue mainly due to shortage of steel products in Egypt.

El Dikheila Iron and Steel Works produces mainly rebar of about 1.0 million tons/year with high productivity and excellent operational technology and delivers steel products to the domestic market and partially foreign markets.

Considering all the above, increase of production of rebar is recommended to El Dikheila Iron and Steel Works as the core of the expansion plan.

In the meantime, consumption of quality steel is seen in Egypt and the demand will increase in accordance with the development of the mechanical, electrical, and car industries. However, the increase in the consumption of quality steel is expected to be small.

As seen in the previous F/S, El Dikheila Iron and Steel Works has some possibility of producing the quality steels. However, considering the production quantity, investment cost, limitation due to process, development of operational technology, etc., production of quality steel will not be beneficial to ANSDK now. Therefore, expansion of the facilities for increase of rebar production is preferable.

With regard to the production capacity of bar and wire rod after the expansion, the target should be 1.5 million tons per year, considering the investment cost, full utilization of the existing facilities, layout, etc., instead of 1.1 to 1.2 million tons per year in the previous F/S because the present production is more than 1.0 million tons per year of rolled products.

### 5.1.2. Expansion of production facilities

In the previous F/S, expansion of the production facilities consisted of one direct reduction plant, two electric arc furnaces, one continuous billet caster, and one strand of wire rod mill to be added to the existing mill, and those specifications of the equipment were the same as those of the existing equipment.

Based on the investigation conducted this time, an economic analysis has been performed to reexamine the feasibility of the expansion plan using the planned expansion of production facilities. The obtained ROI is as low as 7.48%. The detailed data and results of the economic analysis are shown in APPENDIX 2.

Therefore, review of the production process for the expansion plan is required to improve the ROI by reduction of the investment cost for the main production facilities consisting of the direct reduction plant, electric arc furnaces and billet caster, and wire rod mill.

Installation of the direct reduction plant was planned to secure iron resources under the unstable market conditions of scrap at the time of previous F/S, and to obtain less contaminated raw material. Presently, scrap can be easily procured from abroad in terms of quality and quantity. Also, HBI can be utilized.

Considering the above, the direct reduction plant is deleted form the expansion plan for production of rebar of some 0.4 million t/y.

In the steelmaking plant, the addition of two electric arc furnaces was planned in the previous F/S. However, the

production of molten steel is now reaching about 1.2 million t/y using the existing four electric arc furnaces. If ladle furnaces are installed in the steelmaking plant, the production capacity of molten steel in El Dikheila Iron and Steel Works will increase by more than 0.4 million t/y. This ladle furnace process is now widely used in many steel mills in order to increase the production capacity through reduction of the tap-to-tap time of electric arc furnace and also the investment cost of ladle furnaces is lower than that of the electric arc furnaces.

Therefore, adoption of ladle furnaces is preferable to the installation of new electric arc furnaces from the viewpoint of investment cost.

The production of billets by the existing three continuous casters in El Dikheila is now about 1.1 million t/y. If the operation ratio of the casters is increased, the billet production will reach about 1.5 million t/y, and this is attainable under the present operation in El Dikheila. Therefore, installation of the new caster is deleted.

In the rolling mill plant, the production of bar and wire rod exceeds the designed capacity and there remains no room to further expand the production capacity.
Therefore, the additional facilities are required to increase the production capacity by about 0.4 million t/y. Addition of one strand in the wire rod mill as planned in the previous F/S is advantageous and recommendable.

The expansion plan has been reviewed in order to increase the production of rebar by 0.4 million t/y with full

utilization of the existing plant and the investment cost as low as possible.

The aim of the expansion is to increase the production of rebar from the present 1.1 million tons per year to 1.5 million tons per year through maximum use of the existing equipment, maximization of scrap as raw material, and minimum investment. Based on this basic concept, the following production facilities are required.

1) Steelmaking plant

Two ladle furnaces will be installed to reduce the tap-to-tap time of the existing electric arc furnaces together with application of oxygen lancing to accelerate scrap melting.

2) Rolling mill plant

In the wire rod mill, a one-strand line consisting of intermediate and finishing mill stands, and one coil cooling and handling line will be installed. The existing reheating furnace will be modified to increase the heating capacity.

3) Other facilities

In accordance with the installation and modification of the production facilities, the plant support facilities like water treatment facilities, oxygen gas generation facilities, compressed air generation facilities, transportation facilities, maintenance facilities, and analysis and inspection facilities will be modified as needed.

### 5.1.3. Further expansion

Advance into new fields

Any enterprise desires to expand its business in consideration of successive advance. To survive, it is important for steel producers to advance into new fields by incorporation of new technologies and by expansion of product mix through sufficient survey of the steel market.

In the case of ANSDK in terms of expansion, the project of 1.0 million t/y rebar production is under successful execution as Stage-1. Then, the expansion plan of additional 0.5 million t/y of steel products, mainly rebars, will lead to the steel complex specialized in long products with the production capacity of 1.5 million t/y.

After completion of this expansion project, the further expansion project, mainly in terms of technologies, will focus on the high value added product such as strip and/or long products.

1) Advance of mini-mills into the production of flat products

   Recently, many projects that allow mini-mills to move up to the production of flat products are successively under execution worldwide. In U.S.A., NUCOR constructed the world-first mini-mill plant for production of strip products in Crawfordsville in 1989. Since its start-up, NUCOR has solved problems one after another to be successful in the American market. Furthermore, NUCOR is active in setting forth new plants, which is a stimulus to the steel producers in the world.

Today, regardless of blast-furnace-integrated steel mills or mini-mills, the production of flat products from electric arc furnace steel is a common topic not only in America and Europe but also in other countries. As a matter of fact, several projects have been announced in various areas in the world for production of flat products by mini-mills using electric arc furnace steel. Some of these projects have been completed to start production, while some others are toward completion.

This situation is explained by the fact that the applicable range of flat products produced from electric arc furnace steel has been extended by the recent improvement and development of steelmaking technologies and that the investment cost, less than that of blast furnace integrated process, is for about 1.0 million t/y of production capacity with utilization of advantage of mini-mills. Also, the recent stability of scrap price contributes to sufficiently high competitiveness thanks to the superior productivity of labor in mini-mills.
To be successful in the steel market, it is of course important to meet surrounding conditions such as the market demand.

Conceptional plan for strip mill is as follows:

A direct reduction (DR) plant can be installed next to the existing DR plant on the premises of El Dikheila Iron and Steel Works.
A steelmaking plant, a strip rolling mill, and related facilities will be installed in the green field in the south of the Works.

The direct reduced iron produced by the new DR plant will be transferred to the new steelmaking plant by a new belt conveyor.
The flat products will be hot rolled coils of 1,250 mm in width, 2.0 to 6.0 mm in thickness, and about 20 tons in coil weight. The steel grade will be carbon steel for general use.
The facilities to produce flat products will consist of one 600-module DR plant, two 100- to 150-ton electric arc furnaces, and one 100- to 150-ton secondary metallurgy equipment. The capacity and type of these facilities should be decided through detailed study in consideration of the required quality of products.
The hot rolling mill will be a finishing mill of five to six stands directly connected to a thin slab caster or a semi-continuous hot strip mill with a coil box. At any rate, the equipment should be selected considering the quality, quantity, and others of flat products to be produced through detailed study.

In the analysis of further expansion plan, study of the demand-supply conditions in Egypt plays a major role.
Concerning the flat products in general, the gap between demand and supply is on the increase and is expected to reach about 0.7 million tons in the year 2002. Though detailed market research including indirect export will be required, successful advance of ANSDK into the production and sales of flat products in future will have a possibility thanks to its advantageous standing of a mini-mill.

2) Expansion for production of long products

Even after completion of the expansion project analyzed in this F/S, supply of long products is expected to run short because of the active demand.

Facilities for additional production of long products in ANSDK will be as follow:

For additional production capacity of long products of 0.3 to 0.5 million t/y utilizing the existing area of El Dikheila Iron and Steel Works, new facilities will consist of one 600-module DR plant, two 70-ton electric arc furnaces, a continuous caster, a new rolling facility, for example a merchant mill, and ancillary facilities.
The steel grade will mainly be carbon steel. The steel grade and kind of products, however, should be decided in consideration of future demand.
As a matter of course, both cases for future expansion should be studied through research of market characteristics and economy as well as feasibility.

## 5.2. Production Plan

### 5.2.1. Size composition and production of products

Composition of rebars by size and annual production plan is shown in Table 5.2-1. Size composition varies according to demand structure, but in this F/S it is assumed that imported products are to be substituted by domestic products and the size composition was discussed and decided between ANSDK and the JICA's Study Mission.

### 5.2.2. Material balance sheet

Material balance sheet used as the basic model in this F/S is shown in Fig. 5.2-1. Unit consumption and yield of raw materials, auxiliary raw materials and semi-products at each plant were established based on the actual results of El Dikheila Iron and Steel Works.

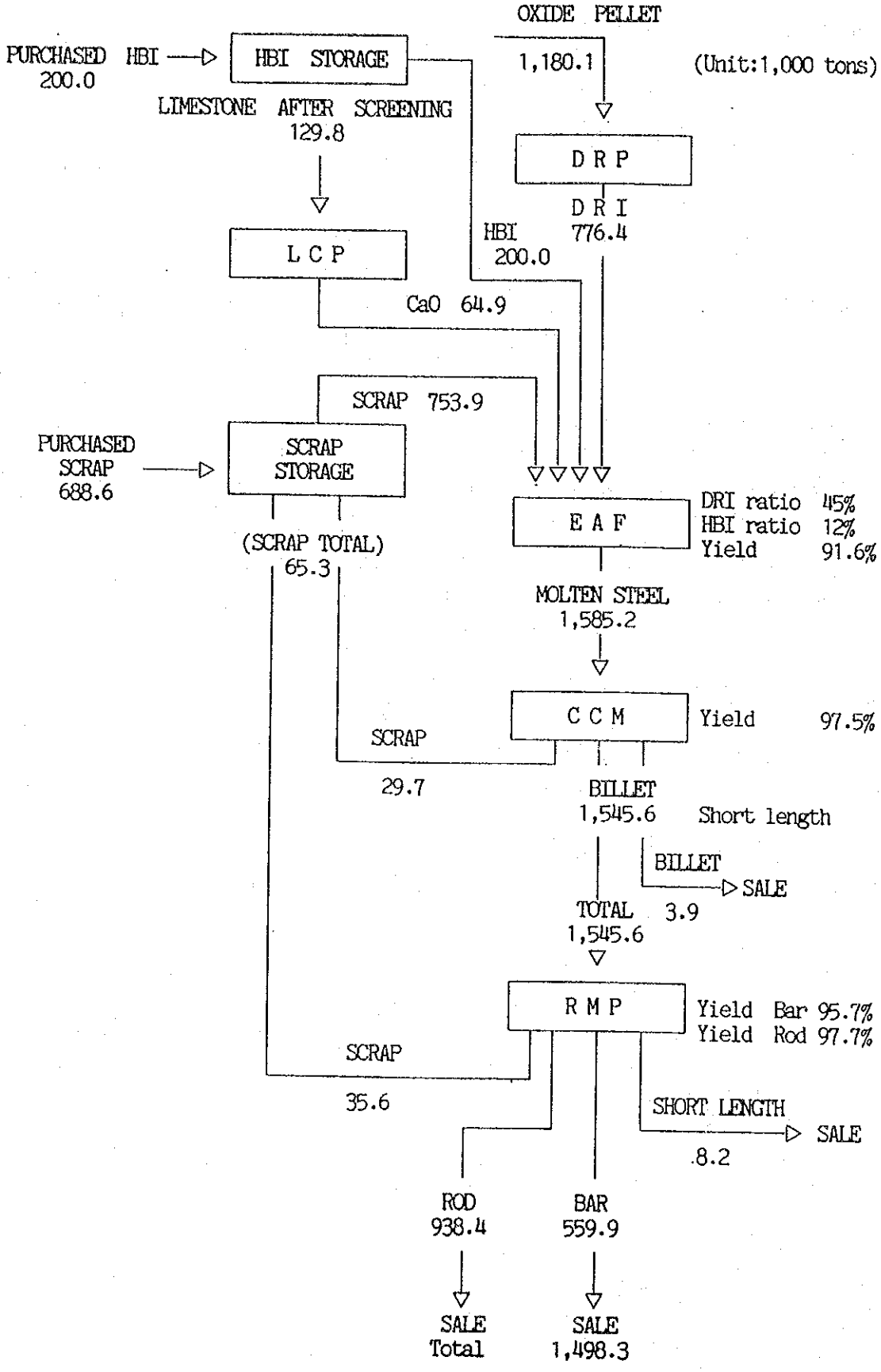



Fig. 5.2-1 Material Balance Sheet after Expansion

Table 5.2-1 Size Composition and Annual Production of Rebars

| Mill | Dia. | Products | | Rolling Productivity | Rolling hour | Available hour |
|---|---|---|---|---|---|---|
| | | Ton | Ratio | | | |
| | (mm) | 1,000t/y | % | t/y | h/y | h/y |
| ROD | 5.5 | 46.9 | 5 | 99.8 | 470 | |
| | 6 | 131.3 | 14 | 124.2 | 1,058 | |
| | 6.5 | 28.1 | 3 | 147.0 | 192 | |
| | 7 | 18.7 | 2 | 147.0 | 127 | |
| | 7.5 | 18.7 | 2 | 147.0 | 127 | |
| | 8 | 145.5 | 15.5 | 147.0 | 990 | |
| | 9 | 18.7 | 2 | 147.0 | 127 | |
| | 10 | 310.0 | 33 | 147.0 | 2,109 | |
| | 12 | 215.8 | 23 | 147.0 | 1,468 | |
| | 13 | 4.7 | 0.5 | 147.0 | 32 | |
| | Total | 983.4 | 100 | | 6,700 | 6,700 |
| BAR | 10 | 112.0 | 20 | 62.6 | 1,789 | |
| | 12 | 156.8 | 28 | 83.1 | 1,886 | |
| | 13 | 0 | 0 | - | - | |
| | 14 | 5.6 | 1 | 94.5 | 59 | |
| | 16 | 173.5 | 31 | 106.0 | 1,636 | |
| | 18 | 50.4 | 9 | 108.2 | 465 | |
| | 19 | 0 | 0 | - | - | |
| | 20 | 5.6 | 1 | 108.7 | 51 | |
| | 22 | 22.4 | 4 | 109.1 | 205 | |
| | 25 | 22.4 | 4 | 109.1 | 205 | |
| | 28 | 5.6 | 1 | 108.0 | 51 | |
| | 32 | 5.6 | 1 | 108.0 | 51 | |
| | Total | 559.9 | 100 | | 6,398 | 6,398 |
| ROD + BAR | | 1,498.3 | | | | |

## 5.3 Estimation of Construction Cost

The construction cost of the project has been estimated on the basis of the following.

1) Assumption for estimation

- Purchase of equipment : Based on the present international prices
- Erection of equipment & civil engineering & building works : Construction equipment and materials imported from abroad to be based on the present international prices, and the equipment, materials and labor available in Egypt to be based on local prices

2) Case with escalation

- Imported materials and equipment : To be 4% p.a.
- Materials and equipment locally purchased : To be 5% p.a.

3) Currency used for indication

The construction cost is indicated in US dollars. Currencies exchange rate for US dollars is assumed to be US$1=LE3.35, US$1=¥115.76, and US$1=DMK1.65.

4) Import duty (Tariff)

- Equipment : 5%
- Materials : Based on Customs Tariff 1992
- Construction equipment and materials for temporary structure : Free on condition that they are to be reexported.

5) Construction cost

The construction cost for the case without escalation and the case with escalation is summarized in Tables 5.3-1 and 5.3-2, respectively.

Table 5.3-1 Summary of Capital Cost Estimation (Without Escalation Case)

Unit: 1000 USD

| | Equipment (CIF) | | | Installation | | | Civil & Building | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | L | T | F | L | T | F | L | T | F | L | T |
| DRP | | | 0 | | | 0 | | | 0 | | | 0 |
| SMP | 53,631 | 2,358 | 55,989 | 2,773 | 953 | 3,726 | 2,470 | 1,260 | 3,730 | 58,874 | 4,571 | 63,445 |
| ROD | 29,141 | 182 | 29,323 | 2,823 | 863 | 3,686 | 4,538 | 1,272 | 5,810 | 36,502 | 2,317 | 38,819 |
| UT | 24,591 | 1,110 | 25,701 | 3,020 | 812 | 3,832 | 2,133 | 1,932 | 4,065 | 29,744 | 3,854 | 33,598 |
| PW | 1,831 | 0 | 1,831 | 146 | 41 | 187 | 126 | 153 | 279 | 2,103 | 194 | 2,297 |
| TR | 5,466 | 0 | 5,466 | 64 | 58 | 122 | 2,827 | 2,595 | 5,422 | 8,357 | 2,653 | 1,010 |
| MS | 1,732 | 0 | 1,732 | 69 | 26 | 95 | 243 | 309 | 552 | 2,044 | 335 | 2,379 |
| AI | 1,751 | 0 | 1,751 | 38 | 10 | 48 | | | 0 | 1,789 | 10 | 1,799 |
| ADM | | | 0 | | | 0 | | | 0 | | | 0 |
| Total | 118,143 | 3,650 | 121,793 | 8,933 | 2,763 | 11,696 | 12,337 | 7,521 | 19,858 | 139,413 | 13,934 | 153,347 |
| Eng. Fees | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | 10,000 | 0 | 10,000 |
| Contingency | | | | | | | | | | | | |
| Price C | | | 0 | | | 0 | | | 0 | | | 0 |
| Physical C | 5,907 | 183 | 6,090 | 447 | 138 | 585 | 617 | 376 | 993 | 6,971 | 697 | 7,667 |
| Imp. tax | | 5,907 | 5,907 | 0 | 0 | 0 | | 2,502 | 2,502 | 0 | 8,409 | 8,409 |
| Sales tax | | 12,770 | 12,770 | | | | | | | 0 | 12,770 | 12,770 |
| Total | 5,907 | 18,860 | 24,767 | 447 | 138 | 585 | 617 | 2,878 | 3,495 | 16,971 | 21,876 | 38,847 |
| Grand Total | 124,050 | 22,510 | 146,560 | 9,380 | 2,901 | 12,281 | 12,954 | 10,399 | 23,353 | 156,384 | 35,810 | 192,194 |

Table 5.3-2 Summary of Capital Cost Estimation (With Escalation Case)

Unit: 1000 USD

| | Equipment (CIF) | | | Installation | | | Civil & Building | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | L | T | F | L | T | F | L | T | F | L | T |
| DRP | | | 0 | | | 0 | | | 0 | | | 0 |
| SMP | 53,631 | 2,358 | 55,989 | 2,773 | 953 | 3,726 | 2,470 | 1,260 | 3,730 | 58,874 | 4,571 | 63,445 |
| ROD | 29,141 | 182 | 29,323 | 2,823 | 863 | 3,686 | 4,538 | 1,272 | 5,810 | 36,502 | 2,317 | 38,819 |
| UT | 24,591 | 1,110 | 25,701 | 3,020 | 812 | 3,832 | 2,133 | 1,932 | 4,065 | 29,744 | 3,854 | 33,598 |
| PW | 1,831 | 0 | 1,831 | 146 | 41 | 187 | 126 | 153 | 279 | 2,103 | 194 | 2,297 |
| TR | 5,466 | 0 | 5,466 | 64 | 58 | 122 | 2,827 | 2,595 | 5,422 | 8,357 | 2,653 | 1,010 |
| MS | 1,732 | 0 | 1,732 | 69 | 26 | 95 | 243 | 309 | 552 | 2,044 | 335 | 2,379 |
| AI | 1,751 | 0 | 1,751 | 38 | 10 | 48 | | | 0 | 1,789 | 10 | 1,799 |
| ADM | | | 0 | | | 0 | | | 0 | | | 0 |
| Total | 118,143 | 3,650 | 121,793 | 8,933 | 2,763 | 11,696 | 12,337 | 7,521 | 19,858 | 139,413 | 13,934 | 153,347 |
| Eng. Fees | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | 10,000 | 0 | 10,000 |
| Contingency | | | | | | | | | | | | |
| Price C | 14,928 | 547 | 15,475 | 1,174 | 458 | 1,632 | 1,566 | 993 | 2,559 | 17,668 | 1,998 | 19,666 |
| Physical C | 5,907 | 183 | 6,090 | 447 | 138 | 585 | 617 | 376 | 993 | 6,971 | 697 | 7,667 |
| Imp. tax | | 5,907 | 5,907 | | | 0 | | 2,502 | 2,502 | 0 | 8,409 | 8,409 |
| Sales tax | | 12,770 | 12,770 | | | | | | | 0 | 12,770 | 12,770 |
| Total | 20,835 | 19,407 | 40,242 | 1,621 | 596 | 2,217 | 2,183 | 3,871 | 6,054 | 34,639 | 23,874 | 58,513 |
| Grand Total | 138,978 | 23,057 | 162,035 | 10,554 | 3,359 | 13,913 | 14,520 | 11,392 | 25,912 | 174,052 | 37,808 | 211,860 |

## 5.4. Construction Schedule

### 5.4.1. Basic policy

1) Start-up of main plants

Start-up of the main plants such as SMP and ROD will be the same time by taking into consideration the learning period needed for securing the full operation and the meterial balance.

Other ancillary facilities will be started up in timing not to cause inconveniene to the start-up of the main plants.

2) Construction period

The period required from CIF contract to start-up will be 28 months for both SMP and ROD.

3) Preparation and tender period

All contracts for this project will be made through limited international tender, and it is assumed that preparation of bidding to signing contract will take 6 months.

### 5.4.2. Overall construction schedule

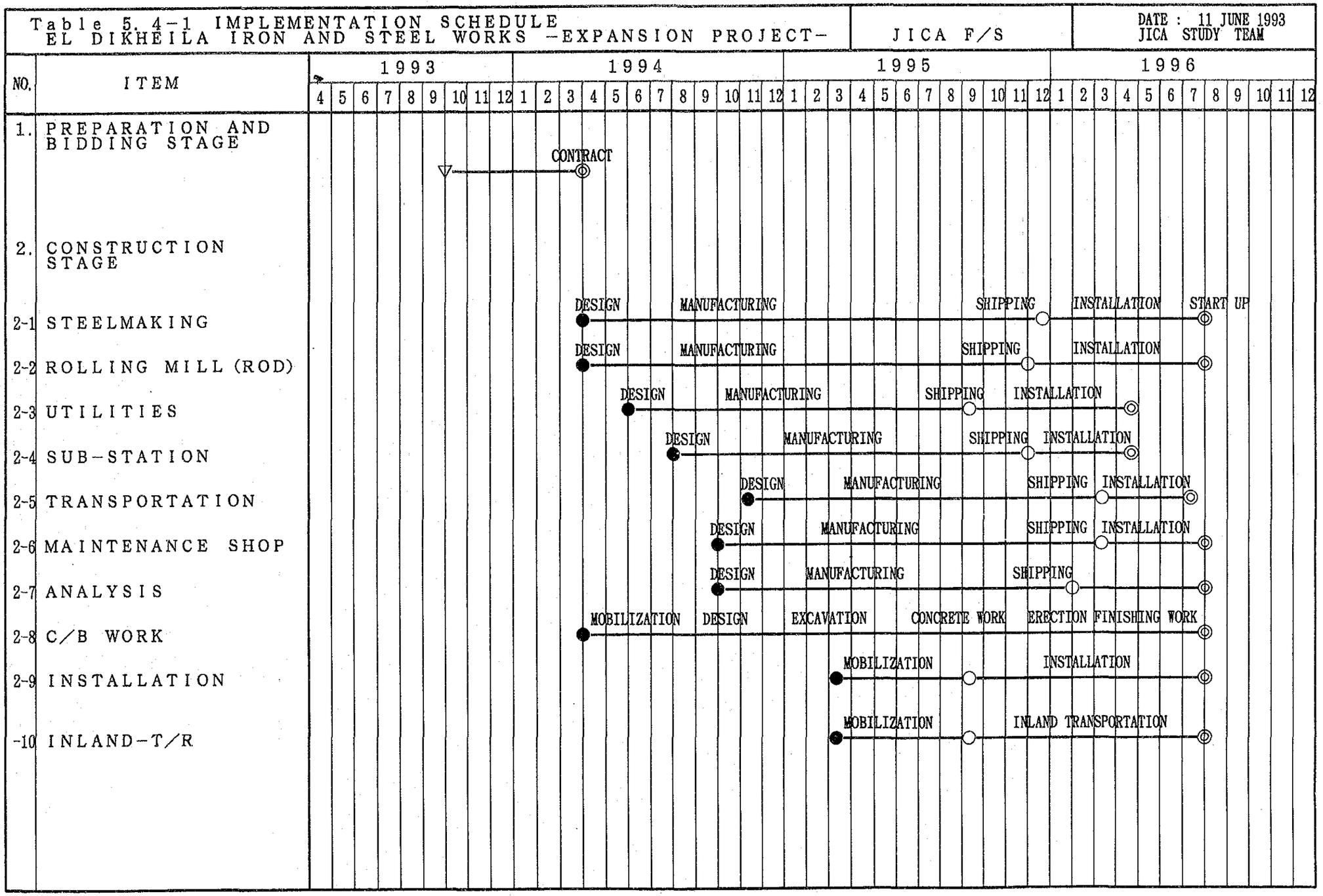
Table 5.4-1 shows the overall schedule for the expansion project based on the above premises. Start-up date of the main plants is assumed as follows:

- SMP: August 1, 1996
- RMP: August 1, 1996

Table 5.4-1 IMPLEMENTATION SCHEDULE
EL DIKHEILA IRON AND STEEL WORKS -EXPANSION PROJECT-

JICA F/S

DATE : 11 JUNE 1993
JICA STUDY TEAM



# 6. FINANCIAL ANALYSIS

## 6.1. Calculation of Production Cost

1) Premises for cost accounting

The cost accounting has been done based on the following premises.

a) Cost accounting standards

Process cost accounting system is adopted.

b) Exchange rates

- US$1 = LE3.35
- US$1 = ¥115.76
- US$1 = DMK1.65

c) Price fluctuation

The price level used in cost accounting is set considering the result of the field survey, discussion with counterparts and the global trends.

(1) Case without escalation

This is the case where no escalation is considered and cost accounting and financial analysis are made based on actual prices in 1992 or in the latest six months at the field survey in March 1993.

(2) Case with escalation

This is the case where cost accounting and

financial analysis are made based on the above price level as the base, taking account of inflation at the rates of 5% and 4% for domestic expenses and imported goods for the first 4 years to 1996 when the expansion plants start operation.

d) Depreciation method

Fixed installment method is adopted.

e) Production

In full operation after the expansion, the production is assumed to be 559,900 t/y of bars and 938,400 t/y of rods.

2) Production cost

For the base case of the expansion project without the escalation, production costs of five production processes are calculated separately for the fixed cost and the variable cost. The year 1995 is the year before the expansion project and the year 1998 is the year when the Works will be in full operation.

Table 6.1 Manufacturing Costs by Process
(With Expansion, Without Escalation)

Unit: U.S.$/ton

| | | 1995 | 1998 |
|---|---|---|---|
| DRP | Fixed cost | 22.4 | 22.0 |
| | Variable cost | 92.8 | 93.0 |
| | Total cost | 115.2 | 115.0 |
| LCP | Fixed cost | 27.2 | 16.0 |
| | Variable cost | 20.8 | 21.0 |
| | Total cost | 48.0 | 37.0 |
| SMP | Fixed cost | 19.6 | 19.6 |
| | Variable cost | 179.6 | 181.2 |
| | Total cost | 199.2 | 200.8 |
| BAR | Fixed cost | 10.6 | 10.2 |
| | Variable cost | 212.0 | 214.1 |
| | Total cost | 222.6 | 224.3 |
| ROD | Fixed cost | 13.7 | 12.6 |
| | Variable cost | 208.8 | 211.0 |
| | Total cost | 222.5 | 223.6 |

## 6.2. Financial Analysis

### 6.2.1. Basic policy for financial analysis

In the present financial analysis, the profitability of investments for the expansion facilities is analyzed and evaluated in net effects (profitability after the expansion facilities - profitability in the existing facilities).
The financial analysis of the existing facilities is made in reference to the expansion facilities only. The financial analysis is managed with the following methods:

1) Analysis and evaluation with regard to the following financial statements:
   a) Manufacturing cost sheet

   b) Profit and loss statement

   c) Cash flow

   d) Balance sheet

2) Evaluation in effects of total investment and equity with the internal rate of return

3) Sensitivity analysis

### 6.2.2. Financial projection case

The financial analysis is made in the financial projection case as shown in Table 6.2-1 and managed with the following conditions:

1) Without escalation case

This is the case that any inflation is not considered and cost calculation and financial projection are made in price level described in CHAPTER 5 CALCULATION OF CONSTRUCTION EXPENSES for construction costs, in price level described in Section 6.1. Calculation of Manufacturing Costs for production costs, and in price level in most recent six months at field survey in March 1993 for sales prices of products.

2) With escalation case

This is the case that inflation is estimated at the price level mentioned in above 1) by the escalation rate as shown in Table 6.2-2 covering a period until the year of start-up of the expansion facilities.

Table 6.2-1 Financial Projection Case

| Case 0-1 | Case 0-2 | Case 1-1 | Case 1-2 |
|---|---|---|---|
| Without expansion | | With expansion | |
| without escalation | with escalation | without escalation | with escalation |

Table 6.2-2 Escalation Rate (Year rate)

| Description | Escalation rate |
|---|---|
| Domestic cost/expense | 5% |
| Import procurement | 4 |
| Product sales price | In the proportion of sales in domestic and export |

6.2.3. Assumption for financial analysis

In the present financial analysis, the profitability of investments for the expansion facilities is analyzed and evaluated on the basis of construction costs and manufacturing costs already described, taking account of the following assumptions:

1) Financial projection period

Financial projection covers the period of 23 years (20 years after the start-up of the expansion facilities from 1993)and financial projection year is calendar year bases, that is, January to December.

2) Sales price of products

Sales prices of products are assumed as shown in Table 6.2-3.

Table 6.2-3 Sales Price of Products

(Unit:US$/ton)

| Description | Without escalation | With escalation | | | |
|---|---|---|---|---|---|
| | Case 0-1 /Case 1-1 | Case 0-2 / Case 1-2 | | | |
| | | 1993 | 1994 | 1995 | 1996~ |
| Bar | 320.1 | 335.7 | 351.9 | 369.0 | 386.9 |
| Rod | 320.1 | 335.7 | 351.9 | 369.0 | 386.9 |
| Short length bar | 291.0 | 304.5 | 319.7 | 335.7 | 352.6 |
| Billet | 258.3 | 271.2 | 284.7 | 299.0 | 314.0 |

Note) Billet includes short length billet.

3) Selling expenses

Selling expenses for sales are assumed to be nil because of customers taking over the purchased products at the products stock yard of steelworks.

4) General and administrative expenses

Labor costs, depreciation costs for office buildings and company houses, and other costs associated with the following affairs and departments are estimated as general and administrative expenses:

a) Top management affairs

b) External relation dept.

c) Administration dept.

d) Finance dept.

e) Purchasing and transportation dept. except transportation section

f) Sales dept.

g) Production control and technical coordination dept. except laboratories and inspection

h) Construction dept.

i) Research dept.

And also the consulting costs for the operation of the existing facilities are estimated as general administrative expenses.

5) Corporate income tax

The expansion facilities are assumed to be exempted from corporate income tax for ten years after the subsequent year of the start-up of the expansion facilities under the provision of Investment Law No.230/1989 of Egypt as the existing facilities.
After the tax-exemption period, corporate income tax is estimated by rate of 32% to taxable income in compliance with Corporate Income Tax Law of Egypt.

6) Dividends payable

The amount equal to 9% of year end balance of paid-up capital in the current year is assumed to be distributed in the subsequent year to investors as dividend.

### 6.2.4. Fund requirement

1) Equipment fund

The payment schedule of the equipment funds described in CHAPTER 5 CALCULATION OF CONSTRUCTION EXPENSES is assumed as shown in Table 6.2-4 and Table 6.2-5.

Table 6.2-4 Payment Schedule of Equipment Fund
Case 1-1 (Without escalation)

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equipment cost | 121,793 | | 24,360 | 78,991 | 18,442 | | | | | | | | | | |
| Installation cost | 11,696 | | | 3,891 | 7,805 | | | | | | | | | | |
| Civil & building cost | 19,858 | | 5,050 | 12,783 | 2,025 | | | | | | | | | | |
| Engineering fee | 10,000 | | 6,391 | 936 | 2,673 | | | | | | | | | | |
| Contingency | 28,847 | | 3,530 | 10,770 | 2,414 | | 348 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |
| Total | 192,194 | 0 | 39,331 | 107,371 | 33,359 | 0 | 348 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |

Note: Contingency was allocated by year according to the payment of equipment cost, installation cost, and civil and building cost.



Table 6.2-5 Payment Schedule of Equipment Fund
Case 1-2 (With escalation)

(単位:千US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equipment cost | 121,793 | | 24,360 | 78,991 | 18,442 | | | | | | | | | | |
| Installation cost | 11,696 | | | 3,891 | 7,805 | | | | | | | | | | |
| Civil & building cost | 19,858 | | 5,050 | 12,784 | 2,024 | | | | | | | | | | |
| Engineering fee | 10,000 | | 6,391 | 936 | 2,673 | | | | | | | | | | |
| Contingency | 48,513 | | 5,823 | 22,602 | 6,620 | | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |
| Total | 211,860 | 0 | 41,624 | 119,204 | 37,564 | 0 | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |

Note: Contingency was allocated by year according to the payment of equipment cost, installation cost, and civil and building cost.

2) Pre-production cost

The costs and expenses to be incurred in the expansion facilities before the start-up of expansion facilities are estimated as pre-production costs.
The pre-production costs with the payment schedule are shown in Table 6.2-6 and Table 6.2-7.

In this financial projection, only labor costs of fresh employees employed during a period of three months before the start-up of the expansion facilities are estimated as pre-production costs. Training before operation for the expansion facilities is assumed to be unnecessary because of the existing facilities having been operated for more than ten years since the start-up. The pre-production costs are amortized equally during a period of ten years after the start-up of the expansion facilities in account of deferred assets.

Table 6.2-6 Pre-production Cost and Payment Schedule
Case 1-1 (Without escalation)

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| Labor cost | 798 | 0 | 0 | 0 | 798 |

Table 6.2-7 Pre-production Cost and Payment Schedule
Case 1-2 (With escalation)

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| Labor cost | 1,057 | 0 | 0 | 0 | 1,057 |

3) Additional working capital fund

The working capital fund yearly increasing before the year 1998 when the normal production of the expansion facilities will be reached is estimated as shown in Table 6.2-8 and Table 6.2-9 in the following assumptions:

a) Cash on hand

Minimum necessary amount for operation after the expansion of facilities is estimated as follows and surplus fund in excess of minimum necessary amount during the year is appropriated for the additional working capital fund in the year:

(Unit:1000US$)

Case 1-1 (Without escalation) : 12,534
Case 1-2 (With escalation ) : 14,363

Any surplus fund including surplus fund after making appropriation for the above-mentioned additional working capital fund in projection years is assumed to be made short-term deposits with year interest rate of 3%.

On the other hand, shortage in minimum necessary amount is also assumed to be raised on short-term loans with year interest rate of 5%.

b) Accounts receivable-trade

Collection of sales amount is assumed to be made upon shipment of products.
The resulting accounts receivable-trade are estimated to be nil at the year end.

c) Advances to suppliers

The amount for one month quantity of raw materials and supplies including manufacturing supplies and other repair parts to be consumed in the subsequent year is assumed as year end balance.

d) Raw materials

The quantity for one month to be consumbed in the subsequent year is assumed as year end inventories.

e) Semi-finished products

The quantity for a half month products in the year is assumed as year end inventories.

f) Finished products

The quantity for one month products in the year is assumed as year end inventories.

g) Accounts payable-trade

Payments for purchase of raw materials and supplies including manufacturing supplies and other repair parts are assumed to be made until receipt of goods. The resulting accounts payable-trade are estimated to be nil at the year end.

h) Accounts payable-others

Payments for dividends are assumed to be made in the subsequent year and other transactions are assumed to be made upon cash payments.

Table 6.2-8 Yealy Additional Working Capital Fund
Case 1-1 (Without escalation)

(Unit:1000US$)

| Description | 1996 | 1997 | 1998 |
|---|---|---|---|
| Account receivable-trade | 0 | 0 | 0 |
| Advances to suppliers | 5,183 | 0 | 0 |
| Inventories: Raw materials | 5,506 | 0 | 0 |
| Semi-finished products | 0 | 354 | -345 |
| Finishied products | 1,059 | 5,702 | 696 |
| Accounts payable-trade | 0 | 0 | 0 |
| Accounts payable-others | -1,845 | -500 | -58 |
| Total | 9,903 | 5,556 | 293 |
| Appropriation of surplus fund | 0 | 0 | 0 |
| Total of additional working capital | 9,903 | 5,556 | 293 |

Table 6.2-9 Yealy Additional Working Capital Fund
Case 1-2 (With escalation)

(Unit:1000US$)

| Description | 1996 | 1997 | 1998 |
|---|---|---|---|
| Account receivable-trade | 0 | 0 | 0 |
| Advances to suppliers | 5,989 | 0 | 0 |
| Inventories: Raw materials | 6,291 | 0 | 0 |
| Semi-finished products | 0 | 401 | -391 |
| Finishied products | 1,074 | 6,637 | 800 |
| Accounts payable-trade | 0 | 0 | 0 |
| Accounts payable-others | -2,088 | -583 | -33 |
| Total | 11,266 | 6,455 | 376 |
| Appropriation of surplus fund | 0 | 0 | 376 |
| Total of additional working capital | 11,266 | 6,455 | 0 |

4) Interest during construction period

The interest on long-term debts raised for the expansion facilities during construction period is assumed to be amortized equally during a period of ten years after the start-up of the expansion facilities after appropriation to deferred assets as is the case with pre-production cost. Yearly interest during construction period is estimated as shown in Table 6.2-10.

Table 6.2-10 Yealy Interest during Contruction Period

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| Case1-1 Without escalation | 22,807 | 0 | 2,597 | 11,701 | 8,509 |
| Case1-2 With escalation | 25,007 | 0 | 2,753 | 12,859 | 9,395 |

5) Total investment fund

As a result of estimation based on the assumptions, the total investment fund is shown in Table 6.2-11.

Table 6.2-11 Total Investment Fund

(Unit:1000US$)

| Description | Case 1-1 Without escalation | Case 1-2 With escalation |
|---|---|---|
| Equipment | 192,194 | 211,860 |
| Pre-production cost | 798 | 1,057 |
| Additional working capital | 15,752 | 17,721 |
| Interest under construction | 22,807 | 25,007 |
| Total | 231,551 | 255,645 |

6.2.5. Fund raising

1) Capital

As in the case of the existing facilities, 30% of the total investment for the expansion facilities is assumed to be managed with paid-up capital.

The amount of necessary paid-up capital is as follows:

(Unit:1000US$)

Case 1-1 (Without escalation) : 69,471
Case 1-2 (With escalation ) : 76,693

2) Long-term debts

The balance of the total investment after deduction of paid-up capital is assumed to be managed on long-term loans with terms and conditions as follows:

a) Interest year rate: 9.0%

b) Loan period : 10 years

c) Grace period : 3 years

3) Hedging of foreign currency fluctuation on long-term debts

Though it is difficult to mention to hedging of foreign currencies fluctuation at present stage because of not being decided by currencies on long-term debts, the following hedging (minimizing) is considered in general:

a) Swapping to stabilized currency in international money market

b) Forward exchange contract in international foreign exchange market

c) Direct settlement with foreign currency earned by export of products

The above-mentioned hedging including other method should be examined and reconsidered concretely after making sure of trend in international money market and foreign exchange market and the best hedging should be decided.

4) Schedule of fund demand and raising

Fund demand and raising schedule for the expansion facilities is shown in Table 6.2-12 and Table 6.2-13.

Table 6.2-12 Schedule of Fund Demand and Raising
Case 1-1 (Without escalation)

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demand: | | | | | | | | | | | | | | | |
| Equipment | 192,194 | | 39,331 | 107,371 | 33,359 | | 348 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |
| Pre-production cost | 798 | | | | 798 | | | | | | | | | | |
| Additional working capital | 15,752 | | | | 9,903 | 5,556 | 293 | | | | | | | | |
| Interest under construction | 22,807 | | 2,597 | 11,701 | 8,509 | | | | | | | | | | |
| Demand total | 231,551 | 0 | 41,928 | 119,072 | 52,569 | 5,556 | 641 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |
| Raising: | | | | | | | | | | | | | | | |
| Capital | 69,471 | | 13,075 | 17,909 | 20,505 | 5,556 | 641 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |
| Long-term loan | 162,080 | | 28,853 | 101,163 | 32,064 | | | | | | | | | | |
| Raising total | 231,551 | 0 | 41,928 | 119,072 | 52,569 | 5,556 | 641 | 1,471 | 1,733 | 1,733 | 1,733 | 1,733 | 1,733 | 1,386 | 263 |

Table 6.2-13 Schedule of Fund Demand and Raising
Case 1-2 (With escalation)

(Unit:1000US$)

| Description | Total | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demand: | | | | | | | | | | | | | | | |
| Equipment | 211,860 | | 41,624 | 119,204 | 37,564 | | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |
| Pre-production cost | 1,057 | | | | 1,057 | | | | | | | | | | |
| Additional working capital | 17,721 | | | | 11,266 | 6,455 | | | | | | | | | |
| Interest under construction | 25,007 | | 2,753 | 12,859 | 9,395 | | | | | | | | | | |
| Demand total | 255,645 | 0 | 44,377 | 132,063 | 59,282 | 6,455 | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |
| Raising: | | | | | | | | | | | | | | | |
| Capital | 76,693 | | 13,787 | 19,779 | 23,204 | 6,455 | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |
| Long-term loan | 178,952 | | 30,590 | 112,284 | 36,078 | | | | | | | | | | |
| Raising total | 255,645 | 0 | 44,377 | 132,063 | 59,282 | 6,455 | 371 | 1,625 | 1,924 | 1,924 | 1,924 | 1,924 | 1,924 | 1,553 | 299 |

### 6.2.6. Sales plan

On the basis of production plan, the sales plan is assumed as shown in Table 6.2-14.

Table 6.2-14 Sales Plan

(Unit:1000 t)

| Description | 1995 | 1996 | 1997 | 1998 | 1999~ |
|---|---|---|---|---|---|
| Bar | 558.6 | 559.9 | 559.9 | 559.9 | 559.9 |
| Rod | 544.7 | 463.6 | 861.4 | 935.1 | 938.4 |
| Short length bar | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 |
| Billet | 3.6 | 2.5 | 43.3 | 5.6 | 3.9 |
| Total | 1,115.1 | 1,034.2 | 1,472.8 | 1,508.8 | 1,510.4 |

Note 1. Including products of the existing facilities
Note 2. Billet includes short length billet

### 6.2.7. Analysis and evaluation of financial statement

Analysis and evaluation are made on statements estimated in accordance with the assumptions and conditions below. Financial statements are attached to APPENDIX 1.

1) Cost of products

Cost of products consisting of manufacturing cost described in Section 6.1. Calculation of Manufacturing Costs, general administrative expenses (GAE), and non-operating expenses (NOE) including interest on long-term debts is shown in Table 6.2-15 and Table 6.2-16 as the result of calculation.

Table 6.2-15 Cost of Products
Case 1-1 (Without escalation)

(Unit:US$/ton)

| Description | Bar | | | | Rod | | | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 1998 | 2005 | 2010 | 1995 | 1998 | 2005 | 2010 |
| Variable cost | 212 | 214 | 213 | 213 | 209 | 211 | 211 | 211 |
| Fixed cost | 11 | 10 | 10 | 10 | 14 | 13 | 12 | 12 |
| Sub-total | 223 | 224 | 223 | 223 | 223 | 224 | 223 | 223 |
| GAE | 8 | 6 | 6 | 6 | 8 | 6 | 6 | 6 |
| NOE | 21 | 14 | -13 | -30 | 21 | 14 | -13 | -30 |
| Total | 252 | 244 | 216 | 199 | 252 | 244 | 216 | 199 |
| Products (1000 t) | 568 | 568 | 568 | 568 | 545 | 938 | 938 | 938 |

Note : Bar includes short length bar.

Table 6.2-16 Cost of Products
Case 1-2 (With escalation)

(Unit:US$/ton)

| Description | Bar | | | | Rod | | | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 1998 | 2005 | 2010 | 1995 | 1998 | 2005 | 2010 |
| Variable cost | 235 | 243 | 243 | 243 | 232 | 239 | 239 | 239 |
| Fixed cost | 11 | 11 | 11 | 11 | 14 | 14 | 14 | 14 |
| sub-total | 246 | 254 | 254 | 254 | 246 | 253 | 253 | 253 |
| GAE | 9 | 7 | 7 | 7 | 9 | 7 | 7 | 7 |
| NOE | 21 | 12 | -23 | -46 | 21 | 12 | -23 | -46 |
| Total | 276 | 273 | 238 | 215 | 276 | 272 | 237 | 214 |
| Products (1000 t) | 568 | 568 | 568 | 568 | 545 | 938 | 938 | 938 |

Note : Bar includes short length bar.

2) Profit and loss statement

Outline of profit and loss statement as the result of calculation is shown in Table 6.2-17 and Table 6.2-18.

a) Case 1-1 (Without escalation)

Though net profit after the expansion is inferior to the case of no expansion in the year of start-up of the expansion facilities, it dominates from the subsequent year of start-up of the expansion facilities because of remarkable increase of sales quantities of products. And accumulated net profit after the expansion exceeds it in the case of no expansion in the fourth year after the year of start-up of the expansion facilities, that is, the year 2000, against being inferior to the case of no expansion during a period of three years after start-up of the expansion facilities.

As a result of the above position, accumulated net profit at the projection year end is 1.2 times against the case of no expansion.

b) Case 1-2 (With escalation)

Net profit after the expansion is in the same position to the above a). Accumulated net profit after the expansion exceeds it in the case of no expansion in the third year after the year of start-up of the expansion facilities, that is, the year 1999.

As a result of the above position, the accumulated net profit at the projection year end is 1.2 times against the case of no expansion like a) above.

Therefore, the investment for the expansion facilities can be said effective on profit and loss statements.

Table 6.2-17 Outline of Profit and Loss Statement
(Without escalation)

(Unit:1000US$)

| Description | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case 0-1(Existing facilities): | | | | | | | | | | | | | | | | | |
| Gross profit | 97,693 | 108,914 | 110,083 | 110,148 | 110,140 | 110,247 | 111,558 | 110,270 | 114,826 | 121,037 | 112,471 | 111,540 | 111,512 | 111,525 | 112,937 | 111,767 | 111,521 |
| Operating profit | 87,585 | 98,877 | 101,367 | 101,772 | 101,760 | 101,869 | 103,180 | 101,884 | 106,450 | 112,661 | 104,094 | 103,164 | 103,135 | 103,148 | 104,558 | 103,391 | 103,145 |
| Profit before tax | 52,935 | 71,269 | 78,066 | 83,095 | 86,647 | 100,408 | 104,804 | 106,871 | 114,779 | 124,303 | 120,270 | 122,269 | 125,479 | 128,845 | 133,773 | 135,948 | 139,038 |
| Net profit | 52,935 | 71,269 | 78,066 | 83,095 | 68,080 | 71,333 | 74,987 | 77,177 | 83,337 | 90,614 | 88,577 | 90,623 | 93,582 | 96,675 | 100,886 | 103,171 | 106,075 |
| Accumulated net profit | 52,935 | 124,204 | 202,270 | 285,365 | 353,445 | 424,778 | 499,765 | 576,942 | 660,279 | 750,893 | 839,470 | 930,093 | 1,023,675 | 1,120,350 | 1,221,236 | 1,324,407 | 1,430,482 |
| Case 1-1(After expansion): | | | | | | | | | | | | | | | | | |
| Gross profit | 97,693 | 108,914 | 110,083 | 72,428 | 138,284 | 146,455 | 148,044 | 146,756 | 151,273 | 157,461 | 148,942 | 148,016 | 147,987 | 148,000 | 149,412 | 148,242 | 147,897 |
| Operating profit | 87,585 | 99,877 | 101,367 | 63,467 | 128,803 | 136,930 | 138,518 | 137,232 | 141,750 | 147,937 | 139,418 | 138,492 | 138,463 | 138,476 | 139,886 | 138,719 | 138,473 |
| Profit before tax | 52,935 | 70,605 | 77,454 | 34,011 | 103,732 | 116,451 | 123,268 | 127,740 | 137,949 | 149,859 | 148,436 | 153,077 | 158,689 | 165,744 | 171,843 | 175,186 | 179,307 |
| Net profit | 52,935 | 70,605 | 77,454 | 34,011 | 75,165 | 87,375 | 93,451 | 98,045 | 106,507 | 116,170 | 116,744 | 121,431 | 126,792 | 133,574 | 127,778 | 131,188 | 135,086 |
| Accumulated net profit | 52,935 | 123,540 | 200,994 | 235,005 | 310,170 | 397,545 | 490,996 | 589,041 | 695,548 | 811,718 | 928,462 | 1,049,893 | 1,176,685 | 1,310,259 | 1,438,037 | 1,569,225 | 1,704,311 |

| Description | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Case 0-1(Existing facilities): | | | | | | |
| Gross profit | 111,525 | 111,527 | 111,530 | 111,622 | 111,535 | 112,936 |
| Operating profit | 103,149 | 103,150 | 103,153 | 103,245 | 103,159 | 104,559 |
| Profit before tax | 142,757 | 146,659 | 150,671 | 154,540 | 158,436 | 165,813 |
| Net profit | 109,517 | 113,137 | 116,863 | 120,427 | 124,107 | 130,469 |
| Accumulated net profit | 1,539,999 | 1,653,136 | 1,769,999 | 1,890,426 | 2,014,533 | 2,145,002 |
| Case 1-1(After expansion): | | | | | | |
| Gross profit | 148,001 | 150,668 | 148,731 | 148,624 | 148,538 | 148,939 |
| Operating profit | 138,477 | 141,144 | 139,206 | 139,100 | 139,014 | 140,414 |
| Profit before tax | 184,088 | 191,613 | 194,624 | 199,277 | 204,191 | 213,463 |
| Net profit | 139,551 | 145,917 | 149,229 | 153,604 | 158,265 | 166,268 |
| Accumulated net profit | 1,843,862 | 1,989,779 | 2,139,008 | 2,292,612 | 2,450,877 | 2,617,145 |

Table 6.2-18 Outline of Profit and Loss Statement
(With escalation)

(Unit:1000US$)

| Description | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case 0-2(Existing facilities): | | | | | | | | | | | | | | | | | |
| Gross profit | 107,238 | 129,028 | 139,471 | 153,454 | 152,956 | 153,073 | 154,570 | 153,103 | 157,642 | 164,961 | 155,921 | 153,086 | 152,900 | 152,913 | 154,522 | 153,185 | 152,911 |
| Operating profit | 96,914 | 119,450 | 129,881 | 144,148 | 143,646 | 143,766 | 145,263 | 143,796 | 148,336 | 155,654 | 146,614 | 143,790 | 143,582 | 143,605 | 145,213 | 143,878 | 143,603 |
| Profit before tax | 62,344 | 91,244 | 107,559 | 127,522 | 141,922 | 146,871 | 152,458 | 155,381 | 164,335 | 176,066 | 172,667 | 173,903 | 178,100 | 182,667 | 189,028 | 182,308 | 196,676 |
| Net profit | 62,344 | 91,244 | 107,559 | 127,522 | 99,903 | 104,301 | 109,055 | 112,127 | 119,304 | 128,396 | 127,116 | 128,968 | 132,930 | 137,185 | 142,727 | 146,130 | 150,281 |
| Accumulated net profit | 62,344 | 153,588 | 261,147 | 388,669 | 488,572 | 592,873 | 701,928 | 814,055 | 933,359 | 1,061,755 | 1,188,871 | 1,317,839 | 1,450,769 | 1,587,954 | 1,730,681 | 1,876,811 | 2,027,092 |
| Case 1-2(After expansion): | | | | | | | | | | | | | | | | | |
| Gross profit | 107,238 | 129,028 | 139,471 | 110,145 | 193,059 | 202,993 | 204,838 | 203,369 | 207,895 | 215,206 | 206,228 | 203,408 | 203,212 | 203,225 | 204,835 | 203,497 | 203,223 |
| Operating profit | 96,914 | 119,450 | 129,881 | 99,999 | 182,595 | 192,486 | 194,331 | 192,863 | 197,391 | 204,702 | 195,723 | 192,904 | 192,707 | 192,720 | 194,327 | 192,993 | 192,718 |
| Profit before tax | 62,344 | 90,580 | 106,936 | 71,465 | 158,887 | 174,913 | 183,517 | 189,417 | 201,275 | 216,000 | 215,845 | 220,362 | 227,598 | 236,628 | 244,679 | 248,608 | 255,434 |
| Net profit | 62,344 | 90,580 | 106,936 | 71,465 | 116,867 | 132,343 | 140,114 | 146,163 | 156,244 | 168,331 | 170,293 | 175,427 | 182,428 | 191,147 | 182,693 | 187,686 | 193,244 |
| Accumulated net profit | 62,344 | 152,924 | 259,860 | 331,325 | 448,192 | 580,535 | 720,649 | 866,812 | 1,023,056 | 1,191,387 | 1,361,680 | 1,537,107 | 1,719,535 | 1,910,682 | 2,093,375 | 2,281,061 | 2,474,305 |

| Description | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Case 0-2(Existing facilities): | | | | | | |
| Gross profit | 152,914 | 152,915 | 152,917 | 153,039 | 152,911 | 154,520 |
| Operating profit | 143,606 | 143,608 | 143,608 | 143,732 | 143,603 | 145,212 |
| Profit before tax | 201,741 | 207,030 | 212,468 | 217,838 | 223,207 | 232,593 |
| Net profit | 155,026 | 159,988 | 165,094 | 170,103 | 175,220 | 183,414 |
| Accumulated net profit | 2,182,118 | 2,342,106 | 2,507,200 | 2,677,303 | 2,852,523 | 3,035,937 |
| Case 1-2(After expansion): | | | | | | |
| Gross profit | 203,226 | 206,157 | 203,400 | 203,248 | 203,120 | 204,729 |
| Operating profit | 192,721 | 195,652 | 192,894 | 192,743 | 192,615 | 194,224 |
| Profit before tax | 262,000 | 271,604 | 275,659 | 282,179 | 289,027 | 300,911 |
| Net profit | 199,437 | 207,743 | 212,300 | 218,496 | 225,040 | 235,431 |
| Accumulated net profit | 2,673,742 | 2,881,485 | 3,083,785 | 3,312,281 | 3,537,321 | 3,772,752 |

3) Cash flow

Outline of cash flow as the result of calculation is shown in Table 6.2-19 and Table 6.2-20.

a) Case 1-1 (Without escalation)

Though cash flow after the expansion in the current year is inferior to the case of no expansion in the year of start-up of the expansion facilities, it dominates from the subsequent year of start-up of the expansion facilities because of remarkable increase of sales revenue of products.
And year end cash balance after the expansion exceeds it in the case of no expansion in the fourth year after the year of start-up of the expansion facilities, that is, the year 2000.

As a result of the above cash position, cash balance after the expansion at the projection year end is 1.2 times against the case of no expansion.

b) Case 1-2 (With escalation)

Cash flow after the expansion in the current year is in the same position to the above a). Year end cash balance after the expansion exceeds it in the case of no expanion in the second year after start-up of the expansion facilities, that is, the year 1998.

As a result of the above cash position, year end cash balance after the expansion at the projection year end is 1.2 times against the case of no expansion like a) above.

Therefore, the investment for the expansion facilities can be said effective on cash flow.

Table 6.2-19 Outline of Cash Flow
(Without escalation)

(Unit:1000US$)

| Description | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case 0-1(Existing facilities): | | | | | | | | | | | | | | | | | |
| Sales revenue | 325,854 | 355,674 | 356,499 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 |
| Interest received on short-term deposits | | 731 | 2,682 | 5,318 | 8,194 | 10,608 | 12,917 | 15,642 | 18,359 | 21,137 | 23,590 | 25,972 | 28,667 | 31,460 | 34,446 | 37,244 | 40,034 |
| Repayment of long-term loans | 38,318 | 48,552 | 34,523 | 26,248 | 22,599 | 18,216 | 13,830 | 13,830 | 13,830 | 13,834 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 |
| Cash balance | -37,865 | 48,725 | 81,344 | 94,413 | 97,298 | 63,660 | 90,235 | 91,430 | 89,709 | 95,476 | 68,066 | 90,751 | 88,932 | 97,269 | 101,805 | 84,678 | 101,350 |
| Year end cash balance | 9,395 | 58,120 | 139,464 | 233,877 | 331,175 | 394,835 | 485,070 | 576,500 | 666,209 | 761,685 | 829,751 | 920,502 | 1,009,434 | 1,106,703 | 1,208,508 | 1,293,186 | 1,394,536 |
| Case 1-1(After expansion): | | | | | | | | | | | | | | | | | |
| Sales revenue | 325,854 | 355,674 | 356,499 | 330,671 | 468,551 | 482,400 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 |
| Interest received on short-term deposits | | 721 | 2,623 | 4,526 | 6,849 | 9,806 | 12,549 | 15,493 | 18,346 | 21,327 | 24,137 | 26,950 | 30,209 | 33,813 | 37,932 | 41,879 | 45,685 |
| Repayment of long-term loans | 38,318 | 48,552 | 34,523 | 26,248 | 22,599 | 22,338 | 32,404 | 36,984 | 36,984 | 36,988 | 38,324 | 38,324 | 34,202 | 19,751 | 15,170 | 15,170 | 15,170 |
| Cash balance | -37,865 | 48,061 | 78,715 | 48,150 | 113,015 | 84,155 | 98,700 | 97,582 | 92,590 | 106,138 | 81,184 | 106,351 | 110,899 | 129,412 | 145,156 | 118,019 | 135,679 |
| Year end cash balance | 9,395 | 57,456 | 136,171 | 184,321 | 297,336 | 381,491 | 480,191 | 577,773 | 670,363 | 776,501 | 857,685 | 964,036 | 1,074,935 | 1,204,347 | 1,349,503 | 1,467,522 | 1,603,201 |

| Description | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Case 0-1(Existing facilities): | | | | | | |
| Sales revenue | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 | 356,740 |
| Interest received on short-term deposits | 43,204 | 46,558 | 50,022 | 53,264 | 56,843 | 61,514 |
| Repayment of long-term loans | 15,170 | 15,170 | 15,173 | 13,782 | ,0 | 0 |
| Cash balance | 109,986 | 113,610 | 117,343 | 98,777 | 139,803 | 171,598 |
| Year end cash balance | 1,504,522 | 1,618,132 | 1,735,475 | 1,834,252 | 1,974,055 | 2,145,653 |
| Case 1-1(After expansion): | | | | | | |
| Sales revenue | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 | 483,029 |
| Interest received on short-term deposits | 49,900 | 54,237 | 58,625 | 62,830 | 67,412 | 73,309 |
| Repayment of long-term loans | 15,170 | 15,170 | 15,170 | 13,782 | 0 | 0 |
| Cash balance | 145,330 | 143,820 | 148,687 | 131,689 | 173,760 | 219,336 |
| Year end cash balance | 1,748,531 | 1,892,351 | 2,041,038 | 2,172,727 | 2,346,487 | 2,565,823 |

Table 6.2-20 Outline of Cash Flow
(With escalation)

(unit:1000US$)

| Description | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case O-2(Existing facilities): | | | | | | | | | | | | | | | | | |
| Sales revenue | 341,671 | 391,031 | 410,952 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 |
| Interest received on short-term deposits | | 1,109 | 3,860 | 7,576 | 11,790 | 15,379 | 18,695 | 22,456 | 26,236 | 30,110 | 33,687 | 37,201 | 41,050 | 45,042 | 49,265 | 53,336 | 57,434 |
| Repayment of long-term loans | 38,318 | 48,552 | 34,523 | 26,248 | 22,599 | 18,216 | 13,830 | 13,830 | 13,830 | 13,834 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 | 15,170 |
| Cash balance | -30,770 | 73,962 | 109,379 | 138,363 | 142,573 | 96,688 | 124,394 | 126,336 | 125,704 | 132,555 | 105,894 | 128,359 | 128,264 | 137,835 | 143,749 | 127,807 | 145,586 |
| Year end cash balance | 9,395 | 83,357 | 192,736 | 331,099 | 473,672 | 570,360 | 694,754 | 821,090 | 946,794 | 1,079,349 | 1,185,243 | 1,313,602 | 1,441,866 | 1,579,701 | 1,723,450 | 1,851,057 | 1,996,643 |
| Case I-2(After expansion): | | | | | | | | | | | | | | | | | |
| Sales revenue | 341,671 | 391,031 | 410,952 | 399,685 | 566,414 | 583,082 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 |
| Interest received on short-term deposits | | 1,099 | 3,798 | 6,681 | 10,350 | 14,827 | 18,935 | 23,264 | 27,528 | 31,969 | 36,294 | 40,648 | 45,493 | 50,764 | 56,635 | 62,337 | 67,876 |
| Repayment of long-term loans | 38,318 | 48,552 | 34,523 | 26,248 | 22,599 | 22,586 | 34,241 | 39,395 | 39,395 | 39,399 | 40,735 | 40,735 | 36,365 | 20,324 | 15,170 | 15,170 | 15,170 |
| Cash balance | -30,770 | 73,298 | 106,625 | 85,543 | 169,014 | 129,426 | 144,485 | 144,101 | 140,124 | 155,957 | 132,367 | 157,935 | 165,075 | 186,299 | 205,135 | 174,956 | 194,336 |
| Year end cash balance | 9,395 | 82,693 | 189,318 | 274,861 | 443,875 | 573,301 | 717,786 | 861,887 | 1,002,011 | 1,157,968 | 1,290,335 | 1,448,270 | 1,613,345 | 1,799,644 | 2,004,779 | 2,179,735 | 2,374,071 |

| Description | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Case O-2(Existing facilities): | | | | | | |
| Sales revenue | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 | 431,194 |
| Interest received on short-term deposits | 61,951 | 66,691 | 71,583 | 76,295 | 81,387 | 87,676 |
| Repayment of long-term loans | 15,170 | 15,170 | 15,173 | 13,782 | 0 | 0 |
| Cash balance | 155,538 | 160,505 | 165,622 | 148,492 | 190,982 | 228,290 |
| Year end cash balance | 2,152,181 | 2,312,686 | 2,478,308 | 2,626,800 | 2,817,782 | 3,046,072 |
| Case I-2(After expansion): | | | | | | |
| Sales revenue | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 | 583,839 |
| Interest received on short-term deposits | 73,877 | 80,041 | 86,291 | 92,410 | 98,965 | 106,982 |
| Repayment of long-term loans | 15,170 | 15,170 | 15,170 | 13,782 | 0 | 0 |
| Cash balance | 205,724 | 205,234 | 211,393 | 196,521 | 240,528 | 293,949 |
| Year end cash balance | 2,579,795 | 2,785,029 | 2,996,422 | 3,192,943 | 3,433,471 | 3,727,420 |

4) Balance sheet

The major financial ratios in balance sheet such as debt equity ratio, fixed assets to net worth ratio (FTNR), current ratio, and quick ratio are shown in Table 6.2-21 and Table 6.2-22.

Table 6.2-21 Major Financial Ratios in Balance Sheet
Case 0-1 and 1-1 (Without escalation)

| Description | 1995 | 1998 | 2005 | 2010 |
|---|---|---|---|---|
| Case 0-1: | | | | |
| D/E ratio | 51:49 | 36:64 | 14:86 | 6:94 |
| FTNR | 98.2% | 43.0% | 10.4% | 5.5% |
| Current ratio | 4767.9% | 1580.5% | 3072.8% | 4209.7% |
| Quick ratio | 2523.3% | 1169.8% | 2696.1% | 3857.5% |
| Case 1-1: | | | | |
| D/E ratio | 58:42 | 47:53 | 13:87 | 6:94 |
| FTNR | 90.4% | 73.8% | 16.0% | 6.6% |
| Current ratio | 3273.4% | 1392.1% | 2832.1% | 3375.9% |
| Quick ratio | 1716.1% | 1001.2% | 2478.3% | 3108.7% |

Note:
D/E ratio:
(Debt/Debt+Equity)×100:(Equity/Debt+Equity)×100
FTNR :(net fixed assets/equity)×100
Current ratio:(Current assets/Current liabilities)×100
Quick ratio :(Quick assets/Current liabilities)×100

Table 6.2-22 Major Financial Ratios in Balance Sheet
Case 0-2 and 1-2 (With escalation)

| Description | 1995 | 1998 | 2005 | 2010 |
|---|---|---|---|---|
| Case 0-2: | | | | |
| D/E ratio | 47:53 | 30:70 | 11:89 | 5:95 |
| FTNR | 82.0% | 32.3% | 7.5% | 3.9% |
| Current ratio | 5712.0% | 1517.7% | 3135.0% | 4374.1% |
| Quick ratio | 3398.5% | 1209.3% | 2844.5% | 4102.0% |
| Case 1-2: | | | | |
| D/E ratio | 55:45 | 41:59 | 10:90 | 5:95 |
| FTNR | 76.1% | 56.5% | 11.7% | 4.8% |
| Current ratio | 3828.1% | 1403.6% | 3096.7% | 3653.5% |
| Quick ratio | 2262.8% | 1099.8% | 2814.4% | 3443.1% |

Note:
D/E ratio:(Debt/Debt+Equity)×100:(Equity/Debt+Equity)×100
FTNR :(Net fixed assets/equity)×100
Current ratio:(Current assets/Current liabilities)×100
Quick ratio :(Quick assets/Current liabilities)×100

## 6.2.8. Internal rate of return on investment fund

### 1) Definition of calculation method

The internal rate of return (IRR) on investment fund is defined as discount rate equalizing net present value of investment funds and net present value of returns earned by investments and shown as "R" calculated in the following formula:

$$\sum_{t=0}^{n} \frac{It}{(1+R)^t} = \sum_{t=0}^{n} \frac{St}{(1+R)^t}$$

It: Investment funds in the t-th year
St: Returns in the t-th year

According to the above formula, IRR on the total investment (ROI) and IRR on Equity (ROE) are calculated in the following conditions:

a) ROI

It : Investments in the t-th year
St : Returns in the t-th year
=Profit after tax + depreciation cost + amortization cost of deferred assets + interest expense - interest income - yearly additional working capital fund + book value of fixed assets and inventories at the projection year end + working capital fund at the projection year end

Note 1): The above returns are calculated by deducting returns incurred in the existing facilities.
2): Fixed assets and inventories remaining at the projection year end are assumed to be sold with book value at the projection year end.

b) ROE

It : Paid-up capital in the t-th year

St : Returns in the t-th year
=Profit after tax + depreciation cost + amortization cost of deferred assets + interest expense on short-term debt - interest income - repayment of long-term debt - yearly additional working capital fund + book value of fixed assets and invenories at the projection year end + working capital fund at the projection year end

Note 1): The above returns are calculated by deducting returns incurred in the existing facilities.

2): Fixed assets and inventories remaining at the projection year end are assumed to be sold with book value at the projection year end.

2) IRR

The result of calculation of IRR is shown in Table 6.2-23.

Table 6.2-23 IRR

| Description | ROI | ROE |
|---|---|---|
| Case 1-1 ( Without escalation) | 13.15% | 16.68% |
| Case 1-2 ( With escalation) | 16.15% | 22.56% |

6.2.9. Sensitivity analysis

The following sensitivity analysis is made to base case described below to examine the change in IRR and the result is shown in Table 6.2-24.

1) Case 1-1 (Without escalation) as base case

a) Increasing the equipment funds by 10% as follows:
--- Simulation A

(Unit:1000US$)

| Base case | Simulation A |
|---|---|
| 192,194 | 211,413 |

b) Decreasing the equipment funds by 10% as follows:
--- Simulation B

(Unit:1000US$)

| Base case | Simulation B |
|---|---|
| 192,194 | 172,975 |

c) Increasing the sales price of Bar and Rod by 10% as follows: ---Simulation C

(Unit:US$/ton)

| Description | Base case | Simulation C |
|---|---|---|
| Bar | 320.1 | 352.1 |
| Rod | 320.1 | 352.1 |

d) Decreasing the sales price of Bar and Rod by 10% as follows: --- Simulation D

(Unit:US$/ton)

| Description | Base case | Simulation D |
|---|---|---|
| Bar | 320.1 | 288.1 |
| Rod | 320.1 | 288.1 |

2) Case 1-2 (With escalation) as base case

Fluctuating the escalation rate as follows:
--- Simulation E

| Description | Base case | Simulation E |
|---|---|---|
| Domestic cost/exp. | 5% | 10% |
| Import | 4 | 7 |

Table 6.2-24 Sensitivity Analysis

| Description | ROI | ROE |
|---|---|---|
| Base case 1-1 | 13.15% | 16.68% |
| Simulation A | -1.28 | -2.27 |
| Simulation B | +1.47 | +2.63 |
| Simulation C | +4.08 | +8.12 |
| Simulation D | -4.61 | -8.29 |

| Description | ROI | ROE |
|---|---|---|
| Base case 1-2 | 16.15% | 22.56% |
| Simulation E | +3.77 | +7.32 |

Note : The values in this table shows the change against the IRR of base case.

## 7. ECONOMIC EFFECTS

As described in CHAPTER 2, the Third Five-year Plan for Economic and Social Development (3rd FYP) started in July 1992 is characterized by the continuous intention to rehabilitate the productive base of national economy by encouraging private sector companies and reducing subsidies so as to finally overcome financial deficits and foreign exchange shortage.

### 7.1. Construction of an Intergrated Steel Works

One of the major characteristics of steelmaking industry is its capital intensiveness. However, as it requires wide range of suppoting industries, steelmaking offers a most efficient prescription to the Egyptian economy with respect to its unemployment problem.

Taking into account other characteristics of the steelmaking and the situation in Egypt as aforementioned, the efficiency of the construction of an integrated steel works could be examined as follows:

#### 7.1.1. Domestic market oriented and import substitute

1) With this project, the market risk is minimum, since it is domestic market oriented and to substitute import goods.

2) The import substitute improves the balance of payment.

#### 7.1.2. Large scale of the steelmaking industry

Among the considerable industrial development projects, it is the advantage of the steelmaking industry that, as a single project, it contributes greatly to the national economy:ANSDK is expected to form a US$500 million industry.

7.1.3. Effective utilization of resources

Natural resources utilized directly by the project are as follows:

| | Annual consumption (after expansion) |
|---|---|
| Natural gas | 283 million $Nm^3$ |
| Limestone | 129,800 tons |
| Ferro-silicon | 5,400 tons |
| Aluminium | 160 tons |
| Coke breeze | 26,600 tons |

### 7.1.4. Ripple effect on industry

Promotion of the steel industry, especially integrated steel works, will have ripple effects on the development of industries which consume steel products (forward-linkage effect) as well as those that are suppliers to the steel industry (backward-linkage effect).

As the ripple effect of the project on other industries, promotion of the following industries can be expected.

- Bar and rod fabrication
- Transportation
- Construction
- Piping and other engineering works
- Manufacture of various parts
- Repair and maintenance
- Manufacture and distribution of various materials and office supplies
- Others

## 7.2. Foreign Currency Saving Effect

For the Without Escalation Case in this study report, the amount of foreign currencies saved by ANSDK by the implementation of the expansion project was studied and the result is shown in Table 7-1.

a) Decrease in the amount of import of steel products

It is assumed that the price of imported steel is based on US$320/ton and that the import amount of steel products is cut by the quantity of production by ANSDK.

b) Foreign currencies required

On the other hand, the initial investment including the equipment fund and the fund for yearly import of raw materials, spare parts and other consumables is assumed as the foreign currencies required for achieving the import substitution.

c) Amount of foreign currencies saved

The difference between the decrease in the amount of import of steel products and the amount of required foreing currencies is the amount of foreign currencies saved by ANSDK as a result of the expansion. The amount of foreign currencies saved is expected to reach US$200 million.

Table 7-1 Balance of Saved Foreign Currencies after the Expansion

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production (1,000 tons) | | | | | | | | | | | | |
| Bar | 568 | 568 | 568 | 568 | 568 | 568 | 568 | 568 | 568 | 568 | 568 | 568 |
| Rod | 456 | 898 | 938 | 938 | 938 | 938 | 938 | 938 | 938 | 938 | 938 | 938 |
| Commercial billet | — | 43 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Total | 1,016 | 1,509 | 1,512 | 1,510 | 1,510 | 1,510 | 1,510 | 1,510 | 1,510 | 1,510 | 1,510 | 1,510 |
| CIF price of imported materials (US$) | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 |
| Decrease in amount of imported products (US$1,000) | 325,120 | 482,880 | 483,840 | 483,200 | 483,200 | 483,200 | 483,200 | 483,200 | 483,200 | 483,200 | 483,200 | 483,200 |
| Amount of imported spare parts and other supplies (US$1,000) | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 | 8,400 |
| Amount of imported raw materials (US$1,000) | 101,104 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 | 187,748 |
| Repayment of loan principal in foreign currencies (US$1,000) | 26,248 | 22,599 | 22,338 | 32,404 | 36,984 | 36,984 | 36,988 | 38,324 | 38,324 | 34,202 | 19,751 | 15,170 |
| Rayment of loan interest in foreign currencies (US$1,000) | 17,895 | 25,039 | 23,522 | 21,125 | 18,459 | 15,790 | 13,122 | 9,471 | 6,894 | 4,688 | 3,783 | 3,290 |
| Foreign currency balance (US$1,000) | 171,473 | 239,094 | 241,832 | 233,523 | 231,609 | 234,318 | 236,942 | 239,257 | 241,834 | 248,162 | 263,518 | 268,592 |

# 8. CONCLUSION AND RECOMMENDATION

## 8.1. Conclusion

With respect to the update of the feasibility study for ANSDK's expansion project conducted by JICA from 1987 to 1988 and reported early 1988, a realistic expansion plan is discovered, which is advantageous not only to ANSDK but also to Egypt, through the field survey conducted by JICA in March 1993, analysis of steel market and developing plan of the domestic industries, evaluation of operation and management in ANSDK, review of the expansion plan, and economic reanalysis.

The aim of the expansion project is to increase rolled products from the present production of over 1.0 million t/y to some 1.5 million t/y by means of minimum investment and maximum utilization of the existing facilities.

According to the economic analysis based on the updated concept of the expansion project to produce more 0.4 million t/y of rolled products than the present rolled production, ROI is about 13%, a very attractive figure.

In addition to this considerable ROI, the amount of the investment for the updated expansion plan is rather small for the steel mill and not difficult to induce finance.

Though some fluctuation of ROI is generated depending upon market price of steel products, overrun of construction cost, etc., the ROI is still attractive.

The implementation of the updated expansion project will also contribute to the improvement of financial condition of ANSDK.

As the conclusion of this feasibility study, early decision to start the expansion project by means of the updated expansion plan is recommended not only to ANSDK but also to Egypt.

Furthermore, it is desired that ANSDK will start planning for further expansion after the present expansion project to increase the production capacity and expand the product mix in El Dikheila Iron and Steel Works by analyzing the market trend of steel products in Egypt with respect to steel demand and trend of requirement for steel grade.

## 8.2. Recommendation

Although the ROI of the updated expansion project is about 13%, which is a considerable level, the following measures will be recommendable to improve the profit of ANSDK.

1) Lowering the price of natural gas

The price of natural gas is about three times as high as in other oil-producing countries. Though Stage-1 was started aimed at effective use of Abu Qir natural gas, this high price only weakens the competitiveness with other mills.

2) Lowering the charge for the use of mineral jetty and stock yard

The present charge for the use of the mineral jetty and stock yard is as high as US$4.4/pellet-ton (US$6.6/DRI-ton). This high charge has lowered the cost competitiveness of ANSDK's products.

Therefore it is recommended that ANSDK should take measures to reduce the charge for the use of the mineral jetty and stock yard.

The following are examples of the charge for the use of mineral jetty and stock yard in foreign countries:

a) Mill A in the Middle East

Mill A pays US$3 per pellet ton. This fee consists of basic fee, cleaning fee of pellets dropped in the harbour and painting fee of handrails along the harbour, stevedore fee, etc.

b) Mill B in South America

Mill B pays US$1 per HBI ton including maintenance cost of the unloader and jetty.

3) Minimizing the cost overrun

The investment cost should be kept within the planned values by negotiations with contractors, good engineering and management to avoid additional cost, optimum cooperation between ANSDK, JC and contractors, etc.

Historically, it is obvious that such governmental assistance has greatly contributed to early establishment of the steel industry in a number of countries and has been considered inevitable for the take-off stage of the steel industry. It deserves the fullest consideration again that strong support of the Egyptian Government is essential in carrying out the expansion project of ANSDK.

JICA