4-2 Coke

The same considerations as in the case of ferro-manganese are applicable to coke used for production of ferrochromium.

4-3 Silica

The same considerations as in the case of ferro-silicon are applicable to the silica used for production of ferrochromium.

4-4 Serpentinite

Serpentinite is required as a source of magnesia, which functions as a flux in the ferrochromium production process. It can be replaced by peridotite and dolomite. Use of material containing 35% or more MgO, little iron and in particle sizes ranging from 10 to 300 mm is recommended.

4-5 Electrode Paste

The same considerations as in the case of ferro-manganese are applicable to electrode paste required for production of ferrochromium.

5. Ferrochromium Production Project in Paraguay

5-1 Plant Site

The criteria for selection of the plant site are the same as in the case of the ferromanganese project. In particular, in the case of ferrochromium there is little possibility of chromium ore, the key raw material for production of ferrochromium, existing in Paraguay. Accordingly, the materialization of this project relies unavoidably on imports of raw materials. It is recommended that this plant be sited on the outskirts of Asuncion in view of the convenience for fluvial transportation and the availability of infrastructure for supply of electrical energy.

5-2 Sources and Prices of Raw Materials

For the chromium ore supply source, imports from South Africa are recommended in view of the transportation distance to the plant site, quality, stability of supply, etc. Ferrochromium produced using chromium ore of South African origin has a low chromium content of the order of 50 to 55%, however, because the ore itself has a low Cr/Fe ratio. Should it be desired to turn out ferrochromium with a high percentage of chromium, it is best to import high Cr/Fe ratio ore from other sources such as Albania, India, Philippines, etc.

As for the supply of coke, import of this material from the USA is recommended to ensure stable supply. Silica and serpentinite can be obtained them from domestic sources.

For the electrode paste, import of this material from Brazil, which is located nearly, is recommended.

The expected plant site CIF prices of the raw materials required for production of ferrochromium are as follows:

Table V-5 Plant CIF Prices of Raw Materials for Production of Ferrochromium

(Unit: US$/ton)

	Source	Exporting Country FOB	Ocean Freight	Fluvial Freight	Other Expenses	Total Plant Site CIF
Chromium Ore (lump)	South Africa	53.00	20.00	35.00	7.70	115.70
Chromium Ore (powder)	South Africa	48.00	20.00	35.00	7.60	110.60
Coke	USA	76.00	28.00	35.00	8.90	147.90
Silica	Domestic					26.00
Serpentinite	Domestic					16.00
Electrode Paste	Brazil	450.00	30.00	35.00	19.00	534.00

5-3 Production Scale of Plant

With respect to the production scale of the ferrochromium plant, furnaces with the largest annual production capacity in the world are of the order of 60,000 tons, in view of the same restrictive conditions which apply to ferromanganese production. Furnaces with an annual production capacity of the 20,000 ton class seem to present the best balance between ease of operation and economy.

On the other hand, when producing ferrochromium in Paraguay, an annual capacity of the 9,000 ton class is recommended to start with as this is adequate to learn operating techniques and at the same time is the minimum scale from the economical point of view. This is termed Case A here. A furnace with an annual production capacity of 20,000 tons termed Case B, is the average economical. The study is done assuming two model plants with the capacities mentioned above.

6. Estimation of Model Plant Construction Cost

The cost of construction of a model plant is estimated on the same premises as in the case of the ferromanganese project.

The estimated costs for construction of the principal facilities are indicated in Table V-6.

7. Expected Operation Conditions of the Model Plant

The operating conditions for the plant scales assumed in Case A and Case B, based on conditions related to the raw materials expected for the project and taking into consideration the empirical data available on similar cases accumulated so far, are estimated to be those indicated in Table V-7.

The flow sheet of this plant is shown in Figure V-7.

Table V-6 Investments, for Construction of Principal Facilities

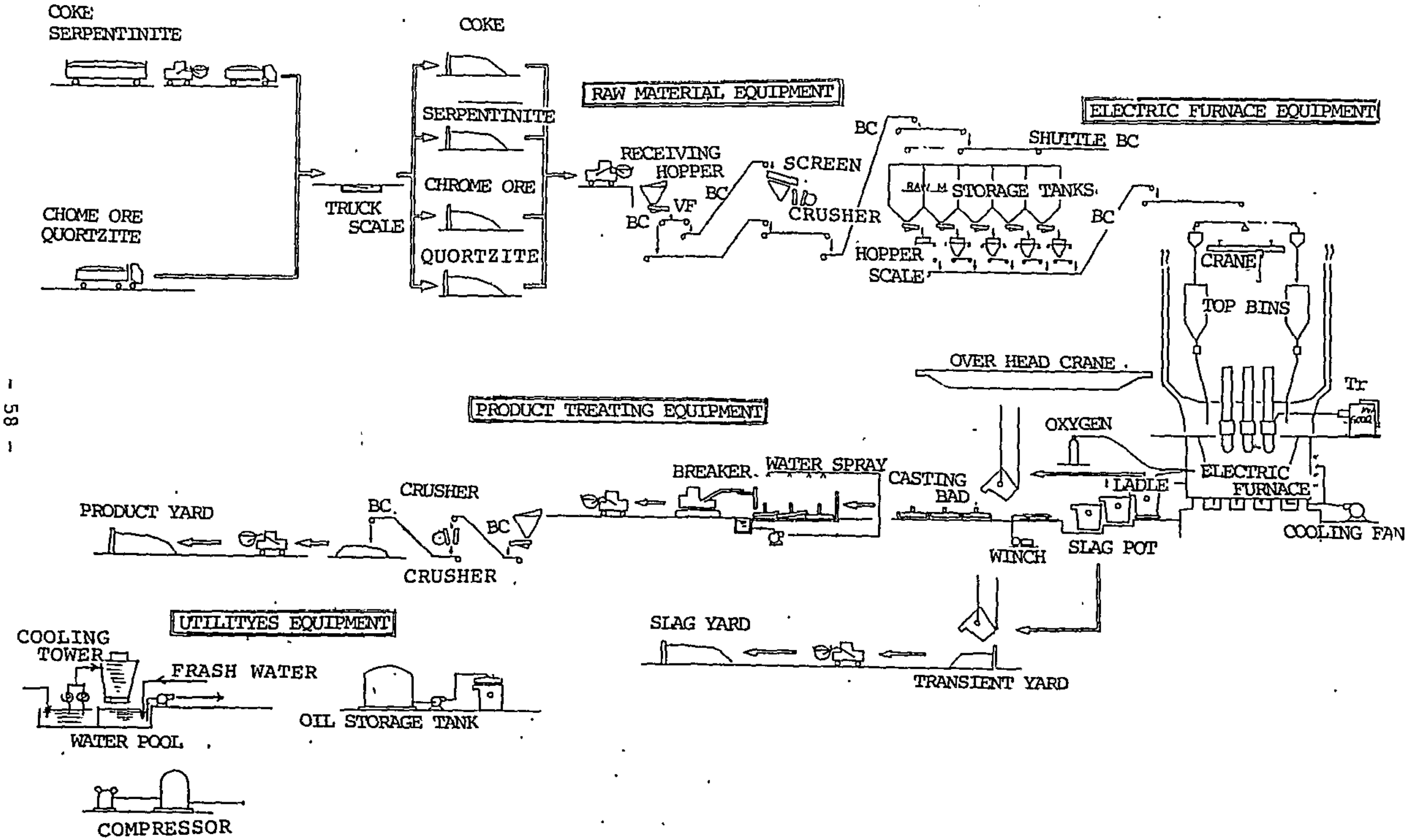
(Unit: US$1,000)

	CASE A	CASE B
Total Construction Cost of the Plant	18,000	30,400
Raw material facilities	1,530	2,580
Electric furnaces	5,630	9,520
Finished product handling facilities	600	1,000
Substation facilities	1,050	1,760
Utility facilities	2,200	3,680
Sheds	5,580	9,400
Others	1,410	2,460

Table V-7 Operation Conditions of the Ferrochromium Plant

	Unit	Case A	Case B
Transformer Capacity	KVA	7,000	16,000
Transformer Power Factor	%	75	72
Average Load	KW	4,600	9,500
Electrical Energy Consumption	MWH/Y	37,500	77,500
Basic Electrical Energy Unit	KWH/T	4,050	3,950
Production of Ferrochromium	T/Y	9,260	19,600
Product Yield	%	93	93
Product Quantity	T/Y	8,500	18,000
Land for Construction of the Plant	m^2	55,000	95,000
Cooling Water Quantity	T/H	80	200
Personnel Requirement for Operation	Persons	(62)	(82)
Management staff	"	1	1
Engineers	"	1	1
Technicians	"	6	6
Workers	"	54	74
Basic Raw Material Unit	KG/T		
Chromium Ore	"	1,852	1,865
Coke	"	470	470
Silica	"	136	138
Serpentinite	"	428	403
Electrode Paste	"	18	18
Number of Days of Operation	Day	340	340

Fig V - 7 FcrH FLOW SHEET



VI. Estimation of Cost in Ferroalloy Model Plant

1. Exfactory Price of Model Plant, Estimated on the Basis of Market Price of the Product

The ex-factory prices of the model plant in Paraguay, estimated on the premise of export of the ferroalloy products to Euro-American markets and based on world prices, are indicated in the Table VI-1.

The study is carried out assuming moderate market prices because the current market prices of ferroalloys are abnormally low.

Table VI-1 Estimated Ex-factory Prices of Model Plant Products

(Unit: US$/T)

	Market Price CIF	Transportation Cost			Total Trans-portation Cost	Ex-factory Price of the Model Plant of Paraguay
		Ocean Trans-portation	Fluvial Trans-portation	Other Costs		
Ferromanganese	400 (350)	25 (")	35 (")	11.70 (11.30)	71.70 (71.30)	328.30 (278.70)
Silicomanganese	430 (380)	25 (")	35 (")	11.80 (11.50)	71.80 (71.50)	358.20 (308.50)
Ferrosilicon	700 (600)	25 (")	35 (")	13.70	73.70 (73.00)	626.30 (527.00)
Ferrochromium	610 (530)	25 (")	35 (")	13.00 (12.50)	73.00 (72.50)	537.00 (457.50)

Note: Figures in parenthesis are current market price bases.

2. Estimation of Product Cost

The estimated cost of each product is indicated in Table VI-2-1. The product cost is estimated on the following premises:

(1) Depreciation (for details of installation cost, refer to Table on installation construction cost for each product)

20-year straight line depreciation is assumed in this cost estimation.

(2) Interest

It is assumed that all investment funds required are covered with loans at an annual interest rate of 10%. The reimbursement period of the principal is assumed to be 15 years.

(3) Real asset tax and insurance

Omitted in this calculation.

(4) Personnel expenditures (for details of required personnel, refer to table on operation conditions for each product).

Wages per function are assumed to be as follows:

Manager:	US$48,000/Y
Engineer:	US$24,000/Y
Technician:	US$14,000/Y
Worker:	US$ 6,000/Y

(5) Maintenance cost

Assumed as 2% of installation cost

(6) Raw material cost

Basic units and prices of raw materials are given in Table VI-2-2.

(7) Marketing cost

Assumed as 10% of production cost.

(8) Head office cost

Assumed as 3% of production cost.

(9) The infrastructure is not taken into consideration in this calculation.

(10) Exchange rate

Assumed as ¥250/US$.

Table VI-2-1 Estimated Cost of Ferroalloys in Paraguay

	Ferromanganese				Silicomanganese				Ferrosilicon				Ferrochromium			
	Case A		Case B		Case A		Case B		Case A		Case B		Case A		Case B	
Average Load (KW)	3500		11.000		5000		15.700		7.000		22.000		4600		9500	
Annual Production (T/Y)	9500		31.000		7800		24600		6000		19.700		8500		18000	
	$/T	Share	$/T	Share	$/T	Share	$/T	Share	$/T	Share	$/T	Share	$/T	Share	$/T	Share
(Fixed costs)																
Depreciation	68.210	9.1	45.437	7.2	93.506	10.4	61.943	8.4	150.000	13.5	82.234	9.5	94.186	10.9	75.165	9.6
Interest	80.842	10.8	53.851	8.5	110.779	12.3	73.401	10.0	177.833	16.0	97.462	11.3	111.628	12.9	89.066	11.3
Sub-Total (1)	149.052	19.9	99.288	15.7	204.285	22.7	135.344	18.4	327.833	29.5	179.696	20.3	205.814	23.8	164.231	20.9
(Variable costs)																
Raw materials	354.030	47.1	360.100	56.9	327.944	36.4	331.867	45.2	222.584	20.1	227.266	26.3	300.966	34.9	304.942	38.9
Electricity	78.000	10.4	77.100	12.1	137.100	15.2	136.200	18.6	270.000	24.3	261.000	30.2	121.500	14.0	118.500	15.1
Consumption materials, etc.	35.000	4.7	34.000	5.4	31.000	3.4	30.000	4.1	41.000	3.7	40.000	4.6	40.000	4.6	40.000	5.1
Byproduct income	△30.016	△4.0	△49.224	△7.8	—		△30.246	△4.1	—		—		—		—	
Labour cost	48.000	6.4	19.029	3.0	55.584	6.2	19.352	2.6	54.666	4.9	20.406	2.4	55.814	6.4	32.967	4.2
Maintenance cost	30.316	4.0	20.194	3.2	41.818	4.6	27.530	3.7	66.667	6.0	36.548	4.2	41.860	4.8	33.407	4.3
Sub-Total (2)	515.330	68.6	461.199	72.8	593.446	65.8	514.703	70.1	654.917	59.0	585.220	67.7	560.140	64.7	529.816	67.6
Production Cost (1) + (2)	664.382	88.5	560.487	88.5	797.731	88.5	650.047	88.5	982.750	88.5	764.916	88.5	765.954	88.5	694.047	88.5
Head Office Cost	19.951	2.7	16.815	2.7	23.932	2.7	19.501	2.7	29.483	2.7	22.947	2.7	22.979	2.7	20.821	2.7
Marketing Cost	66.438	8.8	56.049	8.8	79.773	8.8	65.005	8.8	98.275	8.8	76.492	8.8	76.595	8.8	69.405	8.8
Total Cost	750.751	100.0	633.351	100.0	901.436	100.0	734.553	100.0	1110.508	100.0	864.355	100.0	865.528	100.0	784.273	100.0

Table VI-2-2 Estimated Basic Units of Ferroalloy Raw Materials in Paraguay (Kg/T)

		Ferro-manganese		Silico-manganese		Ferro-silicon		Ferro-chromium	
		A	B	A	B	A	B	A	B
	$/T								
Ampa lump	130.2	1,056	991	-	-				
Assoman HG	130.2	338	248	-	-				
Mamatwan lump	109.6		568	628	-				
BHP HG	135.0	718	451	816	856				
BHP MG	108.4			-	600				
Slag from high carbon ferro-manganese	44.8			730	714				
Chromium ore lump	115.7							1,305	1,865
Chromium ore fine	110.6							547	-
Quartzite	26.0			744	685	1,846	1,910	136	138
Serpentine	16.0							428	403
Limestone	14.0	159		507	669				
Scale	40.0					300	300		
Coke	147.9	469	461	498	512	663	678	470	470
Coal	100.0					353	359		
Wood chips	20.0					260	270		
Electrode paste	534.0	15	15	30	30	45	45	18	18
Total		2,755	2,734	3,954	4,066	3,467	3,562	2,904	2,894

- to be continued -

		Ferro-manganese		Silico-manganese		Ferro-silicon		Ferro-chromium	
		A	B	A	B	A	B	A	B
Amount of electricity	KWH/T	2,600	2,570	4,570	4,540	9,000	8,700	4,050	3,950
	$/T								
Returned slag	44.8	670	638	1,575	1,590	-	-	-	-
Furnace gas	0.048/ Nm^3	-	430	-	630	-	-	-	-

3. Influence of Electricity Unit Price on Estimated Cost

Of the 4 types of ferroalloys taken into consideration in this study, ferromanganese requires the smallest consumption of electricity while ferrosilicon requires the largest. Electricity costs for unit prices varying in 4 steps from US1¢/KWH to 4¢/KWH are calculated for Model Case B of both products and their influence on production costs are indicated in Table VI-3.

Table VI-3 Influence of Electricity Cost on Ferroalloy Production Cost

	Unit price of electricity	US 1¢/KWH	2	3	4
Ferromanganese	Basic electricity consumption unit (KWH/T)	2,570	Same as left	Same as left	Same as left
	Electricity cost (US$/KWH)	25.7	51.4	77.1	102.8
	Electricity cost/ Production cost (%)	4.4	9.6	13.8	17.5
Ferrosilicon	Basic electricity consumption unit (KWH/T)	8,700	Same as left	Same as left	Same as left
	Electricity cost (US$/KWH)	87.0	174.0	261.0	348.0
	Electricity cost/ Production cost (%)	14.7	25.7	34.1	40.8

As indicated in the table above, the influence of the unit price of electricity on the production cost is more pronounced for products with larger consumption of electricity. When the unit price of electricity varies 1¢, the percentage of the production cost of ferromanganese will be affected by approximately 4%, while in the case of ferrosilicon it is approximately 10%.

VII. International Competitiveness of Estimated Cost

The estimated costs of the model plants of Paraguay calculated in this study are indicated in Table VI-2-1. The production costs of all 4 kinds of ferroalloys exceed by far not only the ex-factory price estimated from current market prices but also the plant ex-factory prices (Table VI-1) assumed as moderate market prices. The principal reasons for this discrepancy are explained below, referring to the composition of the cost.

(1) The depreciation and interest represent a large percentage of the cost because the model plants are newly constructed. For instance, even in case B, which is a model plant of average world scale, it reaches 15 to 20%.

(2) The transportation cost is high because Paraguay is an inland country. Particularly when a large proportion of the material is imported, th- fluvial transportation cost alone contributes to increasing the raw material cost by at least US$100/ton.

(3) A further basic problem is the fact that the moderate market price is assumed on the basis of the profitability line for traditional ferroalloy makers which have raw materials available from domestic sources, electricity available at low cost and depreciation of the production facilities is advanced.

Countermeasures studied with care to cope with the aforesaid demerits are therefore required in order to make possible participation of Paraguay in the world market. Examples of such countermeasures are described below:

(1) The installation cost can be cut to less than half of the amounts estimated in this study by raising low interest rate funds (interest free funds in extreme cases).

(2) It is recommended to exploit domestically available minerals in order to cut down transportation costs. For example, ferrosilicon and ferromanganese are promising ferroalloys because quartzite is available in the country. Furthermore, there is good chance manganese ore deposits exist in Paraguay.

(3) Transportation should be rationalized through measures such as improvement of fluvial routes in order to make possible navigation of large-sized ships, etc.

(4) The feasibility of the project is evaluated assuming a unit price of US3¢/KWH for electricity. The demerits inherent to an inland country can be compensated for by making the electricity price par or lower than in other ferroalloy exporting countries. For example, in Brazil, the preferential electricity price for export industries is 1.2¢/KWH, which is half the ordinary domestic electricity rate.

Table VII World Electricity Rates (Mill /KWH)

Country	Electricity Charge	
	Ordinary Domestic Rate	Preferential Rate for Export Industries
Brazil	24	12
Venezuela	14	-
Norway	10 20	-
Canada	15	-
China *	27 63	25 33
France*	20 25	-
South Africa	20 25	-
Spain	20 25	-
India	33 38	-
Japan	60	-

Source: Metal Bulletin

Note: Figures for countries marked (*) in the table above are preferential electricity charges applicable to ferroalloy industries.

In addition to the aforementioned countermeasures, it is presumed that there are other aspects such as determination of plant scale, sharing of personnel expenditure, etc., related to the industrial policy of the nation which may compensate for the poor international competitiveness of the project.

Under the current abnormally weak world market situation, however, any project is expected to encounter difficulty regarding commercial feasibility. Accordingly, it is necessary to wait for the recovery of prices. Even with the moderate prices assumed in this study however it is not easy for the products of this project to compete in the international market.

In the case of implementation of a ferroalloy industry in Paraguay, it is indispensable to ascertain the trends in ferroalloy prices in the world market, in addition to adopting a vigorous industrialization incentive policy.

VIII. Problems Requiring Further Discussion in This Study

Fundamental elements such as data and information on the location of industrial plants in Paraguay, customs of the people, etc., were not sufficient for this study, therefore, most of the conditions taken into consideration are based on hypothesis and assumptions. Accordingly, the results obtained can be used as a reference for determination of a general direction, but accuracy is in sufficient.

It is necessary to make a further detailed study of the relevant conditions such as plant scale, construction costs, transportation of raw materials, etc., after carrying out a field survey in Paraguay, discussions with concerned authorities to collection of information, etc., in order to improve the accuracy of the study on projects of this kind.

SECTION V

IRON AND STEEL INDUSTRY
(ELECTRIC FURNACE-SMALL BAR MILL PLANT)

CONTENTS

I. Introduction

Integrated steel works adopting electric furnaces can be taken into consideration when discussing the feasibility of iron and steel as an electricity-intensive industry to be introduced in Paraguay. This country currently has no domestic production of iron and steel, however, and total demand is covered by imports from foreign countries. On the other hand, abundant electricity is expected to become available soon at very low prices. Such being the case, it is thought pertinent to start the discussion with a discussion of a mini-mill plant consisting of electric furnace and rolling mill for production of small scale non-flat products. This alternative is convenient from the following points of view:

- In a country where the iron and steel industry is at an early stage of development and there is no domestic production of these items, consumption is mainly of construction materials like steel bars for reinforced concrete and small sections.

- The mini-mill plant has a convenient scale from the point of view of capital required, management, technology, labour, etc., as a first step for the construction of an iron and steel industry.

Under the circumstances, this report discusses principally the two aspects below:

(1) General information on types, production, raw materials, etc., related to small bars, aimed at promoting a better understanding for people involved.

(2) Preliminary study of feasibility of a mini-mill plant (combination of electric furnace and rolling mill for small bars and small sections).

It is possible to produce small sections together with small bars in the mini-mill plant but in this report discussion focuses mainly on small bar because the demand for small sections is presumed to be negligible in Paraguay.

ACEPAR (Acero del Paraguay S.A.) is currently constructing a blast furnace integrated steel works (charcoal blast furnace - converter - continuous casting - small bar mill) in Paraguay. This report is a pre-feasibility study for a mini-mill plant using a electric furnace as a form of electricity-intensive industry and, therefore, its relation to the ACEPAR project is not discussed here. In future steps of the study, however, it will be necessary to discuss the relation between the ACEPAR project and the mini-mill project.

II. Types of Steel Bar

1. Types of Steel Products

Generally speaking, steel products are classified into non-flat steel, flat steel and steel pipes, according to external appearance. Non-flat steel is a general nomenclature which comprises steel products rolled in the form of "strips" and is classified into rails, sheet pilings, shape steel, steel bars and wire rods according to the shape of the product.

Table II-1 Types of Steel Materials

Type		Nomenclature
Non-flat steel	Rail	Heavy rail, light rail, accessories
	Sheet pile	Sheet pile, simple sheet pile
	Shape steel	H-steel, heavy shape steel, medium shape steel, small shape steel, light gauge steel, rim ring bar, sash bar
	Steel bar	Large steel bar, medium steel bar, small steel bar
	Wire rod	Ordinary wire rod, special wire rod, coil
Plate and sheet	Plate and sheet	Heavy plate, medium plate, sheet, cold-rolled sheet
	Wide hoop	Wide hoop, cold-rolled wide hoop
	Hoop	Hoop, cold-finished hoop
	Silicon steel	Silicon steel, cold-rolled silicon steel
	Plated sheet	Tin plated sheet, galvanized sheet
Steel pipe		Seamless pipe, butt welded pipe electric welded tube, spiral tube, gas welding pipe
Tyre (for rolling stock)		

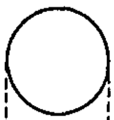
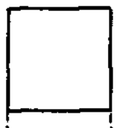
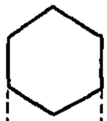
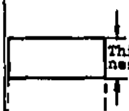
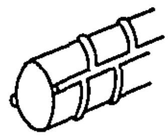
2. Types of Steel Bars

2-1 Classification by Shape and Dimensions

In terms of shape, steel bars are classified into round bar, flat bar, square bar, hexagonal bar, octogonal bar and semi-circular bar according to the cross section, and into deformed bar (protuberances on the surface), coil (bar would in the form of a coil), etc. according to the external appearance.

Steel bars are also classified as large, medium and small according to the size of the cross section. The size is expressed by the diameter in the case of round bars and semi-circular bars, by the distance between opposite sides in the case of square bars and by the width in the case of flat steel bars. In the case of deformed bar, it is converted into round bar having approximately the same cross section, and is expressed in terms of its diameter as D_{xx} (D_{19} in the case of deformed bar equivalent to round bar with 19 mm diameter).

Table: II-2-3-1-(b) Bars Classified According to Cross-sectional Shapes and Dimensions

Kind		Round Bar & Bar in Coil	Square Bar	Hexagonal Bar	Flat Bar	Half-round Bar	Deformed Bar
Cross-sectional Shape							
Cross-sectional Dimension		Diameter	Opposite Side Distance	Opposite Side Distance	Width Width x Thickness	Diameter	Expressed by the diameter of a round bar having a substantially equivalent cross-sectional area (DXX)
Classification by Cross-sectional Dimension	Large Bars	Diameter: exceeding 100 mm	Side: exceeding 100 mm	Opposite: side distance: exceeding 100 mm	Width: exceeding 130 mm	Diameter: exceeding 130 mm	-
	Medium-size Bars	Diameter: between 50 and 100 mm, both inclusive	Side: between 50 and 100 mm, both inclusive	Opposite side distance: between 50 and 100 mm, both inclusive	Width: exceeding 65 mm and not exceeding 130 mm	Diameter: exceeding 65 mm and not exceeding 130 mm	Nominal diameter: between 50 and 100 mm, both inclusive
	Small Bars	Diameter: under 50 mm	Side: under 50 mm	Opposite side distance: under 50 mm	Width: not exceeding 65 mm	Diameter: not exceeding 65 mm	Nominal diameter: under 50 mm
Production Ratio (Japan, 1974)	Large Bars	0.6%	0.09%	-	1.7%	-	-
	Medium-size Bars	2.2%	0.3%	0.06%	2.6%	0.0	-
	Small Bars	20.2%	0.6%	0.02%	3.8%	0.0	67.8%

2-2 Classification by Use

Steel bars have an extremely wide variety of uses but the principal ones are as reinforcing bars, secondary processing, machinery, ships and rolling stock. Examples of secondary products are bolts, nuts, pickaxes, hammers, cold-finished steel bars, etc. The standards for these products are determined according to their use and the corresponding quality requirements.

3. Steel Bars for Reinforced Concrete

Small bars for reinforced concrete represent the major share of steel bar production and, as can be seem from the nomenclature, they are used for reinforcing concrete.

Two types of steel bars are popularly used in reinforced concrete, namely round bars and deformed bars. This classification is in terms of the external appearance of the product but small bars for reinforced concrete can also be classified in terms of the production process used, namely hot rolled steel bars and cold-processed deformed bars (cold-processed deformed bars are not produced currently in Japan). In terms of packing form, steel bars can be classified into straight and bar in coil types.

3-1 Round Bar for Reinforced Concrete

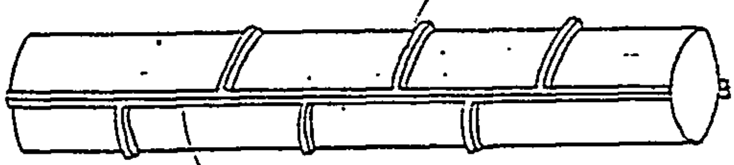
Until about 1970, approximately 50% of steel bar for reinforced concrete used to be the round type. In view of recognition of the advantages of deformed bar in reinforced concrete, however, the share of round bars has declined, being currently of the order of 20%.

3-2 Deformed Bar for Reinforced Concrete

3-2-1 General Description of Deformed Bar

As indicated in Figure II-3-2-1(a), deformed bars for reinforced concrete have protuberances on the surface, unlike traditional round steel bars. The protuberances in the longitudinal direction are called ribs, while those in the circumferential direction are called knots.

Figure II-3-2-1(a) Deformed Bar



The deformed bar was developed to solve the problem of concrete adherence, which is a weak point of round bar.

The protuberances on the surface increase the area of contact between the steel bar and the concrete and penetrate the concrete, contributing as a result to considerable improvement in adherence with the concrete and the strength of the concrete structure. Bar in coil is used as a material for construction of mesh (welded wire net) for concrete reinforcement. Bar in coil of deformed type has been developed recently in view of the excellent concrete adherence properties of deformed bar. Deformed bars are produced in the form of straight bars sized from 10 mm (D_{10}) to 51 mm (D_{51}) in steel bar plants. On the other hand, deformed bar in coil is produced in wire rod plants in the form of coils sized from 6 mm (D_6) to 13 mm (D_{13}).

3-2-2 High Tension Deformed Bar

High tension deformed bars are those with a yield point higher than 35 kg/mm^2 and a tensile strength larger than 50 kg/mm^2 according to the Japanese Industrial Standards (JIS). Concurrent with the trend toward use of lighter steel materials, the concrete structure itself tends to have a smaller volume and lighter weight. Accordingly, the use of deformed bars of the high tension type is becoming increasingly popular. Generally speaking, there are three methods for production of high tension steel, as described below:

(1) Composition Adjustment

The tensile strength of the material (billet) is increased by adjusting the chemical composition of elements such as silicon, manganese, etc., contained therein.

(2) Cold Processing

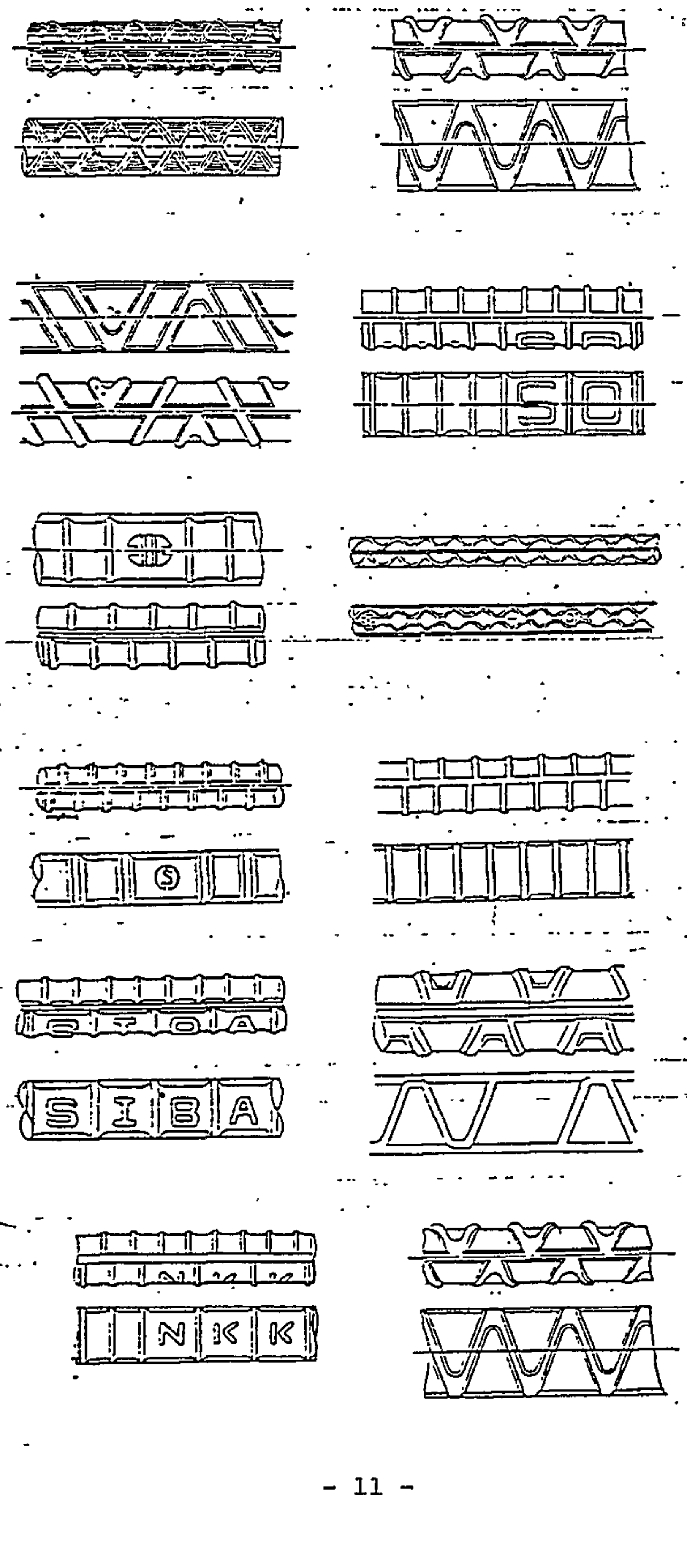
The product obtained by hot rolling is submitted to twisting (plastic deformation) under normal temperature in order to increase strength.

(3) Heat Treatment

The strength of the steel bar is increased through the hardening effect produced by quenching the bar in the finishing process following hot rolling.

Most high tension deformed bar on the Japanese market is produced through the composition adjustment process.

Figure II-3-2-1(b) Kinds of Deformed Bar in Japan



III. Operations of Small Bar Makers (Mainly Electric Furnace-Based Steel Works)

Small bars are currently produced by four different types of steel works.

(1) Blast furnace-based integrated steel works
(2) Open hearth/electric-arc furnace steelmakers
(3) Rolling makers
(4) Re-roll makers

An important peculiarity of the small bar industry is the existence of a large number of makers classified in the last 3 types listed above, unlike in the case of other steel products.

It is estimated that the number of makers are currently producing small bars in Japan is approximately 245 (including makers which suspended operation in 1976), consisting of 7 blast furnace steel works, 54 open hearth electric furnace steel works, 30 rolling makers (part of them operating also as re-roll makers) and 154 re-roll makers.

When the economy is in recession, bankruptcy, suspension of operation, merger, etc., take place often. Accordingly the number of companies operating in a certain sector of business may vary considerably.

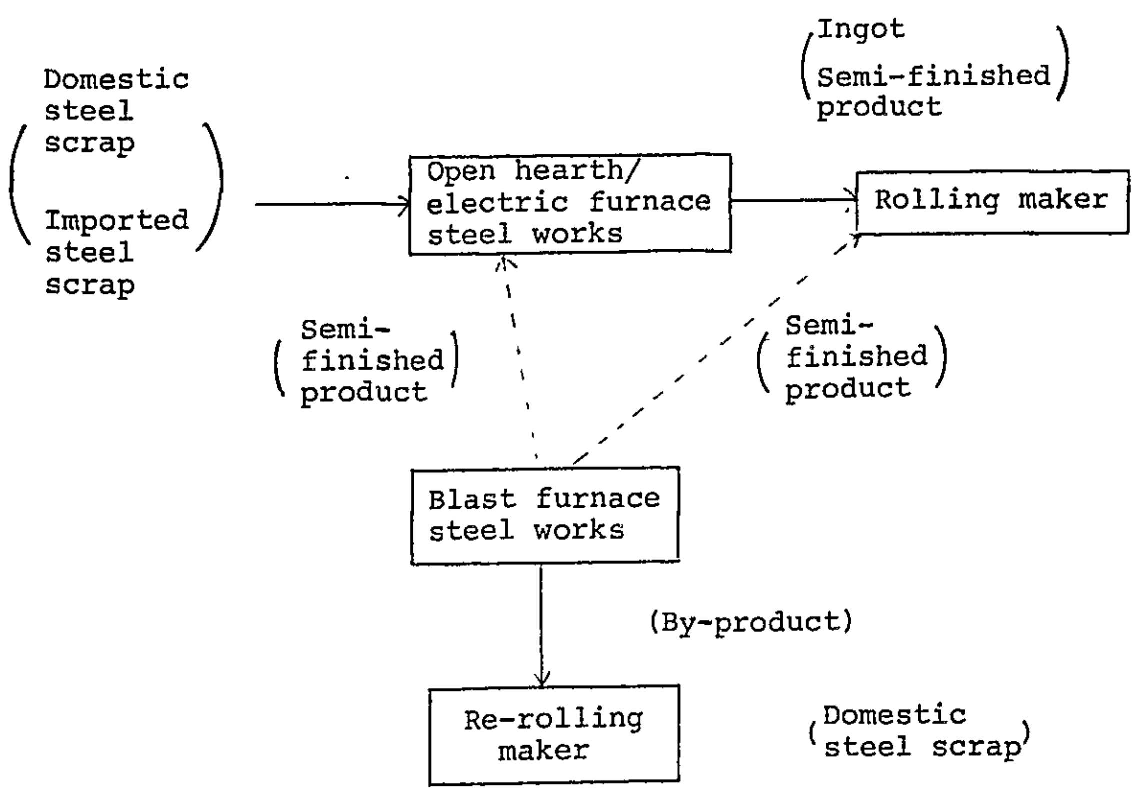
In terms of production, the open hearth/electric furnace steel works produces more than 60% of the steel, followed by rolling makers, re-roll makers and blast furnace steel works in that order. The production weight of blast furnace steel works is extremely low. This is another important peculiarity of the small bar industry - the most of the production (approximately 90%) is by medium and small makers. The aforesaid peculiarity is attributable to the facts below:

- The lots of demand for small bars are small in comparison with cold rolled sheets, slabs, and other steel products.

- The requirements for production facilities and quality of the product are not as severe as with other steel products.

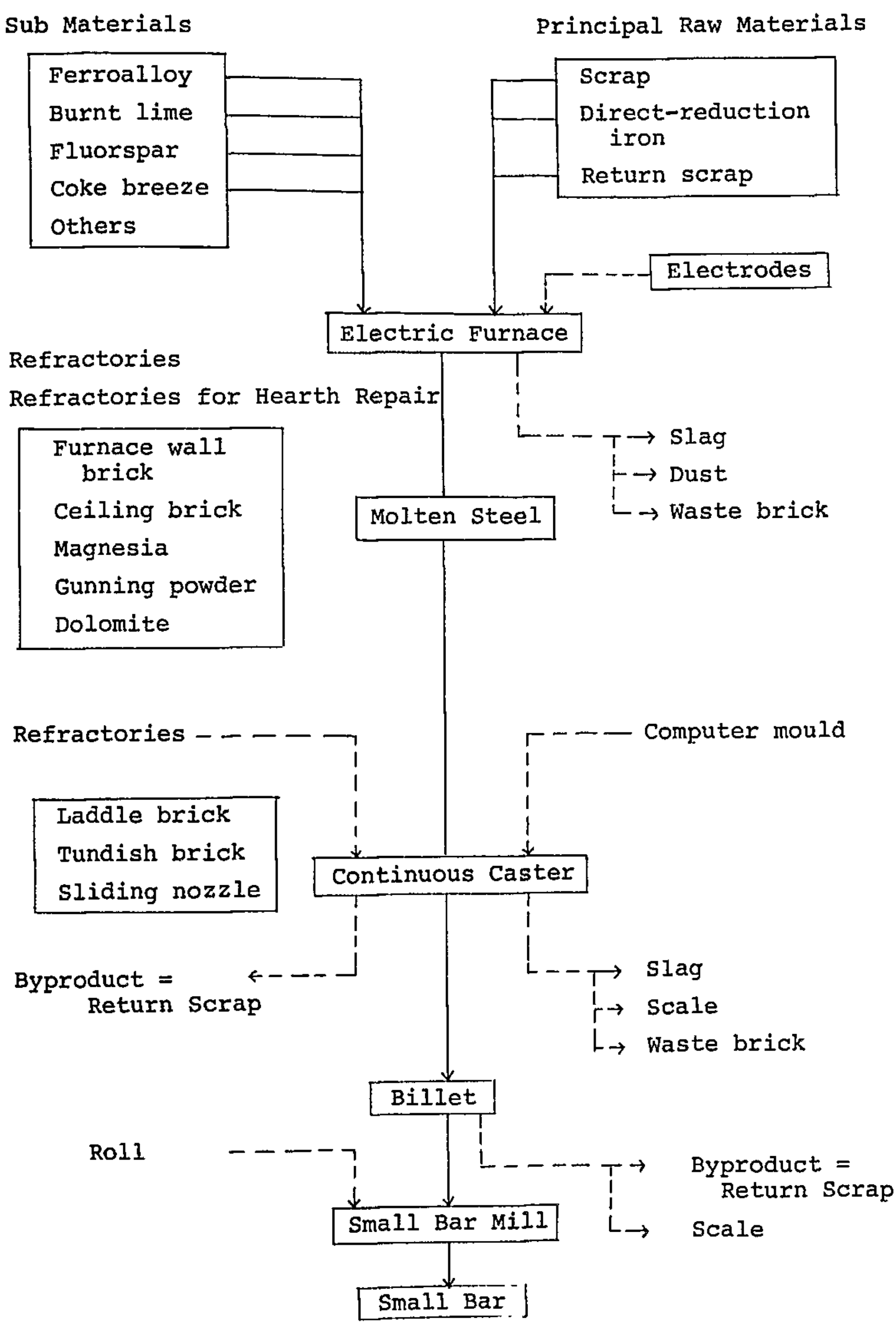
- The production system must be quite flexible.

Figure III-1 Flow of Materials



As indicated in Figure III-1, the key role in the supply of iron and steel is played by (1) blast furnace steel works which adopt the mass supply system by mass production. On the other hand, (2) electric furnace steel works, (3) rolling makers and (4) re-rolling makers supply their products to small-lot demand sectors through a flexible small-lot production system. Accordingly, their production is concentrated mostly on small bars and small shape products. Even on a worldwide scale, small bars and small shapes, the principal products of electric furnace steel works, are market-sensitive commodities for the construction industry, which is prone to be strongly affected by the prevailing economic situation. Such being the case, it is common knowledge that operation of electric furnace steel works is often unstable because profitability is subject to pronounced fluctuations according to the economic situation.

IV. Flow of Production of Small Bars in Electric Furnace Steel Works



Production Process of Small Bar Mill

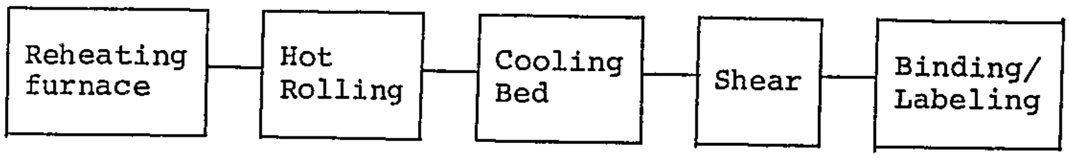
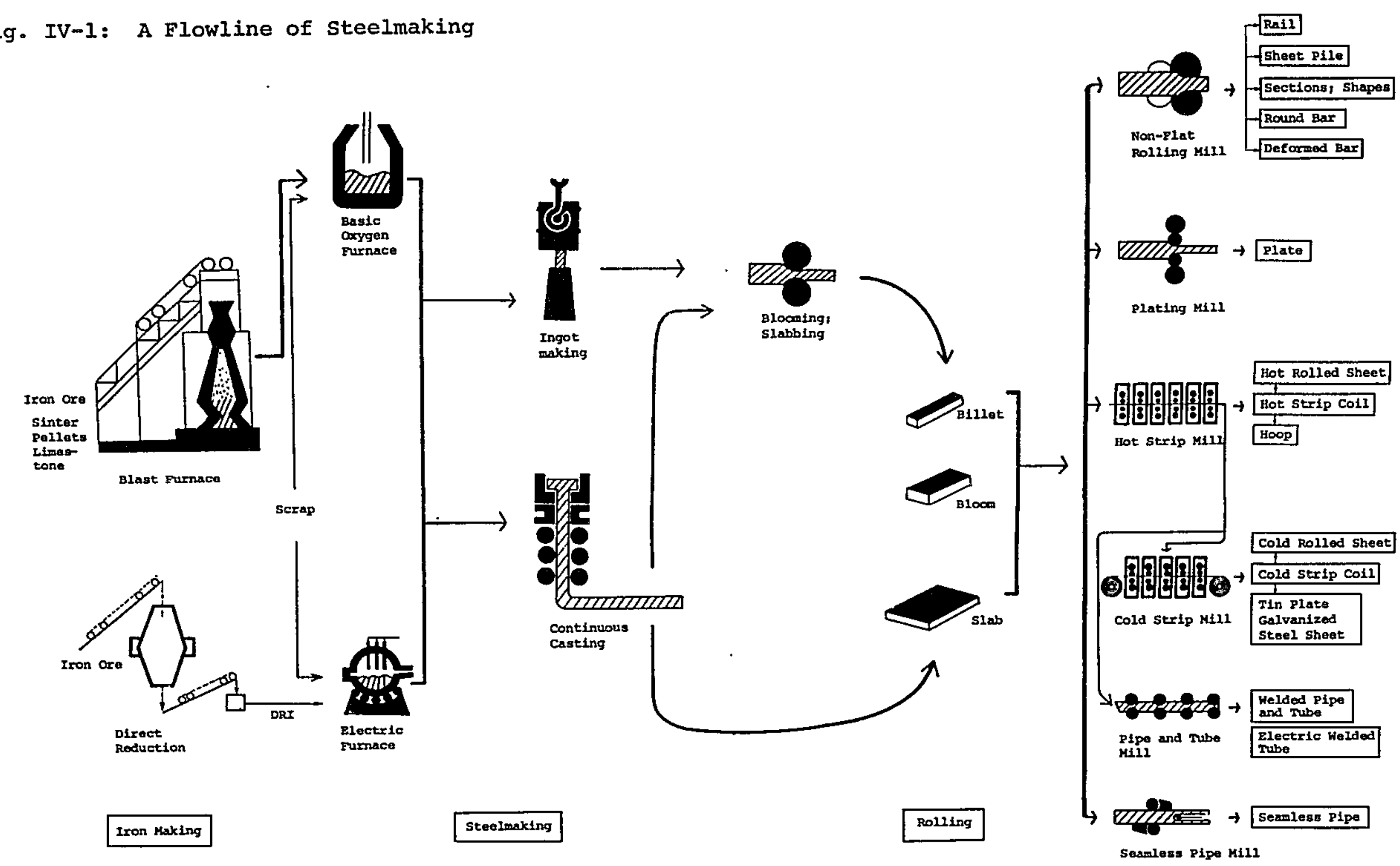


Fig. IV-1: A Flowline of Steelmaking



V. Comparison of Merits of Small Bar Production Processes

1. Cost Comparison of Blast Furnace-Converter Process and Electric Furnace Process

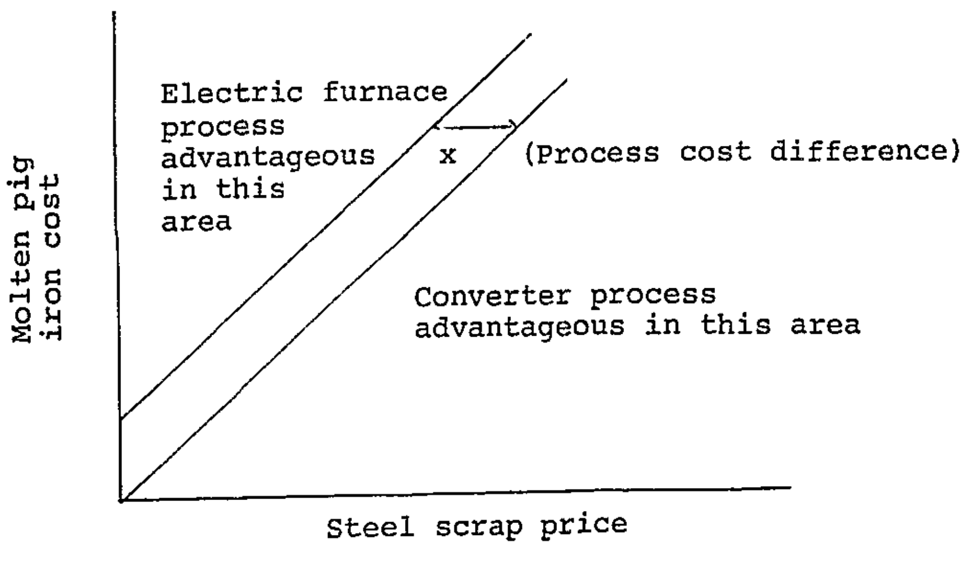
In advanced iron and steel producing countries such as Japan, West Germany, etc., the production of crude steel by means of the blast furnace-converter process represents 75 to 80% of total production. This process is popularly used in view of its economic merits. In the particular case of Japan, however, it is necessary to use pig iron as a source of Fe because the amount of steel scrap generated in the market is small, in spite of the evolution iron and steel production. In other words, in the case of the blast furnace and converter process the required raw material is economically available at stable prices, unlike in the case of the electric furnace process, where the cost of steel scrap used as raw material suffers a strong market influence.

The production of steel by means of the blast furnace and converter process involves many processes, namely coking, sintering, blast furnace and converter. In contrast, only an electric furnace is involved in the production of steel by means of the electric furnace process. In the blast furnace and converter process the required plant and equipment investment is more than twice as large as that required for the electric furnace process. On the other hand, the former process has excellent economic merits and is suited for mass production, because the work involved is rational and efficient.

At one time the electric furnace process experienced outstanding improvements regarding increases in productivity and reduction of raw material consumption through the use of ultra-high power furnaces. Particularly in the U.S., the electric furnace process became very popular because these improvements added to compactness, which is a merit inherent to the process. Soaring energy prices after the oil shock of 1973 brought about an enourmous burden in terms of production cost to the electric furance process because it relies on electricity as an energy source for operation, therefore, the converter process has become more advantageous in terms of total process cost, including variable costs and fixed costs.

The cost competitiveness of the converter process and electric furnace process is determined by the capital cost (installation cost) and the balance between the prices of molten pig iron and steel scrap. Steel scrap must be cheaper than molten pig iron in addition to the cost difference of the production process itesel, for the electric furnace process to be advantageous compared with the converter process (refer to Figure V-1).

Figure V-1



2. Example of the U.S.

A considerable portion of the production of steel bar (consisting mostly of deformed bars) in the U.S. is by small- and medium-scale companies. In particular most of the so called mini-mills, which have become very popular recently, are used for production of steel bars.

The principal reasons which make these mini-mills pertinent are described as follows.

(1) Low cost steel scrap
(2) Cheap electricity
(3) Appropriate market scale

It is reported that mini-mills are able to compete with the cost of large scale makers through use of ultra-high power electric furnaces and continuous casting facilities. These mini-mills have annual production capacities of the order of 50,000 to 500,000 tons, and produce principally concrete reinforcing bars.

As can be seen from the considerations above, the production of steel bar in the U.S. relies mostly on small and medium scale companies, as in the case of Japan. The "raison d'etre" of these companies is flexibility regarding aspects of labour, acquisition of raw materials, production, marketing, quotation, etc., and adaptability to the demands of the local market.

Generally speaking, when mini-mills compete with large scale companies and rival makers of the same scale, they offer merits such as shorter terms of delivery, specialization in the products handled, sophisticated processing, and sometimes discounts in prices. Further, they attribute more importance to quality rather than quantity and make efforts not to loose customers, therefore, there are makers which pass large lot contracts on to large scale makers and give priority to rather small lots of the order of 10 tons. Makers of this kind contact customers at least once a week. As can be seen from the considerations above, most products are sold directly by the maker to the user. Transactions of this kind account for approximately 80% of all scales.

Generally speaking, mini-mills of the U.S. which produce steel bar maintain competitiveness through the measures described below:

- Rolling of the varieties and forms of products according to local market demand.
- Investment of the minimum amounts necessary to accomplish the aforesaid.
- Training of employees to the highest degree of skill possible for the specific job.
- Use of installations of the plant up to the maximum rate of operation.

The so-called "economy of scale" has advantageous effects in the case of the mini-mill. Normally the production cost per unit (excluding the capital cost and including the raw material cost) is considerably higher in the case of mini-mills than with large-scale steel works. Comparison of the operation costs, assuming the same prices for the molten pig iron and steel scrap, shows that the electric furnace process is approximately 10% more expensive in the U.S.A. and this difference is reported to result from energy cost (electricity cost). In terms of total production cost, taking into consideration capital cost, it is presumed that there is no difference between mini-mills and large scale steel works, however. Therefore, in the case of the U.S., the key point in operation of mini-mills is obtaining of raw materials as cheaply as possible in order to make use of the merits of the capital cost instead of considering measures to cover the demerits in operation costs. Under the circumstances, steel bar makers pay special attention to raw material supply sources and restrict their market within a radius of approximately 100 miles of the factory in order to compete advantageously with large-scale makers.

It is reported that the average annual production capacity of each mini-mill is of the order of 150,000 tons. This is said to be the appropriate economic scale in terms of the aforesaid points of view of minimization of capital cost, supply of cheap steel scrap, relation between market and plant site, etc., mentioned above. The considerations above on the state of things in the U.S. are generally applicable to other countries.

VI. Raw Materials - Steel Scrap

1. Relation between Small Bar and Steel Scrap

As described in the section on production processes, small bars are produced by rolling billets. The principal raw materials of billets are iron ore and coal in the blast furnace process and steel scrap in the electric furnace process. The majority of small bar production is by electric furnace makers, therefore, the demand for steel scrap is influenced by the production of small bars. On the other hand, the production of small bars is restricted by the amount of steel scrap generated in the market. Fluctuations in the prices of small bars are reflected in the prices of steel scrap and the steel scrap market situation has an influence on the price of small bars.

Therefore, small bar and steel scrap are intimately related to each other.

In addition to steel scrap, the electric furnace process requires other sub-materials such as limestone and fluorspar as slag-formation agents, ferroalloys as composition adjustment and reductor agents, etc. The amounts of these materials is minor, however, and the share of the raw material cost is small. Accordingly, discussion of raw materials for production of small bar focuses on steel scrap.

2. Prospects of Demand for Steel Scrap

2-1 Generation of Steel Scrap

2-1-1 Purchased Scrap:

There are two types of steel scrap negotiated in the market.

Process scrap:	Scrap generated in mechanical workshops, automobile plants, shipyards, etc.
Superannuation scrap:	Scrap generated by dismantling of scrapped cars, superannuated domestic godss (automobiles, freezers, washing machines, etc.), wrecked buildings, etc.

2-1-2 Return Scrap

This is the kind of scrap which is consumed in the plant where it is generated and does not appear in the circulation market. Return scrap is generated at a fixed rate (currently approximately 15%) with regard to the production of crude steel.

2-2 Supply of Steel Scrap

2-2-1 Return Scrap

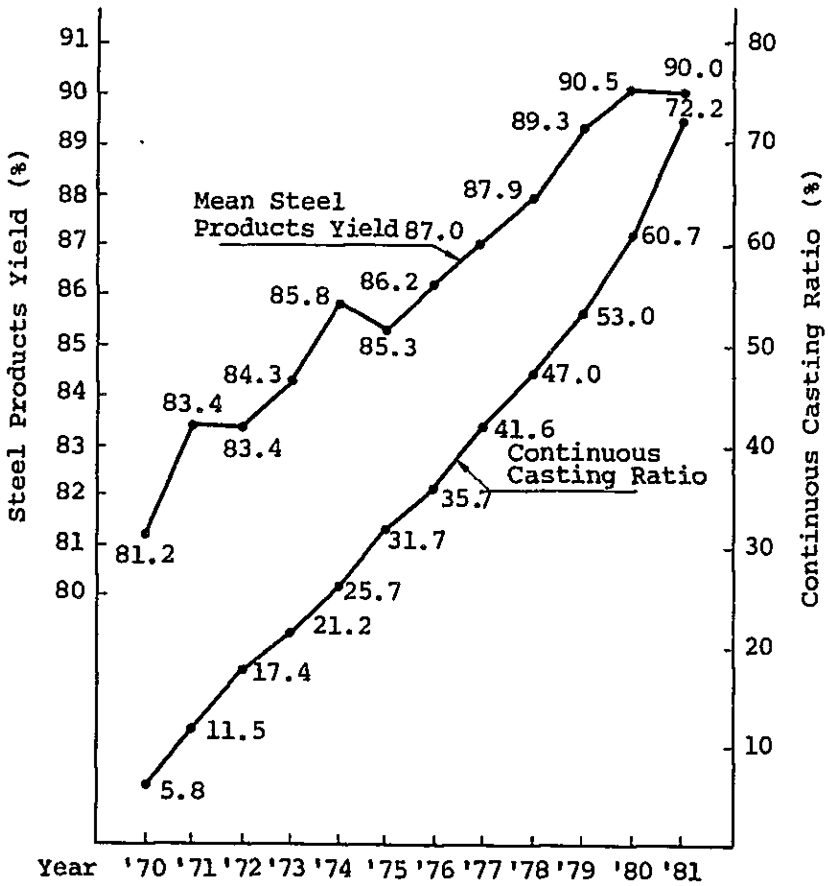
The prospect of generation of return scrap is determined by the prospect of production of crude steel and to the conditions of operation, which are related to yield when turning out a given amount of steel.

Particularly in Japan, where the conversion from the ingot making & blooming process to the continuous casting process is very advanced, the yield of steel materials from crude steel is improving considerably. In 1975 that yield was of the order of 85.3%, but by 2,000 it is expected to reach 88.6%.

The rate of generation of return scrap is dropping as a result of the improvement in yield. The rate of generation of return scrap improved to 15% in 1980 compared with 20% in 1965, and by 2,000 it is expected to drop to approximately 13%. Technical progress is keeping the generation of scrap at a minimum level in spite of the increase in production of crude steel.

Fig. VI-2-2-1

Trends in Steel Products Yield and Continuous Casting Ratio



2-2-2 Process Scrap

In Euro-American industrial countries and in Japan the supply of process scrap is expected to suffer a relative decline as a result of technical progress. On the other hand, generation of superannuation scrap is expected to increase considerably.

2-3 Steel Scrap Demand

The key point in forecasting future steel scrap demand is the proportion of the production of steel per type of furnace (i.e., converter, electric furnace, etc.) and the mixing ratio of steel scrap in each type of furnace.

2-3-1 Share of Production per Type of Furnace

As a consequence of successive construction of converters, with the technical progress and the increase in demand as a background, the production share of the Siemens-Martins furnace (open hearth furnace) is declining. The production share of electric furnaces around the world is currently of the order of 20% but opinions on whether the status quo will continue or concurrently with the increase in crude steel production are not unified among experts.

2-3-2 Steel Scrap Mixing Ratio

The demand for steel scrap is determined not only by the production share per type of furnace but also by the mixing ratio of scrap in either type of furnace. Raw material charged in electric furnaces contains minor amounts of ferroalloys and slag generating agents but in essence it consists of steel scrap. As far as the steel scrap is used as the principal raw materials, the mixing ratio in electric furnaces is not expected to suffer significant changes in future.

On the other hand, the mixing ratio of steel scrap in converters is decided by synthesizing the factors below:

- Steel scrap price trends
- State of supply and price of fuel
- Operation efficiency
- Supply and demand product
- Capacity of the installation, etc.

2-3-3 Future Prospects

There is no unified opinion about future prospects of electric furnaces, steel scrap and direct reduction iron but the most convincing points of view of experts are as follows:

Iron and steel are expected to become more important for developing countries in the coming decade and most of the additional steelmaking capacity to be constructed in this period is expected to be based on electric furnaces. The average annual growth rate of steelmaking capacity in Europe and the U.S. is expected to be less than 1% in the coming decade. On the other hand, in the developing countries it is expected to be far larger, of the order of 25 to 40%. In 1980 the share of electric furnaces in world steelmaking capacity was of the order of 20%. By 1990 the electric furnace production capacity in terms of crude steel is expected to double, reaching 30%. Electric furnace steelmaking has many merits and these are the cause of the aforementioned increase in production share. The construction cost of an electric furnace plant based on steel scrap is approximately 1/2 that one of an integrated steel works. When using direct-reduction iron and the raw material, the construction cost is approximately 60%.

The size of electric furnaces is becoming increasingly large, with some exceeding by far the scale of ordinary converters. The use of direct-reduction iron is making possible the production of types of steel which used to be exclusive to integrated steelworks and is further reducing the degree of reliance on steel scrap. Direct-reduction iron should be considered a subsidiary raw material in the electric furnace steelmaking process rather than a substitute for steel scrap because the demand for steel scrap is expected to surpass supply in future. It is expected that many electric furnace steelmakers will be forced to import steel scrap, with a negative influence on their international competitiveness resulting due to increased transportation cost.

The U.S. has considerable sources of steel scrap but there are doubts about whether there will be the capacity to cope with sudden increases in demand. The Soviet Union used to export steel scrap but is now increasing its electric furnace steelmaking capacity and therefore the amount of scrap available from that country in future is expected to decline.

2-4 Current Status of Import and Export of Steel Scrap

As shown in Table VI-2-4-1 and Table VI-2-4-2, the principal scrap steel exporter in the world is the U.S. The quantity of steel scrap exported by the U.S. is practically equivalent to the total consumption of Latin American countries (11.489 million tons) in 1980. In 1980 it exported 10.173 million tons.

Table VI-2-4-1 Evolution of Steel Scrap Export/Import by Country (Unit: 1,000 tons)

E: Export I: Import		Japan		U.S.		W. Germany		Great Britain		France		Belgium/Luxemburg		Italy		Netherlands	
		E	I	E	I	E	I	E	I	E	I	E	I	E	I	E	I
1971 (S46)		373	2,552	5,674	257	2,143	1,042	1,024	294	2741	249	450	630	9	5,479	560	91
1972 (S47)		222	2,499	6,697	330	2,099	1,204	1,091	40	3,000	239	394	026	15	5,679	031	176
1973 (S48)		200	5,409	10,211	354	2,270	1,470	742	222	2,788	436	659	690	10	5,604	1,101	172
1974 (S49)		301	3,559	7,888	224	2,407	1,005	311	135	3,727	320	727	069	11	6,274	1,302	165
1975 (S50)		275	3,093	0,027	330	2,204	1,710	914	00	2,009	277	531	706	5	5,413	1,095	204
1976 (S51)		203	1,802	7,367	534	2,597	1,540	597	609	3,425	200	527	506	24	6,272	957	160
1977 (S52)		211	1,440	5,602	1,660	2,401	1,420	937	100	3,357	207	501	493	11	5,025	925	113
1978 (S53)		1,64	3,229	0,417	757	2,765	1,647	1,565	459	3,664	394	532	900	7	6,566	1,190	166
1979 (S54)		151	3,346	10,130	735	2,990	1,605	1,330	36	3,526	422	550	971	13	6,091	1,241	125
1980 (S55)		159	2,906	10,173	506	3,075	1,504	2,005	26	3,296	436	537	059	0	7,411	1,195	153
Breakdown for 1980	W. Germany	—	1	06	·	—	—	320	4	154	109	195	296	2	2,322	542	59
	France	—	·	46	4	113	163	64	·	—	—	164	160	6	2,609	13	3
	Italy	—	·	027	·	2,316	5	158	·	2,590	1	29	·	—	—	49	·
	Belgium/Luxemburg	—	·	8	·	299	167	71	2	152	160	—	—	·	16	320	20
	Netherlands	—	·	11	7	31	542	70	1	1	12	37	296	·	44	—	—
	EC (6)	—	1	970	11	2,759	077	699	7	2,097	202	425	760	0	4,991	924	02
	Breat Britain	·	1	4	·	2	200	—	—	·	01	·	65	·	162	·	52
	Ireland	—	—	·	—	—	2	0	14	—	·	—	4	·	·	—	·
	Denmark	—	·	·	—	20	74	136	1	—	·	—	5	·	·	·	1
	EC (9)	·	2	982	11	2,759	1,241	043	22	2,097	365	425	034	0	5,153	924	135
	Spain	—	—	1,055	—	5	·	1,010	·	392	·	20	4	·	1	193	—
	Greece Countries	—	1	494	—	—	—	1	—	·	·	·	—	·	3	3	1
	Other Western Europe	—	·	343	7	197	49	00	1	4	1	91	3	·	74	30	2
	Soviet Union &	—	119	31	·	56	170	43	·	·	·	1	·	—	797	33	7
	Canada Eastern	—	14	717	432	—	2	·	1	—	4	—	2	—	123	—	2
	U.S. Europe	·	2,581	—	—	·	25	·	2	—	56	—	15	—	1,147	—	2
	Mexico	—	—	1,052	23	—	—	—	—	—	·	—	—	—	—	—	—
	Argentina	·	·	·	—	—	—	—	—	—	—	—	—	—	—	—	—
	India	·	2	84	—	—	—	15	—	·	—	·	—	—	·	·	·
	Japan	—	—	2,575	23	—	—	·	·	—	·	—	—	·	·	—	—
	South Korea	81	7	1,575	·	—	—	—	—	—	—	—	—	—	2	—	—
	Taiwan	1	16	898	—	—	—	1	—	—	—	—	·	—	—	—	·
	Other Asian Countries	70	30	226	·	20	5	6	·	3	5	·	·	—	24	3	1
	Australia	—	104	·	·	·	·	—	·	—	·	—	·	—	1	—	·

Table VI-2-4-2 U.S. Steel Scrap Export Record

(Unit: 1,000 tons)

Country \ Year	1971 S46	1972 S47	1973 S48	1974 S49	1975 S50	1976 S51	1977 S52	1978 S53	1979 S54	1980 S55
Japan	1,583 (28.7%)	2,095 (32.2%)	4,233 (42.6%)	2,702 (35.1%)	2,181 (25.0%)	1,141 (15.5%)	947 (16.9%)	2,894 (34.4%)	2,651 (26.2%)	2,575 (25.3%)
Italy	533 (9.7%)	670 (10.3%)	318 (3.2%)	439 (5.7%)	556 (6.4%)	657 (8.9%)	189 (3.4%)	595 (7.1%)	1,076 (10.6%)	827 (8.1%)
Spain	552 (10.0%)	608 (9.3%)	1,021 (10.3%)	813 (10.5%)	1,566 (18.0%)	1,695 (23.0%)	715 (12.8%)	675 (8.0%)	1,270 (12.5%)	1,055 (10.4%)
South Korea	269 (4.9%)	337 (5.2%)	701 (7.1%)	618 (8.0%)	717 (8.2%)	867 (11.8%)	1,397 (24.9%)	1,364 (16.2%)	1,287 (12.7%)	1,575 (15.5%)
Taiwan	352 (6.4%)	386 (5.9%)	621 (6.2%)	443 (5.7%)	276 (3.2%)	276 (3.7%)	405 (7.2%)	357 (4.2%)	575 (5.7%)	898 (8.8%)
Canada	811 (14.7%)	825 (12.7%)	767 (7.7%)	852 (11.1%)	628 (7.2%)	808 (11.0%)	474 (8.5%)	939 (11.1%)	883 (8.7%)	717 (7.1%)
Mexico	500 (9.1%)	527 (8.1%)	917 (9.2%)	807 (10.5%)	1,187 (13.6%)	540 (7.3%)	311 (5.6%)	409 (4.9%)	739 (7.3%)	1,052 (10.3%)
China	—	—	387 (3.9%)	172 (2.2%)	159 (1.8%)	—	—	—	—	—
Argentina	57 (1.0%)	210 (3.2%)	204 (2.1%)	—	312 (3.6%)	82 (1.1%)	115 (2.1%)	—	7 (0.1%)	—
Others	859 (15.5%)	852 (13.0%)	776 (7.7%)	862 (11.2%)	1,136 (13.0%)	1,301 (17.7%)	1,049 (18.7%)	1,184 (14.1%)	6,142 (16.2%)	1,474 (14.5%)
Total	5,516 (100.0%)	6,510 (100.0%)	9,946 (100.0%)	7,708 (100.0%)	8,718 (100.0%)	7,367 (100.0%)	5,602 (100.0%)	8,417 (100.0%)	10,130 (100.0%)	10,173 (100.0%)

Note: International Trade Statistics of Each Country.

VII. Price of Small Bar and Steel Scrap

The prices of small bar and steel scrap are basically determined by the relation between supply and demand as in the case of other commodities. Steel scrap is a special commodity because it is a "generated" product and therefore its price is determined principally by the price of small bars and by the relation between demand and supply in addition to other subsidiary factors like the prices of pig iron and direct-reduction iron, steel scrap cost, etc.

1. Steel Scrap Price in the U.S.

As can be seen in Table VII-1, the price of steel scrap in the U.S. in the 3 year period from 1979 to 1981 declined from $136.5/t (February, 1979) to $79/t (September, 1981). The price of this commodity then continued to decline, reflecting recession in the U.S. steelmaking industry, reaching a price of the order of $60/t (composite) as of September, 1982. The price on an FOB basis is presumed to be of the order of $60 to $70.

2. Price of Small Bar

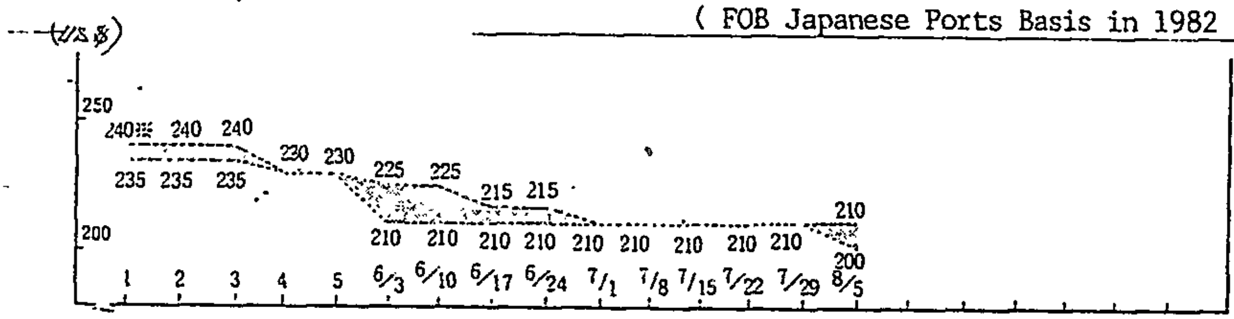
As can be seen in Table VII-2-1, the price of small bar exported from Europe declined from $24 to $200 (actual export price of Belgium, FOB basis) during the January to August period in 1982.

Table VII-2-1 Price of Small Bar for Concrete

Steel bar for concrete reinforcement (Fob basis)

Table VII - 2 - 1 Trends in Reinforcing Bar Prices

(FOB Japanese Ports Basis in 1982)



Source: Metal Bulletin

The prices of small bar in Latin American countries are indicated in Table VII-2-2. The price levels are quite uneven due to circumstances such as price controls by the state, etc., but generally speaking small bars are negotiated at relatively high price levels compared with Europe and the U.S.

3. Relation between Prices of Small Bar and Steel Scrap

Examples of prices of small bar and steel scrap in Japan are indicated in Table VII-3-1 and Table VII-3-2.

Fig. VII-1 Trends in U.S.A. Steel Scrap Prices

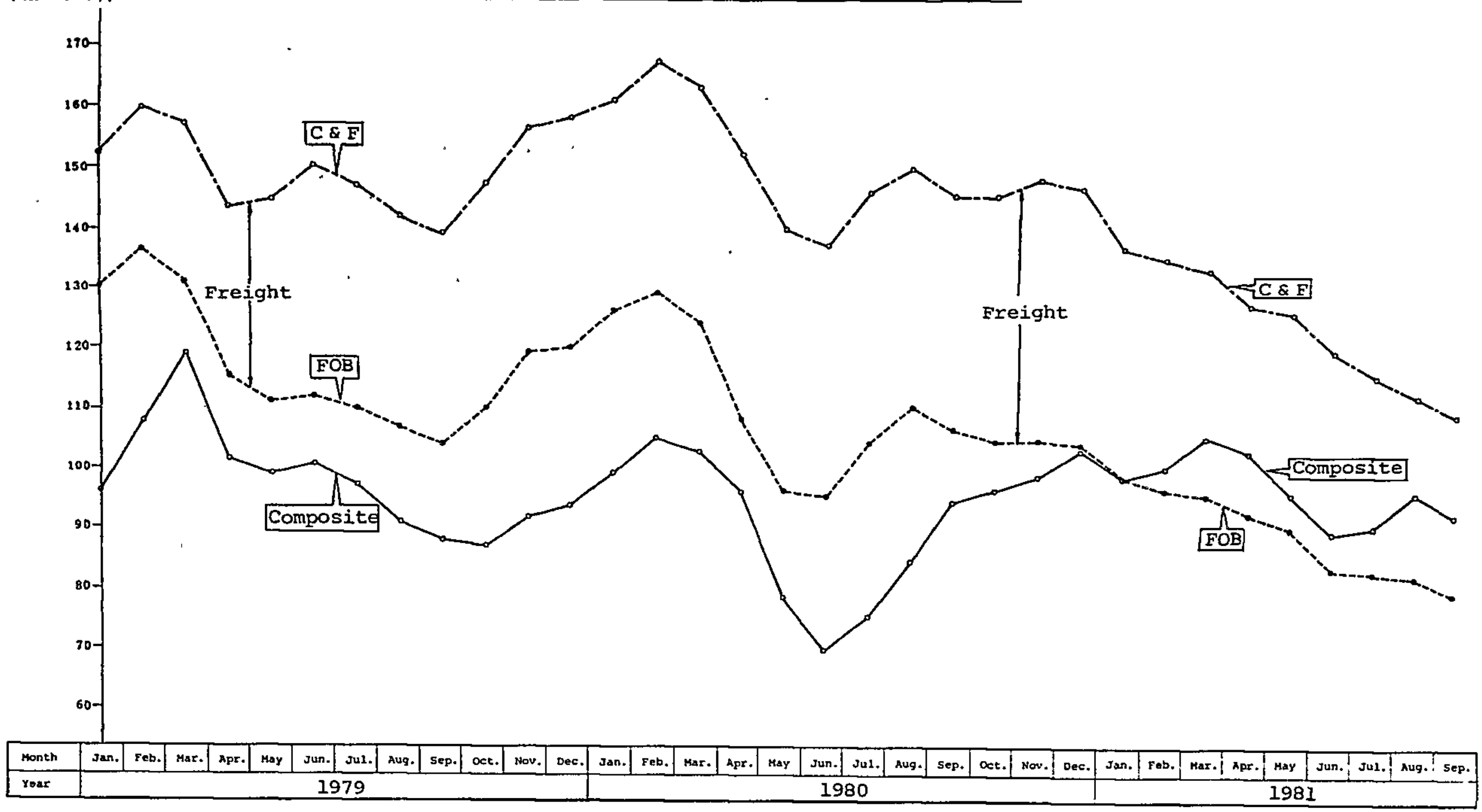


Table VII-2-2: AMERICA LATINA: PRECIOS INTERNOS DE PRODUCTOS SIDERURGICOS
(por tonelada métrica en moneda nacional)
Cotizaciones por supuestas compras por 20 toneladas de cada producto de acero, puesto en la ciudad que se indica pagaderos a 30 días de facturación.

Al último día	Barras Concreto	Alambrón	Alambrón	Planchas en caliente	Láminas en frío	Láminas cincadas	Láminas cincadas	Angulos	Barras planas	Tubos c/ costura	Hojalata electr.	Hojalata electr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
EN ARGENTINA, BUENOS AIRES, EN MILES DE PESOS NACIONALES												
Nov. 1981[1]	5.210	5.248	5.267	5.837[2]	7.304[2]	11.213	11.062	5.288	4.800	12.704	10.340[2-3]	9.600[2]
Feb. 1982	8.689	9.890	9.924	7.802[2]	10.056[2]	17.346	17.123	8.802	8.580	16.412	13.825[2-3]	12.835[2]
Mayo 1982[1]	11.460	12.776	13.123	9.449[2]	12.176[2]	24.985	24.650	11.608	11.315	20.949	16.741[2-3]	15.542[2]

[1] Incluye el 20% de impuesto al valor agregado

[2] Precio contado. Para estimarlos pagaderos a 30 días de facturación, agregar 9,35% de interés.
[3] Recubrimiento de 0,25. Los anchos corresponden a 740, 780 y 822 mm. Los largos de 606 a 912 mm. de 2 en 2 mm.

BRASIL, SAO PAULO, EN CRUZEIROS*												
Nov. 1981	48.900[1-4]	46.800[1-4]	47.700[1-4]	42.800	54.200	80.400	75.900	48.600[1-4]	50.400[1-4]	139.500	133.100	112.100
Feb. 1982	74.100[1-4]	69.000[1-4]	70.400[1-4]	52.600	66.500	102.300	96.600	72.800[1-4]	75.700[1-4]	171.900	153.100	129.000
Mayo 1982	70.600[1-4]	82.400[1-4]	84.000[1-4]	57.900	73.200	112.500	106.300	79.500[1-4]	93.200[1-4]	171.900	168.400	141.900

* Precios FOB Planta
[1] Son precios sin tratamiento extra
[2] Los precios FOB productos está incluido el ICM (11%) para operaciones fuera del estado y excluido el IPI
[3] Los precios FOB productos, para las empresas que están fuera de los estados de ES/RS, serán aumentados en un 4%
[4] Los precios FOB productos, para las empresas fuera de los estados de ES/MG/PR/RJ/RS/SP, serán aumentados en un 10%

COLOMBIA, BOGOTA, EN PESOS COLOMBIANOS*												
Nov. 1981	35.928	32.265	35.604	30.810	-	...	...	...	...	...	...	...
Feb. 1982	36.730	32.990	35.020	30.810	-	...	...	...	...	...	...	...
Mayo 1982	36.730	32.990	35.020	33.280	-	...	...	...	...	...	...	...

* Precios FOB planta, no incluyen impuestos sobre ventas, ni fletes

CHILE, SANTIAGO, EN PESOS NACIONALES*												
Nov. 1981	18.747	15.444	17.695	15.056	20.174	28.610	27.955	22.359	20.939	-	41.519	35.396
Feb. 1982	18.065	14.980	16.832	18.026	20.888	28.610	27.955	18.467	18.447	-	39.987	35.396
Mayo 1982	18.065	14.980	16.832	18.026	20.888	28.610	27.955	18.467	18.447	-	39.987	35.396

* Precios FOB planta, no incluyen impuesto al valor agregado ni impuestos

Table VII-2-2 (Cont'd)

Al último día	Barras concreto	Alambrón	Alambrón	Planchas en caliente	Láminas en frío	Láminas cincadas	Láminas cincadas	Angulos	Barras planas	Tubos c/ costura	Hojalata electr.	Hojalata electr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					MEXICO, MEXICO D.F. EN PESOS MEXICANOS							
Nov. 1981	12.110	12.891	12.891	20.290	25.545	32.908	30.703	11.472	11.472	30.826	28.303	24.782
Feb. 1982	...	...	...	...	...	...	...	...	...	...	...	...
Mayo 1982	...	...	...	...	...	...	...	...	...	...	...	...
					PERU, LIMA, EN SOLES*							
Nov. 1981[1]	205.028	222.575	226.659	274.510	325.712	423.868	425.822	363.200[2]	341.938[2]	...	626.803	452.277
Feb. 1982[3]	338.720	368.548	374.692	379.320	422.194	557.844	560.976	380.932[2]	358.633[2]	...	644.175	480.132
Mayo 1982[3]	434.304	443.904	451.710	406.252	443.366	620.936	560.976	380.932	358.633	...	778.915	592.459

* Precios FOB planta
1 En los rubros del 1 al 9 incluyen el 11% de impuesto por Bienes y Servicios. En el 11-12 incluye solamente el 6%
2 Precios Aceros Arequipa
3 Precios FOB planta, incluyen 16% impuesto a las ventas excepto en la hojalata que no se cobra

Al último día	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					VENEZUELA, CARACAS, EN BOLIVARES*							
Nov. 1981	1.750	2.140	2.120	2.220	2.410	5.790	5.920	2.520	2.170	5.568	4.019	3.552
Feb. 1982	2.220	2.500	2.530	2.464	2.850	6.330	6.894	2.860	2.800	6.590	5.100	4.400
Mayo 1982	2.220	2.140	2.120	2.464	2.850	6.330	6.894	2.860	2.800	6.590	5.100	4.400

* Precios FOB planta, no incluyen comercializacion ni flete

(1) Barras corrugadas para concreto. Con carga de ruptura entre 49 a 63 kg/mm², de Ø 13mm, (1/2") y en largos de 6 a 12m. (2) Alambrón d acero SAE 1010 (o su equivalente), de Ø 9,5mm (3/8"). (3) Alambrón de acero SAE 1010 (o su equivalente) de Ø 6mm (1/4"). (4) Planchas o chapas negras lisas, laminadas en caliente de acero SAE 1010 (o su equivalente) de 1m x 3m x 6,4mm (1/4"). (5) Láminas o chapas lisas laminadas en frío, doble decapadas de acero SAE 1010 (o su equivalente), de 1m x 3m BWG 24 o MSG N°24 (0,6mm). (6) Láminas o chapas galvanizadas o cincadas lisas, de acero SAE 1010 (o su equivalente) de 1m x 3m x 0,4mm (calibres BWG N°28 o MSG N°28). (7) Láminas o chapas galvanizadas o cincadas acanaladas de acero SAE 1010 (o su equivalente) de 0,851m x 3m x 0,5mm (calibre BWG 26 o MSG 26), con ondas de 3" (76mm). (8) Barras ángulos de acero SAE 1010/1015 (o su equivalente) de alas iguales de 38,1mm x 38,1mm x 4,8mm (1 1/2" x 1 1/2" x 3/16") en largos de 6 a 12m. (9) Barras planas (platinas, planchuelas o soleras) laminadas en caliente de acero SAE 1010/1015 (o su equivalente) de 38,1mm x 9,5mm (1 1/2" x 3/8"), en largos de 6 a 12m. (10) Tubos con costura (soldados), galvanizados (cincados) con rosca y cupla, tamaño nominal 1/2" (21,3mm Ø exterior), en espesor normal o espesor cédula 40, largos 5 a 7m. (11) Hojalata electrolítica de 80 libras/caja base (0,22mm) recubierto por ambas caras, peso del revestimiento 0,75 libras/caja base, tamaño 356mm x 508mm (14" x 20"). (12) Hojalata electrolítica de 100 libras/caja base (0,28mm), recubierto por ambas caras, peso del revestimiento 0,75 libras/caja base, tamaño 356mm x 508mm (14" x 20").

FUENTE: Elaborado por ILAFA, según datos oficiales ... Sin datos - No producido

Nota: Las estadísticas de precios tienen por objeto sólo indicar la evolución de los precios internos de algunos productos siderúrgicos en las distintas plazas comerciales de la región, ya que la existencia de diferentes condiciones de comercialización y distintas políticas cambiarias en los países de América Latina, entre otras, invalidan totalmente cualquier comparación Internacional que se haga entre los mismos.

Fig. VII-3-1 Relationships among Steel Scrap Prices, Small Bar Prices and Iron-to-Steel Ratio in Japan

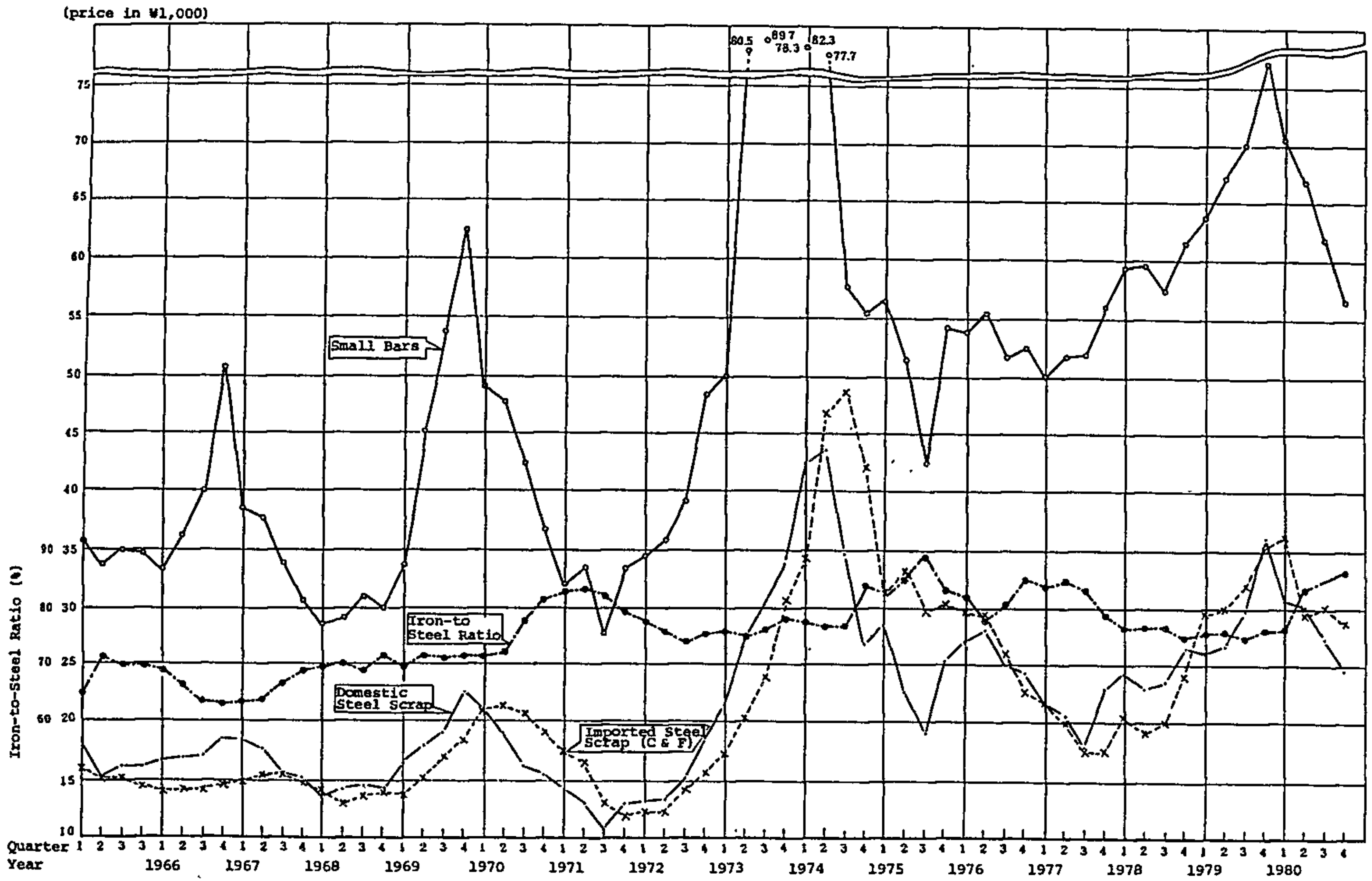
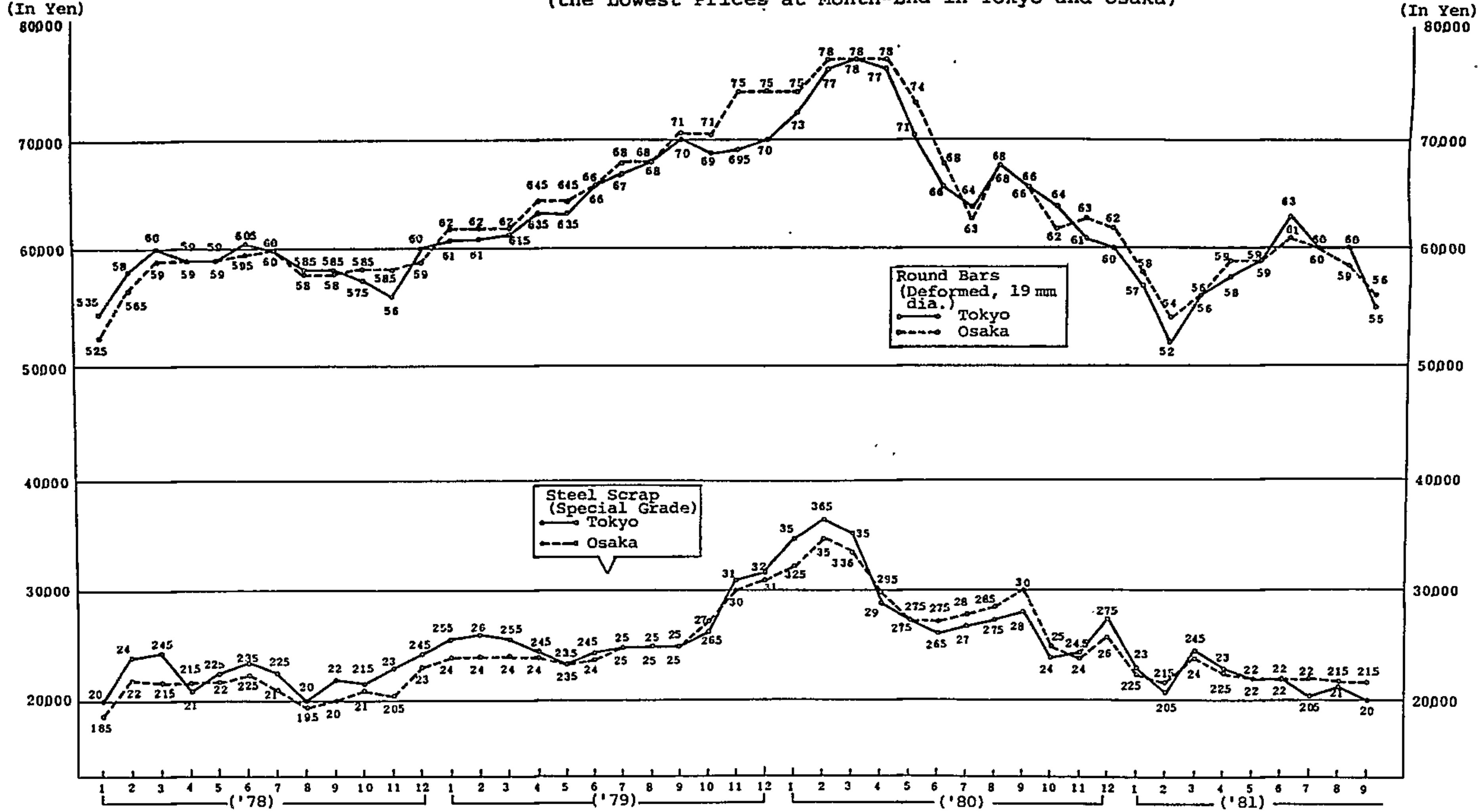


Fig. VII-3-2 Trends in Market Prices of Steel Scrap and Round Bars (the Lowest Prices at Month-End in Tokyo and Osaka)



VIII. Pre-feasibility Study of Mini-mill Plant in Paraguay

1. Market for Small Bar

1-1 Domestic Market of Paraguay

The domestic consumption of small bars and small sections in Paraguay has been increasing in the recent years due to the construction of large scale hydroelectric power stations and other projects. It was 38,000 ton in 1979, as indicated in Table VIII-1-1 (it is presumed that the consumption of small bars in the gigantic hydroelectric power stations of Itaipu and Yacireta are not included in the aforementioned figure because these are joint-venture projects with Brazil and Argentina). Small bars and small sections (the majority being small bars) represent 94% of the total apparent consumption of steel materials (40,641 tons in 1979).

Generally speaking, the minimum production scale considered economically feasible for a mini-mill is of the order of 150,000 tons/year. Construction of a plant of this capacity in a country which has the aforementioned domestic consumption of steel bar is an extremely risky investment. Even with an annual growth rate of 10%, domestic consumption of this material in Paraguay would be barely 67,000 tons in 1985 and 108,000 tons in 1990. It is therefore necessary to ensure an export market of the order of 50,000 to 100,000 tons/year.

Table: VIII-1-1

Paraguay: Apparent consumption of rolled steel products
By products
(in metric tons)

Productos	1976	1977	1978	1979* (%)
Laminados	*19.131*	*26.889*	*23.566*	*40.641* (100)
No planos	**16.879**	**24.350**	**22.540**	**39.557**
Barras y perfiles	16.664	23.166	22.006	38.036 (94)
Alambrón	215	1.184	534	1.521 (4)
Planos	**2.252**	**2.539**	**1.026**	**1.084**
Planchas y láminas	2.252	2.539	1.026	1.084 (2)

Source: ILAFA

1-2 Origin of Small Bars and Small Sections Imported by Paraguay

The total demand for steel materials is currently covered by imports in Paraguay. As can be seen from Table VIII-1-2-1 and Table VIII-1-2-2, the principal suppliers are Brazil and Argentina, which provide 85% of the total. In other words, self-sustenance in small bar in these two countries exceeds 100% (refer to Table VIII-1-3-2(a)) and, therefore, it is quite difficult for Paraguay to export to these countries.

Table: VIII-1-2-1

Paraguay: Imports of iron and steel products in 1978
By countries of origin
(in metric tons)

Paises	Barras y perfiles livianos	(%)	Alambres y sus manufacturas	Tubos	Total	(%)
Alemania Occidental	373		7	46	426	
Argentina	7.977	(36)	361	354	8.692	(37)
Bélgica	2.789	(13)		9	2.798	(12)
Brasil	6.505	(30)	23	406	6.934	(30)
Chile	827				827	
EE.UU.	59		7	59	125	
España	222		25	2	249	
Francia	175				175	
Holanda	19			5	24	
Japón	1.967	(9)	4		1.971	(8)
Reino Unido	2		5	6	13	
Suecia	32				32	
Suiza	6				6	
Uruguay	849	(4)		45	894	(4)
Otros	204		53	1	258	
Total	***22.006***	(100)	***485***	***933***	***23.424***	(100)

(ILAFA)

Table: VIII-1-2-2

Paraguay: Imports of iron and steel products in 1979*
By countries of origin
(in metric tons)

Paises	Barras y perfiles livianos	(%)	Alambre y sus manufacturas	Tubos	Total	(%)
Alemania Occidental	1.629	(4)	14	21	1.664	(4)
Argentina	12.161	(32)	642	305	13.108	(32)
Bélgica	1.033			1	1.034	
Brasil	20.306	(53)	649	532	21.487	(53)
Chile	207		1		208	
EE.UU.	48		4	25	77	
España			11		11	
Francia	591			4	595	
Holanda	5			2	7	
Italia	11			44	55	
Japón	1.039	(3)	6	45	1.090	(3)
Reino Unido				2	2	
Suecia	24			5	29	
Suiza	13				13	
Uruguay	440	(1)			440	(1)
Otros	529		56		585	
Total	***38.036***	(100)	***1.383***	***986***	***40.405***	(100)

(ILAFA)

1-3 Export Markets for Paraguay

1-3-1 Current Status of Production of Steel Bar in Latin American Countries

The development history of the iron and steel industry in the world reveals that in most countries it started from the production of non-flat steel. The reason for this is two-fold.

- In the early stage of economic development, demand consists mostly of construction materials such as small bars and small sections.

- Facilities for production of these materials have an appropriate scale from the point of view of ease of construction.

As can be seen in Table VIII-1-3-1(a), the aforesaid has taken place also in the case of developing countries in Latin America.

- Countries with no production of iron and steel: Paraguay, Bolivia, Guyana, Surinam, French Guyana.

- Countries where the share of small bars and small sections exceeds 50% of production: Columbia, Ecuador, Peru, Uruguay and Central American countries (Costa Rica, El Salvador, Guatenala, Honduras, Nicaragua, Panama, Dominican Republic).

The total production of steel materials in Latin America (24,451,256 tons in 1980) consists of 5,012,366 tons (20.5%) of small bar for reinforced concrete, 1,703,253 tons (7.0%) of other steel bar and 858,881 tons (3.5%) of small sections, showing that steel bar is the product with largest demand. Most production of steel bar consists of small bars sized less than 50 mm diameter.

Table VIII-1-3-1(a) Latin America: Production of rolled steel, bar and small sections

(Unit: ton)

	a Total of Rolled steel Production	b Prefiles livianos	c Otras Barras	d. Barras para concreto	b+c+d/a (%)
Argentina 79	2.935.490	82.633	248.334	544.700	29.8
80	2.823.921	64.361	194.449	542.986	28.4
Bolivia 79	—	—	—	—	—
80	—	—	—	—	—
Brasil 79	10.795.798	318.819	1.031.051	1.528.612	27.2
80	12.294.293	308.197	1.209.311	1.687.676	26.1
Centroamérica 79	145.424	—	—	145.424	100.0
80	220.670	9.180	—	181.098	86.2
Colombia 79	264.167	6.059	21.326	166.633	73.4
80	319.317	65.546	—	176.755	75.9
Chile 79	422.331	10.587	55.791	79.215	34.5
80	515.793	13.180	67.598	100.586	35.2
Ecuador 79	117.662	—	—	117.662	100.0
80	115.747	—	—	115.747	100.
México 79	5.758.753	287.502	250.412	1.275.676	31.5
80	6.220.669	322.563	202.742	1.509.935	32.7
Paraguay 79	—	—	—	—	—
80	—	—	—	—	—
Perú 79	272.778	22.830	18.274	147.529	69.2
80	273.584	32.215	6.228	122.705	58.9
Uruguay 79	28.984	6.134	—	21.650	95.9
80	52.053	11.238	—	39.465	98.4
Venezuela 79	1.176.708	61.671	—	380.453	37.6
80	1.615.209	32.401	22.925	534.913	36.5
Total 79	21.898.075	276.235	1.625.168	4.407.604	31.4
80	24.451.256	858.881	1.703.253	5.012.336	31.0

Source: ILAFA

Table VIII-1-3-1(b) Latin America: Rolled Steel Production by Products

(Unit: ton)

Productos		1976	1977	1978	1979	1980
Laminados		15.655.456	17.805.192	19.687.078	21.898.075	24.451.256
		(100%)	(100%)	(100%)	(100%)	(100%)
No planos		7.739.097	8.311.368	9.069.552	9.987.555	11.240.533
		(49.4)	(46.7)	(46.1)	(45.6)	(46.0)
	Rieles y accesorios	102.120	92.245	60.033	125.106	144.368
		(0.7)	(0.5)	(0.3)	(0.6)	(0.6)
	Perfiles pesados	595.959	506.153	581.203	566.178	637.809
		(3.8)	(2.8)	(3.0)	(2.6)	(2.6)
	Perfiles livianos	759.163	731.497	763.349	846.235	858.881
		(4.8)	(4.1)	(3.9)	(3.9)	(3.5)
	Otras barras	1.251.263	1.576.788	1.524.030	1.625.168	1.703.253
		(8.0)	(8.9)	(7.7)	(7.4)	(7.0)
	Barras para concreto	3.192.427	3.541.278	3.949.071	4.407.604	5.012.366
		(20.4)	(19.9)	(20.1)	(20.1)	(20.5)
	Alambrón	1.838.165	1.863.407	2.191.866	2.417.264	2.742.050
		(11.7)	(10.5)	(11.1)	(11.0)	(11.2)
	Otros no planos	—	—	—	—	141.806
						(0.6)
Planos		7.261.268	8.817.461	9.821.217	11.061.823	12.302.741
		(46.4)	(49.5)	(49.9)	(50.5)	(50.3)
Tubos sin costura		655.921	676.363	796.309	848.697	907.982
		(4.2)	(3.8)	(4.0)	(3.9)	(3.7)

Source: ILAFA

Table VIII-1-3-1(c) Principal Countries: Production of Small Bar and Light Section Steel (1979, Unit: 1,000 tons)

	a. Hot-rolled steel products Total	b. Small bar and small section steel	b/a (%)
Japan	101,614	22,342	22
U.S. (Note 1)	90,959	15,968	18
West Germany	38,487	4,834	13
France	20,804	3,026	15
Italy	18,548	7,652	41
Belgium	11,549	1,133	10
Luxemburg	3,938	864	22
Netherlands	4,990	316	6
Great Britain (Note 1)	17,121	2,868	17
EC (7)	115,437	20,693	18
Spain	9,750	2,731	28
Soviet Union	105,117	38,716 (Note 2)	37
Poland	13,915	2,504	18
Czechoslovakia	10,245	1,813	18

Note (1) U.S. and Great Britain: shipment basis

(2) Heavy sections plus small sections

1-3-2 Possible Markets for Export from Paraguay

(1) Small bars and small sections are produced practically all over the world, unlike other products with high added value, therefore the export market is becoming relatively small.

In Latin America as a whole self-sufficiency exceeds 100% and Brazil, Argentina, Mexico and Peru are exporters of small bars and sections. Furthermore, other countries in the area are also acquiring self-sufficient capacity and they are expected to become self-sufficient in the near future (refer to Table VIII-1-3-2(a) and Table VIII-1-3-2(b)).

Table VIII-1-3-2(a) Latin America: Components of the apparent consumption of Light shapes, Bars and Concrete bars in 1978 and 1979 (Unit: tons) (1)

País	Productos	1978					1979				
		a Producción	b Importación	c Exportación	d. Consumo aparente	a/d, %	a Producción	b Importación	c Exportación	d Consumo aparente	a/d, %
	Perfiles livianos	84980	2.051	27.425	57546	142.7	82633	4716	19507	67742	121.8
Argentina	Barras	241340	6.009	76.807	558616	112.0	248334	6096	84403	714727	111
	Barras para concreto	418074					544700				
	sub-total	744.394	8.060	104.292	648.162	114.8	875.667	10.812	103910	782369	111.9
	Perfiles livianos							3205		3805	0
Bolivia	Barras							22076		22076	0
	Barras para concreto										
	sub-total	—	30.653	—	30653	0	—	25.881	—	25.881	0
	Perfiles livianos	294197	500	2700	291.998	100.8	416300	200	8400	408.100	102.0
Brasil	Barras	962.573	8200	296500	2148.169	113.4	2846700.	11.500	326.500	2531.700	112.4
	Barras para concreto	1473.896									
	sub-total	2.730.666	8.700	299.200	2440166	111.9	3.263.000	11.700	334.900	2939800	111
	Perfiles livianos	1.802									
Centroamérica	Barras	40.065									
	Barras para concreto	131.484									
	sub-total	173.351			237.729	0	148.425	48.954	6084	188.295	99.2
	Perfiles livianos	57565	1952	5	59.512	96.9	6.059	1.599	—	7658	99.1
Colombia	Barras	27.930	4288	1.111	140.892	97.9	21.326	33.584	809	220.934	85.2
	Barras para concreto	109.785					166693				
	sub-total	195.280	6.240	1.116	200.404	97.4	194.018	35.183	809	228.392	84.9
	Perfiles livianos	10603	1.179	—	11.782	90.0	13180	—	—	13180	100
Chile	Barras	66.694	5.805	755	123.728	45.9	168.184	1.577	144	169.617	99.2
	Barras para concreto	52.004									
	sub-total	129.281	6.984	755	135.510	95.4	181.364	1.577	144	182.797	99.2
	Perfiles livianos	220	18542	—	18.762	1.2	—	12345	—		0
Ecuador	Barras	3.676	15.102	—	100.143	84.9	—	17429	—	135.091	87.1
	Barras para concreto	81.365					117662				
	sub-total	85.261	33.644		118.905	71.9	117.662	29.774		147436	79.8

Components of the apparent consumption of Light shapes, Bars and Concrete bars in 1978 and 1979

(Unit: tons) (2)

País	Productos	1978					1979				
		a Producción	b Importación	c Exportación	d Consumo aparente	a/d, %	a Producción	b Importación	c Exportación	d Consumo aparente	a/d, %
México	Perfiles livianos	256.269	6117	16.829	245.557	104.4	287.502	24.085	?	296.527	
	Barras	177.245	41.886	176.885	1.176.338	111.5	250.412	112.891	113.231	1.525.735	100
"	Barras para concreto	1.134.094					1.295.676				
	sub-total	1.567.106	48.003	193.714	1.421.895	110.2	1.813.590	136.963	?	?	?
Paraguay	Perfiles livianos										
	Barras										
"	Barras para concreto										
	sub-total		22.006		22.006	0		38.036		38.036	0
Perú	Perfiles livianos	22.019	275	310	22.034	100.2	22.830	394	2449	20.775	109.9
	Barras	4527	7.860	2961	124.750	96.1	18.274	7798	10.086	163.515	101.4
"	Barras para concreto	115.324					147.529				
	sub-total	141.920	8.135	3.271	146.784	96.7	188.633	8192	12.535	184.290	102.4
Uruguay	Perfiles livianos	–	1.032	659	373	0	6.134	2.766	900	8000	76.7
	Barras	–	5.779	60	19.700	71.0	–	20.090	6100	35.640	60.7
"	Barras para concreto	13.981					21.650				
	sub-total	13.981	6811	719	20.073	69.9	27.784	22.856	2.000	43.640	63.7
Venezuela	Perfiles livianos	35.644	1.696	28	37.312	95.5	61.671	1.648	16.367	46.952	131.3
	Barras	–	287.791	–	706.855	59.3	–	100.841	3.995	477.299	79.9
"	Barras para concreto	419.064					380.453				
	sub-total	454.708	289.487	28	744.167	61.1	442.124	102.489	20.362	524.251	84.3
America Latina Total	Perfiles livianos	763.349					846.235				
	Barras	1.524.030					1.625.168				
"	Barras para concreto	3.949.071					4.407.604				
	sub-total	6.236.450	517.452	612.426	6.141.476	101.5	6.879.007	472.517	599.175	6.752.349	101.9
	Perfiles livianos										
	Barras										
"	Barras para concreto										
	sub-total										

Components of the apparent consumption of Light shapes, Bars and Concrete bars in 1978 and 1979 (3)
(Unit: tons)

País	Productos	1978					1979				
		a Producción	b Importación	c Exportación	d Consumo aparente	d/a, %	a Producción	b Importación	c Exportación	d Consumo aparente	d/a, %
Costa Rica	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		10.030	1.206				5.730	394		
El Salvador	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		5.183	171				4.745	184		
Guatemala	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		12.572	4992.				7.785	5.301		
Hondulas	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		4371	—				6326	—		
Nicaragua	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		576	147				580	—		
Panamá	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		6.757	25				8.085	205		
Republica Dominicana	Perfiles livianos										
	Barras										
	Barras para concreto										
	sub-total		9240	?				16.703	?		

Table VIII-1-3-2(b) Self-sufficiency in Small Bars and Small Sections in Latin American Countries (Production/Apparent Consumption) (1979, Unit: %)

	Small Bar	Small Sections plus Small Bars
Argentina	111.0	111.9
Bolivia	0	0
Brazil	112.4	111
Centroamerica	(No-data)	77.2
Colombia	85.2	84.9
Chile	99.2	99.2
Ecuador	87.1	79.8
Mexico (1978)	111.5	110.2
Paraguay	0	0
Peru	101.4	102.4
Uruguay	60.7	63.7
Venezuela	79.7	84.3
America	(No-data)	96.8
Latin American Total	(")	101.9

(2) When seeking export markets in the neighbouring countries, Bolivia and Uruguay can be taken into consideration but the total export market to these two countries barely reaches 50,000 tons/year. Furthermore, setting apart the feasibility of the export business itself, these countries cannot be considered stable export market because they are setting forth their own plans for self-sufficiency (refer to Table VIII-1-3-2(a)).

(3) With regard to areas other than Latin America, it is possible to take into consideration export to countries of the Middle East, Asia and Africa which do not have self-sufficiency.

It is ultimately presumed that the key points for the export of the commodities in question are the domestic product preference policy of the various countries and price competitiveness.

(4) On a long-range basis of the order of several decades, however, apparent per capita consumption in the Latin America as a whole is small. Particularly in Paraguay, a country in the process of social development, the consumption of steel will increase without doubt because steel is said to be the "barometer of the civilization." The consumption per capita of steel in Latin America as a whole is small but latent demand is enormous in view of the future development potential (refer to Table VIII-1-3-2(c) and Table VIII-1-3-2(d)).

Table: VIII-1-3-2-(c)

Latin America: Consumption per capita of rolled steel products
By countries
in terms of ingots
(kg, per capita)

Países	1976	1977	1978	1979*
Argentina	117,5	139,7	108,7	142,8
Bolivia	15,8	18,8	23,1	20,4
Brasil	92,0	107,0	104,3	110,3
Centroamérica	27,2	36,3	40,7	31,5
Colombia	24,7	25,8	32,3	34,2
Chile	41,4	49,3	56,6	65,9
Ecuador	37,6	49,2	44,3	51,8
México	95,4	98,2	123,1	136,2
Paraguay	9,3	12,7	10,7	18,1
Perú	35,7	33,5	29,7	29,2
Uruguay	32,8	37,9	63,9	49,8
Venezuela	238,6	266,5	231,8	178,3
Total	***83,9***	***91,4***	***93,6***	***98,7***

(ILAFA)

Table VIII-1-3-2-(d) Apparent Consumption of Steel in Selected Regions and Countries (Thousands of tons of crude steel equivalent and kilogrammes per capita)

	1977	1978	1979
U.S.S.R.	565	587	576
United States	618	672	640
(E C 9)	404	393	427
(E C 6)	424	407	449
Japan	512	535	637
China	38	46	47
Germany West	538	526	602
Italy	368	332	400
France	383	367	395
United Kingdom	357	359	368
Poland	540	561	545
Canada	550	575	635
Rumania	506	528	563
India	16	16	17
Czechoslovakia	748	756	720
Germany East	591	605	591
Spain	249	186	214
South Africa	161	185	207
Australia	365	358	401
Yugoslavia	239	246	250
Eastern-Europe-U.S.S.R.	551	576	567
Western Europe	339	320	345
North America	611	662	639
South-East Asia	55	59	67
Latin America	91	95	98
Africa	36	34	32
Oceania	279	273	310
Middle and Near East	106	106	127
World Total	163	167	172

2. Sources of Supply of Raw Materials for Small Bar

2-1 Principal Raw Materials

2-1-1 Scrap

Part of the scrap consumed by the steelmaking industries of Latin American is supplied by domestic sources but most demand is covered by imports from the U.S. It is presumed that normally there is no circulation of scrap between the various countries in the Latin American region.

Brazil is in principle self-sufficient in terms of scrap and imports are authorized by the government on a spot transaction basis only in special cases. The export of scrap from Brazil is prohibited because it is considered an energy saving resource.

As for Argentina, it is a scrap importing country, and there are no reserves for export. For other Latin American countries it is presumed that they have no export capacity in view of their domestic reserves of iron and steel.

In the case of Paraguay therefore it is unavoidable to meet the majority of its needs by imports from the U.S.

Table: VIII-2-1-1

Latin America: Scrap consumption
By countries
(in thousands of metric tons)

Países	1976	1977	1978	1979	1980*
Argentina	1.503	1.716	1.382	1.471	1.198
Brasil	4.213	4.576	5.262	5.894	6.468
Colombia	208	227	166	237	191
Centroamérica	61	52	55	116	149
Chile	169	206	161	185	190
Ecuador	...	...	...	...	18
México	3.090	2.440	2.810	2.454	2.127
Perú	168	167	136	209	157
Uruguay	18	23	8	20	22
Venezuela	453	529	546	954	969
Total	***9.883***	***9.936***	***10.526***	***11.540***	***11.489***

Source: ILAFA

2-1-2 D.R.I. (Sponge Iron)

Latin America as a whole currently has an annual production of the order of 5 million tons of sponge iron, with Venezuela and Mexico the principal producers. If necessary, there is a possibility for Paraguay to import sponge iron from Latin American countries (refer to Table VIII-2-1-2(a) and Table VIII-2-1-2(b)).

Table: VIII-2-1-2-(a)

Latin America: Sponge iron and consumption
By countries
(in thousands metric tons)

Países	1976	1977	1978	1979	1980*
Argentina	27	252	354	757	710
Brasil	227	230	270	332	243
Colombia	...	...	...	1	11
México	1.077	1.195	1.353	1.194	1.013
Perú	0	1	1	2	23
Venezuela	-	209	284	660	1.214
Total	*1.331*	*1.887*	*2.263*	*2.946*	*3.214*

Table: VIII-2-1-2-(b)

Latin America: Sponge iron production
(thousand of tons)

PAISES	JUNIO 1982	MAYO 1982	JULIO 1982	JUNIO-MAYO 82 %	ENERO - JUNIO		
					1982	1981	82/81%
Argentina	67,2	59,4	74,9	13,1	402,5	323,2	24,5
Brasil	20,8	27,5	17,7	-24,4	118,1	110,6	6,8
México	111,2	144,8	...	-23,2	790,6	871,3	-9,3
Perú	2,8	2,1	...	33,3	23,5	26,8	12,3
Venezuela	154,7	177,0	187,2	-12,6	1.037,3	793,8	30,7
Total	356,7	410,8	...	-13,2	2.372,0	2.125,7	11,6

(ILAFA)

Table: VIII-2-1-2-(c)

Latin America: Ferro-alloys consumption
By types
(in metric tons)

Tipos	1976	1977	1978	1979	1980*
FeMn	161.699	171.839	166.442	206.633	210.218
FeSi	48.986	56.102	58.186	58.421	74.701
FeSiMn	50.039	57.969	66.738	94.567	103.413
FeCr	18.171	20.162	18.116	25.061	42.437
FeNi	6.613	7.779	7.380	8.069	8.171
FeMo	1.136	1.370	1.129	1.380	968
FeNb	109	233	85	359	189
Otras	27.599	24.212	26.369	28.775	29.119
Total	***314.352***	***339.666***	***344.445***	***423.265***	***469.216***

(ILAFA)

Table: VIII-2-1-2-(d)

Latin America: Ferro-alloys production
By types (in metric tons)

Tipos	1976	1977	1978	1979	1980
FeMn:	**185.200**	**261.759**	**256.931**	**298.271**	**292.586**
AC	178.466	165.731	222.706	...	...
MC	6.724	95.904	34.225	...	...
BC	10	124	-	...	...
FeSi:	**91.140**	**107.417**	**104.126**	**132.017**	**213.657**
15% Si	626	626	-	...	...
45% Si	26.111	34.933	24.255	...	...
75% Si	64.353	71.858	79.871	...	...
90% Si	50	-	-	-	-
SiMn:	**84.452**	**105.782**	**150.549**	**160.943**	**176.951**
12/16% Si	28.213	34.698	-	...	...
16/20% Si	55.944	71.084	100.785	...	...
20/25% Si	720	-	49.764	...	...
FeCrSi	3.575	4.121	4.698	-	-
FeCr:	**68.900**	**68.758**	**66.165**	**89.308**	**93.443**
AC	63.017	62.489	60.321	...	...
BC	5.883	6.269	5.844	...	...
FeNi:	**9.970**	**10.860**	**10.976**	**11.355**	**11.280**
AC	3.143	3.945	8.674	...	...
BC	6.827	6.915	2.302	...	...
FeMo	1.700	2.015	1.822	2.636	1.403
OMo	4.864	6.715	10.528	11.355	6.971
FeW	286	141	336	488	235
FeV	255	410	515	1.069	1.000
FeNb	10.088	6.888	8.533	24	-
FeTi	419	40	-	-	-
Otras	3.758	10.103	21.839	50.579	62.094

(ILAFA)

2-2 Other Materials

2-2-1 Ferroalloys (Fe-Man, Fe-Si)

As can be seen from the table, both Fe-Mn and Fe-Si are in an oversupply state in Latin America. There is no problem of importing these products by Paraguay if necessary.

2-2-2 Limestone

There is a possibility of supply of limestone from domestic sources.

2-2-3 Coal

There is a possibility of imports from neighbouring coal producing countries.

2-2-4 Coke

There is a possibility of imports from the steelmaking industries of Brazil and Argentina.

Table: VIII-2-2-4

Latin America: Coke consumption
By countries
(in thousands of metric tons)

Países	1976	1977	1978	1979	1980*
Argentina	670	558	824	553	489
Brasil	2.487	3.549	4.026	4.223	4.338
Colombia	256	203	207	219	205
Chile	262	262	314	341	380
México	1.886	2.323	2.597	2.529	2.443
Perú	117	133	128	137	151
Uruguay	2	2	3	2	1
Venezuela	164	106	142	177	130
Total	*5.844*	*7.136*	*8.241*	*8.181*	*8.137*

Source: ILAFA

2-3 Refractories (Firebrick, etc.)

To be imported from Europe, the U.S., Japan, etc. A portion of the required refractories can be imported from Brazil and Argentina.

3. Mini-mill Plant Project in Paraguay

3-1 Technical Premises

3-1-1 Type of products:

Deformed bars for reinforced concrete. Sizes ∅9 mm to ∅32 mm.

3-1-2 Production capacity:

12,500 t/M = 150,000 t/Y (Billet basis)

3-1-3 Operation conditions:

3 shifts/day by 4 crews

3-1-4 Products:

Total sold outside company (domestic and export markets).

3-2 Basic Plan of the Plant

3-2-1 Principal Installations:

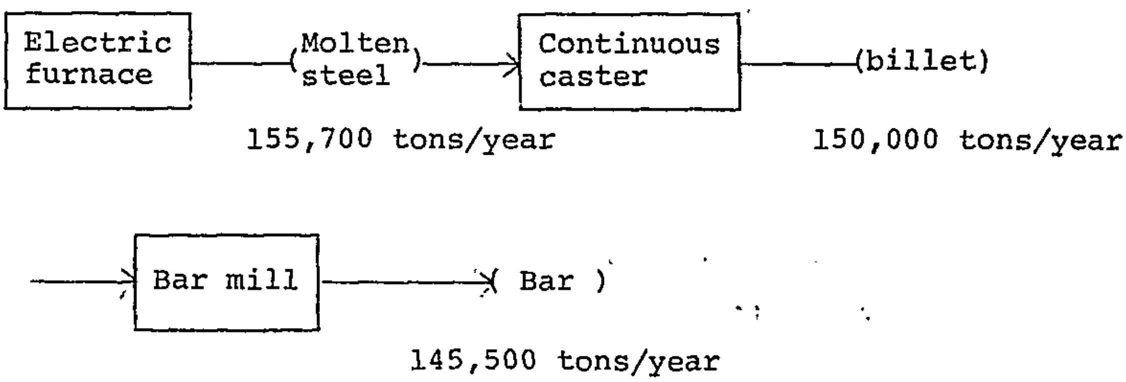
To be imported from overseas.

(1) Electric furnace plant: 25 tons/heat x 2 units

(2) Continuous casting plant: Continuous billet casting machine x 1 unit (billet size 100x100mm, 3-strand type).

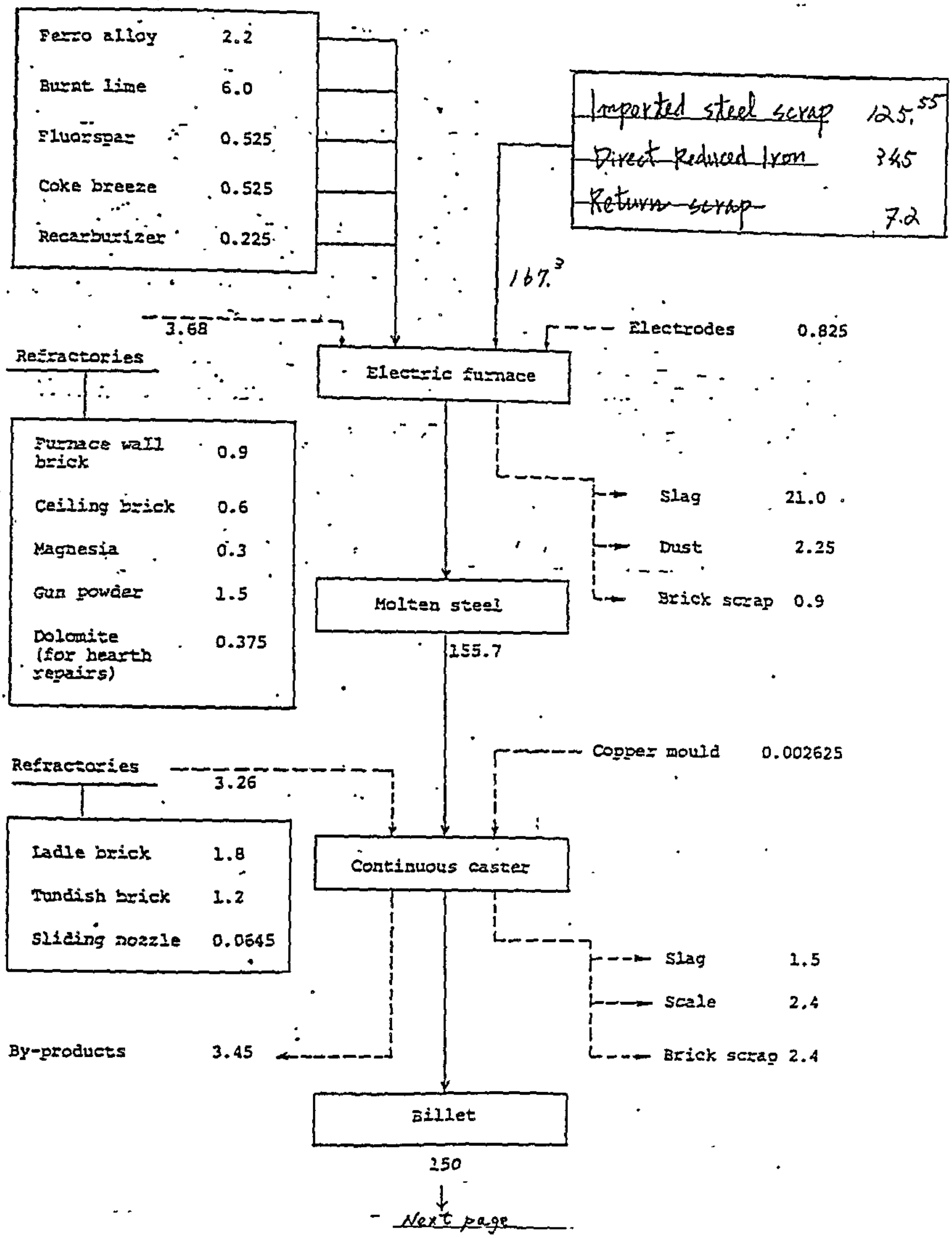
(3) Steel bar rolling plant: Bar mill x 1 line

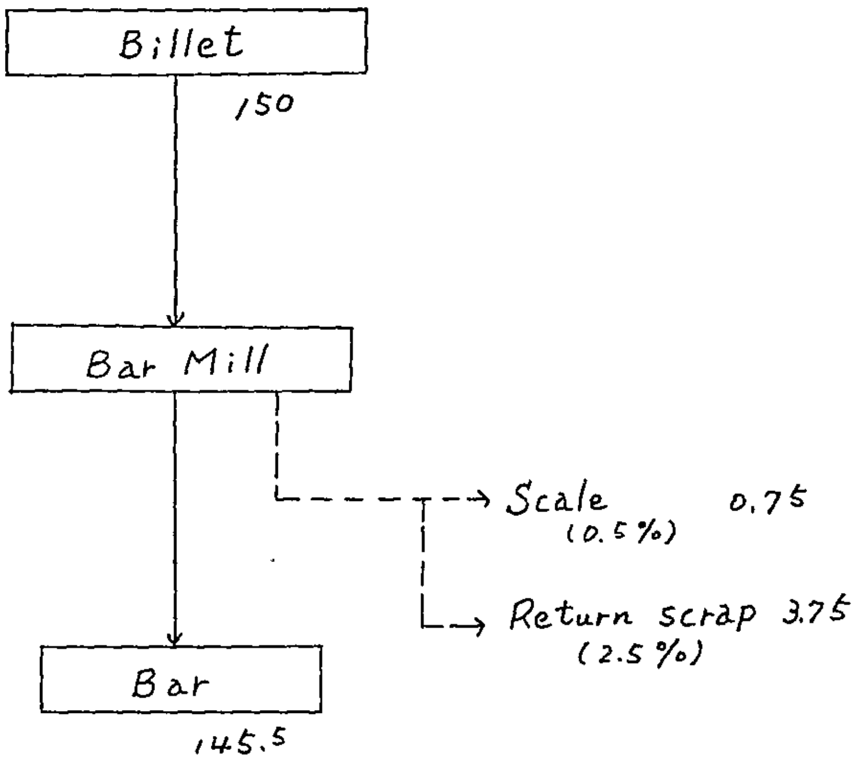
3-2-2 Production Process and Output



3-2-3 Material Balance

Unit: 1000 t/yr




Billet
150
Bar Mill
Scale
(0.5 %)
0.75
Return scrap 3.75
(2.5 %)
Bar
145.5

3-3 Raw materials consumption schedule

	production 12,500 T/M			
	Item	Unit consumption	Monthly consumption	Yearly consumption
Major raw materials	Direct-reduced iron	230 kg/T	2,875 Ton	34,500 Ton
	Imported scrap	837	10,463	125,550
	Return scrap	48	600	7,200
By-products	Scrap steel (C.C	23	287.5	3,450
	(Bar Mill	25	312.5	3,750
	Scale (CC	16	200	2,400
	(Bar Mill	5	62.5	750
Sub-raw materials	Fe - Mn	9.51 kg/T	118.875 Ton	1,427 Ton
	Fe - Si	9.15	64.375	773
	Quicklime	40.0	500	6,000
	Fluorspar	3.5	43.75	525
	Carbon fines	1.5	18.75	225
	Coke breeze	3.5	43.75	525
Hearth materials	Burnt dolomite	2.5	31.25	375
	Magnesia	2.0	25	300
	Bittern	0.2	2.5	30
	Gun powder	10.0	125	1,500
Refractories	Furnace proper	6.0	75	900
	Ceiling	4.0	50	600
	Ladle	12.0	150	1,800
	Sliding nozzle	0.43	5.375	64.5
	Tundish	8.0	125	1,200

	Item	Unit consumption	Monthly consumption	Yearly consumption
Electric furnace	Oxygen	34 kg	425 T	5,100 T
	Fuel (Light oil)	3.0 ℓ	37.5 kℓ	450 kℓ
	Electricity for melting	530 KWH	662.5 million KWH	7,950 million KWH
	Electricity for motive power	35 "	43.75 "	525 "
	Electrodes	5.5 kg	68.75 T	825 T
	Water	15.5 m^3	193.75 km^3	2,325 km^3
Continuous casting	Power	8.0 m^3	10 million KWH	120 million KWH
	Water	0.5 m^3	6.25 km^3	750 km^3
	Moulds	0.0175 kg	218.75 kg	2,625 T
	Fuel (Light oil)	5.5 ℓ	68.75 kℓ	825 kℓ
Bar mill	Fuel			
	Water			
	Electricity for rolling	60 kWH	75 million kWH	900 million kWH
	Electricity for general	5 kWH	6.25 million kWH	75 million kWH
	Roll	1 kg	12.5 T	150 T

Major raw materials blending standard

The major raw materials will be belended in the following ratio.

Direct-reduced iron	20.5%	(Fe 80%)
Imported scrap	75%	(Fe 92%)
Return scrap	4.5%	(Fe 95%)

3-4 Manning Plan.

Manning Allocation

		Office and technical jobs					Shop jobs					Totals
		Superintendent, General manager	Manager	Assistant Manager	Rank and file	Total	Foremen	Assistant foreman	Rank and file (A)	Rank and file (B)	Total	
Production Department	Steelmaking Section (EF-cc)	2	1	3	6	12	4	17	88	84	193	205
	Bar Mill Section	1	1	3	4	9	4	16	32	32	94	93
	Maintenance Section (EF-cc)		1	2	2	5	1	2	9	9	21	26
	(Bar Mill)		1	2	2	5	1	2	9	9	21	26
	Total	3	4	10	14	31	10	37	138	134	319	350
Business Department	Storage Section		1	2	6	9	1	3	15	14	33	42
	Control Section		1	2	6	9		1	4	4	9	18
	Administrative Section	1	1	3	20	25						25
	Total	1	3	7	32	43	1	4	19	18	42	85
Totals		4	7	17	46	74	11	41	157	152	361	435

3-5 Estimate of Construction Costs

3-5-1 Premises for Estimate

(1) Estimate date: September, 1982

(2) Prices of imported commodities: CIF basis, exempt of import duties.

(3) Scope of estimate

1) One complete set of plant and equipment to be purchased (electric furnace plant, continuous casting plant, steel bar rolling plant)
2) Machinery installation and erection costs
3) Buildings
4) Civil works
5) Engineering cost
6) Spare parts

3-5-2 Price (¥250/US$)

	Yen Basis ¥ Billion	Share (%)	US$ Basis US$ Million
EF-CC Plant			
Imported machinery	6		
Erection cost			
Building	6		
Civil works			
	12	52	48
Bar Mill Plant			
Imported machinery	5.5		
Erection cost			
Building.	4.5		
Civil works			
	10	43	40
Direct Construction Cost	22		88
Engineering cost, spare parts, etc.	1	1	4
Total	23	100	92

3-6 Price List of Raw Materials, Supplies & Utilities

(September, 1982 basis)

Cost items	Sources	Unit prices (US$)		
		C & F ($/T)	other cost	Delivered price ($/T)
1. Major raw materials		FOB Freight $		
(1) Imported scrap	U.S.A	65+35=100	—	100
(2) Direct Reduced Iron	Latin-America	50+30=80	—	80
2 Sub raw materials				
(1) Fe-Mn	Latin-America	500	—	500
(2) Fe-Si	"	800	—	800
(3) Burnt lime	Domestic	? (50)	—	50
(4) Flourspar	Latin-America	120	—	120
(5) Carbon fines	"	300	—	300
(6) Coke breeze	"	150	—	150
3 Hearth Materials and Refractories				
Dolomite, Magnesia, Bittern, Gunpowder		?	—	x̄ = 300
Refractory, EF	Brazil	220,000 Cr/T	—	x̄ = 1,000
Ladle	"	180,000 Cr/T	—	
Tundish	"	50,000 Cr/T	—	
4 Liquid oxygen	?	?	—	?
Electrode	import	3,000 $	—	3,000
Fuel (light oil)	"	?	—	?
Electricity	Domestic	?	—	?
Copper mould	import	20,000 $	—	20,000
Water	Domestic	?	—	?

3-7 Estimated Total Cost of Billet and Small Bar

Cost element		Unit price	Unit consumption	Cost/unit	%	Alternative of unit price (*4)	
1 Billet cost						$/t	%
Variable cost	Imported scrap	100 $/t	837 kg	83.7 $/t		108.81	
	Direct Reduced Iron	80	230	18.4		27.6	
	Return scrap	80	48	3.84		3.84	
	sub-total			105.94	45.0	140.25	50.4
	Fe-Mn	500 $/t	9.51 kg	4.76 $/t			
	Fe-Si	800	9.15	7.32			
	Burnt lime	50	40	2			
	Flouspur	120	3.5	0.42			
	Carbon fines	300	1.5	0.45			
	Coke breeze	150	3.5	0.53			
	sub-total			15.48	6.6	15.48	5.6
	Refractory	1.000	30	30			
	Magnesia		2				
	Bittern	400	0.2	5.88			
	Gunpowder		10				
	Dolomite		25				

Cost element		Unit price	Unit consumption	Cost/unit	%		
	Electrode	3,000 $/t	5.5 kg	16.5			
	Copper mould	20,000	0.0175	0.35			
	Electricity	3 ¢/kWH	565 kWH	17	(7.2)		
	Others	—	—	1			
	Sub-total			70.73	30.0	70.73	25.4
Fixed cost	Labour cost Maintenance Depreciation Interest			47.08	(20)		
	Sub-total			47.08	20 *3	56.66	20
Income	By product (Return scrap)	80	▲ 48	▲3.84	▲1.6	▲3.84	▲1.4
	Total			235.39	100	278.38	100
2. Bar cost (*1)							
	Billet cost × 1.1			258.50		306.11	
3 Total cost of Bar (*2)							
	Bar cost × 1.1			284.35	(*5)	336.72	(*5)

*1 The percentage represented by the material (billet) cost in the production cost is normally of the order of 90% in the case of steel bar plants. Accordingly, it is assumed that the Billet Cost x 1.1 = Bar Cost.

*2 Sales of the product require further marketing costs. Direct marketing costs, etc., are assumed as 10% of the prime cost. Accordingly, the total cost of the small bar is assumed as Bar Cost x 1.1.

*3 The fixed cost (personnel expenditure - direct operation personnel, management personnel, maintenance costs, installation depreciation cost, interest, etc.) is assumed to represent 20% of the prime cost.

*4 Calculations are set forth assuming a fluvial transportation cost (from Buenos Aires to the plant site in Paraguay) of $30/t, therefore the unit price of the materials becomes:

- Steel scrap unit price 100 + 30 = 130$
- DRI unit price 80 + 30 = 110$

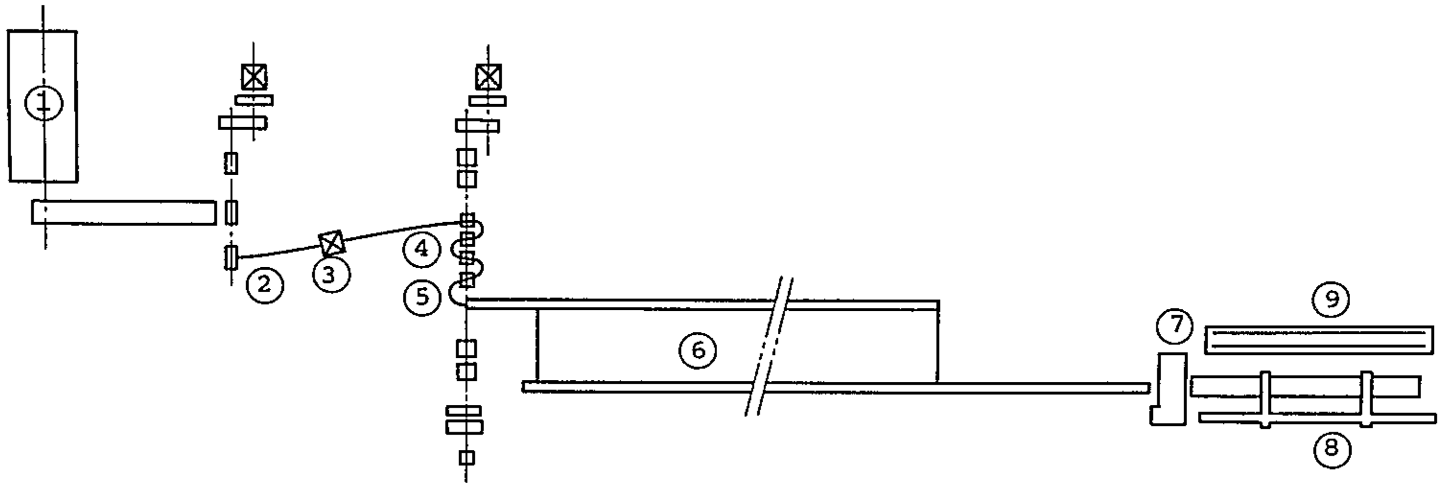
The ratio between the small bar production prices in the two cases becomes 306.11/258.50 = 1.18, i.e., the fluvial transportation cost increases the production cost by 18%.

*5 Small bars have recently been negotiated at prices of the order of 200 to 220 US$/t (Europe FOB base). The estimated total cost in Paraguay becomes 284 to 337 US$/t. Accordingly a considerable cut in the cost is required in order to ensure competitiveness.

3-8 Plant Layout

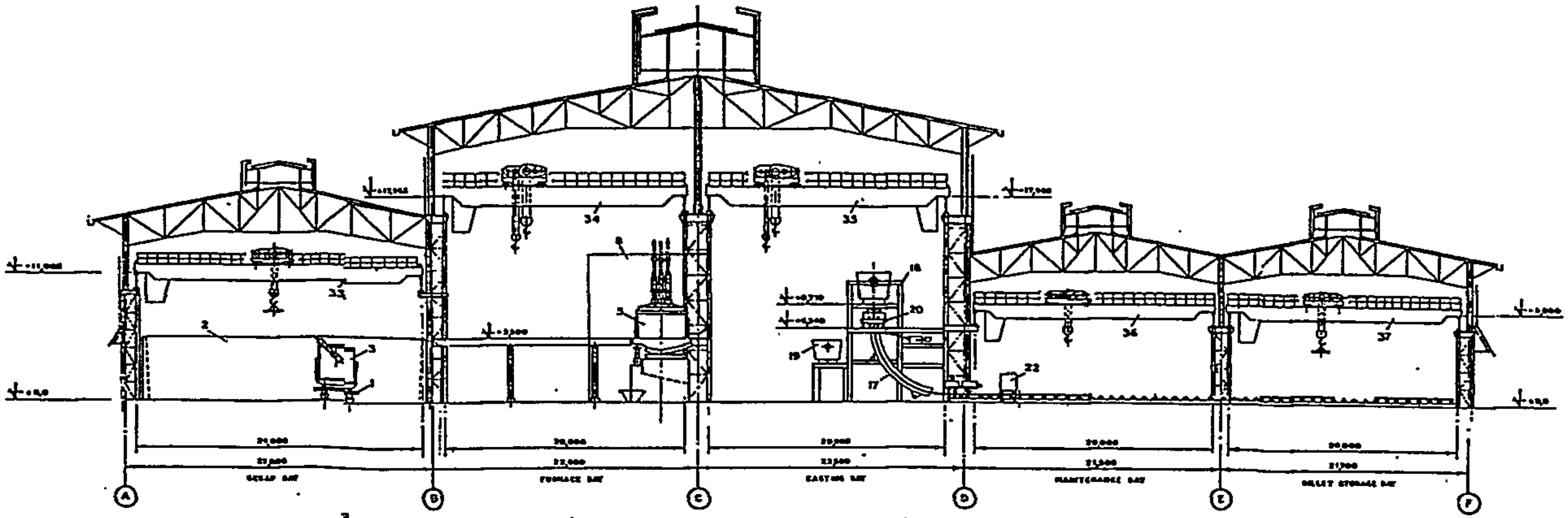
Fig. VIII-3-8-1

Typical layout of bar mill plant



① Reheating furnace	④ Intermediate mill	⑦ Cold shear
② Roughing mill	⑤ Finishing mill	⑧ Shear gauge
③ Flying shear	⑥ Cooling bed	⑨ Bundling machine

Fig. VIII-3-8-2 Typical Cross Section of the Electric-arc Furnace Shop (Steel Melting Shop)



3-9 Feasibility of Mini-mill Plant in Paraguay

3-9-1 Product Market Survey

Generally speaking, the use of locally generated steel scrap as raw material and the supply of products to the local market are conditions required to make commercial operation of a mini-mill plant for production of small bars feasible, as described earlier in this report, because mini-mill plants of this kind can be constructed anywhere with relative ease since they require no sophisticated technical skills and labour. In other words, the key factor which determines a plants' feasibility is a location in proximity with the consumption market and raw material supply source.

Generally speaking, a mini-mill plant constructed on the premise of exporting most of its products has poor competitiveness compared with domestic makers. Furthermore, it is forced to operate under extremely unstable conditions because the small bar price in the export market is subject to considerable fluctuation.

Accordingly, it is very important to study carefully the prospects for small bar demand in the domestic market.

3-9-2 Supply of Raw Materials

No domestic supply of steel scrap can be expected in developing countries, which do not have a sufficient accumulation of social capital goods (factories, buildings, home appliances, etc.). Accordingly imports must be relied upon for the supply of this material.

Also with regard to other raw materials, it is not possible to expect supply from domestic sources under stable quantity, quality and price conditions. In view of the considerations above, we have to say that Paraguay presents extremely unfavourable conditions for construction of a mini-mill plant. Furthermore, the river transportation which intervenes in the supply of raw materials is a factor which contributes to worsening feasibility demerits.

3-9-3 Influence of Electricity Charge

The electricity cost in the mini-mill plant represents 7.2% of the billet cost, as described in Section 3-7. The cost of small bar fluctuates depending on the electricity charge, as shown in the table below:

Electricity Charge	3 cents/ KWH	5 cents/ KWH	1 cent/ KWH
Electricity cost (US$/KWH)	$ % 17 (7.2)	$ % 28 (11.4)	$ % 6 (2.7)
Billet cost	235 (100)	245 (100)	224 (100)
Bar cost	259	271	246

The share of the electricity cost in the smaller bar cost is small compared with the raw material cost, therefore, it is not a decisive factor in cost competitiveness.

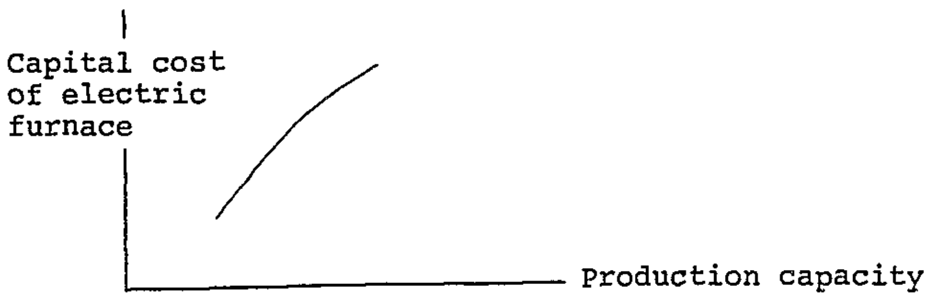
3-9-4 Availability of Infrastructure and Related Industries

Refractories an- electrodes represent a considerable share of small bar cost. It is indispensable to ensure sources able to supply these materials under sufficiently stability quality, quantity and price conditions.

Industries of the mechanical, electrical, chemical and other sectors must reach a certain level in order to make possible the supply of operation materials and spare parts (e.g. rolls for rolling mill, CC molds, bearings, rolling oil, etc.), in addition to the aforementioned refractories and electrodes. The feasibility of the mini-mill plant alone is almost nil without implementation of these related industries.

3-9-4 Scale Merit of Production Process

This project assumes an annual production capacity of 150,000 tons/year but it is possible to cope with the increase in installation cost accompanied by expansion of capacity by increasing the power supply capacity (transformer capacity). Production capacity is therefore related to installation cost by exponential factor.



Therefore, the electric-arc furnace itself has considerable scale merit.

However, with regard to the continuous caster and the rolling mill, the speed of the strand or line is determined by the material which is being produced. Accordingly, expansion of production capacity is related to the increase in number of strands or lines and therefore the capital cost can be considered proportional to the production capacity. In other words, no scale merit can be expected in the case of a continuous caster and rolling mill.

Generally speaking, not much scale merit can be expected with the electric-arc furnace - rolling mill process.

Direct Construction Cost	150,000 tons/year		300,000 tons/year	
	¥ Bil.	(US$ Mil.)	¥ Billion	(US$ Mil.)
Electric-arc furnace	5	(20)	60	(24)
Continuous casting	7	(28)	120 - 130	(48 - 52)
Small bar mill	10	(40)	170 - 180	(68 - 72)
Total	22	(88)	350 - 370	(140 - 148)

3-9-6 Conclusion

It is not pertinent to draw definitive conclusions from this study because it is carried out on data available in Japan and some premises. According to our experience and the results of the discussions carried out so far, however, it must be said that construction of a mini-mill plant in Paraguay is not feasible. Further studies, if any, should be undertaken by focusing on the considerations given in Sections 3-9-1 and 3-9-2.

3-10 Supplement: Procedure for Preparation of a Rudimentary Plan for a Mini-mill Plant

It is necessary to carry out a survey of the items listed in Appendix 5 in order to concretely and accrately prepare a rudimentary plan for a mini-mill plant (consisting principally of a study of the location). It will be possible to draw up a rudimentary plan for the construction site and the layout of the mini-mill plant, general planning of facilities, investment required and other relevent technical aspects by carrying out a study based on the survey data.

It will also be necessary to carry out a feasibility study for commercialization by means of a survey on aspects such as price trends for raw materials, products, energy, labour, etc., and prospects for production and marketing in addition to the aforementioned technical data in order to calculate the economic effects of the project such as cost of the product, commercial profitability, etc.

According to our experience, it is necessary to carry out a field survey, data collection and study with a team of 5 to 6 experts (e.g., electric furnace, CC, rolling, market survey, accounting, civil engineering, etc.) in order to draw up a rudimentary plan of this level.

JICA