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0 8079 (1 of 4)

FINAL REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

THE DEVELOPMENT OF IRON AND STEEL INDUSTRY IN COLOMBIA

VOLUME I

SUMMARY AND RECOMMENDATIONS

MAY 1976

DASTUR ENGINEERING INTERNATIONAL GMBH
Consulting Engineers
DÜSSELDORF

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LIST OF VOLUMES

EXPLANATIONS

Three dots (.../N.A.) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A full stop (.) between numerals indicates decimal.

A space between numerals is used to distinguish thousands and millions (1 346 849).

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954. The fiscal year adopted is from 1st July through 30th June.

'To' between the years indicates the full period, e.g. 1960 to 1964 means inclusive of the years 1960 and 1964.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Conversion rate adopted is US $ 1.00 = Colombian peso (Col $) 30, unless otherwise stated.

ABBREVIATIONS

PDR	-	Acerias Paz del Rio S.A.
BOYACA	-	Metalurgica Boyaca S.A.
FUTEC	-	Fundiciones Tecnicas S.A.
SIDELPA	-	Siderurgica del Pacifico S.A.
SIDUNOR	-	Siderurgica del Norte
SIMESA	-	Siderurgica Medellin S.A.
SIMUNA	-	Siderurgica del Muna S.A.
COLAR	-	Colombiana de Arrabio Ltda.
NSP	-	National Steel Plan
SIP	-	Semi-integrated Plants

DASTUR ENGINEERING INTERNATIONAL GMBH

CONSULTING ENGINEERS

4 DUSSELDORF · SCHADOWPLATZ 9

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28th May 1976
548-71A

Chief
Purchasing and Contracting Services
United Nations Industrial Development Organization
P.O. Box 707
Vienna, Austria

Re: Study for the Development of Iron and Steel Industry in Colombia

Dear Sir,

In accordance with our Contract 75/1 (Project No.DP/COL/72/020) dated 3rd February 1975, we have pleasure in submitting herewith 40 copies of the final report (in English) on the 'Development of Iron and Steel Industry in Colombia'. The final report has been prepared taking into account the suggestions emerging from the discussions held at Bogota in February 1976 as well as the comments received from UNIDO on the draft final report. The aim of the project and the statement of work according to the terms of reference of the contract along with the reference of discussions made therein in various portions of the report are given in Volume I (Summary and Recommendations) to facilitate reference.

We take this opportunity to express our gratitude to UNIDO, UNDP, the Government of Colombia and other agencies for the cooperation extended to us during the course of the study.

Respectfully submitted
DASTUR ENGINEERING INTERNATIONAL GmbH
by

M.N. Dastur

MND:pgk

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INTRODUCTION

1. This study, carried out at the instance of the United Nations Industrial Development Organization (UNIDO), seeks to formulate a strategy for the immediate and long-term development of the iron and steel industry in Colombia over the decade ending 1985. A short report covering the core aspects of the study was submitted to UNIDO in September 1975, followed by a presentation in Bogota during the same month. The Draft Final Report was submitted to UNIDO in December 1975 and was discussed at Bogota between 24th and 26th February 1976. The conclusions and suggestions emerging from these discussions as well as comments received from UNIDO have been incorporated in this final report. The discussions in the report corresponding to the aims and objectives of the project and the statement of work corresponding to the terms of contract are given on pages 2 and 3 for easy reference.

STEEL IN COLOMBIA

Steel production

2. Colombia's present position in the overall steel picture does not appear to be happy, viewed against

Reference to contract	Reference to summary and recommendations Para No.	Reference to Text Chapter No	 Page No.
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4. Techno-economic analysis and recommendations on the establishment of new iron and steel capacities. New capacities should guarantee supply of raw materials and semi-finished products needed by the existing facilities as well as of steel products competitive in price in the Andean sub-region and in comparison of production of third countries based on a common external tariff of around 20%.	38 to 46 65 104 to 110	7 9 13	7-1 to 7-14 9-19 to 9-22 13-1 to 13-14
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the wider background of the Andean Group, Latin America and the world. Steel production in Colombia rose from about 242,000 tons in 1965 to about 333,000 tons in 1974. The average annual growth rate between 1965 and 1974 has been only 3.6 per cent compared to 6.7 per cent for the Andean Group, 8.6 per cent for the Latin America and 5 per cent for the world as a whole. In terms of per capita production, Colombia has been more or less stagnant at the 13 kg average which is lower than that for all developing countries put together and much lower than the average for Andean Group as well as that for Latin American countries.

Steel consumption

3. In respect of steel consumption too, Colombia has registered only a nominal rise in per capita consumption from 24 kg in 1965 to 29 kg in 1974, compared to 45 kg to 63 kg by the Andean Group and 52 kg to 63 kg by Latin America. According to recent forecasts, the per capita steel consumption in the world as a whole is expected to rise to about 231 kg, to 191 kg in Latin America, to 100 kg in the Andean Group in 1985.

But in the case of Colombia, it would be only 62 kg, which would in effect, mean that even in 1985 steel consumption in Colombia would be 20 years behind Argentina, Mexico, Brazil, the Andean Group, the Latin America as a whole, a fact which underscores the need for the adoption of a bold and realistic programme for the speedy development of the iron and steel industry.

IRON AND STEEL DEMAND

ORDINARY STEEL DEMAND

4. The future demand for ordinary steel in Colombia has been projected by adopting the end-use method. This projection has been compared in Table 1 with the earlier demand projections in the Indicative Plan (January 1972) and in the feasibility study for Paz del Rio expansion (October 1973). To make them strictly comparable, seamless tubes, heavy profiles and railway materials have been excluded.

Table 1

DEMAND PROJECTION ON COMPARABLE BASIS[a]
(thousand tons)

	1980			1985		
	Flat	Non-flat	Total	Flat	Non-flat	Total
Indicative Plan	425	535	960	592	775	1 367
PDR	405	561	966	563	843	1 406
This study	545	640	1 185	1 068	1 095	2 163

a/ Excludes seamless tubes, heavy profiles and railway material.

Summary and Recommendations (cont'd)

5. The validity of the end-use forecasts has been checked against macro-projections made by time-trend analysis, regression analysis and steel intensity methods. On the basis of this analysis, the minimum possible demand for ordinary finished steel in Colombia is placed at about 1.3 million tons in 1980 and 2.3 million tons in 1985. The sector-wise and size-wise breakdown of the demand is given in Table 2.

Minimum probable demand by 1985

6. Taking into consideration the importance attached to the development of metal-mechanic sector in the Colombian economy, it is reasonable to expect that bulk of products involving simple fabrication which are hitherto being imported, will be manufactured within the country by 1985. Accordingly, the minimum probable demand in 1985 may rise by another 100,000 tons to 2.4 million tons of rolled products or 3 million tons of equivalent crude steel.

ALLOY AND SPECIAL STEELS DEMAND

7. The future demand for finished alloy and special steels estimated by the end-use method is expected to rise from the 1974 consumption level of 44,000 tons to about 97,000 tons in 1980 and 210,000 tons by 1985.

Table 2

SECTORWISE AND SIZEWISE ORDINARY STEEL DEMAND

A. SECTORWISE ORDINARY STEEL DEMAND

Sector			1980 '000 tons	1980 %	1985 '000 tons	1985 %
Transport equipment	..	..	123	9.7	296	12.9
Electrical equipment	..	..	56	4.4	198	8.7
Industrial and agricultural machinery	..	..	36	2.8	63	2.7
Metal products	..	..	314	24.8	518	22.6
Sub-total	..	..	529	41.7	1 075	46.9
Construction	..	..	745	58.3	1 217	53.1
Total	..	..	1 274	100.0	2 292	100.0

B. SIZEWISE BREAKDOWN OF DEMAND

Category			Size range mm	Demand 1980 '000 tons	Demand 1985 '000 tons
NON-FLATS					
Bars and rods		..	Below 75	300	526
			Above 75	40	70
Beam	- Medium	..	100 x 50 - 250 x 125	12	21
	- Heavy	..	Above 250 x 125	8	14
Channels	- Light	..	30 x 33 - 60 x 45	15	24
	- Medium	..	100 x 50 - 150 x 75	31	50
	- Heavy	..	Above 175 x 75	4	6
Equal angles	- Light	..	20 x 20 - 75 x 75	23	35
	- Medium	..	90 x 90 - 130 x 130	30	44
	- Heavy	..	Above 130 x 130	2	4
Unequal angles	- Light	..	30 x 20 - 60 x 40	4	6
	- Medium	..	85 x 45 - 125 x 90	5	10
	- Heavy	..	Above 125 x 90	1	1
Tees		..		4	8
Narrow flats	- Light	..	25 to 75	40	70
	- Medium	..	Above 75 to 150	10	18
	- Heavy	..	Above 150	10	16
Wires		..		130	215
Seamless tubes		..		40	72
Rails and other railway materials		..		20	14
Sub-total non-flats		..		729	1 224
FLATS					
Plates		..	Below 1 200 width	35	63
			Above 1 200 width	35	62
CR sheets/strip		..	Below 1 200 width	88	250
			Above 1 200 width	37	100
HR sheets/strip		..	Below 1 200 width	63	112
			Above 1 200 width	27	48
Tinplate		..		120	190
Galvanised sheets		..		80	135
Welded pipes		..		60	108
Sub-total flats		..		545	1 068
Total non-flats and flats		..		1 274	2 292

POSSIBILITIES OF STEEL EXPORT TO ANDEAN COUNTRIES

8. Available data on future steel demand and production programme of the Andean countries would indicate that there is hardly any scope for making specific export provision while planning Colombia's future steel capacity. In respect of alloy and special steels, however, it is likely that Colombia will continue to have a share of the Andean market.

DEMAND FOR PIG IRON

9. The demand for iron and steel castings is expected to rise to about 76,000 tons and 25,000 tons in 1980 and to around 138,000 tons and 46,000 tons in 1985 respectively. On the basis of the present rate of consumption, the pig iron requirements would be of the order of 40,000 tons in 1980 and 65,000 tons in 1985.

<u>FUTURE SCRAP AVAILABILITY</u>

<u>Analysis of present scrap availability</u>

10. The scrap trade in Colombia is not organised and data on its generation, availability are not readily available. Based on the data collected for the five year period 1970-74, total domestic scrap purchases by various consumers amounted to about 490,000 tons. This is in fair agreement with domestic scrap availability estimated on the basis of process scrap and capital scrap generation.

Summary and Recommendations (cont'd)

Future scrap availability

11. The future scrap availability estimated on the same basis has been estimated at about 238,000 tons in 1980 and 440,000 tons in 1985. After allowing for the requirements of foundries and other industries, the scrap availability for electric furnace steel production would be around 173,000 tons in 1980 and 333,000 tons in 1985.

ANALYSIS OF SEMI-INTEGRATED PLANTS

PAST PERFORMANCE

Installed capacity and production

12. There are six existing semi-integrated steel plants (SIP). The installed capacity of SIP is estimated at about 230,000 tons of ingot per year and the total rolling capacity is estimated at about 270,000 tons. As against this, the rolled steel production was about 94,000 tons only in 1974 (113,000 tons in 1972 and 1973).

Capacity utilisation

13. The capacity utilisation in terms of actual ingot production was highest in 1967 (about 75 per cent) and declined to 43 per cent in 1974, primarily due to rising scrap shortage. In terms of market coverage, though the position actually improved to

about 65 per cent in 1974, this is largely due to the sharp decline in the market for SIP after 1970.

14. The rolling mill capacity utilisation has been generally around 40 per cent, the maximum being about 60 per cent in 1965 and 1969. In terms of market attended, after achieving a maximum of 90 per cent in 1968, it dropped to 60 per cent in 1971 and has improved to about 80 per cent from 1972. The higher market coverage by rolled products compared to ingots is explained by the use of purchased billets for rolling.

Technology and quality control

15. As most of the plants produce only rebars, the quality requirements are adequately met by the existing acid practice. However, realising the advantages of the basic practice, two plants are operating with basic steelmaking and two others have plans to switch over to the basic practice. All the plants are equipped with laboratory facilities.

Financial performance

16. From an analysis of the financial performance of three SIP for which annual reports were available, it is observed that

i) the improvement in the sales income has mainly come from increase in steel prices

ii) despite the fairly high interest rates, these and other financial charges do not form a significant proportion of the total sales income

iii) investment in gross blocks has been steadily rising in all plants

iv) the cumulative effect of the above factors has resulted in an upward trend in net profit before tax and there is a very sharp rise in 1974. However, as the provision for taxation as a percentage of the net profit has also risen steadily, the upward trend in net profit after tax has not been as impressive as the net profit before taxes

v) The ratio of current assets to current liabilities has been maintained at a fairly satisfactory level in all plants. However, the liquidity ratio, that is the ratio of liquid cash to current liabilities, has been unsatisfactory.

POSSIBLE FUTURE ROLE OF SIP

Future market

17. The possible future role of SIP has been planned keeping in view the future market, the geographic pattern of the market and the possibility of their specialisation. The future market for SIP is estimated at 337,000 tons and 701,000 tons of ordinary steel bars and rods and light profiles for the years 1980 and 1985 respectively. The share of SIP in the market for special steel products is 63,000 tons and 146,000 tons of bars and rods and wire rods respectively for 1980 and 1985.

Summary and Recommendations (cont'd)

Future production programme

18. The annual production programme of SIP is given in Table 3. It is expected that the semi-integrated plants would diversify to produce special steels including special steel wire rods, in addition to ordinary steel products.

Table 3

SEMI-INTEGRATED PLANTS' FUTURE PRODUCTION PROGRAMME
(thousand tons)

	Ordinary steel				Special steel		
	Bars and rods	Wire rods	Light profiles	Total	Bar and rods	Wire rods	Total
1974 ..	39.4	6.1	30.5	76	17.6	-	17.6
1976 ..	58	15	40	113	18	5	23
1977 ..	60	21	48	129	20	10	30
1978 ..	80	35	49	164	24	14	38
1979 ..	77	55	50	182	24	14	38
1980 ..	90	55	68	213	35	20	55
1981 ..	95	65	83	243	40	21	61
1982 ..	95	65	83	243	48	21	69
1983 ..	95	65	83	243	48	21	69
1984 ..	95	65	83	243	48	21	69
1985 ..	95	65	83	243	60	21	81

Melting stock situation

19. Domestic scrap shortfall is expected to rise from about 50,000 tons in 1976 to 200,000 tons in 1981. This widening gap will have to be met either by imported scrap or the use of imported billets or of sponge iron. The vagaries of the international market in billets and scrap are well known and

none of the Andean countries has plans to produce salable billets or sponge iron on a long-term basis. Therefore, it would be logical to plan and install direct reduction plants and fit them into the larger framework of the national steel programme.

INVESTMENT AND OPERATING COSTS

Investments for new facilities

20. The augmentation of SIP ingot steel capacity from the current level of about 230,000 tons to about 500,000 tons in 1985, would involve an investment of the order of US $ 66 million, for additional plant facilities. This would necessitate separate studies for individual plants to identify specific balancing facilities required to enable the full utilisation of the installed capacity, and to obtain more precise estimates of costs.

Operating costs

21. It is estimated that the average works cost of rolled steel utilising 50 per cent domestic scrap and 50 per cent imported scrap would be about US $ 260 per ton compared to about US $ 245 per ton when using 50 per cent domestic scrap and 50 per cent sponge iron. However, the cost of imported billets (US $ 267 per ton) would be even higher than the cost of rolled products using either imported scrap or domestic scrap and sponge iron.

Summary and Recommendations (cont'd)

EXPANSION OF ACERIAS PAZ DEL RIO S.A.

ANALYSIS OF PAST PERFORMANCE

Capacity utilisation

22. The capacity utilisation of Acerias Paz del Rio S.A. (PDR) which is the only integrated steel plant in Colombia, in terms of ingot steel has ranged between 80 to 92 per cent during 1970 to 1974 as against the installed capacity of 300,000 tons per year. The highest production (276,000 tons) was achieved in 1972. The recent fall in ingot steel production has been largely due to hot metal shortage arising from inadequate coke availability.

23. Due to inadequate iron and steelmaking capacity as well as absence of cold rolling facilities, the rolling mills have been utilised only to the extent of 30 per cent. In 1974, only about 8 per cent of the 400,000-ton capacity steckel mill was utilised.

Technology

24. The high phosphorus content of the local iron ore and consequently of the hot metal, has led to the adoption of Thomas process of steelmaking. Though the blast furnace operations have improved considerably with the use of fluxed sinter and

fuel oil injection, the movement of stock in the blast furnace is not satisfactory. While plant return scrap is utilised for electric arc furnace steelmaking, basic refractories, sintered magnesite and calcined dolomite, and bulk of the ferro-alloys are imported.

Financial performance

25. The major conclusions of an analysis of the financial performance of PDR from 1970 to 1974 on the basis of their annual reports, are:

i) The large increase in the net sales income has resulted from an increase in the average sales price of steel.

ii) The sales cost has maintained an upward trend, in harmony with the increasing average sales price.

iii) The net profit before taxes increased by 136 per cent, though the net sales income rose by 98 per cent during the same period. However, due to the rise in the provision for tax, the net profit after taxes has registered an increase of only 53 per cent.

iv) The wages and salaries have risen by about 83 per cent.

v) The ratio of share holders equity to long term loan has declined from 2.1:1 in 1970 to 1.8:1 in 1974. The gross block per ton of finished steel produced has increased from Colombian peso 6,636 in 1970 to Colombian peso 10,447 in 1974.

vi) The ratio of current assets to current liabilities has been fairly satisfactory throughout the period. The ratio of liquid cash and current liabilities was at an unsatisfactory level of 1.0:1.2 at the end of 1972 and improved to 1.0:1.3 at the end of 1974.

CURRENT IMPROVEMENT PROGRAMME

26. The current improvement programme envisages the installation of a 57-oven coke battery expected to go on stream in 1975; and of cold rolling facilities in two stages - the first stage with an annual capacity of 240,000 tons, and its duplication essentially during the second stage. This essential programme should be implemented without delay.

EXPANSION SCHEMES

<u>Existing scheme</u>

27. The concept of expansion of PDR to 1 million ton of crude steel according to the feasibility report prepared in October 1973 and updated in February 1975, is based on the installation of a new bottom-blown oxygen steelmaking shop to replace the existing Thomas converter shop as well as the installation of a new billet mill and a new wire rod mill. Requisite expansion of ironmaking, mining and other auxiliary facilities is also envisaged. This expansion scheme is referred to as PDR-I.

<u>Alternative possibilities</u>

28. The Thomas shop at Belencito is still young to be retired and, therefore, two alternative schemes of expansion through conversion of the existing shop to oxygen bottom-blown process has been suggested, namely:

Summary and Recommendations (cont'd)

i) PDR-II - to fully utilise the existing hot rolling mills, but the new wire rod and billet mills (PDR-I) will not be installed.

ii) PDR-III- to fully utilise the existing hot rolling mills. A new 200,000 tons per year wire rod mill will be installed, but no billet mill (PDR-I).

Comparison of schemes

29. The three alternative schemes are compared in Table 4.

Table 4

COMPARISON OF ALTERNATIVE SCHEMES OF PDR EXPANSION

	PDR-I	PDR-II	PDR-III
PRODUCT-MIX, '000 tons/yr			
Flat products			
Hot rolled ..	75	31	31
Cold rolled ..	237	240	240
Tinplate ..	62	60	60
Sub-total ..	347[a]	331	331
Non-flat products			
Bars and rods ..	150	70	180
Wire rods ..	197	110	200
Medium profiles ..	14	30	30
Sub-total ..	361	210	410
Salable billets ..	57	-	14
Total salable steel	792	541	755
INGOT STEEL CAPACITY, '000 tons/yr			
Additional for expansion	700	425	652
Total after expansion	1 000	725	952
INVESTMENT[b]			
For additional facilities, mill US $	441	223	388
Per annual ton of additional capacity, US $ ..	630	520	595
AVERAGE PRODUCTION COST/TON SALABLE STEEL, US $ ..			
Works cost ..	134	138	135
Total ..	248	243	244

a/ In the feasibility report for PDR expansion steckel mill capacity is assumed as 442,000 tons/yr, whereas PDR has indicated it as 400,000 tons/yr which is considered for PDR-II and PDR-III.

b/ Excludes investment of current improvement programme.

Summary and Recommendations (cont'd)

Elimination of PDR-I

30. The above analysis indicates that the average cost of steel would be approximately the same for both PDR-II and PDR-III and marginally lower than that for PDR-I. Since both PDR-I and PDR-III envisage PDR expansion to about 1 million tons with similar product-mix, for further analysis in this study, PDR-III has been selected as the one million ton scheme.

Phased implementation

31. PDR-II as well as PDR-III can be implemented in two phases. In Phase 1, the crude steel production would be about 380,000 tons per year - 340,000 tons through increased hot metal production from the existing blast furnace with the use of oxygen enriched blast and modification of the existing three Thomas converters to LWS; and 40,000 tons from the electric arc furnace. Phase 1 could be implemented in about two years' time and would involve an investment of the order of US $ 11 million. The work on Phase 2, starting concurrently with Phase 1, may take about 4 years to complete and become operative by about 1981.

RAW MATERIALS SITUATION

Iron ore

32. The measured reserves of iron ore, estimated at about 105 million tons of which 65 million tons are

considered mineable, would be adequate to meet the ore requirements of the expanded plant for 30 to 35 years. However, in view of the low quality of the ore (43 to 45 per cent Fe, and 11 per cent SiO_2), beneficiation studies should be pursued.

Coal

33. PDR has estimated its recoverable coking coal reserves as 22 million tons, which would be adequate for 12 to 16 years' operation. Further exploration would, therefore, be needed, but this need not be a constraint on expansion, because coal could be purchased.

Limestone

34. Proved reserves of limestone are about 11 million tons, adequate to meet the plant requirements for 7 to 10 years. It would be essential to block out separately steelmaking grade limestone, because with the adoption of LWS process, it may be preferable to use lime containing 90 per cent CaO minimum and 3 per cent SiO_2 maximum.

INFRASTRUCTURE FACILITIES

Electric power

35. The increased electric power for the plant is to be met from the Paipa Thermal Station, and no major difficulty is anticipated regarding the power supply.

Water

36. The water requirements can be met from the Lake Tuta, provided the draw off is restricted to make-up water requirements, and recirculation water system is installed at the plant.

Transport

37. The captive railway system of PDR would have to be suitably expanded and appropriate investigation carried out to ensure adequate rail facilities to handle increased raw materials and finished products traffic. The present practice of transporting the bulk (85 per cent) of the finished products from the plant to Bogota by road may not be feasible after expansion.

CREATION OF NEW CAPACITY

Demand considered for domestic production

38. The total demand for steel covers a wide range of items, some of which are not envisaged for domestic production for technical and/or economic reasons. Excluding these items, the net finished steel demand considered for domestic production would be about 1.1 million tons in 1980 and about 2.1 million tons in 1985.

Summary and Recommendations (cont'd)

Projected future production of SIP and PDR

39. Taking into consideration the SIP production programme and the alternative PDR expansion schemes, three production combinations are feasible, namely:

Case-I - SIP + PDR-I
Case-II - SIP + PDR-II
Case-III - SIP + PDR-III

As PDR-I has been eliminated from further consideration, the Case-I has not been analysed.

Gap between demand and production

40. The annual gap between the net demand considered for production and the planned productions for SIP and PDR is shown in Table 5 on page 22 for the period 1979 to 1985, as no major new facilities will go into production prior to 1979.

New rolling mill requirement

41. The shortfalls in bars and rods, and wire rods would justify the installation in 1985 of additional 400,000 tons capacity in Case-II, and of about 200,000 tons capacity in Case-III. In case-II, a mill with an initial capacity of 200,000 tons could be installed in 1979. In both the cases, additional capacity for the production of 50,000 tons of light profiles and 200,000 tons of medium profiles should be operating by 1985.

Table 5

PROJECTED GAP BETWEEN DEMAND CONSIDERED AND PRODUCTION OF SIP AND FDR
(thousand tons)

	1979					1980				
		Case II		Case III			Case II		Case III	
	Demand	Prodn	Shortfall	Prodn	Shortfall	Demand	Prodn	Shortfall	Prodn	Shortfall
ORDINARY STEEL										
Bars and rods ..	191	146	45	146	45	216	160	56	160	56
Wire rods ..	188	157	31	157	31	214	160	54	160	54
Light profiles ..	69	50	19	50	19	82	68	14	68	14
Medium profiles ..	87	9	78	9	78	128	10	118	10	118
HR sheets/strip ..	149	89	60	89	60	156	94	62	94	62
CR sheets/strip ..	180	70	110	70	110	210	110	100	110	100
Tinplates ..	104	-	104	-	104	120	-	120	-	120
Total ..	968	521	447	521	447	1 126	602	524	602	524
SPECIAL STEELS										
Bars and rods ..	30	24	6	24	6	36	35	1	35	1
Wire rods ..	28	19	9	19	9	32	25	7	25	7
Total ..	58	43	15	43	15	68	60	8	60	8

	1981					1982				
		Case II		Case III			Case II		Case III	
	Demand	Prodn	Shortfall	Prodn	Shortfall	Demand	Prodn	Shortfall	Prodn	Shortfall
ORDINARY STEEL										
Bars and rods ..	242	165	77	235	7	271	165	106	235	[illegible]
Wire rods ..	238	170	68	200	38	265	170	95	240	[illegible]
Light profiles ..	91	83	8	83	8	100	83	17	83	[illegible]
Medium profiles ..	142	15	127	15	127	158	30	128	30	128
HR sheets/strip ..	175	106	69	106	69	197	119	78	119	78
CR sheets/strip ..	250	150	100	150	100	297	170	127	170	[illegible]
Tinplates ..	131	-	131	-	131	144	-	144	-	[illegible]
Total ..	1 269	689	580	789	480	1 432	737	695	877	[illegible]
SPECIAL STEELS										
Bars and rods ..	41	40	1	40	1	49	48	1	48	1
Wire rods ..	36	26	10	26	10	43	26	17	26	17
Total ..	77	66	11	66	11	92	74	18	74	[illegible]

	1983					1984					1985				
		Case II		Case III			Case II		Case III			Case II		Case III	
	Demand	Prodn	Shortfall	Prodn	Shortfall	Demand	Prodn	Shortfall	Prodn	Shortfall	Demand	Prodn	Shortfall	Prodn	Shortfall
ORDINARY STEEL															
Bars and rods ..	304	165	139	255	49	341	165	176	275	66	379	165	214	275	104
Wire rods ..	295	170	125	[illegible]	35	329	170	159	260	69	362	170	192	260	102
Light profiles ..	111	83	28	83	28	123	83	40	83	40	135	83	52	83	52
Medium profiles ..	175	30	145	30	145	194	30	164	30	164	213	30	183	30	183
HR sheets/strip ..	230	52	168	52	168	247	31	216	31	216	278	31	247	31	247
CR sheets/strip ..	353	240	113	240	113	430	240	190	240	180	495	240	255	240	255
Tinplates ..	158	42	116	42	116	173	60	113	60	113	190	60	130	60	130
Total ..	1 616	782	834	962	654	1 327	779	1 048	979	868	2 052	779	1 273	979	1 073
SPECIAL STEELS															
Bars and rods ..	58	48	10	48	10	69	48	21	48	21	80	60	20	60	20
Wire rods ..	50	26	24	26	24	59	26	33	26	33	71	26	45	26	45
Total ..	108	74	34	74	34	128	74	54	74	54	151	86	65	86	65

42. In respect of flat products, as PDR has already a steckel mill, the new mill should be a semi-continuous mill. In order to cover a wider specturm of demand, the new mill may preferably be of 1,730 mm (68 in) size and a minimum capacity of about 1 million tons of hot rolled products. The short-falls justify such a mill commencing operation in 1984. At the same time, adequate cold rolling and finishing facilities would also have to be set up.

SELECTION OF IRON AND STEELMAKING ROUTES

43. Taking into consideration the new rolling mill facilities, two alternative capacities have been considered, namely

Alt. 1 - 500,000 tons continuous cast semis
Alt. 2 - 1.3 million tons continuous cast semis

44. In the Colombian context, both the blast furnace-basic oxygen steelmaking (BF-BOS) route and the direct reduction-electric arc furnace (DR-EF) route merit consideration. For direct reduction, adoption of gas based processes which are commercially established have been envisaged. The electric arc furnace steelmaking will be based on the use of 50 per cent sponge iron.

Summary and Recommendations (cont'd)

45. The relative economic evaluation of the alternative routes and alternative capacities (Table 6) indicates that for the smaller capacity plant, the DR-EF route would be advantageous, while the BF-BOS route would be more economical for the larger plant.

Table 6

RELATIVE ECONOMICS OF ALTERNATIVE ROUTES

	DR-EF		BF-BOS	
	Alt. 1	Alt. 2	Alt. 1	Alt. 2
Investment, mill US $ ..	80	185	175	347
Production cost, US $/ton liquid steel				
Cost of raw materials ..	87	100	75	75
Cost above material ..	37	33	35	29
Works cost ..	124	133	110	104
Fixed charges[a/] ..	24	22	53	40
Total ..	148	155	163	144

a/ 15% per year on investment.

PRODUCTION PROGRAMME OF NEW FACILITIES

46. Based on the economic evaluation of alternative routes, the DR-EF route for bar and rod mill complex and the BF-BOS route for the integrated plant for the production of flat and medium

Summary and Recommendations (cont'd)

profile products have been envisaged. The production programme for Case-II and Case-III, given in Table 7 takes into account the normal time required to build up the rated capacity.

Table 7

PRODUCTION PROGRAMME OF NEW FACILITIES
(thousand tons)

	Case-II				Case-III			
	Bars, rods	Profiles		Flat	Bars, rods	Profiles		Flat
Year	& wire rods	Light	Med	products	& wire rods	Light	Med	products
1979	50	-	-	-	-	-	-	-
1980	150	-	-	-	-	-	-	-
1981	200	-	-	-	-	-	-	-
1982	200	-	-	-	-	-	-	-
1983	255	-	-	-	100	-	-	-
1984	355	25	100	455	145	25	100	455
1985	400	50	140	640	200	50	140	640

DIRECT REDUCTION

Sponge iron requirement

47. In planning the sponge iron capacity, the melting stock requirements for SIP, the new bar and rod mill complex, and a new light profile mill have been taken into account as indicated in Table 8.

Summary and Recommendations (cont'd)

Table 8

SPONGE IRON REQUIREMENTS
(thousand tons)

	Ingot production[a/]		Purchased scrap requirement[b/]		Domestic scrap availability	Scrap shortfall		Sponge iron requirement[c/]	
	Case II	Case III	Case II	Case III		Case II	Case III	Case II	Case III
1979	327	267	332	271	153	179	118	197	130
1980	509	329	517	334	173	344	161	378	177
1981	613	346	623	352	186	437	166	481	183
1982	625	363	635	369	218	417	151	459	166
1983	685	503	696	511	252	444	259	488	285
1984	832	569	845	576	294	551	282	606	310
1985	931	681	946	692	333	613	359	674	395

a/ From SIP, and the proposed new bar and rod mill, and light profile mill complexes, after allowing for salable billets available in PDR-III.

b/ Ingot steel x 1.016.

c/ 1 ton scrap = 1.1 ton sponge iron.

Selection of production processes and unit sizes

48. HyL and Midrex are the two gaseous direct reduction processes which are now commercially established. The Armco process, which has one operating plant now, may also be considered to have reached the stage of commercial acceptance. The HyL plants in operation are of varying unit sizes, while most of the Midrex units are of the same unit size.

Summary and Recommendations (cont'd)

A unit size of 350,000 tons per year capacity can be considered both for HyL and Midrex processes, while a smaller unit size of 220,000 tons can also be considered for HyL process.

49. Of the different coal-based sponge iron processes, only rotary kiln units have found industrial application in recent years. However, none of the three existing rotary kiln units producing sponge iron has achieved the rated production level. For instance, the New Zealand plant rated at 150,000 tons produces about 120,000 tons per year; the plant at Charquedas in Brazil rated at 65,000 tons was operating at about 54 per cent capacity, two years after commissioning; and the third plant at Benoi, South Africa, rated at 150,000 tons per year produced about 45 per cent of the rated capacity in 1974.

50. For the purpose of comparison of processes, therefore, the output achievable from the rotary kiln units may be somewhat lower than the rated capacity indicated by process and equipment suppliers. Accordingly, assuming suitable quality raw materials and good operating conditions, a 3.6 m dia kiln unit may produce about 50,000 tons and a 4.6 m dia kiln about 115,000 tons per year.

Summary and Recommendations (cont'd)

Comparison of alternative processes and unit size

51. The ralative economics of the alternative processes is compared in Table 9.

Table 9

ECONOMIC COMPARISON OF ALTERNATIVE PROCESSES AND UNIT SIZES FOR DIRECT REDUCTION

	Gas-based process		Coal-based process	
Unit size, '000 t/yr	220	350	50	115
Investment, mill US$	44	52	16	26
Cost of sponge iron including fixed charges at 15% of investment, US$/ton	114	104	158	135

The analysis indicates that a 50,000 ton coal-based plant would not be economical even as a captive unit, because the delivered cost at consuming centres of sponge iron produced in a 115,000 ton capacity plant would be lower.

Alternative plans for direct reduction capacity

52. Taking into consideration the present commercial status of the sponge iron processes and the availability of natural gas in Colombia, it would be advisable to set up the initial direct reduction

capacity with gas-based plant. In the meantime, the operation of rotary kiln units elsewhere should be carefully observed, and tests and investigations on raw materials completed. The decision on installing a rotary kiln unit may be taken at a later date.

53. Based on an evaluation of alternative plans for direct reduction capacity for Case-II and Case-III, the following are suggested for adoption:

Case-II	Case-III
350,000 tons gas-based plant in 1979	220,000 tons gas-based plant in 1979
115,000 tons coal-based plant in 1981	115,000 tons coal-based plant in 1983
350,000 tons gas-based plant in 1984	-

The average delivered cost of sponge iron in Case-II would be US $ 115 per ton and for Case-III US $ 127 per ton.

<u>Raw materials situation</u>

54. The electric arc furnaces installed at SIP are designed for scrap use and, therefore, it would be advantageous to utilise high quality sponge iron (with minimum gangue content) to keep the slag volume low. The high grade iron ore/pellets required for the production of sponge iron will have to be imported

from countries such as Peru, Brazil, Canada, etc. The natural gas required would be available from the Guajira field by 1978. Adequate test work will have to be carried out to identify suitable sources of non-coking coal and necessary prospecting work would be required to establish their results.

NEW INTEGRATED STEEL PLANT

Plant capacity and product-mix

55. The new integrated steel plant will have a capacity of 1.3 million tons of crude steel per year and the product-mix of salable steel will be as follows:

	Size range mm	Annual quantity '000 tons
Medium profiles ..	75 to 200	200
HR sheets/coils ..	600 to 1500	300
CR sheets/coils ..	600 to 1500	532
Galvanised sheets/ coils ..	600 to 1250	80
Total ..		1 112

Raw materials

56. The annual requirements and sources of supply of major raw materials will be as follows:

Material	Source	Annual requirement '000 tons
Iron ore	Imported	1 980
Coal	Cundinamarca-Boyaca	1 350
Limestone	Barranquilla	630

Summary and Recommendations (cont'd)

Plant flow sheet and general layout

57. The plant flow sheet indicating the requirements of the major raw materials as well as production of major units is given in Figure 9-1.

Utilities

58. The requirements and sources of supplies of utilities are as follows:

		Requirement	Source
Electric power	..	120 MW	CORRELCA system
Make-up water	..	2 500 cu m/hr	Magdalena river
Natural gas	..	3 500 cu m/hr	Guajira

Maximum possible use of by-product gas is envisaged and natural gas will be needed mainly for auxiliary injection in the blast furnace.

Pollution control

59. Adequate environmental pollution control measures have been provided in the form of appropriate dust and fume extraction systems, gas cleaning facilities and water treatment facilities.

Total capital requirement

60. The total capital requirement is indicated in Table 10. The estimates exclude the cost of land, site preparation and off-site facilities, and do not provide for escalation.

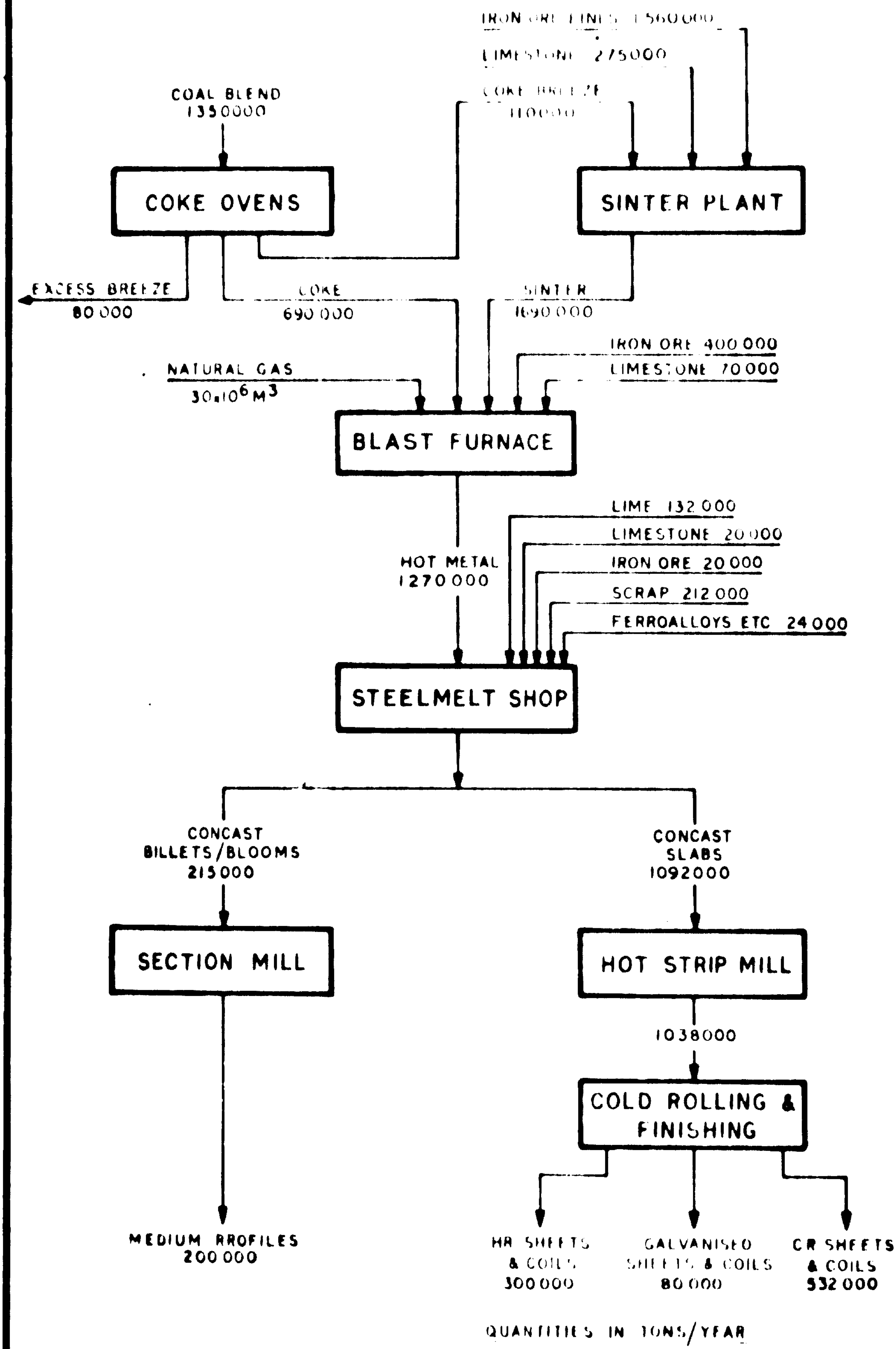


FIGURE 9-1 NEW INTEGRATED STEEL PLANT MATERIAL FLOW SHEET

Summary and Recommendations (cont'd)

Preliminary financing plan

61. Based on the pattern of financing steel projects in Latin American countries, the following pattern of financing has been assumed (Table 11). It is assumed that the long-term loans will bear simple interest at 10 per cent per annum, while the short term loan for working capital will carry an interest rate of 25 per cent per annum.

Table 10

TOTAL CAPITAL REQUIREMENT

		Million US $
Plant cost	..	1 035
Spares	..	30
Preliminary, start-up and commissioning expenses	..	45
Interest on long term loans during construction	..	190
Fixed investment	..	1 300
Working capital	..	48
Total capital requirement		1 348

Table 11

ASSUMED FINANCING PATTERN FOR THE TOTAL CAPITAL REQUIREMENT

	Million US $		
	Loan	Equity	Total
Fixed investment excluding interest on long-term loan during construction	650	460	1 110
Interest on long-term loans during construction	190	-	190
Working capital	48	-	48
Total capital requirement	888	460	1 348

Summary and Recommendations (cont'd)

62. Apart from bilateral aid and equipment suppliers' credit, agencies like the International Bank for Reconstruction and Development, International Development Bank, Inter-American Development Bank, Corporation Andina de Fomento and Fondo de Inversiones Venezuela are the likely sources of long-term credits.

Manufacturing expenses

63. The annual manufacturing expenses including raw materials, labour and supervision and other manufacturing expenses but excluding depreciation and interest charges is estimated at US $ 194 million for the rated capacity operation. The average manufacturing cost per ton of salable steel at full production level works out to US $ 175.

Works cost of products

64. The estimated works costs of the various products, excluding fixed charges, are given below:

Product		US $/ton
Sinter	..	30
Coke (run-of-oven)	..	53
Hot metal	..	82
Billets/slabs	..	112
Medium profiles	..	136
Hot rolled sheets/coils	..	146
Cold rolled sheets/coils		199
Galvanised sheets/coils	..	216

Summary and Recommendations (cont'd)

Annual sales realisation

65. The annual sales realisation at the rated capacity production is estimated at US $ 424 million assuming a sales price based on the 1975 selling prices in Colombia and those assumed in the feasibility report for PDR expansion which appear competitive in the Andean sub-region.

Profitability analysis

66. The preliminary profit and loss statement for the fourth year of operation which is the first year of rated capacity operation is summarised below:

		Million US $
A.	Sales realisation ..	424
B.	Annual manufacturing expenses	194
C.	Gross profit (A-B) ..	230
D.	Fixed charges/expenses ..	155
E.	Net profit before tax (C-D)	75
F.	Taxation ..	30
G.	Net profit after tax (E-F)	45
H.	Return on equity after tax	10%

The plant profitability would improve substantially in the future years, due to the progressive reduction in the interest charges on long-term loans and working capital as these loans get repaid in annual instalments.

67. The break-even analysis indicates that the plant work break even at 70% of its rated capacity operation. The sensitivity analysis carried out

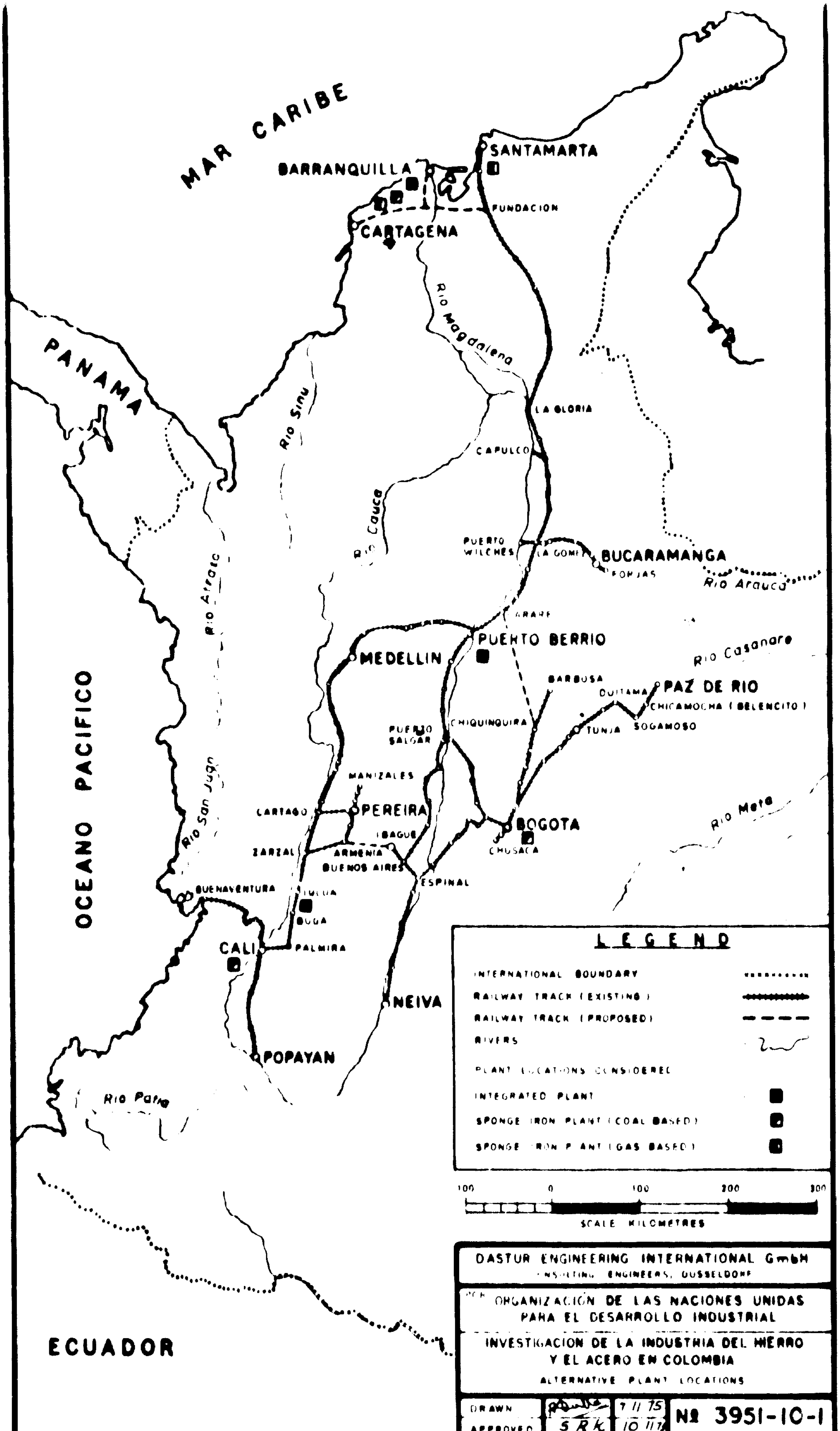
to study the effects of 10 per cent variation in the annual sales realisation, manufacturing expenses and fixed charges on the project profitability indicates that under rather adverse circumstances, the project would require higher steel price support to provide adequate financial rate of return.

LOCATION OF NEW PLANTS

68. The preliminary selections of possible locations for the new integrated steel plant, direct reduction plant and the bar and rod mill complex are shown in Drawing 3951-10-1.

New integrated steel plant

69. Of the three locations, Barranquilla, Buga Tulua, Puerto Berrio considered for the new integrated steel plant, Barranquilla, a typical coastal location on the Atlantic coast, offers the best advantage from the view point of transport cost (raw materials assembly and product distribution). A confirmation on the suitability of the Barranquilla location would, however, involve further investigations on infrastructure development. While selecting the steel plant site, the possibility of integrating


MAR CARIBE
BARRANQUILLA
SANTAMARTA
FUNDACION
CARTAGENA
PANAMA
Rio Magdalena
Rio Sinu
LA GLORIA
CAPULCO
Rio Cauca
PUERTO WILCHES
LA GOMEZ
BUCARAMANGA
FORJAS
Rio Arauca
Rio Atrato
PUERTO BERRIO
MEDELLIN
Rio Casanare
BARBOSA
DUITAMA
PAZ DE RIO
CHICAMOCHA (BELENCITO)
PUERTO SALGAR
CHIQUINQUIRA
TUNJA
SOGAMOSO
OCEANO PACIFICO
Rio San Juan
MANIZALES
CARTAGO
PEREIRA
IBAGUE
BOGOTA
CHUSACA
Rio Meta
ZARZAL
ARMENIA
BUENOS AIRES
ESPINAL
BUENAVENTURA
TULUA
BUGA
CALI
PALMIRA
NEIVA
POPAYAN
Rio Patia
ECUADOR
LEGEND
INTERNATIONAL BOUNDARY
RAILWAY TRACK (EXISTING)
RAILWAY TRACK (PROPOSED)
RIVERS
PLANT LOCATIONS CONSIDERED
INTEGRATED PLANT
SPONGE IRON PLANT (COAL BASED)
SPONGE IRON PLANT (GAS BASED)
100 0 100 200 300
SCALE KILOMETRES
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DUSSELDORF
ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA EL DESARROLLO INDUSTRIAL
INVESTIGACION DE LA INDUSTRIA DEL HIERRO Y EL ACERO EN COLOMBIA
ALTERNATIVE PLANT LOCATIONS
DRAWN
APPROVED
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the infrastructure development with that required for the Guajira gas field and Cerrejon coal deposits should be kept in view.

Direct reduction plants

70. Barranquilla on the Atlantic coast is considered a typical location for the gas-based direct reduction plant to take advantage of the Guajira gas pipeline and proximity to a port. For the coal-based direct reduction plant, Cali offers the minimum transport cost for raw materials and sponge iron. The possibility of developing a suitable port on the Pacific coast for importing pellets for the coal-based plant needs further investigation.

New bar and rod mill complex

71. The new bar and rod mill complex would be integrated with the gas-based direct reduction plant on the Atlantic coast. Alternatively, this additional capacity could also be installed through expansion of SIP.

Infrastructure development required

72. Barranquilla is not yet on the railway map and it would be essential to link the selected plant location on the Atlantic coast with the hinterland by railway. The possibility of utilising river

barge transport, specially for carrying coal to the integrated steel plant needs to be investigated. Port locations should be studied and port facilities have to be developed on the Atlantic coast for importing iron ore and pellets, and on the Pacific coast for importing pellets.

73. The development of the Guajira gasfield and the installation of the gas pipeline to Barranquilla should be completed by 1978. The electric power requirement of the new plants will have to be taken into consideration, while finalising the national power programme. On the Atlantic coast, it would be advisable to increase the thermal power component of the CORRELCA system.

74. New transport links, port for export of coal, and water and power supply systems will have to be developed for the Cerrejon coal deposit and natural gas-based industries. The possibility of integrating the infrastructure facilities to serve the steel industry may be kept in view.

Summary and Recommendations (cont'd)

Ecology

75. No specific pollution control regulations are as yet in vogue in Colombia. In selecting plant facilities, however, adequate provision for installing pollution control facilities has been made.

NATIONAL STEEL PLAN

Basis of the National Steel Plan

76. On the basis of production programme of SIP, the alternative possibilities of PDR expansion and the creation of new capacity, two alternative plans - National Steel Plan II(NSP-II) and National Steel Plan III (NSP-III) - for steel development have been evolved. The National Steel Plan I (NSP-I) based on PDR-I is not considered, because the PDR-I scheme has been eliminated from further consideration.

NSP-II has been formulated on the basis of (i) expansion of SIP; (ii) expansion of PDR to 725,000 tons per year ingot steel capacity (PDR-II); and (iii) production from new plants as per Case-II. Similarly, NSP-III has been formulated on the basis of (i) expansion of SIP;

Summary and Recommendations (cont'd)

(ii) expansion of PDR to 952,000 tons per year ingot steel capacity (PDR-III); and production from new facilities according to Case-III.

Both NSP-II and NSP-III include the cold rolling mill facilities proposed under the 'Current Improvement Programme' of PDR.

77. <u>Time Table of NSP</u>

The time table for commissioning of new facilities under NSP-II and NSP-III are shown in Figure 11-1.

<u>Comparison of the two plans</u>

78. The two alternative plans, NSP-II and NSP-III are compared in Table 12 on the basis of various criteria such as degree of self-sufficiency; investments required and the additional capacities created; the total cost of steel to meet the national requirements; payback period; and utilization of domestic resources.

<u>Guidelines for selection of Plan</u>

79. It is observed that NSP-II would involve a lower investment of about US $ 80 million compared to NSP-III. However, as the investment on development of additional mining capacity of PDR accounts for about US $ 50 million, the difference in the investment on plant and equipment would be only

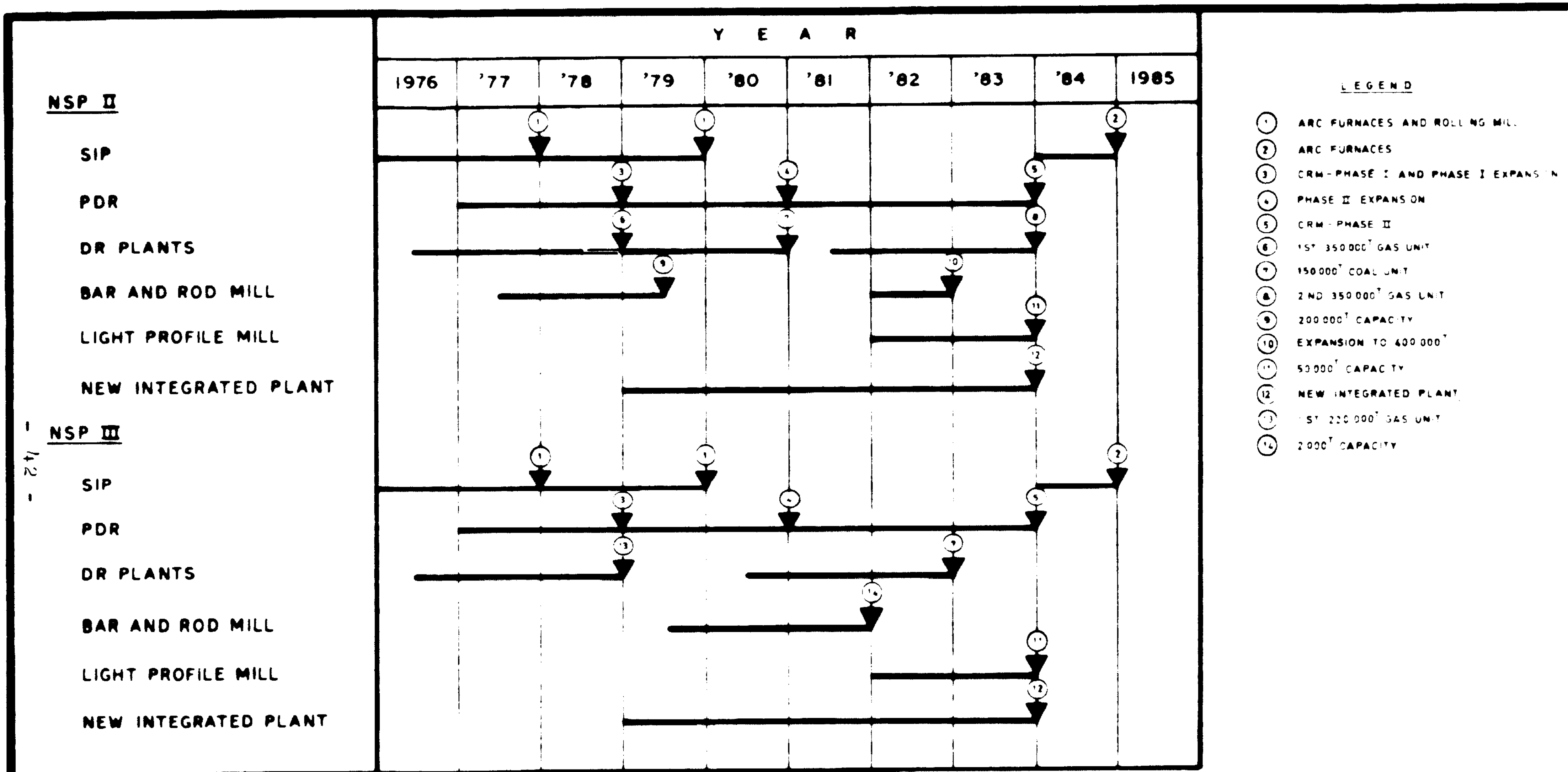

FIGURE II-1. TIME TABLE OF COMMISSIONING NEW FACILITIES

Summary and Recommendations (cont'd)

Table 12

COMPARISON OF NSP-II AND NSP-III

		NSP-II	NSP-III
1.	Total demand of rolled steel 1976 to 1985, '000 tons ..	15 261	15 261
2.	Total rolled steel production from 1976 to 1985, '000 tons	9 588	9 243
3.	DEGREE OF SELF-SUFFICIENCY (2) ÷ (1), % ..	63	60
4.	Investments on expansions and new facilities, million US $	1 716	1 797
5.	Additional crude steel capacity installed by 1985, '000 tons	2 544	2 531
6.	Average investment per additional annual ton of crude steel capacity, US $	675	710
7.	Total cost of domestic steel production from 1976 to 1985, million US $	3 072	2 918
8.	Average cost of steel produced, (7) ÷ (2), US $/ton ..	320	316
9.	Total cost of steel imported from 1976 to 1985, million US $[a]	2 124	2 254
10.	TOTAL COST OF STEEL FROM 1976 TO 1985 (7) + (9), million US $	5 196	5 172
11.	Current value of installed steelmaking facilities in 1975, million US $	87	87
12.	Total outflow at current prices .. .. (4) + (11), million US $	1 803	1 884
13.	Total inflow at current prices, 1976 to 1985, million US $[b]	1 604	1 586
14.	Present value of total outflow at 11% discount rate, million US $	1 104	1 153
15.	Present value of total inflow at 11% discount rate, million US $	802	794
16.	Ratio of present values (14) ÷ (15) ..	0.73	0.69
17.	PAY BACK YEAR OF INVESTMENT AT 11% DISCOUNT RATE ..	1988	1989
18.	Foreign exchange requirement for imports of steel, raw materials and supplies, 1975 to 1985, million US $ ..	2 289	2 265
	UTILISATION OF DOMESTIC RESOURCES		
19.	Annual requirement of local iron ore for full utilisation of facilities installed by 1985, million tons ..	1.5	2.0
20.	Annual requirement of imported iron ore and pellets for full utilisation of facilities installed by 1985, million tons	3.2	2.5
21.	Annual requirement of coking coal blend for full utilisation of facilities installed by 1985, million tons ..	2.2	2.5
22.	Annual requirement of non-coking coal blend for full utilisation of facilities installed by 1985, million tons	0.1	0.1
23.	Annual requirement of natural gas for full utilisation of facilities installed by 1985, million cu m ..	400	160
24.	Additional electric power demand for full utilisation of new facilities installed by 1985, MW ..	409	367

a/ Includes manufacturing, administration and sales expenses, and fixed charges.

b/ Derived by deducting the sum of manufacturing, administration and sales expenses from sales realisation.

Summary and Recommendations (cont'd)

about US $ 30 million, which is less than 2 per cent of the total investment for new facilities in NSP-II. The maximum investment to be made in 1980 in both the cases differs only marginally, about 6 per cent lower in NSP-II. Other commercial aspects are also similar, and therefore, it is difficult to choose between the two in commercial terms.

80. NSP-III, however, has greater advantage in the years beyond 1985, in terms of increased use of local raw materials and lesser dependence on more expensive forms of energy. The infrastructure development required in the case may be somewhat less, as the existing infrastructure facilities of PDR would be better utilised by its expansion to about a million tons.

81. The PDR expansion to about a million ton (PDR-III) has been formulated taking into consideration the conversion/expansion of the existing Thomas shop to oxygen bottom-blown process, full utilisation of the existing 710 mm mill, and the installation of continuous billet casting facilities to meet the additional requirements for the new wire rod mill. The concept of PDR-III scheme may be

Summary and Recommendations (cont'd)

further examined and confirmed, which alone would make NSP-III economically as attractive as NSP-II.

82. These factors may be kept in view by the Government of Colombia while finally selecting one of the plans for implementation, within the framework of their national/sub-regional development policy and programme.

Steel Development Strategy

83. The implementation of the National Steel Plan would involve the following strategy:

i) Short-term: In the immediate future, the only way to augment the domestic steel production would be the optimum utilization of the existing semi-integrated plants, This, however, would primarily depend on the market conditions and also on augmenting scrap supply, may be through imports, till such time as the first direct reduction plant goes on stream.

ii) Mid-term: During the mid-term period 1979-1982, requisite sponge iron capacity would be in operation; the existing Thomas converters at PDR would have been converted to bottom-blown oxygen process; the first cold rolling mill complex at PDR would have gone into production; SIP expansion completed; and the domestic steel production improved through better utilization of the primary iron and steelmaking facilities as well as by importing slabs to meet the steel requirements of PDR.

iii) Long-term: The long-term strategy of steel development would involve the completion of the expansion and the second phase of the cold rolling mill programme of PDR; the installation of the new integrated iron and steel plant as well as the new facilities; and implementing the balancing schemes of SIP expansion.

PIG IRON PRODUCTION

84. The additional pig iron requirement in the future could be met either through the expansion of the COLAR blast furnace plant (existing capacity 30,000 tons per year) or by the installation of electric smelting furnace in areas with abundant and cheap electric power. The possibility of utilising charcoal blast furnaces could be of interest at a future date in the Amazon region which has the potential of supplying large quantities of charcoal.

FERRO-ALLOYS

85. At present about 1500 tons of ferro-silicon is being produced annually by Metalico and this plant is to be expanded to about 3000 tons by 1976. To meet the domestic shortfall in ferro-silicon, additional capacity of about 6000 tons per year could be installed by 1985. The selection

Summary and Recommendations (cont'd)

of suitable location would depend on the availability of cheap electric power and suitable source of quartz/quartzite. Production of ferro-manganese could also be considered, provided suitable domestic sources of manganese ore are identified.

UTILIZATION OF NICKEL ORES

86. The estimated reserves of nickeiferrous ore occurring at Cerro Matoso deposit in the department of Cordoba are 40 million tons with an average nickel content in the range of 2.5 to 2.6 per cent. ECONIQUEL plans to exploit the ore and produce ferro-nickel by 1978-79. The plan is based on utilising 2.72 per cent average nickel in the ore feed. As this grade of the feed is higher than the average grade of the deposit, further detailed study should be made before taking a final decision on the feed grade for the ferro-nickel plant.

87. To utilise with advantage the ferro-nickel, a stainless steel complex with an initial capacity of at least 25,000 tons per year can be set up, to meet the demand of the Andean sub-region.

NSP AND THE NATIONAL ECONOMY

88. To ascertain the socio-economic advantages to be gained through the National Steel Plan (NSP), a detailed social cost-benefit analysis would be necessary, which is beyond the scope of this study. However, a preliminary examination has been made to indicate the effect of the steel industry on selected economic aspects.

<u>Inter-sectoral dependence</u>

89. From the latest available internally consistent input-output table (1966), it is observed that in terms of combined dispersion effects, the iron and steel industry has a high coefficient of 4.096, second only to the transport sector (coefficient 4.468). With the greater availability of steel envisaged, and the likely development of the capital goods and metal-mechanic sector, the combined dispersion effect of the steel industry would improve further.

Summary and Recommendations (cont'd)

Effect on foreign exchange requirement

90. With the implementation of NSP, the degree of self-suffiency in domestic steel production would improve and the recurring import bill will be kept at a lower level, specially for the years beyond 1985 when the benefits of the major investments would commence flowing in.

91. If the NSP were not implemented, the steel industry would stagnate. A comparison of the two situations indicates that the foreign exchange requirements during 1976 to 1985 for NSP-II and NSP-III at current prices would be about US $ 3,300 million compared to US $ 3,900 million in the case of the stagnating steel industry. In terms of the present value (at 11 per cent discount rate), this would correspond to US $ 1,900 million for NSP, compared to about US $ 2,000 million for a stagnating steel industry. This possible saving in foreign exchange requirement should be taken into consideration along with other advantages of NSP such as the additional value added, the increased direct and indirect employment created, the possibilities of assured steel supplies to the consuming industries, the skill formation, etc.

Summary and Recommendations (cont'd)

RAW MATERIALS AND INFRASTRUCTURE

Raw material requirements

92. The requirements of major raw materials in 1985 are given in Table 13.

Table 13

REQUIREMENTS OF MAJOR RAW MATERIALS (1985)
(thousand tons)

	NSP-II			NSP-III		
	PDR	New plants a/	Total	PDR	New plants a/	Total
Local iron ore:						
Lump ..	390	-	390	390	-	390
Fines ..	1 080	-	1 080	1 587	-	1 587
Imported iron ore:						
Lump ..	24	294	318	32	294	326
Fines ..	-	1 092	1 092	-	1 092	1 092
Pellet ..	-	1 170	1 170	-	498	498
Coking coal blend	835	945	1 780	1 125	945	2 070
Non-coking coal	-	127	127	-	127	127
Limestone ..	732	445	1 177	980	445	1 425

a/ Includes new integrated steel plant and sponge iron plants.

Iron ore

93. The iron ore/pellet requirements for the new plants would have to be imported. The annual iron ore exports from Latin America are expected to rise from the present 100 million tons level to about 160 million tons by 1980. Chile, Venezuela, and Brazil are prospective sources of supply of iron ore, and Peru, Brazil and Canada of pellets. Beyond 1980, Chile and Venezuela may also be potential sources of pellet supply.

Summary and Recommendations (cont'd)

Coal

94. The total coal reserves of Colombia are estimated at 1,766 million tons, of which 414 million tons have been proved. Further investigations are essential for proving the domestic coal reserves and quality. On the basis of available information, it has been assumed that the coal requirements of the new integrated plant will be met from the Cundinamarca region.

Export of coal

95. Colombia has the potential to emerge as an important exporter of coal required for power generation and production of coke. By virtue of its low ash and sulphur contents, Colombian steam coal may have a good market in developed countries like USA, Germany etc, where pollution laws are stringent.

96. The Latin American region is significantly poor in coking coal reserves, and the annual imports of coking coal in the region is expected to increase from 3 million tons at present to 13 million tons in 1980 and 28 million tons in 1985.

Exchange of coal and ore

97. There is good scope for exchanging Colombian coal with imported iron ore as the countries which are possible sources of supply of iron ore and pellets

to Colombia, are also the major importers of coking coal. However, Colombia would have to develop suitable port and handling facilities particularly on the Atlantic coast, as well as the requisite hinterland transport links including river barge transport.

National coal development plan

98. In planning the development of export-oriented coking coal industry in Colombia, the following factors would need consideration:

i) The countries planning to install integrated steel plants with large blast furnaces would prefer to import coking coal to enable utilisation of the locally available blendable coals as well as to recover and utilise the coke-oven by-products.

ii) Some countries such as Brazil have already gone ahead in making long-term arrangements for the import of coal from sources like USA and Poland. Negotiations with other countries are in progress.

iii) In order to minimise the dependence on imported coking coal, there will be more intensive efforts towards technological solutions, such as the use of pre-heated charge and formed coke, which would enable utilisation of larger proportions of domestic coal.

iv) Imported coke would be utilised mainly in the electric smelting furnaces for the production of iron and ferro-alloys, and in some cases for small blast furnaces or to supplement in periodic shortage in the domestic coke availability.

v) The planning should form an integral part of an overall national coal programme.

Limestone

99. Further investigations on limestone deposits would be necessary to identify suitable sources for the new steel capacity.

Electric power

100. The additional power requirement for the steel development programme will be of the order of 200 MW in 1980 and 400 MW in 1985. An analysis of the effective power potential of Colombia indicates that there may be shortfalls in the overall power availability upto 1986. It may, therefore, be necessary to advance the 1340 MW Patia hydel project by about two years. On the thermal side, the completion of the full development stage of the 550 MW Cerrejon station by 1981 may also be considered.

Natural gas

101. Adequate availability of Guajira natural gas for the production of sponge iron has been assured by the Government. According to the present plan, the development of this gasfield with proved reserves of about 110,000 million cu m, installation of a 360 km pipeline would be completed by 1978. In order to implement the suggested steel programme, it is essential that this schedule is adhered to.

Summary and Recommendations (cont'd)

Transport

102. The development of the steel industry would generate substantial new traffic which road transport alone will not be able to handle. More extensive use of rail and river transport system for the movement of steel products and raw materials will be therefore essential. For the transport of coking coal, investigations would have to be conducted on the techno-economics of using the rail-cum-barge system. The transport system for sponge iron would also have to be studied further.

Port facilities

103. Necessary investigations would have to be conducted to identify suitable locations for the port on the Atlantic coast, preferably adjacent to the plant site, for the import of iron ore/pellet.

COMPETITIVENESS OF COLOMBIAN STEEL

Colombian steel prices

104. A comparison of domestic steel prices with those of other Latin American countries, on the basis of information supplied by ILAFA, indicates that Colombian prices are not only competitive within

the Andean subregion, but also in Latin America as a whole - with the exception perhaps of Mexico. They are also comparable to West European domestic prices. In 1975 the ex-works price of reinforcing bars in PDR was US $ 262 per ton, compared to US $ 269 to US $ 348 per ton in Western Europe; and the wire rod price of PDR was US $ 303 per ton, compared to US $ 262 to US $ 335 per ton in Western Europe.

Domestic vs imported prices in Colombia

105. A comparison of prices of the major domestic steel products of Colombia, namely reinforcing bars and wire rods, has been made in Table 14 on the next page. A similar comparison of steel prices derived at Bogota, the major steel market in Colombia, also indicates that the domestic prices in Colombia have been competitive with imported steel, after allowing for a 20 per cent protection.

Summary and Recommendations (cont'd)

Table 14

COMPARISON OF DOMESTIC AND IMPORTED STEEL PRICES
(US $ per ton)

	Continental export price (f.o.b) a/	Computed landed price b/	Sales price at Belencito c/
Reinforcing bars ..	199	337	271
Wire rods ..	207	357	326

a/ Continental steel export prices prevailing in April 1975, Metal Bulletin, April 1975.

b/ Prices at Colombian port, based on ocean freight/ insurance at $ 30 per ton, agency charges at 5% of c.i.f. price, port handling charges at $ 8 per ton, customs duty of 20% ad valorem on bars and 24% on wire rods, and financial charges at 18% on c.i.f. price.

c/ As in Appendix 13-2.

FUTURE PROSPECTS

Comparison of raw materials cost per ton of iron

106. The competitiveness of Colombian steel in the future could be judged on the basis of the prevailing prices of major raw materials in Colombia and other countries. A comparison of cost of iron ore and coal required per ton hot metal for selected Latin American countries is given in Table 15, on the next page.

Summary and Recommendations (cont'd)

Table 15

COMPARISON OF COSTS OF IRON ORE AND COAL PER TON OF HOT METAL
(US $)

	Colombia				Venezuela	
	PDR	Barranquilla	Chile	Peru	Maracaibe	Brazil
Iron ore/ pellet	.. 9	43	16	19	28	7
Coal[a]	..16	21	48[b]	65[c]	64[d]	62[d]
	25	64	64	84	92	69

a/ Assumed 1,470 kg coal per ton BF coke. Coke rate excluding fuel injection. Average price of imported coal assumed at US $ 75 at all locations.

b/ 65% imported coal. Local coal assumed at US $ 40 per ton
c/ 100% imported coal.
d/ 80% imported coal.

107. With regard to direct reduction route, Venezuela enjoys certain advantages over Colombia, specially in respect of the price of natural gas and electric power. The pellet price in Venezuela may also be lower. However, the average manpower cost in Venezuela is thrice that in Colombia, and this would offset the advantages of lower unit prices gained by Venezuela.

Dependence on imports

108. Unlike other Andean and Latin American countries, dependent on coking coal imports, the Colombian steel industry would be less subject to fluctuation/ escalation characterising international trade in raw materials, because it would be importing only iron ore/pellet.

Summary and Recommendations (cont'd)

Investments on new facilities

109. The average investment of US $ 676 per annual ton for NSP-II and US $ 710 per annual ton for NSP-III is reasonable and well within the limits obtaining in other Latin American countries.

Competitiveness of PDR

110. On the basis of the cost analysis, it is expected that the average cost per ton of finished steel at PDR after expansion would be US $ 243 compared to US $ 300 for SIP and new plant after expansion. The PDR prices would continue to be the lowest in Colombia.

OTHER RECOMMENDATIONS AND SUGGESTIONS

Exploration and surveys on raw materials

111. Detailed and systematic geological investigation would have to be conducted on all major raw materials, namely:

i) Iron ore: The prospecting work on the iron ore deposits other than those of PDR, is meagre. Extensive exploration work including surveys of promising regions, such as Llanos Orientales may be undertaken.

ii) Coal: An appropriate organisation/agency for the planning and coordination of national coal development would have to be set up. Systematic prospecting work would have to be carried out to establish the reserves as well as to classify the coals according to the grades. Suitable areas and mines to sustain the coal requirement of the new integrated plant would have to be identified at an early date.

Summary and Recommendations (cont'd)

iii) Limestone: The deposits near Barranquilla should be explored and the reserves blocked out gradewise.

iv) Dolomite and magnesite: Geological investigations need to be carried out in the sedimentary rock formations for locating suitable quality dolomite. Similar explorations will have to be conducted in areas containing ultrabasic rocks to locate magnesite.

v) Ferro-alloy minerals: Geological investigations should be taken up to locate suitable manganese ore deposits for planning a ferro-manganese industry. Further, exploration on quartz and quartzite would be necessary for planning additional ferro-silicon capacity.

Laboratory and pilot plant tests

112. Extensive laboratory and pilot plant tests on various raw materials, would be required specifically on the following:

i) Iron ore beneficiation: Further investigations and beneficiation tests on local ores to explore the possibilities of upgrading the local ores, including PDR ores.

ii) Utilisation of ore fines: Tests to establish the optimum parameters for the production of good quality sinter with local ore fines; investigations at the COLAR pilot plant to find out not only possible uses for the by-products and wastes, but also to encourage the development of local technology.

iii) Coal blending: A series of systematic tests to establish the optimum coal blend that could be utilised at the new integrated steel plant.

iv) Direct reduction: For the gas-based sponge iron plant, some tests at the laboratories of process/equipment suppliers, to select a suitable source of pellets as well as to obtain the requisite process guarantees. For the coal-based direct reduction plant, laboratory scale tests for identifying the possible sources of iron ore/pellets and coals to be used, followed by extensive pilot plant tests. Facilities for conducting full scale trials at the Piratini plant in Brazil would have to be negotiated with SIDERBRAS.

v) Laboratory scale tests may have to be conducted to establish the calcining characteristics of limestone from the new deposits.

Follow-up studies

113. In addition to the follow-up studies mentioned earlier, such as those for ferro-nickel project and stainless steel project, the following specific studies would have to be completed at an early date, namely:

i) A project report on PDR expansion to finalise the plan of execution and for obtaining more precise estimates of costs.

ii) Plans for SIP expansion, including requirements of balancing facilities, would have to be studied in for each plant.

iii) A project report on the gas-based direct reduction plant to enable the selection of plant location and plant capacity.

iv) A feasibility report on the new integrated steel complex to take a decision on the plant location and to draw up preliminary plans for further work on this project.

Investigations on transport

114. In respect of transport, particular attention needs to be paid to the development of railway and road network; river transport and port facilities to

Summary and Recommendations (cont'd)

meet the growing needs of the steel industry, as discussed below:

i) Railways: The carrying capacity of the railway system in different sectors, including Belencito and Bogota, would have to be investigated. Barranquilla will have to be connected with the existing railway network and new rail links may have to be established between Saboya-Carare and Armenia. Possibilities of cutting down turn-round time and arrangements for augmenting the rolling stock and motive power to meet the increasing traffic requirements of the steel industry would have to be investigated.

ii) Road: The completion and strengthening of road network in certain sectors, specially those between Barranquilla and the other major steel centres, such as Bogota, Medellin and Cali, need to be taken up.

iii) River: The utilisation of the Magdalena river for the transport of coal and steel needs to be studied.

iv) Port facilities: Port facilities for importing iron ore and pellets on the Atlantic coast and for pellets on the Pacific coast would be necessary, for which further investigations for selecting the port locations would be required. Similar studies would be required for installing port facilities for exporting coal.

National energy policy

115. An overall national energy policy would have to be drawn up to define the tariff patterns, priorities of development and use of different forms of energy namely electric power, natural gas and coal.

i) Electric power: For a more realistic assessment of the anticipated demand, an actual load survey of prospective consumers, particularly the major ones, is advisable. The electric tariff structure varies widely from region to region, and this needs to be rationalised. The possibilities of offering some concessional tariffs to electro-metallurgical plants with good power factor, such as electric smelters may be considered.

ii) Natural gas: The policy on natural gas should cover priorities and method of conservation/utilisation as well as pricing policy of natural gas.

iii) National coal plan: An appropriate agency in in the form of a Coal Board or a National Coal Authority may be set up to plan, coordinate and execute the coal development programme. The national coal programme would have to be evolved in close coordination with the development programme of the other sectors, mainly electric power and iron and steel. From the long-term viewpoint, it may be desirable to initiate necessary research and development work on coal gasification, blending, washing etc.

Coordination of steel development programme

116. For the implementation of the steel development programme, the establishment of an apex body is suggested, with requisite authority and power to coordinate and implement the national steel plan, within the overall framework laid down by the Government. It may also help in the procurement of capital and operating resources for the steel industry, coordinate the industrial and commercial policies and stimulate the formation and development

of the human resources needed for the steel programme. This apex body should be assisted by specialised working groups in different fields of activity. In addition, it may also obtain the services of consultants from time to time, for evaluation of specific techno-economic aspects and other specialised activities.

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FINAL REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

THE DEVELOPMENT OF IRON AND STEEL INDUSTRY IN COLOMBIA

VOLUME II
STEEL DEMAND AND SCRAP AVAILABILITY

000589

MAY 1976

DASTUR ENGINEERING INTERNATIONAL GMBH
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LIST OF VOLUMES

EXPLANATIONS

Three dots (.../N.A.) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A full stop (.) between numerals indicates decimal.

A space between numerals is used to distinguish thousands and millions (1 346 849).

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954. The fiscal year adopted is from 1st July through 30th June.

'To' between the years indicates the full period, e.g. 1960 to 1964 means inclusive of the years 1960 and 1964.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Conversion rate adopted is US $ 1.00 = Colombian peso (Col $) 30, unless otherwise stated.

ABBREVIATIONS

PDR	-	Acerias Paz del Rio S.A.
BOYACA	-	Metalurgica Boyaca S.A.
FUTEC	-	Fundiciones Tecnicas S.A.
SIDELPA	-	Siderurgica del Pacifico S.A.
SIDUNOR	-	Siderurgica del Norte
SIMESA	-	Siderurgica Medellin S.A.
SIMUNA	-	Siderurgica del Muna S.A.
COLAR	-	Colombiana de Arrabio Ltda.
NSP	-	National Steel Plan
SIP	-	Semi-integrated Plants

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FIGURES

1 - INTRODUCTION

Colombia made a small beginning in the steel industry in 1937 with the start-up of a semi-integrated plant at Medellin to roll merchant bars. Subsequently in 1954, the Belencito plant, which is the only integrated steel plant in the country, commenced operation utilising local raw materials. Since then, five more semi-integrated plants have been installed, as also a pig iron plant and a ferro-silicon plant. However, the imports of steel have been gradually increasing and in 1974 accounted for about 55 per cent of the domestic requirements. The prospects of future development of the iron and steel industry in Colombia are based on its large coking coal potential, the current shortfalls in the domestic production of steel and the need for meeting the growing steel demand.

The Indicative Plan

The National Council of Economic and Social Policies adopted in January 1972 an Indicative Plan for the development of the iron and steel

1 - Introduction (cont'd)

sector. Amongst other things the Indicative Plan recommended:

i) Efforts by the Government for the development of the iron and steel industry in an integrated manner, with the purpose of utilising the country's natural resources and realising a more favourable balance of payments through rational substitution of steel imports by domestic production and export of such products in which the country may compete in the international market,

ii) Coordination of all coal activity by Government,

iii) Expansion of Acerias Paz del Rio (Belencito plant) up to 1 million tons of raw steel,

iv) Study on the installation of a new steel plant by 1980 on the Atlantic coast, and

v) Special attention to the production of alloy steels in view of the nickel projects being developed in Colombia.

THE PRESENT STUDY

Subsequently, the Government of Colombia requested the United Nations Development Programme (UNDP) to assist in carrying out a study on the development of iron and steel industry in Colombia.

Authorisation

United Nations Industrial Development Organisation (UNIDO) acting in agreement with UNDP for the execution of the study engaged the services of Dastur Engineering International GmbH (DEI) in

1 - Introduction (cont'd)

accordance with Contract No.75/1 (Project No. DP/COL/72/020, Activity Group No. 2) dated 3rd February 1975, subsequently modified by Amendment 1 dated 11th February 1975, Amendment 2 dated 13th March 1975 and Amendment 3 dated 20th May 1975.

Top Strategists

Two top strategists, Mr Marc Allard and Mr Fernando Aguirre Tupper were associated with DEI to provide overall guidance, as required by UNIDO.

Scope of Work

The objective of the present study is to formulate a strategy for the development of the Colombian iron and steel industry over a time horizon up to 1985 covering both the immediate and long-term requirements. Relevant extracts from the contract covering the aim of the project and statement of work of DEI are given in Appendix 1-1. The scope of work for the present study includes:

Estimation of steel demand by 1980 and 1985,

Estimation of future scrap availability,

Evaluation of raw materials and infra-structure,

1 - Introduction (cont'd)

Analysis of the semi-integrated plants with particular reference to their capacity utilisation,

Examination of the feasibility of setting up direct reduction plants to meet the scrap shortages,

Appraisal of the expansion proposals of Paz del Rio,

Determination of new steel capacity to be created to meet the growing demand for steel keeping in view the Andean sub-region for exchange of raw materials and import of semi-finished products,

Assessment of the competitiveness of Colombian steel, and

Finally, the formulation of a strategy for the integrated development of the iron and steel industry.

Field Study

In connection with this study, DEI deputed its team of specialists to Colombia for data collection through discussion with various Government and other organisations, and visits to steel plants, selected industries, promising locations for future steel plants etc. Visits were also undertaken to some other Andean countries like Peru, Chile, Ecuador and Venezuela to collect information on their steel programme. The list of the specialists deputed for field work and the duration of their

1 - Introduction (cont'd)

stay in Colombia are given in Appendix 1-2. A list of the organisations/plants contacted/visited is given in Appendix 1-3. The Consulting Engineers were assisted all through their field work by their Local Consultant, Dr Joaquin Prieto.

Involvement of Colombians

In order to assist the field team in data collection, the Government of Colombia had nominated a group of specialists with Dr Saulo Arboleda Gomez of the Ministry of Ecoomic Development as the Coordinator. The members of the Colombian Group are listed in Appendix 1-4.

The field team was also provided with necessary staff assistance - secretaries, translator and statisticians.

The Colombian Government nominated Dr Hernando Fomez Otalora and the private sector nominated Dr Fernando Sanz Manrique as their strategists for the study.

Dr Fernando Sanz Manrique and Dr Saulo Arbolenda Gomez, Coordinator, Colombian Group, visited the home office of the consultants in July/August 1975 to get acquainted with the methodology, analysis of the data, preliminary results of analyses and the techno-economic alternatives considered in preparing the study.

1 - Introduction (cont'd)

UNDP, Bogota

UNDP, Bogota extended full cooperation and assistance to the field team.

Presentation at Bogota

In accordance with the terms of contract, a short report covering the core aspects of the study and outlining the techno-economic alternatives was submitted to UNIDO in September 1975 and a presentation was made at Bogota between 15th and 18th September 1975. The various techno-economic alternatives were discussed with the representatives of the Government of Colombia, Government agencies, and the industry as well as with representatives of UNIDO and UNDP. The various proints raised during the discussions in September 1975 were taken into consideration for the preparation of the draft final report. The following important conclusions had emerged out of the September discussions and these have been adopted for the preparation of this report.

1. The Government of Colombia accepts the 1985 ordinary rolled steel demand as 2.3 million tons.

2. Natural gas from Guajira field would be available for production of sponge iron by 1978.

1 - Introduction (cont'd)

Draft Final Report

In accordance with the terms of Contract, the Draft Final Report was submitted to UNIDO on the 15th December 1975, who made copies of the report available to the Colombian Government.

A series of discussions on the Draft Final Report was held at Bogota between 23rd and 27th February 1976 in which the representatives of UNIDO, UNDP, Colombian Government, Colombian Steel Industry and the Consulting Engineers participated. The recommendations and conclusions contained in the Draft Final Report were accepted by the UNIDO, UNDP and the Colombian Government, and the UNIDO/UNDP assured the Colombian Government of their fullest cooperation and help in the follow-up of the present study.

In submitting this final report, the observations made by UNIDO have been taken into consideration.

Structure of the Report

The report is presented in four volumes - the first volume containing the 'Summary and Recommendations'. The remaining three volumes of the report contain fourteen chapters supported by necessary tables, appendices and drawings.

1 - Introduction (cont'd)

Acknowledgement

DEI gratefully acknowledges the cooperation and assistance extended by UNDP officials at Bogota, UNIDO officials at Vienna, Government of Colombia and its agencies, the private sector, and the iron and steel producing and consuming industries. Special mention needs to be made of the interest taken by the Hon'ble Dr Jorge Ramirez Ocampo, the Minister of Economic Development and Dr Octavio Gallon Restrapo, Jefe Programmacion, in the present study. DEI wishes to thank the two top strategists, Mr Marc Allard and Dr Fernando Aguirre Tupper, as well as the two Colombian strategists Dr Hernando Gomez Otalora and Dr Fernando Sanz Manrique for their guidance. The cooperation and help extended by the Colombian Group, in arranging for visits, discussions, data collection and accompanying the specialists on all meetings and visits is gratefully acknowledged. Thanks are also due to the various Government and private sector agencies for permission to visit their plants and for furnishing relevant information for this study, and in this connection special mention needs to be made of the cooperation extended by all the steel plants. The Consulting Engineers are also grateful to their local Consultant, Dr Joaquin Prieto for his continued cooperation and guidance in the study.

2 - STEEL IN COLOMBIA

The production and consumption of steel in Colombia is presented in this section, against the wider background of the Andean Group, Latin America and the world in order to indicate Colombia's position in the overall picture. The statistics have been compiled from the same source or sources for all the regions/countries covered under this review, to ensure comparability. The statistical data and demand projections of Colombia contained in subsequent chapters are, therefore, not necessarily the same as in this chapter.

STEEL PRODUCTION

World steel production

World crude steel production increased from 457 million tons in 1965 to 710 million tons in 1974, an increase of 55 per cent in 9 years or an average annual growth of 5 per cent. The region-wise production is shown in Table 2-1.

2 - Steel in Colombia (cont'd)

Table 2-1

WORLD: PRODUCTION OF CRUDE STEEL
(million tons)

Region	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
West Europe ..	129.7	126.9	132.0	144.9	156.6	161.5	152.4	166.2	179.1	182.2
East Europe ..	28.6	30.5	33.1	34.9	37.0	39.7	42.0	44.7	46.8	49.4
USSR ..	91.0	96.9	102.2	106.5	110.3	115.9	120.6	126.0	131.5	136.3
North America	128.4	130.8	124.2	129.5	137.5	130.5	120.3	132.6	149.9	145.6
Latin America	8.4	9.2	9.8	11.2	12.1	13.2	14.0	15.5	16.5	17.5
Africa ..	3.5	3.5	3.9	4.3	5.1	5.3	5.5	6.1	6.7	6.8
Middle East ..	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	...	...
Asia ..	61.4	68.4	85.0	91.1	107.6	121.9	119.6	131.2	154.8	154.4
Oceania ..	5.6	6.0	6.4	6.7	7.1	7.0	6.9	6.9	7.7	7.8
Total WORLD	457.0	472.7	497.1	529.6	573.9	595.6	581.9	629.8	697.2	710.1

Source: 1965 to 1972 IISI, January 21, 1974.
1973 and 1974 - ILAFA (Revista April 1975 p. 24) based on IISI Statistics etc. Figures do not add up to the totals as the production for some countries which should have been included in the appropriate regions are not separately available.
1974 figures provisional.

In 1971, the production was below that of the previous year due to a general recession in the world economy; it then recovered and the rates of growth in 1972 and 1973 were more than 8 per cent and 10 per cent respectively but dropped to 2 per cent in 1974 consequent to the energy crisis.

It will be observed that the most significant increase has been recorded in Asia - two and a half times, from 61 million tons in 1965 to 154 million tons in 1974. This has been mainly due to the contribution of Japan with a spectacular three-fold increase from 41 million tons to 117 million tons. Next, in terms of growth, comes Latin America which doubled its production. The increase in the other regions have been lower, varying from 40 to 70 per cent during this period, representing an average annual growth of 3.8 to 6.0 per cent.

Latin American steel production

The crude steel production in Latin America, given in Table 2-2 on the next page, has increased from 8.3 million tons in 1965 to 17.5 million tons in 1974. The average annual growth works out to 8.6 per cent. The share of Latin America in the world steel production has risen from 1.8 per cent in 1965 to 2.5 per cent in 1974.

2 - Steel in Colombia (cont'd)

Table 2-2

LATIN AMERICA: PRODUCTION OF CRUDE STEEL
(thousand tons)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
ANDEAN GROUP										
Bolivia ..	-	-	-	-	-	-	-	-	-	-
Colombia ..	242	216	258	299	272	310	325	373	362	333
Chile ..	477	577	631	568	641	592	654	631	549	635
Ecuador ..	-	-	-	-	-	-	-	-	-	-
Peru ..	94	80	80	106	194	94	179	181	356	450
Venezuela ..	685	537	690	860	840	927	924	1 128	1 063	1 058
Sub-total ..	1 438	1 410	1 659	1 793	1 947	1 923	2 082	2 313	2 330	2 476
OTHERS										
Argentina ..	1 368	1 267	1 326	1 599	1 690	1 823	1 915	2 150	2 205	2 354
Brazil ..	3 017	3 713	3 665	4 452	4 925	5 390	5 997	6 518	7 149	7 503
C. America ..	-	-	2	3	3	8	9	6	10	10
Mexico ..	2 455	2 763	3 023	3 256	3 467	3 881	3 821	4 431	4 760	5 138
Paraguay ..	-	-	-	-	-	-	-	-	-	-
Uruguay ..	13	10	14	8	14	16	15	13	11	14
Sub-total ..	6 853	7 753	8 030	9 278	10 099	11 118	11 757	13 118	14 135	15 019
Total ..	8 291	9 163	9 689	11 071	12 046	13 041	13 839	15 431	16 465	17 495

Source: 1965 to 1972 - ILAFA Annual Statistics.
1963 and 1974 - ILAFA Revista Sept 1975, p. 75.
1974 figures provisional.

Brazil and Mexico are the major producers. Brazil's production increased two and a half times, from 3 million tons in 1965 to 7.5 million tons in 1974, and Mexico's production doubled from 2.5 million tons to 5 million tons in this period. While these two countries together accounted for 66 per cent of the Latin American production in 1965, their share increased to 72 per cent in 1974. Over 19 per cent of the production comes from Argentina and Venezuela, and the contribution of the other countries including Colombia has been less than 9 per cent.

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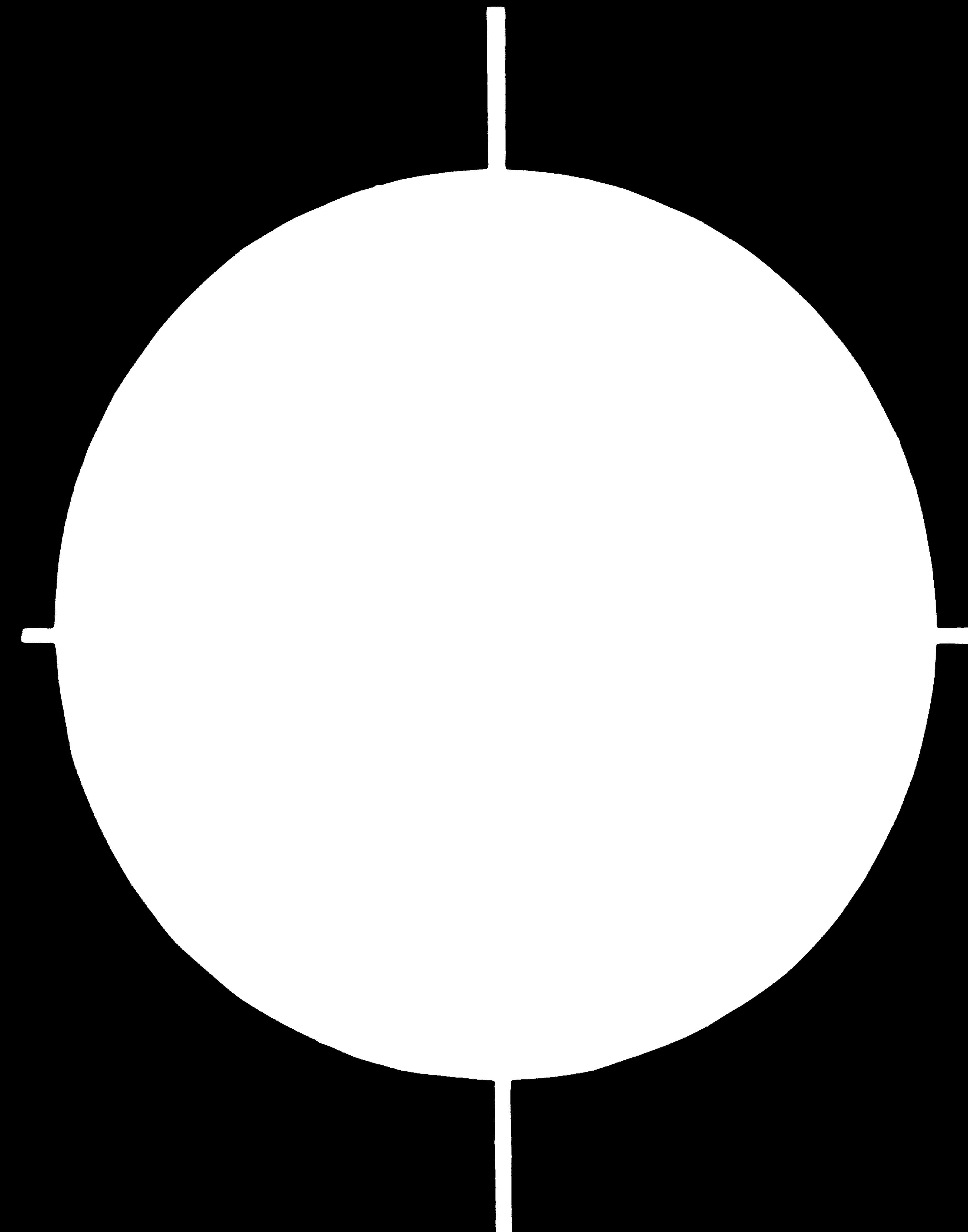

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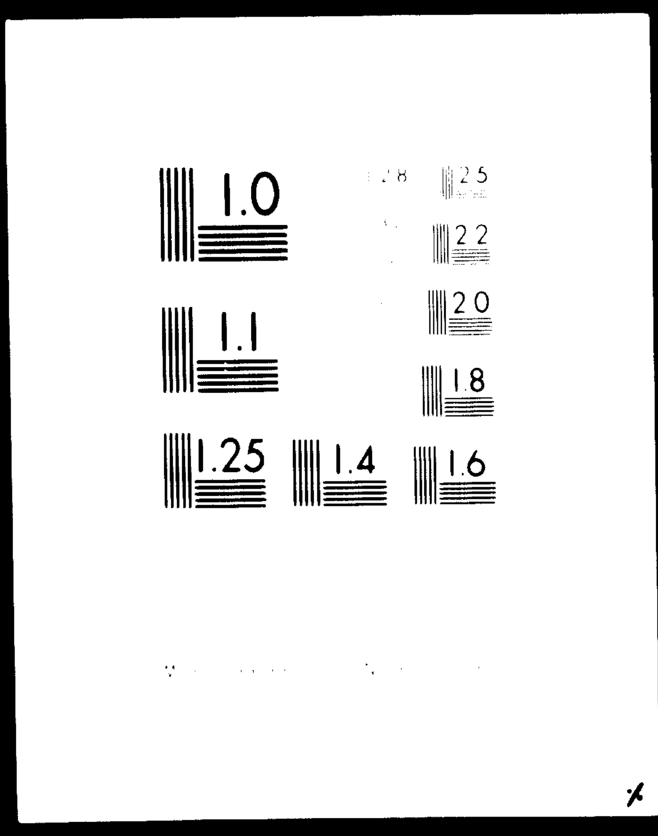

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2 - Steel in Colombia (cont'd)

Production in the Andean Group and in Colombia

Steel production in the Andean Group rose from 1.4 million tons in 1965 to 2.5 million tons in 1974, representing an average annual growth of 6.7 per cent. The Andean Group's share in the total Latin American production in 1974 is only about 14 per cent, which is lower than the 17 per cent it held even in 1965. The single largest producer in the Andean Group has been Venezuela, accounting for over 40 per cent.

So far as Colombia is concerned, the growth has been very slow, from 242,000 tons in 1965 to 333,000 tons in 1974, the maximum production being 373,000 tons achieved in 1972. Its share in the Andean Group in 1974 has been about 13 per cent, and in Latin America less than 2 per cent. The average annual growth for Colombia during the period 1965 to 1974 has been only 3.6 per cent compared to 6.7 per cent for the Andean Group, 8.6 per cent for Latin America and 5 per cent for the world.

Figure 2-1 shows the crude steel production for the world, Latin American and the Andean Group. Figure 2-2 shows the crude steel production for the Latin American countries.

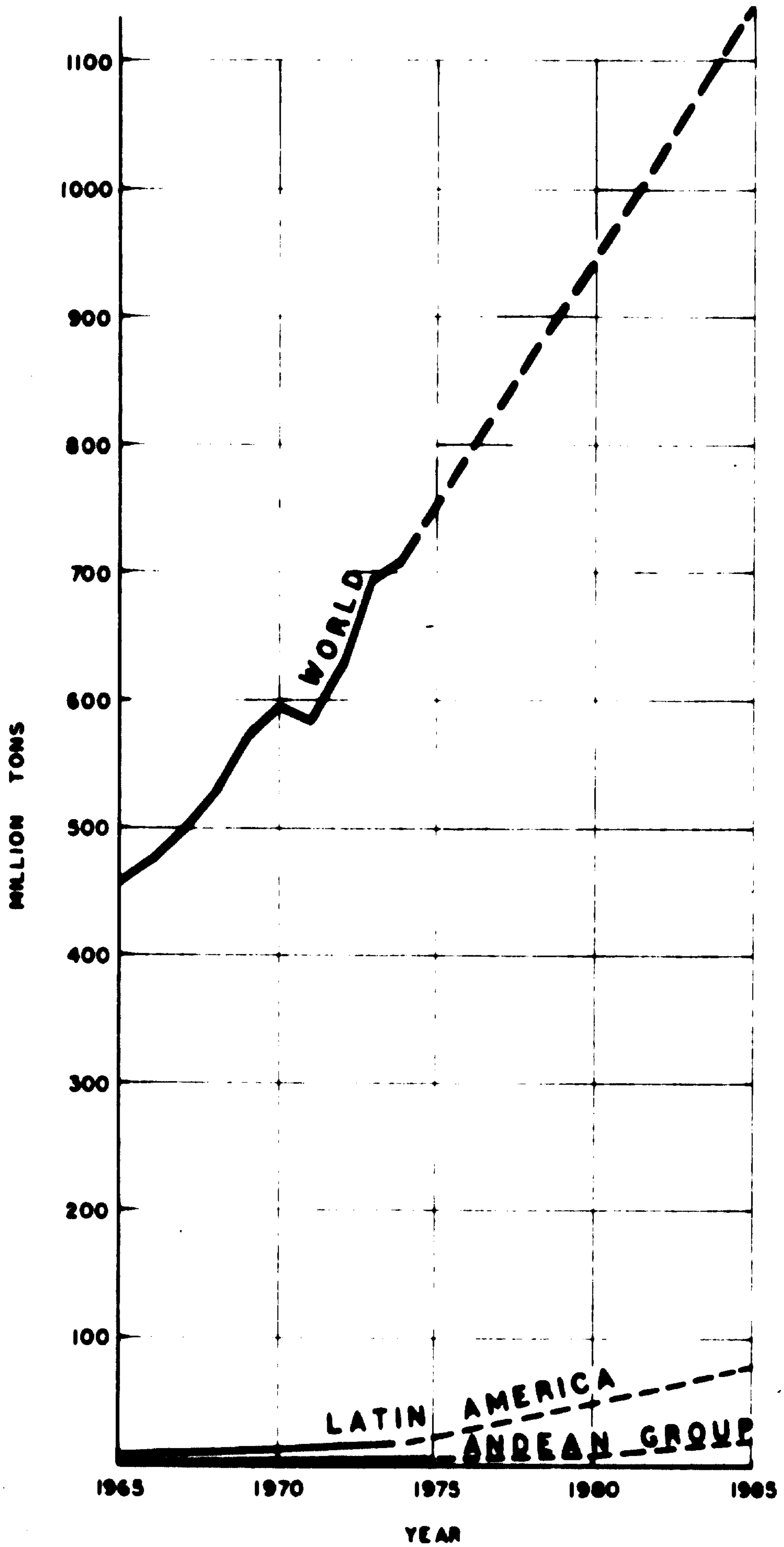

FIGURE 2-1. CRUDE STEEL PRODUCTION

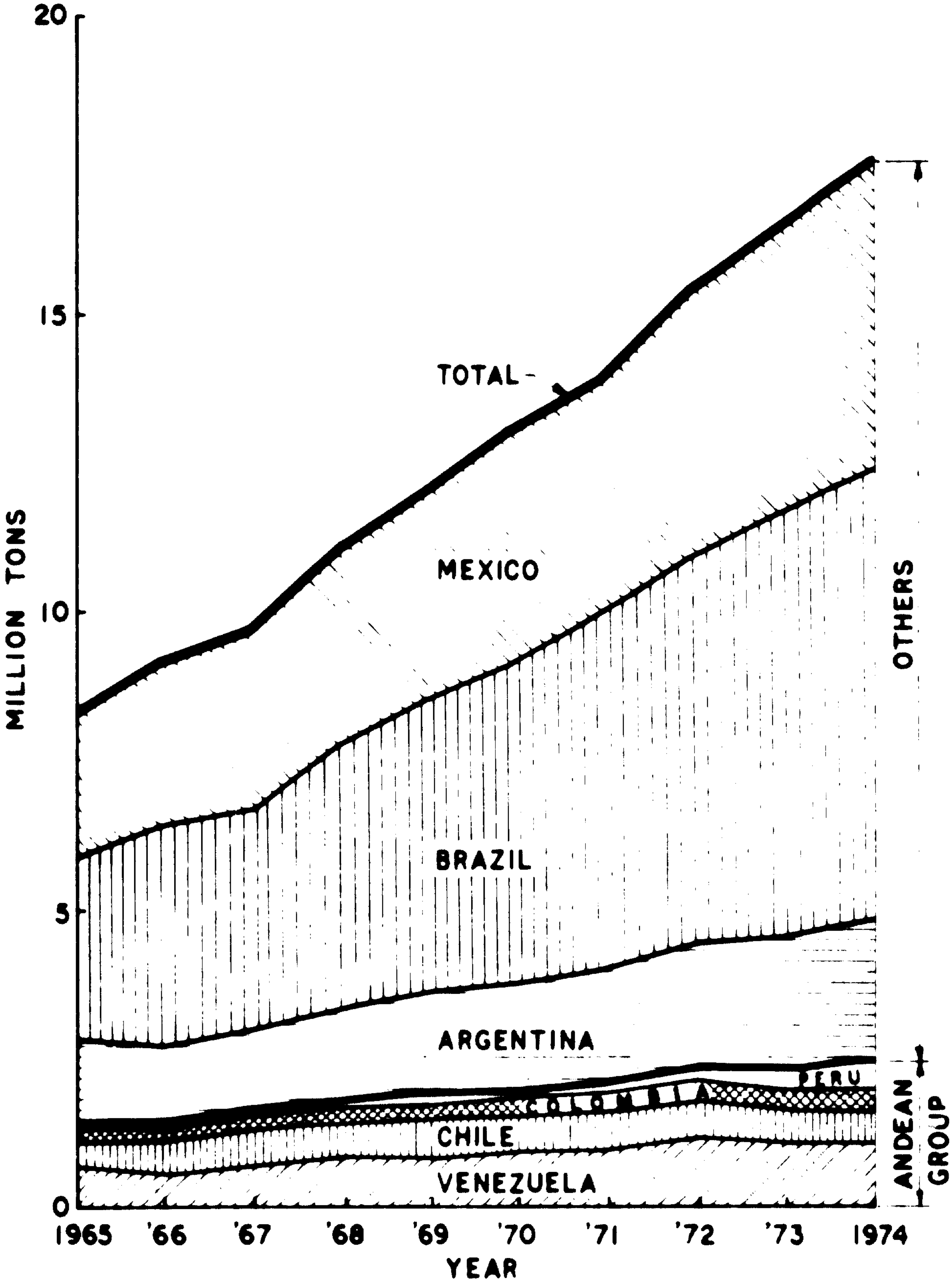

FIGURE 2-2. LATIN AMERICA: CRUDE STEEL PRODUCTION

2 - Steel in Colombia (cont'd)

Per capita production

Table 2-3 shows the per capita production of crude steel in Latin American countries for the last 10 years (1965 to 1974), which has been illustrated graphically in Figure 2-3. It would be seen that during this period, all the other Latin American countries except Colombia and Chile, have increased their per capita production. Venezuela has raised its production from 69 kg to 86 kg, Argentina from 61 kg to 91 kg, Brazil 37 kg to 72 kg and Mexico from 57 kg to 88 kg. Compared to this, the per capita production of Chile and Colombia have been almost stagnant around 60 kg and 13 kg respectively.

Table 2-4 shows the per capita production of crude steel for some typical developed and developing countries. It would be seen that while per capita production for developed countries has been over 500 kg (exceeding 1,000 kg in some cases, for example, 1,601 kg in Belgium and 1,093 kg in Japan in 1973), it has hardly been 50 kg in the developing countries (except North Korea). The developed countries as a whole had an average per capita production of 577 kg in 1973, as against 20 kg for all the developing countries put together. The per capita production of 15 kg in 1973 for Colombia (which incidentally decreased to 13 kg in 1974, the highest being 16 kg in 1972) is lower than the world average for the developing countries. Also, it is much lower than the 1973 average of 32 kg and 59 kg for the Andean Group and Latin America respectively.

2 - Steel in Colombia (cont'd)

Table 2-3

LATIN AMERICA: PER CAPITA PRODUCTION OF CRUDE STEEL
(kg)

Country	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Andean Group - Avg	25	24	27	29	30	29	30	32	32	33
Colombia ..	13	11	13	13	13	14	14	16	15	13
Chile ..	55	65	69	57	67	61	66	62	54	61
Peru ..	8	7	6	8	15	7	13	12	24	29
Venezuela ..	69	57	71	85	81	89	83	98	89	86
Others - Avg ..	42	46	46	52	55	59	60	65	68	70
Argentina ..	61	55	57	66	70	75	78	86	86	91
Brasil ..	37	45	43	51	54	58	63	66	70	72
Mexico ..	57	63	66	69	71	77	73	82	85	88
Latin America - Avg	37	40	41	46	48	51	52	57	59	61

Source: Crude steel production from Table 2-2 and population figures from Appendix 2-1.

Table 2-4

COMPARISON OF PER CAPITA PRODUCTION OF CRUDE STEEL
IN SELECTED COUNTRIES

Country	1965 Production '000 t	1965 Per capita kg	1970 Production '000 t	1970 Per capita kg	1973 Production '000 t	1973 Per capita kg
Developed countries						
Belgium ..	9 162	968	12 607	1 303	15 525	1 601
Japan ..	41 161	420	93 322	903	119 325	1 093
West Germany ..	36 821	624	45 041	732	49 521	798
United States ..	122 490	596	122 120	540	137 550	653
Canada ..	9 098	466	11 198	525	13 388	606
Australia ..	5 556	490	6 909	553	7 525	570
USSR ..	91 000	395	115 886	477	129 600	516
UK ..	27 439	503	28 315	508	26 625	475
Developing countries						
North Korea ..	1 230	102	1 900	137	2 250	149
Greece ..	210	25	450	51	450	50
Turkey ..	586	19	1 520	43	1 350	35
China ..	12 000	17	18 000	24	24 000	30
India ..	6 413	13	6 228	12	6 924	12
Egypt ..	179	6	250	8	300	8
Algeria ..	28	2	31	1	40	3

Source: The Iron & Steel Industry in Developing Countries, UNIDO, Lima Conference, March 1975.

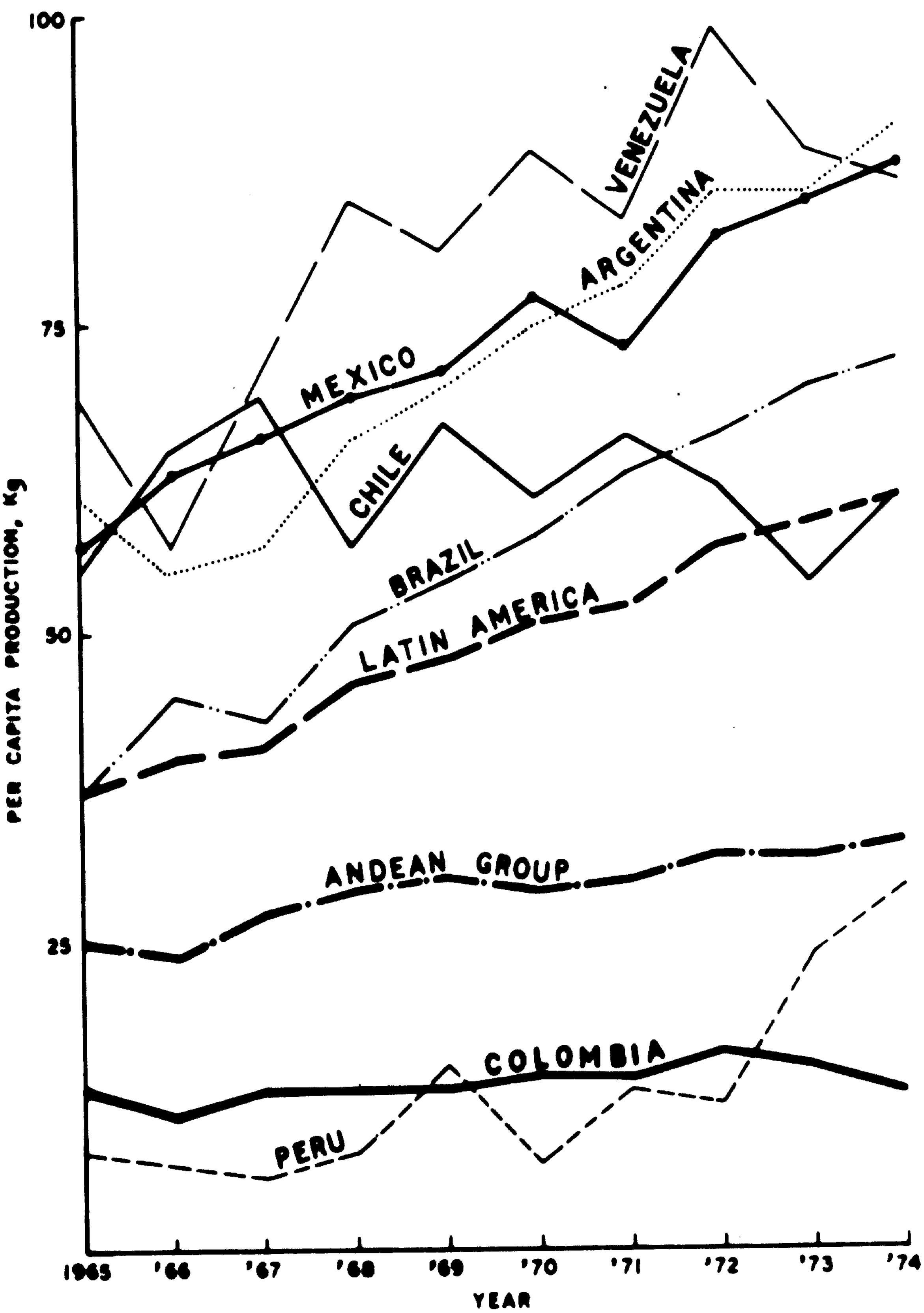

FIGURE 2-3. PER CAPITA PRODUCTION OF CRUDE STEEL: LATIN AMERICAN COUNTRIES

2 - Steel in Colombia (cont'd)

APPARENT STEEL CONSUMPTION

World consumption

The world crude steel consumption and the world population for the last ten years are given in Table 2-5, from which the per capita steel consumption has been derived on a global basis for each year.

Table 2-5

WORLD: PER CAPITA CONSUMPTION OF CRUDE STEEL

Year		Crude steel consumption million tons	Population millions	Per capita consumption kg
1965	..	457.0	3 289.5	139
1966	..	472.7	3 349.5	141
1967	..	497.1	3 411.1	146
1968	..	529.6	3 475.5	152
1969	..	573.9	3 539.8	162
1970	..	595.6	3 605.9	165
1971	..	581.9	3 706.0	157
1972	..	629.8	3 782.0	166
1973	..	697.2	3 861.0	180
1974	..	710.1	3 942.0	180

Source: Table 1 for crude steel consumption
IISI - 'Projection 85' for populations 1965 to 1970
Statistical Yearbook 1972 and 1973, United Nations for populations in 1971 and 1972
Populations in 1973 and 1974 derived on the basis of growth rates given in IISI - 'Projection 85'.

The world per capita consumption shows a steady increase from 139 kg in 1965 to 180 kg in 1974, except in 1971 when there was a drop due to lower world steel production, on account of the general recession in the world economy. The average annual growth has been about 3 per cent.

2 - Steel in Colombia (cont'd)

Consumption in Latin America

Crude steel consumption in the Latin American countries for the period 1965 to 1974 together with their populations is given in Appendix 2-1, based on which the per capita consumption of crude steel in these countries has been derived and shown in Table 2-6.

Table 2-6

LATIN AMERICA: PER CAPITA CRUDE STEEL CONSUMPTION
(kg)

Country		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Argentina	..	121	93	100	109	143	141	146	161	156	165
Brazil	..	37	46	47	54	61	65	74	77	91	119
C. America	..	23	17	21	26	28	28	27	24	30	...
Mexico	..	67	70	74	75	77	76	72	78	94	104
Paraguay	..	10	12	15	14	11	8	11	10	15	...
Uruguay	..	34	41	28	30	35	34	40	31	34	...
Bolivia	..	20	13	14	15	18	19	19	19	17	17
Colombia	..	24	35	25	24	32	34	35	29	28	29
Chile	..	71	83	62	65	85	73	72	78	66	76
Ecuador	..	15	16	21	21	23	30	45	48	48	47
Peru	..	33	30	32	21	26	24	30	28	33	46
Venezuela	..	110	88	105	113	122	129	133	142	155	172
Latin America		52	53	54	58	67	67	71	75	83	98
Andean group	..	45	46	43	43	51	52	55	55	56	63
Colombia	..	24	35	25	24	32	34	35	29	28	29

Source: Refer Appendix 2-1

From Appendix 2-1, it is noted that the crude steel consumption in Latin America has risen from 11.6 million tons in 1965 to 28.3 million tons in 1974 - an increase of 144 per cent over a period of 9 years, whereas that in Andean Group has grown from 2.6 million tons to 4.8 million tons, an increase of only 85 per cent. Crude steel consumption in Colombia during this period has gone up from 444,000 tons to 745,000 tons (the highest being 801,000 tons in 1971), showing an increase of 68 per cent. The corresonding average annual growth rates have thus been 10.4 per cent for Latin America, 7.1 per cent for the Andean Group and 5.9 per cent for Colombia. The Andean Group's share in Latin American steel consumption, which had been about 20 per cent till 1972, has decreased to 17 per cent in 1973 and 1974. The share of Colombia in the Andean Group steel consumption which had been 20 per cent till 1971, has now dropped to 16 per cent. The crude steel consumption for the Andean Group countries showing the share of each country during the past 10 years is graphically illustrated in Fig 2-4.

From Table 2-6, it is observed that amongst the Latin American countries, the per capita consumption has been highest in Venezuela and Argentina (172 kg and 165 kg respectively in 1974). Brasil and Mexico come next with per capita consumption of 119 kg and 104 kg respectively. For Latin America as a whole, the per capita consumption has increased from 52 kg in 1965 to 98 kg in 1974 or by 88 per cent.

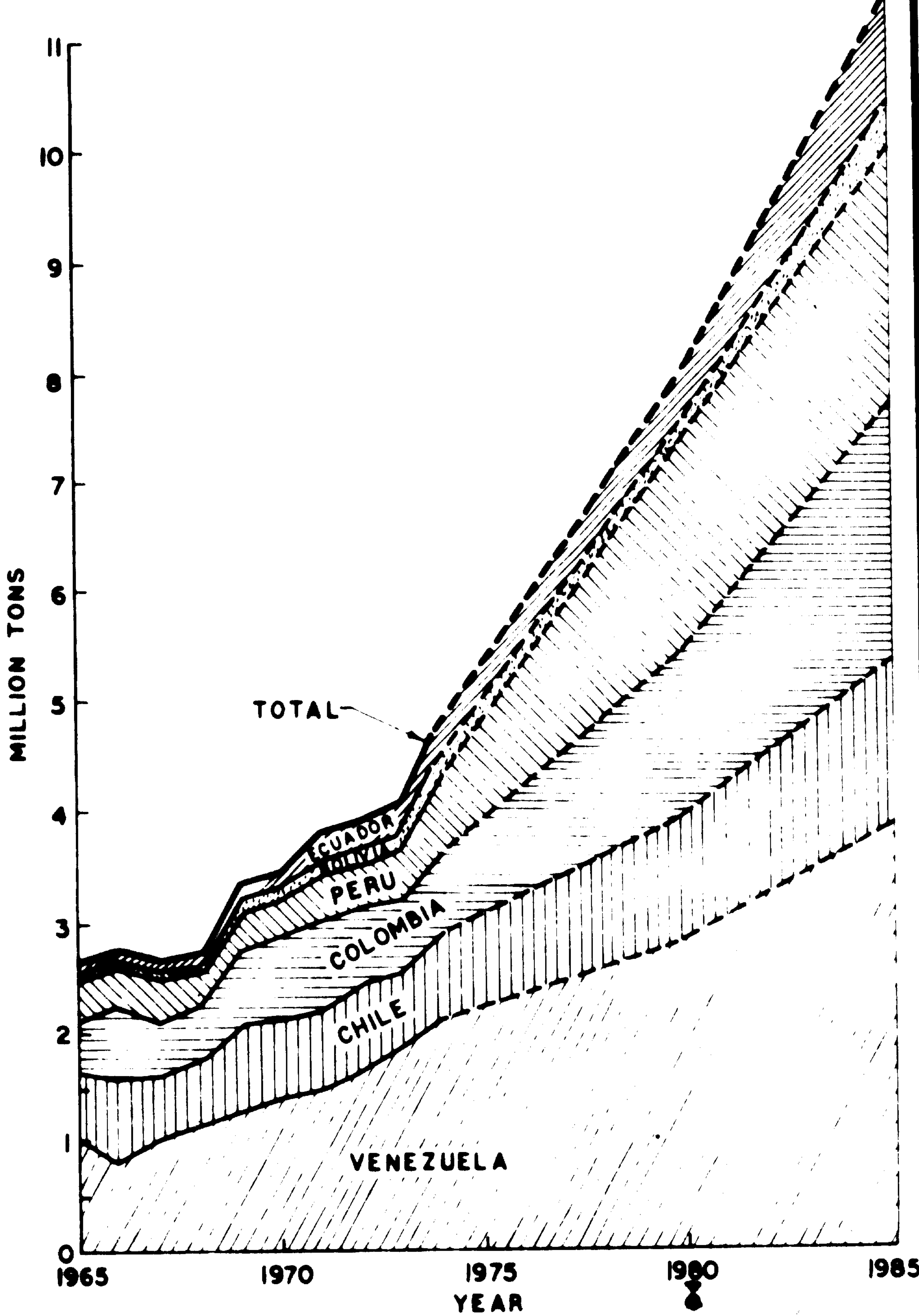

FIGURE 2-4. ANDEAN GROUP: CONSUMPTION OF CRUDE STEEL

2 - Steel in Colombia (cont'd)

Consumption in the Andean Group and in Colombia

The per capita consumption in the Andean Group rose from 45 kg in 1965 to 63 kg in 1974, or by 40 per cent. For the individual countries in the Group, the figures for 1973 and 1974 were as follows:

		1973 kg	1974 kg
Venezuela	..	155	172
Chile	..	66	76
Ecuador	..	48	47
Peru	..	33	46
Colombia	..	28	29
Bolovia	..	17	17

Colombia's per capita consumption rose from 24 kg in 1965 to 29 kg in 1974 (the highest being 35 kg in 1971) or by 20 per cent. Its consumption is higher than that of only Bolivia in the Andean Group, and only above those of Praguay and Bolivia amongst all the Latin American countries. In terms of per capita consumption, Colombia occupied the seventh place in 1966 amongst the Latin American countries, but since 1973 it has dropped down to the tenth place.

Fig 2-5 shows the per capita crude steel consumption for the world, Latin America, the Andean Group, Brazil, Venezuela and Colombia from 1965 to 1985.

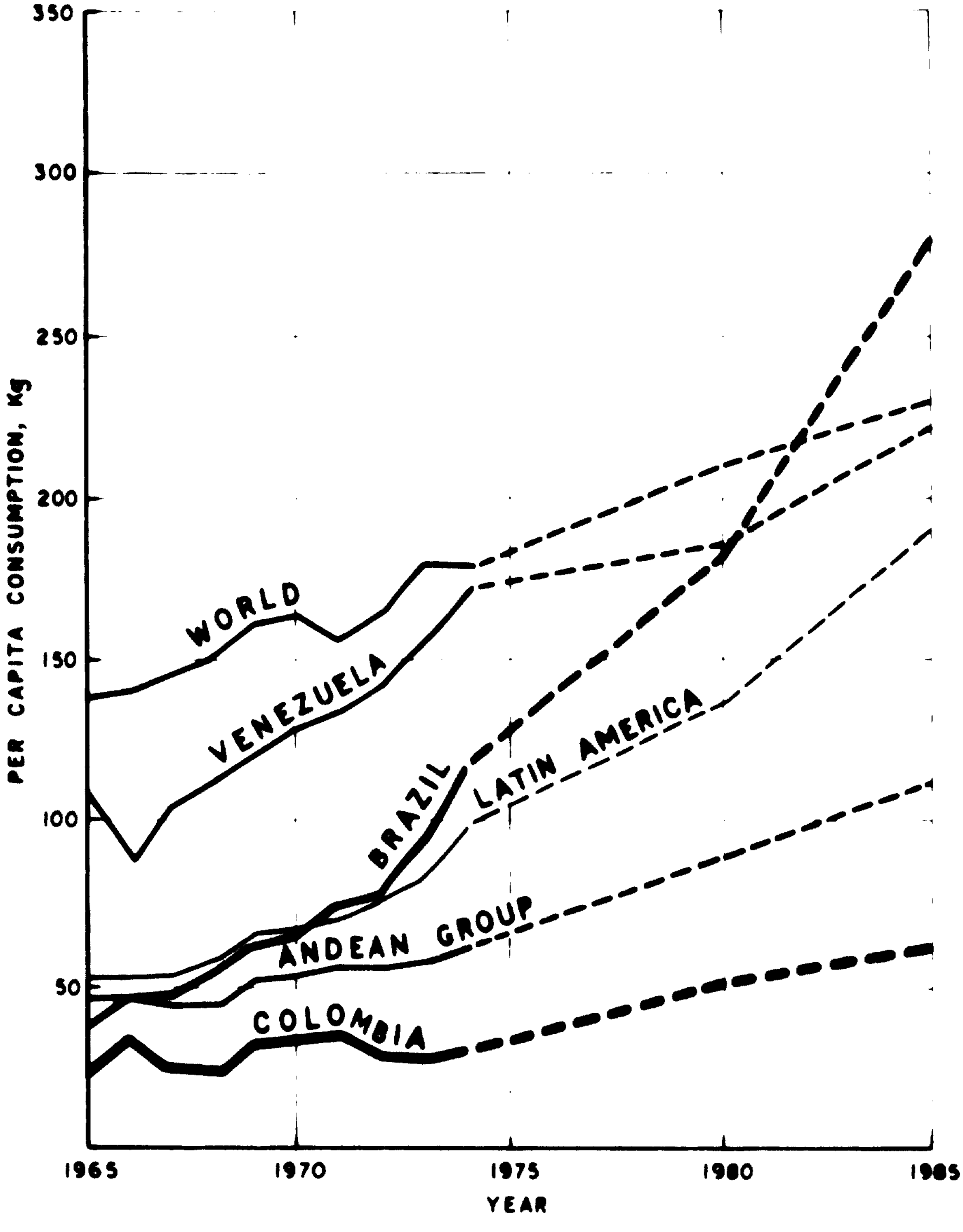

FIGURE 2-5. PER CAPITA CRUDE STEEL CONSUMPTION

2 - Steel in Colombia (cont'd)

Consumption versus production

The apparent steel consumption and domestic production in the Latin American countries are shown in Table 2-7.

Table 2-7

LATIN AMERICA: CONSUMPTION VS PRODUCTION OF CRUDE STEEL
(thousand tons)

Year	Latin America Apparent consumption	Latin America Domestic production	Latin America Self sufficiency %	Andean Group Apparent consumption	Andean Group Domestic production	Andean Group Self sufficiency %	Colombia Apparent consumption	Colombia Domestic production	Colombia Self sufficiency %
1965	11 641	8 291	71.2	2 605	1 438	55.2	444	242	54.5
1966	12 157	9 163	75.4	2 735	1 410	51.6	672	216	32.1
1967	12 841	9 689	75.5	2 646	1 659	62.7	497	258	51.9
1968	14 100	11 071	78.5	2 699	1 793	66.4	492	259	52.6
1969	16 652	12 046	72.3	3 306	1 947	58.9	680	272	40.0
1970	17 349	13 041	75.2	3 474	1 923	55.4	764	310	40.6
1971	18 875	13 839	73.3	3 796	2 082	54.8	801	325	40.6
1972	20 302	15 431	76.0	3 923	2 313	59.0	693	373	53.8
1973	23 262	16 465	70.8	4 097	2 330	56.9	678	362	53.4
1974	28 346	17 495	61.7	4 759	2 476	52.0	745	333	44.7

Source: Appendix 2-1 and Table 2-2

The consumption and domestic production in terms of crude steel for the developing countries is given in Table 2-8.

Table 2-8

DEVELOPING COUNTRIES[a/]: SELF SUFFICIENCY IN STEEL PRODUCTION
(thousand tons crude steel equivalent)

	1950	1960	1965	1970	1972	1973[b/]
Apparent consumption	9 715	20 770	49 200	66 758	77 870	80 000
Domestic production	2 836	9 282	31 977	41 266	51 000	55 000
Self sufficiency factor, %	29.2	44.5	64.9	61.8	65.5	69.0

a/ The term 'developing countries' comprises whole of Latin America, Africa (excluding South Africa), the Far East (excluding Japan) and the Middle East.

b/ Rough estimates.

Source: The Iron & Steel Industry in Developing Countries, UNIDO, Lima Conference, March 1975.

2 - Steel in Colombia (cont'd)

It will be seen that the self-sufficiency factor (domestic production as a percentage of consumption) for steel in developing countries in general has increased from 29 per cent in 1950 to 69 per cent in 1973. In Latin America it has decreased from about 75 per cent in the past to 62 per cent in 1974. In the Andean Group as a whole, it has stagnated at around 55 per cent during the last decade and in Colombia at an even lower level of 40 to 50 per cent.

FUTURE STEEL CONSUMPTION

Several forecasts on future steel consumption have been made from time to time. The more recent figures are presented here.

Projected World Consumption

The world crude steel consumption in 1974 was about 710 million tons. According to IISI's forecasts in 'Projection 85', March 1972, it will reach 939 million tons in 1980 and 1,144 million tons in 1985. The regionwise figures are shown in Table 2-9.

Table 2-9

WORLD: PROJECTIONS OF APPARENT CRUDE STEEL CONSUMPTION FOR 1980 AND 1985
(million tons)

Region		1980	1985
West Europe	..	220.5	266.8
East Europe	..	74.1	91.2
USSR	..	183.9	215.0
North America	..	186.5	210.0
Latin America	..	35.0	48.0
Africa	..	13.5	17.3
Middle East	..	11.3	16.9
Asia	..	202.2	263.9
Oceania	..	12.2	15.3
Total World		939.2	1 144.4

Source: IISI, 'Projection 85', March 1972 - Apparent Crude Steel Consumption.

Projected Consumption in Latin America

The consumption of crude steel in Latin America was 23 million tons in 1973 and 28 million tons in 1974 and the recent projections indicate that it will reach 51 million tons in 1980 and 83 million tons in 1985 as shown in Table 2-10.

Table 2-10

LATIN AMERICA: PROJECTED CONSUMPTION OF CRUDE STEEL
(thousand tons)

		1980	1985
Argentina	..	9 400	13 100
Brasil	..	22 400	40 000
Colombia	..	1 567	2 312
Chile	..	1 159	1 506
Mexico	..	9 500	16 152
Peru	..	1 732	2 337
Venezuela	..	2 752	3 878
Others a/	..	2 395	3 615
Total	..	50 905	82 900

a/ Bolivia, Ecuador, Central America, Paraguay and Uruguay.

Source: III National Metallurgical Congress and XX General Assembly of FEDEMETAL, Bogota, June 1975. Paper by Alfredo Astaburuega Latelier, ILAFA.

The above projections are much higher than the IISI projections.

Projections for Andean Group and Colombia

The apparent crude steel consumption in the Andean Group was 4.8 million tons in 1974. Available forecasts indicate that this will rise to 8 million tons in 1980 and over 11 million tons in 1985 as shown in Table 2-11.

2 - Steel in Colombia (cont'd)

Table 2-11

ANDEAN GROUP: PROJECTED CONSUMPTION OF CRUDE STEEL
(thousand tons)

	1980				1985			
	Rolled products			Crude	Rolled products			Crude
Country	Non-flat	Flat	Total	steel	Non-flat	Flat	Total	steel
Bolivia ..	110	109	219	298	167	159	326	440
Colombia ..	679	488	1 167	1 567	679	488	1 167	2 312
Chile ..	412	444	856	1 159	530	582	1 112	1 506
Ecuador ..	242	187	429	584	451	380	831	1 120
Peru ..	431	814	1 245	1 732	626	1 085	1 711	2 337
Venezuela	1 125	935	2 060	2 752	1 630	1 253	2 883	3 878
Total ..	2 999	2 977	5 976	8 022	4 083	3 947	8 030	11 593

Source: 1) III National Metallurgical Congress and XX General Assembly of FEDEMETAL, Bogota, June 1975. Paper by Alfredo Astaburuega Latelier, ILAFA. Non-flat includes seamless tubes.

2) Figures for Bolivia and Ecuador are obtained from the author of the above paper personally in terms of rolled products. These have been suitably converted to equivalent ingot tons.

NOTES:

(1) Projected consumption figures for these countries are also available from 'Junta de Cartagena' which are in general lower than the figures considered. However, for Colombia, Cartagena figures are same as above. For Chile, Cartagena figures are about the same as given above.

(2) In case of Peru, Cartagena figures are lower. But the above figures are in fair agreement with the recent projections by SIDERPERU (Feb. 1974).

(3) For Venezuela, Cartagena figures are much lower. Figures considered above are about the same as the recent projections made in the Plan Siderurgica National 1975-1985, Resumen, Caracas, May 1974.

The consumptions in 1974, the projections for 1985 and the average annual growths for the world and the Latin American countries are shown in Table 2-12.

Table 2-12

FUTURE GROWTH OF CRUDE STEEL CONSUMPTION

Country	Crude steel consumption in 1974 mill. tons	Projected consumption in 1985 mill. tons	Increase in 1985 over 1974 %	Average annual growth 1974 to 1985 %
World ..	710.1	1 144.0	61.1	4.4
Latin America..	28.3	82.9	192.9	10.3
Andean Group ..	4.8	11.6	141.7	8.4
Argentina ..	4.3	13.1	204.7	10.7
Brazil ..	12.5	40.0	220.0	11.2
Mexico ..	6.1	16.2	165.6	9.3
Colombia ..	0.75	2.3	206.7	10.8
Bolivia ..	0.1	0.4	300.0	13.4
Chile ..	0.8	1.5	87.5	5.9
Equador ..	0.3	1.1	266.7	12.5
Peru ..	0.7	2.3	228.6	11.4
Venezuela ..	2.1	3.9	85.7	5.8

Source: Refer Appendix 2-1 and Tables 2-10 and 2-11

It is interesting to note that crude steel consumption in Brazil is expected to incrsase from 12.5 million tons in 1974 to 40 million tons in 1985, more than three-fold increase in 11 years period. This gives an average annual growth of 11.2 per cent in spite of its large base of 12.5 million tons. The average annual growth in this period is estimated to be 4.4 per cent for the world, 10.3 per cent for Latin America and 8.4 per cent for the Andean Group. For Colombia, the corresponding growth rate works out to 10.8 per cent. Although, on the face of it, this may appear to be a satisfactory growth rate, it is in fact not so, because of the low starting base of only 0.75 million tons in 1974 and the projected increase of only 1.55 million tons over the next 11 years. In countries which start with a low base, the growth rates have to be even higher to achieve a reasonable level of development. For instance, starting with a consumption level of 3 million tons in 1965, Brazil's consumption has increased at an average annual rate of more than 17 per cent to reach a level of 12.5 million tons in 1974. For the same reason, Bolivia also has a higher growth rate.

Projected per capita consumption

Although the apparent consumption of crude steel in Colombia is projected at 1.6 million tons in 1980 and 2.3 million tons in 1985, the per capita consumption in these years would be only 51 kg and 62 kg respectively. Based on the projected steel consumption and the population growth for the world and the Latin American countries, the projected per capita steel consumption is given in Table 2-13 and is shown graphically in Fig. 2-5.

2 - Steel in Colombia (cont'd)

Table 2-13

PROJECTED PER CAPITA CRUDE STEEL CONSUMPTION

Country		1974	1980			1985		
		Per capita kg	Consumption million t	Population million	Per capita kg	Consumption million t	Population million	Per capita kg
World	..	[illegible]	939.8	4 447.0	210	1 144.4	4 948.3	231
Latin America	..	98	50.9	377.0	135	82.9	434.7	191
Andean Group	..	63	6.1	70.0	89	11.6	105.7	110
Argentina	..	160	9.4	28.0	333	13.1	30.3	432
Brazil	..	119	20.4	124.0	181	40.0	143.0	280
Mexico	..	104	9.5	71.4	133	16.0	84.6	191
Bolivia	..	37	0.3	6.0	50	0.4	6.8	59
Colombia	..	50	1.4	31.4	50	2.3	37.3	60
Chile	..	76	1.2	11.5	104	1.5	10.4	149
Ecuador	..	47	0.6	8.4	71	1.1	10.0	110
Peru	..	65	1.7	18.5	90	2.3	21.4	106
Venezuela	..	170	2.0	15.0	187	3.9	17.6	[illegible]

Sources:

(1) 1974 per capita consumption from Tables 2-5 and 2-6.
(2) Projected population for the world and Latin America from IISI 'Projection 85'.
(3) Projected population for Latin American countries for 1980 from [illegible] Statistical Year Book 1977 and for 1985 projected on the basis of growth rate for 1975-1980.

It would be seen from Table 2-13 that Argentina would have the highest per capita consumption both in 1980 and 1985, at 333 kg and 432 kg respectively, as against the world average of 210 kg and 231 kg in these years. Next in order comes Brazil which, despite its large population, shows an impressive growth in per capita consumption which has increased from 37 kg in 1965 to 119 kg in 1974 and is expected to rise to 181 kg and 280 kg in 1980 and 1985 respectively. This isiillustrated clearly in Fig. 2-5 by the steep gradient of Brazil's per capita consumption line cutting sharply across the consumption lines of the Andean Group, Latin America, Venezuela and of the world.

Amongst the Andean Group countries, Venezuela will have the highest per capita consumption at 187 kg in 1980 rising to 222 kg in 1985 followed by Chile and others as shown below:

		Per capita consumption, kg	
		1980	1985
Venezuela	..	187	222
Chile	..	104	121
Peru	..	92	106
Ecuador	..	71	110
Colombia	..	51	62
Bolovia	..	50	59

This only shows that while the per capita consumption of the other Andean Group countries will pass the 100 kg mark in 1985, Colombia and Bolivia will still belagging behind with a consumption of around 60 kg. In terms of ranking, Colombia will remain only marginally above Bolivia, the position it held in 1974 (Fig. 2-6). Even with a projected average annual growth of 10.8 per cent, its per capita consumption of 62 kg in 1985 will correspond to the consumption levels which Argentina had in 1963, Mexico in 1965, Brazil in 1969, Andean Group in 1974 and Latin America as a whole in 1968. It will be about only one-seventh that of Argentina, one-fourth that of Venezuela and half that of Chile.

FUTURE SHORTFALL/SURPLUS IN CRUDE STEEL PRODUCTION

The projections for crude steel apparent consumption, capacity and production, and the resulting surplus or shortfall in 1980 and 1985 are given in

Table 2-14, together with the actual figures for 1974. It will be noted that in 1974 the shortfall in production amounted to 38 per cent of the apparent consumption in Latin America, 48 per cent in the Andean Group and 55 per cent in Colombia. There will be only a marginal shortfall in 1980 and 1985 for Latin America as a whole, and even this shortfall may not be there, if the large demand of 40 million tons forecast for Brazil in 1985 does not fully materialise. On the other hand, in the Andean Group, there will be a surplus of about 7 per cent in 1980 increasing to about 70 per cent in 1985, mainly due to the large surplus capacity projected for Venezuela. However, so far as Colombia is concerned, there will still be large deficits of about 30 per cent both in 1980 and 1985.

Fig 2-7 shows the shortfalls/surplus in crude steel production in Latin American countries during the period 1965 to 1985. Mexico will have about 22 per cent surplus in 1980, but in 1985 it will have practically no surplus. Argentina may have a little surplus by 1985, but Brazil and Colombia will continue to have large gaps between production and consumption. Against this, Venezuela will have a large surplus both in 1980 and 1985; and Chile will attain self-sufficiency by 1980 and even produce about 30 per cent surplus in 1985.

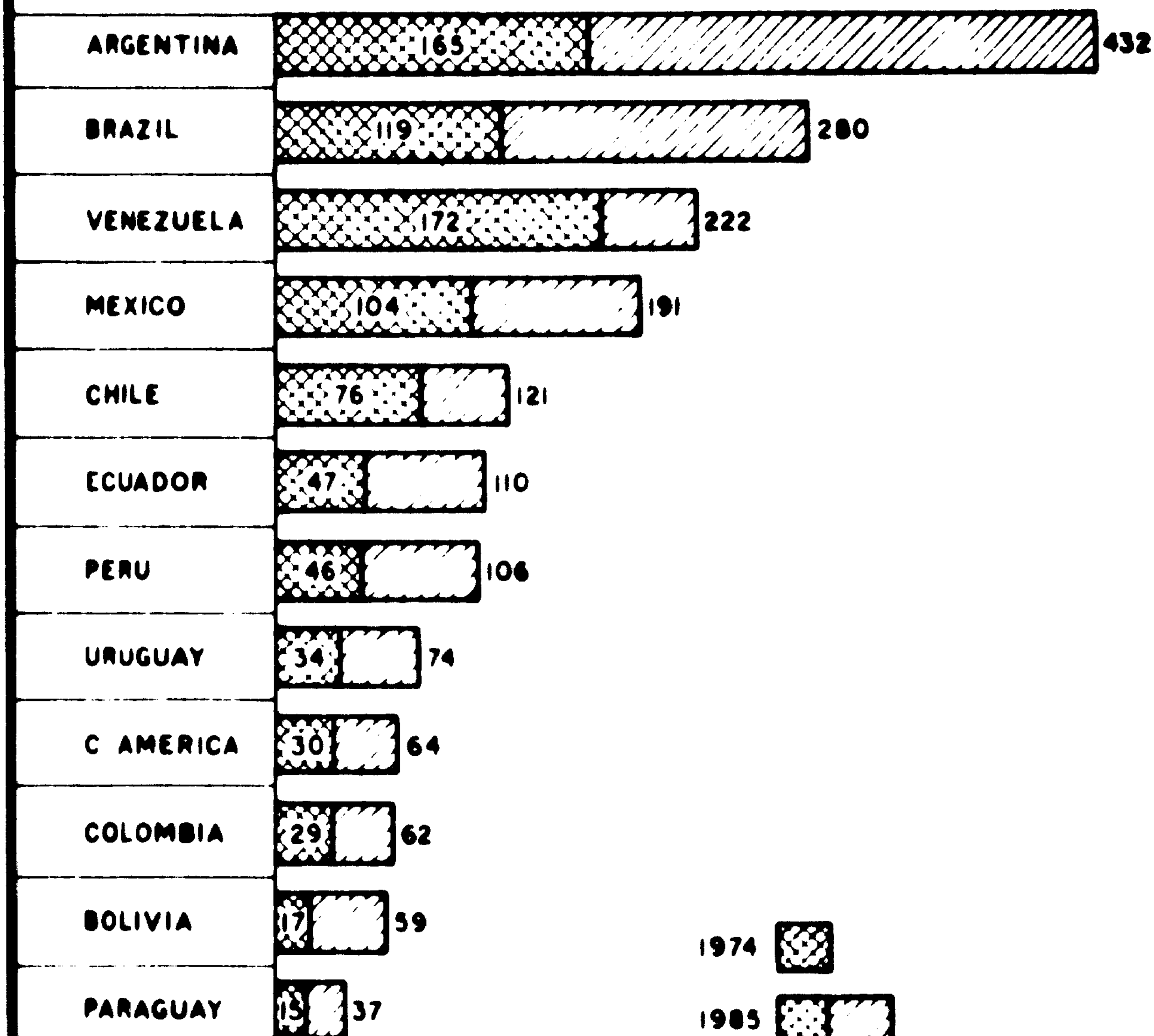

FIGURE 2-6 PER CAPITA CONSUMPTION OF CRUDE STEEL (Kg): LATIN AMERICAN COUNTRIES

Table 2-14

LATIN AMERICA: CRUDE STEEL SHORTFALL/SURPLUS
(thousand tons)

	1974				1980				1985			
	Capacity	Production	Consumption	Shortfall/ surplus	Capacity	Production	Consumption	Shortfall/ surplus	Capacity	Production	Consumption	Shortfall/ surplus
Andean Group												
Bolivia ..	-	-	86	- 86	-	-	298	- 298	-	-	440	- 440
Colombia ..	420	333	745	-412	1 200	1 080	1 567	- 487	1 850	1 665	2 312	- 647
Chile ..	730	635	787	-152	1 300	1 170	1 159	+ 11	2 200	1 980	1 506	+ 474
Ecuador ..	-	-	322	-322	250	225	584	- 359	400	360	1 120	- 760
Peru ..	550	450	707	-257	1 400	1 260	1 732	- 472	2 500	2 250	2 337	- 87
Venezuela ..	1 467	1 058	2 111	-1 053	5 500	4 950	2 752	+2 198	15 000	13 500	3 878	+9 622
Sub-total	3 167	2 476	4 758	-2 282	9 650	8 685	8 092	+ 593	21 950	19 755	11 593	+8 162
Others												
Argentina ..	4 523	2 354	4 275	-1 921	10 000	9 000	9 400	- 400	15 000	13 500	13 100	+ 400
Brasil ..	9 283	7 503	12 453	-4 950	22 420	20 178	22 400	-2 222	32 000	28 800	40 000	-11 200
Mexico ..	5 150	5 138	6 068	- 930	12 900	11 610	9 500	+2 110	18 000	16 200	16 152	+ 48
C. America ..	15	10	(		100	90	1 217	-1 127	150	135	1 675	-1 540
Paraguay ..	-	-	(792	- 768	-	-	100	- 100	-	-	135	- 135
Uruguay ..	20	14	(		100	90	196	- 106	150	135	245	- 110
Sub-total	18 991	15 019	23 588	-8 569	45 520	40 968	42 813	-1 845	65 300	58 770	71 307	-12 537
Total ..	22 158	17 495	28 346	-10 851	55 170	49 653	50 905	-1 252	87 250	78 525	82 900	- 4 375

Source:
(1) Capacities: Paper by Alfredo Astaburagea Latelier, ILAFA: III National Metallurgical Congress and XX General Assembly of FEDEMETAL, Bogota, June 1975.
(2) Productions: for 1974 from Table 2-2 and for 1980 and 1985 on the basis of 90% of capacity.
(3) Consumptions: for 1974 from Appendix 2-1 and for 1980 and 1985 from Tables 2-10 and 2-11.

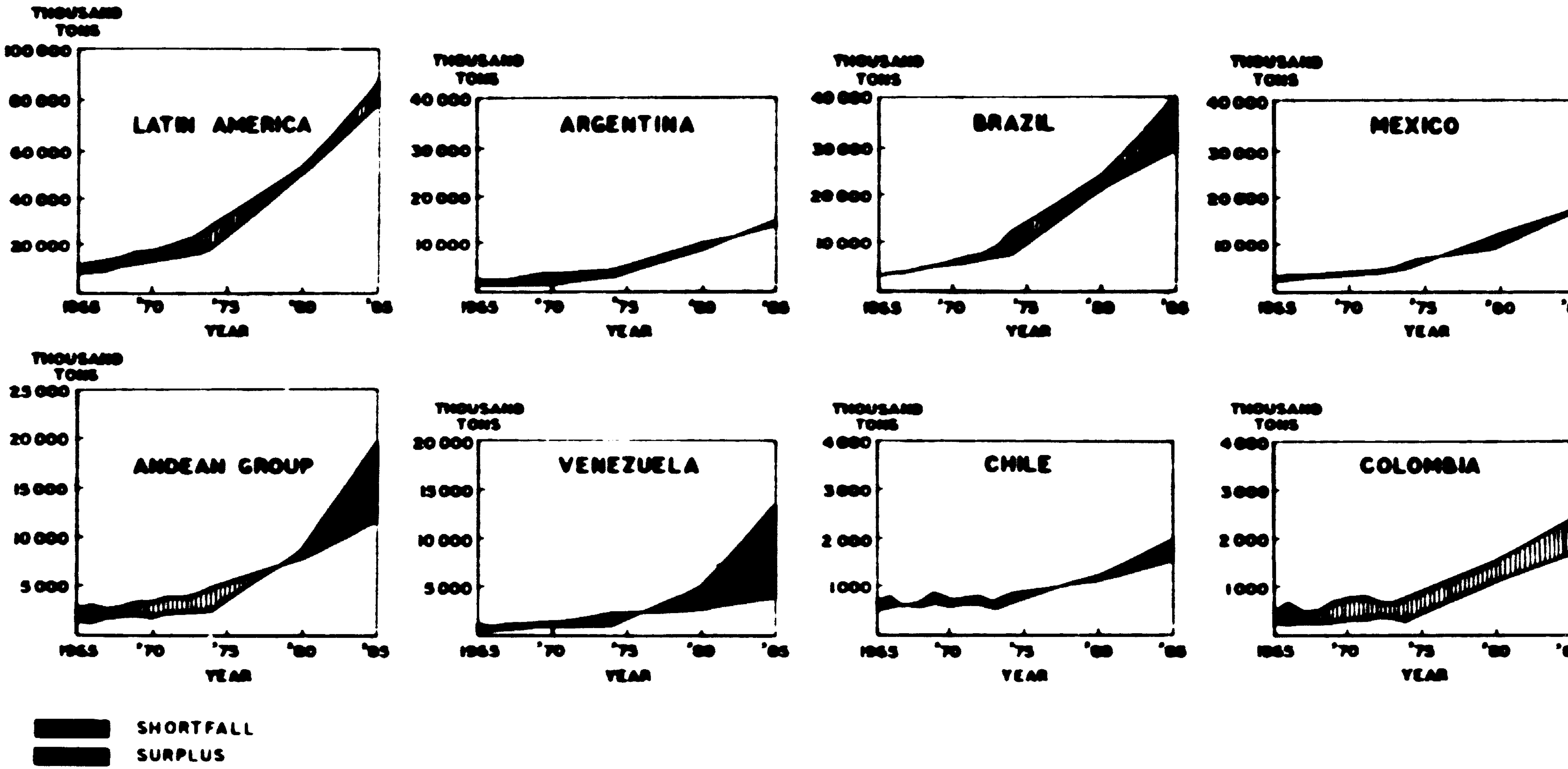

FIGURE 2-7. CRUDE STEEL PRODUCTION : SHORTFALL / SURPLUS

3 - IRON AND STEEL DEMAND

RECENT FORECASTS

The recent forecasts for steel demand in Colombia are contained in the Indicative Plan (January 1972) and in the Feasibility Report (October 1973) for Paz del Rio (PDR) expansion.

Indicative Plan Projections

The market projections in the Indicative Plan are made on the basis of historical apparent consumption of rolled products from 1951 to 1969. Only common grades of steels are included. Railway materials, seamless pipes, alloy and special steels are not considered. The lower trend of past consumption was adopted for projecting the future demand. Growth rates of 6.8 per cent for flat products and 7.5 per cent for non-flat products have been assumed.

Paz del Rio projections

The market projections contained in the PDR expansion report are based on studies carried out by Acerias Paz del Rio S.A. in 1971 and 1972. The past apparent steel consumption has been examined. The market demands were calculated through regression relationships, in which the gross national product was used as the principal factor of the various criteria reflecting economic growth in Colombia. An annual average rate of 6 per cent was used as a realistic and prudent growth rate. Based on this analysis, a growth rate of 7 per cent for flat products and 8.3 per cent for non-flat products has been assumed for projecting the future demand. The PDR estimates exclude rails and accessories, seamless pipes and profile shapes larger than 8 inches.

PROJECTIONS OF ORDINARY STEEL DEMAND IN THIS STUDY

An independent forecast of the demand for ordinary steels has been made in this study, principally based on the end-use method and then crosschecked with other appropriate techniques. The total demand for finished ordinary steel, including rails and accessories, seamless pipes and heavy profiles by 1980 and 1985 according to this study, are as follows:

Rolled products		Demand 1980 '000 tons	Demand 1985 '000 tons
Flat[a/]	..	545	1 068
Non-flat[b/]	..	729	1 224
Total	..	1 274	2 292

a/ Includes welded pipes.
b/ Includes heavy profiles, seamless tubes and railway materials.

In order to make the above estimates comparable with the demands projected in the Indicative Plan and by PDR, the demand for seamless tubes, heavy profiles and railway materials has been excluded and shown in Table 3-1.

3 - Iron and Steel Demand (cont'd)

Table 3-1

DEMAND PROJECTIONS ON COMPARABLE BASIS[a]
(thousand tons)

	1980			1985		
	Flat	Non-flat	Total	Flat	Non-flat	Total
Indicative Plan	425	535	960	592	775	1 367
PDR	405	561	966	563	843	1 406
This study	545	640	1 185	1 068	1 095	2 163

a/ Excludes seamless tubes, heavy profiles and railway material.

Methodology

As mentioned earlier, the end-use method has been adopted in this study. This method is considered more relevant to a developing economy, because it is a micro-approach which takes care of technological, structural and other changes in the very process of estimation. Secondly, it enables the breakdown of the steel demand by categories and sizes, whereas in the other methods such as time-trend and regression, only aggregate figures can be projected. Lastly, with the end-use approach, it is possible to trace and pin down at any time in the future as to where and why the actual consumption has deviated from the estimated demand. Suitable revisions can also be made from time to time based on such examination.

Steps involved

The following steps were taken for forecasting the demand by the end-use method:

1) Questionnaires were issued to producers, end-users, importers and Government agencies to obtain information on the present levels of consumption, estimated future levels of outputs and the steel consumption norms for the manufacture of products.

3 - Iron and Steel Demand (cont'd)

2) The field survey was designed to cover as many important steel consuming industries as possible.

3) The steel consuming items in the various economic sectors such as transport, electrical, industrial and agricultural machinery, and metal products were identified and listed.

4) Based on the field survey data and information obtained from various reports and discussions with Government and private organisations and agencies, the possible future output levels of steel consuming items were determined. These output levels are cross-checked wherever possible with projections made by other methods, such as time trend, regression etc. For some items where no specific information is available, the output levels are projected on the basis of correlation with macro-economic indicators, time trend and assumed growth rates.

5) The steel consumption norms by product categories, such as profiles, bars and rods, pipes and tubes etc for most of the items that are now being produced in Colombia, were determined on the basis of the field survey data. For the remaining items, the consumption norms prevailing in countries with similar economies manufacturing such items were adopted.

6) To check the validity of the norms and to compare the future sectoral consumption pattern with the past pattern, a detailed analysis of tne past data for the years 1970 to 1974 has been made.

7) Applying the above consumption norms to the output levels of steel consuming items projected for the years 1980 and 1985, the categorywise requirements of steel were determined. To arrive at the total demand, some additional provision has been made for repairs and maintenance, small scale industries and stocks.

8) The total demand thus arrived at by the end-use study has been compared with projections made by macro-economic methods, such as steel intensity, time trend and regression.

3 - Iron and Steel Demand (cont'd)

Questionnaire

Questionnaires covering various aspects of the market study were framed, in order to elicit information from as many user industries as possible and also from the various related Government authorities and private agencies including the steel trade. Comprehensive questionnaires were prepared and issued to

i) Producers of steel
ii) End-users of steel
iii) Importers of steel
iv) Government department and agencies
v) Housing construction agencies

On request, a separate questionnaire was also made for Colombiana Automotriz.

Response to Questionnaires

In all, questionnaires to 90 parties were sent out and replies were received from 43. The breakdown is given below:

Category	No. of parties: Questionnaire issued	No. of parties: Reply received
Steel producers ..	7	6
End-users ..	65	24
Importers ..	1	1
Foundries ..	13	8
Government department and agencies ..	4	4
Total ..	90	43

3 - Iron and Steel Demand (cont'd)

Interviews

The questionnaires were first issued to the various parties and followed up by personal visits to selected parties for discussion. Major consumers of steel in Bogota, Cali, Medellin, Buccaramanga and Barranquilla were contacted. A total of 65 steel industries were interviewed.

Collation of data

The steel consuming items were grouped under the following sectors:

- Manufacture
  - Transport equipment
  - Electrical equipment
  - Industrial and agricultural machinery
  - Metal products
- Construction

The data and information obtained from the replies to the questionnaires and during discussions were tabulated separately for each item under each sector. These were analysed and used wherever possible to arrive at the future output levels and to evolve the consumption norms by steel types and product categories. So far as the four sectors grouped under manufacture are concerned, the data and analysis relate mainly to the organised units.

Output forecast

For forecasting the output levels of steel consuming items, only those which are now being manufactured in Colombia and those for which there are already some plans for manufacture, such as car engines, big transformers, big capacity motors etc have been considered. However, other items like turbo-generators, heavy metallurgical equipment etc, which are not likely to be manufactured even by 1985 are excluded.

Of the 74 items in the manufacturing sector covered in this study, the future output levels for 27 items are available from the field survey data - for 12 items the future output levels are available up to 1985, for another 9 items up to 1980 and for the remaining 6 items only up to 1977 - and have been taken into account for projecting the output levels for these items.

For all other items, the output levels have been forecast by using appropriate forecasting techniques - for some items, statistical projection of past consumption is taken as the guideline; for some others, relevant growth rates have been applied; for some like cement machinery, sugar machinery etc, the output levels are estimated assuming that it would be possible to manufacture a certain percentage indigenously; and for items which are not manufactured now in Colombia, but whose production is under planning, the output levels have been derived on the basis of planned programme. The basis on which the output forecast is made for each of the end-using items in the manufacturing sectors is given in Appendix 3-1.

3 - Iron and Steel Demand (cont'd)

The output forecast for the construction sector is to be based on the anticipated investments in the various sectors of the economy. The basis for the forecasts for the construction sector is given in Appendix 3-2.

The output levels for the various steel consuming items projected on the bases indicated in Appendices 3-1 and 3-2, are given in Table 3-2, on the next page.

Norms of consumption

The norms for most of the items that are now being manufactured in Colombia were determined on the basis of the field survey data. For the remaining items, the norms prevailing in countries with similar economies and manufacturing such items were adopted. The norms comprise the steel content of the product as well as the process scrap generated during its manufacture. The basis for the derivation of the norms for each item is given in Appendix 3-3.

The norms of consumption of steel thus derived are given in categorywise for each item in Appendix 3-4, and summarised in Table 3-3, on page 3-10.

Analysis of past consumption

A detailed analysis of the past consumption for 5 years (1970 to 1974) has been made by applying the norms established above to the actual production of the various

Table 3-2

OUTPUT FORECASTS

Sector	Unit	1980	1985
I. TRANSPORT EQUIPMENT			
1. Wagons	Nos	1 055	1 807
2. Coaches	Nos	50	90
3. Trucks	Nos	16 000	25 000
4. Buses	Nos	9 250	14 500
5. Jeeps and station wagons	Nos	11 000	15 800
6. Cars	Nos	60 000	100 000
7. Bicycles	Nos	280 000	400 000
8. Motor cycles	Nos	34 500	43 300
9. Car engines	Nos	30 000	50 000
10. Trailers	Nos	10 000	15 000
11. Automobile ancillaries	Million pesos	7 500	12 000
12. Leaf springs	tons	4 800	6 800
II. ELECTRICAL EQUIPMENT			
13. Transformers	KVA	960	2 000
14. Switchgears and controlgears	Million pesos	70	174
15. Electric fans	'000 Nos	17	22
16. Electric motors	'000 kW	1 500	3 100
17. Air conditioners	'000 Nos	8	12.5
18. Refrigerators (domestic)	'000 Nos	315	1 100
19. Refrigerators (commercial)	'000 Nos	19	65
20. Washing machines	'000 Nos	16.5	28.2
21. Electric stoves	'000 Nos	54	88
22. Gas stoves	'000 Nos	27	33
23. Water heaters	'000 Nos	88	160.8
24. Cooking ranges	'000 Nos	85	180.0
25. Water coolers	'000 Nos	12.5	20.0
26. ACSR cables	tons	2 000	2 550
27. House service meters	'000 Nos	203.7	332.8
28. TV sets	'000 Nos	6.0	12.0
29. Radio receivers	'000 Nos	201.6	284.8
III. INDUSTRIAL AND AGRICULTURAL MACHINERY			
30. Weighing machines	Million pesos	38.1	56.6
31. Agricultural tractors	'000 Nos	8.9	13.5
32. Stationary diesel engines	'000 Nos	0.5	0.7
33. Cranes	tons	3 660	6 450
34. Passenger and industrial lifts	Nos	250	900
35. Industrial boilers	Million pesos	364	642
36. Concrete mixers	Nos	510	715
37. Ventilation equipment	Million pesos	12	24
38. Air compressors	Million pesos	150	400
39. Power driven pumps	'000 Nos	55	115
40. Textile machinery	Million pesos	25	40
41. Cement machinery	Million pesos	9.6	21.2
42. Sugar machinery	Million pesos	1.0	2.0
43. Machine tools	Million pesos	50.0	90.0
44. Machine tool accessories	Million pesos	1.6	2.8
Agricultural implements			
45. Ploughs	Nos	2 500	3 300
46. Harrows	Nos	1 700	2 200
47. Planters	Nos	860	1 150
48. Cultivators	Nos	800	1 100
49. Rotary cutters	Nos	1 500	2 000
50. Trailers	Nos	580	988
IV. METAL PRODUCTS			
51. Steel doors and windows	'000 tons	14.0	30.0
52. Furniture	'000 tons	12.3	20.0
53. Kerosene stoves	'000 Nos	222	237
54. Gas bottles	'000 Nos	151	197
55. Tincans and crown corks	'000 tons	100	159
56. Steel wire rope	'000 tons	7	9
57. Prestressed concrete strands	tons	3 800	5 650
High tensile wire			
58. Textile	tons	1 620	2 025
59. Tyres	tons	153	239
60. Bolts, nuts and screws	'000 tons	9.6	19.2
61. Rivets	'000 tons	1.7	3.5
62. Wire nails	'000 tons	20.0	38.0
63. Barbed wire	'000 tons	29.0	40.0
64. Wire netting & wire products	'000 tons	18.0	30.0
65. Sewing machines	'000 Nos	52.0	84.0
66. Hand tools	'000 tons	3.5	5.2
67. Welding electrodes	'000 tons	10.6	19.0
68. Transmission towers	'000 tons	6.0	3.4
69. Razor blades	Million Nos	390.0	523.0
70. Expanded metal	'000 tons	1.3	2.3
71. Drums and containers	'000 tons	12.5	20.0
Tanks			
72. Oil	'000 tons	13.8	22.1
73. Water	'000 tons	8.0	13.8
74. Utensils	'000 tons	5.8	10.0
V. [illegible]			
1. Agricultural and allied activities	Million pesos	11 829	23 650
2. Large and medium industries and mining	Million pesos	8 959	13 145
3. Oil and gas	Million pesos	9 000	14 400
4. Social services	Million pesos	31 675	50 985
5. Transport and communication	Million pesos	11 583	18 875
6. Power - Hydel	'000 MW	3.1	7.4
[illegible]	'000 MW	-	0.9
7. [illegible]	km	474	344

Table 3-3

NORMS OF CONSUMPTION OF ORDINARY STEEL

Item		Unit	Norms of consumption kg
I. TRANSPORT EQUIPMENT			
1. Wagons	..	Nos	8 000
2. Coaches	..	Nos	9 000
3. Trucks			
1980	..	Nos	1 000
1985	..	Nos	1 500
4. Buses	..	Nos	8 300
5. Jeeps and station wagons	..	Nos	825
6. Bicycles	..	Nos	12
7. Motor cycles	..	Nos	85
8. Cars			
1980	..	Nos	640
1985	..	Nos	770
9. Car engines			
1980	..	Nos	124
1985	..	Nos	248
10. Trailers	..	Nos	2 025
11. Automobile ancillary	..	Million pesos	1 000
II. ELECTRICAL EQUIPMENT			
12. Transformers	..	MVA	4 600
13. Switchgear and controlgear	..	Million pesos	9 330
14. Electric fans	..	Nos	6.7
15. Electric motors	..	'000 kW	1 800
16. Air conditioners	..	Nos	30
17. Refrigerators (domestic and commercial)	..	Nos	88
18. Washing machines	..	Nos	64
19. Electric stoves	..	Nos	30
20. Gas stoves	..	Nos	59.4
21. Water heaters	..	Nos.	10
22. Cooking ranges	..	Nos.	58.4
23. Water coolers	..	Nos	40
24. ACSR cables	..	tons	350
25. House service meters	..	'000 Nos	1 160
26. T.V. Sets	..	'000 Nos	425
27. Radio receivers	..	'000 Nos	480
III. INDUSTRIAL AND AGRICULTURAL MACHINERY			
28. Weighing machinery	..	Million pesos	27 500
29. Agricultural tractors	..	Nos	880
30. Stationary diesel engines	..	Nos	116
31. Cranes	..	tons	790
32. Passenger and industrial lifts	..	Nos	2 930
33. Industrial boilers	..	Million pesos	30 000
34. Concrete mixers	..	Nos	400
35. Ventilation equipment	..	Million pesos	10 000
36. Air compressors	..	Million pesos	670
37. Power driven pumps	..	Nos	24
38. Textile machinery	..	Million pesos	19 000
39. Cement machinery	..	Million pesos	14 000
40. Sugar machinery	..	Million pesos	10 200
41. Machine tools	..	Million pesos	4 500
42. Machine tool accessories	..	Million pesos	6 600
Agricultural implements			
43. Ploughs	..	Nos	108.2
44. Harrows	..	Nos	431.6
45. Planters	..	Nos	480.6
46. Cultivators	..	Nos	40
47. Rotary cutters	..	Nos	55
48. Tractors	..	Nos	829
IV. METAL PRODUCTS			
49. Steel doors and windows	..	tons	1 100
50. Furniture	..	tons	1 100
51. Kerosene stoves	..	'000 Nos	500
52. Gas bottles	..	Nos	13
53. Tincans and crown corks	..	tons	1 100
54. Bolts, nuts and screws	..	tons	1 140
55. Rivets	..	tons	1 140
56. Wire nails	..	tons	1 020
57. Barbed wire	..	tons	1 080
58. Wire netting and wire products	..	tons	1 100
59. Sewing machines	..	'000 Nos	5 300
60. Hand tools	..	tons	870
61. Transmission towers	..	tons	1 100
62. [illegible] metals	..	tons	1 110
63. Drums and containers	..	tons	1 050
64. Tanks	..	tons	1 050
V. CONSTRUCTION SECTOR			
65. Agricultural and allied activities	..	Million pesos	8 000
66. Large and medium industries & mining	..	Million pesos	[illegible] 500
67. Oil and gas	..	Million pesos	3 900
68. Social services	..	Million pesos	7 834
69. Transport and communication	..	Million pesos	17 125
70. Power - Hydel	..	MW	56 000
Thermal	..	MW	48 000
71. Rail transport	..	Km	5[illegible] 000

3 - Iron and Steel Demand (cont'd)

steel-consuming items, and comparing the estimated consumption so arrived with the apparent steel consumption. This analysis has been carried out to check the validity of the norms, to examine the past pattern of sectoral consumption, and to estaimate the non-coverage.

The details of consumption are given in Appendix 3-5 and the sectoral consumption is summarised in Table 3-4.

Table 3-4

ESTIMATED PAST CONSUMPTION OF STEEL BY SECTORS (thousand tons)

Sector	1970	1971	1972	1973	1974
Transport equipment	13.5	8.1	10.0	8.1	8.1
Electrical equipment	11.4	17.0	19.3	21.2	25.3
Industrial and agricultural machinery	3.4	4.0	5.8	6.6	10.4
Metal products	138.8	113.4	128.9	129.1	118.0
Sub-total ..	167.1	142.5	164.0	165.0	161.8
Construction ..	282.7	269.3	255.3	329.3	380.0
Total ..	449.8	411.8	419.3	494.3	541.8
Spares and maintenance work at 10% of manufacturing sector[a]/	16.7	14.3	16.4	16.5	16.2
Small scale industries at 3% of manufacturing sector[b]/	5.0	4.3	4.9	5.0	4.9
Stock at 1% of total[c]/	4.7	4.3	4.4	5.2	5.4
Grand total	476.2	434.7	445.0	521.0	541.3

a/ Assumed
b/ Assumed
c/ Based on indications during field survey

3- Iron and Steel Demand (cont'd)

The past production, imports and exports, and the apparent consumption of ordinary steel are given in Appendices 3-6, 3-7 and 3-8 respectively. The apparent consumption is compared with the steel consumption estimated above (Table 3-4) for the years 1970 to 1974, in Table 3-5.

Table 3-5

ESTIMATED STEEL CONSUMPTION AND APPARENT STEEL CONSUMPTION (thousand tons)

	Apparent consumption[a] (1)	Estimated consumption (2)	Difference (1-2)
1970 ..	529	476	53
1971 ..	552	435	117
1972 ..	513	445	68
1973 ..	437	521	-84
1974 ..	568	541	27
Total	2 599	2 418	181

a/ Excluding electrode production by PDR which is considered as special steel.

It will be observed that the estimated aggregate steel consumption for the total period of five years could be accounted for 2.42 million tons against the apparent steel consumption of 2.6 million tons. The average coverage in the estimated consumption thus works out to about 93 per cent of the apparent consumption for the five-year period, leaving a non-coverage of 7 per cent. The difference between the apparent consumption and the estimated consumption for the individual years may be attributed to variations in stocks, besides non-coverage. It will be noted that the estimated consumption in 1973 is higher than the apparent consumption by 84,000 tons. This should have been obviously met from the stocks accumulated in the previous years.

The non-coverage of 7 per cent indicated by the above analysis can be considered reasonable for a steel demand which covers a large number of steel consuming items. Therefore, the norms of consumption that have been evolved can be considered as realistic.

Future steel requirements

Having established the validity of the norms of consumption, the norms have been applied to the estimated future output levels of each steel consuming item in order to arrive at the steel demand by 1980 and 1985. The categorywise demand for ordinary steel by each consuming sector is given in Appendix 3-9 for the year 1980 and in Appendix 3-10 for the year 1985. In order to arrive at the total demand, provision for repairs and maintenance, small scale industries, stock and non-coverage has been made.

3 - Iron and Steel Demand (cont'd)

To meet the requirements of spares and maintenance, a provision of approximately 10 per cent of the steel requirements of the organised manufacturing sector has been made.

Besides the organised industrial units, there are a large number of small units engaged in the production and servicing of metal products such as consumer durables, domestic appliances, agricultural implements etc. It is understood that at present there are more than 1,000 units producing different metal products and consumer items, and such units are likely to increase in future. A provision of 5 per cent and 7 per cent of the steel requirements of the organised manufacturing sector has been made to meet the requirements of the small scale industries for the years 1980 and 1985 respectively.

In regard to the provision for stock, it is assumed that one month's consumption would be adequate. As there will be a carry over of the stock from year to year, the increment in the stock would be one-twelfth of the annual growth of steel demand. This approximately works out to 1 per cent of the demand including provision for repairs and maintenance, and small scale industries. To this a provision of 5 per cent has been made for non-coverage. The total demand thus arrived is given in Appendix 3-11 and summarised sectorwise in Table 3-6 and categorywise in Table 3-7 respectively. The sectorwise demand for ordinary steel and demand by product categories are shown in Fig 3-1 and Fig 3-2 respectively.

3 - Iron and Steel Demand (cont'd)

Table 3-6

SECTORWISE ORDINARY STEEL DEMAND

Sector		1980		1985	
		'000 tons	%	'000 tons	%
Transport equipment	.. ..	123	9.7	296	12.9
Electrical equipment	.. ..	56	4.4	199	8.7
Industrial and agricultural machinery	.. ..	36	2.8	63	2.7
Metal products	.. ..	316	24.8	518	22.6
Sub-total	.. ..	531	41.7	1 075	46.9
Construction	.. ..	743	58.3	1 217	53.1
Total	.. ..	1 274	100.0	2 292	100.0

Table 3-7

CATEGORYWISE BREAKDOWN OF DEMAND

Category			Size range mm	Demand 1980 '000 tons	Demand 1985 '000 tons
NON-FLATS					
Bars and rods		..	Below 75	300	986
			Above 75	40	70
Beams	- Medium	..	100 x 50 - 250 x 125	18	81
	- Heavy	..	Above 250 x 125	8	14
Channels	- Light	..	30 x 33 - 60 x 45	15	26
	- Medium	..	100 x 50 - 150 x 75	31	50
	- Heavy	..	Above 175 x 75	4	6
Equal angles	- Light	..	20 x 20 - 75 x 75	20	35
	- Medium	..	90 x 90 - 130 x 130	30	44
	- Heavy	..	Above 130 x 130	8	4
Unequal angles	- Light	..	30 x 20 - 60 x 40	4	6
	- Medium	..	65 x 45 - 125 x 90	5	10
	- Heavy	..	Above 125 x 90	1	1
Tees		..		4	8
Narrow flats	- Light	..	25 to 75	40	70
	- Medium	..	Above 75 to 150	10	18
	- Heavy	..	Above 150	10	16
Wires		..		130	215
Seamless tubes		..		40	70
Rails and other railway materials		..		20	16
Sub-total non-flats		..		709	1 226
FLATS					
Plates		..	Below 1 200 width	35	63
			Above 1 200 width	35	68
CR sheets/strip		..	Below 1 200 width	80	250
			Above 1 200 width	37	100
HR sheets/strip		..	Below 1 200 width	63	112
			Above 1 200 width	87	48
Tinplate		..		120	190
Galvanised sheets		..		80	135
Welded pipes		..		40	100
Sub-total flats		..		565	1 066
Total non-flats and flats		..		1 274	2 292

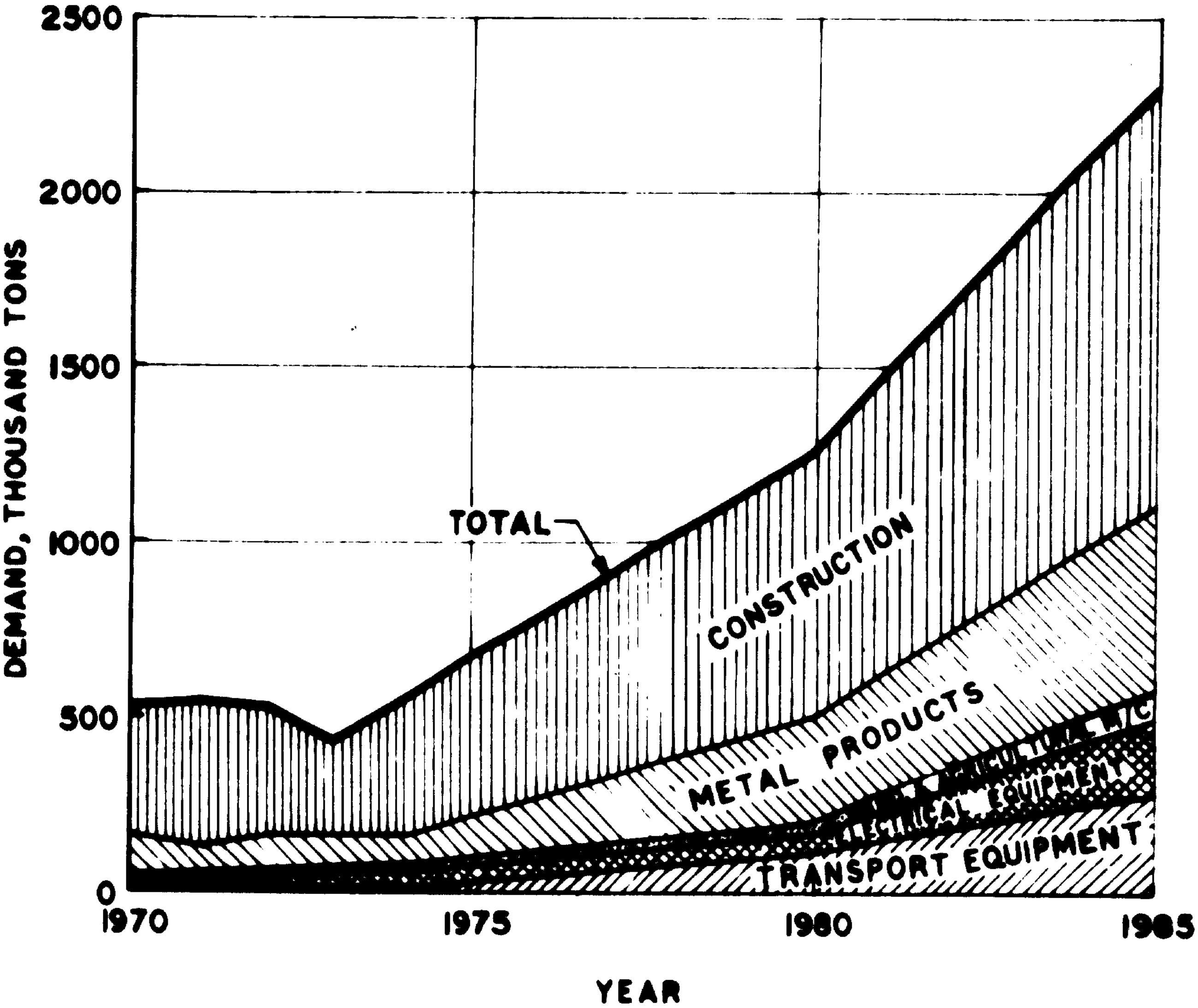

FIGURE 3-1. SECTORWISE DEMAND OF ORDINARY STEEL

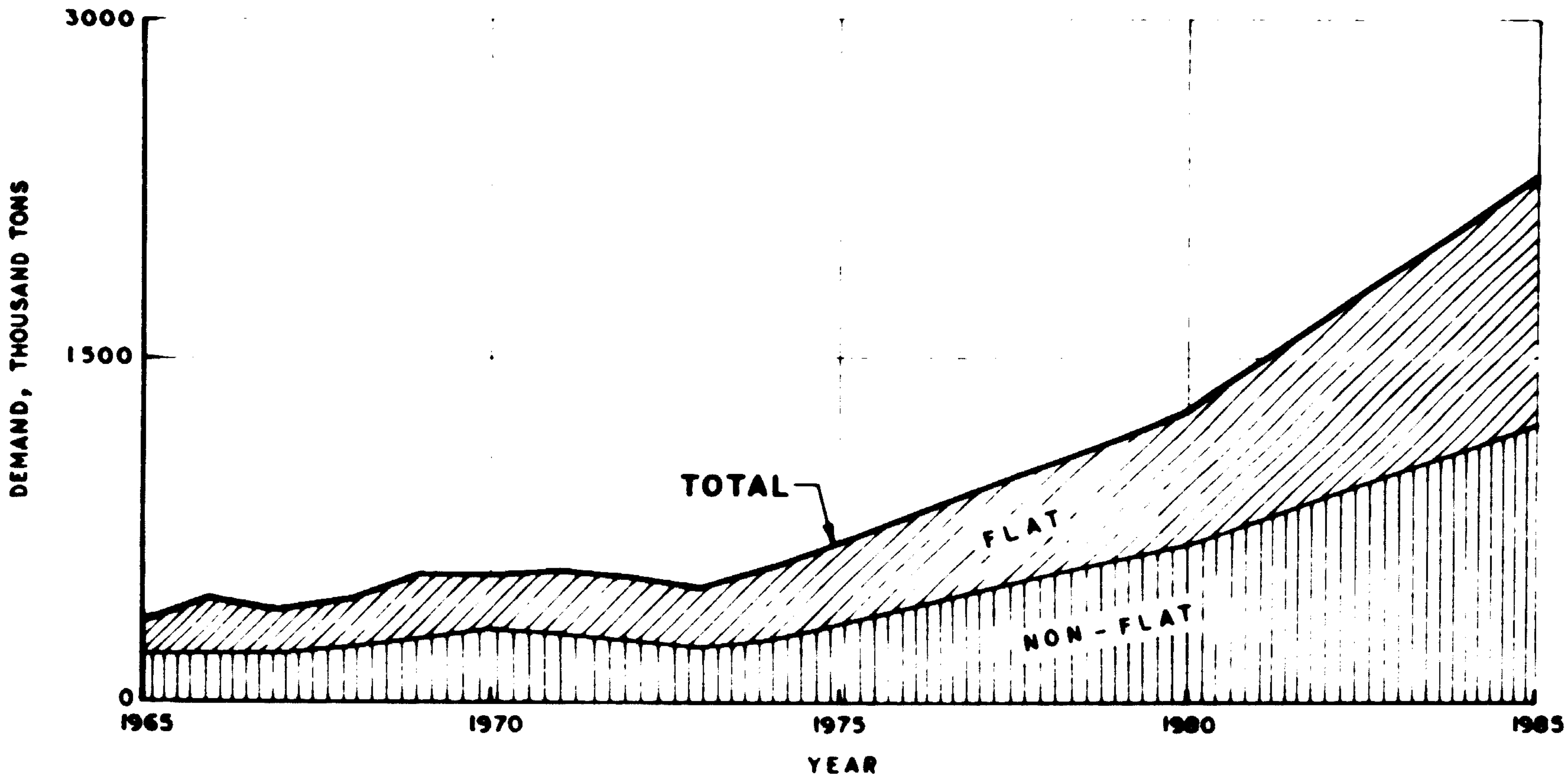

FIGURE 3-2. DEMAND OF ORDINARY STEEL BY PRODUCT CATEGORIES

3 - Iron and Steel Demand (cont'd)

COMPARISON OF DEMAND WITH PROJECTIONS BY OTHER TECHNIQUES

The validity of the forecast of the demand arrived at by the end-use approach using micro-level projections, has been checked against macro-level projections derived by the application of time trend analysis, regression analysis and steel intensity method.

Time trend analysis

From the past finished steel consumption, the time trend equation derived is $Y = 444.3 + 19.3t + 2.72t^2$ with the base year 1969. The projections on the basis of the above equation are given below:

Year	t	19.3t '000 tons	$2.72t^2$ '000 tons	Y '000 tons
1980 ..	11	212.3	329.1	985.7
1985 ..	16	308.8	696.3	1 449.4

Regression equation

From the past correlation between the apparent finished steel consumption and the corresponding value of GDP at constant 1958 prices, the regression equation derived is $Y = -209 + 0.02X$ with the correlation coefficient of 0.90. On the basis of this equation, the steel demands projected are as follows:

Year	X million pesos	0.02X '000 tons	Y '000 tons
1980	74 000	1 480	1 271
1985	107 000	2 140	1 931

3 - Iron and Steel Demand (cont'd)

Steel itensity method

The International Iron and Steel Institute (IISI) in 'Projection 85' (March 1972) evolved the steel intensity method and applied it to project the steel demand of various countries. Steel intensity as defined by IISI is the amount of steel input (apparent steel consumption) per US dollars of output (gross national product). The IISI model is based on GNP at 1963 constant prices.

In advanced industrial countries where steel and steel-based industries contribute in a large measure to GNP, the steel intensity is high. In general, in industrialised countries with per capita GNP of over US $ 1,000, the steel intensity shows no tendency to rise. In other words, the coefficient of change of the steel intensity is 1.0, with less than 10 per cent deviation plus or minus in most cases. Countries with lower per capita GNP around US $ 500 per annum show maximum rate of increase of steel intensity of about 1.4, apparently due to rapid industrialisation.

Past steel intensities of Colombia for the period 1965 to 1974 have been derived from the value of GNP and apparent crude steel consumption. The levels of GNP in US dollar at constant 1963 price and crude steel consumption along with steel intensity values are given in Table 3-8, on the next page.

3 - Iron and Steel Demand (cont'd)

Table 3-8

PAST STEEL INTENSITIES OF COLOMBIA

Year	GNP [a] million US $	Population million	Per capita GNP US $	Steel consumption Finished '000 tons	Steel consumption Crude [b] '000 tons	Per capita crude consumption kg	Steel intensity kg/US $
1965	4 347	18.043	241	338 [c]	439	24	0.099
1966	5 054	18.620	271	434 [c]	564	30	0.111
1967	4 867	19.215	253	342 [c]	445	23	0.091
1968	5 157	19.829	260	350 [c]	455	23	0.088
1969	5 344	20.463	261	512 [c]	666	33	0.126
1970	5 662	21.117	268	529 [d]	688	33	0.123
1971	5 956	21.792	273	553 [d]	719	33	0.121
1972	6 280	22.489	279	512 [d]	666	30	0.108
1973	7 355	23.212	317	437 [d]	568	24	0.076
1974	8 255	23.954	345	568 [d]	738	31	0.090

a/ At 1963 constant price.
b/ On the basis of conversion factor of 1.3.
c/ Excluding electrode quality steel produced by PDR, estimated on the basis of actual production. of electrode and its ratio to total wire rods for the period 1970-74.
d/ Actuals of electrode production deducted.

3 - Iron and Steel Demand (cont'd)

For arriving at the likely level of steel intensity in 1980 and 1985, the steel intensity values of countries with similar economy are analysed. For the selected countries, the economic structure in terms of contribution of the major sectors to GDP, is shown in Table 3-9.

Table 3-9

CONTRIBUTION TO GDP BY MAJOR SECTORS
(per cent)

Country selected		Agriculture	Manufacturing	Industry	Construction
Colombia	(1972)	27	23	20	5
Egypt	(1970)	25	21	18	4
South Korea	(1971)	29	24	22	5
Malaysia	(1971)	31	22	14	4
Morocco	(1971)	31	22	14	4
Philippines	(1971)	29	18	16	3
Syria	(1972)	26	20	15	3

The values of steel intensities along with per capita GNP in US dollars for these selected countries are given in Table 3-10, on the next page.

3 - Iron and Steel Demand (cont'd)

Table 3-10

STEEL INTENSITIES (SI) OF SELECTED COUNTRIES

Year	Egypt		South Korea		Malaysia		Morocco		Philippines		Syria	
	Per capita GNP US $	SI kg/US $	Per capita GNP US $	SI kg/US $	Per capita GNP US $	SI kg/US $	Per capita GNP US $	SI kg/US $	Per capita GNP US $	SI kg/US $	Per capita GNP US $	SI kg/US $
1963 ..	252	0.082	130	0.141 a/	221	0.127	188	0.074	144	0.136	198	0.108
1964 ..	197	0.120	80	0.146 a/	225	0.163	180	0.088	150	0.146	216	0.133
1965 ..	234	0.116	100	0.150 a/	243	0.164	178	0.072	156	0.155	227	0.076
1966 ..	190	0.153	124	0.154 a/	246	0.163	170	0.087	163	0.168	224	0.111
1967 ..	189	0.138	145	0.159 a/	251	0.158	175	0.092	186	0.159	251	0.131
1968 ..	195	0.123	173	0.164	251	0.164	192	0.100	200	0.164	246	0.136
1969 ..	209	0.116	203	0.180	255	0.162	195	0.122	216	0.186	258	0.202
1970 ..	215	0.150	238	0.158	260	0.160	193	0.130	249	0.167	269	0.188
1971 ..	216	0.140	237	0.223	283	0.164	208	0.109	290	0.086	301	0.127
1972 ..	218	0.172	261	0.260	296	0.171	213	0.126	313	0.079	341	0.157

a/ Estimated graphically.

3 - Iron and Steel Demand (cont'd)

These values of steel intensities along with those of Colombia are plotted against per capita GNP in Fig 3-3. Two lines representing the upper limit and lower limit of the steel intensity values have been drawn.

The past analysis of growth rates of GNP at constant 1963 price for the period 1963 to 1974 indicates that for future, an average growth rate of 7 per cent may be assumed. On this basis, the projected values of GNP for the years 1980 and 1985 work out to US $ 12,194 million and US$ 17,901 million respectively. The population level by 1980 and 1985 will be 28.8 million and 33.5 million, on the basis of 3.2 per cent growth rate. The per capita GNP thus derived will be US $ 423 and US$ 534 for the years 1980 and 1985 respectively.

For the projected level of per capita GNP, the upper and lower limits of steel intensities that may be attainable by Colombia, as can be seen in Fig 3-3 are given below:

Year		Steel intensity	
		Lower limit	Upper limit
1980	..	0.134	0.192
1985	..	0.148	0.210

Applying these steel intensities to per capita GNP, the crude steel demands by 1980 and 1985 are

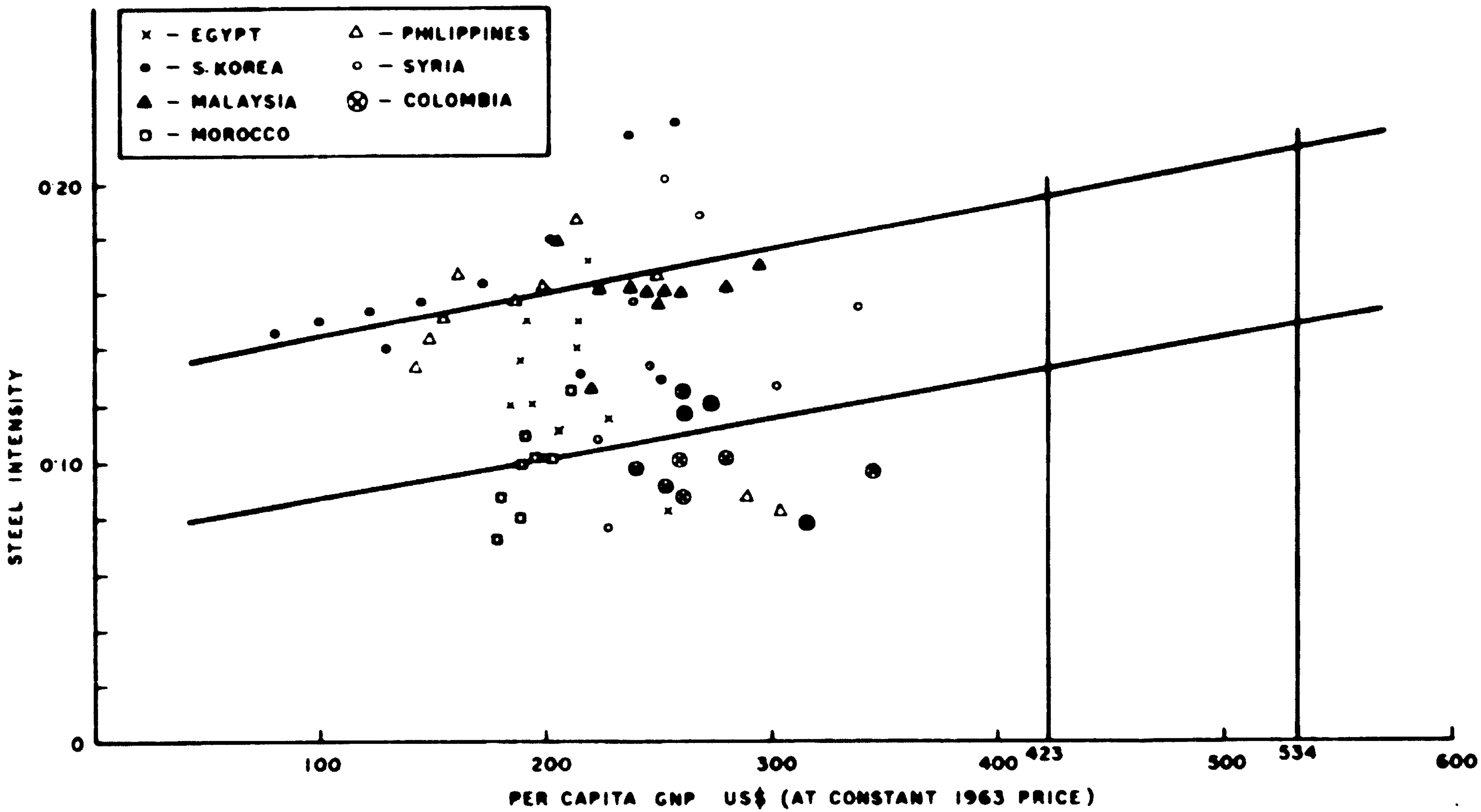

FIGURE 3-3. VARIATION OF STEEL INTENSITY WITH PER CAPITA GNP

3 - Iron and Steel Demand (cont'd)

estimated. On the basis of conversion factor of 1.3, the finished steel demands by 1980 and 1985 are alse estimated. These are shown below:

	1980	1985
Steel intensity		
- Upper limit ..	0.192	0.210
- Lower limit ..	0.134	0.148
Per capita GNP, US $	423	534
Population, million	28.8	33.5
Projected steel demand		
Crude steel, '000 t		
- Upper limit ..	2 340	3 780
- Lower limit ..	1 630	2 630
Finished steel, '000t		
- Upper limit ..	1 800	2 890
- Lower limit ..	1 250	2 040

Forecasts by different techniques

The projections obtained by various techniques are compared in Table 3-11 and shown in Fig 3-4.

Table 3-11

COMPARISON OF STEEL DEMAND FORECASTS
(thousand tons)

Methodology	Finished steel		Equivalent crude steel	
	1980	1985	1980	1985
End-use ..	1 274	2 292	1 655	2 977
Time-trend ..	986	1 449	1 281	1 882
Regression analysis	1 271	1 931	1 910	2 508
Steel intensity				
- Upper limit ..	1 800	2 890	2 340	3 780
- Lower limit ..	1 250	2 040	1 630	2 630

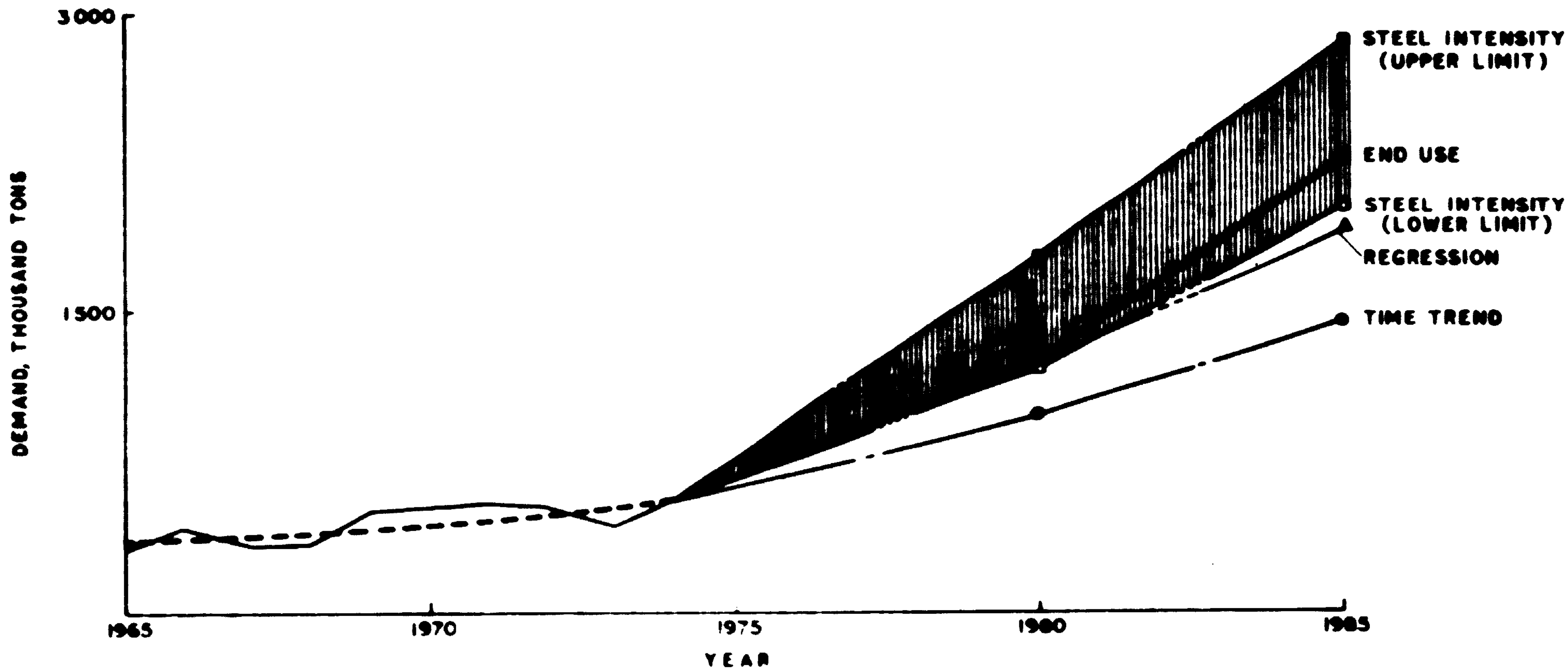

FIGURE 3-4. COMPARISON OF FINISHED STEEL DEMAND FORECASTS

3 - Iron and Steel Demand (cont'd)

As can be expected, the time-trend method gives the lowest figure which is of the same order as projected in the Indicative Plan and by PDR by using the same technique. The results of the regression analysis and the lower value obtained by the steel intensity method are almost the same and somewhat lower than the end-use figure. On the other hand, the upper value obtained by the steel intensity method is appreciably higher than the end-use figure. The realistic future demand would possibly lie between the upper and lower limits of the steel intensity method, because these values are derived from a correlation of the stage of economic development and the steel requirement in countries with economies similar to Colombia. While the upper value of the steel intensity method may be considered optimistic, the lower value is possibly too conservative. Therefore, the end-use demand of 3 million tons of equivalent crude steel may be considered realistic. It should, however, be noted that in addition to this direct demand, a sizeable quantity of steel will continue to be imported in the form of machinery and goods. Such indirect imports of steel are estimated in the following paragraphs.

3 - Iron and Steel Demand (cont'd)

INDIRECT IMPORTS

Besides direct imports of steel products, a sizeable quantity of steel is imported in the form of manufacture such as machinery, fabricated items like steel structures, tanks and vessels, automobiles and other transport equipment, domestic appliances etc. Though the steel content of these items forms a part of the country's steel consumption, it does not get reflected in the demand till such time as these items are produced indigenously. It is, therefore, necessary to know also the tonnage of steel indirectly imported, so that the country's total steel requirements could be assessed and adequate provision be made for ensuring timely supplies of steel as and when indigenous manufacture of these items is taken up.

Analysis of past indirect consumption

An analysis of the import statistics of the steel consuming items from 1965 to 1973 has been made. To arrive at the steel content of these imports, appropriate coefficients of steel content of various items in the manufacturing sector have been used. On similar basis, the quantum of steel exported for the various engineering goods is also estimated. The apparent indirect consumption for the manufacturing sectors such as transport equipment, electrical equipment, industrial and agricultural machinery and metal products thus derived is given in Appendix 3-12 and is summarised in Table 3-12.

3 - Iron and Steel Demand (cont'd)

Table 3-12

APPARENT INDIRECT CONSUMPTION
(thousand tons)

Year	Indirect imports (1)	Indirect exports (2)	Apparent direct consumption (3)	Apparent direct consumption (4)	% (3) ÷ (4)
1965	80.3	2.7	77.6	341	23.0
1966	91.7	3.4	88.0	437	20.0
1967	109.1	3.1	106.0	346	30.0
1968	95.9	3.5	92.4	373	25.0
1969	128.2	4.3	123.9	515	24.0
1970	145.6	5.1	140.0	535	25.0
1971	122.9	20.1	102.8	557	19.0
1972	105.5	10.5	90.0	516	17.0
1973	97.1	4.3	92.8	442	21.0
	970.5	57.0	913.5	4 062	22.5

It will be noted that the indirect imports of ordinary steel over the last nine years averaged to 22.5 per cent of the direct apparent consumption.

In the present study, it is assumed that certain items or component parts which have been hitherto imported will be progressively taken up for local manufacture in accordance with the Plan Programmes and the manufacturer's expansion plans. The steel requirements due to this increase in the local manufacture have been estimated at about 92,000 tons for the transport equipment and 23,000 tons for the electrical equipment.

The direct consumption of ordinary steel has been projected at 2.3 million tons by 1985, including a provision of 115,000 tons of steel towards items to be newly manufactured, which otherwise would have formed a part of the indirect consumption. Without making such provision, the direct demand would have been 2.185 million tons. The indirect consumption during the years 1971 to 1973 works out to 20 per cent of the total consumption. Assuming the same percentage would hold good in 1985, the indirect consumption at 20 per cent of 2.185 million tons would be 437,000 tons. As a provision of 115,000 tons has already been made in arriving at the demand of 2.3 million tons, the remaining indirect consumption of steel would be about 322,000 tons.

MINIMUM PROBABLE DEMAND FOR ORDINARY STEEL

It will be noted from Appendix 3-12 that the metal products sector has accounted for about 30 per cent of the indirect imports. On this basis, the indirect steel imports for metal products can be projected at 130,000 tons in 1985. As many of these products will comprise simple items of fabrication, it may be possible to set up indigenous facilities for the manufacture of the bulk of these items by 1985. Therefore, the estimated finished steel demand of 2.3 million tons (3 million tons equivalent crude steel) is likely to increase at least by 100,000 tons to 2.4 million tons (3.12 million tons of equivalent crude steel). In view of these considerations, the demand for 3 million tons of equivalent crude steel can be considered as the minimum probable demand in 1985.

3 - Iron and Steel Demand (cont'd)

ALLOY AND SPECIAL STEELS DEMAND

Past consumption

The past apparent consumption of alloy and special steels is given in Appendix 3-13 and summarised in Table 3-13.

Table 3-13

APPARENT CONSUMPTION OF ALLOY AND SPECIAL STEELS
(thousand tons)

	Domestic production	Imports	Exports	Apparent consumption
1965	3.3	7.2	-	10.5
1966	3.3	14.1	-	17.4
1967	7.3	11.3	-	18.6
1968	10.0	14.7	-	24.7
1969	19.6	18.7	-	38.3
1970	25.6	28.0	0.4	53.2
1971	19.5	17.1	1.7	34.9
1972	15.5	16.1	0.4	31.2
1973	28.9	22.1	1.9	39.1
1974	22.0	23.9	1.6	44.3

Demand analysis

The output levels projected for the steel consuming items are given in Table 3-2. Out of the 74 items in the manufacturing sector, 28 are exclusively ordinary steel consuming items. For the remaining items, therefore, the norms of consumption of alloy and special steels are derived. For derivation of these norms, a similar approach as adopted in the case of ordinary steel has been followed. The norms of consumption of alloy and special steels for 46 items are given by steel types in Appendix 3-14 and summarised in Table 3-14.

Table 3-14

NORMS OF CONSUMPTION OF ALLOY AND SPECIAL STEELS

Item			Unit	Norms of consumption kg
I. TRANSPORT EQUIPMENT				
1. Wagons	..	..	Nos	300
2. Coaches	..	..	Nos	733
3. Trucks	..	..	Nos	719
4. Buses	..	..	Nos	719
5. Jeeps and station wagons	..	..	Nos	263
6. Bicycles	..	..	Nos	1.15
7. Motorcycles	..	..	Nos	17.26
8. Cars	..	..	Nos	351
9. Car engines	..	..	Nos - 1980	55
			1985	109
10. Trailers	..	..	Nos	65
11. Automobile ancillaries	..	..	Million pesos	1 017
12. Leaf springs	..	..	Tons	1 100
II. ELECTRICAL EQUIPMENT				
13. Transformer	..	..	KVA	3 000
14. Switchgear and controlgear	..	..	Million pesos	0.33
15. Electric fan	..	..	'000 Nos	20
16. Electric motor	..	..	'000 kW	1 970
17. Air conditioner	..	..	Nos	2.9
18. Refrigerator	..	..	Nos	3.16
19. Armoured [illegible]	..	..	Tons	16
III. INDUSTRIAL AND AGRICULTURAL MACHINERY				
20. Weighing machinery	..	..	Million pesos	177
21. Agricultural tractors	..	..	Nos	340
22. Stationary diesel engine	..	..	Nos	195
23. Cranes	..	..	Tons	290
24. Passenger and industrial lifts		..	Nos	150
25. Industrial boilers	..	..	Million pesos	1 300
26. Air compressor	..	..	Million pesos	290
27. Power driven pumps	..	..	Nos	3
28. Textile machinery	..	..	Million pesos	427
29. Cement machinery	..	..	Million pesos	20.2
30. Sugar machinery	..	..	Million pesos	365
31. Machine tools	..	..	Million pesos	349
32. Machine tool accessories	..	..	Million pesos	530
Agricultural implements				
33. Plough	..	..	Nos	40
34. Harrow	..	..	Nos	15
35. Trailers	..	..	Nos	1.3
IV. METAL PRODUCTS				
36. Furniture	..	..	Tons	5
37. Steel wire rope	..	..	Tons	1 100
38. Prestressed concrete strands		..	Tons	1 100
39. High tensile wire	..	..	Tons	1 100
40. Tyre wire	..	..	Tons	1 100
41. Bolts, nuts and screws	..	..	Tons	165
42. Sewing machinery	..	..	'000 Nos	500
43. Hand tools	..	..	Tons	250
44. Welding electrodes	..	..	Tons	700
45. Razor blades	..	..	Million Nos	230
46. Utensils	..	..	Tons	1 100

3 - Iron and Steel Demand (cont'd)

Future alloy and special steels requirement

The norms of alloy and special steels consumption are applied to the estimated output levels of each item in order to determine the alloy and special steels requirement by 1980 and 1985. The demand by steel types of each consuming item under each sector is given in Appendix 3-15 for the year 1980 and in Appendix 3-16 for the year 1985. Tool and die steels are not given in the norms sheets, as these are process materials. Their requirements are estimated as a percentage of the total alloy and special steel requirement.

Repairs and maintenance

A provision of approximately 10 per cent of the steel requirement of the organised manufacturing sector has been made to meet the requirements of repairs and maintenance.

Small scale industries

To meet the requirements of small and medium scale industries, a provision of 3 per cent and 5 per cent of the steel requirements has been made for the years 1980 and 1985 respectively.

Tool steels

The requirement of tool steels is dependent on the production processes and the quantity of tonnage steel processed. The proportion of tool steel in the total alloy and special steel requirements will be high in the initial stages, but it will gradually diminish as production processes become more refined, massive and continuous, though the actual tonnage of tool steel will increase. For instance, in Japan, the consumption of tool steel in 1959 was about 4.8 per cent of the total alloy steel consumption and this declined to 2.5 per cent in 1966. Accordingly, the tonnages of tool steel demand have been assumed at 5 per cent and 4 per cent of the alloy and special steel requirements for the years 1980 and 1985 respectively.

Provision for stock

Alloy and special steel going into stock is not accounted for anywhere and, therefore, separate provision needs to be made for this in the demand forecast. With increasing indigenous production and ready availability of alloy and special steels, stock equivalent to two months consumption would be required as many items will be imported. As there will be carry over of the stocks from year to year, the increased production necessary to maintain the stocks at one-sixth of consumption level will be one-sixth of the estimated growth of demand, that is about 2 per cent.

Non-coverage

Similar to ordinary steel, a provision of 5 per cent has been made for non-coverage.

3 - Iron and Steel Demand (cont'd)

Total requirement

The total demand for different types of alloy and special steels including the requirements for spares and maintenance, small scale industries, tool steels, stock and non-coverage are given in Appendix 3-17 and summarised in Table 3-15.

Table 3-15

TOTAL DEMAND FOR ALLOY AND SPECIAL STEELS BY STEEL TYPES

Steel type	1980 Total demand		1985 Total demand	
	'000 tons	%	'000 tons	%
Carbon construction[a]	27.1	28.02	54.3	26.06
Alloy constructional	17.5	18.09	48.5	23.27
Free cutting	5.8	6.00	18.6	8.93
Spring	19.9	20.59	36.7	17.62
Stainless	9.1	9.41	17.7	8.49
Electrical steel sheet	5.3	5.48	11.2	5.37
Tool steel	4.1	4.24	7.2	3.45
Electrode	7.9	8.17	14.2	6.81
Total ..	96.7	100.00	208.4	100.00

a/ Includes pre-stressed wire.

The total requirements by major consuming sectors are also given in Appendix 3-17 and summarised in Table 3-16.

Table 3-16

OVERALL DEMAND FOR ALLOY AND SPECIAL STEELS BY CONSUMING SECTORS

Sector	1980 Total demand		1985 Total demand	
	'000 tons	%	'000 tons	%
Transport equipment	44.7	46.22	117.8	56.52
Electrical equipment	7.5	7.76	17.8	8.54
Industrial and agricultural machinery	6.1	6.31	10.1	4.85
Metal products[a]	34.6	35.78	56.1	26.92
Construction[b]	3.8	3.93	6.6	3.17
Total	96.7	100.00	208.4	100.00

a/ Include electrodes and tool steel
b/ Include pre-stressed wire

POSSIBILITIES OF STEEL EXPORTS TO ANDEAN COUNTRIES

The possibility of exportint rooled steel products from Colombia to the other Andean countries has been reviewed on the basis of the available data on the future demand and production programme of these countries discussed in Chapter 2.

From Table 2-14, it would be observed that all the Andean countries except Venezuela and Chile will have shortfalls in the domestic production, both in 1980 and 1985. Primarily because of the large capacity planned by Venezuela, the Andean region as a whole will have a surplus of about 600,000 tons in 1980 and over 8 million tons in 1985. In view of this, there is hardly any scope for making a specific provision for exports in planning the future steel capacity in Colombia.

In respect of special steels, Colombia at present exports some quantities to the other Andean countries. Data on the future development of special steel industries in the other Andean countries are not readily available. It is understood, however, that Venezuela has already planned a special steels project and Ecuador is also investigating the possibility of setting up a special steels plant. Even if these projects were to materialise, Colombia can still be expected to have an edge over them by virture of its being in the special steels field for already over a decade and its ability to diversify it into more sophisiticated categories, particularly in view of its nickel resources. It is likely, therefore, that Colombia may still be able to continue to have a share in the Andean export market. However, it is difficult to predict at this stage the export potential, in the absence of adequate information on the Andean market for special steels.

Demand for pig iron

The iron and steel foundries in Colombia are now mainly engaged in producing castings for automobiles such as brake drums and wheel sprockets, casings for electric motors and pumps, valves, grinding balls, liner plates, spares and parts for industrial machinery, and castings for agriculture and other equipment and machinery. Adequate data with regard to the installed capacity and past productions of the foundries are not readily available. Based on the information collected during the field survey, the production of iron castings and steel castings during the period 1971 to 1974 is roughly estimated (Appendix 4-2) to amount to about 6 per cent and about 2 per cent respectively of the total apparent steel consumption.

Past studies

Demands for iron castings in Colombia were estimated by Junta del Acuerdo de Cartagena in 1974 and it was projected that the requirements would be about 65,000 tons in 1980 and 93,000 tons in 1985.

3 - Iron and Steel Demand (cont'd)

In a recent study (Sept. 1975) by UNIDO for modernisation and rationalisation of ferrous and non-ferrous metal foundries in Andean countries, prepared for Junta del Acuerdo de Cartegana, the iron and steel castings requirements for Colombia for 1980 and 1985 have been estimated and these projections are higher than those indicated in the 1974 study.

This Study

In the present study, the future requirements of iron and steel castings have been estimated (Appendix 3-18) based on output forecasts of different sectors (Table 3-2) and norms of casting requirements. The iron and steel castings requirements have also been calculated on the basis of the past norms of production of castings in relation to the apparent steel consumption. Forecasts of iron and steel castings requirement made in the past as well as those arrived in this study are compared in Table 3-17.

Table 3-17

COMPARISON OF FUTURE REQUIREMENT OF IRON AND STEEL CASTINGS PROJECTED BY DIFFERENT AGENCIES
(thousand tons)

	Past studies		This study	
	Junta 1974	UNIDO 1975	End-use method[a]/	Past norms[b]/
1980				
Iron castings	65	93	74	76
Steel castings	-	20	25	25
1985				
Iron castings	93	111	127	138
Steel castings	-	30	43	46

a/ Refer Appendix 3-18

b/ Iron castings at 6% of apparent steel consumption and steel castings at 2% of apparent steel consumption.

Keeping in view the emphasis laid on the development of the metal-mechanic sector, the estimates made in this study by the end-uee method, which closely agree with the UNIDO estimates made on the basis of percentage correlation, may be assumed as reasonable.

Requirement of pig iron for castings

The pig iron requirement for iron castings is mainly dependent on the quality of pig iron available and the relative costs of pig iron and steel scrap. If pig iron of acceptable quality were to be made available at reasonable costs, the average consumption o' pig iron would be of the order of 800 kg per ton of finished casting. However, from the field survey, it was observed that in view of the high phosphorus content of the local pig iron and the cost of scrap available in the vicinity of the foundries, the pig iron consumption averages about 500 kg per ten of casting. On the basis of the present rate of consumption and adopting the demands projected by the end-use mthod, the pig iron requirements in 1980 would be of the order of 40,000 tons and in 1985 about 65,000 tons.

4 - FUTURE SCRAP AVAILABILITY

The semi-integrated plants depend on scrap for steelmaking. Their low capacity utilisation in the past is attributed to shortage of scrap. Future availability of scrap and the possibilities of augmenting supplies of metallic charge need to be studied to assess the possible participation of the semi-integrated plants in the steel programme.

PAST ESTIMATES ON SCRAP AVAILABILITY

An assessment of the future availability of scrap was made in the Indicative Plan (1972). This aspect aas also covered in the feasibility report of Paz del Rio (PDR) expansion to one million ton.

Projections in Indicative Plan

In the Indicative Plan, the scrap availability was estimated on the basis of the following assumptions:

a) PDR will continue to use its recirculating scrap and will not enter the local scrap market, either as a purchaser or as a seller.

b) The domestic generation of scrap (excluding recirculating scrap) was estimated at about 50,000 tons per year in 1970.

c) A 5.5 per cent rate of growth was taken as the annual generation index.

The national scrap generation (excluding recirculating scrap) was projected at 80,000 tons in 1980 and 121,000 tons in 1985.

4 - Future Scrap Availability (cont'd)

Projections in PDR expansion report

In the feasibility report for PDR expansion, the share of the semi-integrated plants in the steel production in 1980 and 1985 has been indicated. This is based on the assumption that they will fully utilise the available domestic scrap. In addition, PDR will also supply some billets. From this data, the scrap purchases of the semi-integrated plants may be estimated as follows:

	1980 '000 tons	1985 '000 tons
Salable steel production of semi-integrated plants	160	310
Use of purchased billets	102	252
Estimated production of salable steel from purchased billets at 86% yield a/	88	217
Salable steel from ingots	72	93
Ingot steel required at 80% yield a/	90	116
Scrap required for ingot steel production (1,100 kg per ton)	99	128
Plant recirculating scrap:		
a) from ingots (18%) a/	13	32
b) from billets (12.6%) a/	16	21
Sub-total (a)+(b)	29	53
Purchased scrap	70	75

a/ The yield and recirculating scrap factors are based on the Indicative Plan

It is observed that according to the PDR expansion report, the domestic scrap availability would be about 70,000 tons per year in 1980 and 75,000 tons in 1985. In the 1974 annual report of PDR, it is indicated that the current domestic scrap generation is about 60,000 to 70,000 tons per year.

4 - Future Scrap Availability (cont'd)

ANALYSIS OF AVAILABILITY

The estimates of future domestic scrap availability contained in the past studies appear to be low, and the scrap users currently (1975) estimate the domestic scrap availability at about 100,000 tons per year. A fresh analysis is, therefore, needed to assess the scrap availability.

Methodology adopted for assessing scrap availability

The market scrap comprises the 'process scrap' and 'capital scrap'. The recirculating scrap is normally used up at steel plants and foundries. In assessing the future scrap availability, therefore, projections are being made only for the process and capital scrap.

The scrap trade in Colombia is not organised, and historical data with regard to past availability, generation and sales are not readily available. Therefore, a field survey (through questionnaires) was made to collect information with regard to the scrap purchased and consumed by different industries for the last 5 years (1970 to 1974). On the basis of the information collected through the field survey, estimates have been prepared of domestic scrap availability. Separate estimates of scrap generation have been prepared to identify the possible availability of process scrap and capital scrap based on past steel consumption. The validity of the methodology in the Colombian context has been verified by comparing the estimated scrap generation during 1970 to 1974 with the actual consumption.

4 - Future Scrap Availability (cont'd)

Purchased scrap for ingot steel production

The purchased scrap consumption for ingot steel production during 1970 to 1974 has been estimated on the basis of the answers to the questionnaire, and other information obtained during the field survey. The semi-integrated plants have indicated their purchases of steel scrap, domestic and imported, as given in Appendix 4-1 and summarised in Table 4-1. It is to be noted that this excludes the scrap purchased by FUTEC, which has been considered with steel foundries.

Table 4-1

PURCHASES OF STEEL SCRAP BY SEMI-INTEGRATED PLANTS - 1970 to 1974[a/]
(tons)

Year	Local supply	Imported	Total
1970	76 441	5 000	81 441
1971	73 810	-	73 810
1972	86 453	-	86 453
1973	63 092	10 327	73 419
1974	84 591	4 293	88 884
Total	384 387	19 620	404 007

a/ Excludes FUTEC which is covered under steel foundry.

Purchased scrap for steel foundries

The steel foundries utilising purchased scrap have indicated their annual productions for the last four years, 1971 to 1974. The foundries have, however, not indicated the annual quantities of scrap purchased or consumed, but some have indicated the norm of purchased scrap requirement. The information furnished by the steel foundries is given in Appendix 4-2. On the basis of this data, the

4 - Future Scrap Availability (cont'd

consumption of purchased scrap by the steel foundries has been estimated in Table 4-2. The average proportion of castings to apparent steel consumption works out to 1.8 per cent which has been assumed for 1970.

Table 4-2

PURCHASED SCRAP CONSUMPTION BY STEEL FOUNDRIES BETWEEN 1971 AND 1974[a/]
(tons)

Year	Production of steel castings	Scrap consumption[b/]
1970	9 625[c/]	10 587
1971	6 845	7 530
1972	9 782	10 760
1973	13 068	14 375
1974	8 863	9 749
Total		53 001

a/ Excludes PDR which does not purchase scrap
b/ 1.1 tons/ton casting
c/ On the basis of 1.8% of apparent steel consumption.

Purchased scrap for iron foundries

Adequate data with regard to the production of iron castings as well as consumption of steel scrap by iron foundries are not available. Therefore, an indirect approach has been adopted to estimate the production of iron castings and the consumption of steel scrap by the iron foundries.

Generally iron castings constitute 5 to 6 per cent of the apparent steel consumption. Assuming 6 per cent, the production of iron castings for 1973 and 1974 could be estimated as follows:

4 - Future Scrap Availability (cont'd)

Year	Apparent steel consumption tons	Estimated production of iron castings tons
1973	442 000	26 500
1974	572 000	34 300
Total		60 800

The pig iron requirement of the iron foundries was mainly met by COLAR. The import of pig iron in 1973 was only 75 tons and there were no imports in 1974. In 1973 COLAR produced 19,954 tons of pig iron and the estimated local sales were about 14,300 tons, the balance was exported. In 1974, about 50 per cent of the total production of 26,317 tons was sold in the domestic market by COLAR. Thus the total local sales of COLAR plus imported pig iron would amount to about 27,500 tons which is about 45 per cent of the iron castings production (about 61,000 tons) during 1973 and 1974. This is in fair agreement with the observation that the iron foundries use about 40 to 50 per cent pig iron.

From the answers to the questionnaire (Appendix 4-3), it is observed that on an average 500 kg of steel scrap is used per ton of castings. Assuming this norm of steel scrap requirement and the estimated production of iron castings, the scrap consumption of the iron foundries is shown in Table 4-3.

4 - Future Scrap Availability (cont'd)

Table 4-3

PURCHASED STEEL SCRAP REQUIREMENT OF IRON FOUNDRIES

Year	Apparent steel consumption '000 tons	Estimated production of iron castings[a/] tons	Purchased steel scrap requirements[b/] tons
1970	535	32 100	16 050
1971	557	33 400	16 700
1972	516	31 000	15 500
1973	442	26 500	13 250
1974	572	34 300	17 150
Total		157 300	78 650

a/ 6% of apparent steel consumption
b/ 500 kg/ton casting

Purchased scrap for ferro-silicon production

The steel scrap consumption for the production of ferro-silicon was 378 tons in 1974. Data for the previous years is not available. Assuming an average consumption of about 360 tons for the previous years, the total consumption from 1970 to 1974 would be about 1,800 tons.

Total purchased scrap

The total steel scrap purchased by the semi-integrated plants, foundries and ferro-silicon plant during the period 1970 to 1974 is summarised in Table 4-4.

4 - Future Scrap Availability (cont'd)

Table 4-4

STEEL SCRAP PURCHASED DURING 1970 to 1974
(thousand tons)

Semi-integrated plants	..	404.0
Steel foundries	..	53.0
Iron foundries	..	78.7
Ferro-silicon production	..	1.8
Total	..	537.5

Scrap imports

A part of the scrap requirement was met through imports. The imports of scrap as given in the annual trade figures compiled by DANE is given in Table 4-5.

Table 4-5

IMPORT OF SCRAP
(thousand tons)

1970	..	13.4	
1971	..	1.6	
1972	..	2.1	
1973	..	12.6	
1974	..	18.0 a/	
Total	..	47.7	Say 48,000

a/ For 1974 the total value of scrap imported in US $ 2.7 million and this has been converted to tonnage figure adopting an average C and F price of US $ 150 per ton.

Availability of domestic scrap

The availability of domestic scrap is arrived at by deducting the scrap imports from the total purchase as given in Table 4-6.

4 - Future Scrap Availability (cont'd)

Table 4-6

DOMESTIC SCRAP AVAILABILITY
(thousand tons)

	Total purchase a/					Imports b/	Domestic availability
	SIP	S.F.	I.F.	FeSi	Total		
1970	81.4	10.6	16.1	0.36	108.5	13.4	95.1
1971	73.8	7.5	16.7	0.36	98.4	1.6	96.8
1972	86.5	10.8	15.5	0.36	113.2	2.1	111.1
1973	73.4	14.4	13.2	0.36	101.4	12.6	88.8
1974	88.9	9.7	17.2	0.38	116.2	18.0	98.2
Total	404.0	53.0	78.7	1.82	537.7	47.7	490.0

a/ Refer Tables 4-1 to 4-3
b/ Refer Table 4-4

On the basis of the consumption pattern analysed above, the domestic availability of scrap during the five-year period, 1970 to 1974 is estimated at about 490,000 tons.

Alternative estimate of domestic scrap availability

In order to cross check the validity of the above estimate, the domestic scrap availability has also been derived by estimating the process scrap and capital scrap generation during the same period.

Process scrap generation

The process scrap has been estimated on the basis of 7 per cent scrap generation on the consumption of non-flat products and 17 per cent scrap generation on the consumption of flat products and are shown in Table 4-7.

4 - Future Scrap Availability (cont'd)

Table 4-7

AVAILABILITY OF PROCESS SCRAP - 1970 TO 1974
(thousand tons)

Year	Non-flats	Flats	Total
1970 ..	20	34	54
1971 ..	22	36	58
1972 ..	19	39	58
1973 ..	16	35	51
1974 ..	18	47	65
Total	95	191	286

Capital scrap generation

For estimating the capital scrap generation, it is assumed that the steel consumed at any point of time would be available as scrap over the next 40 years. However, the recoverable scrap would amount to only about 70 per cent of the steel consumed. The rate at which the scrap would be generated is assumed as follows:

Base five year period[a]	..	2%
1st five year period	..	8%
2nd five year period	..	10%
3rd five year period	..	10%
4th five year period	..	20%
5th five year period	..	25%
6th five year period	..	15%
7th five year period	..	5%
8th five year period	..	5%

a/ Period during which the consumption has occurred.

On this basis, the generation of capital scrap during the 5-year period 1970 to 1974 is given in Table 4-8.

4 - Future Scrap Availability (cont'd)

Table 4-8

AVAILABILITY OF CAPITAL SCRAP - 1970 TO 1974

	Total apparent steel consumption '000 tons	Recoverable scrap at 70 per cent '000 tons	1970-74 Rate of scrap generation %	1970-74 Scrap generated '000 tons
1930-34	126 a/	88	5	4.40
1935-39	181 a/	127	5	6.35
1940-44	224 a/	157	15	23.55
1945-49	328 a/	230	25	57.50
1950-54	729	510	20	102.00
1955-59	1 050	735	10	73.50
1960-64	1 577	1 104	10	110.40
1965-69	2 012	1 407	8	112.60
1970-74	2 622	1 835	2	36.70
Total				527.00

Scrap available for melting, 40% = 211

a/ Based on graphic extrapolation.

All the scrap generated will not be available for melting, because part of the scrap will require processing to make it suitable for remelting; some machinery scrap may be reconditioned and used; some scrap may be at locations where it is difficult to reach; some scrap may be in small quantities at remote places which would be uneconomical to collect etc. Therefore, it is assumed that only about 40 per cent of the capital scrap generated during the period 1970-74 was available for remelting. Thus the scrap available for remelting will be about 211,000 tons.

4 - **Future Scrap Availability (cont'd)**

Total availability of process and capital scrap

Thus the total scrap availability during 1970 to 1974 would be:

Process scrap	..	286 000	tons
Capital scrap	..	211 000	tons
		497 000	tons

This is in fair agreement with the domestic scrap availability of about 490,000 tons estimated earlier on the basis of the consumption pattern.

Annual availability of process and capital scrap

The annual availability of scrap for the years 1970 to 1974 is computed in Table 4-9.

Table 4-9

ANNUAL AVAILABILITY OF SCRAP - 1970 TO 1974
(thousand tons)

		Process scrap	Capital scrap	Total
1970	..	54	35	89
1971	..	58	38	96
1972	..	58	42	100
1973	..	51	46	97
1974	..	65	50	115
Total		286	211	497

ESTIMATION OF FUTURE SCRAP AVAILABILITY (1976 TO 1985)

Methodology

The foregoing analysis shows that the domestic scrap availability estimated on the basis of process scrap and capital scrap generation agrees closely with the estimate made on the basis of the actual consumption

4 - Future Scrap Availability (cont'd)

pattern in the period 1970 to 1974. Having established the validity of this method, the projection for domestic scrap availability in future is also made on the estimated process scrap and capital scrap generation.

Process scrap projection

The estimated availability of process scrap is given in Table 4-10.

Table 4-10

PROJECTED AVAILABILITY OF PROCESS SCRAP
(thousand tons)

	Estimated consumption		Scrap available from		
	Non-flats	Flats	Non-flats	Flats	Total
1976 ..	342	331	24	56	80
1977 ..	405	364	28	62	90
1978 ..	479	401	34	68	102
1979 ..	567	442	40	75	115
1980 ..	669	485	47	82	129
		Sub-total 1976 to 1980			516
1981 ..	745	558	52	95	147
1982 ..	830	642	58	109	167
1983 ..	925	738	65	125	190
1984 ..	1 030	849	72	144	216
1985 ..	1 148	960	80	163	243
		Sub-total 1981 to 1985			963

Capital scrap projection

The availability of capital scrap is assumed to improve from the 40 per cent level in 1970-74 to 50 per cent in 1976-80 and 60 per cent in 1981-85. The projected availability of capital scrap is given in Table 4-11.

4 - Future Scrap Availability (cont'd)

Table 4-11

PROJECTED AVAILABILITY OF CAPITAL SCRAP

	Apparent steel consumption[a] '000 tons	70% recoverable '000 tons	1976 to 1980 Rate of scrap generation %	1976 to 1980 Scrap generation tons	1980 to 1985 Rate of scrap generation %	1980 to 1985 Scrap generation tons
1936-40	191[b]	134	5	7	-	-
1941-45	235[b]	164	5	8	5	8
1946-50	370[b]	259	5	39	5	13
1951-55	857	600	15	150	15	90
1956-60	1 120	784	20	157	25	196
1961-65	1 625	1 138	10	114	20	228
1966-70	2 206	1 544	10	154	10	154
1971-75	2 707	1 895	8	152	10	190
1976-80	4 864	3 405	2	68	8	272
1981-85	9 272	6 490	-	-	2	130
				849		1 281
			50[c]	424	60[c]	769

a/ Including rails and railway materials and pipes and tubes
b/ Based on graphic extrapolation
c/ Availability factor.

Future availability of domestic scrap

The total availability of domestic scrap is derived by adding the estimated availability of process and capital scrap.

	Process scrap '000 tons	Capital scrap '000 tons	Total '000 tons
1976 to 1980	516	424	940
1981 to 1985	963	769	1 732

Future annual availability

The annual availability of scrap is projected in Table 4-12 and shown in Fig 4-1.

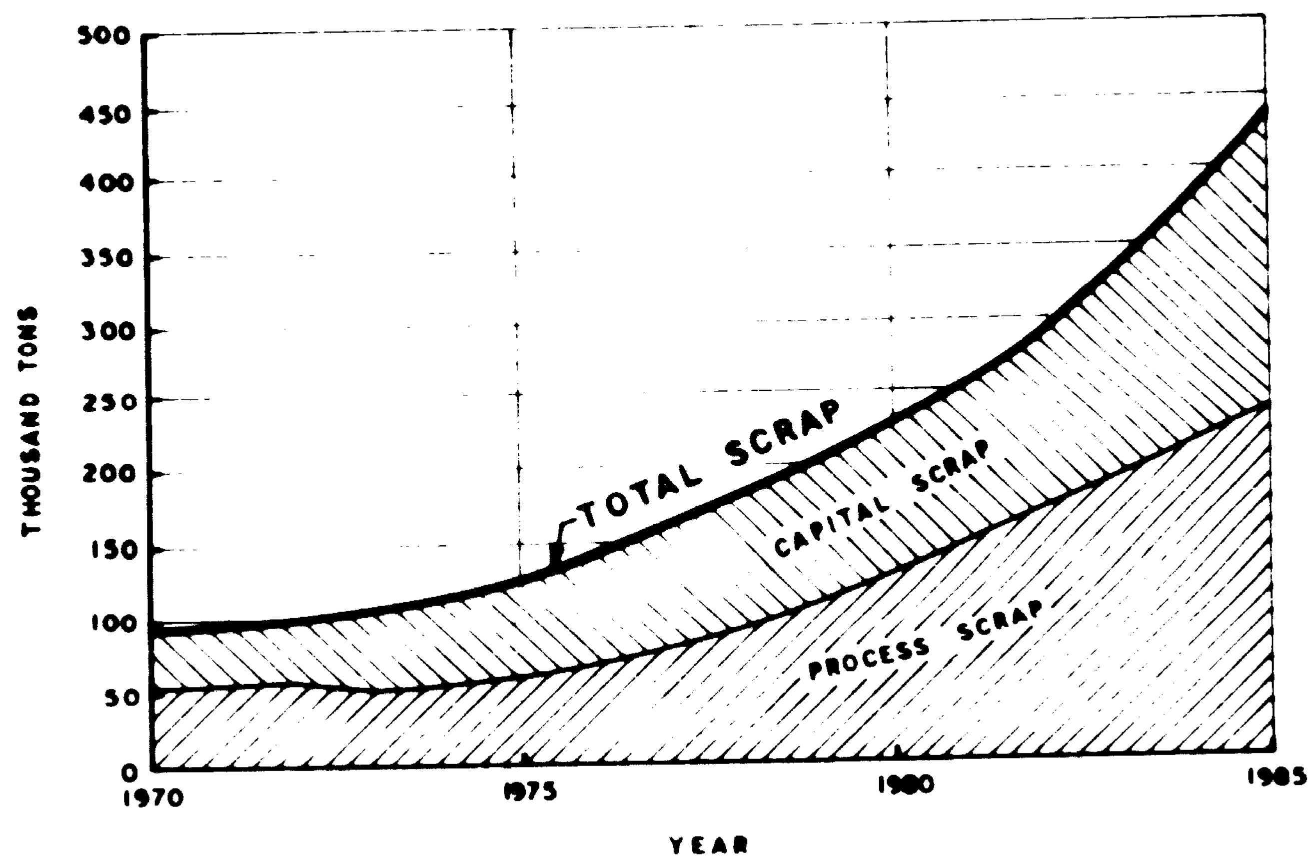

FIGURE 4-1. DOMESTIC SCRAP AVAILABILITY

4 - Future Scrap Availability (cont'd)

Table 4-12

PROJECTED ANNUAL SCRAP AVAILABILITY
(thousand tons)

	Process scrap	Capital scrap	Total
1976 ..	80	64	144
1977 ..	90	73	163
1978 ..	102	83	185
1979 ..	115	95	210
1980 ..	129	109	238
Sub-total	516	424	940
1981 ..	147	111	258
1982 ..	167	131	298
1983 ..	190	151	341
1984 ..	216	175	391
1985 ..	243	201	444
Sub-total	963	769	1 732

If the availability of capital scrap were to remain at 40 per cent as at present, the total aggregate capital scrap during the period 1976 to 1980 and 1981 to 1985 would be about 340,000 tons and 512,000 tons respectively. Thus the total scrap availability will be reduced by only 10 per cent in 1980 and only 15 per cent in 1985 with respect to the estimates given in Table 4-12.

4 - Future Scrap Availability (cont'd)

Steel consumption versus scrap availability

The relationship between steel consumption and the estimated scrap availability is shown below:

Period	Steel[a/] consumption '000 tons (1)	Scrap available '000 tons (2)	(2) ÷ (1) %
1970 to 1974	2 622	490 (actual)	18.7
		497 (estimated)	19.0
1976 to 1980	4 864	940	19.3
1981 to 1985	9 272	1 732	18.6

a/ Ref. Table 4-8 for 1970 to 1974 and Table 4-11 for others

The scrap availability works out to 18 to 19 per cent of finished steel consumption.

Availability of scrap for semi-integrated plants

From the national domestic purchased scrap balance of 1970 to 1974 (Table 4-6), it would be noted that about 80 per cent of the domestic scrap is used for ingot steel production. It is assumed that this ratio will continue for the next few years, say till end 1978.

From 1979, by which time sponge iron production may commence, the entire scrap requirement of foundry and other uses could be met from local sources.

The scrap available for ingot steel production in semi-integrated plants is computed in Table 4-13.

4 - Future Scrap Availability (cont'd)

Table 4-13

FUTURE AVAILABILITY OF SCRAP FOR SEMI-INTEGRATED PLANTS
(thousand tons)

Year	Total availability of domestic scrap	Consumption by foundry and other uses[a/]	Available for ingot steel
1976 ..	144	29	115
1977 ..	163	33	130
1978 ..	185	37	148
1979 ..	210	57	153
1980 ..	238	65	173
1981 ..	258	72	186
1982 ..	298	80	218
1983 ..	341	89	252
1984 ..	391	97	294
1985 ..	444	111	333

a/ 1976 to 1978, 20 per cent of domestic scrap will be used for foundry and other uses and 80 per cent for ingot steel. From 1979 onwards the total requirement of foundry and other uses will be met from domestic source.

From the above table, it will be noted that the domestic scrap availability for semi-integrated plants will be about 173,000 tons in 1980 and 333,000 tons in 1985.

The semi-integrated steel plants had jointly formed SIPSA in May 1974 for augmenting the domestic scrap supply. SIPSA has already taken necessary measures to improve the collection of scrap. Further, it has set up ship cutting facilities at Cartagena. Seven ships were purchased by mid-1975. It is expected that scrap from the first ship would be made available to the members by the end of 1975.

A P P E N D I C E S

Appendix 1-1

SCOPE OF WORK OF CONSULTING ENGINEERS

Relevant extracts from the UNIDO Contract No. 75/1 dated 3rd February 1975 between the United Nations Industrial Development Organisation and Dastur Engineering International GmbH are reproduced below:

1.00 AIM OF THE PROJECT

The aim of the Project is as follows:

A. Long-term Objectives

Establishment of an iron and steel industry with competitive production costs in order to satisfy the requirements of the markets and possibly to export finished and semi-finished products.

B. Immediate Objectives

The immediate objectives of this Project are:

a) Analysis of the demand for finished and semi-finished products, flat and non-flat for 1980 and 1985 in the internal markets and extended market of the Andean Group.

b) Evaluation of the existing studies on the availability of mineral resources for the development of the steel industry.

c) Determination of requirements and availability of energy necessary to the steel industry.

d) Analysis of the present situation of the existing iron and steel industry concerning its level of efficiency, technology etc. and presentation of alternatives for the improved utilisation of installed capacity.

e) Projection of scrap availability and generation for 1980 and for 1985.

f) Recommendations on the most adequate technologies for the national economy as well as for the sub-region, in the iron and steel industry sector.

Appendix 1-1 (continued)

g) Recommendations on the inter-relationships of production among the semi-integrated steel plants, taking into consideration the expanded capacity of the SIDERRIO plant.

h) Analysis of the expasnion of the SIDERRIO plant and of the production costs for finished and semi-finished products.

i) Recommendations regarding the techno-economic feasibility for the production of pre-reduced products utilising the maximum possible extent of natural resources.

j) Analysis and recommendations on the feasibility of installation of a new plant, taking into consideration the capacity of SIDERRIO and the full utilisation of capacity of semi-integrated plants.

2.00 RESPONSIBILITIES OF THE CONTRACTOR

Statement of Work

Having in mind the aim of the Project as detailed under paragraph 1.01 hereinbefore, the Contractor shall, under the terms hereinafter set forth, carry out all the work as follows:

A. Study and Analysis of Conditions, Problems and Possibilities

1. Prepare a study of demand broken down by semi-finished and finishsd flat-rolled and other steel products, fcr 1980 and for 1985, in the domestic market and the enlarged Andean Group market, based on existing studies (Latin American Iron and Steel Institute, Board of Cartagena Agreement, Economic Commission for Latin America, etc.), on the Government guidelines and on additional information collected during the study. This study should idnetify the iron and steel products (semi-finished, finished, ferro-alloys, special steels) which can be produced efficiently in Colombia to supply the Andean market.

Appendix 1-1 (continued)

2. On the basis of studies available in the Country (Minminas, Ingeominas, Siderrio, Colar, Ecopetrol, Econiquel, Conicol, etc), analyse the availability of natural resources (iron ore, limestone, coal, natural gas) required for the development of the iron and steel industry. Also, taking into consideration the electricity generation and interconnection programmes (Colombian Electric Power Institute, National Planning Department - UINF), determine the availability of electric power, and, in the light of the findings establish priorities among various development alternatives for the iron and steel industry.

3. Study the domestic availability of scrap and its sources, with projections for 1980 and 1985.

4. Study the current situation in all the existing semi-integrated iron and steel plants with respect to their level of efficiency, technology used, domestic availability of inputs etc and analyse alternatives oriented towards optimum utilisation of installed capacity.

5. Identify the iron and steel industry technologies currently available in the world market in order to ascertain the most favourable and suitable alternatives in view of the economic situation of the country and sub-region (article 22, Decree 1900, 15 September 1973).

6. The technological alternatives most attractive for Colombia should be presented and evaluated in detail, taking into consideration national production targets (or targets suggested in this study) as well as the availability of raw materials and other factors of production. In this part of the study clear proposals should be made regarding the optimum modern technologies to be applied: blast furnace, oxygen converter, blooming slabbing, continuous casting etc and sponge iron, electric furnace etc.

Appendix 1-1 (continued)

B. Recommendations for Expansion of the Iron and Steel Industry

1. Analyse the different alternatives (corresponding to different technological options, sizes or locations) and recommend the optimum pattern for development of the Colombian iron and steel industry, through expansion of existing facilities and the establishment of new steel plants, as well as the time table for the commissioning of the new production units, up to 1985. If necessary, different alternatives should be proposed and analysed. In particular, recommendations should cover the items below.

2. Taking into account the expanded capacity of the SIDERRIO plant, and analysing techno-economic aspects of this expansion in Belencito, recommend interrelation between the production of this iron and steel plant and the production of the semi-integrated iron and steel plants in order to achieve full utilisation of installed capacity and better specialisation and complementation of domestic production before contemplating the installation of new plants.

3. In view of the expansion of the SIDERRIO plant in Belencito, determine whether the prices of both its semi-finished and finished products will be competitive in the domestic market and the enlarged market of the Andean Group.

4. Taking into consideration the expanded capacity of the SIDERRIO steel plant at Belencito and the full utilisation of installed capacity at the semi-integrated steel plants and on the basis of detailed techno-economic analyses, elaborate recommendations on the establishment of new iron and steel capacities, using direct reduction and/or conventional processes, needed to supply the expanding steel market of Colombia and possibly the markets of the Andean Group of countries. These new capacities should guarantee an adequate supply of raw materials and semi-finished products needed by the existing facilities, including electric furnaces, as well as of steel products competitive in price in the Andean Sub-region and in comparison with the production of third countries with comparison based on a common external tariff of around 20 per cent.

Appendix 1-1 (continued)

C. **Recommendation for the Establishment of New Facilities**

1. The study on the advisability of setting up new iron and steel facilities (direct reduction plant and/or integrated iron and steel works) should include, but not be limited to, detailed analysis and recommendations on the following:

   a) sources of raw materials (iron ore, fuels, fluxes, refractories, etc);

   b) sources of utilities (water, electrical energy etc);

   c) location of plants, including analysis of transport costs for raw materials and finished products; based on relevant considerations not only alternative locations should be analysed but also optimal sites should be justified and recommended. Ecological aspects should also be included in the elaborations related to the plant location;

   d) production capacities;

   e) type of pre-reduced iron most suitable in view of the characteristics of the electric furnaces installed in the country (when considering the advisability of establishing a direct reduction plant);

   f) investment and operational costs, including a comprehensive information and data on profitability aspects;

   g) capital financing plan on the basis of available alternatives for obtaining the investment required from both domestic and international sources.

Appendix 1-1 (continued)

D. Recommendation on the Establishment of New Plants

1. If the establishment of new iron and steel plants (direct reduction and/or conventional) operating on the basis of some imported raw materials (iron ore, pre-reduced iron, scrap etc.) is advisable; requirements in respect of coking coal or coke from the Andean Group or the Latin American Free Trade Area countries which would supply the inputs should be analysed with a view to establishing an exchange, with preliminary studies on transport and on the technical and economic interest for Colombia.

2. As an alternative, determine the advisability for Colombia of obtaining supplies of steel ingots from the existing integrated iron and steel plants in the countries of the sub-region which might carry out production at a high level of efficiency.

E. Other Recommendations

Present, among others, specific recommendations on the number and type of follow-up studies, surveys, exploratory work and laboratory and pilot plant tests of raw materials, which may have to be carried out to reach final decisions regarding optimal conditions and technologies for the recommended new metallurgical installations. Information should be included on samples needed, characteristics to be tested and potential laboratories and pilot plant stations which may carry out such testing.

Appendix 1-2

LIST OF SPECIALISTS DEPUTED FOR FIELD WORK AND DURATION OF STAY IN COLOMBIA

Name	Date of arrival	Date of departure
Mr T.V.S. Ratnam Team Leader	7.2.75 23.4.75	26.3.75 18.5.75
Mr S. Das Gupta	7.2.75	18.5.75
Mr S.P. Neogi	7.2.75 20.4.75	28.2.75 27.4.75
Mr A.B. Roy	7.2.75	15.3.75
Mr C.P. Ramachandran	7.2.75	20.5.75
Mr T.K. Roy	26.2.75	18.5.75
Mr D.S. Basu	7.3.75	26.3.75
Mr S. Sarkar	14.3.75	29.3.75
Mr R.N. Datta	14.3.75	6.4.75
Mr S.R. Kulkarni	21.3.75	24.4.75
Mr S.S. Retnam	21.3.75	24.4.75
Mr A.B. Rabadi	11.4.75	25.4.75
Strategists		
Mr Marc Allard	8.2.75	17.2.75
Mr Fernando Aguirre Tupper	8.2.75 20.4.75	10.3.75 27.4.75
Local Consultant		
Dr Joaquin Prieto	7.2.75	20.5.75

Appendix 1-3

LIST OF PLANTS/AGENCIES VISITED

The plants/agencies visited have been listed countrywise. The plants/agencies visited in Colombia have been grouped under nine heads as follows:

a) Government departments/agencies
b) Iron and Steel plants
c) Mines and agencies connected with raw materials
d) Manufacturers
e) Transport agencies
f) Electric power agencies
g) Associations
h) Financing agencies and
i) Others

COLOMBIA

GOVERNMENT DEPARTMENTS/AGENCIES

1. Ministerio de Desarrollo Economico
2. Departamento Nacional de Planeacion (DNP), Seccion de Integracion Economica
3. DNP, Division de Programacion Global
4. Instituto de Fomento Industrial (IFI)
5. Instituto de Comercio Exterior (INCOMEX)
6. Departamento Nacional de Estadistica (DANE)
7. Ministerio de Obras Publicas (MINOBRAS)
8. Instituto Nacional de Mon Fomento Municipal (INSFOPAL)
9. Empresa Colombiana de Petroleos (ECOPETROL)

IRON AND STEEL PLANTS

10. Acerias Paz del Rio S.A. (SIDERRIO)
11. Fundiciones Tecnicas (FUTEC)
12. Metalurgica Boyaca (METAL BOYACA)
13. Siderurgica de Medellin (SIMESA)
14. Siderurgica del Muna S.A. (SIMUNA)
15. Siderurgica del Norte (SIDUNOR)
16. Siderurgica del Pacifico (SIDELPA)
17. Acerias de Bogota
18. Colombiana de Arrabio Ltda (COLAR)
19. Siderurgica Valle de Tenza
20. Minera Metalurgica S.A. (METALICO)

Appendix 1-3 (continued)

MINES AND AGENCIES CONNECTED WITH RAW MATERIALS

21. Ministry of Mines
22. Instituto Nacional de Investigaciones Geologicas Mineras (INGEOMINAS)
23. Departamento Nacional Planeacion (Division of Natural Resources)
24. GEOCOLOMBIA
25. Instituto de Fomento Industrial
26. ECONIQUEL
27. INDERENA - Instituto de los Recursos Naturales Renovables
28. DNP - Departamento Nacional de Planeacion, Natural Resources
29. El Cerrejon Carboneras Ltda
30. Minas Paz del Rio
31. Minas Belencito
32. Minas Samaca
33. Mina Pericos
34. Mina de Hierro de Ubala
35. Mina Zerba Buena
36. Manta-Macheta Mines
37. New Carrarae Coal Co

MANUFACTURERS

38. Fundicion de Repuestos S.A. (FURESA)
39. Industrias Metalurgicas Apolo S.A. (APOLO)
40. Acero Estructural S.A. (ASESCO)
41. Distral S.A. (DISTRAL)
42. Corporacion de Acero (CORPACERO)
43. Gutemberto
44. Colombiana de Carrocerias Ltda
45. Industrias Centrales del Acero S.A. (INDUACERO)
46. Reamericas S.C.A. (REAMERICA)
47. A. Johnson & Co D.E. Colombia, S.A.
48. Fundiciones Torino S.A.
49. ICASA
50. Consorcio Metalurgica Nacional S.A. (COLMENA)
51. Siemens S.A.
52. Chrysler Colmotores
53. Superbus de Bogota Ltda (SUPERIOR)
54. Sociedad de Fabricacion de Automotores S.A. (SOFASA)
55. H.B. Estructuras Metalicas
56. Crown Litometal S.A.
57. Compania de Productos de Acero S.A. (CODACERO)
58. Otis Elevator Company
59. Industria Nacional de Repuestos "INCABE"
60. Gillete de Colombia S.A.
61. CEAT General
62. TISSOT
63. Carrocerias Superior
64. Industrias Metalicas de Palmira - IMP

Appendix 1-3 (continued)

MANUFACTURERS (cont'd)

65. Collins Colombiana, S.A.
66. Talleres Gaitan
67. Monark
68. Fundacion para el Desarrollo Industrial
69. Coldesarrollo
70. Laminados y Derivados
71. PROMINSA
72. Forjas de Colombia, S.A.
73. West Arco
74. TAMSA - Tamillerias y Aplicaciones Mecanicas, S.A.
75. Worthington Colombiana, S.A.
76. Transejas
77. Trefilco
78. Empresa Metalurgica
79. Envac
80. Impuche
81. Alombre Industrial S.A.
82. Remaches Industriales
83. Gerosa
84. Zubiola
85. Emcocables
86. Compania Colombiana Automotriz, S.A.
87. DORCO
88. Suelos, Fundaciones
89. AGA FANO, S.A.
90. Degremont H. Lopez Ltda
91. General Electric

TRANSPORT AGENCIES

92. Instituto Nacional del Transporte (INTRA)
93. Departamento Nacional Planeacion - Transport
94. Departamento Nacionale Planeacion - Division Desarrollo Fronterizo
95. Ferrocarriles Nacionales de Colombia
96. Puertos de Colombia (COLPUERTOS)
97. Compania Nacional de Navegacion S.A.
98. Flota Mercante Gran Colombiana
99. Terminal Maritimo de Barranquilla
100. Port Authority, Santa Marta
101. Coal Loading Port Facilities near Cartegena
102. Departamento Nacional Planeacion, Junta Nacional de Tarifas de Services Publicos Unida Infrastructura
103. CUTMA
104. Corporacion Financiera del Transporte

Appendix 1-3 (continued)

ELECTRIC POWER AGENCIES

105. Instituto Colombiano de Energia Electrica (ICEL)
106. Interconexion Electrica S.A. (ISA)
107. Empresa Energia Electrica de Bogota (EEEB)
108. Instituto Colombiano de Normas Technicas (ICONTEC)
109. Ministry of Economic Development (Division de Control de Normas y Calidades)
110. FADALTEC S.A.
111. Departamento Nacional Planeacion, Junta Nacional de Tarifas de Servicos Publicos Unida Infraestructura
112. Electrificadora del Atlantico S.A.

ASSOCIATIONS

113. Federation Metalurgica Colombiana, FEDEMETAL
114. ANDI - Associacion Nacional de Industriales
115. SIPSA
116. Associacion Colombiana de Ingenieros Constructores (ACIC)
117. Camara Colombiana de la Construccion (CAMACOL)
118. Instituto Colombiana de Construcciones Escolares (ICCE)
119. Corpoacion Financiera del Norte
120. Camara de Comercio

FINANCING AGENCIES/AUTHORITIES

121. IBRD - International Bank for Reconstruction and Development, Industrial Projects Division - Washington
122. Minister for Economic Development, Dr Jorge Ramirez Ocampo
123. Deputy Minister of Finance, Dr J. Bohorquez
124. IFI - Instituto de Fomento Industrial
125. Banco de la Republica
126. Subdirector General de Impuestos, Nacionales
127. Departamento Nacional de Planeacion
128. Corporacion Financiera Colombiana
129. Instituto de Credito Territorial
130. Corporacion Financiera del Valle, S.A.

OTHERS

131. Gobernador del Atlantico
132. Gobernador de Bolivar
133. Gobernador del Magdalena
134. Senator, Dr Raul Munoz Agudelo
135. Council President, Puerto Berrio
136. Council V.P., Puerto Berrio
137. Stuescac, Ingenieros Contratistas
138. Siderurgica del Atlantico
139. Alcalde

Appendix 1-3 (continued)

OTHERS (cont'd)

140. Zona Franca, Barranquilla
141. Town Planning Department, Barranquilla
142. Cementos del Caribe, S.A.
143. Parrish & Cio
144. Celonese Colombiana, S.A.
145. Rusco de Colombia
146. Quimica Internacional
147. CORELCA
148. Zona Franca de Cartagena
149. Fundacion para el Desarrollo Industrial de Cartagena
150. Instituto Georgrafico Agustion Codazzi
151. Servicio Colombiana de Meteorologia a Hidrologia
152. Fundacion para el Desarrollo Industrial, Cali
153. Construcciones Tissot & Cia
154. Zona Franca, Buenaventura
155. COPESCOL
156. Camara de Camercio, Buga-Tula
157. Grasas, S.A.
158. Alcalde
159. Aerocivil de Colombia, S.A.
160. Instituto Geografico des los Andes
161. ELOSPINA
162. Rapistan Gleason de Colombia, S.A.
163. Guellar Serranco Gomez & Cia
164. Servico Nacional de Aprendizaje (SENA)
165. Grandicon Ltda
166. Aguirre Monroy & Asociados
167. Construcciones y Disenos
168. SADE, S.A.

PERU

1. Junta Acuerdo de Cartagena, Lima
2. Chimbote Steel Plant of Empresa/Siderurgica del Peru (SIDERPERU)

CHILE

1. Instituto Latinoamericano del Fierro y el Acero (ILAFA), Santiago
2. Economic Commission for Latin America (CEPAL), Santiago
3. Huachipato Steel Plant at Concepcion of Cia de Acero del Pacifico S.A.

Appendix 1-3 (continued)

ECUADOR

1. Centro de Desarrollo Industrial del Ecuador (CENDES), Quito
2. Direccion de Industrias del Ejercito (DINE), Quito

VENEZUELA

1. UNDP, Resident Representative Auxiliar
2. CAF - Corporacion Andina de Fomento, Unidad de Promocion
3. CORDIPLAN
4. CVG - Siderurgica del Orinoco, "SIDOR", C.A.
5. Corporacion Venezolana de Guayana
6. Siderurgica Venezolana "SIVENSA", S.A.
7. Cerro Bolivar Iron Ore Mines
8. Puerto Ordaz Iron Ore Installations
9. Sociedad Financiera Finalven, S.A.
10. Fondo de Inversiones de Venezuela

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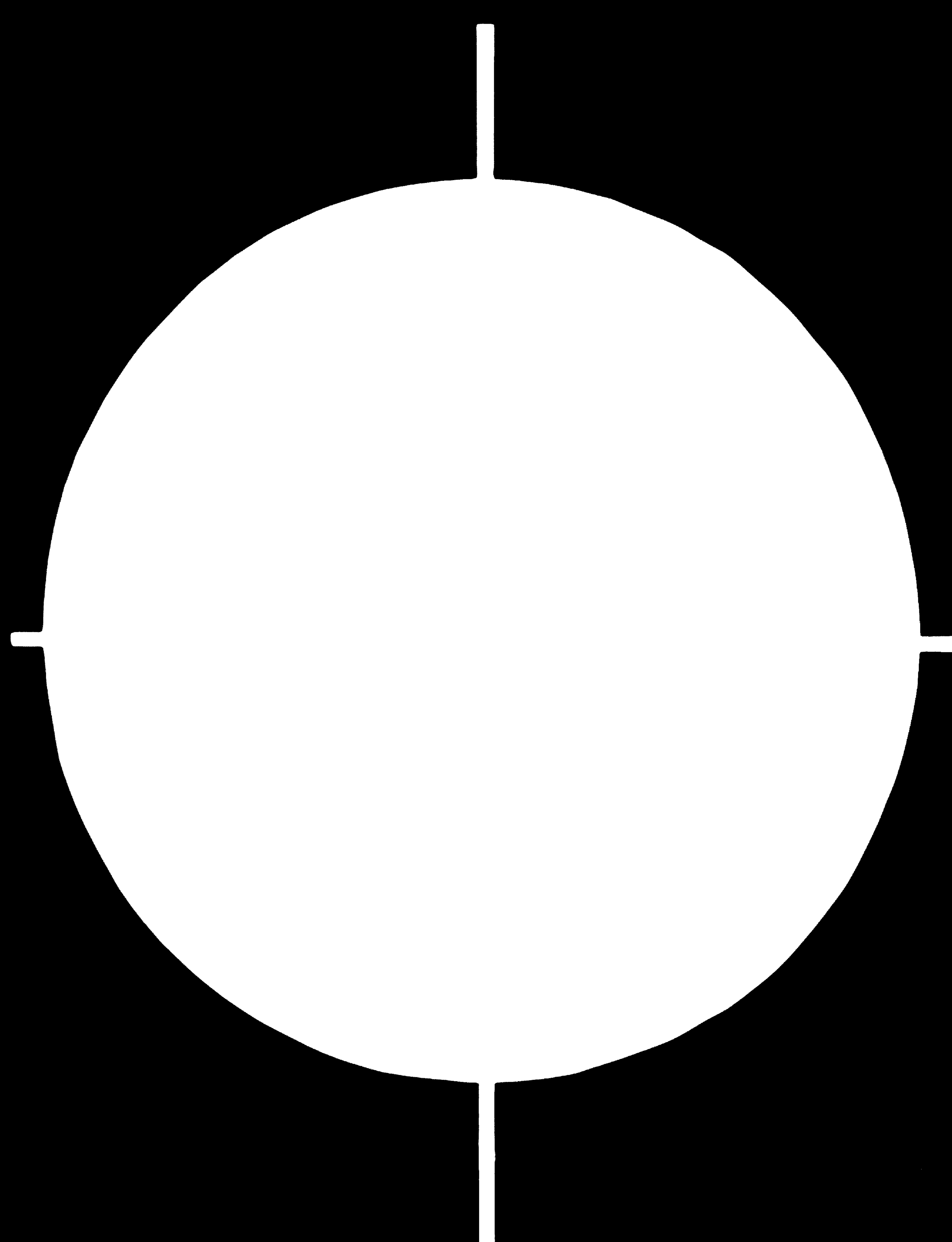

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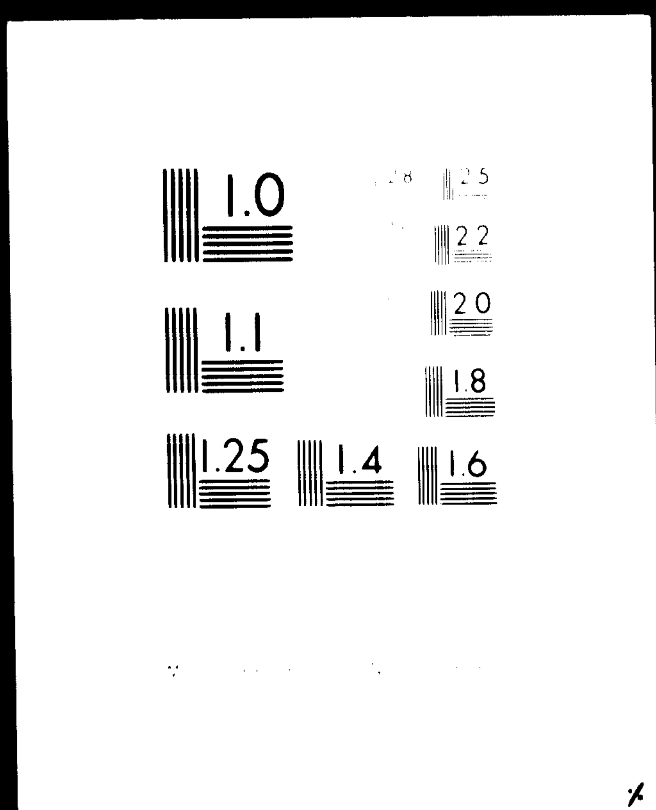

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Appendix 1-4

MEMBERS OF COLOMBIAN GROUP

Name		Organisation
Dr Saulo Arboleda Gomez, Coordinator	..	Ministry of Economic Development
Dr Marcos Suarez	..	DNP
Dr Mauricio Mick	..	IFI
Dr Luis E. Mateus	..	MINMINAS
Dr Elias Herrera M.	..	INCOMEX
Dr Carlos E Velez J.	..	FEDEMETAL
Dr Tomas Cipriano Montaya B.		ANDI
Dr Francisco Ospina	..	Corporacion Financiera del Transporte

Appendix 2-4

LATIN AMERICA: PER CAPITA CRUDE STEEL CONSUMPTION

		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974 a/
APPARENT CONSUMPTION OF CRUDE STEEL, thousand tons											
Andean Group											
Bolivia	..	81.2	55.0	61.1	68.0	79.5	90.0	92.6	92.5	86.1	86.0 b/
Colombia	..	444.1	678.2	496.7	498.0	680.1	763.9	801.3	693.0	677.9	765.0
Chile	..	618.3	741.5	565.7	607.4	803.3	709.3	715.[illegible]	798.2	660.5	787.0
Ecuador	..	77.2	86.3	113.2	117.5	133.1	193.6	278.[illegible]	304.2	381.6	382.0 b/
Peru	..	379.3	356.3	393.8	269.0	344.5	333.1	496.[illegible]	406.6	493.7	707.0
Venezuela	..	1 005.3	883.7	1 015.6	1 144.7	1 365.9	1 397.5	1 481.1	1 635.0	[illegible]	2 111.0
Sub-total	..	2 605.4	2 735.0	2 646.1	2 698.6	3 306.4	3 474.4	3 796.5	3 983.5	4 097.4	4 758.0
Others											
Argentina	..	2 723.2	2 134.5	2 331.7	2 569.6	3 432.1	3 438.4	3 618.2	4 042.0	3 974.4	4 879.0
Brasil	..	3 003.6	3 790.8	4 059.7	4 766.6	5 558.5	6 091.4	7 074.9	7 576.9	9 836.8	12 453.0 b/
Central America	..	389.5	249.1	318.7	402.1	443.7	496.7	453.1	483.4	534.2	798.0
Mexico	..	2 867.3	3 107.7	3 372.0	3 546.5	3 785.1	3 830.2	3 790.2	4 217.0	5 279.1	6 068.0 b/
Paraguay	..	19.0	25.3	34.0	32.1	24.5	19.6	86.3	25.8	39.8	-
Uruguay	..	92.7	114.7	79.1	85.0	102.1	98.4	116.3	93.4	108.5	- b/
Sub-total	..	9 035.1	9 422.1	10 195.2	11 481.9	13 346.0	13 874.7	15 079.0	16 278.5	19 164.0	[illegible]
Total	..	11 640.7	12 157.1	12 841.3	14 180.5	16 652.4	17 349.1	18 875.5	[illegible]	[illegible]	[illegible]
POPULATION, millions											
Andean Group											
Bolivia	..	4.1	4.2	4.3	4.4	4.5	4.7	4.8	4.9	5.0	5.1
Colombia	..	18.7	19.3	20.0	20.7	21.4	22.2	22.9	23.8	24.6	25.5
Chile	..	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.2	10.4
Ecuador	..	5.1	5.3	5.5	5.6	5.8	6.0	6.2	6.4	6.7	6.9
Peru	..	11.6	12.0	12.4	12.8	13.2	13.6	14.0	14.5	14.9	15.4
Venezuela	..	9.1	9.4	9.7	10.1	10.4	10.8	11.1	11.5	11.9	12.2
Sub-total	..	57.3	59.1	61.0	62.9	64.8	67.0	68.9	71.2	73.3	75.6
Others											
Argentina	..	22.5	22.9	23.3	23.6	24.0	24.4	24.7	25.1	25.5	25.9
Brasil	..	81.0	83.3	85.7	88.1	90.6	93.2	95.9	98.7	101.5	104.5
Central America	..	14.1	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.1	18.7
Mexico	..	42.7	44.2	45.7	47.3	49.0	50.7	52.5	54.3	56.2	58.2
Paraguay	..	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.8
Uruguay	..	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.0
Sub-total	..	165.0	169.9	174.7	179.6	184.8	190.1	195.5	201.2	207.0	213.1
Total	..	222.3	229.0	235.7	242.5	249.6	257.1	264.4	272.4	280.3	288.7
PER CAPITA CONSUMPTION, kg											
Andean Group											
Bolivia	..	20	13	14	15	18	19	19	19	17	17
Colombia	..	24	35	25	24	32	34	35	29	28	29
Chile	..	71	83	62	65	85	73	78	78	66	76
Ecuador	..	15	16	21	21	23	30	45	48	48	47
Peru	..	33	30	32	21	26	24	30	28	33	46
Venezuela	..	110	88	125	113	128	129	133	142	155	173
Group Average		45	46	43	43	51	52	55	55	56	63
Others											
Argentina	..	121	93	100	109	143	141	146	161	156	165
Brasil	..	37	46	47	54	61	65	74	77	91	119
Central America	..	23	17	21	26	28	28	27	24	30	...
Mexico	..	67	70	74	75	77	76	72	78	94	104
Paraguay	..	10	12	15	14	11	8	11	10	15	...
Uruguay	..	34	41	28	30	35	34	40	31	34	...
Group Average		55	55	58	63	72	73	77	81	92	111
Total - Latin America (Average)		52	53	54	58	67	67	71	73	82	92

a/ 1974 figures are provisional

b/ Only the total consumption for Bolivia, Ecuador, Central America, Paraguay and Uruguay is available; hence for Bolivia and Ecuador the 1973 consumption has been assumed for 1974 also and the rest is taken as the consumption for the other three countries combined.

Source: 1965-1971 consumption - ILAFA Annual Statistics.
1972 consumption - ILAFA Revista, April 1975; gives rolled products which is multiplied by an average factor of 1.35 to arrive at crude steel.
1973 and 1974 - consumption - III National Metallurgical Congress and II General Assembly of FEDEMETAL, Bogota, June 1975. Paper by Alfredo Astaburuaga Letelier; figures given in rolled products which are multiplied by 1.4 for planes and by 1.3 for no-planes to arrive at crude steel. No-plane includes seamless tubes.
Population from Statistical Year Book for Latin America, 1973, ECLA.

Appendix 3-1

BASIS OF FORECASTS OF END-USING ITEMS

Item	Basis of forecast
I. TRANSPORT EQUIPMENT SECTOR	
1. Wagons	Rio Magdalena report on transport (1972) indicates that the average quantity of freight handled by a car per year is 560 tons. Ferrocariles has indicated that the expected freight to be handled would be of the order of 5.5 millions by 1980 which will be doubled by 1985. On this basis, the freight car population required for 1980 and 1985 are estimated. The incremental requirement of wagons is taken as new wagons. For replacement, the past purchase of wagons as indicated by CFT (Corporacion Financiera del Transporte) is analysed and the replacement of wagons is estimated on the basis of 30 years' life.
2. Coaches	Analysis of the volume of traffic for the years 1968 to 1972 indicates that on an average about 14% of the total population was transported by rail. It is assumed that this percentage will come down to 12% and 10% by 1980 and 1985 respectively, because of the higher envisaged income and as a result of more use of cars. On this basis, about 3.46 and 3.35 million people will use coaches. In 1974, about 3 million people were transported by coaches. Therefore, there is hardly any need for increasing the number of coaches from the present level of 350. However, these coaches need to be replaced and for this 35 coaches are to be built every year up to 1985. Taking 70% availability, the total number of coaches to be manufactured per year is 50.

Appendix 3-1 (continued)

Item	Basis of forecast
3. Trucks	According to the recent DNP report on the Automobile Industry, the average production programme during the period 1970 to 1974 was 12,790 trucks. Assuming the growth rate of 7% as indicated in the Rio Magdalena report, the output by 1980 and 1985 would be 15,585 and 22,000 trucks respectively. Alternatively, correlating with the index of industrial production, the demand for trucks works out to 15,710 and 27,000 in 1980 and 1985 respectively. From these two estimates the average outputs are 16,000 and 25,000 trucks for 1980 1985 respectively, and these have been adopted.
4. Buses	The demand for buses is projected up to 1985 on the basis of the growth rate envisaged in the Rio Magdalena report. This comes to 10,000 and 14,000 buses respectively. The park of bus from 1965 to 1972 is analysed against the population. It is seen that the number of buses per million persons increased from 1,550 to 2,520 during 1965 to 1972. The growth rate of buses/million persons was 7.5% during this period. With the rising income, it is likely that this growth rate will come down. Assuming 7% and 6% for the period 1972 to 1980 and 1980 to 1985 respectively, the number of buses per million persons works out to 4,500 and 6,000 for 1980 and 1985 respectively. Based on the projected population, the bus park required by 1980 and 1985 is estimated at 125,000 and 200,000 respectively. The increment over 1972 up to 1980 = 67,983 i.e. 8,500/year and over 1980 up to 1985 = 75,000 i.e. 15,000/year. Therefore, the average derived from these two projections are 9,250 and 14,500 for the years 1980 and 1985.

Appendix 3-1 (continued)

Item	Basis of forecast
5. Jeeps and station wagons	Based on the Rio Magdalena report, the new addition of jeeps and station wagons envisaged for the years 1980 and 1985, are 9,000 and 13,000 respectively. Alternatively, the park of jeeps and station wagons is correlated with GDP which gives a demand of 11,000 and 15,000 numbers for 1980 and 1985 respectively. The averages of these two projections are taken as the possible targets.
6. Bicycles	Up to 1977, the demand for bicycles is obtained on the basis of Monark's production programme. For projections for 1980 and 1985, the correlation ratio between population and bicycle production is plotted and graphically extrapolated. On this basis, the demand for bicycles would be about 280,000 and 400,000 respectively for the years 1980 and 1985.
7. Cars	Chrysler Corporation's projection of car consumption is of the order of 41,000 cars by 1980. At present, the consumption is more than 40,000 cars based on DANE report. For arriving at the likely demand, the well established formula for Latin American countries as given in the Rio Magdlena report has been adopted. On this basis, the demand of cars by 1980 and 1985 would be 56,230 and 98,000 respectively. Alternatively, the growth rate as envisaged in the Rio Magdalena report for cars is 8% between 1972 and 1980. Assuming the same growth rate for the period 1973 to 1980, the demand is 70,000 and 100,000 by 1980 and 1985 respectively. For the estimation of steel requirement the output levels assumed are 60,000 and 100,000 cars for the years 1980 and 1985 respectively.

Appendix 3-1 (continued)

Item	Basis of forecast
8. Car engines	SOFASA and FIAT have plans to manufacture car engines by 1980. The envisaged capacity is 30,000 and 50,000 numbers by 1980 and 1985. According to the Cartagena report on Automobiles, the envisaged production is 20,000 and 30,000 engines by 1980 and 1985. For 1980, it is envisaged that at least 30,000 engines will be produced and by 1985 this will increase to 50,000.
9. Automobile ancillary	In the Cartagena report on Automobiles, it is indicated that the value of production of automobile ancillaries by 1980 will be US $ 154 million i.e. 4,620 million Pesos. This was based on an anticipated production of only 70% envisaged in this study. Therefore on this basis, the production of automobile ancillaries will be about US $ 230 million. Assuming the growth rate between 1980 and 1985 as 10%, same as indicated by DNP, for the automobile sector, the likely production by 1985 will be US $ 368 million.
10. Leaf spring	Projected on the basis of replacement percentage as indicated by IMCABE.
II. ELECTRICAL EQUIPMENT	
11. Transformer	In accordance with the power plant installation programme as indicated by ICEL, ISA etc, the requirement of transformer for single step, for second step, for power, for distribution and for industrial consumers is estimated. The total demand for transformers by 1980 and 1985 works out to be 1600 MVA and 2000 MVA for the incremental capacity in power generation. Assuming 60% and 100% of these would be made in Colombia by 1980 and 1985 respectively, the demand for transformers will be 960 MVA and 2000 MVA respectively.

Appendix 3-1 (continued)

Item	Basis of forecast
12. Switchgear and controlgear	Siemens produced in 1974 about 15 million Pesos worth of switchgear and controlgear. Siemens caters to about 50% of the market. Thus, the total consumption in the country was about 30 million Pesos worth for the type manufactured by Siemens. From the production data furnished by DANE for the years 1970 and 1972, it is calculated that the growth rate was 15% during 1970 to 1974. Assuming a growth rate of 20% between 1980 and 1985, as it is envisaged that by 1985 outdoor switchgear and controlgear will be manufactured. On this basis, the demand by 1980 and 1985 will be 70 million and 174 million Pesos respectively.
13. Electric fan	On the basis of regression with per capita income, the demand is estimated as 17,000 and 22,000 numbers in 1980 and 1985 respectively.
14. Electric motor	On the basis of regression with index of industrial production, the demand is estimated at 1.5 million kW and 3.1 million kW in 1980 and 1985 respectively. Siemens indicated that by 1976, motors aggregating to about 1.08 million kW will be produced. DNP indicated a growth of 10% up to 1980 and 15% between 1980 and 1985. On this basis, the demand for motors alternatively will be 1.48 million kW and 2.96 million kW by 1980 and 1985 respectively. As the two estimates agree closely, a level of output of 1.5 million kW in 1980 and 3.1 million kW in 1985 is adopted for this study.
15. Air conditioner	On the basis of correlation between consumption and per capita income, the future level of demand for air conditioners is estimated at 8,000 and 12,500 numbers in 1980 and 1985 respectively.

Appendix 3-1 (continued)

Item	Basis of forecast
16. Refrigerator	The demand for domestic refrigerator is estimated on the basis of correlation of savings with consumption of refrigerator. The formula for future projection assumed is $Y = c \left(\frac{S}{P}\right)^n$, where Y = number of refrigerators, S = savings, D = population and c & n are constants. The value of c and n are estimated for the period 1969 to 1973 and the average value arrived at is 2.63 for n and 1.4×10^{-6} for n. On the basis of this value, the demand for refrigerator for the years 1980 and 1985 will be 315,000 and 1,100,000 respectively. Commercial refrigerator market has been determined on the basis of average percentage ratio between domestic and commercial refrigerator observed during 1969 to 1973.
17. Washing machine	Induacero indicated that in future washing machine demand will grow at the rate of 20% per year. For conservative estimate growth rate of 15% between 1974 and 1980 and 10% between 1980 and 1985 has been assumed. The demand on this basis works out to 16,000 by 1980 and 25,600 by 1985. Alternatively, on the basis of regression with per capita income, the demand by 1980 and 1985 will be 16,500 and 22,200 numbers respectively. For this study, the later demand is assumed.
18. Stove	For electric stoves, the demand has been estimated on the basis of correlation with population and annual growth of stoves consumed per million persons over the period 1969 to 1974. On this basis, the demand for electric stoves will be 54,000 and 82,000 by 1980 and 1985 respectively.

Appendix 3-1 (continued)

Item	Basis of forecast
	For gas stoves, these are determined on the basis of ratios between electric and gas. It is seen that the ratio is declining which was also indicated by manufacturers. Keeping this trend in view, the percentages assumed are 50% by 1980 and 40% by 1985. On this basis the demand for gas stoves will be 27,000 in 1980 and 33,000 in 1985.
	Lasco SA indicated the production of kerosene stoves which is of small size. By 1977, the anticipated production of kerosene stoves is 190,000. During the past years the production has increased by 10,000 per year. Therefore, by 1980 the demand will be about 220,000. Due to rural electrification, it is anticipated that the use of kerosene stoves will decline and there may be only a marginal increase after 1980. Assuming yearly increment of 5,000, the demand for kerosene stoves will be 245,000 by 1985.
19. Water heater	In 1973, the production of water heaters was 30,287 numbers and import was 12,800 numbers. The total consumption of water heaters was therefore 43,087. On the basis of regression of consumption with per capita income, the demand for water heaters (electrical) will be about 88,000 in 1980 and 160,000 in 1985. For gas heaters, it is observed that its percentage gradually declined from 6% in 1970 to 1% in 1974. It is therefore assumed that there will be hardly any production of gas water heaters in future.

Appendix 3-1 (continued)

Items	Basis of forecast
20. Cooking range	Total production of cooking ranges including electrical and gas was of the order of 70,000 in 1974. In 1972, the production was about 80,000. On the basis of correlation with per capital income, the demand for cooking ranges will be about 86,000 and 180,000 by 1980 and 1985. Induacero indicated a growth rate of 10% and 15% for electric cooking ranges and 8% for gas cooking ranges. On this alternative basis, the demand projected is 90,000 and 182,000 by 1980 and 1985 respectively. For this study, the demand considered is 85,000 and 180,000 by 1980 and 1985.
21. Water cooler	Production of water coolers increased from 6,600 to 7,000 numbers during 1969-1974. Assuming 10% growth rate in accordance with the growth of public services as indicated by DNP, the demand will be 12,500 and 20,000 by 1980 and 1985 respectively.
22. ACSR cable	According to EMCO Cables, about 300 tons of core wire will be produced for ACSR cable by 1976. For projecting the demand for 1980 and 1985, the electrification programme has been considered. According to ICEL, route length to be electrified in 1980 and 1985 will be 450 km and 600 km respectively. On the basis of an average norm of 3 tons of aluminium per km of ACSR conductor, the aluminium requirement will be 1,350 tons and 1,784 tons. On an average, 70% by weight is aluminium in ACSR conductor and on this basis, the demand for ACSR cables in 1980 and 1985 will be 2,000 tons and 2,500 tons respectively.
23. Armoured cable	According to CEAT, 5% of ACSR cable is taken as armoured cable.

Appendix 3-1 (continued)

Items	Basis of forecast
24. House Service meter	Total number of houses built in 1973 was 32,000. The total number of houses to be built by 1980 and 1985 on the basis of growth rate of housing construction as indicated by DNP, works out to be 74,000 and 132,000 respectively. On the basis of distribution pattern of the types of houses as indicated by CAMACOL, the number of houses by each type has been determined for 1980 and 1985. On the basis of the number of meters generally installed for each type of house, the house service meters required by 1980 and 1985 are determined. Adding replacement as 20%, the total house service meters will be 203,712 and 332,000 by 1980 and 1985 respectively.
25. T.V. set	G.E. Colombia manufactures T.V. sets (19 inch), the only type which consumes steel. In 1974, about 3,500 such sets were produced. Assuming 10% growth rate, the demand by 1980 and 1985 will be 6,000 and 10,000 respectively.
26. Radio receiver	On the basis of the ratio between population and production during the period 1966 to 1972, the demand for radio receivers has been determined. From the successive yearly increment in the ratios of radio receivers per million persons, it is observed that the average increment during this period was 250 per year. In 1974, the norm was 5,300 radios per million persons. Taking this as the base and the yearly increment as 250, the norm per million persons will be 7,000 radios by 1980 and 8,500 radios by 1985. On this basis, the demand will be 201,600 and 284,750 by 1980 and 1985 respectively.

Appendix 3-1 (continued)

Items	Basis of forecast
III. INDUSTRIAL AND AGRICULTURAL MACHINERY	
27. Weighing machinery	On the basis of growth rate of index of industrial production, the demand will be 32.1 million and 56.57 million by 1980 and 1985 respectively.
28. Agricultural tractor	Till today, agricultural tractors are imported. APOLO is planning to produce these tractors by 1977. The regression equation taking consumption and index of agricultural production is worked out as $Y = -0287.2 + 7x$. On the basis of growth rate indicated by DNP, the projected index of agricultural production by 1980 and 1985 will be 242 and 316 respectively. Applying these values, the demand of agricultural tractors will be 8,886 and 13,526 by 1980 and 1985 respectively.
29. Stationary diesel engine	The production of stationary diesel engines in 1972 was only 372. The growth of stationary diesel engines is correlated with the growth of agricultural sector. On this basis, the demand for stationary diesel engines will be 500 and 650 respectively in 1980 and 1985.
30. Crane	On the basis of the growth rate in industrial sector, the demand for cranes will be 244 by 1980 and 430 by 1985.
31. Concrete mixer	On the basis of growth rates indicated by APOLO, the demand for concrete mixers will be 510 and 715 by 1980 and 1985 respectively.
32. Ventilation equipment	In 1970 the value of the production of ventilation equipment was 4.72 million pesos. Taking this as the base, the demand on the basis of 10% growth rate, will be 12 million and 24 million pesos by 1980 and 1985 respectively.

Appendix 3-1 (continued)

Item	Basis of forecast
33. Power driven pumps	Worthington indicated the demand up to 1976 as 6,000 numbers for hydraulic pumps. As the growth is closely interlinked with the Agricultural sector, the demand is estimated accordingly. Adding the replacement of pumps as 20% of new pumps, the total demand works out to 10,000 and 13,000 by 1980 and 1985 respectively. For oil, gas etc the pumps are imported. The trend of imports from 1963 to 1973 is analysed and on the basis of derived equation $Y = 36,460 + 5,455\ t + 54\ t^2$, the demand is 110,000 and 145,000 by 1980 and 1985 respectively. Assuming 40% and 70% indigenous production, the demand considered is 45,000 and 102,000 by 1980 and 1985 respectively.
34. Textile machinery	The value of the consumption of textile machinery in 1973 was 22 million pesos. The growth of textile industry is envisaged as 4% by DNP, and on this basis the demand of textile machinery will be about 33 million and 40 million pesos in 1980 and 1985 respectively. Up to 1973, the production to import ratio was 50:50. For 1980 and 1985, the indigenous production is assumed to increase to 75% and 100% respectively. On this basis, the output to be considered will be of the value of 25 million pesos in 1980 and 40 million pesos in 1985.
35. Cement machinery	The ratio between value of cement machinery production and the cement production in tons during the period 1969 to 1974, shows a rising trend from 0.68 to 1.27. Graphically extrapolating, the ratios for 1980 and 1985 will be 1.6 and 2. The growth rates of cement consumption between 1969 and 1975 was 8%. As the construction sector

Appendix 3-1 (continued)

Item	Basis of forecast
	is expected to grow by 10% between 1975 and 1980 and 12% between 1980 and 1985, the cement consumption will be 6 million tons and 10.6 million tons in 1980 and 1985 respectively. On the basis of ratio of cement machinery to cement production, the demand will be of the value of 9.6 million pesos in 1980 and 21.2 million pesos in 1985.
36. Sugar machinery	The value of past production of sugar machinery was very low. Assumed for 1980 and 1985 are 1 million pesos and 2 million pesos respectively.
37. Machine tools	Prominsa indicated the likely output level for machine tools by 1980 as 52 million pesos, in value. The output level for 1985 is projected on the basis of the industrial sector's growth rate.
38. Machine tool accessories	From the field survey data, it is found that about 3% of the total value of machine tool production may be taken as machine tool accessories. On the basis, the output level will be of the value of 1.6 million pesos and 2.8 million pesos by 1980 and 1985 respectively.
Agricultural implements	
39. Plough	In 1980 the production of ploughs will be about 2,500 numbers as collected from field survey. For 1985 the output is projected on the basis of 5.5% growth rate envisaged for agricultural sector.
40. Harrow	Similarly, the output level by 1985 is projected on the basis of 5.5% growth rate.
41. Planter	Likewise, the output level by 1985 is projected on the basis of 5.5% growth rate.

Appendix 3-1 (continued)

Item	Basis of forecast
42. Cultivator	In the same manner, the output level by 1985 is projected on the basis of 5.5% growth rate.
43. Trailer - agricultural	By 1975 the production is expected to be 360 numbers. Assuming 10% growth rate between 1975 and 1985, the output will be 580 and 928 respectively.
IV. METAL PRODUCTS	
44. Steel door and window	From the value of production of metallic doors and windows during the period 1966 to 1972, the quantities in tons were determined on the basis of the average value of 10,000 pesos per ton of fabricated steel. The past ratio shows that on an average 1.6 tons of steel doors and windows are used per 1,000 m^2 of house constructed. In 1974, about 4 million m^2 area was constructed for housings. On the basis of construction growth rates as indicated by DNP, the area for housing will be 9 million m^2, 18 million m^2 by 1980 and 1985 respectively. On the basis of the average ratio of 1.6, the requirement of steel doors and windows will be 14,400 tons and 28,800 tons by 1980 and 1985 respectively.
45. Furniture	From the production date of metallic furniture in 1970 and 1972, the quantity of furniture in tons on the basis of 10,000 pesos per ton is determined. Assuming 80% as steel furniture the production of steel furniture was of the order of 6,000 tons in 1970. On the basis of field survey, the production of steel furniture was 7,500 tons in 1974. From the production of total furniture,

Appendix 3-1 (continued)

Item	Basis of forecast
	the proportions of metallic furniture during 1966 to 1969 were estimated. Establishing the time series from 1966 to 1974, the time analysis yielded an equation, $Y = 6,839.8 - 121t + 66.6\ t^2$. On the basis of this equation, the demand by 1980 and 1985 will be 12,300 tons and 20,000 tons respectively.
46. Gas bottle	In 1970, the production of gas bottles was 108,498 numbers. Due to paucity of gas, the production decreased to 68,119 in 1972, and in 1973, there was hardly any production. With the proposed development of the Gujira gas field, it is expected that there will be greater demand for gas bottles in future. Taking 100,000 as base and assuming 5% growth rate, the requirement of gas bottles will be 151,000 and 197,000 by 1980 and 1985 respectively.
47. Tincan/Crown cork	HOLASA indicated that the demand for tinplate by 1980 and 1985 may be up to 112,000 tons and 180,000 tons respectively. It is noted that 50% of total requirement will be for cans and 50% will be for crown corks. Analysing the per capita consumption of tinplate in Latin American countries, it is seen that Colombia consumes only 2 kg in comparison to 4 kg to 6 kg observed in Mexico, Argentina, Venezuela and Chile. Assuming at least the per capital consumption of tinplate will be 4 kg and 5 kg by 1980 and 1985 respectively, the requirement of tinplate will be 115,000 tons and 168,000 tons by 1980 and 1985. Assuming that 1.1 tons of tinplate are required per ton of finished product, the demand for tincans and crown corks will be about 100,000 tons by 1980 and 159,000 tons by 1985.

Appendix 3-1 (continued)

Item	Basis of forecast
48. Wire rope	EMCO CABLE indicated that by 1980 the demand for wire rope will be about 7,000 tons. For 1985, the growth rate 5% has been assumed i.e. by 1985 the output will be 9,000 tons.
49. Textile wire	Correlating with textile production, it is observed that about 100 kg of high tensile wire is required per million pesos worth of textile production. On this basis, from the projected production of textiles by 1980 and 1985, the requirement of wires will be 1,620 tons and 2,025 tons by 1980 and 1985 respectively.
50. Tyre	On the basis of projected output of automobiles and cycles, the total number of tyres including replacement estimated from the part volume will be 3.05 million in 1980 and 4.782 million in 1985.
51. Bolt, nut and screw	On the basis of correlation with the index of industrial production during the period 1966 to 1974, the likely level of production of bolts, nuts and screws by 1980 and 1985 will be 9,600 tons and 19,200 tons respectively.
52. Rivet	The average proportion of rivets is 18% of the nuts and screws as observed during 1969 to 1974. On this basis, the output of rivets will be 1,700 tons and 3,500 tons by 1980 and 1985 respectively.
53. Wire nail	The time trend analysis for the period 1966 to 1974 shows that the consumption was according to $Y = 11,000 + 2t + 0.02t^2$ with the base year 1970. On this basis, the demand will be 20,000 tons in 1980 and 38,000 tons in 1985.

Appendix 3-1 (continued)

Item	Basis of forecast
54. Wire netting and wire product	Assumed 15% of total wire demand as observed in other countries.
55. Sewing machine	The ratio between availability of sewing machines and population during the period 1966 to 1972 varied between 1.18 and 2.20 machines per 100 persons. The weighted average ratio estimated is 1.8. For 1980, the same ratio is adopted and for 1985, a ratio of 2.5 is assumed. On the basis of projected population, the demand will be 52,000 numbers and 84,000 numbers in 1980 and 1985 respectively.
56. Welding electrode	WEST ARCO produced about 3,000 tons of welding electrodes and as it catered to 50% of the total requirements, the national consumption was 5,520 tons. For future demand, the consumption of welding electrode is estimated on the basis of growth rates envisaged for industrial sector. On this basis, the demand will be 10,600 tons and 19,000 tons by 1980 and 1985 respectively.
57. Transmission tower	From the envisaged electrification programme, the total length of transmission towers by 1980 and 1985 will be 471 km and 314 km respectively. The average span between two towers depends on the tension voltage. On the basis of the tension voltage, the number of towers and the average requirement of steel per unit tower for the different tension lines, the requirement of transmission towers in tons have been estimated at 6,050 tons and 3,384 tons for the years 1980 and 1985 respectively.

Appendix 3-1 (continued)

58. Razor blade	Gillet de Colombia manufactures razor blades. Deducting the export, the total consumption of blades including imports was 267 tons in 1974. On the basis of an average norm of 1.11 kg per 1,000 blades, the number of blades consumed in 1974 was 252 million. On an average, the population using razor blades may be assumed as 20%. Therefore, 55 blades per year were used per person. On the basis of population growth of 3.2%, the estimated population will be 28.8 million and 33.5 million by 1980 and 1985 respectively. With the growth in per capital income, the likely average number of blades per person may be taken as 65 and 78 in the years 1980 and 1985 respectively. Assuming that 20% of total population will continue using blades, the requirements will be 390 million and 523 million by 1980 and 1985 respectively.
59. Drum and container	The production of drums and containers was 5,670 tons in 1966 and came down to 4,023 tons in 1969. Assuming 7% growth rate between 1969 and 1975 and 8% between 1975 and 1980 and 10% between 1980 and 1985, the requirements will be 12,500 tons and 20,000 tons by 1980 and 1985 respectively.
60. Utensils	In developed countries, it is observed that about 1 kg of stainless steel is used in utensils. Assuming 0.2 kg per capita in 1980 and 0.3 kg per capita in 1985 for Colombia, the requirement of stainless steel utensils by 1980 and 1985 will be 5,800 and 10,100 tons respectively.

Appendix 3-2

INVESTMENT TARGET FOR CONSTRUCTION SECTOR

The out put forecasts for construction sector are to be based on likely investments. From a recent study, the anticipated gross fixed investments are indicated up to 1980 at current million pesos. The pattern of investment in different sectors in 1974 and 1980 are given below:

SECTORAL DISTRIBUTION OF PUBLIC GROSS FIXED INVESTMENT

Sectors		1974 Current million pesos	1974 %	1980 Current million pesos	1980 %
Agriculture and allied activities	..	3 133	12.4	11 954	11.9
Industry and mining	..	1 870	7.4	9 141	9.1
Power	..	2 148	8.5	9 141	9.1
Transport	..	5 104	22.2	17 881	17.8
Communication	..	632	2.5	2 310	2.3
Nutrition and health	..	1 945	7.7	10 447	10.4
Water supply and sewerage	..	808	3.2	6 730	6.7
Housing and urban development	..	2 299	9.1	11 050	11.0
Education	..	4 194	16.6	13 963	13.9
Tourism	..	202	0.8	904	0.9
Central services	..	531	2.1	1 406	1.4
Others	..	2 400	9.5	5 525	5.5
Total	..	25 266	100.0	100 452	100.0

In order to estimate the requirement of steel from the investments, these are to be converted at 1974 prices as the norms of steel consumption are based on average steel prices prevailing in 1974. The conversion has been made on the basis of wholesale price index. With the base 1970, the rise in the price index was 227 in 1974. The rate of increase thus was 23 per cent

Appendix 3-2 (continued)

per year. In view of the measures planned by Government to contain inflation, the average rate of increase of price index up to 1980 assumed is 18 per cent. On this basis, the public gross fixed investment by 1980 at 1974 price will be as follows. For sectoral distribution, the same percentages as given for 1980 in this study have been adopted.

PROJECTED INVESTMENT IN THE CONSTURCTION SECTOR
(million pesos)

Item		1980	1985
Agricultural and allied activities	..	11 829	23 650
Industry and mining[a]	..	8 959	13 145
Social services			
Nutrition and health	..	5 908	11 360
Water supply and sewerage	..	4 532	9 730
Housing and urban development	..	12 076	17 305
Education	..	9 249	12 570
Sub-total (Social services)	..	31 765	50 965
Transport and communication	..	11 583	18 895

a/ Excluding investments of 4,000 million pesos and 6,000 million pesos for petroleum.

In addition to the above, the investments on oil and gas, the targetted programmes for electric power plant installation and laying of railway lines have to be taken into account in the construction sector. So far as oil and gas are concerned, the investments have been indicated for 1980 and 1985 by Ecopetrol. For power plants, the programme is available from ICEL, ISA etc.

Regarding building of rail tracks, according to the programme indicated by Ferrocarriles, about 80 km of new railway line will be laid in 1980. In addition, the entire existing railway line of 3,440 km which is all single tract, is proposed to be converted into double tract during the 10-year period 1976 to 1985. This would mean the installation of 344 km of rail track per year on an average for doubling till 1985. Thus, the rail track to be laid in 1980, including the new line of 80 km, will be 424 km and that in 1985 will be 344 km.

Appendix 3-2 (continued)

On the above basis, the targets, for oil and gas, power and rail track have been adopted as follows:

		Unit	1980	1985
Oil and gas	..	Million pesos	9 000	14 000
Hydel power	..	MW	310	740
Thermal power	..	MW	-	90
Rail track	..	km	424	344

The total investment thus arrived at are given below:

TOTAL INVESTMENT BY 1980 AND 1985[a]
(million pesos)

Sector	1980 Public	1980 Private	1980 Total	1985 Public	1985 Private	1985 Total
Agricultural and allied activities	4 427	7 402	11 829	7 450	16 200	23 650
Industry and mining[b] ..	3 386	9 573	12 959	8 940	10 205	19 145
Power ..	3 386	408	3 794	7 450	605	8 055
Transport ..	6 623	3 923	10 546	11 175	6 665	17 840
Communication ..	856	181	1 037	745	310	1 055
Nutrition and health ..	3 869	2 039	5 908	8 940	2 420	11 360
Water supply and sewerage ..	2 493	2 039	4 532	6 705	3 025	9 730
Housing and urban development ..	4 093	7 983	12 076	9 685	7 620	17 305
Education ..	5 171	4 078	9 249	8 940	3 630	12 570
Tourism ..	335	408	743	745	302	1 047
Central services	535	408	943	745	605	1 350
Others ..	2 046	2 338	4 384	2 980	8 913	11 893
Total ..	37 220	40 780	78 000	74 500	60 500	135 000

a/ At 1974 price
b/ Including petroleum

Investment in the Construction Sector

From the above projected total investment, the steel consuming items which relate to the construction sector are given along with the corresponding investments.

Appendix 3-2 (continued)

The percentage share of private investment in total investment from 1958 to 1973 has been plotted. It is observed that the contribution by the private sector to the total investment declines from a level of more than 80 per cent to about 60 per cent during this period. Extrapolating the trend, the likely contribution by the private sector in 1980 and 1985 may be taken as 52 per cent and 45 per cent respectively.

On the basis of the projected percentage share of the private sector, the total investment by 1980 and 1985 will be 78,000 million pesos and 135,000 million pesos of which the private sector investment will be 40,780 million pesos and 60,500 million pesos by 1980 and 1985 respectively. The possible pattern of distribution of the private sector investment for the years 1980 and 1985 is given below. The assumed distribution is based on the Government investment pattern, with more emphasis on the manufacturing sector.

ESTIMATION OF INVESTMENT BY PRIVATE SECTORS

Sectors	1980[a]		1985[a]	
	Million pesos	%	Million pesos	%
Agricultural and allied activities ..	7 402	18.2	16 200	26.8
Industry and mining ..	9 573	23.2	10 205	16.8
Power ..	408	1.0	605	1.0
Transport ..	3 923	9.8	6 665	11.0
Communication ..	181	0.4	310	0.5
Nutrition and health ..	2 039	5.0	2 420	4.0
Water supply and sewerage	2 039	5.0	3 025	5.0
Housing and urban development ..	7 983	19.4	7 620	12.6
Education ..	4 078	10.0	3 630	6.0
Tourism ..	408	1.0	302	0.5
Central services ..	408	1.0	605	1.0
Others ..	2 338	6.0	8 913	14.8
Total ..	40 780	100.0	60 500	100.0

a/ At 1974 price.

Appendix 3-2 (continued)

PUBLIC FIXED GROSS INVESTMENT IN 1980[a]

Sectors		Million pesos	%
Agriculture	..	4 427	11.9
Industry and mining	..	3 386	9.1
Power	..	3 386	9.1
Transport	..	6 623	17.8
Communication	..	856	2.3
Nutrition and health	..	3 869	10.4
Water supply and sewerage	..	2 493	6.7
Housing and urban development		4 093	11.0
Education	..	5 171	13.9
Tourism	..	335	0.9
Central services	..	535	1.4
Others	..	2 046	5.5
Total	..	37 220	100.0

a/ At 1974 price.

It is expected that the investment by public sector will increase at an accelerated growth and in future the public sector will take part in investing more in industries. It is assumed that by 1985 the investment will be doubled by public sector. On this basis the investment will be 74 500 million pesos in 1985.

ESTIMATION OF PUBLIC FIXED GROSS INVESTMENT IN 1985[a]

Sectors		Million pesos	%
Agriculture and allied activities	..	7 450	10.0
Industry and mining	..	8 940	12.0
Power	..	7 450	10.0
Transport	..	11 175	15.0
Communication	..	745	1.0
Nutrition and health	..	8 940	12.0
Water supply and sewerage	..	6 705	9.0
Housing and urban development		9 685	13.0
Education	..	8 940	12.0
Tourism	..	745	1.0
Central services	..	745	1.0
Others	..	2 980	4.0
Total	..	74 500	100.0

a/ At 1974 price

Appendix 3-3

BASIS FOR EVOLVING NORMS OF CONSUMPTION FOR ORDINARY STEEL

Items	Basis of norms evolution
I. TRANSPORT EQUIPMENT	
1. Wagons	On the basis of information furnished by H.B. Estructurals.
2. Coaches	Ferrocarriles indicated that coaches are made to the local design and 80% is made locally. The requirement of steel per unit coach according to Ferrocarriles is 11 tons. Excluding the weight of wheels and brakes, the consumption norm is estimated.
3. Trucks	At present, trucks are only assembled, except for some parts such as springs, brakes, shock absorbers etc. It is gathered during the field survey that by 1980, about 70% will be made indigenously, and it is assumed that 100% will be produced indigenously by 1985.
4. Buses	On the basis of information furnished by COLCAR and Superior, the wieghted average norms of steel requirements for each type of bus such as P-900, D-600 etc are derived.
5. Jeeps and station wagons	SOFASA manufactures jeeps and station wagons, but at present, only assembling is done. The body building will be 100% indigenous by 1980. For evolving norms, Indian practice is adopted.
6. Bicycles	Material balance given by Monark.
7. Motor cycles	At present, only assembling is done, and for norms, Indian, Iranian and Moroccan practices have been considered.

Appendix 3-3 (continued)

Items	Basis of norms evolution
8. Cars	At present, Chrysler, Sofasa and Renault assemble cars. They use some locally made items such as springs and shock absorbers but import bodies and chasis as it is uneconomical to fabricate them locally at the present low level of production. Even by 1980, the demand will not be adequate for economic fabrication of these items. However, by 1985, with increased demand, it is expected that fabrication facilities will be installed and the bodies and chasis will all be made indigenously. Keeping this in view, the norms of consumption have been determined.
9. Trailers	On the basis of Indian practice.
10. Car engines	SOFASA has plans to manufacture car engines. Also Transejas has already established the facilities for building the transmission system of automobiles. The norms of consumption for car engines have been determined from the information obtained from Transejas, supplemented by Forjas de Colombia. This has been cross-checked and adjusted according to the practices observed in Morocco and India.
11. Automobile ancillaries	On the basis of value of steel content as indicated by Chrysler and SOFASA.
II. ELECTRICAL EQUIPMENT	
12. Transformer	On the basis of information furnished by Siemens.
13. Switchgear and controlgear	On the basis of information furnished by Siemens.
14. Electric fan	On the basis of information furnished by LARCO S.A.

Appendix 3-3 (continued)

Items	Basis of norms evolution
15. Electric motor	On the basis of information furnished by Siemens.
16. Air conditioner	On the basis of information furnished by G.E. Colombia who manufacture air conditioners. Steel is used only for casing.
17. Refrigerator (domestic)	From the material balance given by Induacero, ICASA and G.E. Colombia, the weighted average norms of consumption have been estimated.
18. Refrigerator (commercial)	On the basis of information obtained from Induacero.
19. Washing machine	On the basis of information obtained from Induacero.
20. Electric stoves	The weighted average norms of consumption have been estimated on the basis of material balance indicated by Induacero and ICASA.
21. Gas stoves	The weighted average norms of consumption have been estimated on the basis of material balance indicated by Induacero and ICASA.
22. Water heaters	The norms are evolved according to the input coefficients given by Induacero.
23. Cooking ranges	On the basis of the input coefficients indicated by Induacero and ICASA.
24. Water coolers	The norms are estimated according to the steel use of ICASA for manufacture of water coolers.
25. ACSR cables	From the information given by CEAT and on the basis of international practices.
26. House service meter	On the basis of Indian practice.
27. T.V. sets	On the basis of information furnished by G.E. Colombia. Only 19-in sets consume steel.

Appendix 3-3 (continued)

Item	Basis of norms evolution
28. Radio receivers	As no data is available, the norm obtaining in Indian practice has been adopted.
III. INDUSTRIAL AND AGRICULTURAL MACHINERY	
29. Weighing machinery	As no data is available, the norm obtaining in Indian practice has been adopted.
30. Agricultural tractors	Till now, this is imported and APOLO is planning to manufacture it by 1976. The material requirements are not available from APOLO. Therefore, the norms are based on practices followed in India.
31. Stationary diesel engine	On the basis of Indian practice.
32. Cranes	As given by Derco.
33. Passenger and industrial lifts	On the basis of consumption by OTIS.
34. Industrial boilers	Distral is the biggest manufacturer of industrial boilers. The value of steel content in the total value of a boiler is taken as the guideline for determining the norms.
35. Concrete mixers	According to the input coefficients indicated by APOLO.
36. Ventilation equipment	Distral and Tissot indicated that 30% to 35% of the total value may be taken as steel.
37. Air compressors	Worthington produces air cooled compressors. G.E. Colombia is contemplating to manufacture compressor motors, which will be used by BUNDI to produce compressors for refrigerators. The norms of steel consumption are based on information gathered from these industries.

Appendix 3-3 (continued)

Item	Basis of norms evolution
38. Power driven pumps	As indicated by Worthington.
39. Textile machinery	On the basis of information obtained from Prominsa.
40. Cement machinery	H.B. Estructurals produce some parts of cement machinery and it is understood that 40% of total value may be assumed as the value of steel. On the basis of 30,000 pesos per ton of steel fabricated including labour, design etc, the requirement of steel per million pesos worth of cement machinery has been calculated.
41. Sugar machinery	Johnson indicated that about 50% value may be taken as value of steel and out of 50%, 80% will account for ordinary steel. On this basis, the steel requirement has been estimated.
42. Machine tools	Prominsa indicated the steel requirement for various types of machine tools. The weighted average requirement is taken as the norm.
43. Machine tools accessories	On the basis of percentage by value for steel content.
Agricultural implements:	
44. Ploughs	On the basis of information furnished by APOLO and Managero.
45. Harrows	On the basis of information furnished by APOLO and Managero.
46. Planters	On the basis of information furnished by APOLO and Managero.
47. Cultivators	On the basis of information furnished by APOLO and Managero.
48. Rotary cutters	On the basis of information furnished by APOLO and Managero.

Appendix 3-3 (continued)

Item	Basis of norms evolution
IV. METAL PRODUCTS	
49. Steel doors and windows	On the basis of scrap generation.
50. Furniture	On the basis of scrap generation.
51. Kerosene stoves	As furnished by Larco S.A.
52. Gas bottles	Induacero and Tissot used to manufacture gas bottles of 3 different sizes viz 100 lb, 40 lb and 20 lb. Tamsa will be producing gas bottles from 1976. No information on steel consumption could be obtained from these industries. Hence, norms consumption prevailing in other countries have been adopted.
53. Tincans/crown corks	On the basis of processing loss.
54. Bolts, nuts and screws	On an average 1,300 kg of steel is required per ton of finished bolts, nuts and screws. As 20% of total nuts and screws are considered to be of special steel, the ordinary steel required per ton of finished bolts, nuts and screws is 1,050 kg.
55. Rivets	On the basis of processing loss.
56. Wire nails	On the basis of processing loss.
57. Barbed wire	On the basis of processing loss.
58. Wire netting and wire products	On the basis of processing loss.
59. Sewing machine	SIGMA produces sewing machines. As no information could be obtained from SIGMA, the consumption norm has been determined on the basis of Indian practice.

Appendix 3-3 (continued)

Item	Basis of norms evolution
60. Transmission towers	On the basis of processing loss.
61. Expanded metal	On the basis of processing loss.
62. Drums and containers	On the basis of processing loss.
63. Tanks	On the basis of processing loss.
V. CONSTRUCTION SECTOR	On the basis of information furnished by CAMACOL, OBRAS, INTRAS and practices prevailing in India and Morocco.

Appendix 3-4

[illegible] (kg)

Sector		Unit of output	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Galvanised sheets	Tin-plate	[illegible]	Total
I. [illegible]															
1. [illegible]	..	Nos	410.0	[illegible]	775.00	16.0	[illegible]	-	4 [illegible]	-	[illegible]	-	-	34.00	[illegible]
2. [illegible]	..	Nos	-	-	-	-	1 [illegible]	-	4 [illegible]	3 [illegible]	-	-	-	-	9 [illegible]
3. Trucks	1980..	Nos	-	[illegible]	26.50	10.0	79.50	-	[illegible]	[illegible]	26.50	26.5	-	[illegible]	1 [illegible]
	1985..	Nos	-	24.0	40.00	12.0	[illegible]	-	400.00	[illegible]	40.00	40.0	-	24.00	1 [illegible]
4. Buses	..	Nos	-	-	53.00	-	[illegible]	-	445.00	1 [illegible]	[illegible]	73.0	-	[illegible]	2 [illegible]
5. Jeeps and station wagons	..	Nos	-	-	-	-	[illegible]	0.50	6.30	[illegible]	25.00	-	-	14.70	[illegible]
6. Bicycles	..	Nos	-	-	-	-	3.90	1.00	-	4.40	0.30	-	-	2.20	[illegible]
7. Motor cycles	..	Nos	-	-	-	-	9.40	1.30	11.00	47.50	6.50	-	-	8.90	[illegible]
8. Cars	1980..	Nos	-	-	-	-	5.00	0.35	0.50	[illegible]	3.00	-	-	0.95	[illegible]
	1985..	Nos	-	-	-	-	[illegible]	9.70	13.00	[illegible]	[illegible]	-	-	11.50	[illegible]
9. Car engines	1980..	Nos	-	-	3.00	-	11.30	-	[illegible]	0.90	15.30	-	-	1.[illegible]	[illegible]
	1985..	Nos	-	-	6.10	-	[illegible]	-	[illegible]	1.00	30.50	-	-	3.[illegible]	[illegible]
10. Trailers	..	Nos	-	391.5	1 [illegible]	-	-	-	142.00	-	791.50	-	-	-	2 [illegible]
11. Automobile auxiliaries	..	Million pesos	-	-	-	-	30.00	-	[illegible]	74.50	95.00	95.0	-	15.[illegible]	1 [illegible]
II. [illegible]															
12. Transformers	..	[illegible]	46.0	[illegible]	430.00	-	[illegible]	-	1 [illegible]	-	[illegible]	-	-	1 [illegible]	4 [illegible]
13. Switchgear and controlgear	..	Million pesos	-	346.0	[illegible]	-	1 [illegible]	-	[illegible]	5 [illegible]	-	-	-	977.00	9 [illegible]
14. Electric fans	..	Nos	-	-	-	-	2.20	-	-	0.50	4.00	-	-	-	6.70
15. Electric motors	..	'000 kW	-	-	-	-	[illegible]	-	-	440.00	13[illegible]	-	-	-	1 [illegible]
16. Air conditioners	..	Nos	-	1.7	[illegible]	1.1	[illegible]	-	-	17.00	-	3.4	-	0.40	30.00
17. Refrigerator (domestic & commercial)	..	Nos	-	-	-	-	1.30	2.70	-	[illegible]	-	-	-	4.[illegible]	[illegible]
18. Washing machinery	..	Nos	-	-	-	-	-	-	-	64.00	-	-	-	-	64.00
19. Electric stoves	..	Nos	-	-	-	-	-	-	-	32.00	-	-	-	-	32.00
20. Gas stoves	..	Nos	-	-	-	-	-	-	-	[illegible]	-	-	-	-	[illegible]
21. Water heaters	..	Nos	-	-	-	-	-	1.00	-	9.00	-	-	-	-	10.00
22. Cooking ranges - gas	..	Nos	-	-	-	-	-	-	-	40.00	-	-	-	-	40.00
- electrical	..	Nos	-	-	-	-	-	-	-	[illegible]	-	-	-	-	[illegible]
23. Water cooler	..	Nos	-	-	4.00	-	0.30	-	-	13.70	[illegible]	-	-	-	40.00
24. ACSR cables	..	Tons	-	-	-	-	-	[illegible]	-	-	-	-	-	-	[illegible]
25. House service meters	..	Nos	-	-	-	-	0.06	-	-	1.00	0.[illegible]	-	-	-	1.16
26. T.V. sets	..	'000 Nos	-	-	-	-	[illegible]	-	-	373.00	-	-	-	-	400.00
27. Radio receivers	..	'000 Nos	-	-	-	-	[illegible]	130.00	-	[illegible]	-	-	-	-	400.00

Appendix 3-4 (continued)

Sector		Unit of output	Sections: [illegible]	Sections: [illegible]	Sections: Angles	Sections: [illegible]	Bars/rods	Wire	Plates	HR sheets/strip	CR sheets/strip	Galvanized sheets	Tin-plate	Pipes/tubes	Total
III. [illegible]															
28. Weighing machinery	..	Million pesos	810.0	1 460.0	1 480.00	60.0	11 580.00	-	9 180.00	1 070.00	1 585.00	94.0	-	-	27 580.00
29. Agricultural tractors	..	Nos	-	44.5	7.90	-	385.70	-	280.00	7.90	224.00	-	-	-	880.00
30. Stationary diesel engines	..	Nos	-	-	-	-	99.30	-	-	-	16.70	-	-	-	116.00
31. Cranes	..	Tons	42.0	285.0	285.00	3.7	111.60	-	77.00	-	15.70	-	-	-	790.00
32. Passenger and industrial lifts	..	Nos	280.0	380.0	780.00	-	570.00	-	420.00	370.00	190.00	-	-	-	2 990.00
33. Industrial boilers	..	Million pesos	-	-	-	-	-	-	20 000.00	-	-	-	-	10 000.00	30 000.00
34. Concrete mixers	..	Nos	-	40.0	40.00	-	-	-	380.00	-	-	-	-	-	420.00
35. Ventilation equipment	..	Million pesos	-	-	2 000.00	1 000.0	-	-	-	-	-	7 000.0	-	-	10 000.00
36. Air compressors	..	Million pesos	-	-	20.50	-	301.50	-	275.00	-	73.0	-	-	-	670.00
37. Power driven pumps	..	Nos	-	-	-	-	17.00	-	-	-	-	-	-	6.00	24.00
38. Textile machinery	..	Million pesos	1 000.0	580.0	780.00	-	5 000.00	-	10 000.00	870.00	750.00	-	-	-	19 000.00
39. Cement machinery	..	Million pesos	1 070.0	430.0	570.00	-	1 000.00	-	9 450.00	-	480.00	-	-	-	14 000.00
40. Sugar machinery	..	Million pesos	1 000.0	1 050.0	585.00	-	785.00	-	5 250.00	196.00	-	7.0	-	1 177.00	10 000.00
41. Machine tools	..	Million pesos	48.5	48.5	650.00	-	940.00	97.00	1 420.00	146.00	194.00	-	-	996.00	4 580.00
42. Machine tool accessories	..	Million pesos	-	-	-	-	6 600.00	-	-	-	-	-	-	-	6 600.00
Agricultural Implements															
43. Ploughs	..	Nos	-	-	112.00	-	24.00	-	50.00	-	-	-	-	-	186.20
44. Harrows	..	Nos	-	18.7	146.30	-	146.00	-	18.60	-	-	-	-	40.00	431.60
45. Planters	..	Nos	-	-	138.96	-	280.00	-	138.84	-	-	-	-	40.00	600.60
46. Cultivators	..	Nos	-	-	60.00	-	-	-	-	-	-	-	-	-	66.00
47. Cutters	..	Nos	-	-	1.00	-	21.00	-	38.00	-	-	-	-	1.00	55.00
48. Trailers	..	Nos	-	-	-	-	173.00	-	96.00	-	-	-	-	-	289.00
IV. METAL PRODUCTS															
49. Steel doors and windows	..	Tons	-	-	40.00	-	18.00	-	6.00	998.00	-	-	-	38.00	1 100.00
50. Furniture	..	Tons	-	-	-	-	-	-	-	800.00	-	-	-	280.00	1 100.00
51. Kerosene stoves	..	Nos	-	-	-	-	-	-	-	0.50	-	-	-	-	0.50
52. Gas bottles	..	Nos	-	-	-	-	1.00	-	-	11.00	-	-	-	1.00	13.00
53. [illegible]	..	Tons	-	-	-	-	-	-	-	-	-	-	1 100	-	1 100.00
54. Bolts, nuts and screws	..	Tons	-	-	-	-	800.00	340.00	-	-	-	-	-	-	1 140.00
55. Rivets	..	Tons	-	-	-	-	800.00	340.30	-	-	-	-	-	-	1 140.00
56. Wire nails	..	Tons	-	-	-	-	-	1 080.00	-	-	-	-	-	-	1 080.00
57. Barbed wire	..	Tons	-	-	-	-	-	1 380.00	-	-	-	-	-	-	1 380.00
58. Wire netting and wire products	..	Tons	-	-	-	-	-	1 100.00	-	-	-	-	-	-	1 100.00
59. Sewing machinery	..	'000 Nos	-	-	-	-	3 480.00	-	80.0	980.00	980.00	-	-	-	5 300.00
60. Hand tools	..	Tons	-	-	-	-	870.00	-	-	-	-	-	-	-	870.00
61. Transmission towers	..	Tons	-	50.0	950.00	-	75.00	-	85.00	-	-	-	-	-	1 100.00
62. Expanded metal	..	Tons	-	-	-	-	-	-	-	-	1 110.00	-	-	-	1 110.00
63. Drums and containers	..	Tons	-	-	-	-	-	-	-	1 090.00	-	-	-	-	1 090.00
64. Tanks	..	Tons	-	-	137.00	-	-	-	458.00	-	485.00	-	-	-	1 080.00

Appendix [illegible] (continued)

Sector		Unit of output	[illegible column 1]	[illegible column 2]	[illegible column 3]	[illegible column 4]	[illegible column 5]	[illegible column 6]	[illegible column 7]	[illegible column 8]	[illegible column 9]	[illegible column 10]	[illegible column 11]	[illegible column 12]	Total
[illegible]															
65. [illegible] allied activities	..	Million [illegible]	[illegible].0	1 [illegible].0	910.00	[illegible].0	1 110.00	-	36.00	-	1 110.00	1 [illegible].0	-	2 [illegible].00	[illegible].00
66. Large & [illegible] industries and mining	..	Million pesos	[illegible].0	1 310.0	1 [illegible].00	-	[illegible].00	1 [illegible].00	1 770.00	-	1 [illegible].00	2 [illegible].0	-	345.00	9 [illegible].00
67. Oil and gas	..	Million pesos	300.0	648.0	[illegible].00	40.9	510.00	-	160.00	-	10.50	81.0	-	1 459.00	3 [illegible].00
68. Social services	..	Million pesos	-	73.0	190.00	35.0	5 [illegible].00	304.00	-	-	106.00	990.0	-	1 23[illegible].00	7 834.00
69. Transport	..	Million pesos	771.0	119.0	260.00	-	12 843.30	529.00	-	-	1 918.00	1 960.0	-	-	18 080.00
70. Communication	..	Million pesos	33.0	2 450.0	660.00	-	7 077.00	[illegible]	-	-	4 [illegible].00	660.00	-	-	16 290.00
71. Power															
- Hydel	..	[illegible]	1 [illegible]	[illegible] 000	356 000	6 000	3 [illegible]	-	110 000	-	50 000	110 000	-	300 000	5 [illegible]
- Thermal	..	[illegible]	[illegible] 000	190 000	230 000	2 000	3 [illegible]	-	70 000	-	30 000	70 000	-	250 000	4 980 000
72. Rail transport	..	Km	-	-	-	-	14 000 ([illegible])	-	-	-	-	-	-	-	34 000
- Rails 34 000															
- Railway [illegible] 6 000															

Appendix 3-5

ESTIMATED PAST CONSUMPTION OF ORDINARY STEEL BY SECTORS
(Tons)

Sector		1970	1971	1972	1973	1974
I. TRANSPORT EQUIPMENT						
Wagons ..	..	3 800	-	560	2 040	880
Ganchos ..	..	700	200	200	200	200
Trucks ..	..	8	238	124	186	164
Buses ..	..	9 100	6 750	8 160	4 300	4 620
Jeeps and station wagons	..	85	55	48	45	54
Bicycles ..	..	535	526	550	850	1 700
Motor cycles ..	..	-	-	9	9	9
Passenger cars ..	..	106	275	369	491	580
Trailers ..	..	6	6	6	6	8
Sub-total ..	..	13 590	8 050	10 986	8 067	8 075
II. ELECTRICAL EQUIPMENT						
Transformer ..	..	1 250	2 050	2 850	3 100	3 320
Electric motors ..	..	-	2 400	3 000	3 600	6 000
Air conditioner ..	..	130	120	100	150	150
Refrigerator ..	..	4 050	5 400	5 600	6 700	6 600
Washing machines	..	370	706	548	370	948
Cooking ranges ..	..	3 630	4 140	4 650	3 780	4 250
Stoves ..	..	645	723	860	860	1 300
Water heaters ..	..	338	272	345	308	265
Commercial refrigerators	..	314	340	540	736	896
Electric fans ..	..	38	54	115	680	690
Switchgear and controlgear	..	160	168	175	242	280
Water coolers ..	..	518	586	548	718	696
Sub-total ..	..	11 423	16 959	19 332	21 244	25 117
III. INDUSTRIAL AND AGRICULTURAL MACHINERY						
Weighing machinery	..	350	412	498	578	660
Agricultural tractors	..	-	-	-	-	-
Stationary diesel engine	..	24	24	60	60	64
Cranes ..	..	980	1 140	1 330	1 330	1 420
Passenger and industrial lifts	..	-	-	3	150	90
Industrial boilers	..	1 020	1 080	2 450	2 940	6 350
Concrete mixers ..	..	96	104	108	120	140
Ventilation equipment	..	47	28	10	28	35
Air compressors ..	..	170	170	181	191	354
Power driven pumps	..	20	49	77	85	93
Textile machinery	..	77	130	264	170	190
Cement machinery	..	35	42	51	58	64
Sugar machinery ..	..	2	2	1	2	2
Machine tools ..	..	122	125	128	131	140
Plough ..	..	164	186	204	223	248
Harrow ..	..	174	175	216	236	259
Planters ..	..	143	152	160	170	187
Cultivators ..	..	27	27	30	32	36
Cutters ..	..	21	22	24	25	28
Trailers ..	..	25	28	29	31	36
Sub-total ..	..	3 437	3 978	5 884	6 579	10 388
IV. METAL PRODUCTS						
Steel drums and containers	..	7 500	7 560	7 680	7 550	8 250
Furniture ..	..	8 360	8 030	5 820	7 500	8 250
Gas bottles ..	..	1 420	1 165	885	-	882
Tin cans ..	..	46 830	29 731	46 661	48 098	39 885
Bolts, nuts, screws and rivets	..	3 420	4 000	4 450	2 960	6 900
Wire nails ..	..	10 700	10 700	10 350	11 250	6 000
Barbed wire ..	..	20 000	13 472	14 040	15 870	14 029
Wire netting and wire products	..	4 950	3 960	3 990	4 450	3 300
Sewing machinery	..	149	179	238	184	184
Transmission towers	..	8 800	5 500	4 550	3 850	4 400
Expanded metal ..	..	640	682	720	770	885
Drums and containers	..	5 250	5 780	6 340	6 950	7 680
Tanks - oil ..	..	10 500	10 850	10 500	9 550	9 050
Stoves - gas ..	..	2 080	2 480	3 370	1 170	672
Stoves - kerosene	..	105	159	173	261	190
Hand tools ..	..	2 920	3 400	3 890	3 890	3 680
Tanks - water ..	..	5 250	5 420	5 250	4 780	4 520
Sub-total ..	..	138 814	113 648	128 866	129 075	118 077
V. CONSTRUCTION ..	..	282 700	269 300	255 300	329 300	380 000
Total ..	..	448 874	411 735	439 348	494 256	541 837

Appendix 3-6

DOMESTIC STEEL PRODUCTION a/
(thousand tons)

	Bars and rods							Wire rods b/	Profiles											Total non-flats excluding specials	PDR sheets/ plate	Total finished excluding specials	Specials SIDELPA	Total finished including specials
									Light							Medium								
	PDR	SIDEMUÑA	SIMESA	FUTEC	SIDELPA	SIDUNOR	Total	PDR	PDR	SIDEMUÑA	BOYACA	SIMESA	SIDELPA	SIDUNOR	Total	PDR	Total	Rails PDR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1965 ..	101.9	4.9	19.0	-	-	-	125.8	40.7 (31.6)	12.1	0.2	10.9	-	11.5	-	34.7	2.4	37.1	0.3	204.9	18.1	223.0	-	223.0
1966 ..	81.8	3.7	16.3	-	-	-	101.8	40.9 (30.0)	5.8	0.1	13.8	-	13.3	-	33.0	1.9	34.9	1.2	178.8	23.6	202.4	-	202.4
1967 ..	81.3	5.8	18.9	-	-	-	106.0	43.5 (32.0)	9.3	-	9.3	-	13.3	-	31.9	1.5	33.4	0.6	183.5	22.6	206.1	3.8	209.9
1968 ..	92.0	8.2	18.4	-	-	-	118.6	36.2 (25.1)	4.3	-	13.8	-	14.4	-	32.5	1.0	33.5	-	188.3	22.3	210.6	7.1	217.7
1969 ..	128.3	8.0	15.2	-	-	1.1	152.6	45.0 (35.9)	-	-	21.2	-	10.2	-	31.4	3.9	35.3	-	232.9	23.6	256.5	16.0	272.5
1970 ..	121.4	7.7	19.0	-	7.6	3.4	159.1	58.6 (30.5)	-	-	28.3	-	-	-	28.3	-	28.3	0.2	246.2	17.9	264.1	19.7	283.8
1971 ..	135.9	8.6	21.6	-	5.2	1.6	172.9	41.5 (25.9)	-	-	31.9	-	7.9	-	39.8	2.6	42.4	0.4	257.2	30.1	287.3	14.8	302.1
1972 ..	107.6	11.1	32.5	2.7	1.8	5.4	161.1	50.2 (26.9)	-	-	32.4	0.2	15.1	-	47.7	3.9	51.6	-	262.9	25.2	288.1	12.1	300.2
1973 ..	71.1	14.5	32.8	3.8	-	3.1	125.3	64.5 (31.0)	-	-	28.4	0.8	14.9	-	44.1	2.0	46.1	1.1	237.0	20.8	257.8	14.4	272.8
1974 ..	95.6	15.0	24.9	3.2	-	2.4	141.1	57.7 (28.2)	-	-	16.6	0.3	13.3	0.3	30.5	4.3	34.8	-	233.6	30.6	264.2	17.6	281.9

	Billets			Ingots											SIP rolled products					PDR rolled products
				Thomas	Electric									Total ingots	Bars and rods	Light profiles	Total ordinary steels	Specials (SIDELPA)	Total including specials	
	PDR	SIMESA	Total	PDR	PDR	SIDEMUÑA	BOYACA	SIMESA	FUTEC	SIDELPA	SIDUNOR	Sub-total SIP	Total							
	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)
1965 ..	13.8	-	13.8	166.9	37.2	4.5	-	22.4	-	9.8	-	36.7	73.9	240.8	23.9	22.6	46.5	-	46.5	176.5
1966 ..	14.8	-	14.8	137.2	37.6	4.7	-	19.5	-	17.0	-	41.2	79.8	216.0	20.0	27.2	47.2	-	47.2	155.2
1967 ..	7.3	-	7.3	171.7	36.6	4.9	-	22.1	-	22.2	-	49.2	95.8	257.5	24.7	22.6	47.3	3.8	51.1	198.8
1968 ..	8.1	-	8.1	161.8	38.2	12.4	-	21.6	-	25.5	-	59.5	97.7	239.5	26.6	28.2	54.8	7.1	61.9	155.8
1969 ..	10.7	-	10.7	168.0	40.2	15.6	-	19.8	-	26.5	1.5	63.4	103.6	271.6	24.3	31.4	55.7	16.0	71.7	200.9
1970 ..	-	0.2	-	200.9	41.1	9.4	-	20.5	-	27.9	1.9	59.6	100.7	301.6	37.7	28.3	66.0	19.7	85.7	198.1
1971 ..	-	0.5	-	204.4	43.8	10.4	-	29.1	-	34.8	3.2	77.5	121.3	325.7	37.0	39.8	76.8	14.9	91.6	210.5
1972 ..	-	1.2	-	233.9	42.1	13.4	-	42.9	-	38.1	2.4	96.8	139.9	372.8	53.5	47.7	101.2	12.1	113.3	186.9
1973 ..	26.4	3.3	29.7	221.0	41.6	15.9	-	39.5	-	35.6	3.1	94.1	135.7	356.7	54.2	44.1	98.3	14.4	112.7	159.5
1974 ..	9.4	6.2	15.6	203.9	40.1	17.3	9.3	31.3	2.2	35.1	3.6	98.8	138.9	342.8	45.5	30.5	76.0	17.6	93.6	188.2

a/ For 1965 to 1969, compiled from IFI report - Estudio de Prefactibilidad para una planta Siderurgica integrada en la costa Atlantica, Tomo I, Oct. 1970. For 1970 to 1974, information collected during field survey.

b/ Includes PDR wires shown in brackets.

Appendix 3-7

PAST IMPORTS AND EXPORTS OF ORDINARY STEEL
(tons)

Category		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
IMPORTS a/											
Semis ..	..	16 950	35 606	1	25 043	39 252	39 380	76 250	16 092	-	478
Non-flats											
Profiles ..	..	3 907	8 473	3 031	5 139	4 751	6 100	7 090	4 449	2 195	8 880
Bars and rods ..	..	2 545	10 448	5 958	2 755	20 697	27 372	50 849	8 921	756	5 491
Wires ..	..	3 414	3 693	1 701	2 716	3 272	2 966	1 389	1 926	2 371	2 185
Sub-total	..	9 866	22 614	10 690	10 610	28 720	36 438	59 328	15 296	5 322	16 436
Flats											
Strip ..	..	4 075	6 325	3 348	5 699	6 132	5 395	3 344	4 901	2 997	-
Hot rolled and cold rolled sheets	..	51 818	80 678	30 376	66 715	113 277	121 958	125 419	140 241	136 090	194 138
Hot rolled coil ..	..	7 997	34 470	7 173	20 282	32 218	19 387	26 321	33 751	31 368	33 306
Coated plates ..	..	29 704	69 202	26 695	32 636	28 369	32 735	28 122	22 488	13 844	20 634
Sub-total	..	93 594	190 675	67 592	125 332	179 996	179 475	183 206	201 381	184 299	248 078
Others											
Pipes and tubes, fittings etc	..	10 279	18 030	60 662	26 108	20 600	26 743	25 191	12 206	13 716	38 250
Rails and railway track materials	..	4 445	3 139	157	31	29 132	30 190	1 736	749	196	6 553
Sub-total	..	14 724	21 169	60 819	26 139	49 732	56 933	26 927	12 955	13 912	44 803
Total Imports	..	135 114	270 124	139 102	187 124	297 954	312 724	345 711	249 213	206 310	312 644
EXPORTS											
Bars and rods ..	..	-	-	-	-	-	2 700b/	1 500b/	5 500c/	20 400d/	3 900e/
Profiles ..	..	-	-	-	-	-	20b/	-	-	1 900d/	200e/
Total Exports	..	-	-	-	-	-	2 720	1 500	5 500	22 300	4 100

a/ Compiled from Anuario Comercio Exterior, DANE
b/ From ILAFA Anuario Estadistico
c/ As indicated by SIDEMSA and PDR
d/ As indicated by SIDEMSA
e/ As indicated by SIDELPA

Appendix 3-8

APPARENT CONSUMPTION OF ORDINARY STEEL[a]
(thousand tons)

Description		1965 Prodn	1965 Import	1965 Export	1965 A.C.	1966 Prodn	1966 Import	1966 Export	1966 A.C.	1967 Prodn	1967 Import	1967 Export	1967 A.C.	1968 Prodn	1968 Import	1968 Export	1968 A.C.	1969 Prodn	1969 Import	1969 Export	1969 A.C.
Non-flat																					
Profiles	..	37.1	3.9	-	41.0	34.9	8.5	-	43.4	33.4	3.0	-	36.4	33.5	5.1	-	38.6	35.3	4.7	-	40.0
Bars and rods	..	125.8	2.5	-	128.3	101.8	10.4	-	112.2	106.0	5.9	-	111.9	118.6	2.7	-	121.3	152.6	20.7	-	173.3
Wires	..	40.7	3.4	-	44.1	40.9	3.7	-	44.6	43.5	2.0	-	45.5	36.2	2.7	-	38.9	45.0	3.5	-	48.5
Sub-total	..	203.6	9.8	-	213.4	177.6	22.6	-	200.2	182.9	10.9	-	193.8	188.3	10.5	-	198.8	232.9	28.5	-	261.8
Flat																					
Strip	..	-	4.1	-	4.1	-	6.3	-	6.3	-	3.3	-	3.3	-	5.7	-	5.7	-	6.1	-	6.1
Hot and cold rolled sheets		18.1	51.8	-	69.9	23.6	80.7	-	104.3	22.6	30.4	-	53.0	22.3	66.7	-	[illegible]	23.6	113.3	-	136.9
Hot rolled coil	..	-	8.0	-	8.0	-	34.5	-	34.5	-	7.2	-	7.2	-	20.3	-	20.3	-	32.0	-	32.0
Coated plates	..	-	29.7	-	29.7	-	69.2	-	69.2	-	26.7	-	26.7	-	32.6	-	32.6	-	28.4	-	28.4
Sub-total	..	18.1	93.6	-	111.7	23.6	190.7	-	214.3	22.6	67.6	-	90.2	22.3	125.3	-	147.6	23.6	179.8	-	203.4
Other																					
Pipes and tubes, fittings		-	10.2	-	10.2	-	18.0	-	18.0	-	60.7	-	60.7	-	26.1	-	26.1	-	20.6	-	20.6
Rails and railway track materials	..	1.3	4.4	-	5.7	1.2	3.1	-	4.3	0.6	0.2	-	0.8	-	-	-	-	-	29.2	-	29.2
Sub-total	..	1.3	14.6	-	15.9	1.2	21.1	-	22.3	0.6	60.9	-	61.5	-	26.1	-	26.1	-	49.8	-	49.8
Total	..	223.0	118.0	-	341.0	202.4	234.4	-	436.8	206.1	139.4	-	345.5	210.6	161.9	-	372.5	256.5	258.7	-	515.2

Description		1970 Prodn	1970 Import	1970 Export	1970 A.C.	1971 Prodn	1971 Import	1971 Export	1971 A.C.	1972 Prodn	1972 Import	1972 Export	1972 A.C.	1973 Prodn	1973 Import	1973 Export	1973 A.C.	1974 Prodn	1974 Import	1974 Export	1974 A.C.
Non-flat																					
Profiles	..	28.3	6.1	-	34.4	42.4	7.1	-	49.5	51.6	4.4	-	56.0	46.1	2.2	1.9	46.4	34.8	8.8	0.3	43.3
Bars and rods	..	159.1	27.4	2.7	183.8	172.9	50.8	1.5	222.2	161.1	8.9	5.5	164.5	125.3	0.8	20.4	105.7	141.1	5.5	3.8	142.8
Wires	..	58.6	3.6	-	62.2	41.5	3.5	-	45.0	50.2	5.4	-	55.6	64.5	5.2	-	69.7	57.7	5.0	-	62.7
Sub-total	..	246.0	37.1	2.7	280.4	256.8	61.4	1.5	316.7	262.9	18.7	5.5	276.1	235.9	8.2	22.3	221.8	233.6	19.3	4.1	248.8
Flat																					
Strip	..	-	5.4	-	5.4	-	3.3	-	3.3	-	4.9	-	4.9	-	3.0	-	3.0	-	-	-	-
Hot and cold rolled sheets		17.9	122.0	-	139.9	30.1	125.4	-	155.5	25.2	140.2	-	165.4	20.8	136.1	-	156.9	30.6	194.1	-	224.7
Hot rolled coil	..	-	19.4	-	19.4	-	26.3	-	26.3	-	33.7	-	33.7	-	31.4	-	31.4	-	33.3	-	33.3
Coated plates	..	-	32.7	-	32.7	-	28.1	-	28.1	-	22.5	-	22.5	-	13.8	-	13.8	-	20.6	-	20.6
Sub-total	..	17.9	179.5	-	197.4	30.1	183.1	-	[illegible]	25.2	201.3	-	226.5	20.8	184.3	-	205.1	30.6	248.0	-	278.6
Other																					
Pipes and tubes, fittings		-	26.7	-	26.7	-	25.2	-	25.2	-	12.2	-	12.2	-	13.7	-	13.7	-	38.2	-	38.2
Rails and railway track materials	..	0.2	30.2	-	30.4	0.4	1.7	-	2.1	-	0.8	-	0.8	1.1	0.2	-	1.3	-	6.6	-	6.6
Sub-total	..	0.2	56.9	-	57.1	0.4	26.9	-	27.3	-	13.0	-	13.0	1.1	13.9	-	15.0	-	44.8	-	44.8
Total	..	264.1	273.5	2.7	534.9	287.3	271.4	1.5	557.2	288.1	233.0	5.5	515.6	257.8	206.4	22.3	441.9	264.2	312.1	4.1	572.2

a/ Domestic steel production figures has been taken from Appendix 3-6. Imports and exports figures have been taken from Appendix 3-7.

Appendix 3-9

DEMAND FOR ORDINARY STEEL IN 1990
(tons)

Sector		Unit of output	Target	Profiles: Beams	Profiles: Channels	Profiles: Angles	Profiles: Tees	Bars/rods	Wires	Plates	HR sheets/strip	CR sheets/strip	Galvanized sheets	Tinplate	Pipes/tubes	Total
I. TRANSPORT EQUIPMENT																
1. Wagons	..	Nos	1 055	433	2 321	105	17	864	-	4 410	-	995	-	-	36	8 441
2. Coaches	..	Nos	50	-	-	-	-	58	-	203	189	-	-	-	-	450
3. Trucks	..	Nos	16 000	-	280	424	160	1 278	-	4 260	8 480	424	424	-	280	16 000
4. Buses	..	Nos	9 250	-	-	490	-	2 063	-	4 116	12 395	777	675	-	750	21 875
5. Jeeps and station wagons	..	Nos	11 000	-	-	-	-	116	6	69	1 868	275	-	-	160	2 476
6. Bicycles	..	Nos	200 000	-	-	-	-	1 092	336	-	1 232	84	-	-	616	3 360
7. Motor cycles	..	Nos	36 500	-	-	-	-	331	45	306	1 639	226	-	-	307	[illegible]
8. Cars	..	Nos	60 000	-	-	-	-	336	81	30	1 800	100	-	-	33	2 400
9. Car engines	..	Nos	36 000	-	-	90	-	339	-	2 760	27	459	-	-	45	3 700
10. Trailers	..	Nos	10 000	-	3 915	15 000	-	-	-	1 420	-	7 915	-	-	-	28 250
11. Automobile ancillaries	..	Million pesos	7 500	-	-	-	-	225	-	5 175	559	713	713	-	116	[illegible]
Sub-total (I)	..			433	6 536	[illegible]	177	6 636	[illegible]	[illegible]	[illegible]	11 246	1 812	-	[illegible]	[illegible]
II. ELECTRICAL EQUIPMENT																
12. Transformers	..	MVA	960	44	[illegible]	413	-	215	-	1 536	-	370	-	-	1 097	4 417
13. Switchgear & control gear	..	Million pesos	70	-	24	61	-	91	-	50	357	-	-	-	70	653
14. Electric fan	..	Nos	17 000	-	-	-	-	37	-	-	9	68	-	-	-	114
15. Electric motors	..	'000 kW	1 500	-	-	-	-	9	-	-	7	2	-	-	-	18
16. Air conditioner	..	Nos	8 000	-	14	22	9	22	-	-	162	-	87	-	3	319
17. Refrigerator domestic	..	Nos	315 000	-	-	-	-	410	851	-	25 200	-	-	-	1 260	27 721
18. Refrigerator commercial	..	Nos	19 000	-	-	-	-	25	51	-	1 520	-	-	-	76	1 672
19. Washing machine	..	Nos	16 500	-	-	-	-	-	-	-	1 007	-	-	-	-	1 007
20. Electric stoves	..	Nos	54 000	-	-	-	-	-	-	-	1 780	-	-	-	-	1 780
21. Gas stoves	..	Nos	27 000	-	-	-	-	-	-	-	1 577	-	-	-	-	1 577
22. Water heaters	..	Nos	88 000	-	-	-	-	-	88	-	702	-	-	-	-	[illegible]
23. Cooking ranges																
- gas	..	Nos	15 000	-	-	-	-	-	-	-	900	-	-	-	-	900
- electrical	..	Nos	70 000	-	-	-	-	-	-	-	4 000	-	-	-	-	4 000
24. Water coolers	..	Nos	12 500	-	-	50	-	-	-	-	171	275	-	-	-	[illegible]
25. ACSR cables	..	Tons	2 000	-	-	-	-	-	700	-	-	-	-	-	-	700
26. House service meters	..	Nos	203 712	-	-	-	-	18	-	-	220	4	-	-	-	236
27. T.V. sets (19")	..	'000 Nos	6	-	-	-	-	-	-	-	8	-	-	-	-	8
28. Radio receivers	..	'000 Nos	201 400	-	-	-	-	6	30	-	50	-	-	-	-	86
Sub-total (II)	..			44	840	546	9	828	1 780	1 586	37 728	728	87	-	2 446	46 536

Appendix 3-9 (continued)

Sector		Unit of output	Target	Profiles: Beams	Profiles: Channels	Profiles: Angles	Profiles: Tees	Bars/rods	Wires	Plates	CR sheets/strip	HR sheets/strip	Galvanised sheets	Tinplate	Pipes/tubes	Total
III. INDUSTRIAL & AGRICULTURAL MACHINERY																
29. Weighing machinery	..	Million pesos	32.10	26	53	52	2	369	-	292	34	51	3	-	-	882
30. Agricultural tractors	..	Nos	8 885	-	395	70	-	2 894	-	2 310	70	2 079	-	-	-	7 818
31. Stationary diesel engines	..	Nos	5 000	-	-	-	-	497	-	-	-	84	-	-	-	581
32. Cranes	..	Tons	3 660	154	933	1 043	14	408	-	282	-	57	-	-	-	2 891
33. Passenger & industrial lifts	..	Nos	250	70	80	195	-	143	-	105	93	48	-	-	-	734
34. Industrial boilers	..	Million pesos	364.1	-	-	-	-	-	-	7 282	-	-	-	-	3 641	10 923
35. Concrete mixers	..	Nos	510	-	20	20	-	-	-	163	-	-	-	-	-	203
36. Ventilation equipment	..	Million pesos	12	-	-	24	12	-	-	-	-	-	64	-	-	100
37. Air compressor	..	Million Pesos	150	-	-	3	-	45	-	41	-	11	-	-	-	100
38. Power driven pumps	..	Nos	55 000	-	-	-	-	946	-	-	-	-	-	-	374	1 320
39. Textile machinery	..	Million pesos	25	25	13	18	-	125	-	270	20	5	-	-	-	476
40. Cement machinery	..	Million pesos	9.6	10	4	5	-	17	-	91	-	7	-	-	-	134
41. Sugar machinery	..	Million pesos	1.0	1	1	-	-	1	-	5	-	-	-	-	1	9
42. Machine tools	..	Million pesos	50	2	2	33	-	47	5	71	7	10	-	-	48	225
43. Machine tool accessories	..	Million pesos	1.6	-	-	-	-	11	-	-	-	-	-	-	-	11
Agricultural implements																
44. Ploughs	..	Nos	2 500	-	-	280	-	61	-	125	-	-	-	-	-	466
45. Harrows	..	Nos	1 700	-	32	283	-	281	-	32	-	-	-	-	107	735
46. Planters	..	Nos	860	-	-	120	-	242	-	114	-	-	-	-	58	534
47. Cultivators	..	Nos	800	-	-	48	-	-	-	-	-	-	-	-	-	48
48. Cutters	..	Nos	1 500	-	-	2	-	32	-	48	-	-	-	-	8	84
49. Trailers	..	Nos	580	-	-	-	-	66	-	56	-	-	-	-	-	122
Sub-total (III)	..			288	1 533	2 196	28	6 385	5	11 287	224	2 352	87	-	4 231	28 436
IV. METAL PRODUCTS																
50. Steel doors and windows	..	Tons	14 000	-	-	560	-	252	-	84	13 972	-	-	-	538	15 400
51. Furniture	..	Tons	12 289	-	-	-	-	-	-	-	10 814	-	-	-	2 704	13 518
52. Kerosene stoves	..	Nos	222 000	-	-	-	-	-	-	-	111	-	-	-	-	111
53. Gas bottles	..	Nos	151 000	-	-	-	-	151	-	-	1 661	-	-	-	151	1 963
54. Tin cans	..	Tons	100 000	-	-	-	-	-	-	-	-	-	-	110 000	-	110 000
55. Bolts, nuts and screws	..	Tons	9 600	-	-	-	-	7 680	3 264	-	-	-	-	-	-	10 944
56. Rivets	..	Tons	1 700	-	-	-	-	1 360	578	-	-	-	-	-	-	1 938
57. Wire nails	..	Tons	20 000	-	-	-	-	-	20 400	-	-	-	-	-	-	20 400
58. Barbed wire	..	Tons	29 000	-	-	-	-	-	29 580	-	-	-	-	-	-	29 580
59. Wire netting and wire products	..	Tons	18 000	-	-	-	-	-	19 800	-	-	-	-	-	-	19 800
60. Sewing machinery	..	'000 Nos	52	-	-	-	-	178	-	4	47	47	-	-	-	276
61. Hand tools	..	Tons	3 500	-	-	-	-	3 045	-	-	-	-	-	-	-	3 045
62. Transmission towers	..	Tons	6 090	-	303	5 748	-	454	-	151	-	-	-	-	-	6 696
63. Expanded metals	..	Tons	1 300	-	-	-	-	-	-	-	-	1 443	-	-	-	1 443
64. Drums and containers	..	Tons	12 500	-	-	-	-	-	-	-	13 125	-	-	-	-	13 125
65. Oil tanks	..	Tons	13 800	-	-	1 891	-	-	-	6 320	-	6 279	-	-	-	14 490
66. Water tanks	..	Tons	8 000	-	-	1 886	-	-	-	3 664	-	1 640	-	-	-	[illegible]
Sub-total (IV)	..			-	303	9 895	-	13 180	73 622	10 223	39 730	11 489	-	110 000	3 387	271 [illegible]
Total (I+II+III+IV)	..			765	9 280	28 226	234	26 810	73 755	45 905	105 893	25 786	1 986	110 000	28 426	442 866

Appendix 3-9 (continued)

Sector		Unit of output	Target	Profiles: Beams	Profiles: Channels	Profiles: Angles	Profiles: Tees	Bars/rods	Wires	Plates	CR sheets/strip	HR sheets/strip	Galvanised sheets	Tinplate	Pipes/tubes	Total
V. CONSTRUCTION SECTOR																
67. Agriculture and allied activities	..	Million pesos	11 829	4 980	12 164	6 033	2 401	13 130	-	482	-	13 154	16 384	-	26 006	94 638
68. Large and medium industries and mining	..	Million pesos	8 959	5 482	11.736	9 183	-	2 105	14 183	10 482	-	9 138	19 710	-	3 091	85 110
69. Oil and gas	..	Million pesos	9 800	2 880	5 760	5 760	365	4 990	-	1 440	-	175	789	-	13 401	35 100
70. Social services	..	Million pesos	31 765	-	2 376	4 765	1 112	164 563	12 204	-	-	5 908	18 741	-	39 177	248 886
71. Transport	..	Million pesos	10 546	1 804	1 255	2 742	-	135 447	8 742	-	-	20 222	19 616	-	-	189 828
72. Communication	..	Million pesos	1 037	86	2 541	685	-	7 349	685	-	-	4 821	686	-	-	16 891
73. Power - Hydal	..	100 MW	3.1	3 720	868	1 042	19	9 920	-	341	-	180	340	-	930	17 360
74. Rail transport Rails -14 416 Rly materials - 2 544	..	Km	424	-	-	-	-	5 936 (sleepers)	-	-	-	-	-	-	-	22 896
Sub-total (V)	..			18 952	36 720	30 230	3 897	343 020	35 816	12 665	-	53 598	75 166	-	88 623	710 603
Grand Total	..			59 717	45 920	58 436	4 111	369 830	111 569	58 570	105 803	79 384	78 970	130 000	95 040	1 353 448

Appendix 3-10

DEMAND FOR ORDINARY STEEL IN 1985

(tons)

Sector	Unit of output	Target	Profiles: Beams	Profiles: Channels	Profiles: Angles	Profiles: Tees	Bars/rods	Wires	Plates	CR sheets/strip	HR sheets/strip	Galvanised sheets	Tin-plate	Pipes/tubes	Total
I. TRANSPORT EQUIPMENT															
1. Wagons	Nos	1 807	741	3 979	316	29	1 447	-	7 553	-	334	-	-	61	14 456
2. Coaches	Nos	50	-	-	-	-	58	-	203	189	-	-	-	-	450
3. Trucks	Nos	25 000	-	600	1 000	300	3 000	-	10 000	20 000	1 000	1 000	-	600	37 500
4. Buses	Nos	14 900	-	-	767	-	3 234	-	6 453	19 430	1 218	1 099	-	1 169	33 350
5. Jeeps and station wagons	Nos	15 800	-	-	-	-	166	8	100	2 654	395	-	-	232	3 555
6. Bicycles	Nos	400 000	-	-	-	-	1 540	480	-	1 760	120	-	-	800	4 800
7. Motor cycles	Nos	43 300	-	-	-	-	477	56	485	2 097	281	-	-	305	3 691
8. Cars	Nos	100 000	-	-	-	-	15 500	970	1 300	50 000	8 000	-	-	1 150	77 000
9. Car engines	Nos	50 000	-	-	305	-	1 125	-	9 200	90	1 525	-	-	155	12 400
10. Trailers	Nos	15 000	-	5 872	22 500	-	-	-	2 130	-	11 873	-	-	-	42 375
11. Automobile ancillaries	Million pesos	12 000	-	-	-	-	340	-	8 280	894	1 140	1 140	-	186	12 [illegible]
Sub-total (I)			741	10 447	24 888	329	26 887	1 514	45 784	97 074	25 886	3 199	-	4 858	241 567
II. ELECTRICAL EQUIPMENT															
12. Transformers	MVA	2 000	92	1 070	860	-	448	-	3 200	-	770	-	-	2 160	9 200
13. Switchgear and controlgear	Million pesos	174	-	60	151	-	226	-	126	887	-	-	-	174	1 624
14. Electric fan	Nos	22 000	-	-	-	-	48	-	-	11	88	-	-	-	147
15. Electric motors	'000 kW	3 100	-	-	-	-	1 934	-	-	1 364	422	-	-	-	3 720
16. Air conditioners	Nos	12 500	-	20	35	14	35	-	-	223	-	43	-	5	375
17. Refrigerators (domestic)	Nos	1 100 000	-	-	-	-	1 430	2 970	-	88 000	-	-	-	4 400	96 800
18. Refrigerator (commercial)	Nos	65 000	-	-	-	-	85	175	-	5 200	-	-	-	260	5 720
19. Washing machine	Nos	22 200	-	-	-	-	-	-	-	1 354	-	-	-	-	1 354
20. Electric stoves	Nos	82 000	-	-	-	-	-	-	-	2 624	-	-	-	-	2 624
21. Gas stoves	Nos	33 000	-	-	-	-	-	-	-	1 927	-	-	-	-	1 927
22. Water heaters	Nos	160 900	-	-	-	-	-	161	-	1 447	-	-	-	-	1 608
23. Cooking ranges gas	Nos	36 000	-	-	-	-	-	-	-	2 160	-	-	-	-	2 160
24. Cooking ranges elec.	Nos	144 000	-	-	-	-	-	-	-	8 410	-	-	-	-	8 410
25. Water coolers	Nos	20 000	-	-	80	-	6	-	-	274	440	-	-	-	800
26. ACSR cables	Tons	2 550	-	-	-	-	-	893	-	-	-	-	-	-	893
27. House service meters	Nos	332 000	-	-	-	-	20	-	-	359	7	-	-	-	386
28. T.V. sets	'000 Nos	12	-	-	-	-	1	-	-	4	-	-	-	-	5
29. Radio receivers	'000 Nos	284.75	-	-	-	-	6	43	-	71	-	-	-	-	120
Sub-total (II)			92	1 750	1 126	14	4 239	4 242	3 326	114 315	1 727	43	-	6 999	137 873

Appendix 3-10 (continued)

Sector	Unit of output	Output	Sections: Beams	Sections: Channels	Sections: Angles	Sections: Tees	Bars/rods	Wires	Plates	HR sheets/strips	CR sheets/strips	Galvanised sheets	Tin-plate	Pipes/tubes	Total
III. INDUSTRIAL & AGRICULTURAL MACHINERY															
30. Weighing machinery	Million pesos	56.97	46	96	91	3	481	-	595	64	98	5	-	-	1 536
31. Agricultural tractors	Nos	13 506	-	681	107	-	4 488	-	3 577	107	3 148	-	-	-	11 988
32. Stationary diesel engine	Nos	780	-	-	-	-	70	-	-	-	12	-	-	-	82
33. Cranes	Tons	6 450	871	1 665	1 050	24	780	-	497	-	101	-	-	-	5 006
34. Passenger and industrial lifts	Nos	980	140	140	390	-	285	-	210	105	95	-	-	-	1 465
35. Industrial boilers	Million pesos	642	-	-	-	-	-	-	12 840	-	-	-	-	6 420	19 260
36. Concrete mixers	Nos	715	-	20	29.0	-	-	-	200	-	-	-	-	-	286
37. Ventilation equipment	Million pesos	24	-	-	48	24	-	-	-	-	-	168	-	-	240
38. Air compressor	Million pesos	480	-	-	10	-	145	-	132	-	35	-	-	-	322
39. Power driven pumps	Nos	115 000	-	-	-	-	1 970	-	-	-	-	-	-	702	2 716
40. Textile machinery	Million pesos	40	40	20	20	-	200	-	432	20	8	-	-	-	740
41. Cement machinery	Million pesos	21.20	25	9	12	-	38	-	888	-	15	-	-	-	897
42. Sugar machinery	Million pesos	2	2	2	1	-	2	-	11	-	-	-	-	2	20
43. Machine tools	Million pesos	90	4	4	59	-	85	9	128	13	17	-	-	84	405
44. Machine tool accessories	Million pesos	2.8	-	-	-	-	10	-	-	-	-	-	-	-	10
Agricultural Implements															
45. Ploughs	Nos	3 300	-	-	370	-	80	-	164	-	-	-	-	-	614
46. Harrows	Nos	2 200	-	41	346	-	343	-	41	-	-	-	-	139	950
47. Planters	Nos	1 150	-	-	160	-	305	-	155	-	-	-	-	70	714
48. Cultivators	Nos	1 100	-	-	66	-	-	-	-	-	-	-	-	-	66
49. Cutters	Nos	2 000	-	-	2	-	42	-	64	-	-	-	-	2	110
50. Trailers	Nos	900	-	-	-	-	105	-	80	-	-	-	-	-	184
Sub-total (III)			526	2 686	3 377	51	9 518	9	20 281	308	3 538	173	-	7 388	47 118
IV. METAL PRODUCTS															
51. Steel doors and windows	Tons	30 000	-	-	1 200	-	540	-	180	29 940	-	-	-	1 140	33 000
52. Furniture	Tons	20 010	-	-	-	-	-	-	-	17 600	-	-	-	4 402	22 011
53. Kerosene stoves	Nos	297 000	-	-	-	-	-	-	-	119	-	-	-	-	119
54. Gas bottles	Nos	197 000	-	-	-	-	197	-	-	2 167	-	-	-	197	2 561
55. Tincans	Tons	159 000	-	-	-	-	-	-	-	-	-	-	175 000	-	175 000
56. Bolts, nuts and screws	Tons	19 200	-	-	-	-	15 300	6 500	-	-	-	-	-	-	21 800
57. Rivets	Tons	3 500	-	-	-	-	2 800	1 190	-	-	-	-	-	-	3 990
58. Wire nails	Tons	38 000	-	-	-	-	-	38 760	-	-	-	-	-	-	38 760
59. Barbed wire	Tons	40 000	-	-	-	-	-	40 000	-	-	-	-	-	-	40 000
60. Wire netting and wire products	Tons	30 000	-	-	-	-	-	33 000	-	-	-	-	-	-	33 000
61. Sewing machinery	'000 Nos	84	-	-	-	-	286	-	7	76	76	-	-	-	445
62. Hand tools	Tons	5 000	-	-	-	-	4 584	-	-	-	-	-	-	-	4 584
63. Transmission towers	Tons	3 400	-	170	3 250	-	235	-	85	-	-	-	-	-	3 740
64. Expanded metals	Tons	2 300	-	-	-	-	-	-	-	-	2 553	-	-	-	2 553
65. Drums and containers	Tons	20 000	-	-	-	-	-	-	-	21 000	-	-	-	-	21 000
66. Oil tanks	Tons	22 000	-	-	3 085	-	-	-	10 113	-	10 046	-	-	-	23 184
67. Water tanks	Tons	13 000	-	-	1 800	-	-	-	6 300	-	6 300	-	-	-	14 400
Sub-total (IV)			-	170	9 346	-	23 942	120 030	16 705	70 911	18 956	-	175 000	5 738	441 866
Total (I+II+III+IV)			1 328	14 503	38 227	384	64 588	186 843	83 006	208 088	58 385	1 415	175 000	83 085	887 588

Appendix 3-10 (continued)

Sector	Unit of output	Demand	Profiles: Beams	Profiles: Channels	Profiles: Angles	Profiles: Tees	Bars/rods	Wires	Plates	HR sheets/strip	CR sheets/strip	Galvanised sheets	Tin-plate	Pipes/tubes	Total
V. [illegible] SECTOR															
68. Agriculture & allied activities	Million pesos	23 [illegible]	9 997	24 340	12 [illegible]	4 [illegible]	86 [illegible]	-	[illegible]	-	86 [illegible]	32 [illegible]	-	58 [illegible]	1[illegible]9 [illegible]
69. Large & medium industries & mining	Million pesos	13 145	8 065	17 [illegible]	13 474	-	3 [illegible]	20 [illegible]	15 3[illegible]	-	73 4[illegible]	[illegible] 919	-	4 534	124 [illegible]
70. Oil and gas	Million pesos	14 4[illegible]	4 [illegible]	9 216	9 216	589	7 344	-	2 304	-	[illegible]	1 166	-	21 448	56 140
71. Social services	Million pesos	50 969	-	3 [illegible]	7 645	1 704	243 999	19 971	-	-	9 479	30 [illegible]	-	62 913	399 [illegible]
72. Transport	Million pesos	17 840	3 051	2 1[illegible]	4 [illegible]	-	[illegible] 119	14 709	-	-	34 277	33 104	-	-	381 1[illegible]
73. Communication	Million pesos	1 095	[illegible]	2 904	606	-	7 470	606	-	-	4 906	606	-	-	17 144
Power															
74. Hydel	100 MW	7.4	8 [illegible]	2 072	2 406	44	23 [illegible]	-	814	-	489	815	-	2 [illegible]	41 440
75. Thermal	100 MW	0.90	774	170	214	2	2 745	-	70	-	35	70	-	[illegible]	4 3[illegible]
76. Rail transport Rails - 11 606 Railway materials 2 064	Km	344	-	-	-	-	4 806 (sleepers)	-	-	-	-	-	-	-	18 976
Sub-total (IV)			35 4[illegible]	61 574	50 431	7 214	[illegible]	55 866	19 323	-	[illegible]	1[illegible]7 526	-	143 371	1 178 181
Total			36 7[illegible]	76 547	[illegible]	7 [illegible]	633 [illegible]	181 [illegible]	104 [illegible]	288 [illegible]	139 1[illegible]	138 9[illegible]	175 [illegible]	168 456	2 0[illegible]9 744

Appendix 3-11

TOTAL DEMAND FOR ORDINARY STEEL

(tons)

Category	Manufacturing sector		Repair and maintenance a/		Small scale industries b/		Total manufacturing sector		Construction sector		Stock c/		Total		Non-commercial d/		Grand total		Adopted	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
(1)	(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)	
Beams ..	766	1 399	77	136	38	95	880	1 590	18 952	35 405	190	370	20 030	37 363	1 000	1 960	21 032	39 231	20 000	35 000
Channels ..	9 200	14 973	920	1 497	460	1 048	10 580	17 518	36 720	61 574	473	791	47 773	79 883	2 389	3 994	50 162	83 877	50 000	80 000
Angles ..	28 226	38 937	2 823	3 894	1 411	2 726	32 460	45 557	30 210	50 431	627	960	63 297	96 948	3 165	4 847	66 462	101 795	65 000	100 000
Tees ..	214	384	21	39	11	38	246	461	3 997	7 214	41	77	4 184	7 752	209	388	4 393	8 140	4 000	8 000
Wires ..	75 795	126 843	7 576	12 684	3 789	8 823	87 119	147 470	35 814	55 865	1 229	2 029	124 162	205 364	6 208	10 268	130 370	215 636	130 000	215 000
Bars and rods ..	26 890	64 978	2 689	6 458	1 341	4 970	30 832	75 956	343 020	568 522	3 739	6 441	377 591	650 419	18 880	32 521	396 471	682 940	400 000	700 000
Rails ..	-	-	-	-	-	-	-	-	14 416	11 696	144	117	14 560	11 813	728	591	15 288	12 404	15 000	12 000
Building materials ..	-	-	-	-	-	-	-	-	2 544	2 064	26	21	2 570	2 085	129	104	2 699	2 189	3 000	2 000
Plates ..	45 905	85 896	4 591	8 584	2 295	5 953	52 791	99 493	12 665	19 772	655	1 189	66 111	120 654	3 306	6 023	69 417	126 677	70 000	125 000
Cold rolled sheets and strip ..	105 893	288 698	10 589	28 870	5 295	19 789	121 777	330 757	-	-	1 218	3 308	122 995	334 065	6 150	16 703	129 145	350 768	125 000	350 000
Hot rolled sheets and strip ..	25 736	50 105	2 573	5 011	1 286	3 507	29 595	58 623	53 998	89 054	832	1 477	84 015	149 154	4 201	7 458	88 216	156 612	90 000	160 000
Galvanized sheets ..	1 926	3 415	193	342	96	239	2 215	3 996	76 [illegible]	127 555	784	1 316	79 143	132 867	3 957	6 643	83 100	139 510	80 000	135 000
Tinplate ..	110 000	175 000	-	-	5 500	12 250	115 500	187 250	-	-	1 155	1 873	116 655	189 123	5 833	9 456	122 488	198 579	120 000	190 000
Pipes and tubes ..	12 436	25 885	1 243	2 588	621	1 756	14 300	30 230	82 683	143 371	969	1 737	97 952	174 448	4 896	8 722	102 776	183 170	100 000	180 000
Total ..	442 846	887 602	33 887	88 864	22 142	60 734	498 875	987 681	719 492	1 172 121	12 099	21 700	1 2[illegible]	2 191 348	61 851	109 566	1 [illegible]	2 300 [illegible]	1 324 000	2 [illegible]

a/ Assumed at the rate of 10 per cent.
b/ Assumed at the rate of 5 per cent and 7 per cent of (2) for 1980 and 1985 respectively.
c/ Assumed at the rate of 1 per cent of (5) plus (6).
d/ Assumed at the rate of 5 per cent of (8).

Appendix 3-12

INDIRECT IMPORTS AND EXPORTS OF ORDINARY STEELS
(thousand tons)

Year	Transport equipment		Electrical equipment		Industrial and agricultural machinery		Metal products		Total		Apparent indirect consumption
	Indirect imports	Indirect exports	Indirect imports	Indirect exports	Indirect imports	Indirect exports	Indirect imports	Indirect exports	Indirect imports	Indirect exports	
1965	38.4	-	4.2	-	19.8	1.1	17.9	1.6	80.3	2.7	77.6
1966	43.7	-	4.8	0.4	15.6	1.4	27.6	1.6	91.7	33.4	88.0
1967	58.9	-	4.9	-	18.8	1.5	26.5	1.6	109.1	3.1	106.0
1968	43.7	-	7.0	0.3	21.2	1.7	24.0	1.5	95.9	3.5	92.4
1969	62.4	-	8.2	0.3	22.7	1.7	34.9	2.3	128.2	4.3	123.9
1970	69.4	0.8	9.2	0.3	22.8	1.6	44.2	2.4	145.6	5.1	140.0
1971	59.5	2.2	8.4	0.5	21.2	1.8	33.8	7.6	122.9	20.1	102.8
1972	51.7	1.4	6.9	0.6	17.1	3.1	29.8	5.4	105.5	10.5	90.0
1973	39.0	0.4	3.5	-	11.8	0.8	42.8	3.1	97.1	4.3	92.8

Appendix 3-13

APPARENT CONSUMPTION OF ALLOY AND SPECIAL STEELS
(thousand tons)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
I. PRODUCTION										
Bars and rods ..	-	-	3.8	7.1	16.0	19.7	14.8	12.1	14.4	17.6
Wire rods ..	3.3	3.3	3.5	2.9	3.6	5.9	4.7	3.4	4.5	4.4
Sub-total (I) ..	3.3	3.3	7.3	10.0	19.6	25.6	19.5	15.5	18.9	22.0
II. IMPORTS										
Forgings ..	-	-	0.2	-	-	0.3	-	-	0.9	2.0
Carbon constructional	1.6	4.2	2.5	5.8	7.3	10.4	7.1	7.5	11.0	12.6
High speed steel ..	-	-	-	-	-	-	-	-	-	-
Stainless steel ..	1.5	1.3	2.4	0.6	0.9	1.8	1.5	1.2	1.8	3.6
Silicon steel ..	0.3	0.5	1.6	1.0	0.8	1.6	0.3	0.2	0.2	3.1
Other alloy steels ..	3.8	8.1	4.6	7.3	9.7	13.9	8.2	7.2	8.2	2.6
Sub-total (II) ..	7.2	14.1	11.3	14.7	18.7	28.0	17.1	16.1	22.1	23.9
III. EXPORTS ..	-	-	-	-	-	0.4	1.7	0.4	1.9	1.6
APPARENT CONSUMPTION	10.5	17.4	18.6	24.7	38.3	53.2	34.9	31.2	39.1	44.3

Appendix 3-14

[illegible] OF CONSUMPTION OF ALLOY AND SPECIAL STEELS

(b)

Sector	Unit of output	Carbon constructional steels	Alloy constructional steels	Free cutting steels	Spring steels	Stainless steels	Electrode steel	Electric steel sheet	Total
I. TRANSPORT EQUIPMENT									
1. Wagons ..	Nos	-	-	-	300	-	-	-	300
2. Coaches ..	Nos	-	-	-	733	-	-	-	733
3. Trucks ..	Nos	138	243	8	330	-	-	-	719
4. Buses ..	Nos	138	243	8	330	-	-	-	719
5. Jeeps and station wagons ..	Nos	104	93	6	60	-	-	-	263
6. Bicycles ..	Nos	0.33	-	1.02	-	-	-	-	1.35
7. Motorcycles ..	Nos	13.84	-	3.78	-	-	-	-	17.66
8. Cars ..	Nos	81	162	73	35	-	-	-	351
9. Car engines (1980) ..	Nos	48	7	-	-	-	-	-	55
(1985) ..	Nos	95	14	-	-	-	-	-	109
10. Trailers ..	Nos	7	26	7	25	-	-	-	65
11. Automobile ancillaries	Million pesos	18	580	400	19	-	-	-	1 017
12. Leaf spring ..	Tons	-	-	-	1 100	-	-	-	1 100
II. ELECTRICAL EQUIPMENT									
13. Transformer ..	MVA	-	-	-	-	-	-	3 000	3 000
14. Switchgear and control gear ..	Million pesos	0.14	-	-	0.19	-	-	-	0.33
15. Electric fan ..	'000 Nos	10	10	-	-	-	-	-	20
16. Electric motor ..	'000 kW	250	-	250	-	-	-	1 400	1 900
17. Air conditioner ..	Nos	0.75	0.75	0.25	0.1	0.25	-	-	2.1
18. Refrigerator ..	Nos	-	-	-	0.66	2.5	-	-	3.16
19. Armoured cables ..	Tons	16	-	-	-	-	-	-	16
III. INDUSTRIAL AND AGRICULTURAL MACHINERY									
20. Weighing machinery ..	Million pesos	26	50.5	62	-	-	-	-	137
21. Agricultural tractors	Nos	-	80	60	200	-	-	-	340
22. Stationary diesel engine ..	Nos	120	60	15	-	-	-	-	195
23. Cranes ..	Tons	50	200	25	15	-	-	-	290
24. Passenger and industrial lifts ..	Nos	-	112.5	-	37.5	-	-	-	150
25. Industrial boilers ..	Million pesos	-	1 250	-	30.0	20	-	-	1 300
26. Air compressors ..	Million pesos	13	43	180	13	1	-	-	250
27. Power driven pumps ..	Nos	-	0.5	0.5	-	2.0	-	-	3
28. Textile machinery ..	Million pesos	97	117	156	19	38	-	-	427
29. Cement machinery ..	Million pesos	-	4.2	-	-	19	-	-	23.2
30. Sugar machinery ..	Million pesos	3	550	-	-	12	-	-	565
31. Machine tools ..	Million pesos	14	235	95	8	3	-	-	355
32. Machine tool accessories ..	Million pesos	15	-	515	-	-	-	-	530
Agricultural implements:									
33. Ploughs ..	Nos	40	-	-	-	-	-	-	40
34. Harrows ..	Nos	15	-	-	-	-	-	-	15
35. Trailers ..	Nos	-	-	-	1.3	-	-	-	1.3
IV. METAL PRODUCTS									
36. Furniture ..	Tons	-	-	-	-	5	-	-	5
37. Steel wire rope ..	Tons	1 100	-	-	-	-	-	-	1 100
38. Prestressed concrete strands ..	Tons	1 100	-	-	-	-	-	-	1 100
39. High tensile wire ..	Tons	1 100	-	-	-	-	-	-	1 100
40. Tyre wire ..	Tons	1 100	-	-	-	-	-	-	1 100
41. Bolts, nuts and screws	Tons	165	-	-	-	-	-	-	165
42. Sewing machinery ..	'000 Nos	65	375	60	-	-	-	-	500
43. Hand tools ..	Tons	125	125	-	-	-	-	-	250
44. Welding electrodes ..	Tons	-	-	-	-	-	700	-	700
45. Razor blades ..	Million Nos	-	-	-	-	200	-	-	200
46. Utensils ..	Tons	-	-	-	-	1 100	-	-	1 100

Appendix 3-15

[illegible] OF ALLOY AND SPECIAL STEELS IN [illegible]
(tons)

Sector		Unit of output	Output	Carbon constructional steels	Alloy constructional steels	Free cutting steels	Spring steels	Stainless steels	[illegible]	Electric steel sheet	Total
I.	TRANSPORT EQUIPMENT										
1.	Wagons ..	Nos	1 055	-	-	-	317	-	-	-	317
2.	Coaches ..	Nos	90	-	-	-	36	-	-	-	36
3.	Trucks ..	Nos	16 000	2 [illegible]	3 [illegible]	[illegible]	5 [illegible]	-	-	-	11 [illegible]
4.	Buses ..	Nos	9 250	1 277	2 [illegible]	74	3 [illegible]	-	-	-	6 [illegible]
5.	Jeeps and station wagons ..	Nos	11 000	1 144	1 [illegible]	66	[illegible]	-	-	-	2 [illegible]
6.	Bicycles ..	Nos	[illegible] 000	[illegible]	-	[illegible]	-	-	-	-	[illegible]
7.	Motor cycles ..	Nos	34 500	467	-	[illegible]	-	-	-	-	[illegible]
8.	Cars ..	Nos	60 000	-	-	-	-	-	-	-	-
9.	Car engines ..	Nos	30 000	1 440	210	-	-	-	-	-	1 650
10.	Trailers ..	Nos	10 000	70	260	70	290	-	-	-	690
11.	Automobile auxiliaries	Million pesos	7 500	135	4 350	3 000	143	-	-	-	7 [illegible]
12.	Leaf spring ..	Tons	4 [illegible]	-	-	-	4 [illegible]	-	-	-	4 [illegible]
	Sub-total (I) ..			[illegible]	11 [illegible]	[illegible]	[illegible]	-	-	-	[illegible]
II.	ELECTRICAL EQUIPMENT										
13.	Transformer ..	MVA	960	-	-	-	-	-	-	[illegible]	[illegible]
14.	Switchgear and control gear ..	Million pesos	70	-	-	-	-	-	-	-	-
15.	Electric fan ..	'000 Nos	17	-	-	-	-	-	-	-	-
16.	Electric motor ..	'000 kW	1 500	375	-	375	-	-	-	1 500	2 250
17.	Air conditioner ..	Nos	8 000	6	6	8	1	8	-	-	[illegible]
18.	Refrigerator domestic	Nos	315 000	-	-	-	[illegible]	700	-	-	[illegible]
19.	Refrigerator commercial ..	Nos	19 000	-	-	-	13	48	-	-	61
20.	Armoured cables ..	Tons	2 000	[illegible]	-	-	-	-	-	-	[illegible]
	Sub-total (II) ..			[illegible]	6	377	[illegible]	[illegible]	-	[illegible]	[illegible]
III.	INDUSTRIAL AND AGRICULTURAL MACHINERY										
21.	Weighing machinery ..	Million pesos	38.10	1	2	2	-	-	-	-	5
22.	Agricultural tractors	Nos	[illegible]	-	711	533	1 777	-	-	-	3 [illegible]
23.	Stationary diesel engines ..	Nos	500	60	30	8	-	-	-	-	[illegible]
24.	Cranes ..	Tons	3 [illegible]	183	738	[illegible]	54	-	-	-	1 [illegible]
25.	Passenger and industrial lifts ..	Nos	250	-	[illegible]	-	10	-	-	-	30
26.	Industrial boilers ..	Million pesos	364.1	-	455	-	11	7	-	-	473
27.	Air compressors ..	Million pesos	150	2	6	27	2	-	-	-	37
28.	Power driven pumps ..	Nos	55 000	-	[illegible]	[illegible]	-	[illegible]	-	-	[illegible]
29.	Textile machinery ..	Million pesos	85	2	3	5	-	1	-	-	11
30.	Cement machinery ..	Million pesos	9.6	-	-	-	-	-	-	-	-
31.	Sugar machinery ..	Million pesos	1	-	1	-	-	-	-	-	1
32.	Machine tools ..	Million pesos	50	1	14	5	-	-	-	-	20
33.	Machine tool accessories ..	Million pesos	1.6	-	-	1	-	-	-	-	1
	Agricultural implements:										
34.	Ploughs ..	Nos	2 500	120	-	-	-	-	-	-	120
35.	Harrows ..	Nos	1 700	26	-	-	-	-	-	-	26
36.	Trailers ..	Nos	580	-	-	-	1	-	-	-	1
	Sub-total (III) ..			[illegible]	2 [illegible]	791	1 [illegible]	[illegible]	-	-	[illegible]
IV.	METAL PRODUCTS										
37.	Furniture ..	Tons	12 [illegible]	-	-	-	-	61	-	-	61
38.	Steel wire rope ..	Tons	7 000	7 700	-	-	-	-	-	-	7 700
39.	Prestressed concrete strands ..	Tons	3 200	3 520	-	-	-	-	-	-	3 520
40.	High tensile wire ..	Tons	1 [illegible]	1 [illegible]	-	-	-	-	-	-	1 [illegible]
41.	Tyre wire ..	Tons	153	[illegible]	-	-	-	-	-	-	[illegible]
42.	Bolts, nuts and screws	Tons	9 600	1 [illegible]	-	-	-	-	-	-	1 [illegible]
43.	Sewing machinery ..	'000 Nos	58	3	[illegible]	3	-	-	-	-	[illegible]
44.	Hand tools ..	Tons	3 500	438	438	-	-	-	-	-	[illegible]
45.	Welding electrodes ..	Tons	10 600	-	-	-	-	-	7 480	-	7 480
46.	Razor blades ..	Million Nos	390	-	-	-	-	[illegible]	-	-	[illegible]
47.	Utensils ..	Tons	5 800	-	-	-	-	6 [illegible]	-	-	6 [illegible]
	Sub-total (IV) ..			15 [illegible]	[illegible]	3	-	6 [illegible]	7 [illegible]	-	[illegible]
	TOTAL ..			[illegible]	[illegible]	[illegible]	[illegible]	7 [illegible]	7 [illegible]	[illegible]	77 [illegible]

Appendix 3-16

DEMAND OF ALLOY AND SPECIAL STEELS IN 1985
(tons)

Sector	Unit of output	Target	Carbon constructional steels	Alloy constructional steels	Free cutting steels	Spring steels	Stainless steels	Electrode steels	Electric steel sheet	Total
I. TRANSPORT EQUIPMENT										
1. Wagons	Nos	1 807	-	-	-	548	-	-	-	548
2. Coaches	Nos	50	-	-	-	36	-	-	-	36
3. Trucks	Nos	25 000	3 450	6 075	800	8 250	-	-	-	17 975
4. Buses	Nos	14 500	2 001	3 584	117	4 784	-	-	-	10 486
5. Jeeps and station wagons	Nos	15 800	1 643	1 469	95	948	-	-	-	4 195
6. Bicycles	Nos	400 000	132	-	408	-	-	-	-	540
7. Motor cycles	Nos	43 300	586	-	161	-	-	-	-	747
8. Cars	Nos	100 000	8 100	16 200	7 300	3 500	-	-	-	35 100
9. Car engines	Nos	50 000	4 750	700	-	-	-	-	-	5 450
10. Trailers	Nos	15 000	105	390	105	375	-	-	-	975
11. Automobile ancillaries	Million pesos	12 000	216	6 960	4 800	228	-	-	-	12 204
12. Leaf spring	Tons	6 800	-	-	-	7 480	-	-	-	7 480
Sub-total (I)			20 980	35 318	13 186	26 143	-	-	-	95 630
II. ELECTRICAL EQUIPMENT										
13. Transformers	MVA	2 000	-	-	-	-	-	-	6 000	6 000
14. Switchgear and control gear	Million pesos	174	-	-	-	-	-	-	-	-
15. Electric fan	'000 Nos	22	-	-	-	-	-	-	-	-
16. Electric motors	'000 kW	3 100	775	-	775	-	-	-	3 100	4 650
17. Air conditioner	Nos	12 500	9	9	4	1	3	-	-	26
18. Refrigerator (domestic)	Nos	1 100 000	-	-	-	786	2 790	-	-	3 476
19. Refrigerator (commercial)	Nos	65 000	-	-	-	43	163	-	-	206
20. Armoured cables	Tons	2 550	56	-	-	-	-	-	-	56
Sub-total (II)			840	9	779	830	2 956	-	9 100	14 428
III. INDUSTRIAL AND AGRICULTURAL MACHINERY										
21. Weighing machinery	Million pesos	56.57	1	3	4	-	-	-	-	8
22. Agricultural tractors	Nos	13 536	-	1 082	812	2 705	-	-	-	4 599
23. Stationary diesel engines	Nos	700	84	42	11	-	-	-	-	137
24. Cranes	Tons	6 450	383	1 290	161	97	-	-	-	1 871
25. Passenger and industrial lifts	Nos	900	-	56	-	19	-	-	-	75
26. Industrial boilers	Million pesos	642	-	803	-	19	13	-	-	835
27. Air compressors	Million pesos	480	6	27	86	6	1	-	-	120
28. Power driven pumps	Nos	115 000	-	58	58	-	229	-	-	345
29. Textile machinery	Million pesos	40	4	5	6	1	2	-	-	18
30. Cement machinery	Million pesos	27.2	-	-	-	-	-	-	-	-
31. Sugar machinery	Million pesos	2	-	1	-	-	-	-	-	1
32. Machine tools	Million pesos	90	1	22	9	-	-	-	-	32
33. Machine tool accessories	Million pesos	2.8	-	-	1	-	-	-	-	1
Agricultural implements:										
34. Plough	Nos	3 300	158	-	-	-	-	-	-	158
35. Harrow	Nos	2 200	33	-	-	-	-	-	-	33
36. Trailers	Nos	980	-	-	-	1	-	-	-	1
Sub-total (III)			610	3 383	1 148	2 848	245	-	-	8 236
IV. METAL PRODUCTS										
37. Furniture	Tons	20 010	-	-	-	-	100	-	-	100
38. Steel wire rope	Tons	9 000	9 900	-	-	-	-	-	-	9 900
39. Prestressed concrete strands	Tons	5 650	6 215	-	-	-	-	-	-	6 215
40. High tensile wire	Tons	2 025	2 228	-	-	-	-	-	-	2 228
41. Tyre wire	Tons	239	263	-	-	-	-	-	-	263
42. Bolts, nuts and screws	Tons	19 200	3 168	-	-	-	-	-	-	3 168
43. Sewing machinery	'000 Nos	84	5	32	5	-	-	-	-	42
44. Hand tools	Tons	5 200	650	650	-	-	-	-	-	1 300
45. Welding electrodes	Tons	19 000	-	-	-	-	-	13 300	-	13 300
46. Razor blades	Million Nos	523	-	-	-	-	115	-	-	115
47. Utensils	Tons	10 000	-	-	-	-	11 000	-	-	11 000
Sub-total (IV)			22 429	682	5	-	11 215	13 300	-	[illegible]
Total			44 870	39 398	15 118	29 761	14 376	13 300	9 100	165 917

Appendix 3-17

TOTAL ALLOY AND SPECIAL STEEL DEMAND IN 1980 AND 1985
(Tons)

	1980 By end use	1980 Spares & maint.a/	1980 Small scale industriesb/	1980 Allowance for stockc/	1980 Total	1980 Non-coveraged/	1980 Grand Total	1985 By end use	1985 Spares & maint.a/	1985 Small scale industriesb/	1985 Allowance for stockc/	1985 Total	1985 Non-coveraged/	1985 Grand Total
Steel types														
Carbon constructional steels	19 316	1 932	580	437	22 265	1 113	23 378	38 655	3 865	1 933	889	45 342	2 267	47 609
Alloy constructional steels ..	14 453	1 445	434	327	16 659	833	17 492	39 392	3 939	1 970	906	46 207	2 310	48 517
Free cutting steels ..	4 833	483	145	109	5 570	279	5 849	15 118	1 512	756	348	17 734	887	18 621
Spring steels ..	16 435	1 644	493	371	18 943	947	19 890	29 761	2 976	1 488	685	34 910	1 746	36 656
Stainless steels ..	7 483	748	224	169	8 624	432	9 056	14 376	1 438	719	331	16 864	843	17 707
Electrical steel sheet ..	4 380	438	131	99	5 048	252	5 300	9 100	910	455	209	10 674	534	11 208
Sub-total ..	66 900	6 690	2 007	1 512	77 109	3 856	80 965	146 402	14 640	7 321	3 368	171 731	8 587	180 318
Tool steel ..	3 345	335	100	76	3 856	193	4 049	5 856	586	293	135	6 870	344	7 214
Electrode steel ..	7 420	-	-	148	7 568	378	7 946	13 300	-	-	266	13 566	678	14 244
Prestressed wire ..	3 520	-	-	70	3 590	180	3 770	6 215	-	-	124	6 339	317	6 656
Sub-total ..	14 285	335	100	294	15 014	751	15 765	25 371	586	293	525	26 775	1 339	28 114
Total ..	81 185	7 025	2 107	1 806	92 123	4 607	96 730	171 773	15 226	7 614	3 893	198 506	9 926	208 432
Sector														
Transport equipment ..	36 922	3 692	1 108	834	42 556	2 128	44 684	95 630	9 563	4 781	2 199	112 173	5 609	117 782
Electrical equipment ..	6 236	624	187	141	7 188	359	7 547	14 422	1 442	721	333	16 918	846	17 764
Industrial & Agri. machinery ..	5 079	508	152	115	5 854	293	6 147	8 234	823	413	189	9 659	483	10 142
Metal products ..	18 663	1 866	560	422	21 511	1 076	22 587	28 116	2 812	1 406	647	32 981	1 649	34 630
Sub-total ..	66 900	6 690	2 007	1 512	77 109	3 856	80 965	146 402	14 640	7 321	3 368	171 731	8 587	180 318
Tool steels ..	3 345	335	100	76	3 856	193	4 049	5 856	586	293	135	6 870	344	7 214
Electrode steels ..	7 420	-	-	148	7 568	378	7 946	13 300	-	-	266	13 566	678	14 244
Prestressed wire ..	3 520	-	-	70	3 590	180	3 770	6 215	-	-	124	6 339	317	6 656
Sub-total ..	14 285	335	100	294	15 014	751	15 765	25 371	586	293	525	26 775	1 339	28 114
Total ..	81 185	7 025	2 107	1 806	92 123	4 607	96 730	171 773	15 640	7 614	3 893	198 506	9 926	208 432

a/ Spares and maintenance assumed @ 10%
b/ Small scale industries @ 3% and 5% for 1980 and 1985 respectively
c/ Allowance for stock @ 2%
d/ Non-coverage @ 5%

Appendix 3-10

DEMAND FOR IRON AND STEEL CASTINGS

Sector	Unit of output	Norms: Iron castings kg/unit	Norms: Steel castings kg/unit	Production targets [illegible]	Production targets [illegible]	Requirement of iron castings [illegible] tons	Requirement of iron castings [illegible] tons	Requirement of steel castings [illegible] tons	Requirement of steel castings [illegible] tons
I. TRANSPORT EQUIPMENT									
1. Wagons	Nos	196	1 090	1 055	1 807	165	292	1 994	3 415
2. Coaches	Nos	181	46	50	50	9	9	2	2
3. Trucks	Nos	297	100	16 000	25 000	4 752	7 425	1 600	2 500
4. Buses	Nos	297	100	9 250	14 500	2 747	4 307	925	1 450
5. Jeeps and station wagons	Nos	120	50	11 000	15 000	1 320	1 096	590	790
6. Cars	Nos	50	50	60 000	100 000	3 000	5 000	3 000	5 000
7. Car engines	Nos	262	50	30 000	50 000	7 860	13 100	1 500	2 500
8. Trailers	Nos	51	60	10 000	15 000	510	765	600	900
9. Automobile ancillaries	Million pesos	100	25	7 500	12 000	750	1 200	150	300
Sub-total (I)						21 113	33 984	10 358	16 857
II. ELECTRICAL EQUIPMENT									
10. Transformer	MVA	54	-	960	2 010	52	109	-	[illegible]
11. Brass service box for mains	'000 Nos	100	-	204	333	20	33	-	[illegible]
12. Refrigerator	'000 Nos	640	-	315	1 100	2 062	7 150	-	[illegible]
13. Electric motor	'000 kW	1 700	-	1 500	3 100	2 550	5 270	-	[illegible]
14. Switchgear and controlgear	Million pesos	1 700	250	70	174	119	296	18	44
Sub-total (II)						4 782	12 857	18	44
III. METAL PRODUCTS									
15. Sewing machine	Nos	22	-	52 000	84 000	1 144	1 848	-	-
16. Reduction gears	Tons	750	250	2 500	4 000	1 875	3 000	625	1 000
Sub-total (III)						3 019	4 848	625	1 000
IV. INDUSTRIAL AND AGRICULTURAL MACHINERY									
17. Weighing machine	Million pesos	12 000	-	32	57	384	684	-	-
18. Agricultural tractors	Nos	480	114	8 886	13 526	3 556	5 410	1 013	1 542
19. Stationary diesel engines	Nos	275	1.2	500	700	138	193	1	1
20. Cranes	Tons	105	125	4 000	7 000	420	735	500	875
21. Passenger and industrial lifts	Nos	3 000	40	250	500	750	1 500	10	20
22. Industrial boilers	Million pesos	500	1 000	364	642	182	321	364	642
23. Concrete mixer	Nos	444	-	510	715	226	318	-	-
24. Ventilation equipment	Million pesos	80	-	12	24	1	2	-	-
25. Air compressors	Million pesos	2 500	-	150	400	375	1 000	-	-
26. Power driven pumps	Nos	114	-	55 000	115 000	6 270	13 100	-	-
27. Textile machinery	Million pesos	18 000	-	25	40	450	720	-	-
28. Cement machinery	Million pesos	2 300	2 500	10	21	23	48	25	53
29. Sugar machinery	Million pesos	1 600	1 700	1	2	2	3	2	3
30. Machine tools	Million pesos	5 280	1 100	50	90	264	475	55	99
Agricultural implements									
31. Ploughs	Nos	171	26	2 500	3 300	428	564	65	86
32. Harrows	Nos	67	93	1 700	2 200	113	147	158	205
33. Planters	Nos	24	25	860	1 150	21	28	22	29
34. Cultivators	Nos	4	300	800	1 100	3	4	240	330
35. Rotary cutters	Nos	24	25	1 500	2 000	36	48	38	50
36. Trailers	Nos	2	-	500	920	1	3	-	-
37. Valves	Nos	22	-	210 000	315 000	4 700	10 000	-	-
Sub-total (IV)						20 361	36 580	2 403	3 935
V. OTHERS									
38. Steel plant maintenance						9 000	10 000	4 000	8 000
39. Other miscellaneous castings						12 000	16 000	6 700	11 000
Sub-total (V)						21 000	36 000	10 700	19 000
Total (I+II+III+IV+V)						70 282	121 282	24 195	40 936
Add 5% non-coverage						3 514	6 064	1 210	2 042
Grand total						73 796	127 346	25 405	42 978
					Say	74 000	127 000	25 400	43 000

Appendix 4-1

SCRAP PURCHASED BY SEMI-INTEGRATED STEEL PLANTS (tons)

Year	Local scrap purchase						Imports						Grand total
	SIMUNA[a]	BOYACA[b]	SIDESA[c]	SIDELPA[d]	SIDUNOR[b]	Total	SIMUNA[a]	BOYACA[b]	SIDESA[c]	SIDELPA[d]	SIDUNOR[b]	Total	
1970	16 190	-	26 000	33 651	600	76 441	-	-	5 000	-	-	5 000	81 441
1971	15 852	-	27 327	30 031	600	73 810	-	-	-	-	-	-	73 810
1972	17 466	-	47 440	20 747	800	86 453	-	-	-	-	-	-	86 453
1973	19 080	-	12 964	29 648	1 400	63 092	-	-	10 327	-	-	10 327	73 419
1974	18 200	10 909	29 379	24 503	1 600	84 591	372	-	2 671	1 250	-	4 293	88 884
Total	86 788	10 909	143 110	138 580	5 000	384 387	372	-	17 998	1 250	-	19 620	404 007

a/ SIMUNA letter to Ministry, December 1974
b/ Answers to questionnaire
c/ SIDESA letter to Ministry, December 1974. For 1974, pro rata increase from 10 months figure
d/ SIDELPA letter to DEI dated July 10, 1975

Appendix 4-2

PURCHASED STEEL SCRAP REQUIREMENT OF STEEL FOUNDRIES

A. PRODUCTION OF STEEL CASTINGS[a/]

(ton)

		1971	1972	1973	1974
Simuna[b/]	..	110[c/]	116	108	110
Futec[d/]	..	5 920	8 752	12 386	8 070
Simesa[e/]		815	914	564	593
Industrie Militar[f/]		-	-	10	50
Fund. Occidente[f/]	..	-	-	-	40
Total	..	6 845	9 782	13 068	8 863

B. NORMS OF SCRAP REQUIREMENT

(tons)

		Steel casting produced	Purchased scrap
Simesa	..	593	702
Fund. Occidente	..	40	40
Barbara	..	800	800
Total	..	1 433	1 542

Scrap required per ton casting = 1,542 ÷ 1,433 = 1,076 kg
say 1,100 kg

C. STEEL CASTING[a/] VS APPARENT STEEL CONSUMPTION

		Apparent steel consumption '000 tons (1)	Domestic[a/] steel casting tons (2)	(2) ÷ (1) %
1971	..	557	6 845	1.23
1972	..	516	9 782	1.90
1973	..	442	13 068	2.96
1974	..	572	8 863	1.55
Total	..	2 087	38 558	1.85

a/ Excludes PDR which does not purchase scrap
b/ Simuna answers to questionnaire for 1972 to 1974
c/ Assumed
d/ Futec answers to questionnaire
e/ Simesa answers to questionnaire
f/ Field survey

Appendix 4-3

PURCHASED STEEL SCRAP FOR IRON FOUNDRIES[a]
(tons)

	Production of iron castings	Purchased steel scrap
SIMESA ..	2 400	-
Barbara ..	1 800	120
Prominsa ..	275	165
APOLO ..	4 297	4 297
Fund. Occidente	1 340	280
Total ..	10 112	4 862

Average consumption = 4,862 ÷ 10,112 = 0.481 ton

Assumed 500 kg/ton iron casting

a/ Data furnished against questionnaire

08079 (3 of 4)

FINAL REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

THE DEVELOPMENT OF IRON AND STEEL INDUSTRY IN COLOMBIA

VOLUME III

EXISTING AND NEW PLANTS

580

MAY 1976

DASTUR ENGINEERING INTERNATIONAL GMBH
Consulting Engineers
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LIST OF VOLUMES

EXPLANATIONS

Three dots (.../N.A.) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A full stop (.) between numerals indicates decimal.

A space between numerals is used to distinguish thousands and millions (1 346 849).

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954. The fiscal year adopted is from 1st July through 30th June.

'To' between the years indicates the full period, e.g. 1960 to 1964 means inclusive of the years 1960 and 1964.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Conversion rate adopted is US $ 1.00 = Colombian peso (Col $) 30, unless otherwise stated.

ABBREVIATIONS

PDR	-	Acerias Paz del Rio S.A.
BOYACA	-	Metalurgica Boyaca S.A.
FUTEC	-	Fundiciones Tecnicas S.A.
SIDELPA	-	Siderurgica del Pacifico S.A.
SIDUNOR	-	Siderurgica del Norte
SIMESA	-	Siderurgica Medellin S.A.
SIMUNA	-	Siderurgica del Muna S.A.
COLAR	-	Colombiana de Arrabio Ltda.
NSP	-	National Steel Plan
SIP	-	Semi-integrated Plants

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5 - ANALYSIS OF SEMI-INTEGRATED PLANTS

Six semi-integrated steel plants (SIP) producing rolled steel products are at present in operation in Colombia. Two of these plants also produce castings and grinding balls. The locations of the semi-integrated plants have been distinctly influenced by the natural division of the country into geographic zones by the Andean ranges which impede easy access and transport between the zones. As a consequence, these plants have been set up to serve mainly the respective zonal markets.

PERFORMANCE OF SEMI-INTEGRATED PLANTS

All the six SIP are equipped with electric arc furnaces, ingot casting facilities and rolling mills. The names and locations of the plants are given below:

Name of the plant		Location
Siderurgica del Muna S.A.	(SIMUNA)	Chusaca
Metalurgica Boyaca S.A.	(BOYACA)	Tuta
Siderurgica de Medellin S.A.	(SIMESA)	Medellin
Fundiciones Tecnicas S.A.	(FUTEC)	Medellin
Siderurgica del Pacifico S.A.	(SIDELPA)	Cali
Siderurgica del Norte S.A.	(SIDUNOR)	Barranquilla

5 - Analysis of Semi-integrated Plants (cont'd)

Existing facilities

The plantwise steelmaking and rolling facilities are given in Appendix 5-1. As of May 1975, there were 15 electric arc furnaces, 11 with acid lining and 4 with basic lining. One of them, a 10-ton furnace, had not been commissioned. The grouping of the furnaces according to the size range is given in Table 5-1.

Table 5-1

DISTRIBUTION OF ARC FURNACE INSTALLATIONS
ACCORDING TO CAPACITY

Capacity tons		No. of furnaces installed
Up to 5	..	6
+ 5 up to 10	..	5
+ 10 up to 15	..	2
+ 15 up to 20	..	1
+ 20 up to 30	..	1
Total	..	15

The rolling mill facilities installed at SIP include bar and rod mills and light profile mills. The breakdown mills at these plants are in the 380 to 450 mm range and the finishing mills are generally of 230 to 300 mm. The breakdown mills also roll some products for sale.

Raw materials and supplies

The most important raw material of SIP is scrap and the bulk of the scrap requirements are being met from domestic sources. Some plants have also occasionally used up to 20 per cent pig iron obtained from COLAR, the only pig iron plant in the country. The other important raw materials and supplies available locally include limestone, burnt lime, ferro-silicon, sand and fire clay refractories.

Besides their own ingots, SIP roll purchased billets obtained partly from PDR and partly through imports. The available information on the supply and use of billets is given in Appendix 5-2.

Dependence on imported supplies: Apart from importing a part of the scrap and billets required, SIP are totally dependent on imports for graphite electrodes, calcined dolomite, ferro-alloys (excluding a small portion of locally available ferro-silicon) and basic bricks.

Past production

The installed facilities at SIP are designed for the production of bars and rods, wire rods and

5 - Analysis of Semi-integrated Plants (cont'd)

profiles up to 75 mm. All the plants produce ordinary steel products and only one plant produces in addition some special steels, mainly carbon and low alloy constructional steels. The past production of SIP from 1965 to 1974 is given in Table 5-2.

Table 5-2

PRODUCTION OF SIP - 1965 TO 1974
(thousand tons)

	Ingot steel[a]	Rolled stell		
		Ordinary	Special	Total
1965 ..	36.7	46.5	-	46.5
1966 ..	41.2	47.2	-	47.2
1967 ..	49.2	47.3	3.8	51.1
1968 ..	59.5	54.8	7.1	61.9
1969 ..	63.4	55.7	16.0	71.7
1970 ..	59.6	66.0	19.7	85.7
1971 ..	77.5	76.8	14.8	91.6
1972 ..	96.9	101.2	12.1	113.3
1973 ..	94.1	98.3	14.4	112.7
1974 ..	98.8	76.0	17.6	93.6

a/ Includes ordinary and special steels.

The share of SIP in the total national production in terms of ingot steel has steadily risen from 15 per cent in 1965 to about 29 per cent in 1974, and in terms of rolled products from 21 to 33 per cent as shown in Table 5-3.

5 - Analysis of Semi-integrated Plants (cont'd)

Table 5-3

SHARE OF SIP IN TOTAL NATIONAL PRODUCTION - 1965 TO 1974

	Ingot steel			Rolled steel		
	Total national prodn '000 tons	Prodn of SIP '000 tons	Share of SIP %	Total national prodn '000 tons	Prodn of SIP '000 tons	Share of SIP
1965 ..	241	37	15.4	223	47	21.1
1966 ..	216	41	19.0	202	47	23.3
1967 ..	258	49	19.0	210	51	24.3
1968 ..	240	60	25.0	218	62	28.4
1969 ..	272	63	23.2	273	72	26.4
1970 ..	302	60	19.9	284	86	30.3
1971 ..	326	78	23.9	302	92	30.5
1972 ..	373	97	26.0	300	113	37.7
1973 ..	357	94	26.3	272	113	41.5
1974 ..	343	99	28.9	282	94	33.3

Analysis of installed capacity

SIP have supplied information on their installed capacities for steelmaking and rolling. However, as each plant has based its estimate on different assumptions and norms, the data furnished by SIP have been analysed to determine the capacities on a more rational and uniform basis.

5 - Analysis of Semi-integrated Plants (cont'd)

The installed capacity for steelmaking has been estimated on the following uniform basis:

	Ordinary steel	Special and alloy steel
Electric arc furnace		
Average heat time, hrs ..	3.2	4
Average heats/furnace/day (No)	7.5	6
Availability of days/year ..	300	300
Utilisation factor ..	0.9	0.9
Yields		
Metallic charge to liquid steel	90%	90%
Liquid steel to ingot ..	92%	92%
Ingot to finished product ..	85%	70%

Based on the aforementioned assumptions, the installed ingot steel capacity of SIP has been estimated at about 230,000 tons per annum in terms of ordinary steel. This does not include the capacity of one 10-ton furnace which has not been commissioned. Also, in the case of FUTEC which makes primarily steel castings, it has been assumed that only 50 per cent of the steelmaking capacity may be available for ingot steel production.

Taking into account the types of mills, the reheating capacities, the types of products rolled, and the mill availability and utilisation, the existing rolling capacity is estimated at 270,000 tons of salable rolled products. It may be noted that in terms of the estimated ingot steel capacity of 230,000 tons, the rolled products would correspond to only 194,000 tons per annum. This would indicate that there is surplus rolling capacity over and above that needed for rolling SIP's own ingots.

Analysis of capacity utilisation

The capacity utilisation in the context of the installed capacity and the market for SIP during the last decade have been analysed. The market for rolled products of SIP has been calculated by adding the export to the apparent consumption and deducting the production of PDR. All the production, import and export figures utilized for this exercise relate only to the categories and sizes which could be produced by SIP. For analysing the ingot capacity utilisation, the market for rolled products of SIP has been indicated in terms of ingot steel equivalent.

It would be observed from Fig 5-1 on the next page that the growth in installed ingot

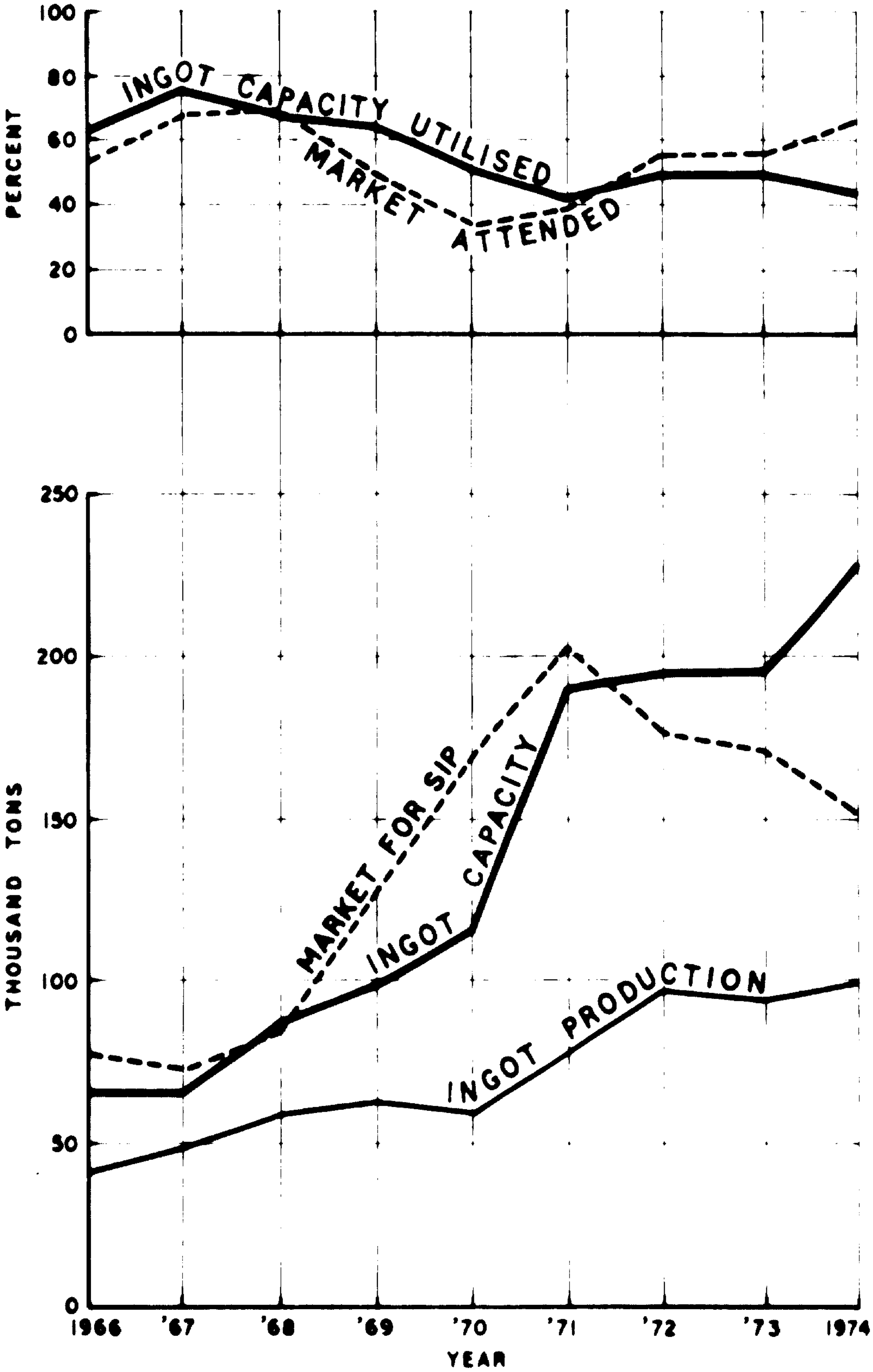

FIGURE 5-1. UTILISATION OF INGOT CAPACITY OF SEMI-INTEGRATED PLANTS (1966-74)

capacity of SIP had generally followed the trend in the growth of the market for SIP. The capacity utilisation in terms of actual ingot production was the highest in 1967 (about 75 per cent), but declined to 43 per cent in 1974, primarily due to rising scrap shortage. However, in terms of market coverage, the ingot production actually improved from a low 35 per cent in 1970 to 65 per cent in 1974 which was as good as the previous best in 1967 and 1968. This was, no doubt, largely due to the sharp decline in the market for SIP after 1970. However, the market is bound to recover and, therefore, it is imperative to plan for augmenting the supply of metallics to SIP to enable fuller utilisation of the installed capacity.

The rolling capacity utilisation of SIP is analysed in Fig 5-2. It would be noted that the rolling capacity rose sharply between 1969 and 1971 and thereafter the increase was gradual till 1974. The capacity utilisation of rolling mills has been generally about 40 per cent during the period under review, the maximum being about 60 per cent in 1965

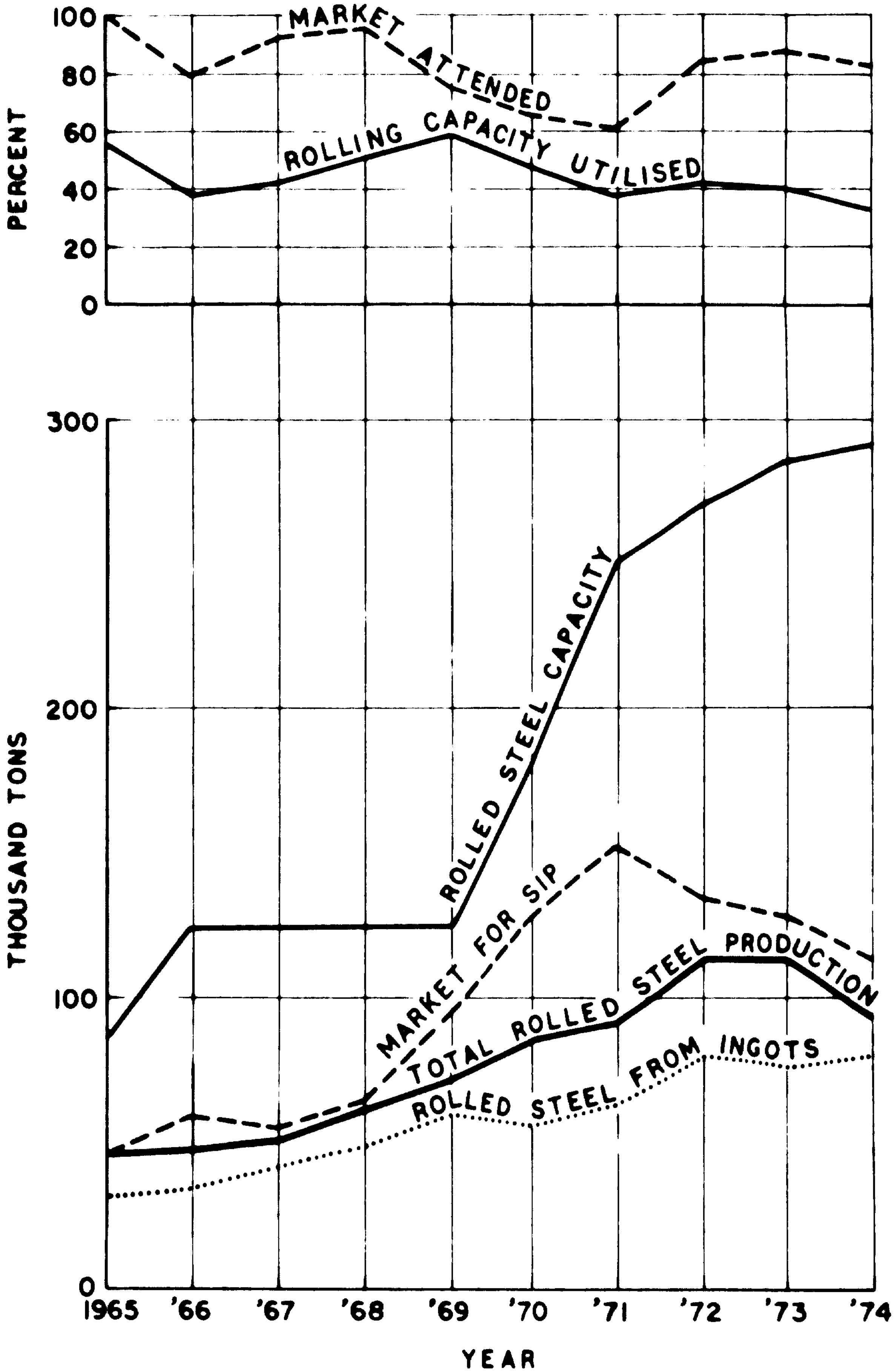

FIGURE 5-2. UTILISATION OF ROLLED STEEL CAPACITY OF SEMI-INTEGRATED PLANTS (1965-74)

5 - Analysis of Semi-integrated Plants (cont'd)

and 1969. This is, however, lower than the ingot capacity utilisation, specially because the rolling capacity has always been higher than the ingot capacity. In terms of the market attended, a maximum of 90 per cent was achieved in 1968, but thereafter it fell to about 60 per cent in 1971, mainly because of the installation of additional rolling capacity. From 1972, it has improved to about 80 per cent. The higher market coverage by rolled products compared to ingots has been largely due to increased rolling by the use of purchased billets.

Technology and quality control

Except two semi-integrated plants which have adopted basic steelmaking practice, all the other follow acid practice. As most of the plants produce only rebars, the quality requirements are adequately met by the acid practice. However, there is an increasing realization of the advantage of the basic practice for improving steel quality, particularly while using power grades of scrap. In view of this, two plants are already planning to switch over to basic practice. The adoption of basic practice may, however, become a necessity when a high proportion of sponge iron would come to be used as melting stock.

5 - Analysis of Semi-integrated Plants (cont'd)

All plants are equipped with laboratory facilities including equipment for quick analysis. A plant producing special steels has incorporated necessary quality control measures such as surface grinding and stage inspection. Plants contemplating diversification of production to include special steels have also plans to install similar quality control facilities.

Financial performance

An analysis of the financial operations of three semi-integrated plants, namely BOYACA, SIMESA and SIDELPA, has been made based on their annual reports for the period 1972 to 1974 (Appendices 5-3, 5-4 and 5-5 respectively). The highlights are summarised in Table 5-4 on the next page. These three companies together contributed 80 to 85 per cent the total salable steel production of SIP and as such, the trends observed from their financial operations could reasonably be considered to be representative of the performance of the semi-integrated sector. It may be mentioned that the annual reports for the other semi-integrated plants were not available.

5 - **Analysis of Semi-integrated Plants** (cont'd)

Table 5-4

SUMMARY OF FINANCIAL ANALYSES OF BOYACA, SIMESA AND SIDELPA

	BOYACA		SIMESA		SIDELPA	
	1972	1974	1972	1974	1972	1974
Net sales income, Mill. Col. pesos	158	186	222	424	153	330
Average sales income, Col. pesos per ton	4 907	11 205	-	-	5 276	10 645
Average cost of sales, Col. pesos per ton	3 889	6 867	-	-	3 655	5 663
Cost of sales ÷ Sales income, % ..	80	61	72	66	69	53
Net profit before tax, Mill. Col. pesos	19	52	16	107	29	118
Net profit before tax ÷ Sales income, %	12	28	7	25	19	36
Net profit after tax, Mill. Col. pesos	12	31	8	72	23	63
Net profit after tax ÷ Sales income, %	8	17	4	17	15	19
Long-term loans, Mill. Col. pesos ..	6	46	70	25	50	53
Share capital : Long-term loans ..	4.5:1	1:1.5	1:1.5	3.8:1	1:1	1.5:1
Investment in gross block, Mill. Col. pesos	33	114	140	165	128	209
Gross block per ton of steel, Col. pesos	1 025	6 867	-	-	4 414	6 764
Current assets : Current liabilities	Average	-	1.4:1	1.6:1	Average	1.5:1
Liquid cash : Current liabilities ..	1:11.6	1:28	1:51	1:27	1:90	1:7

5 - Analysis of Semi-integrated Plants (cont'd)

It is observed that there are some basic differences in the nature of operations of these three companies. For example, the operation of BOYACA were based exclusively on purchased billets till the middle of 1974, but since then, it has started producing a part of its steel requirements. SIMESA, in addtion to rolled steel, also produces castings, forgings and tubes, and therefore, in the financial analysis of this company, it has not been possible to isolate the effect of the other products. Further, BOYACA and SIMESA have been producing ordinary steel, while SIDELPA has concentrated on the production of special steels. In terms of rolled products, BOYACA has specialised in light profiles and SIMESA in rods and bars of ordinary steel.

The analysis of financial performance has been made in terms of Colombian pesos to obviate any distortion due to the varying exchange rates. From the ana' sis of the financial operations the following general observations emerge:

i) The average net sales income per ton of rolled steel has been rising steadily and there has been a very sharp increase in the year 1974.

5 - **Analysis of Semi-integrated Plants** (cont'd)

ii) The cost of sales has registered an upward trend, but this upward trend in costs has been somewhat lower compared to the increase in trend in sales income.

iii) Although the interest rates are fairly high in Colombia, the interest and other financial charges do not form any significant proportion of the total sales income.

iv) Investment in gross block has been steadily rising in all the plants. Consequently, the annual depreciation charges have also registered an upward trend. The investment in gross block per ton of steel produced has registered a steep upward trend.

v) The cumulative effect of the above factors has been an upward trend in the net profit before tax which has risen sharply in 1974.

vi) The provision for taxation as a percentage of the net profit has also risen steadily, with the result that the upward trend in the net profit after tax has not been as impressive as in the case of the net profit before tax.

vii) It appears that the surplus fund generated in 1974 due to the sharp increase in sales income has been utilised towards the repayment of long-term loans. The dependence on long-term loans as a source of finance for increase in gross block consequently seems to have declined at least temporarily.

viii) The ratio of current assets to current liabilities has been maintained at a fiarly satisfactory level in all points. However, the liquidity ratio, that is, the ratio of liquid cash to current liabilities has been unsatisfactory.

5 - Analysis of Semi-integrated Plants (cont'd)

Future plans of semi-integrated plants

Some of the SIP are planning the installation of additional arc furnaces, and retiring of some of the smaller furnaces from ingot steel production. Installation of continuous casting facilities and new rolling mills is also being contemplated by some plants. Based on the information furnished and the replies to the questionnaire, the ingot capacity of SIP would rise to about 450,000 tons by 1980 and 500,000 tons by 1985. To take advantage of the current domestic market, some of the plants are contemplating raising their production of profiles and wire rods, while others are considering increased production in their own specialised lines.

POSSIBLE FUTURE ROLE OF SIP

In planning the possible future role of SIP, a number of factors need to be taken into consideration, the major ones being (a) the future market for SIP; (b) the geographic pattern of the market; and (c) the possibility of specialisation and complementarity amongst all the steel plants including PDR.

Future market for SIP ordinary steel

An estimate of the future demand for the products which could be produced by SIP has been derived from the market projections made in Chapter 3. It is assumed that the products of SIP would continue to be bars and rods, wire rods, and light profiles up to 75 mm. Some of these products are also manufactured by PDR, and in order to arrive at the net market demand for SIP products, the production by PDR of these products at full utilisation level of its existing mills has been deducted from the projected demand. At full mill utilisation level, the production by PDR of these products would be as follows:

		Tons/yr
Bars and rods	..	70 000
Ordinary wire rods	..	105 000
Special wire rods	..	5 000
Total	..	180 000

The future demand for ordinary steel products which can be produced by SIP is given in Appendix 5-6 and the market of SIP for these products is given in Table 5-5.

5 - Analysis of Semi-integrated Plants (cont'd)

Table 5-5

MARKET OF SEMI-INTEGRATED PLANTS FOR ORDINARY STEEL IN 1980 AND 1985
(thousand tons)

	1980			1985		
	Total demand[a]	PDR prodn	Market of SIP	Total demand[a]	PDR prodn	Market of SIP
Bars and rods ..	216	70	146	379	70	309
Wire rods[b] ..	214	105	109	362	105	257
Light profiles ..	82	-	82	135	-	135
Total ..	512	175	337	876	175	701

a/ Refer Appendix 5-3.
b/ Includes rods and coils.

Geographic distribution of ordinary steel market

The geographic pattern of ordinary steel market has been projected on the following basis:

i) The domestic market has been divided into the following six zones:

Zone I .. Cundinamarca, Boyaca and Meta
Zone II .. Antioquia, Choco and Cordoba
Zone III .. Valle, Cauca and Narino
Zone IV .. Santander and Norte de Santander
Zone V .. Magdalena, Sucre, Bolivar, Atlantico, Cesar and Guajira
Zone VI .. Others

5 - **Analysis of Semi-integrated Plants** (cont'd)

ii) The data made available by PDR and some of the semi-integrated plants for the period 1971 to 1974 have been analysed to ascertain the overall pattern of domestic sales of their products, and grouped according to the zones indicated above. On the assumption that the sale of flat products by PDR was restricted to Zone I only, the following pattern of market distribution has been derived for non-flat products:

		Per cent
Zone I	..	51
Zone II	..	13
Zone III	..	13
Zone IV	..	10
Zone V	..	6.5
Zone VI	..	6.5

iii) Since the bulk of the demand for the products under consideration has been covered for domestic supply, it is assumed that the geographic distribution pattern of the imported supplies was similar.

iv) This geographic pattern of market is presumed to hold good for all categories of products under consideration, except wire rods for wire drawing.

v) With regard to wire rods for wire drawing, the following geographic pattern has been determined, on the basis of the capacities of the wire drawing plants located in the different zones, revealed by the field survey data:

		Per cent
Zone I	..	75
Zone IV	..	21
Zone V	..	4

5 - Analysis of Semi-integrated Plants (cont'd)

Annual zonewise market for SIP ordinary steel

For planning the future production programme of SIP, an attempt has been made to project the growth of the market for SIP annually from 1976 to 1985. This has been worked out as follows:

i) The year 1974 is taken as the base year and the apparent domestic consumption of steel in 1974 has been considered as the total market.

ii) The total demand of the various products in individual years has been derived on the basis of geometric progression between the base year (1974) and the terminal year 1980, and the same methodology has been adopted between the two terminal years 1980 and 1985.

iii) To arrive at the yearwise market for SIP, the production of PDR has been deducted from the total annual demand.

iv) It is assumed that the full capacity utilisation of the existing PDR mills for bars and rods as well as wire rods would stabilize in 1980. Taking PDR's actual production of 1974 as the base, the production figures of PDR from 1976 to 1979 have been projected adopting arithmetic progression.

v) For deriving the geographic pattern of the market for SIP, it is assumed that PDR products would first meet the demand of Zone I, and any surplus would be sold first in Zone VI and then in Zone IV - the regions where the existing semi-integrated plants are operating.

The product-wise zonal distribution of the market of SIP is given in Table 5-6 on the next page.

Table 5-6

ZONAL DISTRIBUTION OF MARKET OF SIP
(thousand tons)

Year	Zones	Bars and rods I	II	III	IV	V	VI	Total
1976	Demand	67.4	17.2	17.2	13.2	8.6	8.5	132.1
	FDR supply	65.0	-	-	-	-	-	65.0
	Attendable market	2.4	17.2	17.2	13.2	8.6	8.5	67.1
1977	Demand	76.2	19.4	19.4	14.9	9.7	9.8	149.4
	FDR supply	66.0	-	-	-	-	-	66.0
	Attendable market	10.2	19.4	19.4	14.9	9.7	9.8	83.4
1978	Demand	86.1	22.0	22.0	16.9	11.0	11.0	169.0
	FDR supply	67.0	-	-	-	-	-	67.0
	Attendable market	19.1	22.0	22.0	16.9	11.0	11.0	102.0
1979	Demand	97.6	24.8	24.9	19.1	12.4	12.4	191.1
	FDR supply	68.5	-	-	-	-	-	68.5
	Attendable market	29.1	24.8	24.9	19.1	12.4	12.4	122.6
1980	Demand	110.2	28.1	28.1	21.6	14.0	14.0	216.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	40.2	28.1	28.1	21.6	14.0	14.0	146.0
1981	Demand	123.4	31.5	31.5	24.2	15.7	15.7	242.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	53.4	31.5	31.5	24.2	15.7	15.7	172.0
1982	Demand	138.2	35.2	35.2	27.1	17.6	17.7	271.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	68.2	35.2	35.2	27.1	17.6	17.7	201.0
1983	Demand	155.0	39.5	39.5	30.4	19.8	19.8	304.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	85.0	39.5	39.5	30.4	19.8	19.8	234.0
1984	Demand	173.9	44.3	44.3	34.1	22.2	22.2	341.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	103.9	44.3	44.3	34.1	22.2	22.2	271.0
1985	Demand	193.3	49.3	49.3	37.9	24.6	24.6	379.0
	FDR supply	70.0	-	-	-	-	-	70.0
	Attendable market	123.3	49.3	49.3	37.9	24.6	24.6	309.0

Year	Zones	Light profiles I	II	III	IV	V	VI	Total
1976	Demand	21.4	5.5	5.5	4.2	2.7	2.7	42.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	21.4	5.5	5.5	4.2	2.7	2.7	42.0
1977	Demand	25.3	6.5	6.5	5.0	3.2	3.1	49.6
	FDR supply	-	-	-	-	-	-	-
	Attendable market	25.3	6.5	6.5	5.0	3.2	3.1	49.6
1978	Demand	29.8	7.6	7.6	5.9	3.8	3.8	58.5
	FDR supply	-	-	-	-	-	-	-
	Attendable market	29.8	7.6	7.6	5.9	3.8	3.8	58.5
1979	Demand	35.2	9.0	9.0	6.9	4.5	4.4	69.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	35.2	9.0	9.0	6.9	4.5	4.4	69.0
1980	Demand	41.8	10.7	10.7	8.2	5.3	5.3	82.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	41.8	10.7	10.7	8.2	5.3	5.3	82.0
1981	Demand	46.4	11.8	11.8	9.1	5.9	6.0	91.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	46.4	11.8	11.8	9.1	5.9	6.0	91.0
1982	Demand	51.0	13.0	13.0	10.0	6.5	6.5	100.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	51.0	13.0	13.0	10.0	6.5	6.5	100.0
1983	Demand	56.6	14.4	14.4	11.1	7.2	7.3	111.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	56.6	14.4	14.4	11.1	7.2	7.3	111.0
1984	Demand	62.7	16.0	16.0	12.3	8.0	8.0	123.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	62.7	16.0	16.0	12.3	8.0	8.0	123.0
1985	Demand	68.9	17.5	17.5	13.5	8.8	8.3	135.0
	FDR supply	-	-	-	-	-	-	-
	Attendable market	68.9	17.5	17.5	13.5	8.8	8.8	135.0

Year	Zones	Wire rods I	II	III	IV	V	VI	Total
1976	Demand	83.0	6.6	6.6	21.1	6.3	3.3	126.9
	FDR supply	83.0	-	-	6.7	-	3.3	93.0
	Attendable market	-	6.6	6.6	14.4	6.3	-	33.9
1977	Demand	94.6	7.5	7.5	24.1	7.2	3.7	144.6
	FDR supply	94.6	-	-	-	-	1.4	96.0
	Attendable market	-	7.5	7.5	24.1	7.2	2.3	48.6
1978	Demand	107.8	8.5	8.5	27.4	8.2	4.3	164.7
	FDR supply	99.0	-	-	-	-	-	99.0
	Attendable market	8.8	8.5	8.5	27.4	8.2	4.3	65.7
1979	Demand	123.0	9.6	9.6	31.3	9.3	4.9	187.7
	FDR supply	102.0	-	-	-	-	-	102.0
	Attendable market	21.0	9.6	9.6	31.3	9.3	4.9	85.7
1980	Demand	140.3	10.9	10.9	35.7	10.7	5.5	214.0
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	35.3	10.9	10.9	35.7	10.7	5.5	109.0
1981	Demand	155.9	12.2	12.2	39.6	11.9	6.2	[illegible]
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	50.9	12.2	12.2	39.6	11.9	6.2	133.0
1982	Demand	173.3	13.8	13.8	44.0	13.3	6.9	365.0
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	68.2	13.8	13.8	44.0	13.3	6.9	160.0
1983	Demand	192.7	15.5	15.5	48.9	14.7	7.7	295.0
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	87.7	15.5	15.5	48.9	14.7	7.7	190.0
1984	Demand	214.5	17.4	17.4	54.4	16.5	8.8	329.0
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	109.5	17.4	17.4	54.4	16.5	8.8	[illegible]
1985	Demand	236.2	19.1	19.1	59.9	18.2	9.5	362.0
	FDR supply	105.0	-	-	-	-	-	105.0
	Attendable market	131.2	19.1	19.1	59.9	18.2	9.5	257.0

5 - Analysis of Semi-integrated Plants (cont'd)

Future market for SIP special steels

The future demand for special steels which can be produced by SIP is given in Appendix 5-7. The market for SIP special steels is indicated in Table 5-7.

Table 5-7

MARKET FOR SPECIAL STEELS OF SEMI-INTEGRATED PLANTS IN 1980 AND 1985
(thousand tons)

	1980			1985		
	Total demand[a/]	PDR prodn	Market of SIP	Total demand[a/]	PDR prodn	Market of SIP
Bars and rods	36	-	36	80	-	80
Wire rods	32	5	27	71	5	66
Total	68	5	63	151	5	146

a/ Refer Appendix 5-7.

Future production programme of SIP

The future production programme of SIP has been evolved on the basis of the expansion envisaged for each plant and the appropriate zonal market it can serve. The zonewise location of the semi-integrated plants is as follows:

Zone I	-	BOYACA and SIMUNA
Zone II	-	SIMESA and FUTEC
Zone III	-	SIDELPA
Zone IV	-	SIDUNOR

5 - Analysis of Semi-integrated Plants (cont'd)

The future development in the growth of ingot steel capacity, taking into account the future plants of SIP, is shown in Table 5-8.

Table 5-8

FUTURE INGOT STEEL CAPACITY OF SEMI-INTEGRATED PLANTS[a/]
(thousand tons)

Year		Installed ingot steel capacity
1976	..	230
1977	..	250
1978	..	290
1979	..	290
1980	..	450
1981	..	450
1982	..	450
1983	..	450
1984	..	450
1985	..	500

a/ In terms of ordinary steels only.

The annual production programme of SIP is indicated in Table 5-9 and the zonal distribution of production is given in Appendix 5-8.

5 - Analysis of Semi-integrated Plants (cont'd)

Table 5-9

SEMI-INTEGRATED PLANTS' FUTURE PRODUCTION PROGRAMME
(thousand tons)

	Ordinary steel				Special steel		
	Bars and rods	Wire rods	Light profiles	Total	Bars and rods	Wire rods	Total
1974 ..	39.4	6.1	30.5	76	17.6	-	17.6
1976 ..	58	15	40	113	18	5	23
1977 ..	60	21	48	129	20	10	30
1978 ..	80	35	49	164	24	14	38
1979 ..	77	55	50	182	24	14	38
1980 ..	90	55	68	213	35	20	55
1981 ..	95	65	83	243	40	21	61
1982 ..	95	65	83	243	48	21	69
1983 ..	95	65	83	243	48	21	69
1984 ..	95	65	83	243	48	21	69
1985 ..	95	65	83	243	60	21	81

Specialisation

Taking into consideration the present production pattern of PDR and SIP, a possible pattern of product specialisation by the semi-integrated plants has been visualized. Apart from producing bars and rods and ordinary wire rods as at present, the semi-integrated plants could specialise in special steels including special steel wire rods, and ordinary steel light profiles.

Melting stock situation

For the future production programme envisaged for SIP, the yearwise purchased scrap requirements, availability of domestic scrap and resulting shortfalls are detailed in Appendix 5-9. It would be noted that the scrap shortfall increases from about 50,000 tons in 1976 to about 200,000 tons in 1981. This emphasises the necessity of taking appropriate measures early to make up for the scrap shortfalls and to ensure full utilisation of SIP.

The shortfalls in scrap could be met by taking one or more of the following measures:

i) the use of imported billets,
ii) the use of imported scrap, and
iii) the use of sponge iron.

The vagaries of the international market in billets and scrap are well known and from a long-term viewpoint, dependence on the international markets for large supplies may not be advisable. From the available information, it is noted that none of the existing plants in the other Andean countries have plants to produce salable billets on a long-term basis and, therefore, regular supplies of billets from these sources may not be feasible. Further, judging from the prices of imported billet and imported scrap obtaining in Colombia (May 1975), it is considered more economical to produce and use sponge iron as will be evident from the estimates of the relative costs of steel production with alternative metallic charges, discussed later in this chapter. Therefore, it is proposed to make up these scrap shortfalls by the use of sponge iron, for which requisite direct reduction facilities have to be installed. However, until such time as these facilities go into production, the scrap requirements will have to be met through imports. Alternatively, billets will have to be imported for the duration.

The planning of direct reduction plants, however, has to be viewed in the larger context of the national steel programme and not in isolation, to serve merely the existing semi-integrated plants. Therefore, the question of setting up direct reduction plants has been discussed later in Chapter 8 taking into account PDR expansion as well as the requirements of the new steel capacity to be set up.

INVESTMENTS AND OPERATING COSTS

Investments for new facilities

For augmenting the ingot steel capacity of SIP from the present level of about 230,000 tons to

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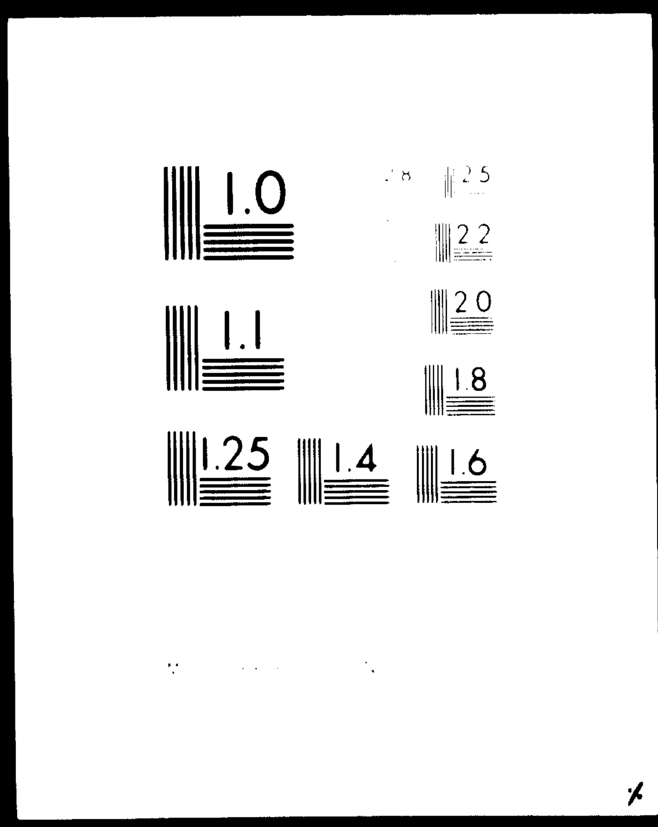

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5 - Analysis of Semi-integrated Plants (cont'd)

500,000 tons in 1985, additional electric arc furnaces, ingot casting/continuous casting and rolling mill facilities would have to be installed. Taking into account the data furnished by some of the semi-integrated plants, the investments for such expansion are estimated to be of the order of US $ 66 million. It needs to be emphasised, however, that separate studies for individual plants would have to be carried out to identify the specific balancing facilities required to enable the full utilisation of the installed capacity as well as to prepare more precise estimates of the costs of the costs of expansion.

Based on the expansion schemes of individual plants considered for the development programme, it is visualised the phasing of investment could be as shown in Table 5-10.

5 - Analysis of Semi-integrated Plants (cont'd)

Table 5-10

PRELIMINARY PHASING OF INVESTMENT
FOR EXPANSION OF SIP
(million US $)

Year		Investment
1975	..	5.0
1977	..	15.5
1978	..	16.0
1979	..	20.5
1980	..	5.0
1981	..	-
1982	..	-
1983	..	1.0
1984	..	2.5
1985	..	0.5
Total	..	66.0

Operating cost

The available data on operating costs indicate that the cost of production of ingot steel and rolled products varies from plant to plant. In 1974, the weighted average works cost of ingot steel (excluding fixed charges) in SIP (adopting mainly acid practice) was US $ 127 per ton comprising US $ 76 for scrap and US $ 51 for other costs, and the weighted average ingot rolling cost was US $ 52 per ton. The relative costs of production of SIP for operating with different metallic charges have been worked out on the basis of the following assumptions:

5 - Analysis of Semi-integrated Plants (cont'd)

i) The cost estimates relate to 1975 price levels. For the 1974 production level, assuming no change in technology/process, it is surmised that the weighted averaged cost would be 10 per cent high in 1975 than in 1974.

ii) The cost of imported scrap as delivered to SIP would be about US $ 147 per ton, as prevailing in Colombia in May 1975.

iii) The cost of imported billets as delivered to SIP would be about US $ 267 per ton, as prevailing in Colombia in May 1975.

iv) The average cost of sponge iron distributed to SIP would be US $ 113 per ton.

v) With 100% scrap charge and adoption of basic steelmaking practice, the works cost of ingot excluding the cost of scrap, would be 10% higher than that for acid practice.

vi) With better utilisation of the electric arc furnaces, the works cost of ingot steel would decrease by about 10% compared to the 1974 utilisation level.

vii) The operating cost of rolling mills in 1975, assuming full utilisation level, would continue to be the same as in 1974 because, while there would be a 10% escalation in the cost in 1975, a similar reduction in the operating costs would accrue from the better utilisation of the mills.

The relative works costs of rolled steel using the two alternative metallic charges (domestic/imported scrap domestic scrap/sponge iron) in the arc furnace have been worked out as follows:

5 - Analysis of Semi-integrated Plants (cont'd)

		Alt. 1	Alt. 2
METALLIC CHARGE TO ARC FURNACE, %			
Domestic scrap	..	50	50
Imported scrap	..	50	-
Sponge iron	..	-	50
COST OF INGOT, US $ PER TON			
Scrap/sponge charged	..	116	104
Other costs	..	55	56
Works cost of ingot	..	171	160
ROLLED STEEL, US $ PER TON			
Ingots	..	209	195
Operating cost	..	52	52
Average works cost of rolled products	..	261	247
	Say	260	245

It would be noted that with the use of sponge iron, the works cost of steel would be lower by about US $ 15 per ton. The cost of rolled products from ingots would be lower than that from imported billets, because cost of imported billets itself is US $ 267 per ton.

6 - EXPANSION OF ACERIAS PAZ DEL RIO S.A.

Acerias Paz del Rio S.A. (PDR) owns and operates the only integrated steel plant in Colombia. The plant is located at Belencito, and exploits its own captive sources of iron ore, coal and limestone situated in the close vicinity to the plant. It mainly serves the market around Bogota, the largest steel consuming centre in the country.

Existing facilities

The present crude steel capacity of the plant is 300,000 tons per year. The major production facilities include coke ovens, sintering plant, blast furnace, Thomas converters, electric arc furnace, slabbing and blooming mill, billet-structural mill, merchant mill, wire drawing facilities, steckel mill and sheet mill (see Appendix 6-1).

PERFORMANCE OF PDR

Production

The production of ingot steel and salable steel products at PDR from 1970 to 1974 is shown in Table 6-1.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Table 6-1

PRODUCTION OF PDR FROM 1970 TO 1974
(thousand tons)

		Ingot steel	Rolled steel[a]
1970	..	242.0	198.1
1971	..	248.2	210.5
1972	..	276.0	186.9
1973	..	262.6	159.5
1974	..	244.0	188.2

a/ Excluding salable billets.

Capacity utilisation

In terms of ingot steel, the capacity utilisation of PDR has ranged between 80 and 92 per cent during the last five years. The ingot steel production was the highest in 1972, but there has been a downward trend since, mainly due to hot metal shortage arising from inadequate coke availability.

The rolling mill utilisation has been low, only about 30 per cent, mainly because of the flat product line. The steckel mill with a capacity of 400,000 tons per year was installed in 1968, but its utilisation in 1974 was only to the extent of about 8 per cent. This gross under-utilisation of the flat product line has resulted from inadequate iron and steelmaking capacity as well as the absence of downstream cold rolling facilities which are essential for marketing the flat product.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Technology

The ore utilised at the blast furnace is characterised by low iron and high silica contents, which result in high slag volume and high coke rate. Some improvement in the blast furnace productivity has been achieved by adopting fuel oil injection and utilising fluxed sinter in the burden. However, it has been observed that the stock movements with the use of fluxed sinter in the burden are not satisfactory and consequently, frequent jerking of the furnace has to be resorted to. The problem of the bad furnace movement needs to be investigated and this will involve a detailed investigation of the quality of sinter produced. These investigations should be conducted at the earliest, to enable appropriate decision on the optimum proportion of sinter in the burden in the future. Suitable ore preparation and agglomeration facilities will have to be selected on the basis of the results of these investigations.

Due to the limitations imposed by the hot blast stoves, oxygen enrichment of the blast is being contemplated. However, the benefits in terms of

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

improved productivity that would accrue from such a practice would largely depend on the control exercised on the burden movement in the furnace.

One of the major reasons of the fluctuations in the quality of hot metal is the irregular burden descent.

In view of the high phosphorous content of iron ore and the consequent high phosphorous content of the hot metal, Thomas process of steelmaking is adopted. However, with the adoption of the bottom-blown oxygen process, it could be possible to augment the production of the existing meltshop and to bring about considerable reduction in the steel cost. The effect of the adoption of oxygen steelmaking process is discussed later in this chapter.

<u>Dependence on imported supplies</u>

The major imported supplies at PDR include baisc refractories - magnesite and sintered dolomite - and bulk of the ferro-alloys. Dependence on these imports would continue in future, till such time as suitable local sources of supply of these materials are established. Also, with the commissioning of the cold rolling mill complex, slabs would have to be imported till the iron and steelmaking capacities are suitably expanded.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Financial performance

The financial performance of PDR from 1970 to 1974 has been analysed on the basis of the annual reports and is presented in Appendix 6-2. This analysis is prepared primarily to determine the important financial ratios as well as to establish the trends in sales income, manufacturing costs and other expenses. The analysis has been carried out in Colombian pesos (and not in US $) to obviate any distortion arising out of varying exchange rates. The conclusions emerging from this analysis are as follows:

i) Though the tonnages of steel sold during the years 1970 and 1974 were approximately the same, the net sales income in 1974 was almost double that of 1970, because the average sales price per ton increased from Colombian pesos 3,468 in 1970 to Colombian pesos 6,868 in 1974.

ii) The cost of sales (excluding depreciation) as percentage of sales realisation has remained steady at about 60 per cent for the period under review except for the year 1973, when it was as high as about 70 per cent. This indicates that the costs have also maintained an upward trend in harmony with the increasing average sales price per ton of steel.

iii) The administrative and sales expenses have also risen in almost the same proportion as the increase in sales income and the cost of sales.

6 - Expansion of Acerials Paz del Rio S.A (cont'd)

iv) The interest and other financial charges as a percentage of total sales income decreased from about 3.3 per cent in 1970 to about 2.3 per cent in 1974.

v) The depreciation provision was maintained at a fairly steady level (between Colombian pesos 56 million and Colombian pesos 74 million) during the period 1970 and 1973. However, this sharply rose in 1974 to Colombian pesos 148, which was more than double that of 1973. This is apparently due to statutory obligations and not on account of a corresponding increase in the gross assets brought into use during the year.

vi) The net profit before tax increased from Colombian pesos 150 million in 1970 to Colombian pesos 353 million in 1974, an increase of 136 per cent. This indicates an improvement in the profitability trend, since the net sales income rose during the period by 98 per cent. The net profit before tax in 1974 was about 25 per cent of the net sales income. However, the provision for tax as a percentage of net sales income registered a sharp increase from 1.7 per cent in 1970 to about 10 per cent in 1974. Therefore, the net profit after provision for tax has registered an increase of only 53 per cent as compared to an increase of 136 per cent in the net profit before provision for tax.

vii) The payments in respect of salaries and wages rose from about Colombian pesos 159 million in 1970 to Colombian pesos 291 million in 1974, corresponding to an increase of about 83 per cent.

viii) The shareholders' equity (share capital plus legal reserves) rose from Colombian pesos 850 million in 1970 to Colombian pesos 917 million in 1971 and thereafter it has remained the same up to 1974.

ix) The long term loans have increased from Colombian pesos 400 million in 1970 to Colombian pesos 498 million in 1974. Consequently, the ratio of shareholders' equity to long term loans has declined from 2.1:1 in 1970 to 1.8:1 in 1974.

6 - **Expansion of Acerias Paz del Rio S.A** (cont'd)

x) The gross block has increased from Colombian pesos 1,359 million in 1970 to Colombian pesos 2,039 million in 1974. Consequently, the investment in gross block per ton of finished steel produced has increased from Colombian pesos 6,636 in 1970 to Colombian pesos 10,447 in 1974.

xi) The ratio of gross block to shareholders' equity has risen from 1.6:1 in 1970 to 2.2:1 in 1974. The ratio of gross block to long term loans has also increased from 3.4:1 in 1970 to 4.1:1 in 1974.

xii) The ratio of current assets to current liabilities is fairly satisfactory throughout the period under review, ranging from 3.1:1 to 2.2:1, the lowest figure being in 1974.

xiii) The ratio of liquid cash to current liabilities was at an unsatisfactory level of 1.0:11.2 at the end of the year 1972. However, it improved to 1.0:1.3 at the end of 1974.

CURRENT IMPROVEMENT PROGRAMME

The Current Improvement Programme envisages the installation of a coke oven battery and cold rolling mill facilities. This programme is essential for balancing the existing facilities and should be implemented at the earliest.

Coke oven battery No.2

A new 57-oven coke battery with a rated capacity of 355,000 tons of coke per year is under construction (May 1975) and is expected to go on stream in 1975.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

On completion, the existing coke oven battery No.1 and the three beehive ovens are expected to be phased out of operation and the purchase of beehive coke terminated. Improvements are being made to the existing by-product facilities to enable the handling of the excess gas from the new battery. The estimated cost for the new coke oven facilities is US $ 16 million (PDR expansion feasibility report, October 1973).

Cold rolling mill complex

Cold rolling facilities are envisaged to be installed in two stages. In the first stage, a 1,350 mm (54 in) 4-high single strand reversing mill having a capacity of about 240,000 tons per year with necessary hydrochloric acid continuous pickling line, stock annealing furnaces, a temper mill and coil strip finishing comprising slitting, trimming and shearing line is proposed to be installed. The feasibility report on PDR expansion envisages that the first stage will become operative in 1978.

The second stage envisages essentially the duplication of the first mill, but with additional facilities to roll light guage black plates and electrolytic cleaning line. The second stage is expected to go on stream by 1983.

6 - **Expansion of Acerias Paz del Rio S.A** (cont'd)

In order to meet the power requirement of the cold mill, a new sub-station with two 115 kV feeders from Paipa thermal power plant is proposed to be installed.

The investment for the cold rolling mill facilities with necessary auxiliaries has been estimated at about US $ 120 million (updated feasibility report, 1975).

EXISTING EXPANSION SCHEME

A feasibility report on the expansion of PDR was prepared in October 1973 and updated in February 1975. This study envisages raising the crude steel capacity of the plant from the present level of 300,000 tons per year to one million tons. This expansion scheme is referred to as PDR-I in this study.

Product-mix: PDR-I

Based on the market study carried out by PDR in 1971 and 1972, the following product-mix has been envisaged for PDR-I in the feasibility report:

		1980 tons	1985 tons
Flat products	..	223 000	375 000
Non-flat products	..	236 000	364 000
Billets for sale	..	74 000	57 000
Total	..	533 000	796 000

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Additional facilities: PDR-I

The additional production facilities n PDR-I include a sinter plant, a coke oven battery and a blast furnace; a completely new steelmelt shop (based on bottom-blown oxygen process) which will replace the existing Thomas converter shop; a billet mill and a wire rod mill. It is also planned to develop the iron ore and coal mines to meet the increased requirements of raw materials.

The expansion facilities were scheduled for start-up on January 1st 1980, on the assumption that the implementation would commence on January 1st, 1976, according to the feasibility report.

ALTERNATIVE EXPANSION POSSIBILITIES

Before taking a final decision on PDR expansion based on the above proposals, it may be worthwhile examining any other possible alternative which is likely to be more economical.

The installation of new steelmelt shops based on oxygen processes is generally a two-stage approach, wherein two converters are installed in the first stage, and the capacity of the shop is doubled by the installation of a third converter at a later date. This concept is

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

a common feature in most steel plants in the world, and is also being followed in the expansion programmes of the integrated steel plants in two other Andean countries - Peru and Chile.

PDR's case

In the case of PDR, the ultimate expansion would be only around 1 million tons, primarily due to limitations of the iron ore reserves. Besides, there may be difficulties of product distribution to the consumers. Therefore, it may not be advisable to install a new steelmelt shop with two 100-ton converters to produce about 1 million tons as proposed in PDR-I, when there is no possibility of doubling the capacity by adding a third converter. As an alternative, it may be worthwhile examining the possibilities of augmenting the capacity of the existing Thomas converter shop, instead of retiring it. The Thomas shop at Belencito is relatively modern and still young to be retired.

Conversion of Thomas shop to bottom-blown oxygen process

The development of bottom-blown oxygen process in recent years has presented unique opportunities to Thomas shops to substantially increase their outputs from the existing converters, with only marginal additional investment. The change-over can be effected speedily, with minimum disruption to existing production. Several Thomas shops in Europe, which are 30 to 50 years old, have adopted with advantage this new process, variously known as OBM, LWS and Q-BOP.

Typical examples of Thomas shop conversion

The Rochling Steelworks at Volklingen is 40 years old. This plant had a crude steel capacity of 1.3 million tons from a Thomas shop with six 25-ton converters. One of the converters has now been shut down and the remaining five have been modified to the OBM process. These converters after modification to OBM are now capable of tapping 40-ton heats. However, due to the limitations of the auxiliary equipment, only 30-ton heats are tapped and about 1.3 million tons per year is produced. When the auxiliary equipment is modified and 40-ton heats are tapped, a production of 1.68 million tons is expected from the five converters.

At Rodange, originally there were five 20-ton Thomas converters with an annual capacity of 420,000 tons. One of them has been converted to LD/AC and the other four modified to OBM, by which the capacity has been raised to 800,000 tons per year. The actual production in 1974 was 716,000 tons. The OBM converters tap 26 to 28 tons per heat. The plant management is confident, however, that 30-ton heats can be tapped, provided the crane capacities and other auxiliary facilities are suitably modified to handle larger heats.

The La Chiers plant at Longwy has modified their Thomas converters to the LWS process. The LWS is similar to the OBM, except that it uses oil for endothermic shielding of the converter bottom refractories, instead of natural gas, propane or butane employed in the OBM process. Originally, there were five 19-ton converters and the maximum production was only 680,000 tons. The converters tap 33-ton heats after conversion to LWS, and in 1974 the production rose to 740,000 tons. The current operating rate is about 900,000 tons per year with 85 heats per day (maximum 99 heats) and it is expected to reach 1 million tons shortly.

ALTERNATIVE SCHEMES FOR PDR EXPANSION

In the light of the foregoing considerations, the expansion of PDR through the conversion of the existing Thomas shop to oxygen bottom-blown process

6 - **Expansion of Acerias Paz del Rio S.A** (cont'd)

would merit serious consideration. Two alternative schemes of PDR expansion, PDR-II and PDR-III, have therefore been developed on the following basis:

PDR-II

PDR will fully utilise its existing hot rolling mills.

The new wire rod mill as well as the new billet mill proposed in PDR-I will not be installed.

PDR-III

The new wire rod mill of 200,000 tons per year capacity proposed in PDR-I will be installed.

With the adoption of continuous billet casting, the new billet mill proposed in PDR-I will not be required.

Product-mix: PDR-II and PDR-III

The product-mix for PDR-II and PDR-III has been evolved on the basis of the demand projections made in this study, taking into account the existing and additional rolling facilities proposed to be installed. These are given in Table 6-2.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Table 6-2

PRODUCT-MIX FOR PDR-II AND PDR-III
(thousand tons)

	PDR-II		PDR-III	
	1980	1985	1980	1985
Flat Products				
Hot rolled ..	94	31	94	31
Cold rolled ..	110	240	110	240
Tin plate ..	-	60	-	60
Sub-total ..	204	331	204	331
Non-flat products				
Wire rods ..	110	110	110	200
Light profiles, bars and rods ..	70	70	70	180
Medium profiles ..	10	30	10	30
Sub-total ..	190	210	190	410
Salable billets ..	-	-	-	14
Total ..	394	541	394	755

Crude steel requirement; PDR-II and PDR-III

The total crude steel requirement for the envisaged production programme in 1985 as well as the production from the electric arc furnace and the bottom-blown oxygen process of PDR-II and PDR-III would be as follows:

	PDR-II '000 tons	PDR-III '000 tons
Electric steel ..	40	40
Oxygen steel ..	685	912
Total requirement ..	725	952

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

With regard to the bottom-blown oxygen process, as there is no natural gas available at Belencito, the adoption of LWS process using fuel oil has been considered. For meeting the crude steel requirements, in addition to converting the existing three Thomas converters to LWS process, it would be necessary to install one new converter in PDR-II and two new converters in PDR-III. The new converters would be of the same size. It may be mentioned that there is already specific provision for adding a fourth converter in the Thomas shop.

Major additional facilities; PDR-II and PDR-III

The major additional production facilities to be installed during expansion under PDR-II and PDR-III are given in Appendix 6-3.

In addition to the major production units indicated in Appendix 6-3, the iron ore, coal and limestone mines would have to be suitably expanded to meet the raw material requirements. The raw material handling and stocking facilities at the plant would also be suitably expanded. The requisite steam raising capacities, turbo blowers, balancing facilities for power supply and other utility systems including the conversion of the existing plant water system to a recirculating system, will be installed.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Material flow sheets: PDR-II and PDR-III

The material flow sheets for PDR-II and PDR-III are shown in Figures 6-1 and 6-2 respectively. The annual requirements of major raw materials and the production of major units at full rated capacity are given below:

	PDR-II '000 tons/yr	PDR-III '000 tons/yr
Iron ore ..	1 470	2 000
Raw coal ..	1 400	1 875
Limestone ..	720	960
Gross coke ..	625	845
Sinter ..	1 250	1 825
Hot metal ..	670	900
Crude steel		
Ingot ..	574	574
C.C. blooms/billets	150	378
Rolled products ..	541	755

With the adoption of LWS process, it would be necessary to purchase some coolant to supplement the plant return scrap available after meeting the arc furnace requirements. The use of purchased ores/pellets has been considered for this study.

Phasing of construction: PDR-II and PDR-III

Keeping in view the growing domestic demand for flat products and the possible completion of the cold mill ahead of the rest of the expansion, it would

6 - **Expansion of Acerias Paz del Rio S.A** (cont'd)

be advantageous to augment the steel production at the earliest, by improved exploitation of the existing blast furnace and Thomas converter shop, which would reduce the import of slabs to some extent. Accordingly, both PDR-II and PDR-III can be implemented in two phases, the work on both the phases to start concurrently from 1977 as follows:

Phase 1 - 380,000 tons crude steel per year

Increase the hot metal production from existing blast furnace to 330,000 tons per year with oxygen injection. This could yield 340,000 tons of crude steel which can be made by modifying the existing 3 Thomas converters to LWS. Together with 40,000 tons from the existing arc furnace, the ingot steel production would be 380,000 tons. The completion of Phase 1 will be determined mainly by the time required to install the oxygen plant which may take about 2 years. Thus Phase 1 would become operative by 1979.

Phase 2 - total crude steel capacity

Work on Phase 2 will start concurrently with Phase 1, and may require about 4 years to complete. Phase 2 will therefore become operative by about 1981 and the total crude capacity would be installed by then as follows:

PDR-II	-	725 000 tons
PDR-III	-	952 000 tons

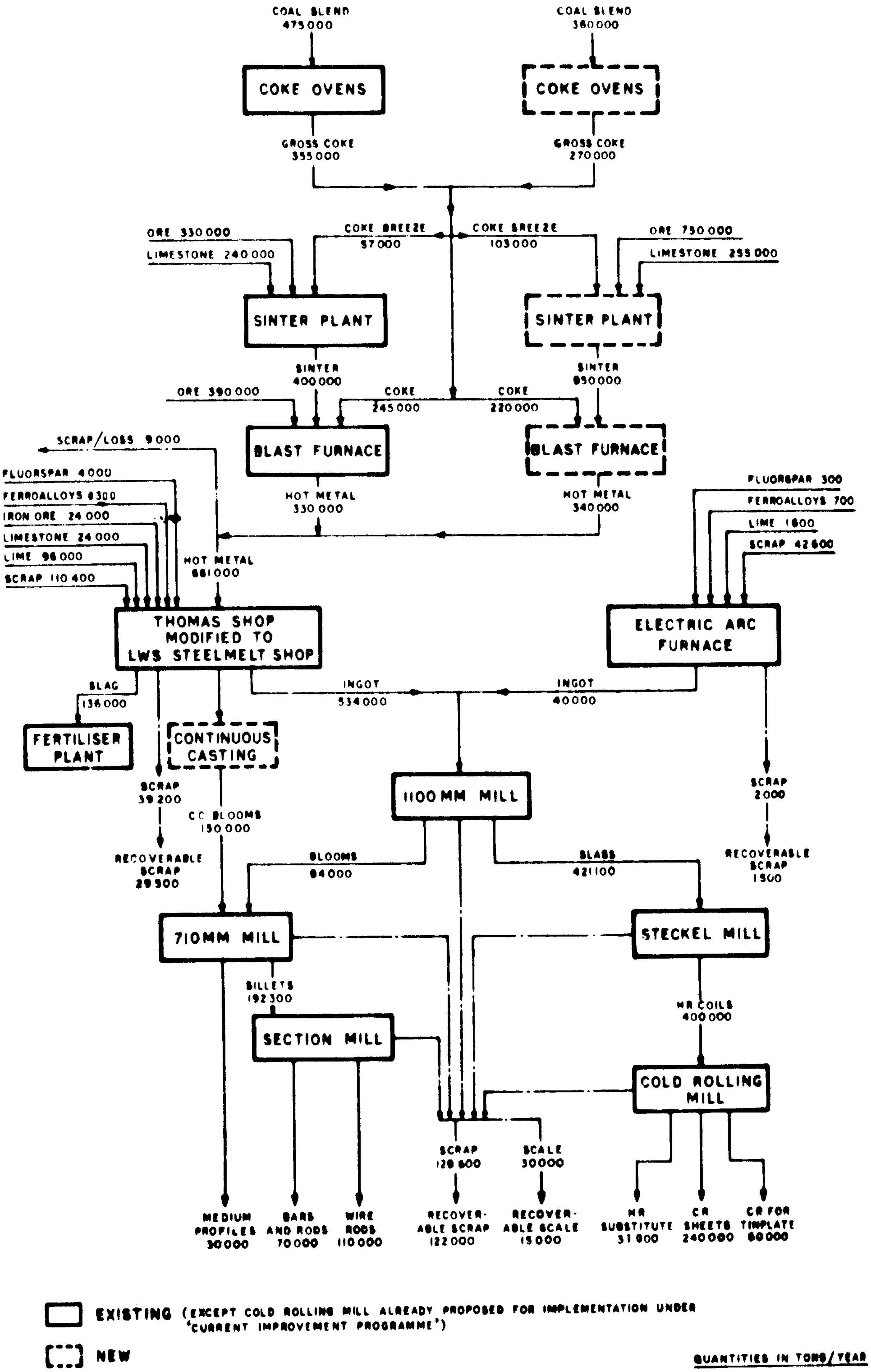


FIGURE 6-1. PDR-II: MATERIAL FLOW SHEET

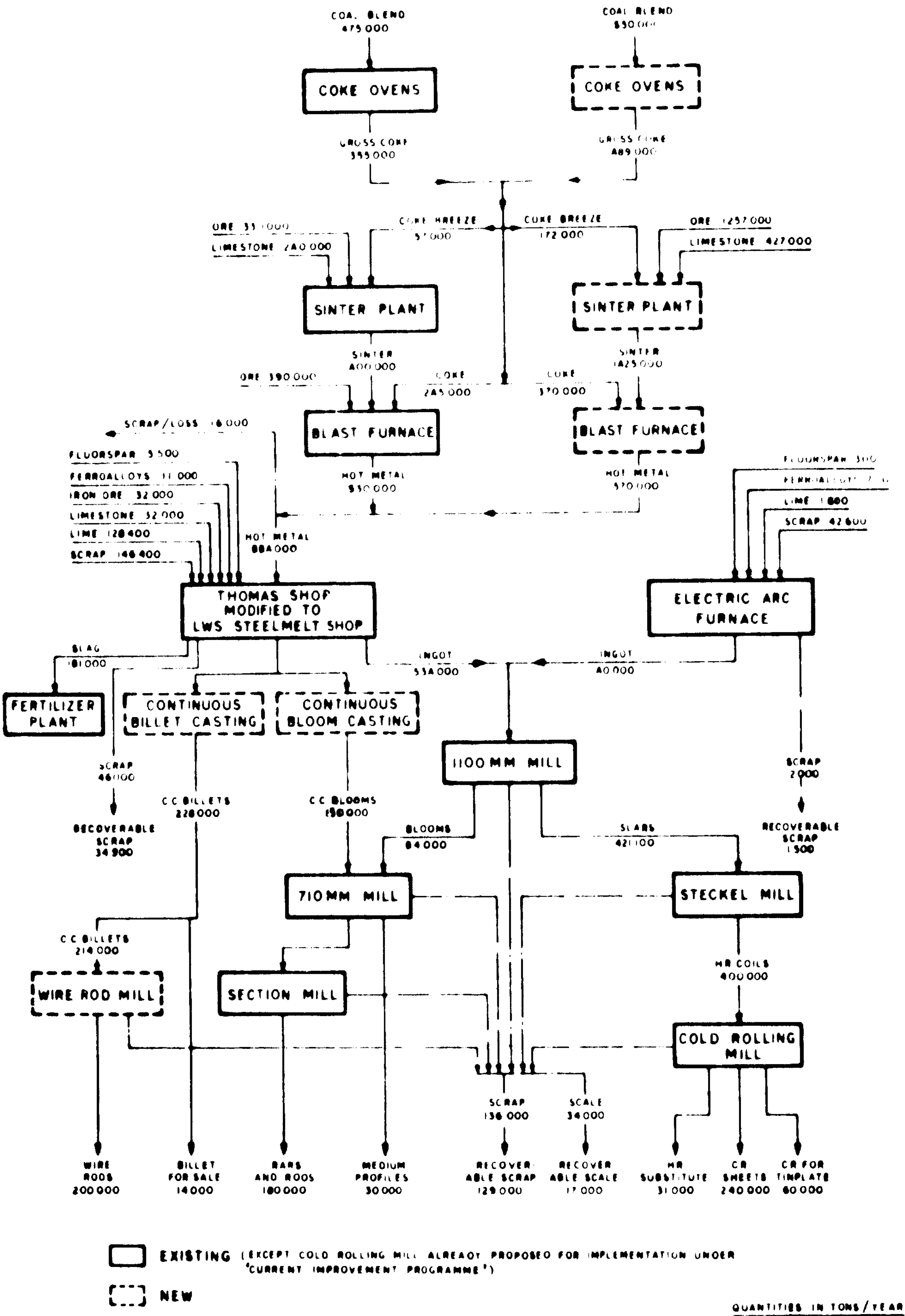


FIGURE 6-2. PDR-III: MATERIAL FLOW SHEET

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

COMPARISON OF EXPANSION SCHEMES

Major milestones

The major milestones in the implementation of the three expansion schemes as well as the installation of the cold rolling facilities under the Current Improvement Programme are assumed as follows:

a) Investment decision to be taken before end of 1976.

b) The work on the installation of the first stage cold rolling facilities would start in January 1977 and commence operations in 1979.

c) The work on the development of mines and the installation of new production facilities under the expansion schemes would start in 1977 and would be completed in 1980. The production from the new facilities would commence in 1981.

d) The Phase 1 facilities of PDR-II and PDR-III would become operative in 1979 with the higher hot metal availability from the existing blast furnace.

e) The installation of the second stage cold rolling facilities would be initiated in early 1981 and would start operation in 1983.

Production programme

The annual production programmes of PDR-I, PDR-II and PDR-III are presented in Table 6-3. The production programme of PDR-I has been derived from the feasibility report on PDR expansion, taking into account the differences in the construction schedule given in the feasibility report and as discussed above. For PDR-II and PDR-III the production programme has been developed taking into account the normal time required to bring up the new facilities to rated production and the proposed construction schedule.

It will be noted that in 1985 (at full production level) the production of flat products indicated in PDR-I is higher than that indicated in PDR-II and PDR-III. This is because, while PDR has indicated the rated capacity of the steckel mill as 400,000 tons per year, in the feasibility report of PDR expansion, the rated capacity of this mill has been assumed as 442,000 tons per year and no adjustments have been made for this in the PDR-I scheme presented in this study.

Capital cost

The relative costs of new facilities to be installed for the three alternative schemes of expansion are given in Appendix 6-4 and summarised in Table 6-4. These estimates do not include preliminary expenses, interest during construction, start-up, commissioning and escalation.

Table 6-3

PDR - PRODUCTION PROGRAMMES OF EXPANSION SCHEMES
(thousand tons)

	PDR-I[a]									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
FLAT PRODUCTS										
Hot rolled ..	50	62	71	[illegible]	[illegible]	50	[illegible]	[illegible]	70	75
Cold rolled ..	-	-	-	152	[illegible]	[illegible]	184	[illegible]	[illegible]	237
Tin plate ..	-	-	-	-	-	-	-	64	62	62
Sub-total ..	50	62	71	[illegible]	204	223	[illegible]	[illegible]	[illegible]	[illegible]
NON-FLAT PRODUCTS										
Bars and rods[b]	62	62	74	74	74	74	150	150	150	150
Wire rods[c] ..	106	106	106	106	106	150	[illegible]	197	197	197
Medium profiles	6	7	-	7	9	9	30	12	13	14
Sub-total ..	174	175	187	187	189	233	325	359	360	361
SALABLE BILLETS ..	12	12	-	-	-	74	138	112	[illegible]	57
Total salable steel	236	249	258	3?? [illegible]	39? [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	PDR-II									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
FLAT PRODUCTS										
Hot rolled ..	50	62	71	99	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cold rolled ..	-	-	-	70	[illegible]	150	170	[illegible]	240	240
Tin plate ..	-	-	-	-	-	-	-	60	60	60
Sub-total ..	50	62	71	199	[illegible]	29? [illegible]	28? [illegible]	334	331	331
NON-FLAT PRODUCTS										
Bars and rods[b]	65	66	67	69	70	70	70	70	70	70
Wire rods[c] ..	98	101	104	107	110	110	110	110	110	110
Medium profiles	6	7	8	9	10	15	30	30	30	30
Sub-total ..	169	174	179	185	190	195	210	210	210	210
SALABLE BILLETS ..	-	-	-	-	-	-	-	-	-	-
Total salable steel	219	236	250	344	[illegible]	[illegible]	49? [illegible]	544	541	541

	PDR-III									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
FLAT PRODUCTS										
Hot rolled ..	50	62	71	99	94	106	119	52	[illegible]	[illegible]
Cold rolled ..	-	-	-	70	110	150	170	240	240	240
Tin plate ..	-	-	-	-	-	-	-	62	60	60
Sub-total ..	50	62	71	199	204	256	289	334	33? [illegible]	331
NON-FLAT PRODUCTS										
Bars and rods[b]	65	66	67	69	70	140	140	160	180	180
Wire rods[c] ..	98	101	104	107	110	140	180	200	200	200
Medium profiles	6	7	8	9	10	15	30	30	35	35
Sub-total ..	169	174	179	185	190	295	350	390	410	410
SALABLE BILLETS ..	-	-	-	-	-	26	19	-	16	16
Total salable steel	219	236	250	344	39? [illegible]	577	658	[illegible]	[illegible]	[illegible]

a. Based on Table 7, page 9/7 of PDR expansion feasibility report ([illegible]). The figures as given in the feasibility report table between 1976 and 1981 have been postponed by one year, e.g. production of 1976 would now occur in 1977 etc. [illegible] 1985 [illegible] not [illegible]. 1976 figures are considered same as 1977 in this table.
b. Includes rebars and small sections.
c. For PDR-I, obtained by adding rods and rounds [illegible] of Table 7 indicated in (a) above. PDR-II and PDR-III include special wire rods also, to the extent of 5,000 tons per year.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Table 6-4

PRELIMINARY CAPITAL COST ESTIMATES FOR NEW FACILITIES FOR EXPANSION SCHEMES[a]

Expansion scheme	Additional crude steel capacity '000 tons	Cost for additional facilities mill US $	Cost per ton of additional capacity US $
PDR-I	700	441	630
PDR-II	425	223	520
PDR-III	652	388	595

a/ Excludes the investments on Current Improvement Programme.

The investments on the major steelmaking facilities to be installed in Phase 1 of PDR-II and PDR-III would be of the order of US $ 11 million.

The preliminary phasing of annual expenses for the installation of the cold rolling mills under the Current Improvement Programme and for the new facilities for expansion is given in Appendix 6-5.

Works cost

The average works cost per ton of rolled steel (excluding depreciation and interest charges) for the three expansion schemes has been estimated and compared with that obtaining in 1974 at PDR in Table 6-5. The costs for the expansion schemes have been calculated on the basis of the 'Basic unit costs' indicated in

6 - Expansion of Acerias Paz del S.A (cont'd)

the feasibility report for expansion (updated in 1975), and also on the basis of the costs of major raw materials furnished by PDR to the Consultants.

Table 6-5

PDR - AVERAGE WORKS COST PER TON ROLLED STEEL, 1974 AND AFTER EXPANSION

		Salable steel	Average works cost	
			Relative[a/]	Adopted[b/]
		'000 tons	US $/ton	US $/ton
1974	..	193	145[c/]	-
PDR-I	..	792	128[d/]	134
PDR-II	..	541	132	138
PDR-III	..	755	129	135

a/ Based on 'Basic unit costs' of feasibility report and excludes depreciation and interest charges.

b/ Based on major raw material prices given by PDR to Consultants. These costs have been adopted in the study.

c/ Derived from 1974 Annual Report. Total cost of sales, Colombian pesos 998 million less depreciation and amortisation charges Colombian pesos 157 million gives the annual manufacturing cost of Colombian pesos 841 million, which for 193,000 tons salable steel gives an average works cost of Colombian pesos 4,358 per ton or US $ 145 per ton.

d/ Feasibility report on PDR expansion (updated 1975) indicates an annual manufacturing expenses of Colombian pesos 3,008 million for 792,000 tons which gives an average works cost of Colombian pesos 3,798 per ton or US $ 127 per ton.

From Table 6-5, it would be noted that the relative average cost of finished steel after expansion would be about 88 per cent to 90 per cent of that in 1974.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

This saving arises from better utilisation of the existing facilities, expansion of the plant and the adoption of bottom-blown oxygen process. Further, the costs adopted in the study for the expansion schemes is about US $ 6 per ton higher than the relative costs due to the differences in unit prices of major raw materials indicated by PDR and those adopted in the feasibility report.

Depreciation and interest charges

The depreciation and interest charges have been worked out as follows:

i) For the existing facilities, the depreciation charges as provided in 1974 have been assumed to be constant for future years.

ii) The depreciation and interest charges for the coke oven battery No. 2 and the cold rolling mill complex being installed under the Current Improvement Programme, and the additional facilities to be installed, have been provided on a straight line basis at the rate of 15 per cent of the estimated additional cost of these facilities.

On the above basis, the estimated depreciation and interest charges for the three alternative schemes of expansion are given in Table 6-6, on the next page.

From Table 6-6 it would be observed that after installation of new facilities, the depreciation and

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

interest charges are expected to rise between US $ 84 to US $ 93 per ton of salable steel compared to the charges for 1974. The increased depreciation and interest charges would therefore result in an increase in the total cost of production of slable steel.

Table 6-6

ESTIMATE OF DEPRECIATION AND INTEREST CHARGES

			1985		
		1974	PDR-I	PDR-II	PDR-III
Depreciation on existing facilities[a/] ..	Mill US $	4	4	4	4
Depreciation and interest charges on Current Improvement Programme[b/]	Mill US $	-	20	20	20
Depreciation and interest charges on new facilities for expansion[c/] ..	Mill US $	-	66	33	58
Total ..	Mill US $	4	90	57	82
Salable steel production	'000 tons	193	792	541	755
Depreciation and interest charges ..	US $/ton	21	114	105	109

a/ Depreciation charges as per 1974 Annual Report is Colombian pesos 123 million.
b/ Investment US $ 136 million.
c/ Refer Appendix 6-2 for capital costs.

Total cost of production of steel

The estimated average total cost per ton of salable steel products for the three alternatives is

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

indicated in Table 6-7 along with the cost figures for 1974.

Table 6-7

ESTIMATED AVERAGE COST OF SALABLE STEEL PRODUCTS FOR THE THREE ALTERNATIVES AS COMPARED TO COST DURING 1974
(US $ per ton)

		1985		
	1974	PDR-I	PDR-II	PDR-III
Works cost ..	145	134	138	135
Depreciation and interest charges	21	114	105	109
Total cost of production:	166	248	243	244

From Table 6-7 it would be noted that at full rated production after expansion, the total average cost of production of steel would be higher by about 46 to 50 per cent as compared to the average total cost during 1974. T e analysis also indicates that the average cost of steel would be approximately the same for both PDR-II and PDR-III, while the average total cost of production under PDR-I would be marginally higher than the average total cost under PDR-II and PDR-III.

Elimination of PDR-I

Both PDR-I and PDR-III envisage the expansion of PDR to about 1 million ton crude steel capacity with similar product-mix. Due to the marginally lower estimate of investment and operating costs of PDR-III, this scheme appears to be preferable to PDR-I, and therefore, PDR-III has been considered in this study for 1 million ton scheme.

RAW MATERIALS SITUATION

PDR would have to ensure adequate availability of major raw materials before implementing the expansion schemes.

Iron ore

PDR has conducted geological investigations at its iron ore deposit. On the basis of the exploration work completed so far, PDR has estimated a total iron ore reserves of about 226 million tons. Of this, about 124 million tons have been classified as measured reserves, of which 78 million tons are mineable reserves.

Based on the data made available, Consulting Engineers have estimated the reserves of the different deposits and these are compared with the reserves reported by PDR in Table 6-8 on the next page.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Table 6-8

COMPARISON OF MEASURED RESERVES ESTIMATED BY PDR AND CONSULTING ENGINEERS
(million tons)

Deposits		Measured reserves PDR	Measured reserves Consulting Engineers
Buenos Aires	..	22.65	23.03 a/
El Salitre	..	23.55	17.96 b/
El Uche	..	4.78	4.79 c/
Pirgua-Sativa	..	43.07	36.54 d/
El Banco	..	19.84	14.34 e/
Fraile-Picacho	..	6.69	6.40 f/
El Uvo	..	0.95	1.44 g/
Paz Vieja	..	2.50	- h/
Total measured reserves		124.03	104.50
Mineable reserves i/	..	78.37	65.42

a/ Estimated on the basis of 10 boreholes out of 28 boreholes drilled.

b/ Estimation based on data available in respect of 3 boreholes out of 15 boreholes drilled.

c/ Estimation based on data available in respect of 5 boreholes out of 10 boreholes drilled. Actual thickness of iron ore bed is determined assuming 45° inclination.

d/ Estimation based on the results of 5 boreholes out of 19 boreholes drilled as per Drawing No. G-0292.

e/ Estimation based on the results of 17 boreholes out of 24 borholes drilled as per Drawing No. BO132.

f/ Estimation based on data available in respect of 14 boreholes out of 36 boreholes drilled as per Drawing No. G-0313.

g/ Estimation based on the results of 4 boreholes. Actual thickness of iron ore bed is determined assuming 45° inclination.

h/ Reserves in Paz Vieja could not be estimated because of inadequate data.

i/ Based on recovery percentage indicated by PDR.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

The iron ore occurring in PDR mines is characterised by low Fe content (43 to 45 per cent) and high silica content. The silica content of the ore has increased from about 10 per cent in 1970 to about 11 per cent in 1974. The beneficiation tests completed so far on the ore have not yielded encouraging results. PDR is considering to get further investigations conducted, and it is suggested that all efforts should be made to find out the economic possibility of beneficating the ore.

The iron ore requirement after the expansion would range between about 1.5 million to 2 million tons per year depending on the scheme selected. The mineable reserves in the concessions of PDR would be adequate to meet these requirements for about 30 to 35 years.

Coal

The reserves of coking coal estimated by PDR in its concessions are as follows:

		Million tons
Measured	..	44
Indicated	..	44
Inferred	..	110
Total	..	198

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Of the 44 million tons of measured reserves, about 39 million tons have been classified as coking coal, of which about 22 million tons are considered recoverable.

The raw coal requirement after expansion would range between 1.4 million and 1.9 million tons per year and the recoverable reserves would be adequate for 12 to 16 years. Further proving work would, therefore, have to be conducted. This, however, need not be a constraint on expansion, as there are possibilities of purchasing coal from nearby sources.

Limestone

The estimated total reserves of limestone is about 116 million tons of which about 11 million tons are classified as measured reserves and this is adequate to meet the requirements of the expanded plant for only about 7 to 10 years. It would, therefore, be necessary to undertake further exploration work. This is not, however, a restraint on the expansion of the plant, as there are possibilities of purchasing from other sources.

The analysis of the limestone available from the captive mines, ranges 48 to 52 per cent CaO and

2 to 8 per cent SiO_2. As the oxygen bottom-blown process will be adopted, it is essential that the steelmaking grade limestone areas be blocked out and consistent good quality limestone be made available to the steelmelt shop. The desired quality of lime for LWS is CaO 90 per cent minimum and SiO_2 3 per cent maximum.

INFRASTRUCTURE FACILITIES

Electric power

The existing power requirement of the plant is met by PDR's captive generating plant comprising two thermal units of 12.5 MW each, supplemented by purchased power from the Paipa thermal power station of ICEL (NORDESTE).

The installed generating capacity at Paipa was only 33 MW and a 66 kV double-circuit line was to carry power from Paipa to Belencito. The capacity of the Paipa station will be, however, raised to 99 MW at the end of 1975 and a new set of double-circuit 115 kV line connects Paipa and Belencito. The 115 kV lines have the capacity to carry about 150 MW of power and would be adequate for meeting the power demand of about 100 MW of PDR after expansion.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Further, the Paipa station will also be connected to the Chivor hydro-electric power station. The Stage-I of the Chivor power station with 500 MW capacity is expected to be commissioned in 1976.

Hence, no major difficulty is anticipated regarding supply of power to Paz del Rio steel plant. The incoming supply taken from a 115 kV system well connected to major power stations and having adequate stiffness would also eliminate the voltage flicker problem that might be caused by the operation of arc furnaces in the plant.

Water

The water requirements of PDR are met from Lake Tota. From the information made available by INDERNA and Departmento Nacional de Planeacion, it is noted that the additional water requirements for the expanded plant would be available from the same source to the extent of the make-up water requirement of a recirculatory water system at the plant. The existing main from Lake Tota to the plant would be adequate to handle the make-up water requirement of the expanded plant.

6 - Expansion of Acerias Paz del Rio S.A (cont'd)

Transport

PDR operates its own captive railway system for transporting raw materials from the mines to the plant. For the expansion of the PDR capacity to 1 million tons, the carrying capacity of the captive railway system would have to be increased.

At present, the bulk of the finished products are transported from the plant to Bogota on road. This, however, will not be possible after expansion. Necessary investigations would have to be carried out for ensuring adequate railway transport facility between Belencito and Bogota, and the existing railway system suitably expanded.

7 - CREATION OF NEW CAPACITY

The facilities to be set up for creating new capacities and the time table for their installation would primarily depend on the extent of the shortfalls existing between the total demand and the possible production achievable by the expansion of SIP and PDR during the time horizon. As a first step, therefore, the gap between the projected demand and the projected production of SIP and PDR needs to be identified.

DEMAND CONSIDERED FOR DOMESTIC PRODUCTION

The total demand for steel projected in Chapter 3 covers the wide range of items. Some of these are not envisaged for domestic production, either because of their too small tonnage to justify the installation of viable units or because the industries to process and consume such items may not come up by 1985. These items have, therefore, been excluded from the total demand to arrive at the net demand considered for possible domestic production in 1980 and 1985 as indicated in Appendix 7-1.

. - Creation of New Capacity (cont'd)

The ordinary steel demand considered for domestic production has been regrouped according to sizes and categories (Table 7-1) primarily to enable the choice of the rolling mills. For this purpose, the present pattern of consumption of rolled products by the consuming industries such as the construction sector, pipe manufacturers and other processing units have been taken into consideration.

Yearwise demand for ordinary steel

For arriving at the yearwise demand for ordinary steel rolled products for domestic production, the 1974 demand has been taken as the base, and the demands for the years 1976 to 1979 have been interpolated by geometric progression from the base year 1974 to the terminal year 1980. Similarly, the demands for the years 1981 to 1984 have been interpolated by geometric progression between the projected demand of the two terminal years 1980 and 1985. The yearwise demand for ordinary steel products envisaged for domestic production is given in Appendix 7-2.

Alloy and special steels

The total demand for alloy and special steels and that envisaged for domestic production have been discussed in Chapter 5.

Table 7-1

SIZEWISE BREAKDOWN OF ORDINARY STEEL DEMAND CONSIDERED FOR DOMESTIC PRODUCTION
(thousand tons)

	1980					1985				
	Demand considered a/	Bars & rods	Wire rods	Light profiles	Medium profiles	Demand considered a/	Bars & rods	Wire rods	Light profiles	Medium profiles
NON-FLATS										
Bars and rods	340	216 b/	84 b/	-	40 c/	596	379 b/	147 b/	-	70 c/
Profiles:										
Beams ..	12	-	-	-	12	21	-	-	-	21
Channels ..	46	-	-	15	31	74	-	-	24	50
Angles ..	62	-	-	27	35	95	-	-	41	54
Narrow flats	50	-	-	40	10	88	-	-	70	18
Wires ..	130	-	130	-	-	215	-	215	-	-
Sub-total	640	216	214	82	128	1 089	379	362	135	213

	1980	Hot rolled		Cold rolled		Tin plate	1985	Hot rolled		Cold rolled		Tin plate
	Demand considered	-1200 mm	+1200 mm	-1200 mm	+1200 mm		Demand considered	-1200 mm	+1200 mm	-1200 mm	+1200 mm	
FLATS												
Plates ..	35	17	18	-	-	-	63	31	32	-	-	-
CR sheets/strip	125	-	-	88	37	-	350	-	-	250	100	-
HR sheets/strip	90	63	27	-	-	-	160	112	48	-	-	-
Tinplates ..	120	-	-	-	-	120	190	-	-	-	-	190
Galvanised sheets	80	-	-	80	-	-	135	-	-	135	-	-
Welded pipes and tubes	36	31	-	5	-	-	65	55	-	10	-	-
Sub-total	486	111	45	172	37	120	963	198	80	395	100	190
Total ..	1 126						2 052					

a/ Refer Appendix 7-1.
b/ Refer Appendix 5-6.
c/ +75 mm.

7 - Creation of New Capacity (cont'd)

Projected future production of SIP and PDR

Taking into consideration the production programme of SIP as discussed in Chapter 5 and the three alternatives for PDR, three combinations of domestic production from the existing plants are possible, namely:

Case-I	-	SIP + PDR-I
Case-II	-	SIP + PDR-II
Case-III	-	SIP + PDR-III

As mentioned in Chapter 6, PDR-I has been eliminated from further consideration. Therefore, Case-I has not been analysed.

Gap between demand and production

The gap between the demand considered for production and the production planned for SIP and PDR in the two cases are shown in Table 7-2, on the next page. This projection has been made for the period 1979 to 1985, because no new major facilities can come into production prior to 1979.

REQUIREMENT OF NEW ROLLING MILLS

Based on the shortfalls in the rolled products indicated in Table 7-2, the new rolling mill capacity required in both the cases has been identified.

Table 7-2

PROJECTED GAP BETWEEN DEMAND CONSIDERED AND PRODUCTION OF SIP AND PBR
(thousand tons)

	1979					1980				
	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall
ORDINARY STEEL										
Bars and rods ..	191	146	45	146	45	216	160	56	160	56
Wire rods ..	188	157	31	157	31	214	160	54	160	54
Light profiles ..	69	50	19	50	19	82	68	14	68	14
Medium profiles ..	87	9	78	9	78	128	10	118	10	118
HR sheets/strip ..	149	89	60	89	60	156	94	62	94	62
CR sheets/strip ..	180	70	110	70	110	210	110	100	110	100
Tinplates ..	104	-	104	-	104	120	-	120	-	120
Total ..	968	521	447	521	447	1 126	602	524	602	524
SPECIAL STEELS										
Bars and rods ..	30	24	6	24	6	36	35	1	35	1
Wire rods ..	28	19	9	19	9	32	25	7	25	7
Total ..	58	43	15	43	15	68	60	8	60	8

	1981					1982				
	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall
ORDINARY STEEL										
Bars and rods ..	242	165	77	235	7	271	165	106	235	36
Wire rods ..	238	170	68	200	38	265	170	95	240	25
Light profiles ..	91	83	8	83	8	100	83	17	83	17
Medium profiles ..	142	15	127	15	127	158	30	128	30	128
HR sheets/strip ..	175	106	69	106	69	197	119	78	119	78
CR sheets/strip ..	250	150	100	150	100	297	170	127	170	127
Tinplates ..	131	-	131	-	131	144	-	144	-	144
Total ..	1 269	689	580	789	480	1 432	737	695	877	555
SPECIAL STEELS										
Bars and rods ..	41	40	1	40	1	49	48	1	48	1
Wire rods ..	36	26	10	26	10	43	26	17	26	17
Total ..	77	66	11	66	11	92	74	18	74	18

	1983					1984				
	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall
ORDINARY STEEL										
Bars and rods ..	304	165	139	[illegible]	[illegible]	[illegible]	165	176	[illegible]	[illegible]
Wire rods ..	295	170	125	[illegible]	[illegible]	[illegible]	170	159	160	[illegible]
Light profiles ..	111	83	28	83	28	123	83	40	83	40
Medium profiles ..	175	30	145	30	145	194	30	164	30	164
HR sheets/strip ..	220	52	168	52	168	[illegible]	31	216	31	216
CR sheets/strip ..	353	240	113	240	113	[illegible]	[illegible]	180	[illegible]	180
Tinplates ..	158	42	116	42	116	172	60	112	60	112
Total ..	1 616	782	834	962	654	1 3?7	7??	1 048	979	[illegible]
SPECIAL STEELS										
Bars and rods ..	58	48	10	48	10	69	[illegible]	31	[illegible]	31
Wire rods ..	50	26	24	26	24	59	[illegible]	33	[illegible]	33
Total ..	108	74	34	74	34	128	74	54	74	54

	1985				
	Demand	Case II Prodn	Case II Shortfall	Case III Prodn	Case III Shortfall
ORDINARY STEEL					
Bars and rods ..	379	165	214	275	104
Wire rods ..	362	170	192	260	102
Light profiles ..	135	83	52	83	52
Medium profiles ..	213	30	183	30	183
HR sheets/strip ..	278	31	247	31	247
CR sheets/strip ..	495	240	255	240	255
Tinplates ..	190	60	130	60	130
Total ..	2 052	779	1 273	979	1 073
SPECIAL STEELS					
Bars and rods ..	80	60	20	60	20
Wire rods ..	71	26	45	26	45
Total ..	151	86	65	86	65

7 - Creation of New Capacity (cont'd)

Bar and rod, and wire rod mill

The shortfalls in bars and rods, and wire rods of ordinary steel and special steel in 1985 are as follows:

Case-II	-	449,000 tons
Case-III	-	259,000 tons

In Case-II, the new facilities for the bars and rods, and wire rods should have a production of about 400,000 tons by 1985. Keeping in view the shortfalls of earlier years, it is proposed that at the initial stage, facilities for 200,000 tons capacity should be installed by about 1979 and this should be expanded to 400,000 tons by 1983.

In Case-III, however, the installation of additional rolling capacity for bars and rods and wire rods for the production of 200,000 tons by 1985 is envisaged. This mill may be installed by 1983, which would enable the full capacity production to be achieved in 1985.

This new capacity (in both cases) could be installed either through the expansion of SIP or by installing a new plant.

7 - Creation of New Cabacity (cont'd)

Light profile mill

Additional capacity for production of light profiles to the extent of about 50,000 tons per year would be required by 1985, in both the cases. It is therefore suggested that a mill of this capacity should go on stream by 1984, preferably to be installed as a part of expansion of SIP.

Medium profile mill

With regard to medium profiles, a new 200,000 ton capacity mill should be operating at full capacity level in 1985 in both the cases. Therefore, such a mill should be installed by 1983 which will allow for the gestation period to build up the production to full capacity level.

Strip mills

With regard to flat products, keeping in view that PDR has already a steckel mill, the next installation should be semi-continuous mill. In order to cover a wide spectrum of demand, the new semi-continuous mill may preferably be of 1730 mm (68 in) size. The minimum capacity of such a mill would be around 1 million tons of hot rolled products. Keeping in view the shortfalls in domestic production and allowing for the normal time required for full rated capacity production in such mills, the installation of the mill in 1984 would be justified. Adequate cold rolling and finishing facilities would also have to be set up at the same time.

SELECTION OF IRON AND STEELMAKING ROUTES

Necessary iron and steelmaking facilities would have to be installed for the new rolling mills. In this connection, the selection of the iron and steelmaking routes for the new bar and rod mill complex, the medium profile mill and the flat product mill are of interest. In view of the time horizon of the requirement of the additional capacity of medium profiles and the flat products, it is suggested that an integrated plant should be set up for the production of both these categories of products.

With regard to the bar and rod, and wire rod capacity, it could be set up, as mentioned earlier, either through expansion of SIP or as a new complex. The expansion of SIP would possibly be through the electric arc furnace route, similar to the present practice of these plants, as this will enable a phased increase in production. In

7 - Creation of New Capacity (cont'd)

the case of a new complex, the plant is proposed to be started with a capacity of 200,000 tons and then expanded, in keeping with the growth of demand. In Case-II, the new mill may have a capacity of about 400,000 tons by 1985.

Therefore, the following two capacities have been considered for the selection of alternative routes of iron and steelmaking.

Alt. 1 - 500,000 tons crude steel capacity
Alt. 2 - 1.3 million tons crude steel capacity

Review of alternative processes

The two most commonly adopted routes of iron and steelmaking are the conventional blast furnace - basic oxygen steelmaking (BF-BOS) route and the direct reduction-electric arc furnace(DR-EF) route. In the Colombian context, both these routes merit consideration; the blast furnace route would utilise the locally available coking coal, while the direct reduction route could be based on the domestic supplies of natural gas.

In planning the new integrated steel complex, it is essential that the possibilities of further expansion of this new plant should be kept in view, as this would form the nucleus for the future development of integrated steel production in Colombia.

7 - Creation of New Capacity (cont'd)

Basis of comparison

For the purpose of comparing the two alternative capacities, the following assumptions have been made:

i) Iron ore pellets required for production of sponge iron will be imported and iron ore required for BF-BOS route will also be imported. A part of the iron ore will be imported as fines and will be sintered before charging into blast furnace.

ii) Of the approximately 330,000 tons of domestic scrap available for steelmaking in 1985, the new electric arc furnace complex would receive about 180,000 tons per year and the balance 150,000 tons will be utilised by SIP. It is assumed that SIP electric arc furnaces will be operating on an average with 50% sponge iron and 50% scrap (including the use of the plant returning scrap).

iii) The new electric arc furnace plants are also assumed to operate on an average with 50% scrap and 50% sponge iron charge.

iv) The annual requirements of scrap beyond 180,000 tons per year for the new electric arc furnace complexes would have to be imported.

v) The coolant requirement for oxygen steelmaking will be met by the plant recirculating scrap and the balance by ore.

The direct reduction-electric arc furnace (DR-EF) plant will comprise pellet storage and handling, sponge iron production storage and handling, and electric arc furnace facilities, complete with utilities and services. The blast furnace-basic oxygen steel (BF-BOS) plant is envisaged to have coke making, sintering, blast

7 - Creation of New Capacity (cont'd)

furnace and oxygen steelmaking facilities, complete with utilities and services.

The consumptions of major raw materials per ton of liquid steel for the two alternative routes are assumed as given in Table 7-3.

Table 7-3

CONSUMPTION OF MAJOR RAW MATERIALS PER TON OF LIQUID STEEL

			DR-EF route kg	BF-BOS route kg
Iron ore:	Sized	...	-	322
	Fines	...	-	1 200
	Pellets	...	770	-
Coking coal		...	-	1 040
Limestone		...	-	280
Lime		...	70	102
Purchased scrap		...	360	-
Recirculating scrap		...	140	140
Natural gas		...	275	26

Economic comparison

The economic comparison of the alternative routes has been made on the basis of the major raw material consumption given in Table 7-3 and the unit costs given in Table 7-4.

7 - Creation of New Capacity (cont'd)

Table 7-4

UNIT COSTS CONSIDERED FOR EVALUATION OF PROCESSES

Item		Unit	Cost as delivered to plant US $/unit
Iron ore:	Sized	ton	26
	Fines	ton	24
	Pellets	ton	40
Coking coal		ton	24
Limestone		ton	3
Lime		ton	17
Scrap:	Domestic	ton	84
	Imported	ton	150
Natural gas		'000 cu m	35
Electric power		'000 kWh	15

The cost of liquid steel for the two alternative routes and the two alternative capacities are given in Table 7-5.

Table 7-5

RELATIVE ECONOMICS OF ALTERNATIVE ROUTES

	DR-EF		BF-BOS	
	Alt.1	Alt.2	Alt.1	Alt.2
Investment, mill US $	80	185	175	347
Production cost, US $/ton liquid steel				
Cost of raw materials	87	100	75	75
Cost above material	37	33	35	29
Works cost	124	133	110	104
Fixed charges a/	24	22	53	40
Total	148	155	163	144

a/ 15% per year on investment

7 - Creation of New Capacity (cont'd)

In Table 7-5, it would be noted that the cost of materials per ton of liquid steel for the DR-EF route is higher in Alt.2 compared to Alt.1. This is because in Alt.2 about 270,000 tons of scrap would have to be imported annually.

From Table 7-5 it would be observed that at 0.5 million ton capacity, the DR-EF route is cheaper, while at 1.3 million ton capacity the BF-BOS route is advantageous.

Production programme of new facilities

The production programme envisaged for the new facilities to be installed in Case-II and Case-III is given in Table 7-6.

Table 7-6

PRODUCTION PROGRAMME OF NEW FACILITIES
(thousand tons)

Year	Case-II				Case-III			
	Bars, rods and wire rods	Profiles Light	Profiles Med	Flat products	Bars, rods and wire rods	Profiles Light	Profiles Med	Flat products
1979	50	-	-	-	-	-	-	-
1980	150	-	-	-	-	-	-	-
1981	200	-	-	-	-	-	-	-
1982	200	-	-	-	-	-	-	-
1983	255	-	-	-	100	-	-	-
1984	355	25	100	455	145	25	100	455
1985	400	50	140	640	200	50	140	640

The production programme has been developed keeping in view the new rolling mill capacities suggested earlier in the chapter and the normal time required to

7 - Creation of New Capacity (cont'd)

build up the production to rated capacity. Based on the economic evaluation of alternative routes, in planning the production facilities, adoption of the DR-EF route for the bar and rod mill complex and the BF-BOS route for the integrated plant (flat products and medium profile mill) has been considered.

8 - DIRECT REDUCTION PLANTS

The electric furnace units rely mainly on purchased scrap for steelmaking, as the small quantities of their own plant recirculating scrap are totally inadequate to meet their requirements. The shortfalls between the requirements of these plants and domestic scrap availability will have to be made up by sponge iron. In estimating the sponge iron requirements, however, the electric furnace capacity of PDR is not taken into consideration, as its scrap requirement will be fully met by the plant recirculating scrap.

Sponge iron requirements

The SIP and the proposed new bar and rod mill complex, as well as the new light profile mill capacity, are based on electric furnace steelmaking. It will be noted from Chapter 7 that the two alternative production programmes, namely Case-II and Case-III have been considered for these plants.

The total electric ingot steel production, purchased scrap requirements, the domestic scrap availability, the resulting scrap shortfalls and

8 - Direct Reduction Plants (cont'd)

the equivalent sponge iron requirements for Case-II and Case-III are given in Table 8-1. As at least two to three years will be required to set up the direct reduction facilities, the sponge iron requirements from 1979 onwards only are relevant for this study.

Table 8-1

SPONGE IRON REQUIREMENTS
(thousand tons)

	Ingot production a/		Purchased Scrap requirement b/		Domestic scrap availability	Scrap shortfall		Sponge iron requirement c/	
	Case II	Case III	Case II	Case III		Case II	Case III	Case II	Case III
1979 ..	327	267	332	271	153	179	118	197	130
1980 ..	509	329	517	334	173	344	161	378	177
1981 ..	613	346	623	352	186	437	166	481	183
1982 ..	625	363	635	369	218	417	151	459	166
1983 ..	685	503	696	511	252	444	259	488	285
1984 ..	832	569	845	576	294	551	282	606	310
1985 ..	931	681	946	692	333	613	359	674	395

a/ From SIP, and the proposed new bar and rod mill, and light profile mill complexes, after allowing for saleable billets available in PDR-III

b/ Ingot steel x 1.016

c/ 1 ton scrap = 1.1 ton sponge iron

In calculating the ingot steel production and purchased scrap requirements for Case-III, saleable billets available from PDR have been taken into account. In Case-II, no such saleable billets are available.

8 - Direct Reduction Plants (cont'd)

Geographic pattern of sponge iron requirements

The total sponge iron requirement is allocated to the different zones in proportion to their respective ingot steel production. The zonewise requirements of sponge iron are shown in Table 8-2.

Table 8-2

ZONEWISE REQUIREMENTS OF SPONGE IRON[a/]
(thousand tons)

Year	Zone I	Zone II	Zone III	Zone V	New mill complexes	Total
CASE-II						
1979	59	47	24	32	35	197
1980	83	72	42	49	132	378
1981	101	87	48	58	187	481
1982	92	83	55	50	179	459
1983	88	83	54	49	214	488
1984	96	79	55	48	328	606
1985	94	77	67	51	385	674
CASE-III						
1979	47	39	18	26	-	130
1980	61	51	30	35	-	177
1981	63	54	31	35	-	183
1982	56	47	33	30	-	166
1983	74	63	43	40	65	285
1984	68	58	41	37	106	310
1985	72	64	51	40	168	395

a/ For zonewise steel production refer Appendix 5-8.

Source of supply

The sponge iron requirements may be met either through imports or by installing domestic capacity. Though a number of Latin American countries have installed and are installing sponge iron plants, the planning of these capacites have not taken into account exports of the magnitude required by Colombia. In the absence of any identifiable source of external supply, the sponge iron requirements would have to be met through domestic production. The domestic production will also enable utilization of locally available reductants.

SELECTION OF PRODUCTION PROCESSES AND UNIT SIZES

Only industrially proven processes and unit sizes have been considered for the selection of direct reduction plants. In the Colombian context, both gaseous and solid reductant processes would merit consideration.

Present status of gas-based direct reduction process

In the field of gaseous reduction, two processes, HyL and Midrex are commercially established. The Armco process, which has only one operating plant, may be also considered as having reached a stage of industrial acceptance. Since plants based on Purofer and FIOR processes are under construction and are yet to be tried out on an industrial scale, these processes have not been considered.

8 - Direct Reduction Plants (cont'd)

The HyL plants reach their rated capacities within a very short time after start-up. These plants have utilised both iron ores and pellets, though the use of pellets has proved more advantageous. The Midrex plants have also stabilised their production within a reasonable time after start-up. In these plants, sized ore has been used only in limited proportions in the charge along with pellets. However, the iron ores and pellets for use in the Midrex process should be lower in sulphur content than that acceptable for the HyL process.

The HyL plants in operation are of two sizes namely, plants producing 220,000 tons and 350,000 tons of sponge iron per year. The Midrex and Armco units in operation are of 350,000 tons annual capacity. Larger capacity units of HyL and Midrex are now under construction, but the performance of these units can be judged only after a few years of their operation. Therefore, the two established unit sizes, 220,000 and 350,000 tons annual capacity, have been considered for gaseous reduction processes.

Present status of the solid reductant process

With regard to the coal-based sponge iron plants, only the rotary kiln units have found industrial application. The first industrial module of Kinglor Metor process with an annual capacity of 20,000 tons per year is now under construction in Italy and is expected to go into production by March 1976. At the present stage, therefore, the possibility of the adoption of Kinglor Metor process has not been considered.

There are three rotary kiln units producing sponge iron for steelmaking with rated capacities ranging from 65,000 tons to 150,000 tons per year. Each of these plants utilises different kind of raw materials. The plant in New Zealand, which utilises iron sand concentrates, was the first industrial unit to go into operation in early 1970. This plant was originally rated at 150,000 tons per year capacity, which has subsequently been lowered down to 120,000 tons per year. The production has now been stabilised at this revised capacity level four years after start-up.

8- Direct Reduction Plants (cont'd)

The plant at Charquedas in Brazil has been rated at 65,000 tons per year and was designed to utilise sized ore and locally available coal. The plant was commissioned in August 1973 and has since switched over to the use of heat-hardened pellets. The annual production of this plant in 1975 is expected to be about 54 per cent of the rated capacity.

The third rotary kiln unit in operation at Benoi, South Africa, is designed to utilise sized ore. This plant is rated at 150,000 tons per year and was commissioned in April 1973. Information on present operation of this plant is not readily available. However, in 1974, the plant production was about 45 per cent of the rated capacity.

Another rotary kiln unit with a production capacity of 400,000 tons has been constructed at the Grifith mines, Canada. The performance of this unit can be judged only after its production is stabilized on a sustained basis.

The operating experiences at these three industrial scale rotary kiln installations indicate that the actual production achieved is substantially lower than the original ratings set by the process/ equipment suppliers. Further, the gestation period in this process is longer and considerable efforts are needed to stabilise the operations.

8 - Direct Reduction Plants (cont'd)

The size of the rotary kiln unit installed in Brazil is 3.6 m dia and 50 m long and that in South Africa 4.6 m dia and 74 m long. These unit sizes have been considered for possible installation in Colombia. Based on the current experience and on the assumption that suitable quality raw materials will be available, the rated capacity has been taken at 50,000 tons per year for a 3.6 m dia and 50 m long kiln unit and 115,000 tons per year for 4.6 m dia and 75 m long kiln, for the purpose of this study.

Comparison of alternative processes and unit sizes

An economic comparison has been made of the proposed processes and unit sizes considered, on the basis of the following assumptions:

a) The plants would be operating at full rated capacity.

b) Suitable quality heat-hardened pellets would be utilised as feed material.

c) Local coals would be suitable for utilization in the rotary kiln.

d) The coal consumption per ton of sponge iron would be 1,100 kg.

e) The natural gas consumption per ton of sponge iron would be 500 cu m.

f) Unit prices of major raw materials would be as follows:

	Unit	US $
Imported pellets	ton	40
Coal	ton	7
Limestone	ton	10
Natural gas	'000 cu m	35

8 - Direct Reduction Plants (cont'd)

The economic comparison of the alternative processes and unit sizes is presented in Table 8-3.

Table 8-3

ECONOMIC COMPARISON OF ALTERNATIVE PROCESSES AND UNIT SIZES FOR DIRECT REDUCTION

	Gas-based		Coal-based	
Unit size, '000 tons/yr	220	350	50	115
Investment, million US $	44	52	16	26
Cost of sponge iron including fixed charges at 15% of investment US $/ton	114	104	158	135

From Table 8-3 it would be observed that the cost of sponge iron produced from a 50,000 tons per year capacity rotary kiln plant is the highest. Therefore, such a plant may be considered only as a captive unit of SIP, and its economics needs to be studied in relation to the cost of purchased sponge iron from a higher capacity regional/national plant.

The ralative costs of sponge iron produced from 50,000 tons and 115,000 tons capacity plants located at three typical locations, Barranquilla, Cali and Bogota, and the costs of sponge iron delivered to the major consuming centres are shown in Figure 8-1. The sponge iron costs include the

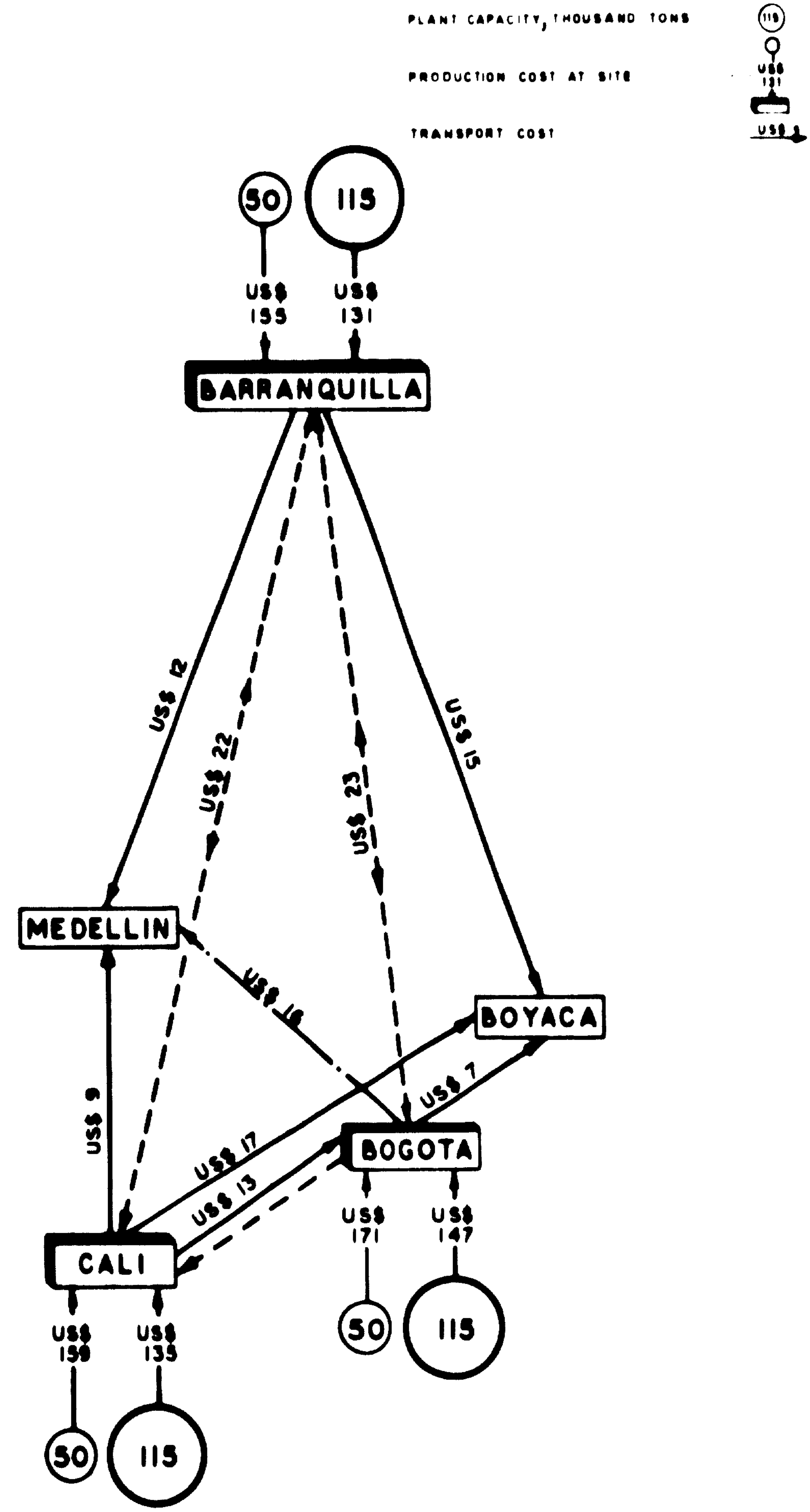


FIGURE 8-1. COAL-BASED DR PLANTS: EVALUATION OF SIZE AND LOCATION

cost of transport of raw materials to the plant site. It would be observed that the installation of captive plants of 50,000 tons per year capacity is not economical, as the cost of sponge iron from the smaller captive units is higher than the delivered cost from a larger capacity plant serving a regional or a bigger market. Therefore, in planning the direct reduction capacity for Colombia, the 50,000 ton rotary kiln unit has not been considered.

Alternative plans for direct reduction capacity

In developing alternative plans, careful consideration is to be given to the choice of technology for the production of sponge iron. It is well-known that in Colombia there are large reserves of coal and it is likely that suitable grades required for the solid reductant process will be available in the different parts of the country. This would *prima facie* suggest the desirability of adopting a solid reductant process immediately. However, taking into consideration the present status of the industrial scale rotary kiln units, and the need for detailed investigations and tests on raw materials prior to deciding on a solid reductant plant, it is considered advisable

8 - Direct Reduction Plants (cont'd)

that the initial direct reduction capacity be set up with gas-based plants. In the meantime, the operation of the other rotary kiln units could be carefully observed, tests and investigations on the raw materials completed, and the decision on installing a rotary kiln unit may be taken at a later date.

The electric arc furnaces installed at SIP are of normal design for the utilization of scrap. It would therefore be advantageous to utilise high quality sponge iron (with minimum gangue content) to keep the slag volume low.

On the basis of the sponge iron requirement indicated in Table 8-2 and the selected unit sizes, alternative plans for creating the direct reduction capacity have been suggested in Table 8-4.

Table 8-4

ALTERNATIVE PLANS FOR DIRECT REDUCTION CAPACITY
(tons per year)

	CASE-II		CASE-III
	Alt.1	Alt.2	
1979	Gas 350 000	Gas 350 000	Gas 220 000
1980	-	-	-
1981	Gas 350 000	Gas 115 000	-
			-
1982	-	-	-
1983	-	-	Coal 115 000
1984	-	Gas 350 000	-
1985	-	-	-

d - Direct Reduction Plants (cont'd)

Evaluation of alternative plans

The alternative plans proposed for Case-II and Case-III have been evaluated from the viewpoint of their capability to meet the sponge iron requirement as well as the total cost of sponge iron, including the cost of transport of raw materials and of distribution of sponge iron. For the purpose of this evaluation, the gas-based plants are considered to be located on the Atlantic coast and the coal-based plants in the Cali region.

For estimating the sponge iron availability the build-up of production with reference to the rated capacity for the different processes are assumed as follows:

		Gas-based %	Coal-based %
1st year	...	70	60
2nd year	...	100	80
3rd year	...	100	100

Case-II

The demand and availability of sponge iron for Case-II is given in Table 8-5. It would be noted that Alt.2 is better suited to meet the sponge iron demand.

8 - Direct Reduction Plants (cont'd)

Table 8-5

AVAILABILITY OF SPONGE IRON - CASE-II
(thousand tons)

		Alt. 1		Alt. 2	
Year	Requirements	Availability	Excess/ shortfall	Availability	Excess/ shortfall
1979	197	245	48	245	48
1980	378	350	(-) 28	350	(-) 28
1981	481	395	114	420	(-) 61
1982	459	700	241	440	(-) 19
1983	488	700	212	465	(-) 23
1984	606	700	94	710	104
1985	679	700	21	815	136

Case-III

The demand for sponge iron and its availability for the plan considered under Case-III are presented in Table 8-6.

Table 8-6

REQUIREMENTS AND AVAILABILITY OF SPONGE IRON - CASE-III
(thousand tons)

Year	Requirements	Availability	Excess/ shortfall
1979	130	154	24
1980	177	220	43
1981	183	220	37
1982	166	220	54
1983	285	290	5
1984	310	310	-
1985	395	335	(-) 60

8 - Direct Reduction Plants (cont'd)

Techno-economic comparison of alternative plans

A techno-economic comparison of the alternative plans is presented in Table 8-7.

Table 8-7

TECHNO-ECONOMIC COMPARISON OF ALTERNATIVE PLANS FOR DIRECT REDUCTION

	Case-II Alt. 1	Case-II Alt. 2	Case-III
Total installed capacity of sponge iron, '000 tons ..	700	815	335
Total investments, million US $	103	130	70
Investments per annual ton, US $ ..	148	158	222
Total quantity of sponge iron distributed to domestic consumers between 1979 and 1985, million tons[a]	3.26	3.15	1.59
Total cost of sponge iron distributed, million US $[b]	358	362	201
Average cost of sponge iron as distributed, US $/ton	110	115	127

a/ Includes some surplus production in certain years which may be considered for export, or for additional consumption if additional electric arc furnaces were installed.

b/ Includes transport cost of raw materials and sponge iron.

8 - Direct Reduction Plants (cont'd)

From Table 8-7 it would be noted that the average cost of sponge iron as distributed to consumers is considerably lower in Case-II. This is mainly because of the economies of scale in the gas-based units. For the purpose of developing the National Steel Plan, Alt. 2 under Case-II has been considered, because its production matches more favourably with the requirements than that of Alt. 1, Case-II.

RAW MATERIAL SITUATION

Iron ore

High grade iron ore with about 66 per cent Fe content is essential for the production of sponge iron. Iron ore of such quality is not locally available. Further, the available information indicates that the local ores are not easily amenable to beneficiation to produce the requisite high grade concentrates. Therefore, till such time as suitable local iron ore sources are established, the iron ore requirement of the sponge iron plant would have to be met through imports.

The planning of direct reduction plant is, therefore, based on the use of imported high grade iron ores and pellets. Metallurgically, pellets are a better feed material, and are therefore, considered for use. Pellets could be available from the neighbouring Andean Group countries such as Peru and Chile, or from other sources like Brazil or Canada. Venezuela could also be a convenient source, when its pelletising plants go into production.

Natural gas

The natural gas required for the gas-based plants would be available from the Guajira gasfield. The Ministry of Economic Development and the Ministry of Mines and Energy have assured that within three years (that is by mid-1978), adequate natural gas would be available for sponge iron plant on the Atlantic coast. It has also been indicated that by that time, the gas pipeline between the gasfield and Barranquilla would be completed.

Coal

Non-coking coals of various qualities occur scattered all over Colombia. However, necessary test work would have to be completed to identify suitable sources for meeting the quality requirements of the direct reduction process. In addition, prospecting work would also be required in certain coal fields to establish the reserves of the selected coal.

It is understood that sizeable quantities of coke breeze have accumulated at Belencito and at the pig iron plant of COLAR. However, the use of coke breeze for the production of highly metallised sponge iron is not yet industrially established. The low reactivity of the coke may not give the required degree of metallization of the product. Further, continued availability of coke breeze from PDR is not assured, in view of the PDR's own expansion programme and proposals for augmenting sintering capacity. Therefore, the use of coke breeze for the production of sponge iron has not been visualised. However, its use as a reductant for production of pre-reduced burden for blast furnace, which is being considered by COLAR, may be pursued.

Development work

In connection with the installation of the direct reduction plants, work on the following items should be taken up on a high priority basis:

8 - Direct Reduction Plants (cont'd)

i) The development of Guajira gasfield and the laying of pipeline from the gasfield the Barranquilla should be completed by 1978, to ensure that the gas would be available for the direct reduction plant on time. The necessary infrastructure facilities to serve the direct reduction plant on the Atlantic coast should also be completed by that time.

ii) Negotiations would have to be conducted with prospective pellet suppliers and a suitable source of supply should be selected.

iii) Adequate port handling facilities for the import of pellets would have to be developed and, in this connection, the possibility of the use of the port to be developed for export of Cerrejon coal would merit serious consideration.

iv) Necessary investigations and test work to identify suitable sources of coal which will satisfy the requirements for direct reduction would have to be initiated at an early date.

9 - NEW INTEGRATED STEEL PLANT

A new integrated steel plant of 1.3 million tons crude steel capacity is proposed to be installed on the Atlantic coast. This plant would form an important nucleus of future steel development and therefore, should have adequate provision for expansion.

Product-mix

The product-mix for the new integrated steel plant, which has been evolved on the basis of an analysis of domestic demand and keeping in view the optimum size rolling units, is given in Table 9-1.

Table 9-1

PROPOSED PRODUCT-MIX FOR THE NEW STEEL PLANT

		Size range mm	Annual quantity '000 tons
Medium profiles	..	75 to 200	200
Hot rolled sheets/coils	..	600 to 1500	300
Cold rolled sheets/coils	..	600 to 1500	532
Galvanised sheets/coils	..	600 to 1250	80
		Total ..	1 112

As discussed in Chapter 7, the new integrated plant would be commissioned in 1984 and the full capacity production is expected to be achieved by about 1987.

9 - New Integrated Steel Plant (cont'd)

Raw materials

The iron ore requirements of the plant are proposed to be imported. The source of import would have to be decided after necessary negotiations.

For the purpose of this study, it has been assumed that the total coking coal requirements would be met from Cundinamarca-Boyaca region and 50 per cent of the blend will comprise washed coal to ensure that the ash content would be kept below 14 per cent. There are possibilities of utilising other coals such as Cerrejon coal. However, this would have to be confirmed by necessary test work. The use of Cerrejon coal may permit utilisation of lower proportions of washed coal in the blend.

The limestone requirement is assumed to be met from the deposits near Barranquilla. Further investigations would have to be conducted to confirm the availability of steelmaking grade limestone from this area. An alternate source of steelmaking quality limestone would be the Cartagena region.

The assumed analyses and proposed sources of major raw materials are given in Table 9-2. The analyses and requirements would have to be confirmed, after suitable sources have been selected.

9 - New Integrated Steel Plant (cont'd)

Table 9-2

ANALYSES AND SOURCES OF RAW MATERIALS

	Iron ore[a/]		Coal blend[b/]		BF limestone		SMS limestone	
Source	Imported		Cundinamarca-Boyaca		Barranquilla		Barranquilla	
Chemical analyses	Fe	63%	F.C.	65.5%	CaO	50%	CaO	52%
	SiO_2	4%	V.M.	25.5%	MgO	1%	MgO	2%
	Al_2O_3	2%	Ash	9.0%	SiO_2	4%	SiO_2	2.5%

a/ Average of lumps and fines.
b/ Assuming 50 per cent washed and 50 per cent raw coal.

Ferro-alloys and refractories

The ferro-alloys requirements would have to be imported. The requirements of major ferro-alloys are as follows:

Ferro-manganese	(standard grade) ..	11,300 tons
Ferro-silicon	(75 per cent grade) ..	3,700 tons

The total refractories requirement is estimated at about 40,000 tons per year. While the ladle bricks and the other firebricks could be obtained from local sources, the basic refractories would have to be imported. For converter lining about 15,000 tons of calcined dolomite would be required annually.

Plant flow sheet

The plant flow sheet indicating the requirements of the major raw materials as well as production of major units is given in Fig 9-1.

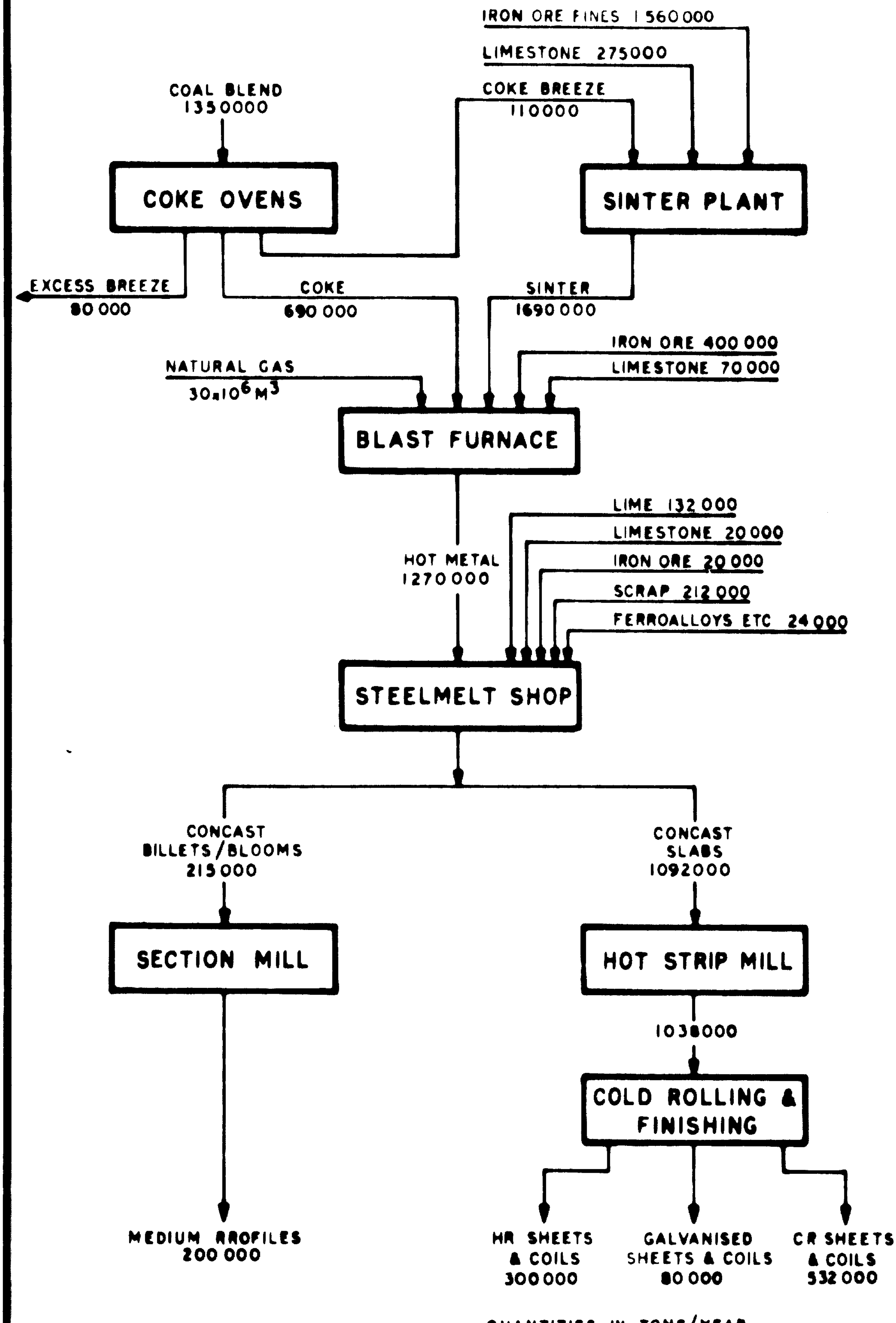


FIGURE 9-1. NEW INTEGRATED STEEL PLANT MATERIAL FLOW SHEET

9 - New Integrated Steel Plant (cont'd)

Major plant facilities

Iron ore is proposed to be imported in two sizes, sized lumps of 10 mm to 40 mm, and fines below 10 mm. Separate storage facilities for the two sizes are provided, with space for stocking about 2 to 3 months' requirement. The ore storage yard would be provided with necessary stackers and reclaimers for blending. The sized iron ore will be screened to remove the fines below 10 mm, before being conveyed to blast furnace stockhouse, and the fines will be used at the sinter plant.

Sized limestone would be received at the plant and separate storages for blast furnaces grade and steelmaking grade are envisaged. The limestone stock will be about four to six weeks' requirement.

A separate coking coal yard will be provided adjacent to the coke ovens, with a storage capacity of six weeks' requirement.

The major production facilities and their rated annual capacities are given in Table 9-3.

9 - New Integrated Steel Plant (cont'd)

Table 9-3

MAJOR PLANT FACILITIES

Facility	Number and capacity	Annual production '000 tons
Sinter plant ..	1 x 196 sq m	1 690
Coke ovens ..	75 ovens (6 m)	690
Blast furnace ..	1 x 10.5 m dia	1 270
Basic oxygen steelmaking	2 x 130-ton converters 2 x 2-strand slab casters 1 x 6-strand bloom caster	1 300
Rolling mills:		
Medium profile mill ..	650/600 mm mill	200
Hot strip mill ..	1 730 mm semi-continuous mill with 6 finishing stands	1 038
Cold rolling mill and finishing facilities	1 730 mm, 5-stand tandem mill	912
	One continuous hot dip galvanising line with shearing line	
	One pickling line and annealing facilities	

Utilities

The electric power requirement of the plant is proposed to be met from the CARELCA system and the plant will be provided with necessary distribution system. The installation of captive power generation at the plant has not been envisaged and may be further investigated.

9 - New Integrated Steel Plant (cont'd)

The plant will have its own steam generating facilities for driving the blast furnace blowers, as well as for meeting the other steam requirements.

Maximum utilisation of by-product fuels has been visualised. The blast furnace gas will be utilised for heating of hot blast stoves, firing of boilers, and underfiring of coke ovens. The coke oven gas will be utilised for various other heating requirements. The use of natural gas as purchased fuel has been assumed for auxiliary injection through blast furnace tuyeres.

The water system will include necessary treatment and recirculation facilities. The make-up water requirement of the plant is proposed to be met from the river Magdalena.

Preliminary requirements of utilities and the sources of supply are given in Table 9-4.

Table 9-4

REQUIREMENTS AND SOURCES OF SUPPLY OF UTILITIES

	Requirement	Source
Electric power	120 MW	CORELCA system
Make-up water	2 500 cu m/hr	Magdalena
Natural gas	700 cu m/hr	Guajira gasfield

9 - New Integrated Steel Plant (cont'd)

Plant layout

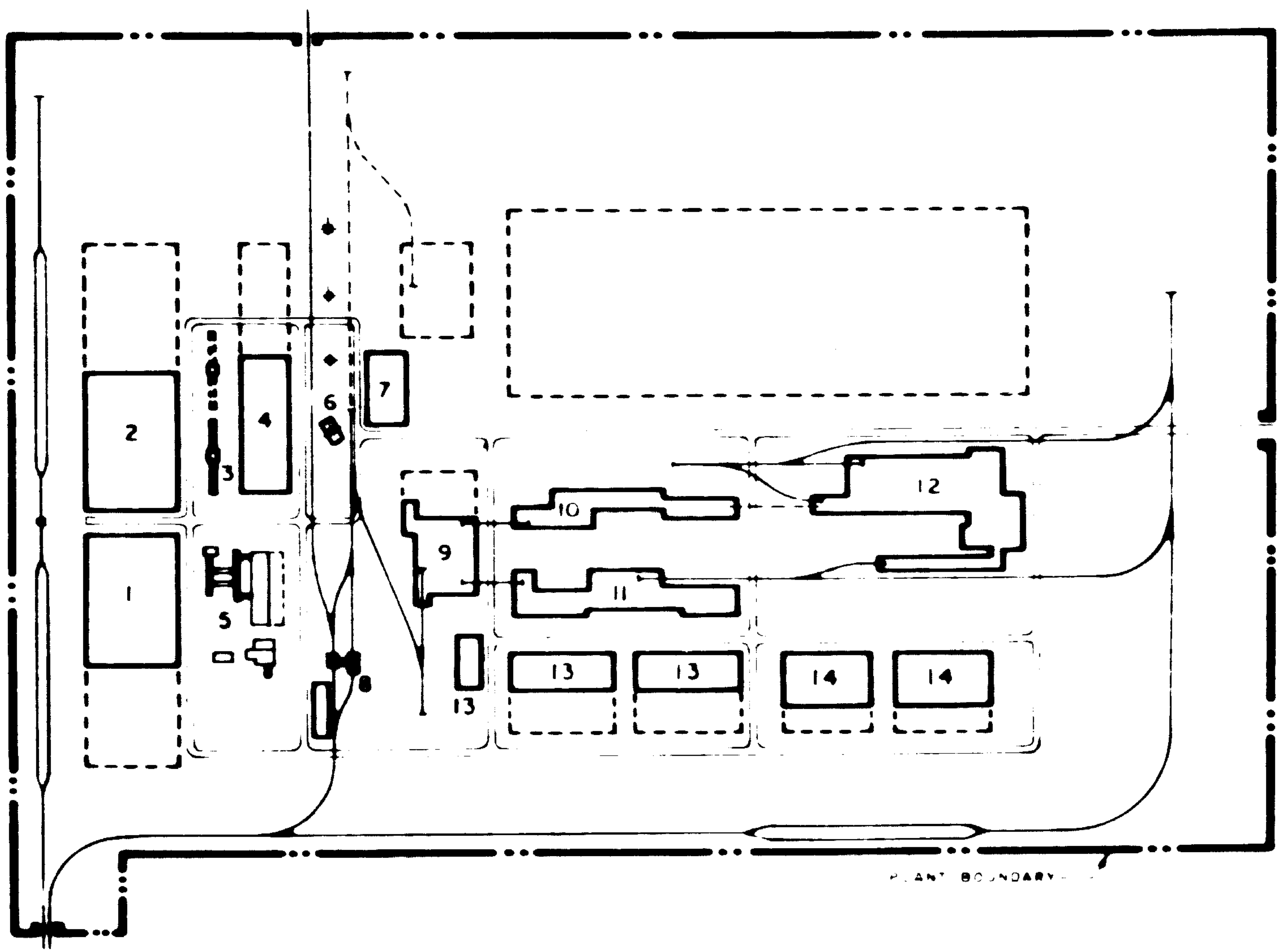
The plant general layout can be prepared only after finalising the plant location. However, a schematic arrangement of the major production facilities is indicated in Drawing 3951-9-1.

Based on the preliminary reconnaisance, it was noted that it would be difficult to acquire a suitable plant site adjacent to river Magdalena and in close proximity to the port. Further investigations are needed to establish a suitable location of port for receiving the iron ore carriers and coal barges. The primary indications are that suitable transport links have to be developed between the proposed port location and the plant site.

Pollution control facilities

Though there are no anti-pollution laws at present in Colombia, adequate provision has been made for pollution control, while selecting the plant facilities. The major pollution control facilities provided are given in Table 9-5, on the next page.

With regard to the waste and by-products, the blast furnace flue dust, mill scale and bulk of the fine coke would be utilised for sintering, along



LEGEND

1 ORE AND FLUX STOCKYARD
2 COAL STOCKYARD
3 COKE OVEN BATTERIES
4 BY PRODUCTS PLANT
5 SINTER PLANT
6 BLAST FURNACES
7 POWER AND BLOWER HOUSE
8 PIG CASTING MACHINE
9 STEELMELT SHOP
10 HOT ROLLING MILL
11 MEDIUM SECTION MILL
12 COLD ROLLING MILLS & FINISHING FACILITIES
13 STORAGES
14 MAINTENANCE AND REPAIR SHOPS

INITIAL PLANT
EXPANSION

100 0 100 300 500
SCALE METRES

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS DUSSELDORF

FOR ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA EL DESARROLLO INDUSTRIAL

INVESTIGACION DE LA INDUSTRIA DEL HIERRO Y EL ACERO EN COLOMBIA

NEW INTEGRATED STEEL PLANT PRELIMINARY GENERAL LAYOUT

DRAWN	[signature]	10 75	Nº 3951-9-1
APPROVED	[signature]	26 75	

9 - New Integrated Steel Plant (cont'd)

Table 9-5

POLLUTION CONTROL MEASURES

Shop/area	Measures for air pollution control	Measures for water pollution control
1) Raw materials handling system	a) Dust extraction systems at intakes and discharge points for conveyors, screens, vibrators etc	-
2) Coke ovens	a) Dust and fume extraction systems for coal storage, handling and conveying sections, coal charging system, coke quenching section etc (complete with wet cleaning)	Waste water treatment and recirculating systems, including filtration, clarification, bio-oxidation etc
	b) Electrostatic cleaning of coke oven gas on the by-product plant	
3) Blast furnace	a) Dust and fume extraction system for materials handling equipment	Waste water treatment, recirculating systems including filtration, clarification etc
	b) Blast furnace gas cleaning using dry separation, wet scrubbing and electrostatic precipitation	
4) Steelmelting shop	a) Dust and fume extraction systems for materials handling, mixers etc	
	b) Converter gas cleaning using two-stage wet scrubbers	Similar to that for Blast furnaces
5) Rolling mills	a) Pickling fume extraction and cleaning by caustic scrubbing	Water recirculating systems including settling, filtration, neutralisation, clarifications etc

with lime and limestone fines obtained as rejects from the calcining plant. The feasibility of utilising granulated blast furnace slag as feed material in the cement plant at Barranquilla may be investigated.

TOTAL CAPITAL REQUIREMENT

The cost of installation of the facilities within the plant boundary has been termed as 'plant cost'. Expenditures incurred on initial spares, preliminary, start-up and commissioning expenses and interest during construction have been added to the plant cost to arrive at the 'fixed investment'. The 'total capital requirement' is arrived at by adding working capital to the fixed investment.

The total capital requirement excludes investments on infrastructure facilities outside the plant boundary such as external water, power and natural gas supply systems, port facilities and transport links.

The estimates are based on available information on prices and no provision is made for escalation in prices.

Plant cost

A preliminary estimate of plant cost is given in Appendix 9-1 and is summarised in Table 9-6.

9 - New Integrated Steel Plant (cont'd)

Table 9-6

PRELIMINARY ESTIMATES OF PLANT COST

	Million US $
Plant facilities ..	880
Engineering and administration	60
Contingencies	95
Plant cost ..	1 035

The cost of facilities within the plant boundary is estimated at US $ 1,035 million. This estimate excludes the costs of land and site preparation.

Spares

To cover the expenses on initial spares which would have to be purchased along with the plant and equipment, a provision of US $ 30 million has been made, as indicated in Appendix 9-1.

Preliminary, start-up and commissioning expenses

A provision of US $ 45 million has been made towards the expenses which will be incurred on preliminary and promotional activities, pre-operational training, as well as start-up and commissioning of the plant.

Interest during construction

The fixed investment, excluding the interest on long-term loans during construction, works out to US $ 1,110 million by adding the plant cost, the cost of spares and the preliminary, start-up and commissioning expenses. Of this US $ 1,110 million,

9 - New Integrated Steel Plant (cont'd)

as discussed later in this chapter,

US $ 460 million has been assumed to be financed from equity capital and the balance of US $ 650 million from long-term loans. For estimating the interest on long-term loans during construction, a preliminary phasing of the long-term loans has been assumed as follows:

Year of construction		Percentage of fund required	Amount in million US $ Total	Amount in million US $ Long-term lonas
1	..	14	160	-
2	..	34	370	250
3	..	24	260	180
4	..	17	200	140
5	..	11	120	80
Total	..	100	1 110[a/]	650

a/ Fixed investment excluding interest during construction.

Based on the assumed simple interest rate of 10 per cent per annum on long-term loans, as discussed later in this chapter, and taking into consideration the phasing of long-term loans as indicated above, the accumulated interest during construction period would amount to US $ 190 million. The interest during the conetruction period has been capitalised.

Fixed investment

The fixed investment is estimated at US $ 1,300 million, as indicated in Table 9-7.

9 - New Integrated Steel Plant (cont'd)

Table 9-7

ESTIMATED FIXED INVESTMENT

		Million US $
Plant cost	..	1 035
Spares	..	30
Preliminary, start-up and commissioning expenses		45
Interest on long-term loans during constn	..	190
Fixed investment	..	1 300

Working capital requirement

The working capital requirement has been estimated at about three months' manufacturing expenses equivalent. The annual manufacturing expenses at full production level are estimated at about US $ 194 million as shown in Appendix 9-2. On this basis, the working capital requirement has been estimated at US $ 48 million.

Total capital requirement

The total capital requirement for the project, including fixed investment and the working capital, works out to US $ 1,348 million.

CAPITAL FINANCING PLAN

Possible modes of financing

The precise mode of financing the project would be decided only at a later date. However, a review

9 - New Integrated Steel Plant (cont'd)

of the recent modes of financing different steel projects in the Latin American countries has been made to indicate the possibilities which may be kept in view, while finalising the financing plan of the new integrated steel plant.

The available information on the financing of the Phase-II expansion programmes of the integrated steel plants in Brasil, Phase-III expansion of CSN Plant, Brasil, and the expansion programmes of HIPASAM, Argentina and NAFINSA, Mexico, indicating the sources of funds, and the terms and conditions of the loans, is given in Appendix 9-3. The sources of financing the abovementioned projects as well as the Phase-III expansions of COSIPA and USIMINAS plants of Brazil are summarised in Table 9-8 on the next page.

From Table 9-8, it would be noted that the loans extended by international financing institutions as well as by bilateral credits, comprise about 50 per cent of the total capital requirement. In addition, the equity capital (own capital) is about 40 per cent and the balance is normally obtained from other domestic sources.

The terms and conditions of the foreign loans vary from agency to agency. However, it may be mentioned that loans from institutions like IBRD and IDB carry an interest of 8 to 10 per cent per annum and the repayment is to be made over a period of about 15 years, including a grace period of 4 to 5 years. Similar terms could be expected for bilateral credits. Generally, the loans from foreign agencies have to be guaranteed by the Government.

<u>Assumed financing pattern</u>

Keeping in view the general pattern of financing of steel projects in the other Latin American countries, the following have been assumed for the financing pattern in Colombia:

i) 40 per cent of the fixed investment excluding interest on long-term loans will be in the form of equity capital and balance of 60 per cent in the form of long-term loans.

ii) The accumulated interest on the long-term loans during the construction period will be capitalised and will also be borrowed as long-term loans.

iii) The long-term loans will carry an average interest at the rate of 10 per cent per annum repayable in about 14 years including a grace period of about 6 years.

iv) The working capital requirement would be borrowed as short-term loan carrying an interest rate of 25 per cent per annum.

9 - New Integrated Steel Plant (cont'd)

Table 9-8

FINANCING OF STEEL PROJECTS IN LATIN AMERICA

Country/company		Sources of financing: Foreign: World Bank	IBRD	IDB	IADB	Bilateral	Others	Total foreign	Domestic: Third parties	Own	Total domestic	Total
Brazil:												
CSN	Mill US $	65	-	-	43	114	-	222	N.A.	N.A.	210	432
(Stage II)	%	15	-	-	10	26	-	51	N.A.	N.A.	49	100
USIMINAS	Mill US $	63	-	-	42	84	-	189	N.A.	N.A.	189	378
(Stage II)	%	17	-	-	11	22	-	50	N.A.	N.A.	50	100
COSIPA	Mill US $	64	-	-	43	-	91	198	N.A.	N.A.	256	454
(Stage II)	%	14	-	-	10	-	20	44	N.A.	N.A.	56	100
CSN	Mill US $	-	95	63	-	553	32	749	66	700	766	1 515
(Stage III)	%	-	6	4	-	37	2	49	4	47	51	100
USIMINAS	Mill US $	-	-	-	-	369	-	369	50	361	411	780
(Stage III)	%	-	-	-	-	47	-	47	6	47	53	100
COSIPA	Mill US $	-	67	45	-	221	-	333	284	271	555	888
(Stage III)	%	-	8	5	-	25	-	38	32	30	62	100
Argentina:												
HIPASAM	Mill US $	-	-	-	32	-	27	59	16	50	66	125
	%	-	-	-	25	-	22	47	13	40	53	100
Mexico:												
NAFINSA	Mill US $	70	-	-	54	178	46	348	300	-	300	648
	%	11	-	-	8	28	7	54	46	-	46	100

Source: 1) Inter-American Development Bank press releases.
2) IISI Panel Discussion: Steel in Latin America, Mexico City, October 12-15, 1975.

9 - New Integrated Steel Plant (cont'd)

On this basis, the financing pattern of the project assumed for this study is given in Table 9-9.

Table 9-9

ASSUMED FINANCING PATTERN FOR THE TOTAL CAPITAL REQUIREMENT

	Million US $		
	Loan	Equity	Total
Fixed investment excluding interest on long-term loan during construction	650	460	1 100
Interest on long-term loans during construction	190	-	190
Working capital	48	-	48
Total capital requirement	888	460	1 348

It would be observed from Table 9-9, that of the total capital requirement, the borrowed capital would account for about 65 per cent and the equity capital for about 35 per cent.

It is expected that the long-term loans could be obtained from international and regional financing agencies such as the International Bank for Reconstruction and Development, Inter-American Development Bank, International Development Bank, Corporacion Andina de Fomento, Fondo de Inversiones Venezuela and through bilaterial credits as well as suppliers' credits.

9 - New Integrated Steel Plant (cont'd)

With regard to equity capital, about 50 per cent may be obtained through the issue of share capital from Colombia, and the balance may be obtained through financing institutions, both domestic like IFI, and international/regional.

The availability of capital from international financing institutions like IBRD and IDB will permit procurement of equipment through international competitive tenders, with local manufacturers receiving some preference which is less than the applicable import duty.

MANUFACTURING EXPENSES

The 'unit costs' used for estimating the manufacturing expenses are given in Table 9-10.

Table 9-10

UNIT COSTS

Item	Unit	Cost at plant US $/unit
Iron ore - Sized ..	ton	26
- Fines ..	ton	24
Coal - Washed ..	ton	32
- Unwashed ..	ton	21
Limestone ..	ton	4
Ferro-manganese (standard)	ton	620
Ferro-silicon (standard)	ton	440
Aluminium ..	ton	2 000
Fluorspar ..	ton	50
Zinc ..	ton	935
Electric power ..	'000 kWh	15
Water ..	'000 cu m	27
Natural gas ..	'000 cu m	35
Labour ..	man-year	2 700

9 - New Integrated Steel Plant (cont'd)

The annual manufacturing expenses, excluding depreciation and interest charges have been estimated for the rated capacity production level in Appendix 9-2 and are summarised in Table 9-11.

Table 9-11

ANNUAL MANUFACTURING EXPENSES

	Annual expenses mill. US $
Raw materials ..	98
Labour and supervision ..	15
Other manufacturing expenses	81
Total ..	194

The annual manufacturing expenses estimated at US $ 194 million would yield an average manufacturing cost (for 1,112,000 tons of saleable steel product) of about US $ 175 per ton of saleable steel.

Works cost of products

The estimated works costs of the various products, excluding fixed charges, are given in Table 9-12.

Table 9-12

ESTIMATED WORKS COSTS OF PRODUCTS[a/]

Product	US $/ton
Sinter ..	30
Coke (run-of-oven) ..	53
Hot metal ..	82
Billets/slabs ..	112
Medium profiles ..	136
Hot rolled sheets/coils ..	146
Cold rolled sheets/coils ..	199
Galvanised sheets/coils ..	216

a/ At the rated capacity production level, excluding fixed charges.

9 - New Integrated Steel Plant (cont'd)

FINANCIAL ANALYSIS

Based on the total capital requirement for the project and the annual manufacturing expenses estimated earlier, a financial analysis is presented below.

Sales price

At present, there is no plant in Colombia with rolling mill facilities similar to those envisaged for the new integrated steel plant. Therefore, there are no established selling prices for the different categories of products, except for medium profiles which are being currently produced in very small quantities by PDR. However, in the feasibility report for PDR expansion (February 1975), the selling prices for flat products (hot rolled and cold rolled) similar to those envisaged to be produced at the new plant, have been indicated.

A comparison of the PDR prices with those prevailing in other countries, and with the prices of imported steel in Colombia for the selected category of products has been made, based on the available information in Appendix 9-4. From this comparison, the following salient points are observed:

9 - New Integrated Steel Plant (cont'd)

i) Medium profiles: The average price fixed by PDR in April 1975 is lower than the price prevailing in Chile and is more or less equal to the imported price and the highest home prices of ECE countries. It is, however, about 12 per cent higher than the USA home price.

ii) Hot rolled sheets/strip: The average price assumed in the feasibility report of PDR is lower than the price in Brazil, 10 per cent higher than the imported price, 15 per cent higher than the price in Peru and considerably higher than the home prices of EEC countries and USA.

iii) Cold rolled sheets/strip: The average price assumed in the PDR feasibility report is comparable to those in Chile and Peru, 26 per cent higher than the imported price, and considerably higher than the home prices of ECE countries and USA.

iv) Venezuelan prices: The 1975 average prices of PDR are 5 to 10 per cent higher than those prevailing in Venezuela in 1974.

As the available price information on the other Andean countries relate to periods earlier than 1975, and as the steel prices in Colombia were revised during April-May 1975, the PDR prices which were raised by 20 to 25 per cent on an average, may be considered comparable with those of the other Andean countries. With regard to the import prices, it may be mentioned that in the context of the changed world market situation, there has been a significant reduction in the f.o.b. export prices. For example, while the

ECE home prices of CR sheets/strip range between US $ 298 and US $ 357 per ton, the f.o.b. continental export price is only about US $ 204 per ton. This would indicate that the current import prices cannot be taken as the basis for future pricing.

Therefore, the PDR prices have been assumed to correspond to the ex-works selling prices for the new integrated steel plant and are as follows:

		Average selling price US $/ton
Medium profiles	..	356
HR sheets/coils	..	347
CR sheets/coils	..	400
Galvanised sheets/coils		450

Sales realisation

The total sales realisation at rated capacity operation level is calculated in Table 9-13.

Table 9-13

ANNUAL SALES REALISATION[a/]

		Quantity '000 tons	Average sales price US $/ton	Annual sales realisation mill US $
Medium profiles	..	200	356	71
HR sheets/coils	..	300	347	104
CR sheets/coils	..	532	400	213
Galvanised sheets/ coils		80	450	36
Total	..	1 112		424

a/ At rated capacity production level.

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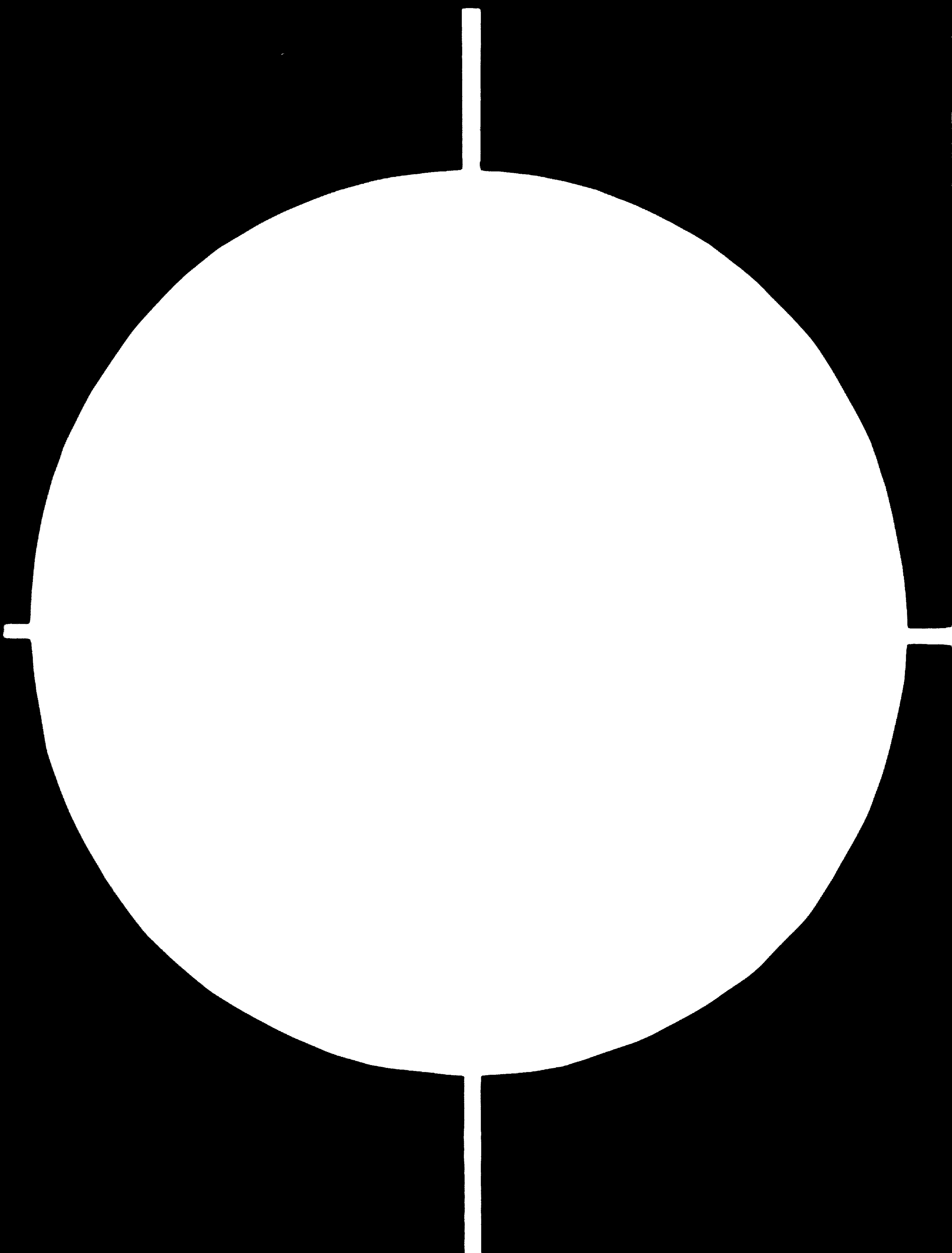

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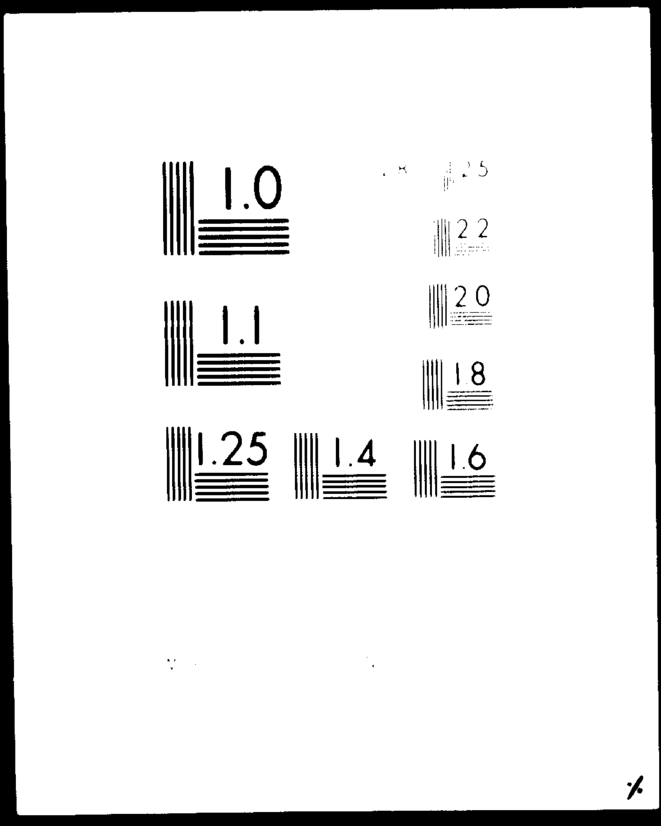

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Contributory margin

The total annual sales realisation at rated capacity operation level would be about US $ 424 million. The annual manufacturing expenses at full capacity operations and at current prices are estimated at about US $ 194 million including US $ 15 million for labour and supervision cost.

Therefore, the contributory margin (assuming labour and supervision cost to be directly variable with the production activity) at full capacity operations would be US $ 230 million in a normal year of operation.

Profitability

A preliminary profit and loss statement in the first year of rated capacity operation is given in Table 9-14.

9 - Integrated Steel Plant (cont'd)

Table 9-14

PRELIMINARY PROFIT AND LOSS STATEMENT FOR THE FIRST YEAR OF RATED CAPACITY OPERATION

		Million US $
A.	Sales realisation ..	424
B.	Annual manufacturing expenses	
	Raw materials ..	98
	Labour and supervision ..	15
	Other conversion costs ..	81
	Total (B) ..	194
C.	Gross profit (A) - (B) ..	230
D.	Fixed charges/expenses:	
	Administration and sales expenses	6
	Interest on long-term loans	74
	Interest on working capital loan	12
	Depreciation charges ..	48
	Amortisation charges ..	15
	Total (D) ..	155
E.	Net profit before tax (C) - (D)	75
F.	Taxation at 40% of net profit	30
G.	Net profit after tax (E) - (F)	45

The administration and sales expenses have been assumed at US $ 6 million per year, which is somewhat higher than the US $ 5.3 million considered by PDR in their feasibility report for expansion (February 1975).

9 - Integrated Steel Plant (cont'd)

The interest charges on long-term loans at the rate of 10 per cent per annum would be about US $ 84 million in the initial years of operation till the repayment is commenced. Assuming that the production build-up in the initial three years will be 50, 70 and 90 per cent of the rated capacity, it is expected that at the end of the third year of operation, there would be sufficient cash surplus to start repaying the long-term loans. Therefore, the interest charges on the long-term loans will progressively decline in the future years and in the 4th year (which would be the first year of full capacity operation), the interest on long-term loans is estimated at US $ 74 million.

Interest on working capital has been provided at 25 per cent per annum on the total working capital requirement.

Depreciation charges have been provided on a straight line basis at 5 per cent per annum on all tangible assets and on this basis, the annual depreciation charge would be US $ 48 million. The expenses to be incurred on interest on capital during construction, preliminary expenses, start-up and commissioning, administration during construction and design, and engineering services have been amortised in twenty equal annual instalments. The annual amortisation charges on this basis works out to US $ 15 million per annum.

The provision for tax has been assumed at a flat rate of 40 per cent on the net profit. The preliminary profitability analysis indicates that the net profit before tax would be US $ 75 million, which is about 16 per cent of the equity capital and after providing for tax, the net profit would be about US $ 45 million corresponding to about 10 per cent of the equity capital in the first year of the rated capacity operation. The rates of return would improve substantially in the subsequent years as interest charges on long-term loans get progressively reduced.

Break-even analysis

The break-even analysis reveals that if manufacturing wages and salaries are assumed to be fixed, the break-even point will be reached when the plant operates at about 70 per cent of its rated capacity as shown in Figure 9-2.

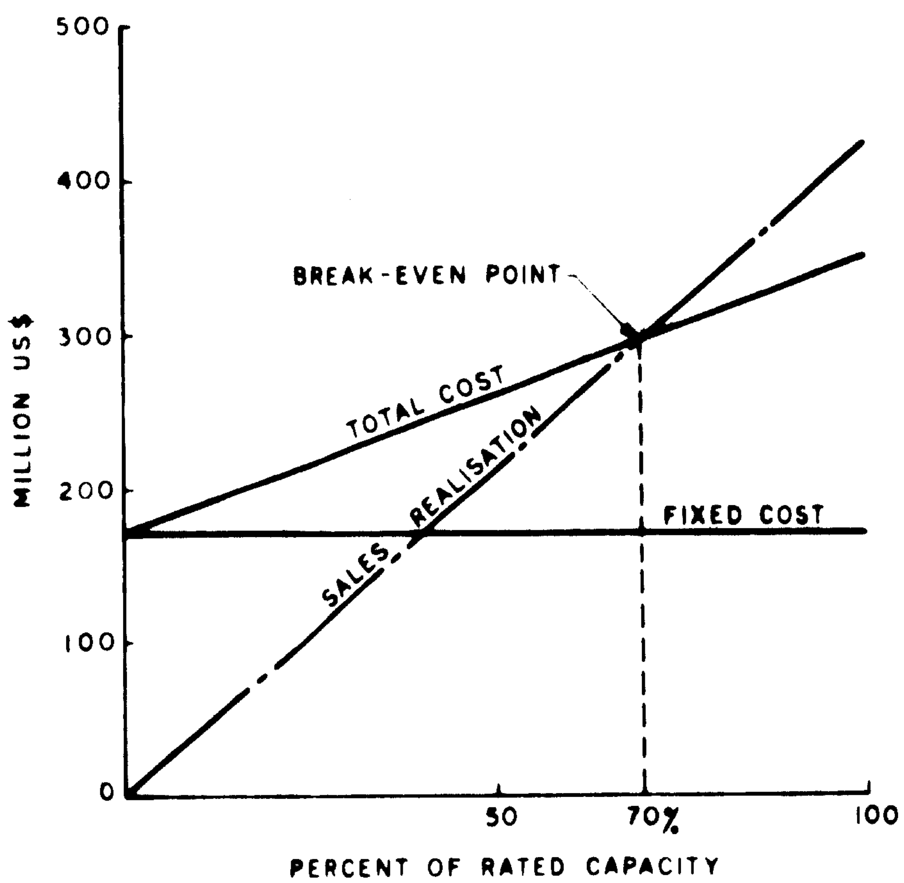


FIGURE 9-2. BREAK-EVEN CHART

9 - New Integrated Steel Plant (cont'd)

Sensitivity analysis

A sensitivity analysis has been carried out to study the effects of variations in the sales realisation, manufacturing expenses and fixed charges/expenses on the project profitability. The variations in the annual profit, for the first year of operation at rated capacity, due to changes in the above three variables are given in Table 9-15.

Table 9-15
SENSITIVITY ANALYSIS

	Base[a]	Variations							
Sales realisation	100	110	110	110	110	100	100	90	90
Annual manufacturing expenses	100	100	110	110	90	110	110	100	110
Fixed charges/expenses	100	100	100	110	90	100	110	100	100
Net profit before tax	100	156	131	110	203	75	53	44	19
Net profit after tax	100	156	131	110	202	76	53	44	18
Return on equity after tax	10%	15%	13%	11%	20%	7%	5%	4%	2%

a/ Base figures for first year of rated capacity operation given in Table 9-14.

The above analysis indicates that under the rather adverse circumstances, the project would require some increase in steel prices to provide adequate financial rate of return.

10 - LOCATION OF NEW PLANTS

Preliminary selections of possible locations for the new plants - the integrated steel plant, the direct reduction plants, and a bar and rod mill complex - have been made, taking into consideration the various locational factors and the relative raw materials assembly and product distribution costs. The infrastructure development required at the selected locations has been indicated. Further detailed studies and investigations would be, however, required before taking a decision on the sites.

It may be mentioned that the new bar and rod mill capacity may also be created by the expansion of SIP, as has been envisaged for the additional light profile capacity.

NEW INTEGRATED STEEL PLANT

Sources of major raw materials

The iron ore requirements of the integrated plant are proposed to be imported. The coking coal requirement would be met from domestic sources and for the purpose of this study, it is assumed to be obtained from Cundinamarca. The possibility of blending other coals available in the region of the selected location with Cundinamarca coals should be studied later. Limestone which occurs widely scattered, is expected to be available from areas adjoining the proposed locations.

Market

The new integrated plant would be producing medium profiles and flat products, the flats accounting for the bulk (over 80 percent) of the product-mix. With regard to the cost of product distribution, the cost of transporting the flat products, for which the geographic pattern of the domestic market is identifiable, has been taken into account, as information on the pattern of domestic market for medium profiles is not readily available.

The geographic pattern of the flat product market to be served by the new integrated steel plant has been worked out as follows:

i) The total demand for flat products considered for domestic production in 1985 has been broken down zonewise, on the basis of data collected during field survey.

10 - Location of New Plants (cont'd)

ii) It is assumed that the PDR products would be first marketed in Zone I and any surplus available thereafter would be sold in other zones. Considering the 1985 production of PDR, it is observed that the entire production of hot rolled and cold rolled sheets/strip would be marketed in Zone I, and tin plate in Zone I and Zone II.

iii) The zonewise demand for flat products of the new integrated steel plant is derived by deducting the PDR supplies from the total zonal demand.

The total zonal demand for flat products by categories and sizes, the PDR supplies to be different zones, and the balance zonewise demand to be met by the new integrated steel plant are given in Appendix 10-1.

For computing the transport cost for distribution of products, the following locations have been considered as the market centres of the different zones:

Zone		Market centre
I	..	Bogota
II	..	Medellin
III	..	Cali
IV	..	Bucaramanga
V	..	Barranquilla
VI	..	Pereira

Location considered

Taking into account the sources of supply of iron ore and coal, the new integrated steel plant

10 - Location of New Plants (cont'd)

could be located either at the coast or inland - in proximity to the coking coal source.

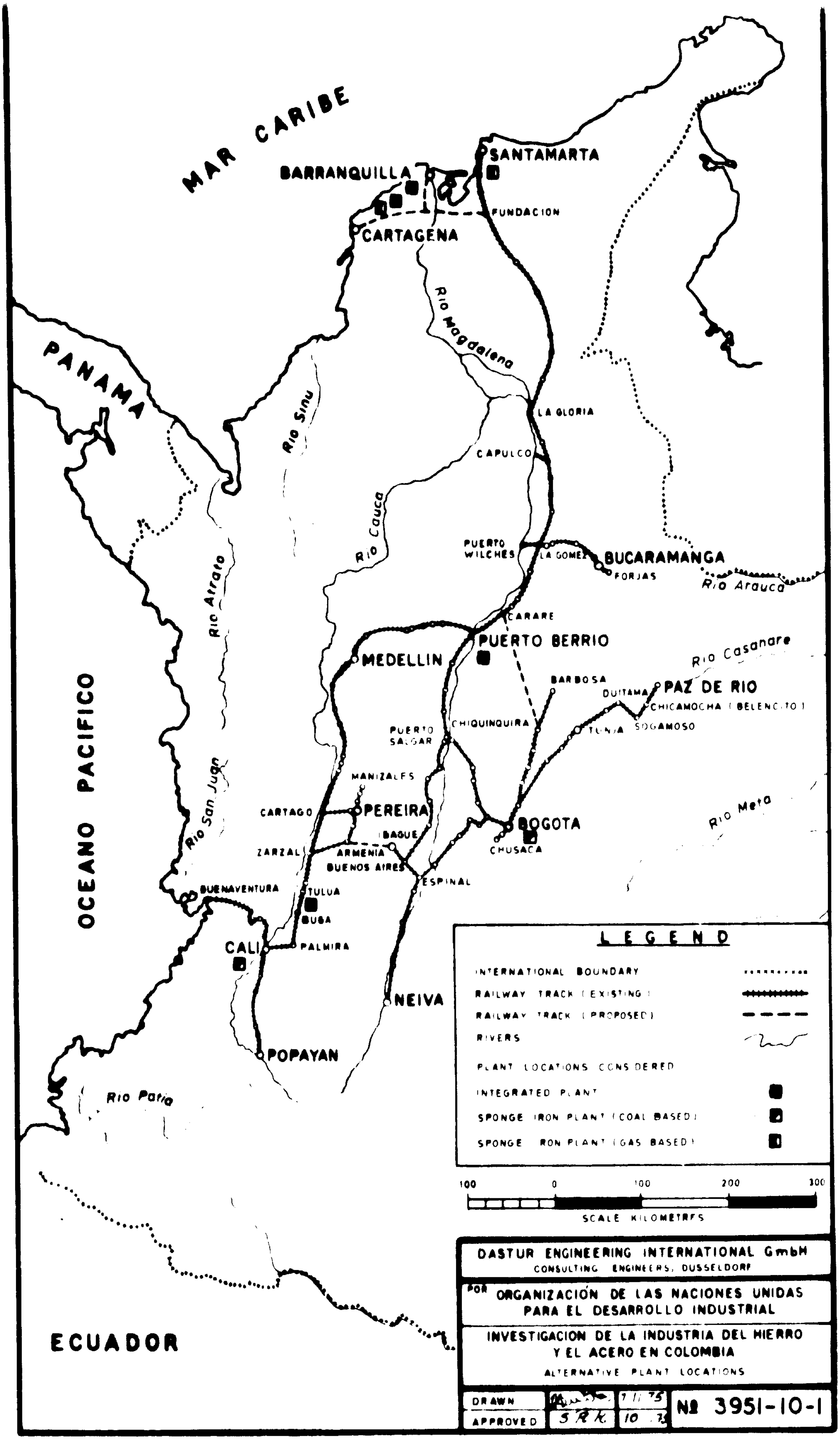
Based on a reconnaisance of different areas, the following three alternative locations have been considered for evaluation:

i) Barranquilla
ii) Buga-Tulua
iii) Puerto-Berrio

Review of Locations

The three alternative locations are shown in Drawing 3951-10-1. Barranquilla has been considered as a typical sea-board location on the Atlantic coast, on the assumption that adequate port facilities for importing ore could be developed adjoining the plant. Further investigations with regard to port development possibilities on the Atlantic coast should be carried out, which could influence the final selection of the plant location. In this connection, the infrastructure to be developed for exporting Cerrejon coal should be taken into consideration.

Buga-Tulua has been identified as a suitable location near the Pacific coast and has been favoured over the Buenaventura port from the viewpoints of availability of land and infrastructure facilities.


MAR CARIBE
BARRANQUILLA
SANTAMARTA
FUNDACION
CARTAGENA
Rio Magdalena
PANAMA
Rio Sinu
LA GLORIA
CAPULCO
Rio Cauca
PUERTO WILCHES
LA GOMEZ
BUCARAMANGA
FORJAS
Rio Arauca
Rio Atrato
CARARE
PUERTO BERRIO
MEDELLIN
Rio Casanare
BARBOSA
DUITAMA
PAZ DE RIO
CHICAMOCHA (BELENCITO)
OCEANO PACIFICO
PUERTO SALGAR
CHIQUINQUIRA
TUNJA
SOGAMOSO
Rio San Juan
MANIZALES
CARTAGO
PEREIRA
Rio Meta
IBAGUE
BOGOTA
ZARZAL
ARMENIA
BUENOS AIRES
CHUSACA
ESPINAL
BUENAVENTURA
TULUA
BUGA
CALI
PALMIRA
NEIVA
POPAYAN
Rio Patia
ECUADOR
LEGEND
INTERNATIONAL BOUNDARY
RAILWAY TRACK (EXISTING)
RAILWAY TRACK (PROPOSED)
RIVERS
PLANT LOCATIONS CONSIDERED
INTEGRATED PLANT
SPONGE IRON PLANT (COAL BASED)
SPONGE IRON PLANT (GAS BASED)
100 0 100 200 300
SCALE KILOMETRES
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DUSSELDORF
POR ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA EL DESARROLLO INDUSTRIAL
INVESTIGACION DE LA INDUSTRIA DEL HIERRO Y EL ACERO EN COLOMBIA
ALTERNATIVE PLANT LOCATIONS
DRAWN
APPROVED
Nº 3951-10-1

10 - Location of New Plants (cont'd)

Puerto-Berrio is in close proximity to the coking coal source, connected by river Magdalena to Barranquilla - the assumed port location to receive imported ore - and is well connected to the major markets.

The locational factors of Barranquilla, Buga-Tulua and Puerto-Berrio are compared in Appendix 10-2.

Evaluation of locations

The transport costs of assembling raw materials and distributing products for the three locations are detailed in Appendix 10-3 and summarised in Table 10-1.

Table 10-1

ANNUAL COSTS OF ASSEMBLING RAW MATERIALS AND DISTRIBUTING PRODUCTS AT ALTERNATIVE LOCATIONS FOR NEW INTEGRATED STEEL PLANTS
(million US $)

Costs	Barranquilla	Buga-Tulua	Puerto-Berrio
Raw materials assembly ..	19	25	27
Product distribution ..	11	9	8
	30	34	35

From Table 10-1 it would be noted that Barranquilla offers the advantage of the lowest total cost of transport of raw materials and products.

10 - Location of New Plants (cont'd)

Suggested location

From the viewpoint of transport costs, therefore, the Atlantic coast location is advantageous. A coastal plant would also facilitate steel exports. Further, the infrastructure development being carried out on the Atlantic coast for the development of the Guajira gasfield and the Cerrejon coal field could be advantageously utilised for the steel complex.

It is, however, reiterated that further detailed investigations would have to be taken up for selecting the exact location on the Atlantic coast for the plant.

DIRECT REDUCTION PLANTS

Gas-based plants

Natural gas for direct reduction would be supplied from Guajira gasfield and a pipeline is being laid from the gasfield to Barranquilla. Therefore, the gas-based sponge iron plant has to be necessarily located on the Atlantic coast.

Barranquilla and Santa Marta (Drawing 3951-10-1) were considered as alternative locations for siting the sponge iron plant.

Santa Marta has the advantage of being on the railway network. However, inadequate

10 - Location of New Plants (cont'd)

availability of suitable land, limited availability of water, difficulties in the expansion of port are some of the major disadvantages. Further, this port city is being developed for tourism and stringent anti-pollution measures are being enforced. Therefore, between the two locations, Barranquilla has been favoured as the site for the gas-based sponge iron plant.

Coal-based plant

The coal-based direct reduction plant will utilise imported pellets and domestic coal. It is assumed that the main consumers of the product would be SIP. In view of these factors, the following locations (Drawing 3951-10-1) have been suggested for the coal-based sponge iron plant:

Bogota/Boyaca area
Cali
Barranquilla

A plant located at Bogota/Boyaca area would utilise the Boyaca/Cundinamarca coals. The pellets to be utilised will be imported through Barranquilla. The plant at Cali is assumed to be based on Valle coals and would receive imported pellets through Buenaventura. The plant at Barranquilla would use Cerrejon coal. It is assumed that the coals occurring in all these areas would be suitable for use in Direct Reduction process, but this would have to be confirmed by tests.

10 - Location of New Plants (cont'd)

For estimating the raw materials assembly costs at Bogota/Boyaca area and Cali, it has been assumed that suitable quality coals would be available within about 50 km radius from the plant. The costs of transporting raw materials to different locations are given in Appendix 10-4.

For estimating the product distribution costs, it is assumed that out of the total annual production of 115,000 tons of sponge iron, the requirements of the existing semi-integrated steel plants located in the same zone as the sponge iron plant would be supplied first, and the balance available would be transported to other zones. The zone-wise distribution of sponge iron for the different plant locations is assumed as follows:

	Bogota/ Boyaca	Cali	Barranquilla
	'000 tons	'000 tons	'000 tons
Zone I ..	100	-	-
Zone II ..	-	60	65
Zone III	15	55	-
Zone V ..	-	-	50

The pattern of distribution has been derived on the basis of zonewise requirements of sponge iron for Case-II in 1983 (Table 8-2). The annual distribution costs of sponge iron for different locations (based on the transport costs per ton given in Figure 8-1) are given in Appendix 10-5.

10 - Location of New Plants (cont'd)

The transport costs of raw materials and sponge iron for the various locations are compared in Table 10-2.

Table 10-2

ANNUAL COSTS OF RAW MATERIALS ASSEMBLY AND SPONGE IRON DISTRIBUTION FOR ALTERNATIVE LOCATIONS OF COAL BASED PLANT
(million US $)

Costs	Bogota/Boyaca	Cali	Barranquilla
Raw materials assembly	2.92	1.04	1.09
Product distribution	0.60	0.57	0.80
	3.52	1.61	1.89

From the view point of the total cost of transport of raw materials and sponge iron, the Cali location is the cheapest and has, therefore, been considered as the location of the coal-based sponge iron plant. The other advantages of this location are the existing infrastructure facilities and developed coal mines in the neighbouring regions. However, the possibility of developing Buenaventura or any other other suitable port on the Pacific coast for importing pellets would require further investigations.

NEW BAR AND ROD MILL COMPLEX

Additional capacity for the bars and rods, and wire rods may be set up either as a new complex or as expansion schemes of the existing SIP. An evaluation of alternative locations has been made to identify a suitable one for a new complex.

10 - Location of New Plants (cont'd)

Source of sponge iron

The new bar and rod mill complex would utilise sponge iron as metallic charge and it is assumed that the sponge iron would be supplied from the gas-based plant at Barranquilla.

Market for bars and rods

The geographic pattern of demand for bars and rods, and wire rods to be served by the new complex would be different for Case-II and Case-III. Based on the shortfall between the demand considered for domestic production, and the productions of SIP and PDR, the market pattern for the new complex in 1985 for Case-II and Case-III would be as follows:

Zones		Case-II %	Case-III %
I	..	49	6
II	..	5	9
III	..	14	28
IV	..	20	40
V	..	3	6
VI	..	9	11

Locations considered

Bucaramanga and Cali have been considered as possible market based locations. From the viewpoint of the source of sponge iron supply, Barranquilla is also another possible location. The locations considered are shown in Drawing 3951-10-1.

10 - Location of New Plants (cont'd)

Evaluation of locations

The annual costs of transporting sponge iron and distributing the products for the three locations are detailed in Appendix 10-6 and summarised in Table 10-3.

Table 10-3

ANNUAL TRANSPORT COSTS FOR SPONGE IRON AND PRODUCT DISTRIBUTION OF BAR AND ROD MILL COMPLEX AT ALTERNATIVE LOCATIONS (million US $)

	Bucaramanga		Cali		Barranquilla	
	Case-II	Case-III	Case-II	Case-III	Case-II	Case-III
Transport of sponge iron	4.3	2.2	5.8	2.9	0.1	-
Distribution of product	4.3	1.8	4.4	2.3	5.6	2.7
Total	8.6	4.0	10.2	5.2	5.7	2.7

From Table 10-3, it would be observed that the Barranquilla location is preferable for siting the bar and rod mill complex for Case-II as well as Case-III.

INFRASTRUCTURE DEVELOPMENT REQUIRED

From the evaluation of locations for the new facilities, it is noted that the Atlantic coast would be favourable for installing the new integrated steel plant, the gas-based direct reduction plant and the new bar and rod mill complex, while Cali is advantageous for siting the coal-based sponge iron plant. This emphasises the necessity of developing the infrastructure facilities on the Atlantic coast.

10 - Location of New Plants (cont'd)

Transport

Barranquilla is not yet on the railway map of the country. It would be essential to connect the selected location on the Atlantic coast with the hinterland by railway to enable easy movement of steel and raw materials. Also, the possibilities of utilising the river barge transport system for transporting coal to integrated steel plant and for transporting steel as a return cargo, need to be investigated.

Port facilities on the Atlantic coast for receiving imported iron ore and pellets would have to be developed at an early date. A similar development for receiving pellets on the Pacific coast would be required to cater to the needs of the coal-based sponge iron plant at Cali.

Natural gas

The most essential development required for the direct reduction plants is the supply of natural gas. The development of the Guajira gasfield and the installation of the gas pipeline between the gasfield and Barranquilla should be completed by 1978 to enable the gas-based direct reduction plant to commence operation in early 1979.

10 - Location of New Plants (cont'd)

Electric power

The electric power requirements of the new plants would have to be taken into consideration in finalising the power development schemes on the Atlantic coast. Taking into account the nature of the electrical load of the integrated steel plant and the new arc furnace plants, a substantial increase in the thermal power component of the CORELCA system would be advisable.

Infrastructure for the Cerrajon coal field

The development of the Cerrajon coal field would require the installation of new transport links including a port for exports, as well as the development of electric power and water supply systems. There are various possibilities of siting the port. For example, if the port has to be an independent facility to serve exclusively the Cerrajon coal field, it may be located eastwards from Santa Marta and may not be connected by railway system to either Santa Marta or to the main market centres of steel. In such an event, this location may not be very advantageous for serving the new plants.

It is suggested that in taking a final decision on the infrastructure development for Cerrajon coal, the possibility of integrating the facilities to serve the steel industry as well, may be kept in view.

10 - Location of New Plants (cont'd)

ECOLOGY

No specific pollution control regulations are as yet in vouge in Colombia. In selecting the plant facilities, however, adequate provision for installing pollution control facilities has been made. These include facilities for dust control, collection and treatment of pickling line effluent, extra high stacks at the coke oven and sinter plant etc. Requisite water treatment facilities have been provided and recirculation water systems have been planned.

A P P E N D I C E S

Appendix 5-1

SEMI-INTEGRATED PLANTS: MAJOR INSTALLED FACILITIES
(As of May 1975)

	SIMUNA			BOYACA	SIMESA			FUTEC		SIDELPA			SIDUNOR		
STEELMAKING															
Furnace No.	1	2	3	1	1	2	3	1	2	1	2	3	1	2	3
Transformer, kVA	1 250	2,500	5,000	10 000	12 500	3 000	2 000	750	1 720	1 500	6 250	6 250	2 500	4 000	7 500
Shell dia, m	1.95	2.62	2.72	3.35	3.74	2.97	2.66	1.5	3.4	2.14	3.00	3.00	-	-	-
Nominal rating, tons	2	4-6	8-10	17.6	30	8	5	1.5	3-4	3	12	12	6	10	10 a/
ROLLING MILLS															
Billet mill/ billet-cum-finishing mill	1 x 450 mm 2-hi b/ 1 x 300 h.p.			2 x 380 mm 3-hi 1 x 1000 h.p.	2 x 400 mm 3-hi 1 x 1250 h.p. 5 x 300 mm 3-hi 1 x 1000 h.p. 2 x 250 mm double duo 1 x 600 h.p.			-		5 x 450 mm 3-hi 1 x 1200 h.p. 1 x 350 mm 3-hi c/ 1 x 500 h.p.			1 x 450 mm 3-hi 1 x 2400 h.p. 3 x 300 mm 3-hi 1 x 1000 h.p. 7 x 225 mm 3-hi 1 x 800 h.p.		
Finishing mill (bar/ bar and rod/ rod/light profile)	1 mill 4 x 250 mm 3-hi 1 x 150 h.p. 1 mill 6 x 260 mm 3-hi 6 x 750 h.p.			1 mill 5 x 250 mm 3-hi 1 x 450 h.p. 1 mill 5 x 250 mm 3-hi 1 x 450 h.p. 1 mill 4 x 250 mm 3-hi 1 x 450 h.p.	1 mill 5 x 275 mm 3-hi 1 x 500 h.p. 4 x 250 mm double duo 1 x 400 h.p. 1 x 250 h.p.			1 mill 3 x 300 mm 3-hi 1 x 250 mm 2-hi 1 x 750 h.p.		1 mill 5 x 320 mm 3-hi 1 x 1200 h.p. 1 mill 5 x 250 mm 3-hi 1 x 500 h.p.			-		

a/ Already installed, but not commissioned till May 1975.
b/ Improvisation of the mill being done.
c/ Commissioned in 1975.

Appendix 5-2

AVAILABLE INFORMATION ON SUPPLY AND CONSUMPTION OF BILLETS
(tons)

Year		Supply			Consumption a/						
		Imports	PDR	Total	SIMUNA	BOYACA	SIMESA	FUTEC	SIDELPA	SIDUNOR	Total
1970	..	39 380	N.A	39 380	-	35 599	-	-	3 000	2 000	40 599
1971	..	76 250	N.A	76 250	-	30 896	-	532	-	-	31 428
1972	..	16 092	N.A	16 092	-	34 522	-	2 294	-	5 000	41 816
1973	..	-	26 400	26 400	-	19 750	1 006	3 940	-	-	24 696
1974	..	478	9 400	9 878	300	8 364	-	1 409	-	-	10 073
				168 000							148 612

a/ Based on information furnished by SIP.

Appendix 5-3

METAL BOYACA - ANALYSIS OF FINANCIAL PERFORMANCE

		1972	1973	1974
Production of steel, tons a/		32 400	29 400	16 600
Sales of steel, tons		32 200	28 300	b/

1972

	Item	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972
1.	Net sales income ..	158	-	100	100
2.	Other income ..	3	93	1.9	100
3.	Total income (1) + (2) ..	161	4 969	-	100
4.	Cost of sales (excluding depreciation) ..	126	3 909	79.7	100
5.	Gross profit (1) - (4) ..	32	988	20.3	100
6.	Administrative and selling expenses ..	13	401	8.2	100
7.	Interest and other financial charges expenses	N.A.	-	-	-
8.	Depreciation provision ..	3	93	1.9	100
9.	Total other expenses (6) + (7) + (8) ..	16	494	10.1	100
10.	Net profit before tax (5) - (9) + (2) ..	19	586	12.0	100
11.	Provision for taxation ..	7	216	4.4	100
12.	Net profit after provision for tax (10 - (11)	12	370	7.6	100
13.	Average sales income per ton of steel sold	-	4 907	-	100
14.	Salaries and wages ..	N.A.	-	-	-
15.	Salaries and wages as percentage of cost of sales	N.A.	-	-	-
16.	Share capital ..	27	-	-	100
17.	Legal reserves ..	8	-	-	100
18.	Share holders equity (16) + (17) ..	35	-	-	100
19.	Long-term loans ..	6	-	-	100
20.	Ratio of share capital to long-term loans (16):(19)	4.5:1	-	-	-
21.	Ratio of share holders equity to long-term loans (18):(19) ..	5.8:1	-	-	-
22.	Gross block ..	33	-	-	100
23.	Investment in gross block per ton of steel produced	1 025	-	-	-
24.	Ratio of gross block to share holders equity (22):(18) ..	1:1.1	-	-	-
25.	Ratio of gross block to long-term loans (22):(19)	5.5:1	-	-	-
26.	Current assets ..	123	-	-	100
27.	Current liabilities ..	81	-	-	100
28.	Ratio of current assets to current liabilities (26):(27) ..	1.5:1	-	-	-
29.	Liquid cash resources ..	7	-	-	100
30.	Liquidity ratio - liquid cash to current liabilities (29):(27) ..	1:11.6	-	-	-

1973

	Item	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972
1.	Net sales income	174	-	100	110
2.	Other income	2	72	1.5	66
3.	Total income (1) + (2)	176	6 107	-	109
4.	Cost of sales (excluding depreciation)	127	4 472	72.9	100
5.	Gross profit (1) - (4)	47	1 665	27.0	146
6.	Administrative and selling expenses	20	724	11.5	153
7.	Interest and other financial charges expenses	N.A.	-	-	-
8.	Depreciation provision	3	106	1.7	100
9.	Total other expenses (6) + (7) + (8)	23	810	13.2	143
10.	Net profit before tax (5) - (9) + (2)	26	915	14.9	137
11.	Provision for taxation	10	352	5.7	142
12.	Net profit after provision for tax (10 - (11)	16	563	9.1	133
13.	Average sales income per ton of steel sold	-	6 321	-	129
14.	Salaries and wages	N.A.	-	-	-
15.	Salaries and wages as percentage of cost of sales	N.A.	-	-	-
16.	Share capital	29	-	-	107
17.	Legal reserves	10	-	-	125
18.	Share holders equity (16) + (17)	39	-	-	111
19.	Long-term loans	54	-	-	900
20.	Ratio of share capital to long-term loans (16):(19)	1:1.9	-	-	-
21.	Ratio of share holders equity to long-term loans (18):(19)	1:1.4	-	-	-
22.	Gross block	74	-	-	225
23.	Investment in gross block per ton of steel produced	3 310	-	-	-
24.	Ratio of gross block to share holders equity (22):(18)	2.4:1	-	-	-
25.	Ratio of gross block to long-term loans (22):(19)	1.7:1	-	-	-
26.	Current assets	77	-	-	63
27.	Current liabilities	52	-	-	64
28.	Ratio of current assets to current liabilities (26):(27)	1.5:1	-	-	-
29.	Liquid cash resources	8	-	-	114
30.	Liquidity ratio - liquid cash to current liabilities (29):(27)	1:6.5	-	-	-

1974

	Item	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972
1.	Net sales income	176	-	100	112
2.	Other income	6	361	3.2	200
3.	Total income (1) + (2)	182	11 666	-	113
4.	Cost of sales (excluding depreciation)	114	6 867	61.3	90
5.	Gross profit (1) - (4)	72	4 337	38.7	225
6.	Administrative and selling expenses	10	602	5.3	77
7.	Interest and other financial charges expenses	10	602	5.3	-
8.	Depreciation provision	6	361	3.2	200
9.	Total other expenses (6) + (7) + (8)	26	1 566	13.9	162
10.	Net profit before tax (5) - (9) + (2)	52	3 133	27.9	273
11.	Provision for taxation	21	1 265	11.3	300
12.	Net profit after provision for tax (10 - (11)	31	1 867	16.6	258
13.	Average sales income per ton of steel sold	-	11 205	-	228
14.	Salaries and wages	N.A.	-	-	-
15.	Salaries and wages as percentage of cost of sales	N.A.	-	-	-
16.	Share capital	30	-	-	111
17.	Legal reserves	11	-	-	138
18.	Share holders equity (16) + (17)	41	-	-	117
19.	Long-term loans	46	-	-	767
20.	Ratio of share capital to long-term loans (16):(19)	1:1.5	-	-	-
21.	Ratio of share holders equity to long-term loans (18):(19)	1:1.1	-	-	-
22.	Gross block	114	-	-	345
23.	Investment in gross block per ton of steel produced	6 867	-	-	-
24.	Ratio of gross block to share holders equity (22):(18)	2.8:1	-	-	-
25.	Ratio of gross block to long-term loans (22):(19)	2.5:1	-	-	-
26.	Current assets	98	-	-	80
27.	Current liabilities	56	-	-	69
28.	Ratio of current assets to current liabilities (26):(27)	1.8:1	-	-	-
29.	Liquid cash resources	2	-	-	29
30.	Liquidity ratio - liquid cash to current liabilities (29):(27)	1:29	-	-	-

a/ Production figures are taken from Chapter 3.
b/ Assumed to be the same as production figures.

Appendix 5-4

[illegible] - ANALYSIS OF FINANCIAL PERFORMANCE

	1972			1973			1974		
	Total in million Pesos	% of sales income	Index base 1970	Total in million Pesos	% of sales income	Index base 1970	Total in million Pesos	% of sales income	Index base 1970
1. Net sales income ..	[illegible]	100	100	296	100	133	424	100	191
2. Other income ..	3	1.3	100	17	5.7	567	26	6.1	867
3. Total income (1) + (2) ..	227	-	100	313	-	138	450	-	198
4. Cost of sales (excluding depreciation) ..	161	72.5	100	214	72.3	133	278	65.6	173
5. Gross profit (1) - (4) ..	63	28.4	100	82	27.7	130	146	34.4	232
6. Administrative and selling expenses ..	22	9.9	100	29	9.8	132	37	8.7	168
7. Interest and other financial charges/expenses	17	7.6	100	17	5.7	100	23	5.4	135
8. Depreciation provision ..	11	4.9	100	11	3.7	100	12	2.8	109
9. Total other expenses (6) + (7) + (8) ..	50	22.5	100	57	19.3	114	72	17.0	144
10. Net profit before tax (5) - (9) + (2) ..	16	7.2	100	42	14.2	263	107	25.2	669
11. Provision for taxation ..	8	3.6	100	12	4.1	150	35	8.3	438
12. Net profit after provision for tax (10) - (11) ..	8	3.6	100	30	10.1	375	72	17.0	900
13. Salaries and wages ..	31	13.9	100	28	9.4	90	34	8.0	110
14. Salaries and wages as percentage of cost of sales	(19%)	-	-	(13%)	-	-	(12%)	-	-
15. Share capital ..	47	-	100	94	-	200	94	-	200
16. Legal reserves ..	10	-	100	13	-	130	16	-	160
17. Shareholders' equity (15) + (16) ..	57	-	100	107	-	188	110	-	193
18. Long-term loans ..	70	-	100	50	-	71	25	-	36
19. Ratio of share capital to long-term loan (15):(18)	1:1.5	-	-	1.9:1	-	-	3.8:1	-	-
20. Ratio of shareholders' equity to long-term loans (17):(18) ..	1:1.2	-	-	2.1:1	-	-	4.4:1	-	-
21. Gross block ..	140	-	100	157	-	112	165	-	118
22. Ratio of gross block to shareholders' equity (21):(17) ..	2.5:1	-	-	1.5:1	-	-	1.5:1	-	-
23. Rate of gross block to long-term loans (21):(18) ..	2:1	-	-	3:1	-	-	6:1	-	-
24. Current assets ..	147	-	100	179	-	122	272	-	185
25. Current liabilities ..	108	-	100	109	-	101	167	-	164
26. Ratio of current assets to current liabilities (24):(25) ..	1.4:1	-	-	1.6:1	-	-	1.6:1	-	-
27. Liquid cash resources ..	2	-	100	4	-	200	6	-	300
28. Liquidity ratio - liquid cash to current liabilities (27):(25)	1:51	-	-	1:27	-	-	1:27	-	-

Appendix 5-5

SIDELPA - ANALYSIS OF FINANCIAL PERFORMANCE

	1972				1973				1974			
Production of steel, tons ..	29 000				29 300				30 900			
Sale of steel, tons ..	29 000				29 000				31 000			
	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1972
1. Net sales income ..	153	-	100	100	187	-	100	122	330	-	100	216
2. Other income ..	5	172	3.3	100	8	273	4.3	160	7	227	2.1	140
3. Total income (1) + (2) ..	158	5 448	-	100	195	6 655	-	123	337	10 906	-	213
4. Cost of sales (excluding depreciation) ..	106	3 655	69.3	100	123	4 198	65.8	116	175	5 663	53.0	165
5. Gross profit (1) - (4) ..	47	1 621	30.7	100	64	2 184	34.2	136	155	5 016	47.0	330
6. Administrative and selling expenses ..	8	276	5.2	100	10	205	5.3	125	13	421	3.9	163
7. Interest and other financial charges/expenses	9	310	5.9	100	16	546	8.6	178	22	712	6.7	244
8. Depreciation provision ..	6	207	3.9	100	6	205	3.2	100	9	291	2.7	150
9. Total other expenses (6) + (7) + (8) ..	23	793	15.0	100	32	1 092	17.1	139	44	1 424	13.3	191
10. Net profit before tax (5) - (9) + (2) ..	29	1 000	19.0	100	40	1 365	21.4	138	118	3 819	35.8	407
11. Provision for taxation ..	6	207	3.9	100	11	375	5.9	183	55	1 780	16.7	917
12. Net profit after provision for tax (10) - (11)	23	793	15.0	100	29	990	15.5	126	63	2 039	19.1	274
13. Average sales income per ton of steel sold	-	5 276	-	100	-	6 448	-	122	-	10 645	-	[illegible]
14. Salaries and wages ..	32	1 103	20.9	100	40	1 365	21.4	125	57	1 844	19.3	178
15. Salaries and wages as percentage of cost of sales	(30%)	-	-	-	(33%)	-	-	-	(33%)	-	-	-
16. Share capital	50	-	-	-	64	-	-	128	79	-	-	158
17. Legal reserves ..	33	-	-	100	21	-	-	64	24	-	-	73
18. Share holders' equity (16) + (17) ..	83	-	-	100	85	-	-	102	102	-	-	123
19. Long-term loans ..	50	-	-	100	77	-	-	154	53	-	-	106
20. Ratio of share capital to long-term loans (16) : (19)	1:1	-	-	-	0.8:1	-	-	-	1.5:1	-	-	-
21. Ratio of share holders' equity to long-term loans (18) : (19) ..	1.7:1	-	-	-	1.1:1	-	-	-	1.9:1	-	-	-
22. Gross block ..	128	-	-	100	181	-	-	141	209	-	-	163
23. Investment in gross block per ton of steel produced	4 414	-	-	-	6 177	-	-	-	6 764	-	-	-
24. Ratio of gross block to share holders' equity (22) : (18) ..	1.5:1	-	-	-	2.1:1	-	-	-	2:1	-	-	-
25. Ratio of gross block to long-term loans (22) : (19)	2.6:1	-	-	-	2.4:1	-	-	-	3.9:1	-	-	-
26. Current assets ..	142	-	-	100	163	-	-	127	197	-	-	111
27. Current liabilities ..	90	-	-	100	118	-	-	131	132	-	-	147
28. Ratio of current assets to current liabilities (26) : (27) ..	1.6:1	-	-	-	1.4:1	-	-	-	1.5:1	-	-	-
29. Liquid cash resources ..	1	-	-	100	2	-	-	200	19	-	-	1 900
30. Liquidity ratio - liquid cash to current liabilities (29) : (27) ..	1:90	-	-	-	1:59	-	-	-	1:7	-	-	-

Appendix 5-6

FUTURE DEMAND FOR ORDINARY STEEL PRODUCTS WHICH CAN BE PRODUCED BY SEMI-INTEGRATED PLANTS

A. CATEGORIES OF STEEL CONSIDERED AND THEIR DEMAND[a]

		1980 '000 tons	1985 '000 tons
Light profiles	..	82	135
Bars and rods (-75 mm)	..	300	526
Wires	..	130	215
Total	..	512	876

For planning of rolling mill facilities this has to be suitably grouped under relevant rolled steel products such as light profiles, bars and rods and wire rods.

B. DEMAND FOR WIRE RODS

a) Wire rods are considered to include all -12mm rods in coils which are used for wire drawing, reinforcing, structural fabrication and other purposes.

b) Methodology adopted for deriving the wire rod demand

i) Wire rods required for wire drawing are assumed to be the same as the wire demand.

ii) For other rods in coils, the past pattern of domestic production, between 1970 and 1974 is assumed to hold good for future.

Appendix 5-6 (continued)

c) Past pattern of domestic production of rods in coils

	1970 to 1974	
	Total Bars and rods '000 tons	Rods in coils d/ '000 tons
PDR ..	531.6 b/	206.7 e/
SIP ..	227.9 c/	8.1
Total	759.5	214.8
	(100%)	(28.2%)

Rods in coils amount to about 28% of total bars and rods production, and this ratio has been applied to the projected demand also.

d) Projected demand for wire rods:

	1980 '000 tons	1985 '000 tons
Wire rod for wire drawing	130	215
Other wire rods	84	147
Total	214	362

C. PROJECTED DEMAND FOR ROLLED STEEL

	1980 '000 tons	1985 '000 tons
Light profiles	82	135
Bars and rods (-75 mm)	216	379
Wire rods	214	362
Total	512	876

a/ Refer Table 3-7
b/ Appendix 3-6, Col (1)
c/ Appendix 3-6, sum of Col (2) to Col (6)
d/ Based on answers to questionnaire
e/ Assuming up to 3/8" plain rods were in coils

Appendix 5-7

FUTURE DEMAND FOR SPECIAL STEEL PRODUCTS WHICH CAN BE PRODUCED BY SEP

A. CATEGORIES OF STEEL CONSIDERED

Bars and rods and wire rods in carbon constructional, alloy constructional, spring steel, stainless, electrode and free-cutting qualities will be produced.

B. DEMAND PROJECTIONS FOR 1980 AND 1985

i) Two approaches are possible to derive the bars and rods and wire rods requirement for special steels. These are:

a) Based on historic data, identifying the proportion of bars and rods and wire rods in the apparent consumption of total special steels;

b) Estimating the normal proportion of bars and rods, and wire rods in the different categories of steel based on the experience in alloy and special steels industry in other countries.

ii) Past pattern of consumption (1970 to 1974): (thousand tons)

	Total Alloy Steels				Bars and rods				Wire rods and Wires		
	Prodn.	Imports	Exports	App. consumption	Prodn.	Imports	Exports	App. consumption	Prodn.	Imports	App. consumption a/
1970 ..	25.6	28.0	0.4	53.2	19.7	1.0	0.4	20.3	5.9	9.9	15.8
1971 ..	19.5	17.1	1.7	34.9	14.8	0.4	1.7	13.5	4.7	7.2	11.9
1972 ..	15.5	16.1	0.4	31.2	12.1	0.3	0.4	12.0	3.4	6.4	9.8
1973 ..	18.9	22.1	1.9	39.1	14.4	0.8	1.9	13.3	4.5	9.5	14.0
1974 ..	22.0	23.9	1.8	44.1	17.6	0.8	1.8	16.6	4.4	13.3	17.7
Total		..		202.5				75.7			68.2
(percentage)		..		(100)				(37.4)			(34.8)

iii) Demand projections based on past pattern: (thousand tons)

	Total demand b/	Bars & rods	Wire rods
1980 ..	97	36	33
1985 ..	208	78	71

iv) Demand projections based on categorywise steel demand: (thousand tons)

	Norms		1980 d/			1985 d/		
	Bars & rods %	Wire rods %	Total demand b/	Bars & rods	Wire rods	Total demand b/	Bars & rods	Wire rods
Carbon constructional	70	30	27.1	19	8	54.3	38	16
Alloy constructional	70	30	17.5	12	5	48.5	34	15
Stainless c/	-	-	9.1	-	-	17.7	-	-
Free-cutting	-	100	5.8	-	6	18.6	-	19
Electric steel	-	-	5.3	-	-	11.2	-	-
Spring steel	75	25	19.9	15	5	36.7	28	9
Tool steel	Not considered		4.1	-	-	7 2	-	-
Electrodes	-	100	7.9	-	8	16.8	-	14
			96.7	46	32	208.4	100	73

v) Adopted demand for bars and rods and wire rods: (thousand tons)

	Ranges of estimate		Adopted	
	1980	1985	1980	1985
Bars and rods ..	36 to 46	78 to 100	36	90
Wire rods ..	32 to 33	71 to 73	32	71

a/ No exports.
b/ Refer Table 3-15, including non-coverage.
c/ Small quantities of bars and rods neglected.
d/ Figures do not add up due to rounding.

Appendix 5-8

ZONAL DISTRIBUTION OF PRODUCTION PROGRAMME - 1976 TO 1985
(thousand tons)

		Ordinary steel					Special steel		
		Zone I	Zone II	Zone III	Zone V	Total	Zone II	Zone III	Total
1976									
a) Bars and rods	..	20	29	-	9	58	-	18	18
b) Light profiles	..	27.5	5	5	8.5	46	-	-	-
c) Wire rods	..	-	14	-	1	15	2	3	5
Total	..	47.5	48	5	18.5	119	2	21	23
1977									
a) Bars and rods	..	15	34	-	11	60	-	20	20
b) Light profiles	..	27.5	10	5.5	5	48	-	-	-
c) Wire rods	..	5	14	-	2	21	6	4	10
Total	..	47.5	58	5.5	18	129	6	24	30
1978									
a) Bars and rods	..	25	30	-	25	80	-	23.5	23.5
b) Light profiles	..	27.5	10	-	11.5	49	-	-	-
c) Wire rods	..	15	15	-	5	35	10	4	14
Total	..	67.5	55	-	41.5	164	10	27.5	37.5
1979									
a) Bars and rods	..	25	25	-	27	77	-	23.5	23.5
b) Light profiles	..	27.5	10	-	12	49.5	-	-	-
c) Wire rods	..	30	20	-	5	55	10	4	14
Total	..	82.5	55	-	44	181.5	10	27.5	37.5
1980									
a) Bars and rods	..	25	30	-	35	90	-	35	35
b) Light profiles	..	41	12	-	15	68	-	-	-
c) Wire rods	..	30	20	-	5	55	16	4	20
Total	..	96	62	-	55	213	16	39	55
1981									
a) Bars and rods	..	25	30	-	40	95	-	40	40
b) Light profiles	..	54	14	-	15	83	-	-	-
c) Wire rods	..	30	30	-	5	65	16	5	21
Total	..	109	74	-	60	243	16	45	61
1982									
a) Bars and rods	..	25	30	-	40	95	-	48	48
b) Light profiles	..	54	14	-	15	83	-	-	-
c) Wire rods	..	30	30	-	5	65	16	5	21
Total	..	109	74	-	60	243	16	53	69
1983									
a) Bars and rods	..	25	30	-	40	95	-	48	48
b) Light profiles	..	54	14	-	15	83	-	-	-
c) Wire rods	..	30	30	-	5	65	16	5	21
Total	..	109	74	-	60	243	16	53	69
1984									
a) Bars and rods	..	25	30	-	40	95	-	48	48
b) Light profiles	..	54	14	-	15	83	-	-	-
c) Wire rods	..	30	30	-	5	65	16	5	21
Total	..	109	74	-	60	243	16	53	69
1985									
a) Bars and rods	..	25	30	-	40	95	-	60	60
b) Light profiles	..	54	14	-	15	83	-	-	-
c) Wire rods	..	30	30	-	5	65	16	5	21
Total	..	109	74	-	60	243	16	65	81

Appendix 5-9

SIP - SCRAP REQUIREMENT, AVAILABILITY AND SHORTFALL
(thousand tons)

	Ingot steel production			Purchased scrap requirement c/	Domestic scrap available for steelmaking d/	Scrap shortfall
	Ordinary a/	Special b/	Total			
1976	132.9	32.8	165.7	168	115	53
1977	151.8	42.8	194.6	198	130	68
1978	192.9	53.6	246.5	251	148	103
1979	213.5	53.6	267.1	271	153	118
1980	250.5	78.6	329.1	334	173	161
1981	285.9	87.1	373.0	379	186	193
1982	285.9	98.6	384.5	391	218	173
1983	285.9	98.6	384.5	391	252	139
1984	285.9	98.6	384.5	391	294	97
1985	285.9	115.7	401.6	408	333	75

a/ Assuming average 85 per cent yield of finished steel (Appendix 5-5)
b/ Assuming average 70 per cent yield of finished steel (Appendix 5-5)
c/ Assuming average 1,016 kg purchased scrap per ingot ton
d/ Refer Table 4-13

Appendix 6-1

PDR - EXISTING MAJOR PRODUCTION FACILITIES

Department		Major facilities	Product	Production in 1974 tons
Coke ovens	..	One 43 oven, by-product recovery type with benzol rectification, tar distillation, ammonia recovery and sulphuric acid plant	Coke	140 700
		Three beehive ovens	Coke	59 300
Sinter plant	..	Ore bedding plant of 11,000 tons capacity with one stacker and two reclaimers		
		One Dwight-Lloyd type, 2 m x 68 m sinter strand	Sinter	286 200
Blast furnace	..	One 5.9 m hearth dia 689 cu m volume furnace with oil injection, three stoves and gas cleaning facilities	Hot metal	239 800
Steelmaking	..	Three 20-ton Thomas converters, one 800-ton hot metal mixer and desiliconising facility	Crude steel	204 000
		One 20-ton, 7,500 kVA electric arc furnace	Crude steel	40 000
Rolling mills	..	1,100 mm, 3,000 HP, 2-high slabbing and blooming mill, one battery of six soaking pits	Blooms	57 700
			Slabs	66 000
				29 600
		710 mm billet - structural mill comprising one 710 mm and one 660 mm stands	Billets a/ Profiles (100 to 200 mm) Flats (+3 mm)	4 300
		One 450 mm merchant mill comprising 3 x 3-high x 457 mm, 5 x 3-high x 305 mm, 2 x 3-high x 279 mm and 6 x 2-high x 254 mm stands	Flats (6 to 24 gauge) Bars, rebars Wire rods	18 700 11 900
		One single stand 690 mm x 1,350 mm x 1,425 mm, reversing, 5,150 HP steckel mill	Hot Strip	
		One hand sheet mill complex	Sheets	
Wire mill	..	16 wire drawing machines, with sulphuric acid pickling two hot dip galvanising lines, and 7 bell type annealing furnaces	Wire	28 300 b/

a/ Includes rails and other products supplied to captive mines and for other internal consumption.
b/ Also included in wire rods.

Appendix 6-8

[illegible] - ANALYSIS OF FINANCIAL PERFORMANCE

	1970				1971			
Production of steel, tons	204 785				210 260			
Sale of steel, tons	200 505				193 834			
	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1970	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1970
1. Net sales income	706	-	100	100	599	-	100	85
2. Other income	18	87	2.5	100	22	105	3.7	122
3. Total income (1) + (2) ..	724	3 535	-	100	621	2 865	-	86
4. Cost of sales (excl. depreciation)	440	2 148	62.3	100	355	1 625	59.3	81
5. Gross profit (1) - (4) ..	266	1 298	37.7	100	244	1 117	40.7	92
6. Administrative and selling expenses	43	209	6.1	100	38	174	6.3	88
7. Interest and other financial charges/expenses	23	112	3.3	100	28	128	4.7	122
8. Depreciation provision ..	68	332	9.6	100	74	339	12.4	109
9. Total other expenses (6)+(7)+(8)	134	654	19.0	100	140	641	23.4	104
10. Net profit before tax (5)-(9)+(2)	150	732	21.2	100	126	577	21.0	84
11. Provision for taxation ..	12	58	1.7	100	20	91	3.3	167
12. Net profit after provision for tax (10) - (11)	138	673	19.5	100	106	485	17.7	77
13. Average sales income per ton of steel sold ..	-	3 460	-	100	-	3 093	-	112
14. Salaries and wages	159	776	22.5	100	180	825	30.0	113
15. Salaries and wages as a percentage cost of sales	(36%)	-	-	-	(51%)	-	-	-
16. Share capital	600	-	-	100	607	-	-	101
17. Legal reserves	250	-	-	100	310	-	-	124
18. Shareholders equity (16)+(17) ..	850	-	-	100	917	-	-	108
19. Long-term loans	400	-	-	100	411	-	-	103
20. Ratio of share capital to long-term loan (16):(19)	(1.5:1)	-	-	-	(1.5:1)	-	-	-
21. Ratio of shareholders' equity to long-term loans (18):(19) ..	(2.1:1)	-	-	-	(2.2:1)	-	-	-
22. Gross block	1 359	-	-	100	1 437	-	-	106
23. Investment in gross block per ton of steel produced ..	6 636	-	-	-	6 834	-	-	-
24. Ratio of gross block to shareholders' equity (22):(18) ..	(1.6:1)	-	-	-	(1.6:1)	-	-	-
25. Ratio of gross block to long-term loans (22):(19) ..	(3.4:1)	-	-	-	(3.5:1)	-	-	-
26. Current assets	554	-	-	100	611	-	-	110
27. Current liabilities ..	205	-	-	100	207	-	-	101
28. Ratio of current assets to current liabilities (26):(27) ..	(2.7:1)	-	-	-	(3:1)	-	-	-
29. Liquid cash resources ..	222	-	-	100	47	-	-	21
30. Liquidity ratio - liquid cash to current liabilities (29):(27) ..	(1.1:1)	-	-	-	(1:4.4)	-	-	-

	1972				1973				1974			
Production of steel, tons	211 0[illegible]				188 659				194 616			
Sale of steel, tons	176 978				260 918				203 944			
	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1970	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1970	Total in mill. Pesos	Amount/ ton in Pesos	% of sales income	Index base 1970
1.	711	-	100	101	1 082	-	100	153	1 401	-	100	198
2.	8	37	1.1	44	21	111	1.9	117	65	333	4.6	361
3.	719	3 407	-	99	1 103	5 846	-	152	1 466	7 532	-	202
4.	444	2 103	62.4	101	736	4 087	68.9	178	850	4 367	60.7	193
5.	267	1 265	37.6	100	346	1 837	32.1	133	551	2 831	39.3	207
6.	42	199	5.9	98	61	323	5.6	142	83	426	5.9	193
7.	34	161	4.8	148	35	186	3.3	157	32	164	2.3	139
8.	56	265	7.9	82	70	371	6.5	103	148	760	10.6	218
9.	132	625	18.6	99	167	885	15.4	125	263	1 351	18.8	196
10.	143	677	20.1	95	180	954	16.6	120	353	1 813	25.2	235
11.	34	161	4.8	283	41	217	3.8	342	142	730	10.1	1 183
12.	109	516	15.3	79	139	736	12.8	101	211	1 084	15.1	153
13.	-	4 063	-	117	-	4 400	-	130	-	6 8[illegible]	-	198
14.	203	962	28.5	128	234	1 250	21.6	147	291	1 495	20.7	183
15.	(46%)	-	-	-	(32%)	-	-	-	(34%)	-	-	-
16.	607	-	-	101	617	-	-	103	617	-	-	103
17.	310	-	-	124	310	-	-	124	310	-	-	124
18.	917	-	-	108	917	-	-	108	917	-	-	108
19.	413	-	-	103	418	-	-	105	408	-	-	102
20.	(1.5:1)	-	-	-	(1.5:1)	-	-	-	(1.2:1)	-	-	-
21.	(2.2:1)	-	-	-	(2.2:1)	-	-	-	(1.8:1)	-	-	-
22.	1 678	-	-	123	1 790	-	-	132	2 039	-	-	150
23.	7 950	-	-	-	9 536	-	-	-	10 467	-	-	-
24.	(1.8:1)	-	-	-	(2.0:1)	-	-	-	(2.2:1)	-	-	-
25.	(4:1)	-	-	-	(4.3:1)	-	-	-	(4.1:1)	-	-	-
26.	848	-	-	148	869	-	-	157	1 179	-	-	213
27.	335	-	-	163	332	-	-	162	267	-	-	257
28.	(2.4:1)	-	-	-	(2.6:1)	-	-	-	(2.2:1)	-	-	-
29.	30	-	-	14	195	-	-	88	400	-	-	180
30.	(1:11.2)	-	-	-	(1:1.7)	-	-	-	(1:1.3)	-	-	-

Appendix 6-3

MAJOR ADDITIONAL FACILITIES: PDR-II AND PDR-III

	PDR-II	PDR-III
Coke ovens	One battery of 27 ovens (6 m high), 270,000 tons of coke per year.	One battery of 45 ovens (6 m high), 490,000 tons of coke, per year.
Sinter plant	One 125 sq m machine, 850,000 tons of fluxed sinter per year	One 210 sq m machine 1,425,000 tons of fluxed sinter per year
Blast furnace	One 7.2 m hearth dia furnace, 340,000 tons of hot metal per year.	One 8.5 m hearth dia furnace, 650,000 tons of hot metal per year.
Steelmaking	Conversion of existing three Thomas converters to LWS and installation of a new LWS converter of the same size.	Conversion of existing three Thomas converters to LWS and installation of 2 new LWS converters of the same size.
Continuous casting	One 2-strand bloom caster for 150,000 tons of blooms per year.	One 2-strand bloom caster for 150,000 tons of blooms per year. Two 3-strand billet caster for 228,000 tons of billets per year.
Rolling mills	-	On wire rod mill of 200,000 tons per year capacity.

Appendix 6-4

PRELIMINARY ESTIMATES OF CAPITAL COST FOR EXPANSION SCHEMES
(million US $)

	PDR-I[a]	PDR-II	PDR-III
I. MINING ..	102.0	55.0	102.0
II. PLANT FACILITIES			
Raw materials handling ..	14.9	10.0	14.9
Coke and by-products ..	44.7	27.0	40.0
Sinter plant ..	35.4	20.0	32.0
Blast furnace ..	48.3	30.0	48.3
Steelmaking ..	39.5	20.0	33.5
Oxygen plant ..	6.1	5.0	6.0
Lime plant ..	6.0	3.0	4.3
Fertilizer plant ..	2.2	2.0	2.3
Continuous casting machine	15.1	included in steelmaking	
Billet mill ..	16.0	-	-
Rod mill ..	32.5	-	32.5
Utilities:			
Electric supply ..	2.4	2.5	4.0
Power house ..	18.7	18.0	18.7
Water and sewerage ..	1.5	1.5	2.0
Additional requirement:			
Shops and building ..	1.8	1.5	1.8
Transport and mobile equipment ..	2.1	1.5	2.1
Social services ..	2.4	2.0	2.4
Dismantling and relocation of equipment ..	1.7	-	-
Contingencies ..	42.7	22.0	36.7
Sub-total (II) ..	334.0	166.0	281.5
III. SPARES ..	5.0	2.0	4.5
Total (I+II+III) ..	441.0	223.0	388.0

a/ Costs as indicated in feasibility report on PDR expansion (updated 1975).

Appendix 6-5

PRELIMINARY PHASING OF INVESTMENTS
(million US $)

	1977	1978	1979	1980	1981	1982	1983	1984	Total
PDR - I									
Cold mill complex ..	41	31	8	-	20	16	4	-	120
Plant expansion ..	48	129	132	31	-	-	-	-	339
Mines expansion ..	5	9	15	24	27	18	2	2	102
Total ..	94	169	155	55	47	34	6	2	561
PDR - II									
Cold mill complex ..	41	31	8	-	20	16	4	-	120
Plant expansion ..	25	66	62	15	-	-	-	-	168
Mines expansion ..	3	5	8	13	14	10	2	-	55
Total	69	102	78	28	34	26	6	-	343
PDR - III									
Cold mill complex ..	41	31	8	-	20	16	4	-	120
Plant expansion ..	40	109	111	26	-	-	-	-	286
Mines expansion ..	5	9	15	24	27	18	2	2	102
Total ..	86	149	134	50	47	34	6	2	508

Appendix 7-1

DEMAND CONSIDERED FOR DOMESTIC PRODUCTION IN 1980 AND 1985
(thousand tons)

Categories		1980 Total demand	1980 Not considered for domestic production	1980 Considered for domestic production	1985 Total demand	1985 Not considered for domestic production	1985 Considered for domestic production
ORDINARY STEEL a/							
Non-flats							
Bars and rods	..	340	-	340	596	-	596
Profiles: b/							
Heavy c/	..	29	29	-	49	49	-
Medium	..	88	-	88	143	-	143
Light	..	82	-	82	135	-	135
Wires	..	130	-	130	215	-	215
Seamless tubes	..	40	40	-	72	72	-
Rails and other railway materials	..	20	20	-	14	14	-
Sub-total non-flats	..	729	89	640	1 224	135	1 089
Flats							
Plates	..	70	35	35	125	62	63
CR sheets/strip	..	125	-	125	350	-	350
HR sheets/strip	..	90	-	90	160	-	160
Tinplate	..	120	-	120	190	-	190
Galvanised sheets	..	80	-	80	135	-	135
Welded pipes and tubes	..	60	24	36	108	43	65
Sub-total flats	..	545	59	486	1 068	105	963
TOTAL ORDINARY STEEL	..	1 274	148	1 126	2 298	240	2 052
SPECIAL STEEL d/							
Carbon constructional	..	27	3	24	54	7	47
Alloy constructional	..	18	3	15	48	7	47
Free cutting	..	6	-	6	19	1	18
Spring	..	20	4	16	37	5	32
Stainless	..	9	9	-	18	18	-
Electrical steel sheet	..	5	5	-	11	11	-
Tool steel	..	4	4	-	7	7	-
Electrode	..	8	1	7	14	1	13
TOTAL SPECIAL STEEL	..	97	29	68	208	57	151

a/ Refer Table 3-7 for size-wise break down of total demand.
b/ Includes beams, channels, equal angles, unequal angles, tees and narrow flats.
c/ Includes heavy profiles and tees.
d/ Refer Table 3-14 for total demand.

Appendix 7-2

YEARWISE DEMAND FOR ORDINARY STEEL ROLLED PRODUCTS CONSIDERED FOR DOMESTIC PRODUCTION
(thousand tons)

	NON-FLATS					FLATS							
						Hot rolled			Cold rolled				
Year	Bars and rods	Wire rods	Light profiles	Medium profiles	Total	-1200mm	+1200mm	Total	-1200mm	+1200mm	Total	Tin plate	Total
1974 ..	103	98	30	13	244	...	...	118	...	...	84	51	253
1976 ..	132	127	42	28	329	...	...	130	...	...	114	68	311
1977 ..	149	145	50	41	385	...	...	135	...	...	133	78	346
1978 ..	169	165	58	60	452	...	...	142	...	...	155	90	387
1979 ..	191	188	69	87	535	...	...	149	...	...	180	104	433
1980 ..	216	214	82	128	640	112	44	156	173	37	210	120	486
1981 ..	242	238	91	142	713	125	50	175	205	45	250	131	556
1982 ..	271	265	100	158	794	141	56	197	242	55	297	144	638
1983 ..	304	295	111	175	885	158	62	220	286	67	353	158	731
1984 ..	341	329	123	194	987	176	71	247	338	82	420	173	840
1985 ..	379	362	135	213	1 089	198	80	278	395	100	491	190	963

Appendix 9-1

PRELIMINARY ESTIMATE OF CAPITAL COST

Basis: 1.3 x 10^6 tons/yr crude steel

Unit		Cost (million US $) Total	Foreign
A. PLANT FACILITIES			
Raw material handling	..	15.00	
Sinter plant	..	40.00	
Coke ovens and by-products	..	60.00	
Blast furnace	..	75.00	
Steelmelt shop	..	130.00	
Rolling mills	..	410.00	
Utilities and services	..	150.00	
Sub-total (A)	..	880.00	525.00
B. ADMINISTRATION AND ENGINEERING			
Administration during construction and design and engineering services		60.00	25.00
Sub-total (A+B)	..	940.00	550.00
C. CONTINGENCIES AT 10% OF A+B	..	95.00	55.00
Total Plant Cost	..	1 035.00	605.00
D. SPARES	..	30.00	30.00

Appendix 9-2

ANNUAL MANUFACTURING COSTS

	Unit cost at site US $/ton	Annual requirement '000 tons	Annual cost '000 US $
A. RAW MATERIALS			
Iron ore lump ..	26.00	420.00	10 920.00
Iron ore fines ..	24.00	1 560.00	37 440.00
Washed coal ..	32.00	810.00	25 920.00
Unwashed coal ..	21.00	540.00	11 340.00
Limestone ..	4.00	630.00	2 520.00
Ferro-manganese ..	620.00	11.30	7 006.00
Ferro-silicon ..	440.00	3.70	1 628.00
Aluminium ..	2 000.00	0.65	1 300.00
Spar ..	50.00	6.60	330.00
Sub-total (A)		3 982.25	98 404.00
B. OTHER COSTS			
Labour and supervision			15 000.00
Utilities including power, water and natural gas			12 000.00
Repair and maintenance materials, consumables and operating supplies			60 000.00
General expenses			9 000.00
Sub-total (B)			96 000.00
Total Manufacturing Costs (A+B)			194 404.00
			Say US $ 194 million
Average cost of production (excluding fixed charges)			US $ 174.8 per ton
			Say US $ 175 per ton

Appendix 9-3

FINANCING OF STEEL PROJECTS IN LATIN AMERICA

Country/ Company	Details of the project	Estimated project cost mill.US $	Sources of loans	mill.US $	Financial terms and conditions
Brazil:					
CSM	Stage II expansion of Volta Redonda steel plant from 1.7 million tons to 2.4 million tons per year	432	Inter-American Development Bank ..	43	Inter-American Bank advanced this loan for a term of 15½ years at an interest of 8% per annum. Loan will be repaid in 23 semi-annual instalments the 1st of which will be due 4½ years after the date of the loan contract. Principal and interest payments will be made proportionately in the currencies lent. The loan will be guaranteed by the Federal Republic of Brazil.
			World Bank ..	65	
			Bilateral Credit ..	114	
			Local sources ..	210	
USIMINAS	Stage II expansion of USIMINAS plant from 1 million to 2.4 million tons per year	378	Inter-American Development Bank ..	42	-do-
			World Bank ..	63	
			Bilateral Credit ..	84	
			Local sources ..	189	
COSIPA	Stage II expansion of COSIPA plant from 1 million to 2.3 million tons per year	454	Inter-American Development Bank ..	43	-do-
			World Bank ..	64	
			Supplier countries	91	
			Local sources ..	256	

Appendix 9-3 (continued)

Country/ Company	Details of the project	Estimated project cost mill.US $	Sources of loans	mill.US $	Financial terms and conditions
CSN	Stage III expansion of Volta Redonda steel plant from 2.4 million to 4.4 million tons per year	1 515[a]	International Bank for Reconstruction and Development ..	95	The Bank loan is made for 15 years, including a grace period of 4 years, at an interest rate of 10% per annum. The IDB loan carries an interest rate of 8% per annum. Commitment fees are $\frac{3}{4}$% for the Bank and 1$\frac{3}{4}$% for the IDB loans, both payable on the undisbursed balance of the respective loans. IDB also charges an inspection and supervision fee equal to 1% of the loan amount. Bilateral credits are assumed to be for 15 years, including a 4 year grace period, at an average interest rate of 9% per annum with a 15% down payment.
			International Development Bank ..	63	
			Bilateral Credit ..	553	
			Others ..	38	
			CSN ..	700	
			Other local credits..	66	
Argentina:					
HIPASAM	Acquisition and installation of mining equipment for extraction of 3.5 million tons of iron ore per year at Sierra Grande and construction of a concentration plant, slurry pipeline, pelletisation plant and a mechanised loading wharf	125	Inter-American Development Bank ..	32	Bank advance this loan for a term of 20 years at an interest rate of 8% per annum. The loan will be repaid in 30 instalments the 1st of which will be due 5½ years after the date of the loan contract. Amortisation and interest will be paid proportionately in the currencies lent. The loan will be guaranteed by the Republic of Argentina.
			Foreign suppliers ..	27	
			Local credit ..	16	
			HIPASAM ..	50	

Appendix 9-3 (continued)

Country/ Company	Details of the project	Estimated project cost mill. US $	Sources of loans	mill. US $	Financial terms and conditions
Mexico:					
NAFINSA	Expansion of its steel production capacity	648	Inter-American Development Bank ..	54	Loan was extended from Bank's ordinary capital resources for a term of 15 years at an interest rate of 8% per annum. The loan will be repaid in 20 semi-annual instalments, the 1st of which will be due 5 years after the date of the loan contract. Principal and interest payments will be made proportionately in the currencies disbursed. The loan will be guaranteed by the United Mexican States.
			SICARTSA ..	300	
			Bilateral credit ..	178	
			World Bank ..	70	
			Other credits ..	46	

a/ Including working capital requirement and provision for price contingencies the total cost is estimated at US $ 2,552 million.

Sources: Inter-American Development Bank press releases.
IISI Panel Discussion: Steel in Latin America, Mexico City, October 12-15, 1975.

Appendix 9-4

COMPARISON OF PDR AND OTHER SELLING PRICES (US $ per ton)

	PDR	Other Andean countries			Brazil[a]	ECE Home[c]	USA	
		Chile[a]	Peru[a]	Venezuela[b]			Home[c]	Imported[d]
Medium profile	...356[e]	419	-	341	-	287 - 348	278	357
HR sheets/ strip	.. 400[f]	-	349	360	510	279 - 358	231	366
CR sheets/ strip	.. 433[f]	427	429	409	-	298 - 357	291	343
Galvanised sheets/coil	-	584	-	614	689	374 - 414	159	381

a/ February 1975, Source: ILAFA
b/ November 1974, Source: ILAFA
c/ For January 1975, Source: Metal Bulletin, March 1975
d/ Based on Continental Export Prices of April 1975, (Source: Metal Bulletin), and adding US $ 30 per ton for ocean freight and insurance, agency charges @ 5% CIF, customs duty @ 20% CIF, port handling charges US $ 8 per ton, and financial charges @ 18% CIF
e/ April 1975 price list
f/ PDR Expansion feasibility report (February 1975)

Appendix 10-1

ZONEWISE DEMAND OF FLAT PRODUCTS - 1985
(thousand tons)

		Zone I	Zone II	Zone III	Zone IV	Total
Hot Rolled + 1,200 mm						
Demand considered for production	..	34	8	20	18	80 a/
PDR products	..	-	-	-	-	-
Balance	..	34	8	20	18	80
Hot Rolled - 1,200 mm						
Demand considered for production	..	87	43	40	28	198 a/
PDR products	..	31	-	-	-	31 b/
Balance	..	56	43	40	28	167
Cold Rolled + 1,200 mm						
Demand considered for production	..	40	16	28	16	100 a/
PDR products	..	-	-	-	-	-
Balance	..	40	16	28	16	100
Cold Rolled - 1,200 mm						
Demand considered for production	..	240	45	70	40	395 a/
PDR products	..	240	-	-	-	240 b/
Balance	..	-	45	70	40	155
Tinplate						
Demand considered for production	..	21	169	-	-	190 a/
PDR products	..	21	39	-	-	60 b/
Balance	..	-	130	-	-	130

a/ Refer Table 7-1
b/ PDR-II and PDR-III productions refer Table 6-3.

Appendix 10-2

COMPARISON OF ALTERNATIVE LOCATIONS FOR [illegible] INTEGRATED PLANT

Factors	Barranquilla	[illegible] - Dulia	Puerto Berrio
1. LAND			
Area	Adequate area available	Adequate area can be found	Adequate area available
Cost	Reasonably cheap	Col. Pesos [illegible],000 - [illegible],000 hectare	Less than Col. Pesos 4,000/hectare
Terrain	Slightly undulating, uncultivated	Fairly flat and cultivated	Flat and partly cultivated
Subsoil conditions	Piling required under heavy loads	-	-
Location	West of Cemento De Caribe	West of [illegible] adjacent to the highway connecting Buenaventura	North of Puerto Berrio by the side of the river Magdalena
2. WATER			
Source	River Magdalena	River [illegible] Dulia	River Magdalena
Quantity	The river is perennial with sufficient dry weather flow	Up to [illegible]	Adequate availability
Tariff	Treated water from city supply costs Col. Pesos 1.40/cu m. Raw water Col. Pesos 0.77/cu m.	Raw water [illegible]	Not available
3. POWER			
Availability	320 MW of thermal generating capacity is available in Barranquilla, out of total installed capacity of 491 MW of CORELCA system in 1975. In 1976 the CORELCA system capacity will increase [illegible] and it will be connected with central and western regional systems over 500 kV [illegible]. CORELCA system will be [illegible] thermal up to 1980. By 1986 its total capacity is expected to [illegible] MW of which 1160 MW will be hydel capacity of [illegible] Sinu plant.	[illegible] a total installed capacity of 592 MW [illegible] only 50 MW [illegible] 110 MW, [illegible] located [illegible] 33 km [illegible] connected [illegible] only [illegible] hydel [illegible]	Power would be available from [illegible] system, located close to the border of ICEL Nordeste supply area. Distance about 100 km from 263 MW Guatape hydel station and 75 km from San Carlos hydel station in [illegible] and 100 km from 94 MW Barranca thermal station of ICEL. San Carlos hydel station is expected to be ready by 1981 with 620 MW capacity which will [illegible] to 1520 MW by 1986. [illegible] system is [illegible] hydel. San Carlos will be connected to CORELCA [illegible] over 500 kV grid by 1979. Barranca station of ICEL is connected to Guatape station of [illegible] 220 kV line which passes through Puerto Berrio
Source	Supply feeders may be taken [illegible] station where [illegible] kV and 115 kV voltages are available	Supply [illegible] 115 kV [illegible] kV and 115 kV are available	Supply feeders may be taken from either Guatape if [illegible] is to supply power or Barranca if ICEL supplies power. At both the places 220 kV is available. If San Carlos station is ready power may also be taken from there as the distance would be shorter and San Carlos would be a major exchange station on 500 kV interconnected system.
Existing Tariff	Demand charges: Col. Pesos [illegible] per kW Energy charges: Col. Pesos 0.49 per kWh (day) Col. Pesos 0.31 per kWh (night)	Demand charges: Col. Pesos [illegible]/kW Energy charges: Col. Pesos [illegible]	Flat rate of Col. Pesos 0.[illegible]/kWh; as given to Simesa semi-integrated plant where [illegible] supplies power. [illegible] rate to Simesa is low presumably because [illegible] system is 100% hydel. If ICEL Nordeste with [illegible] thermal capacity supplies power the rate would be [illegible]. Their present rate to [illegible] del Rio is Col. Pesos 0.3 kWh and to Metal Boyaca is Col. Pesos 0.[illegible] kWh.

Appendix 19-2 (continued)

Factors	Barranquilla	Buga - Tulua	Puerto Berrio
4. TRANSPORT LINES			
Road	Well connected to all major cities	Good road to all cities. New highway to Buenaventura.	Road connection from Barbosa exists but not metalled.
Railway trunk	No railway at present. Barranquilla is proposed to be connected with Fundacion station which lies on Bogota-Santamarta line	Connected to Cali and Medellin.	Connected to Bogota and Santamarta
Port	Draft about 9 m, carriers up to 30,000 DWT handled	Nearest port Buenaventura which has 9.6 m draft, and limited scope for expansion as the harbour is getting silted.	Connected to Barranquilla port by river Magdalena
River transport	The river Magdalena is navigable up to a length of about 900 km.	No	The river port at Puerto Berrio has a draft of about 1 m, maximum convoy capacity 1,500 tons in summer and 3,000 tons in winter. The average capacity is 750,000 tons. Not provided with facilities for bulk raw material handling.
5. HOUSING	Some housing is available in the city having a population of 700,000.	Housing will have to be provided.	Housing will have to be provided.
6. MANPOWER	There is an industrial training centre of SENA and also a free trade zone (Zona Franca) with many small and medium industries. Hence availability of skilled labour is good.	SENA centre at Buga. Availability of manpower is fair.	Skilled labour will have to come from outside as this is a small town with practically no industries.
7. CONSTRUCTION FACILITIES	Contractors available.	Contractors will be available from Cali about 150 km away.	Contractors will have to come from Medellin or Bogota.

Appendix 10-3

ANNUAL TRANSPORT COST OF RAW MATERIALS ASSEMBLY AND PRODUCT DISTRIBUTION OF NEW INTEGRATED PLANT FOR ALTERNATIVE LOCATIONS

	Annual quantity '000 tons	Source/ destination	Barranquilla		Buga-Tulua		Puerto-Berrio	
			Mode of transport	Annual freight mill US $	Mode of transport	Annual freight mill US $	Mode of transport	Annual freight mill US $
A. MAJOR RAW MATERIALS								
Iron ore ..	1 980	Imported[a]		0.36	Rail	11.68	Rail	17.73
Coal ..	1 350	Cundinamarca	Rail/River	18.78	Rail	12.67	Rail	8.58
Limestone ..	600	Local	Road	0.13	Road	0.64	Rail	0.91
Sub-total (A)		..		19.27		24.99		27.22
B. FLAT PRODUCT DISTRIBUTION								
H.R. and C.R. ..	173	Zone I	River/Rail	2.41	Road	2.88	Road	2.58
H.R., C.R. and tin plate ..	367	Zone II	River/Rail	4.92	Rail	2.87	Rail	1.59
H.R. and C.R. ..	226	Zone III	Rail	3.86	Rail	0.64	Rail	2.76
H.R. and C.R. ..	146	Zone V	Road	0.03	Rail	2.34	River	1.34
Sub-total (B)		..		11.22		8.73		8.27
Total transport cost (A+B)		..		30.49		33.72		35.49

a/ Barranquilla is the importing port for plant location at Barranquilla and Puerto-Berrio. Buenaventura is the importing port for Buga-Tulua location.

Appendix 10-4

ANNUAL TRANSPORT COST OF RAW MATERIALS ASSEMBLY OF COAL-BASED SPONGE IRON PLANT FOR ALTERNATIVE LOCATIONS

	Annual quantity '000 tons	Bogota/Boyaca		Cali		Barranquilla	
		Mode of transport	Annual freight mill US $	Mode of transport	Annual freight mill US $	Mode of transport	Annual freight mill US $
Pellets[a] ..	190	River/rail	2.65	Rail	0.77	-	0.06
Coal ..	127	Road	0.27	Road	0.27	Road	1.03
Total ..			2.92		1.04		1.09

a/ Pellets imported through Barranquilla for the plant locations at Bogota/Boyaca and Barranquilla; and through Buenaventura for Cali.

Appendix 10-5

ANNUAL DISTRIBUTION COST OF SPONGE IRON FOR COAL-BASED PLANTS AT ALTERNATIVE LOCATIONS
(thousand US $)

Consuming Zones		Bogota/Boyaca	Cali	Barranquilla
I	..	400	-	-
II	..	-	540	780
III	..	195	28	-
V	..	-	-	25
		595	568	805
	Say	600	570	800

Appendix 10-6

ANNUAL TRANSPORT COSTS FOR SPONGE IRON AND DISTRIBUTION OF PRODUCTS OF BAR AND ROD MILL COMPLEX FOR ALTERNATIVE LOCATION

	Annual quantity		Source/ destination	Bucaramanga		Cali		Barranquilla	
	Case II '000 tons	Case III '000 tons		Case II mill US $	Case III mill US $	Case II mill US $	Case III mill US $	Case II mill US $	Case III mill US $
A. Sponge iron ..	340	170	Barranquilla	4.33	2.16	5.81	2.90	0.07	0.04
B. Finished products	196	12	Zone I	2.42	0.15	2.10	0.13	2.77	0.17
			Zone II	0.17	0.15	0.30	0.27	0.26	0.24
			Zone III	1.04	1.04	0.01	0.01	0.96	0.96
			Zone IV	0.02	0.02	1.49	1.49	0.80	0.80
			Zone V	0.12	0.12	0.21	0.21	-	-
			Zone VI	0.53	0.32	0.28	0.17	0.81	0.50
			Sub-total	4.30	1.80	4.39	2.28	5.60	2.67
			Total	8.63	3.96	10.20	5.13	5.67	2.71

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FINAL REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

THE DEVELOPMENT OF IRON AND STEEL INDUSTRY IN COLOMBIA

VOLUME IV

STEEL DEVELOPMENT PLAN

580

MAY 1976

DASTUR ENGINEERING INTERNATIONAL GMBH
Consulting Engineers
DÜSSELDORF

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DÜSSELDORF

LIST OF VOLUMES

EXPLANATIONS

Three dots (.../N.A.) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A full stop (.) between numerals indicates decimal.

A space between numerals is used to distinguish thousands and millions (1 346 849).

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954. The fiscal year adopted is from 1st July through 30th June.

'To' between the years indicates the full period, e.g. 1960 to 1964 means inclusive of the years 1960 and 1964.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Conversion rate adopted is US $ 1.00 = Colombian peso (Col $) 30, unless otherwise stated.

ABBREVIATIONS

PDR	-	Acerias Paz del Rio S.A.
BOYACA	-	Metalurgica Boyaca S.A.
FUTEC	-	Fundiciones Tecnicas S.A.
SIDELPA	-	Siderurgica del Pacifico S.A.
SIDUNOR	-	Siderurgica del Norte
SIMESA	-	Siderurgica Medellin S.A.
SIMUNA	-	Siderurgica del Muna S.A.
COLAR	-	Colombiana de Arrabio Ltda.
NSP	-	National Steel Plan
SIP	-	Semi-integrated Plants

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11 - NATIONAL STEEL PLAN

On the basis of the production programme of SIP, the alternative possibilities of PDR expansion and creation of new capacities, two alternative plans for steel development in Colombia have been evolved. These are designated as:

National Steel Plant II (NSP-II)
National Steel Plan III (NSP-III)

The National Steel Plan I (NSP-I), which was formulated on the basis of PDR-I expansion, is not considered because the PDR-I scheme has been eliminated from further consideration as mentioned in Chapter 6.

National Steel Plan II (NSP-II)

NSP-II has been formulated on the following basis:

a) Expansion and production programme of SIP for 1976 to 1985 as discussed in Chapter 5;

b) Expansion of PDR to 725,000 tons per year crude steel capacity corresponding to PDR-II;

c) Production from new plants as per Case-II (Table 7-6).

National Steel Plan III (NSP-III)

NSP-III has been formulated on the following basis:

a) Expansion and production programme of SIP for 1976 to 1985 as discussed in Chapter 5;

b) Expansion of PDR to 952,000 tons per year crude steel capacity as per PDR-III;

c) Production from new facilities as per Case-III (Table 7-6).

11 - National Steel Plan (cont'd)

COMPARISON OF THE TWO PLANS

The two alternative plans, NSP-II and NSP-III, are compared in respect of the following criteria:

a) Degree of self-sufficiency;

b) Investments required and the new capacities to be created;

c) The total cost of steel to meet the national requirements;

d) Foreign exchange requirements;

e) Return on investments; and

f) Utilisation of domestic resources.

Degree of self-sufficiency

The degree of self-sufficiency is measured in terms of the proportion of the demand satisfied by the domestic steel production. The estimated production of steel for the two alternative plans is compared with the projected total demand in Table 11-1.

Table 11-1

SEFL-SUFFICIENCY IN STEEL PRODUCTION[a/]

Year	Total demand '000 tons	Production NSP-II '000 tons	NSP-III '000 tons	Self-sufficiency NSP-II %	NSP-III %
1974 ..	616[b/]	286	286	46	46
1976 ..	793	355	355	45	45
1977 ..	902	395	395	44	44
1978 ..	1 030	452	452	44	44
1979 ..	1 184	614	564	51	47
1980 ..	1 371	812	662	59	48
1981 ..	1 543	955	855	62	56
1982 ..	1 744	1 011	951	58	55
1983 ..	1 968	1 111	1 136	57	58
1984 ..	2 226	1 788	1 778	80	80
1985 ..	2 500	2 095	2 095	83	83
Total 1976 to 1985	15 261	9 588	9 243	63	60

a/ Includes ordinary and special steels as rolled
b/ Apparent consumption of steel

It would be observed that the demand in 1985 would be met to the extent of 83 per cent both by NSP-II and NSP-III. This would signify a substantial improvement in self-sufficiency over 1974, when the domestic production was only about 46 per cent of the apparent steel consumption. From Table 9-1, it would also be observed that the cumulative domestic production in NSP-II will be about 4 per cent higher than that in NSP-III during the decade 1976 to 1985. Further, the aggregate self-sufficiency during the same decade in the case of NSP-II would be about 63 per cent compared to about 60 per cent in the case of NSP-III.

Investments and new capacities

The order of magnitude of total investments required for augmenting the existing capacities of SIP and PDR as well as for the installation of new plants has been estimated in Table 11-2. The estimate excludes preliminary and promotional expenses, interest during construction, working capital, costs of land and site preparation and infrastructure facilities.

Table 11-2

PRELIMINARY ESTIMATES OF INVESTMENT FOR EXPANSION OF STEEL CAPACITY[a/]
(million US $)

	NSP-II	NSP-III
PDR:		
a) Cold rolling facilities under Current Improvement Programme	120	120
b) Expansion of plant and mines[b/]	223	388
SIP Expansion[c/]	66	66
Direct reduction plant[d/]	130	70
Bar and rod mill complex and light profile mill facilities[e/]	112	88
New integrated steel plant[f/]	1 065	1 065
Total	1 716	1 797

a/ Excludes preliminary and promotional expenses, interest during construction, working capital, costs of land and site preparation, and of infrastructure facilities.

b/ Refer Appendix 6-4

c/ Refer Table 5-10

d/ Refer Table 8-7

e/ Refer Appendix 11-1

f/ Refer Appendix 9-1

With the above investments, the installed capacities for ironmaking, ingot steel production and rolling would be raised as shown in Table 11-3.

11 - National Steel Plan (cont'd)

Table 11-3

IRON AND STEELMAKING CAPACITIES - EXISTING AND 1985
(thousand tons)

	Existing capacity	Installed capacity in 1985	
		NSP-II	NSP-III
IRONMAKING[a]			
Blast furnace[a] ..	280	1 940	2 170
Sponge iron ..	-	815	335
Total ..	280	2 755	2 505
INGOT STEEL			
Thomas process ..	260	-	-
Oxygen process ..	-	1 992	2 219
Electric furnaces	268	1 080	840
Total ..	528	3 072	3 059
ROLLING MILLS			
Non-flat ..	480	1 286	1 286
Hot rolled flat ..	400	1 438	1 438
Cold rolled flat	-	972	972
Total (non-flat and hot rolled flat)	880	2 724	2 724

a/ Excludes COLAR

The annual phasing of the new investments between 1976 and 1985 for both alternatives is presented in Appendix 11-2 and summarised in Table 11-4. The time tables for commissioning the new facilities for NSP-II and NSP-III are shown in Fig. 11-1.

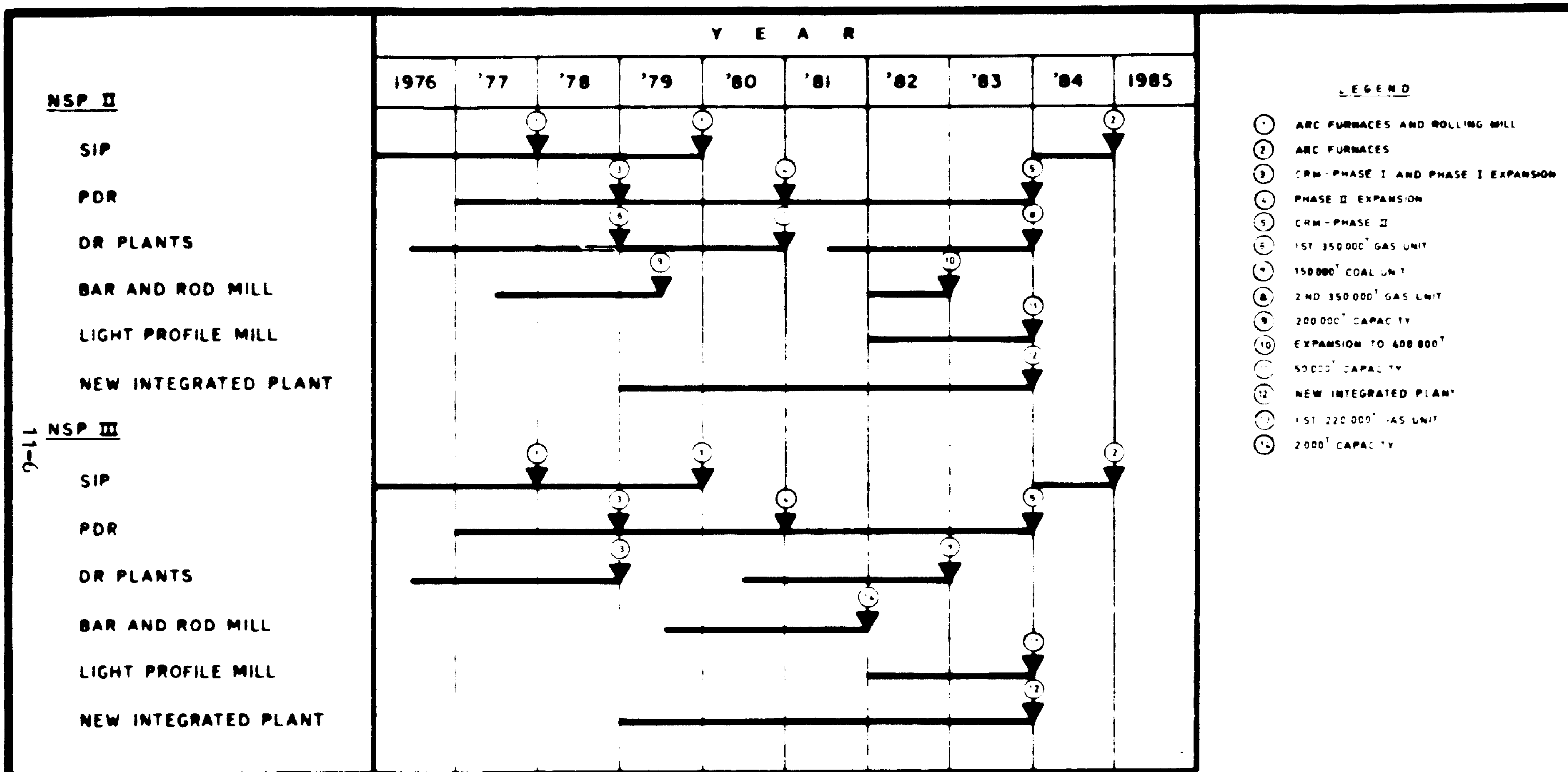

FIGURE II-1. TIME TABLE OF COMMISSIONING NEW FACILITIES

Table 11-4

ANNUAL PHASING OF INVESTMENTS FOR NEW FACILITIES
(million US $)

Year		NSP-II	NSP-III
1976	..	15	14
1977	..	118	117
1978	..	170	185
1979	..	292	304
1980	..	395	420
1981	..	294	322
1982	..	233	251
1983	..	196	167
1984	..	2	16
1985	..	1	1
	Total	1 716	1 797

From the foregoing it would be seen that the investments under NSP-II would be about US $ 81 million less than for NSP-III. The average investments per additional annual ton of crude steel capacity for NSP-II would be US $ 675 and for NSP-III US $ 710.

Total cost of steel

The total cost of steel is computed by adding the total cost of domestic production and the cost of imported steel.

The cost of domestic steel production comprises the manufacturing costs, administrative and sales expenses, and depreciation and interest charges. The estimates of cost of production have been worked out as follows:

11 - National Steel Plan (cont'd)

i) The manufacturing cost of SIP has been estimated taking into account the scrap and sponge iron inputs on a national average basis, and the other cost of operation as given in page 5-26.

ii) The manufacturing expenses of PDR have been estimated on the basis of an average cost of US $ 138 per ton for NSP-II and US $ 135 per ton for NSP-III with the adoption of bottom-blown oxygen process from 1979 onwards, and at US $ 145 per ton for the earlier years for both the alternatives. (refer Table 6-5).

iii) The manufacturing costs for the bar and rod mill complex and the light profile mill complex have been estimated on the same basis as SIP.

iv) The manufacturing expenses for the new integrated steel plant are based on an average of US $ 175 per ton (refer Appendix 9-2).

v) The administrative and sales expenses have been provided at an average of 10 per cent of the total direct manufacturing costs.

vi) The annual depreciation and interest charges for the existing facilities have been considered to be the same as provided by the individual companies in 1974.

vii) The depreciation and interest charges for the new facilities have been provided at 15 per cent per annum of the total investment in plant facilities indicated in Table 11-1 and the time table of commissioning indicated in Fig. 11-1.

The manufacturing costs of domestic steel production and the annual depreciation and interest charges have been computed in Appendices 11-3 and 11-4. The total cost of domestic steel production is summarised in Table 11-5.

11 - National Steel Plan (cont'd)

Table 11-5

TOTAL COST OF DOMESTIC STEEL PRODUCTION - NSP-II AND NSP-III
(million US $)

Year	NSP-II Manufacturing expenses a/	NSP-II Administration and sales expenses b/	NSP-II Depreciation and interest charges c/	NSP-II Total	NSP-III Manufacturing expenses a/	NSP-III Administration and sales expenses b/	NSP-III Depreciation and interest charges c/	NSP-III Total
1976	74	7	8	89	74	7	8	89
1977	84	8	11	103	84	8	11	103
1978	99	10	14	123	99	10	14	123
1979	132	13	47	192	119	12	35	166
1980	180	18	50	248	144	14	38	196
1981	199	20	83	302	160	16	91	267
1982	204	20	83	307	173	17	91	281
1983	226	23	95	344	212	21	115	348
1984	349	35	265	649	327	33	277	637
1985	408	41	266	715	391	39	278	708
Total	1 955	195	922	3 072	1 783	177	958	2 918

a/ Refer Appendix 11-3.
b/ At 10% of manufacturing cost.
c/ Refer Appendix 11-4.

From Table 11-5, it would be noted that the cumulative cost of domestic steel manufactured from 1976 to 1985 would be US $ 3,072 million for NSP-II and US $ 2,918 million for NSP-III. Considering the cumulative domestic rolled steel production during the same period (Table 11-1), the average cost per ton of steel works out to US $ 320 for NSP-II and US $ 316 for NSP-III.

Cost of imported steel: The quantity of steel to be imported in each year between 1976 and 1985 has been calculated on the basis of the projected demand and the projected production programmes of NSP-II and NSP-III. To arrive at the annual cost of imported steel, these quantities have been multiplied by the estimated average cost per ton of steel. Considering that Colombia's imports would mainly cover items such as heavy plates, other flat products (coated and uncoated), medium and heavy profiles, tubes, high alloy and special steels, the price of the cold rolled sheet/coil has been assumed to reflect the average price of steel to be imported, as this would constitute the major portion of the imports up to 1982/83.

The current export prices are significantly lower than the home prices of the exporting countries, and the export prices are continuously falling since mid 1974.

11 - National Steel Plan (cont'd)

Further, compared to other steel products, the peak price in the case of the cold rolled coils in 1974 was lower. In addition, the price of cold rolled coils in 1975 second quarter was about the same as in 1973 second quarter. While the 1974 prices were inordinately high, the present export prices may be considered unduly low, specially taking into account the general escalation in costs from 1973 to 1975.

In view of this, the arithmetical average of the last two years has been taken as a rough indication of a reasonable average price under the present conditions. The average continantal price of cold rolled coils for the 8 quarters ending April 1975 is about US $ 270 per ton and that for the 7 quarters ending April 1975 is US $ 275 per ton.

It may be mentioned that the average per ton c.i.f. prices of imported steel in Colombia (excluding handling charges and customs duty) were US $ 190 in 1972, US $ 223 in 1973 and US $ 438 in 1974. The arithmetic average of the c.i.f. prices for the three-year period 1972 to 1974 works out to US $ 284 per ton, and for the two year period 1973 and 1974, to US $ 331 per ton. However, the weighted average c.i.f. price for the three-year period (1972 to 1974) would be US $ 294 per ton and that for the last two years (1973 and 1974), US $ 346 per ton. Assuming an average per ton f.o.b price of US $ 275, the average c.i.f price would be about

11 - National Steel Plan (cont'd)

US $ 305 per ton. As the cost estimates in this study are being prepared on the basis of prices prevailing in the second half of 1975, it would be reasonable to adopt an average f.o.b price of US $ 275 per ton.

On this basis, the per ton cost of steel as landed in Colombia, including handling charges and customs duty, has been computed as follows:

	US $/ton
Average f.o.b price ..	275
Ocean freight and insurance	30
Handling charges ..	8
Customs duty at 20% on c.i.f	61
Average landed price	374

The annual costs of imported steel for NSP-II and NSP-III are given in Table 11-6.

Table 11-6

COSTS OF IMPORTED STEEL a/
(million US $)

Year		NSP-II	NSP-III
1976	..	164	164
1977	..	190	190
1978	..	216	216
1979	..	213	232
1980	..	209	265
1981	..	220	257
1982	..	274	297
1983	..	320	311
1984	..	164	168
1985	..	154	154
	Total	2 124	2 254

a/ Refer Appendix 11-5

11 - National Steel Plan (cont'd)

The total costs of steel comprising the cost of domestic production and the cost of imported steel from 1976 to 1985 are given in Table 11-7.

Table 11-7

TOTAL COSTS OF STEEL
(million US $)

Year		NSP-II	NSP-III
1976	..	253	253
1977	..	293	293
1978	..	339	339
1979	..	405	398
1980	..	457	461
1981	..	522	524
1982	..	581	578
1983	..	664	659
1984	..	813	805
1985	..	869	862
	Total	5 196	5 172

From Table 11-7 it would be noted that the total cost of steel during the 10-year period, 1976 to 1985, for both NSP-II and NSP-III are practically the same.

Foreign exchange requirements

In addition to importing steel, foreign exchange expenditure would also have to be incurred on imports of iron ores, pellets, ferroalloys, basic refractories, graphite electrodes etc. Further, for PDR, slabs would have to be imported for some years. The annual

11 - National Steel Plan (cont'd)

foreign exchange requirements of NSP-II and NSP-III are estimated in Appendix 11-6 and summarised in Table 11-8.

Table 11-8

ANNUAL FOREIGN EXCHANGE REQUIREMENTS FOR IMPORTS OF STEEL, RAW MATERIALS AND SUPPLIES[a]
(million US $)

Year		NSP-II	NSP-III
1976	..	154	154
1977	..	178	178
1978	..	205	205
1979	..	216	225
1980	..	237	263
1981	..	234	238
1982	..	275	270
1983	..	322	297
1984	..	230	211
1985	..	238	224
	Total	2 289	2 265

a/ Refer Appendix 11-6

Present value analysis

A present value analysis of the return on investments for NSP-II and NSP-III has been prepared considering 1975 as the zero point and a discount rate of 11 per cent per annum. For this purpose, the present values of annual investments for the new facilities have been taken as given in Table 11-4 for 1976 to 1985. The present value of the investment in 1975 refers to the cost of the facilities already installed. The cost of the installed facilities has been computed from the annual reports for 1974 of the individual steel companies and additional information supplied by the plants regarding the total cost of plant and equipment (depreciable assets) at current prices in Colombian peso. The total cost of plant and equipment thus arrived at has been converted to US $ assuming an exchange rate of US $ 1 = Colombian peso 30. In addition, the estimated co t of the coke oven battery No. 2 being installed at PDR has been added.

The present values of annual inflows have been calculated on the basis of the production programmes of SIP, PDR, and the new facilities, and the 1975 domestic selling prices of steel. The production for 1975 has been taken as an average between the actual production of 1974 and the projected production for 1976 for SIP and PDR. The earnings from the new bar and rod mill complex and the light profile mill complex have been calculated on the basis of the selling prices of SIP. The selling prices of SIP vary from plant to plant and, therefore, an arthmetical average of the sales prices has been assumed.

The present value analysis is presented in Appendix 11-7 and summarised in Table 11-9 on the next page.

Table 11-9

PRESENT VALUES OF OUTFLOW AND INFLOW - NSP-II AND NSP-III
(million US $)

	NSP-II	NSP-III
Total outflow at current prices[a]	1 803	1 884
Total inflow at current prices[a]	1 604	1 586
Present values of total outflow at 11% discount rate	1 104	1 153
Present values of total inflow at 11% discount rate	802	794
Ratios of inflow to outflow:		
At current prices	0.89	0.84
At discounted values	0.73	0.69

a/ Refer Appendix 11-7

The present value analysis indicates that the ratios of inflows and outflows at 11 per cent rate of discount is 0.73 for NSP-II and 0.69 for NSP-III.

From this analysis, it is observed that for the period of analysis (up to 1985), the total outflows would exceed the inflows. This is because the new integrated steel plant which accounts for the largest increase in the new capacity would be commissioned only in 1984 and would not be operating at rated capacity level till 1985. An exercise has, therefore, been prepared for an extended period of operation for the same facilities beyond 1985 to determine the year in which the present values of outflows and inflows at

11 per cent discount rate will become equal. The exercise indicates that in the case of NSP-II, this would occur in 1987 and in the case of NSP-III, in 1988. This shows that the ratio of the discounted present value of outflows and inflows at 11 per cent would be unity within a period of 4 to 5 years from the start-up of the new integrated plant.

Utilisation of domestic resources

A comparison of the utilisation of major domestic resources and imported raw materials in the two alternative plans is given in Table 11-10. The major raw materials and energy requirements have been calculated assuming production at full rated capacity from the existing as well as new steel plants.

Table 11-10

UTILISATION OF DOMESTIC RESOURCES IN NSP-II AND NSP-III

	NSP-II		NSP-III	
	Domestic	Imported	Domestic	Imported
Iron ore, mill tons ..	1.5	2.0	2.0	2.0
Pellets, mill tons ..	-	1.2	-	0.5
Coking coal blend, mill tons ..	2.2	-	2.5	-
Non-coking coal, mill tons ..	0.1	-	0.1	-
Natural gas, mill cu m	400	-	160	-
Additional power demand, MWh ..	409	-	367	-

11 - National Steel Plan (cont'd)

From the local raw materials utilisation viewpoint, it would be noted that an additional quantity of about 200,000 tons of finished steel is produced utilising local iron ore in the case of NSP-III compared to NSP-II. The same additional quantity of steel is also being produced utilising local coking coal blend in NSP-III. Further, from Table 11-10, it would also be noted that NSP-II will have a higher dependence on electrical power and natural gas than NSP-III. The steel development through NSP-III would offer scope of greater utilisation of domestic raw materials and greater dependence on coal with which Colombia is better endowed than natural gas.

GUIDELINES FOR SELECTION OF PLAN

From the foregoing comparison of the two plans, it would be observed that NSP-II would involve a lower investment of about US $ 80 million compared to NSP-III. However, of this amount, the investment on additional development of mining capacity required in PDR-III itself accounts for about US $ 50 million. As such, the difference in the two investments for the plant and equipment required for production of iron and steel would be only of the order of US $ 30 million or less than 2 per cent of the total investment required for the new facilities in NSP-II, which is insignificant. Further, there would be only a marginal difference between the maximum investment to be made in any one particular year (1980 in both cases) though it is lower by about 6 per cent in the case of NSP-II.

11 - National Steel Plan (cont'd)

The steel making capacities to be installed by 1985 in both cases are about the same. From the commercial view-point, such as rate of return on investment, the average cost of domestic steel and requirement of foreign exchange, both the plans are similar. Therefore, it is difficult to choose between the two on commercial grounds.

NSP-III would, however, have a decided advantage in the years beyond 1985, in terms of both greater use of local raw materials and lesser dependence on the more expensive types of energy, such as electric power and natural gas.

It may also be mentioned that the infrastructure development required in the case of NSP-III may be somewhat less than that for NSP-II, because the existing infrastructure facilities of PDR would be better utilised by expanding the plant to about a million-ton capacity.

It, however, needs to be emphasised that the major reasons of NSP-III becoming equally attractive economically as NSP-II are the following:

1) In PDR-III, the existing Thomas shop is envisaged to be expanded and converted to oxygen bottom-blown process to about 900,000 tons annual capacity, compared to the installation of a new melt shop and retiring of the existing Thomas shop in PDR-I.

2) In PDR-III, continuous casting for production of billets has been suggested and the 710 mm mill is proposed to be fully utilised, compared to the installation of a new billet mill and low utilisation of the 710 mm mill considered in PDR-I.

These aspects of PDR-III scheme would have to be further investigated and confirmed.

These factors may be kept in view by the Government, while finally selecting one of the plans for implementation within the framework of their national/subregional development policies and programmes.

Steel development strategy

To sum up, national steel plan would involve the following steps in its implementation:

Short-term strategy

The only way to augment the domestic steel production in the immediate future would be the optimum utilisation of the existing semi-integrated plants. This, however, would be dependent on the market conditions and also on the feasibility of augmenting scrap supply, may be through imports till such time as the first direct reduction plant goes on stream.

Mid-term strategy

The years 1979 to 1982 could be considered as the mid-term period. During this period, requisite sponge iron capacity would be in operation; the existing Thomas converters at PDR would have been converted to bottom-blowing oxygen process; the first cold rolling mill complex at PDR would have gone into production; SIP expansion completed; and the domestic steel production improved through better utilisation of the primary iron and steelmaking facilities as wll as by importing slabs to meet the steel requirements of PDR.

Long-term strategy

The long-term strategy of development would be the completion of the expansion in accordance with the selected scheme and the second phase of the cold rolling mill programme of PDR; installation of the new integrated iron and steel plant as well as the other new facilities; and implementing the balancing schemes of SIP expansion.

PIG IRON PRODUCTION

Colombiana de Arrabio Ltda

The pig iron requirements of Colombia are met from the small blast furnace plant, COLAR, located at Cajica, 50 km from Bogota near Zipaquira. This plant has a single blast furnace of 2.7 m hearth diameter and the rated capacity is 30,000 tons per year. Purchased sized raw materials are utilised. Since its inception in late 1972, considerable part of the production has been exported.

The bulk of the pig iron produced is characterised by high phosphorus content (0.5 to 0.7 per cent), due to the use of high phosphorus iron ore. Also, some quantities of 0.2 to. 0.3 per cent phosphorus pig iron are produced.

An enlargement of the existing furnace is under consideration. In addition, COLAR had an expansion scheme to augment its production to 60,000 tons per year by installing an additional blast furnace and beehive coke ovens by 1980.

It is understood that a pilot unit for reducing iron ore fines utilising the coke breeze available from screening of beehive coke, is under installation. The excess blast furnace gas (70% of the total make), which is being presently flared, will be utilised as fuel in the reduction unit. The pilot plant facilities have been completely designed and fabricated locally, and are scheduled to be commissioned by end of 1975.

Other plants

Other attempts made for the production of pig iron include a small blast furnace installed at Pacho mines. This unit is, however, not in operation at present.

Another small blast furnace of about 10 tons per day capacity at Siderurgica Valle de Tenza, designed and fabricated locally, has been under construction for the last two years and is yet to be completed.

Future prospects

The high phosphorus content of local iron ore is a major handicap in producing acceptable quality of foundry grade pig iron and therefore, the rate of consumption of pig iron in grey iron foundries is low. Till such time as adequate supplies of low phosphorus ores could be ensured from local sources, possibilities of utilising imported iron ore/pellets for the production of pig iron would merit consideration. COLAR is planning to make trials with imported pellets from Peru.

The domestic pig iron demand is estimated at about 40,000 tons by 1980 and 65,000 tons by 1985. This could be met either by installing an additional blast furnace as planned by COLAR, or by examining other alternatives such as installing electric smelting furnaces and charcoal blast furnaces.

Electric smelting

The electric smelting unit could use either beehive coke or small size coke from steel plants. The main consideration in selecting the plant location would be the cost and availability of electric power. For the production of low phosphorus pig iron, imported ore/pellets could be used. Investments for small capacity plants based on electric smelting are lower than those for blast furnace.

Charcoal blast furnace

The technology of charcoal blast furnace is well advanced in Latin America, and Brazil alone produces over three million tons of iron through this route. Considerable portion of this iron is also converted into steel. At present, however, the availability of charcoal in Colombia is limited and the production is oriented towards meeting the domestic needs, rather than industrial requirements. Therefore, the adoption of charcoal blast furnace technology may be deferred to a later date. The Amazon region has great potential for production of charcoal. However, for industrialisation of this area, considerable development of infrastructure facilities would be necessary. Ironmaking plants in this area may have to depend on imported ores.

FERRO-ALLOYS

Demand

Apart from a small production of ferro-silicon (about 1,500 tons/year) by Metallico, the entire requirement of ferro-alloys is met through imports. The demand for ferro-alloys would grow with the rise in domestic steel production. The estimates of demand for common ferro-alloys - ferro-manganese and ferro-silicon - for 1980 and 1985 are given in Appendix 11-8 and summarised in Table 11-11.

Table 11-11

DEMAND OF FERRO-SILICON AND FERRO-MANGANESE
(tons)

	NSP-II		NSP-III	
	1980	1985	1980	1985
Ferro-silicon (75% grade)	3 820	8 720	3 330	8 640
Ferro-manganese (standard grade) ..	10 455	26 170	8 285	25 890

The demands indicated in Table 11-11 include the requirements for iron and steel foundries also.

Domestic production

The ferro-silicon requirement in 1980 would be about 4 000 tons, rising to about 9,000 tons by 1985. The existing Metallico plant is proposed to be expanded to about 3,000 tons by 1976. Thus, the additional requirement by 1985 would be around 6,000 tons per year, which would justify the creation of additional capacity.

With regard to ferro-manganese, the requirement in 1980 would be of the order of 10,000 tons, rising to about 26,000 tons by 1985. By 1985, therefore, a plant of 25,000 tons capacity per annum could be considered, provided a suitable source of supply of manganese ore could be identified.

UTILISATION OF NICKEL ORES

Cerro Matoso deposit

Nickeliferrous ore occurs at Cerro Matoso deposit located on the eastern bank of the river Ure, a tributary of San Jorge in the department of Cordoba, about 20 km south of the village of Montelibano.

Nickeliferrous ores are associated with ultrabasic rocks overlain by a capping of lateritic iron ore, with thickness varying from 3 m to 10 m.

The reserves have been estimated at about 40 million tons and the nickel content in the ore is about 2.5 per cent. However, there are 15 to 25 million tons of ore with 2.6 per cent to 2.8 per cent nickel. The average range of chemical analysis of the ore is as follows:

Ni %	Co %	Fe %	MgO %	SiO_2 %	Al_2O_3 %
2.5 to 2.6	0.07 to 0.08	19.0 to 20.0	13.0 to 15.0	37.0 to 38.0	3.0 to 5.0

Plans for utilisation

The possibility of utilising the nickel ore for production of ferro-nickel is being considered by ECONIQUEL and the plant is expected to start operation by 1978/1979. The mining scheme envisages the production of 733,000 tons of ore annually by open cast method. The cost of development of the mines including transport facilities has been estimated at about US $ 70 million. It is understood that the ferro-nickel plant has been designed on the basis of an average feed analysing 2.72 per cent nickel, which is higher than the average grade of the deposit.

In this connection, it may be noted that to obtain this grade feed for the ferro-nickel plant, it will be necessary to adopt selective mining. This is not advisable, because it will not only shorten the life of the mine, but will also render the operations of the mine and the process plant considerably uneconomic and problematic at a later date. It is, therefore, suggested that a detailed study should be made before taking a final decision on the feed grade for the ferro-nickel plant.

Production of stainless steel

The ferro-nickel could be utilised for the production of stainless steel. As no other country in the Andean sub-region has known occurrences of such high grade nickel ores, Colombia would be in an advantageous position to produce stainless steel to cater to the entire Andean market. In addition, there may be scope for export to other Latin American countries as well as to countries in other regions.

The bulk of the stainless steel demand (about 90%) is generally for cold rolled sheets and the new stainless steel complex should be designed accordingly.

The total domestic demand for stainless steel in Colombia is about 18,000 tons in 1985 and of this, about 16,000 tons are expected to be as cold rolled sheets. In a study (August 1974) on the iron and steel sector for the Andean sub-region prepared by Junta del Cartagena, the total alloy and special steel demand for the sub-region has been projected at 670,000 tons in 1985. Assuming that stainless steel would constitute about 10 per cent of the total demand for alloy and special steels, the demand for stainless steel in 1985 would be about 65,000 tons in the sub-region. Of this, about 58,000 tons may be considered as cold rolled sheets. Therefore, the demand for cold rolled stainless steel sheets in other Andean countries would be about 42,000 tons in 1985.

The cold rolled stainless sheets are consumed in a wide range of widths and the maximum demand is generally in the 1,000 mm width. For rolling this size of coils/sheets, a 1,070 mm mill would be required. A single unit 1,070 mm Sendzimir mill is capable of producing between 25,000 tons to 30,000 tons of cold rolled coils per year.

It is, therefore, suggested that a stainless steel complex could be set up with an initial annual capacity of at least 25,000 tons of cold rolled sheets/coils with provision for expansion. The liquid steel requirement for initial production would be around 35,000 tons per year. To meet the steel requirement, necessary electric arc furnaces, vacuum degassing/decarburising unit and continuous casting facilities would be installed. For the production of this tonnage, however, installation of hot rolling facilities may not be economical. Therefore, it is suggested that the hot rolling of slabs to hot coils may be advantageously done either at the new integrated steel plant or at PDR and the hot coils transported back to the stainless steel complex for cold rolling and finishing. This plant could be suitably expanded after the operators gain necessary experience and hot rolling facilities are installed at a later date.

It is suggested that a feasibility study should be undertaken for selecting the plant location, determining the relevant technological parameters and estimating the costs and profitability.

NSP AND THE NATIONAL ECONOMY

During 1967 to 1974, the manufacturing sector in Colombia registered an annual growth rate of 9 to 10 per cent. Despite this accelerated growth, it is observed that the iron and steel sector has continued to stagnate, and the country has become increasingly dependent on imports. The efficient and internationally comparable metal-mechanic sector and consumer good industries which require significant steel inputs, have been consequently faced with shortages of raw materials and spares as well as uncertainty in supplies, and rises in the international prices. Further, the share of capital goods industries in the total value added in the manufacturing sector (between 7 and 10 per cent) is somewhat lower in Colombia than in a number of other countries at similar stages of development. Presumably, this may be due to the limited domestic market. The economies of scale required for the development of the capital goods sector could be achieved through the enlarge Andean market. However, the capital goods industry would also require assured supplies of steel at reasonable prices. With the implementation of the National Steel Plan (NSP), the availability of steel at predictable prices would be assured. This, together with the well-trained labour force, lower cost and a more developed industrial structure than in any other member country would place Colombia in a favourable position in the enlarged Andean market.

The implementation of NSP would involve an investment of the order of US $ 1,750 million during the coming decade. Though prima-facie, the magnitude of the investment required appears to be big, it forms only a small fraction of the GNP and GFCF. Further, the economic advantages to be gained through this investment would be considrable and this may be ascertained by a detailed social-cost benefit analysis. This is, however, beyond the scope of the present study.

In the following paragraphs, a preliminary examination of the role of steel industry has been discussed in view of the following major consideration:

i) The Colombian economy had been working with a persistent import constraint on growth. Correlation of steel consumption with national income, cement consumption and import of capital goods reveals that there is a potential unsatisfied steel demand in Colombia of about 50 to 60 per cent of the volume of steel imports, indicating thereby the bottleneck effect of steel scarcity on the economic growth.

ii) Steel imports are subject to special balance of payment uncertainties and the production of engineering items based on imported steel is particularly risky, because of uncertain world market and inflationary conditions.

Inter-sectoral dependence

The inducement mechanisms in the economy would be released by the expansion of steel capacity through inter-industrial dispersion. The sectoral growth potential would be maximum, if inter-industrial

11 - National Steel Plan (cont'd)

dispersions are high. Based on the latest available internally consistent input-output table[a], the backward and forward dispersion of different economic sectors have been evolved and are given in Table 11-12. The coefficients represent the effect of an increase of 1 million Colombian pesos in the final demand on the output of backward-linked industries and forward-linked industries. It is observed from Table 11-12 that the coefficient of backward dispersion is 2.126 which is the highest for the iron and steel industry. The relative dependence of the Colombian steel industry on scrap based steel production will decline in future and consequently, backward dispersion will further increase.

The forward dispersion effect of iron and steel industry is also very high, being of the order of 1.970. With the continued importance of the metal-mechanic sector as one of the major sectors of the Colombian economy and with the growth of the capital goods sector, will find increased use in these activities and consequently its forward dispersion is likely to increase.

In terms of combined dispersion effects, the iron and steel industry has a high coefficient of 4.096, which is second only to be transport sector. Thus,it provides very high stimuli to the growth of the country.

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a/ Input-output table for 1966 is the latest avilable, for at the time of field study, as the table for 1970 was reported to be internally inconsistent.

11 - National Steel Plan (cont'd)

Table 11-12

DISPERSION COEFFICIENT OF COLOMBIAN[a/] ECONOMIC SECTORS

Sector	Backward dispersion	Forward dispersion	Total dispersion
1. Coffee sector ..	1.025	1.307	2.332
2. Agriculture sector ..	1.198	2.073	3.271
3. Hunting/fishing ..	1.360	1.019	2.379
4. Forestry ..	1.141	1.302	2.443
5. Mining sector ..	1.135	2.196	3.331
6. Food sector ..	1.936	1.320	3.256
7. Beverages sector ..	1.564	1.066	2.630
8. Tobacco sector ..	1.360	1.003	2.363
9. Textile sector ..	1.841	2.017	3.858
10. Clothing sector ..	2.079	1.046	3.125
11. Wood except furniture ..	1.810	1.248	3.058
12. Wood furniture ..	1.710	1.075	2.785
13. Paper industry ..	1.924	1.811	3.735
14. Printing ..	1.622	1.264	2.886
15. Skin except footwear ..	1.753	1.152	2.905
16. Rubber products ..	1.357	1.290	2.647
17. Chemical products ..	1.481	1.852	3.333
18. Coal and oil ..	1.613	2.484	3.097
19. Mining non-metals ..	1.562	1.457	3.019
20. Basic metals incl. iron and steel ..	2.126	1.970	4.096
21. Metallic products excl. transport equipment	1.561	2.222	3.783
22. Electrical machinery ..	1.545	1.218	2.763
23. Machinery non-electrical	1.602	1.130	2.732
24. Transport materials ..	1.393	1.242	2.635
25. Other transport materials	1.431	1.174	2.605
26. Construction, housing, building etc ..	1.731	1.000	2.731
27. Transport ..	1.500	2.968	4.468
28. Communications ..	1.154	1.135	2.287
29. Electricity, gas, water	1.320	1.501	2.821

a/ The effect of a change in one million pesos of final demand on sectoral output.

Source: Input-Output Table, DNP, 1966.

11 - National Steel Plan (cont'd)

The analysis of the generation of direct and indirect demand, given in Table 11-13, shows that the total generation by iron and steel industry is the highest.

Table 11-13

GENERATION OF DIRECT AND INDIRECT DEMAND
(Million pesos)

Sector	Demand
Agriculture	1.16
Mining	1.28
Chemical products	1.44
Petroleum refineries ..	1.97
Cement	2.01
Iron and steel	2.37
Other basic metals ..	2.30
Metallic products excluding transport equip.	1.73
Non-electrical machinery ..	1.68
Wire and cable conductor ..	1.45
Electrical materials for installations	1.51
Heavy motor parts	1.52
Housing construction ..	2.17
Other construction ..	1.66
Communication	1.08
Electricity	1.61

Source: Aspectos Cuantitavos del Plan de Desarrollo. by Eduard Sarmiento Palacio. DNP.

Balance of payment consider tions

The balance of payments deficit on current account has risen from about US $ 2 million in 1972 to an estimated US $ 275 million in 1975. It is stated that one of the major causes of the setback to the growth of Colombian economy in the last decade is the shortage of foreign exchange. The balance of payments

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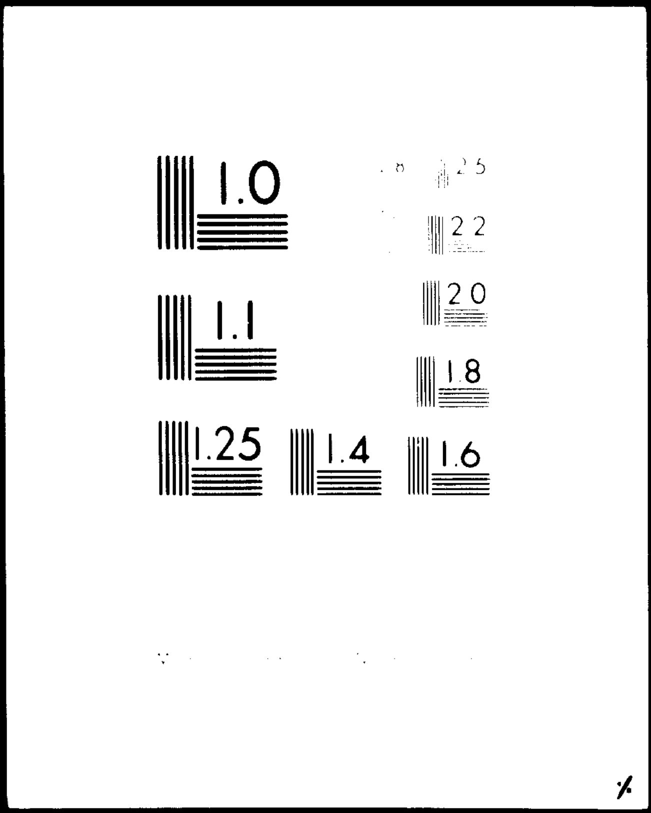

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11 - National Steel Plan (cont'd)

difficulties in Colombia are characterised by

i) The rising foreign debt servicing ratio[a/]. This ratio has increased from 11.4 per cent in 1970 to about 13 per cent in 1974, inspite of higher export earnings.

ii) The erosion in the value of peso in terms of US $, which has resulted in the adverse terms of trade for the country.

iii) Increase in the ratio of import of goods and services to Gross Domestic Product, which has risen from 14 per cent to 17 per cent in recent years.

iv) The current energy crisis and the changed position of Colombia from an exporter of crude oil to an importer, which would further worsen the foreign exchange position.

Impact of steel imports on foreign exchange situation

The imports of steel products have increased from US $ 77 million in 1970 to US $ 137 million in 1974. Thus, the proportion of steel imports in the total imports of goods in Colombia has gone up from 8.7 per cent in 1970 to 11.8 per cent in 1974 as shown in Table 11-14.

Table 11-14

SHARE OF IRON AND STEEL PRODUCTS IN IMPORTS

Year	Total currency outflow including freight '000 US $	Rolled steel products '000 US $	Share of iron and steel products in total imports %
1970	880	77	8.7
1971	985	80	8.1
1972	701	52	7.4
1973	811	53	6.5
1974	1 161	137	11.8

Source: Import statistics - DANE.

a/ The proportion of servicing charges on the external public debt to the volume of exports of goods and services.

<u>Effect on foreign exchange requirement</u>

In implementing the NSP, foreign exchange expenditure would be involved for the installation of new facilities. In addition, some raw materials and supplies would have to be imported to meet the requirements of domestic steel production. Further, the gap between the total demand and domestic production would have to be met through imports. However, if the NSP were not to be implemented and the steel industry were to stagnate at the 1974 level, the growing demand of steel would have to be met through additional imports, apart from the foreign exchange expenditure on the import of materials and supplies for the operation of the existing steel plants at the current production level.

The total foreign exchange requirements of NSP-II and NSP-III, and for the existing steel industry stagnating at the 1974 level, are compared in Table 11-15. From the comparison it would be noted that the total foreign exchange requirements at current prices for NSP-II and NSP-III would be about US $ 3,300 million compared to US $ 3,900 million required to keep the existing steel industry in operation. In terms of present value (at 11 per cent discount rate), the foreign exchange requirements for implementing the NSP would be about US $ 1,900 million compared to about US $ 2,000 million required for keeping the steel industry going at the present level.

11 - National Steel Plan (cont'd)

Table 11-15

NSP'S EFFECT ON FOREIGN EXCHANGE REQUIREMENT
(million US $)

Year	NSP-II		NSP-III		Stagnating steel industry [a/]	
	At current value [b/]	At 11% discount	At current value [b/]	At 11% discount	At current value [b/]	At 11% discount
1976	163	147	162	146	168	151
1977	249	202	248	201	201	163
1978	307	225	316	231	240	175
1979	391	258	407	268	287	189
1980	474	281	515	306	344	204
1981	410	219	431	231	396	212
1982	415	200	421	203	458	221
1983	440	191	397	172	526	228
1984	231	90	221	86	605	236
1985	239	84	225	79	688	242
Total	3 319	1 897	3 343	1 923	3 913	2 021

a/ Domestic production stagnationg at the 1974 level.
b/ Includes 60% of annual investment, Table 11-4.

This indicates that implementation of the NSP would be somewhat advantageous from the view point of foreign exchange requirement. However, this saving in foreign exchange requirement should not be considered in isolation from the other advantages accruing from the implementation of the steel programme, such as the additional value added of the domestic steel product, additional direct and indirect employment created, the possibility of obtaining assured supplies of steel for the consuming industries at stabilised prices, the skill formation etc.

12 - RAW MATERIALS AND INFRASTRUCTURE

For the successful implementation of the National Steel Plan, adequate availability of major raw materials and timely development of infrastructure facilities would have to be ensured.

RAW MATERIALS

The requirements of major raw materials in 1985 for NSP-II and NSP-III are given in Table 12-1.

Table 12-1

REQUIREMENTS OF MAJOR RAW MATERIALS (1985)
(thousand tons)

	NSP-II			NSP-III		
	PDR	New Plants[a]	Total	PDR	New Plants[a]	Total
Local iron ore:						
Lump ..	390	-	390	390	-	390
Fines ..	1 080	-	1 080	1 587	-	1 587
Imported iron ore:						
Lump ..	24	294	318	32	294	326
Fines ..	-	1 092	1 092	-	1 092	1 092
Pellet ..	-	1 170	1 170	-	498	498
Coking coal blend	835	945	1 780	1 125	945	2 070
Non-coking coal ..	-	127	127	-	127	127
Limestone ..	732	445	1 177	980	445	1 425

a/ Includes new integrated steel plant and sponge iron plants.

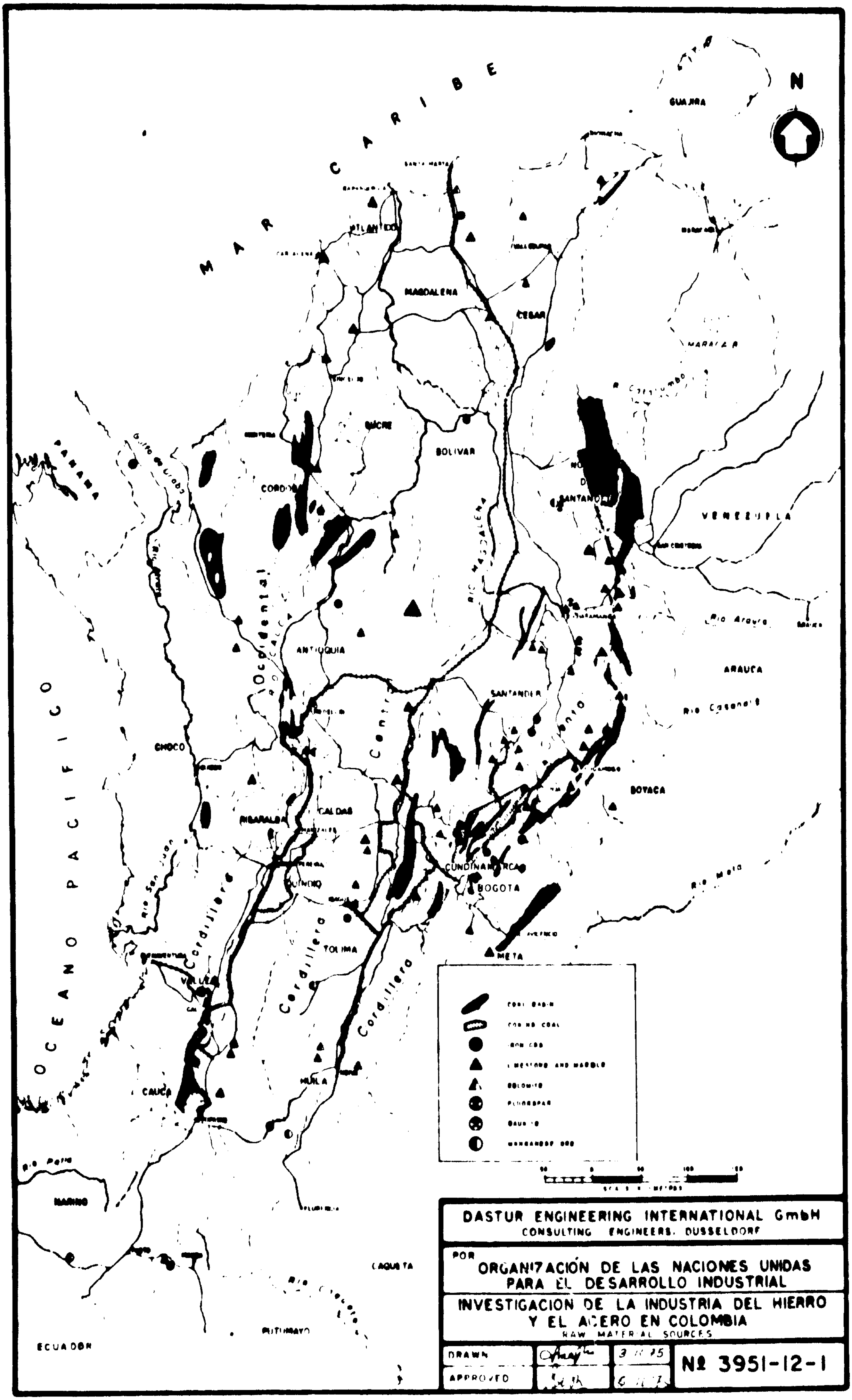
12 - Raw Materials and Infrastructure (cont'd)

The raw materials requirements of PDR will be met from its captive mines and the raw materials situation has been discussed in Chapter 6. For meeting the requirements of the new integrated steel plant and sponge iron plants, the availability of local raw materials has been discussed, and the import requirements indicated. The occurrences in Colombia of various raw materials for iron and steelmaking are shown in Drawing 3951-12-1.

Iron ore

Iron ore deposits occur in various parts of Colombia and are particularly concentrated in the eastern part of the country. The major iron ore deposits belong to PDR and the other important deposits are at Ubala, Sabanalarga and Cerro Matoso. The Cerro Matoso deposit is characterised by a capping of lateritic iron ore underlain by nickeliferrous deposits, which are proposed to be exploited for nickel extraction. The available information regarding the reserves, grade and the present status of exploitation of the iron ore deposits other than those of PDR are given in Table 12-2.

The total reserves of iron ore (excluding PDR deposits) of all categories are only about 206 million tons, of which 175 million tons are in the category of potential reserves. Of this, less than 0.5 million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MAR CARIBE
OCEANO PACIFICO
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MAGDALENA
CESAR
SUCRE
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SANTANDER
VENEZUELA
ARAUCA
BOYACA
CHOCO
CALDAS
RISARALDA
QUINDIO
CUNDINAMARCA
BOGOTA
META
TOLIMA
VALLE
CAUCA
HUILA
NARIÑO
CAQUETA
PUTUMAYO
ECUADOR
Cordillera Occidental
Cordillera Central
Cordillera Oriental
Rio Magdalena
Rio Arauca
Rio Casanare
Rio Meta
Rio San Juan
Rio Patia
Golfo de Uraba
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DUSSELDORF
POR
ORGANIZACIÓN DE LAS NACIONES UNIDAS
PARA EL DESARROLLO INDUSTRIAL
INVESTIGACION DE LA INDUSTRIA DEL HIERRO
Y EL ACERO EN COLOMBIA
RAW MATERIAL SOURCES
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Table 12-2

IRON ORE DEPOSITS IN COLOMBIA - CHEMICAL ANALYSIS, RESERVES AND STATUS OF EXPLOITATION[a/]

Name of the deposit	Chemical analysis (per cent)			Reserves (million tons)				Mining	
	Fe	SiO_2	P	Measured	Indicated	Inferred	Potential	Type	Output
Pacho ..	50	6	0.5	0.03	-	-	-	-	-
Ubala ..	48-58	3.6-10.5 (Insol.)	0.12 max	-	-	27.5	50	Open-cast[b/] and under-ground	500 tons per day
Savanalarga ..	22-32	25	0.83	-	-	-	125	-	-
Sopo ..	32-58	10 (Max. 40)	0.24 (Max. 1.3)	-	0.26	1.0	-	-	-
Pericos ..	Min.37 Avg.48	6-31 (Avg.15.5)	-	-	0.7	-	-	Open-cast[b/]	1 000 tons to 1 400 tons/month
Volador Hill	54	8.5	-	-	-	0.05	-	-	-
La Caldera ..	40-55	-	-	-	-	0.05	-	-	-
Paradera ..	43-49	19 (Max. 29)	0.3 max	-	0.85	-	-	-	-
Tibirita ..	47	12	-	0.27	-	-	-	-	-
Ocana ..	14-44	-	-	-	-	-	-	-	-
El Imas ..	57-67	3-12	0.5-1.9	-	-	0.05	-	-	-
Rio Luisa ..	25-35	25-35	0.3-0.6	-	-	-	-	-	-
Total ..			..	0.30	1.81	28.65	175		

a/ Excludes the concessions and mines of Acerias Paz del Rio S.A.
b/ Supplies to COLAR pig iron plant.

tons have been proved. Further, most of the ores are characterised by oolitic texture as well as low iron, high silica and phosphorous contents. These ores are also not easily amenable to beneficiation.

In view of the limited availability of local iron ores and their poor quality, it is imperative that requirements for the proposed integrated steel complex and sponge iron plants will have to be met by imports, till such time as suitable domestic sources are identified.

<u>Possible sources of imported iron ore</u>

The iron ore production in Latin America in 1974 was about 125 million tons and after meeting the local requirements, over 100 million tons, corresponding to about one-third of the world trade in iron ore, were exported. According to the available information, the production in 1980 is expected to reach about 230 million tons, which will enable about 160 million tons to be exported. Therefore, the iron ore requirements of Colombia could be met from Latin American sources, though there may be scope for procuring the supplies from other countries like Canada.

12 - Raw Materials and Infrastructure (cont'd)

The prospective Latin American sources for iron ore import would be the other Andean countries and Brazil. The available information with regard to iron ore production and export of these countries in 1974 and 1980 are given in Table 12-3.

Table 12-3

PRODUCTION AND EXPORT OF IRON ORE FROM OTHER ANDEAN COUNTRIES AND BRAZIL DURING 1974 AND 1980
(thousand tons)

	Production		Export	
	1974	1980	1974	1980
Chile ..	10 600	15 000	9 200	13 000
Peru ..	9 200	10 500	9 600	10 000
Venezuela ..	26 200	35 000	23 500	20 000
Brazil ..	73 000	140 000	59 400	115 000
Total ..	119 000	200 500	101 700	158 000

Source: ILAFA

The iron ore requirements for the new integrated steel plant are proposed to be imported in the form of sized ore and fines. The fines would be converted to fluxed sinter which will also enable utilisation of some of the plant by-products and wastes, such as flue dust, converter dust, coke breeze and mill scale.

Pellets are proposed to be used for the production of sponge iron. The prospective sources of pellets include Peru, Brazil and Canada. Chile and Venezuela are also potential sources of pellet supply beyond 1980.

12 - Raw Materials and Infrastructure (cont'd)

The available information with regard to the grades and f.o.b. prices of different types of ore from selected Latin American sources are given in Table 12-4 on the next page.

Pellets from Peru and Brazil are being utilised in a number of sponge iron plants. Pellets to be produced at Venezuela are proposed to be utilised for sponge iron production and have already been tested and found suitable.

In Table 12-4, the prices of ores and pellets have been indicated for different sources on f.o.b. basis except for Marcona (Peru) pellets which is on c.i.f. Buenaventura basis. To arrive at the c and f costs, the ocean freight would have to be added to the f.o.b. price. There are no existing ocean freight rates for iron ore transport between Brazil/Venezuela/Chile and Colombia and, therefore, only some preliminary estimates are indicated based on available information.

The ocean freight between Brazil and an Atlantic port of Colombia may range between US $ 8 to US $ 15 per ton, depending on the size of the bulk carrier. The freight between Porto Ordaz (Venezuela) and an Atlantic port in Colombia may range between US $ 8 and

Table 12-4

QUALITY AND PRICES OF IRON ORES AND PELLETS FROM SELECTED SOURCES

Country		Type of ore	Fe %	SiO_2 %	Al_2O_3 %	P %	Indicative f.o.b. price US $ per ton
Brazil	..	Lump	64 to 68	3 (SiO_2+Al_2O_3)		0.05	20
		Sinter feed	64 to 66	5.5 (SiO_2+Al_2O_3)		0.07	16
		Pellet	64 to 67	2 to 3.5	0.7 to 1	0.03 to 0.04	30 to 34
Chile	..	Lump/fines	62	6	2	0.2	14
Peru	..	Sinter feed	63 to 65	6 (SiO_2+Al_2O_3)		0.05	N.A.
		Pellet	65 to 67	2	1	0.07	30 to 35a/
Venezuela	..	Lump and Sinter feed	58 to 60	2 to 3	1	0.1	13 to 16b/

a/ CIF Buenaventura.
b/ Prices vary depending on type and grade.

US $ 10 per ton for 30,000 dwt bulk carrier, based on an indication that the freight rate between Porto Ordaz and Maracaibo would be about US $ 5 to US $ 6 per ton.

With the rapid growth of direct reduction capacity in the world, there is an increasing demand of high grade pellets. It is, therefore, suggested that advance action should be taken on negotiating the purchase of pellets, and preliminary decisions on port of import and the size of bulk carriers.

Coal

Colombia is endowed with vast reserves of coal. However, detailed prospecting work has not been carried out so far, except in a few areas, which has led to widely varying estimates of the reserves by different agencies. The information furnished by the Ministry of Mines and Petroleum regarding the reserves of coal is given in Table 12-5.

Table 12-5

COAL RESERVES IN COLOMBIA
(million tons)

		Coal reserves		
		Proved	Probable	Possible
Cundinamarca Boyaca	..	43	432	1 111
Meta[a]	..	-	-	-
Santander	..	-	34	28
Norte de Santander	..	-	-	60
Ele Cesar	..	-	-	480
Guajira	..	350	-	-
Valle del Cauca Y Cauca	..	-	40	24
Caldas Y Risaralda	..	-	1	-
Antioquia	..	21	-	63
Cardoba[a]	..	-	-	-
Bolivar[a]	..	-	-	-
Total	..	414	507	1 766

Source: Based on information furnished by Ministry of Mines and Petroleum.

NOTE:

a/ Coal is known to occur but no estimates available.

Reserves of coking and non-coking coals are not available separately. Very often, coking coal occurs together with non-coking coal, sometimes at different points in the same deposit. Further investigation work will have to be conducted to establish the reserves of coal according to grade.

Coking coals are known to occur in Cundinamarca and Boyaca regions. In these regions, coal is already being exploited by PDR to meet its requirements. In addition, small scale mining is also in vogue and the coal produced is being used for the manufacture of beehive-coke utilised mainly by COLAR and the foundries.

The investigations conducted in Checua Lenguzaque coal field (Cundinamarca), about 40 km north of Bogota, have indicated that these coals are suitable for the manufacture of blast furnace coke. The other area where coking coal is available, is Norte de Santander where some mining and beehive coke-making is being practised.

As the bulk of the known reserves of coking coal is in the Cundinamarca region, it is envisaged that the coal requirements of the new integrated steel plant will be met from this area. At full production level, the new integrated steel plant would require about 1.35 million tons of coal per year which is about 40 per cent of the present total national coal production. Therefore, it would be necessary to identify specific sources, undertake development of the mines and determine the extent of washing required for the coals. For the purpose of this study, it is assumed that 50 per cent washed coal will be used in the blend to contain the coke ash to about 12 per cent. The possibilities of blending other coals, for example Cerrejon coal, may be investigated, as this may reduce the average cost of the blend and also help in lowering the ash content.

Non-coking coal will be required for the rotary kiln sponge iron plant and for this purpose, adequate tests will have to be undertaken to prove the suitability of the coal for use in the process. Non-coking coals of different types and quality, including anthracite and bituminous, are locally available and are being mined. A part of anthracite is also being exported. It is reasonably expected that coals suitable for the direct reduction process would be available. For the purpose of this study, it is assumed that suitable quality coal would be available in the neighbourhood of the proposed plant location, Cali. This will have to be, however, confirmed by tests.

The prices of coal widely vary in Colombia. For the purpose of this study, the cost of washed coking coal (ex-mines) has been taken at about US $ 18 per ton, on the basis of indications given by PDR. The pit head costs of unwashed coking/blendable and non-coking coals have been assumed at US $ 7 per ton.

Possibilities of exporting coal

Coal is the world's most abundant fossil fuel resource and with the end of the era of cheap oil fuel supplies, there has been an added stimulus to the demand for coal throughout the world. There are two main consumers of coal, namely thermal power stations and coke ovens, and Colombia has the potential to serve both of these.

With regard to steam coals, extensive deposits have been located at Cerrejon, not far from the Atlantic coast. At present, detailed exploration work is being carried out at these deposits, which is expected to be completed by May 1976 and this would be followed by the preparation of a mining project report. El Cerrejon Carboneras Ltda has been set up for mining and exporting the coal. The project envisages an ultimate production between 5 million to 8 million tons per year, depending on the financial resources available.

The Cerrejon coal by virtue of its low ash and sulphur contents is expected to find a good market in the thermal power plants specially of developed countries like USA, where the pollution laws are stringent. In this connection, it may be mentioned that the coal requirements for electric power generation in USA has been estimated at about 775 million tons by 1985, which is about double the current (1975) consumption. To meet this demand, a large number of new mines would have to be opened, and the US coal industry would need to grow at a rate of 9 per cent per year. With such a high growth rate, it is unlikely that the goal of national self-sufficiency would be attained by 1985. Therefore, unless new or alternative source of energy is developed, it is evident that USA will become increasingly dependent on foreign supplies to meet its energy needs. An expeditious development of the Cerrejon coal deposits might enable Colombia to take advantage of this big market for steam coal. In addition, this coal could also be utilised at the national thermal power plants on the Atlantic coast.

The Latin American region is significantly poor in reserves of coal suitable for cokemaking by conventional methods. Only Mexico and Colombia have coking coal deposits, while the rest of the countries largely depend on imported coal. Countries like Brazil and Chile are utilising some proportions of domestic coal in blend with imported coals while Venezuela has already taken up an intensive exploration work on local coals and the recent information indicates that some of these could be utilised in blend with imported coal for the production of coke.

The production of metallurgical and blendable coals in Latin American countries, except Colombia, was about 4 million tons in 1974 and is expected to increase to about 16 million tons by 1980. During the same period, the dependence on imported coking coal is estimated to rise from about 3 million tons to about 13 million tons. In addition, imports of coke in 1980 would be about 1 million ton. This emphasises the need for urgent measures to ensure adequate supplies of coking coal for Latin American countries, in the face of the current international energy crisis. Colombia has, therefore, a great international energy crisis. Colombia has, therefore, a great opportunity to set up an industry capable of producing and exporting coking coal on a scale commensurate with its immense coal potential.

Based on the available information, the possible requirements of imported coking coal and coke in some selected Latin American countries including the other Andean countries are estimated in Appendix 12-1 and summarised in Table 12-6.

Table 12-6

IMPORTED COKING COAL AND COKE REQUIREMENTS OF SELECTED LATIN AMERICAN COUNTRIES[a]
(million tons)

Country		Imported coking coal 1980	Imported coking coal 1985	Imported coke 1980
Argentina	..	2.64	4.88	-
Brazil	..	6.90	12.18	-
Chile	..	0.52	1.50	-
Mexico	..	2.25	2.84	0.82
Peru	..	0.84	1.41	-
Venezuela	..	-	5.00	0.30
Total	..	13.15	27.81	1.12

a/ Refer Appendix 12-1.

In planning the future development of an export-oriented coking coal industry in Colombia, the following factors would need consideration:

i) The countries which are planning installation of integrated steel plants with large blast furnaces would prefer to import coking coal to enable utilisation of the locally available blendable coals, as well as to recover and utilise the coke-oven by-products.

ii) Some countries such as Brazil have already gone ahead in making long-term arrangements for the import of coal from sources like USA and Poland. Negotiations with other countries are in progress.

iii) In order to minimise the dependence on imported coking coal, there will be more intensive efforts towards technological solutions such as use of pre-heated charge and formed coke which would enable utilisation of larger proportions of domestic coal.

iv) Imported coke would be utilised mainly in the electric smelting furnaces for the production of iron and ferro-alloys and in some cases in small blast furnaces or to supplement in periodic shortage in the domestic coke.

v) The planning of the coal industry should form an integral part of an overall national coal programme.

Exports of Colombian coal need not necessarily be limited to Latin American countries. A recent forecast suggests that the world coking coal requirements would increase by about 240 million tons (about 70% increase) between 1970 to 1990 - which corresponds to a growth rate of about 12 million tons per year. This will have a significant effect on the supply/demand balance in the future and the world trade in coal must necessarily increase substantially. The main competitors of Colombia in the international as well as the Latin American coking coal markets would be Australia, Canada, Poland and the USA. Other countries endeavouring to penetrate the Latin American Market include West Germany.

The development of export-oriented coking coal industry would require detailed geological prospecting work to be completed for identifying suitable sources, large-scale development of mines, development of necessary transport links and port facilities. These activities are capital intensive as well as time-consuming. The development of coal mines itself, under US conditions, require an investment of the order of US $ 50 per annual ton, excluding the expenses on transport links and infrastructure development. A coordinated plan of development of the coal industry would have to be drawn up to enable Colombia to meet its growing domestic needs and to enter the world market.

Limestone

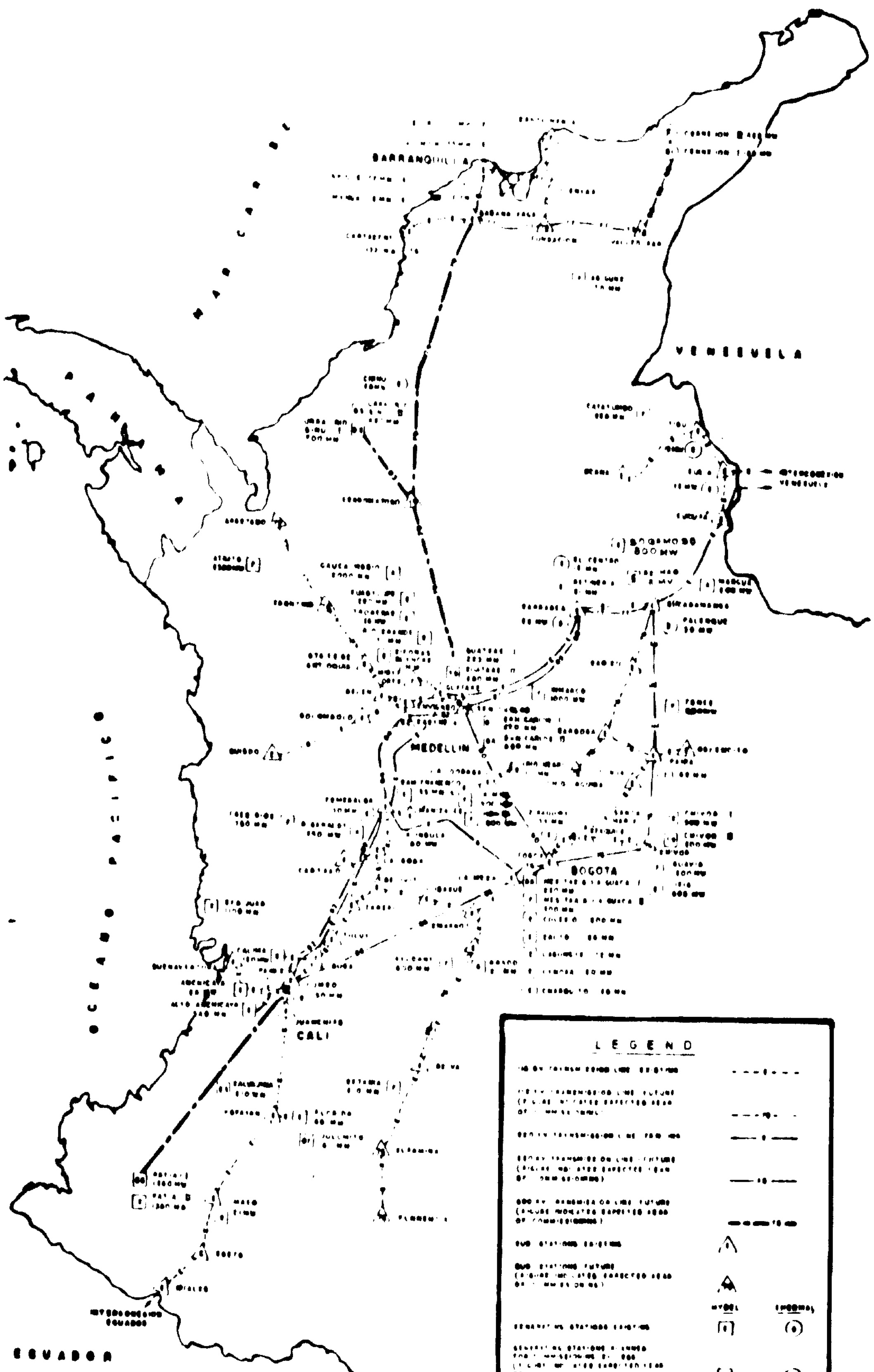
Limestone is widely scattered all over the country (Appendix 12-2) and the requirements of SIP are being currently met from their neighbouring areas. The same sources are expected to meet their future needs also.

The limestone requirement for the new integrated steel plant is proposed to be met from the deposits in that area. A limestone deposit with estimated reserves of about 10 million tons occurs in the vicinity of Barranquilla and is currently being exploited for production of Cement. An extensive deposit of high grade limestone analysing 54 per cent CaO and less than 2 per cent SiO_2 has been reported near Cartagena and the reserves are estimated at about 1,000 million tons. The thickness of the workable bed is about 10 m and a part of the Cartegena deposit can be exploited by open cast method. Necessary exploration work will have to be carried out to identify suitable areas from where the limestone requirements of the new steel plant could be met.

ELECTRIC POWER

Power development programme

The total present (1975) installed generating capacity is about 3,200 MW, which is planned to be increased to about 9,500 MW in 1986 and 31,600 MW by the end of this century. In keeping with this development, expansion of transmission and distribution networks has also been planned. Some of the future power generation and transmission projects are already under execution and others are in the process of investigation and study. A power grid map of Colombia showing the present and future major generating stations, substations and interconnections is given in Drawing 3951-12-2. The existing programmes of power generation and transmission systems are indicated in Appendix 12-3.



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ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA EL DESARROLLO INDUSTRIAL

INVESTIGACION DE LA INDUSTRIA DEL HIERRO Y EL ACERO EN COLOMBIA
ELECTRIC POWER GRID MAP OF COLOMBIA

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Power requirement for steel development

The estimated additional power requirements for the steel development programme would be of the order of 200 MW in 1980 and this will rise to about 400 MW in 1985 (Appendix 12-4). For assessing the adequacy of the power development programme to meet this need, a review of the effective power potential of Colombia has been made in Appendix 12-5. The review indicates that there may be a shortfall in the overall power availability in the country, even if the power demand on account of NSP were not to be treated as additional, but already included in the demand projections which take into account the overall industrial growth.

Priorities needed

With a view to avoid any possible shortfalls in power supply by 1980, the suitability of advancing the following projects scheduled to be commissioned in early 80's should be studied by ISA. The first stage of the San Carlos hydel station with a capacity of 620 MW, the Julumito hydel station with 51 MW capacity and the thermal power station at Cerrejon with 125 MW capacity are expected to be commissioned in 1981. The 520 MW Mesitas and La Guaca hydel complex is expected to be partly ready by 1982.

For avoiding the anticipated shortfalls in the subsequent years up to 1986, it may be necessary to bring forward by about two years the 1,340 MW Patia hydel project, which is now scheduled to be progressively commissioned between 1983 and 1986. On the thermal side, the completion of Cerrejon station to the full development stage with the envisaged total capacity of 550 MW by 1981 may also be considered. At present only 125 MW of its capacity has been planned to be implemented by 1981.

As regards the transmission line interconnections, it is imperative that the commissioning dates of all the major lines should also be advanced corresponding to any possible advancement of the power station projects. Timely steps should also be taken to construct the 500 kV line proposed to be built in future for connecting the high power hydel station at Patia with the national grid network. Without this tie, Patia will not be able to make any significant contribution towards sharing of the grid power demand.

NATURAL GAS

About 110,000 million cu m of natural gas reserves have been proved in Guajira. It has been indicated that the gas contains about 97 per cent methane, and less than 10 ppm sulphur with traces of CO_2 and N_2. Various schemes for the utilisation of this gas are now under consideration and this includes its utilisation for power generation, production of urea etc. Adequate availability of gas for the production of sponge iron has been assured by the Government. According to the present plan, the development of gas field including the installation of the chemical complex and a 360 km long pipeline would be completed by 1978 at a total investment of US $ 660 million. The gas pipeline would be laid up to Barranquilla. It is essential that this implementation schedule is adhered to.

TRANSPORT

At present, the transport requirement of the steel industry is met mainly by road transport. PDR has a captive railway system for transporting its raw materials from mines to the plant. About 85 per cent of the products of PDR are transported by road and balance by rail. The transport of scrap as well as steel for the semi-integrated plants is mainly by road.

The development of the steel industry would generate considerable amount of traffic, and dependence mainly on road transport will not enable it to cope up with the needs. Greater use of rail transport system and river barge transport system would be essential.

The pattern and volume of interzonal transport for the various major commodities in 1985 are given in Appendix 12-6. The development of the external transport system required for PDR expansion has been discussed in Chapter 6 and the requirement for the new facilities to be installed are discussed below.

Raw materials transport

The iron ore and pellets required for the new integrated steel plant and the gas-based sponge iron plant are expected to be received in bulk carriers at a port adjacent to the plant locations. The pellets required for the coal-based sponge iron plant would be received at a suitable port on the Pacific coast; assuming it to be Buenaventura, there is already a railway link between this port and the proposed plant location at Cali.

The heaviest inland bulk material traffic would be transport of coal to the new integrated steel plant. It is suggested that coal from the selected mines of Cundinamarca area be transported by rail to the nearest river port on river Magdalena, and from there barge transport be utilised for hauling the coal to the plant at Barranquilla. This would require augmenting the barge fleet as well as the development of necessary coal handling facilities at the river loading point. Some new type of barges exclusively for coal transport may be required.

Sponge iron transport

Further investigations are needed to establish the most suitable method of transporting sponge iron. It would be necessary to keep the sponge iron out of contact from rain/water during transit as well as in storage. It would, therefore, be advisable to avoid any transhipment of sponge iron during transport from the plant to the consumer. In some areas, for example between Cali and Medellin, rail transport could be utilised, whereas in certain other areas, for example, between Barranquilla and Medellin road transport may be very convenient. Depending on the final plans of the development of the railway net work system, a decision on the mode of transport and the type of carrier to be utilised would have to be decided.

Steel transport

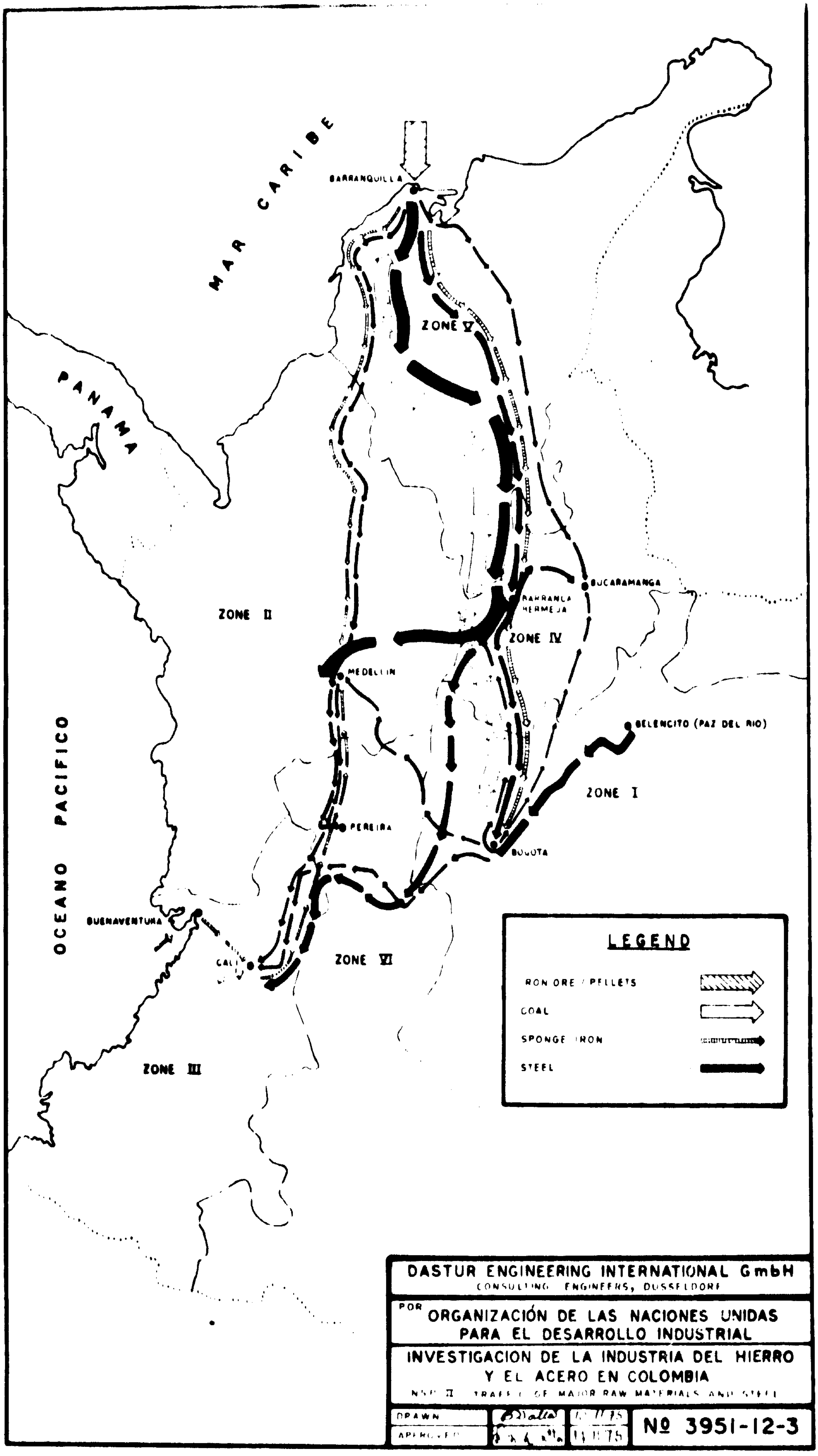
River as well as rail transport are proposed to be extensively used for transporting steel. Road transport also could be conveniently utilised for distributing steel in the neighbouring areas.

The transport of major raw materials and finished products for NSP-II and NSP-III are schematically shown in Drawing 3951-12-3 and -4.

Transport of coal for export

The possibilities of Colombia emerging as an important coal exporter is significantly linked with the development of its internal transport system. Considering the volume of coal to be transported, specially over long distances in the case of coking coals, either rail or river, or a combination of rail and river transport systems, would have to be utilised. In addition to the development of the inland transport link, necessary port handling facilities would have to be developed. The possibility of utilising a single port for exporting coals from different fields may merit consideration.

The export of Cerrejon coal has necessarily to be done through Atlantic coast. Plans for the infrastructure development are expected to be drawn up in the near future. It is understood that various locations such as Dibullia, Boca de Palamino and Bahia de Portete are being considered as possible port locations.


MAR CARIBE
BARRANQUILLA
PANAMA
ZONE V
ZONE II
BUCARAMANGA
BARRANCA BERMEJA
ZONE IV
MEDELLIN
BELENCITO (PAZ DEL RIO)
ZONE I
OCEANO PACIFICO
PEREIRA
BOGOTA
BUENAVENTURA
CALI
ZONE VI
ZONE III
LEGEND
IRON ORE / PELLETS
COAL
SPONGE IRON
STEEL
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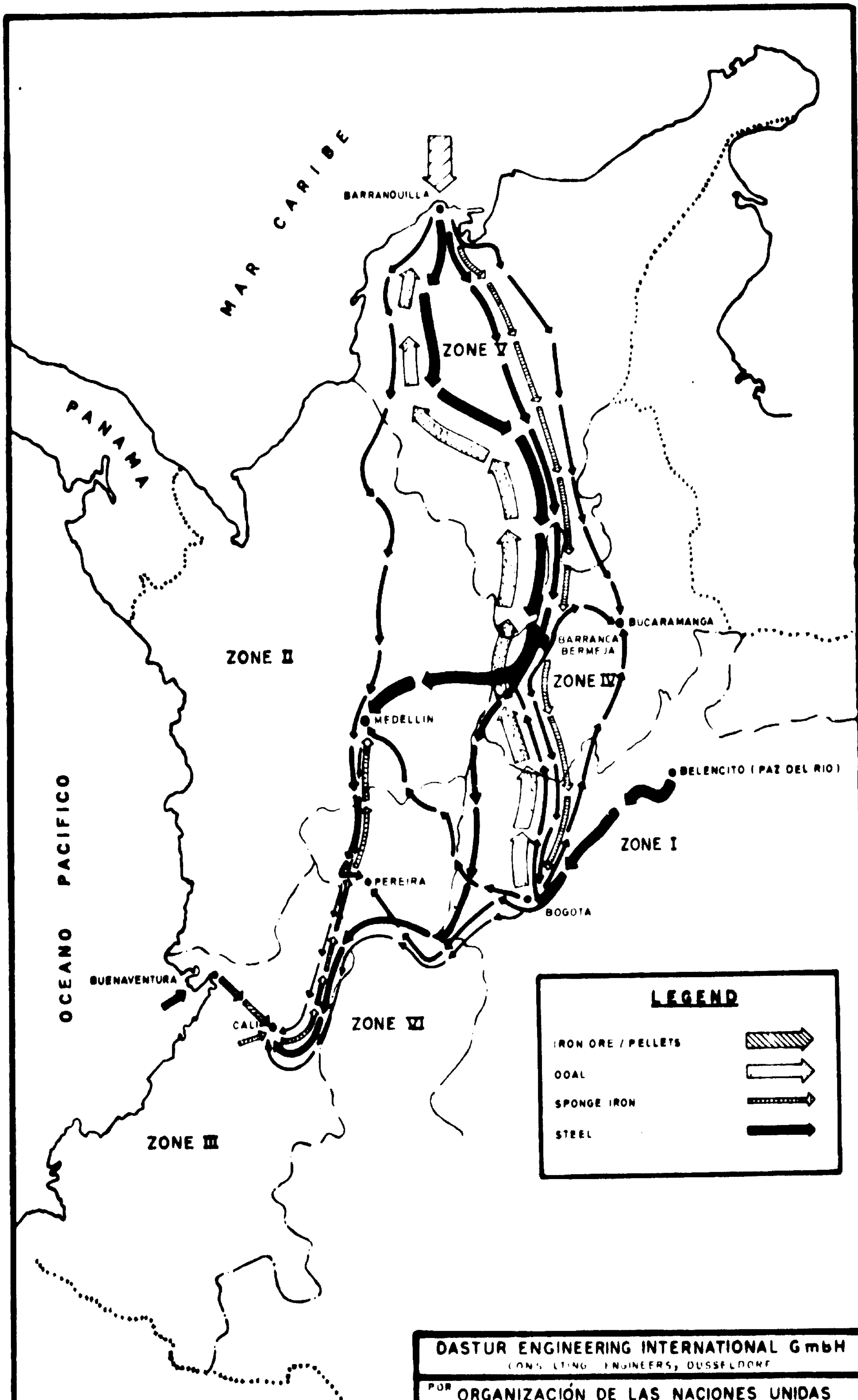
PARA EL DESARROLLO INDUSTRIAL
INVESTIGACION DE LA INDUSTRIA DEL HIERRO
Y EL ACERO EN COLOMBIA
TRAFFIC OF MAJOR RAW MATERIALS AND STEEL
DRAWN
APPROVED
Nº 3951-12-3



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INVESTIGACION DE LA INDUSTRIA DEL HIERRO Y EL ACERO EN COLOMBIA

NSP III TRAFFIC OF MAJOR RAW MATERIALS AND STEEL

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While at Dibullia and Boca de Palamino, 2 km off-shore loading facilities have to be developed, at Bahia de Portete a natural draft of about 10 m would be available. Further, a new rail link of about 115 to 175 km to connect the port and the coal field at Fonseca/Sarahita will have to be constructed. This rail link would remain isolated from the existing national network system. Therefore, an additional transport link would be required for connecting Cerrejon coal field to the existing national railway network to enable the utilisation of the coal in other areas and if necessary, to use the same port facilities for exporting other coals.

For the export of anthracite from Landa Zuri, coal loading facilities have already been developed at Puerto Baru in Isla Baru, south of Cartagena, where 30,000 dwt carriers are handled at present. The coal from the mines is transported by road to Puerto Agudelo, and from there it is hauled to Puerto Baru in barges.

For exporting coking coal from the Cundinamarca-Bouaca region, it may be advantageous to utilise barge transport to the extent possible, to minimise the inland transport cost. As exports from the Atlantic coast may be more advantageous for catering to a larger market, the possibility of exporting coking coals through Puerto Baru would merit consideration. If the same port were also to be used for exporting Cerrejon coal, the possibility of connecting the Cerrejon coal field to the river port El Banco via Chiriguana (a new rail link of about 300 km) would have to be investigated. This linkage will also connect the Cerrejon coal field to the overall transport network of the country.

Of the existing ports on the Atlantic coast, Cartagena area appears preferable to Barranquilla and Santa Marta for developing coal export facilities. However, a decision on the selection of the port would require a study of alternative locations and evaluation of various alternatives, taking into account the quantities of coal to be exported from different coal fields, the destinations etc.

For exporting coking coal through Pacific coast, it would be necessary to improve the rail connection between the Cundinamarca/Boyaca region and the Pacific coast which may include the construction of a new link between Armenia-Ibaque. However, the existing port at Buenaventura has a limited draft and is faced with problems of silting. Therefore, this port may be considered only for limited exports and even for this further investigations will be necessary. The possibility of installing the port facilities at a new location may be studied.

Port facilities for importing iron ore

Adequate port facilities for importing iron ore and pellets will have to be developed for the new integrated steel plant and the gas-based sponge iron plant. Necessary investigations will have to be conducted to identify suitable locations for the port on the Atlantic coast and it would be advantageous if the port could be located adjacent to the plant site. From locational considerations, of the existing Atlantic ports, Barranquilla is more advantageous for siting the plants as discussed in Chapter 10.

For importing pellets for the coal-based sponge iron plant also, requisite port facilities will have to be installed on the Pacific coast. This would also require necessary investigations to be conducted.

13 - COMPETITIVENESS OF COLOMBIAN STEEL

For analysing the competitiveness of Colombian steel in the local and the enlarged Andean market as well as other Latin American countries, the prices of Colombian steel have been compared with the domestic steel prices of other countries, and with the prices of steel imported into Colombia. Price comparisons of this nature are always difficult, as the exact size and quality of the product sold differ from case to case, the actual transaction prices may differ from the posted prices, the selling prices may include concealed discounts and dimensional extras, and also because the selling prices may not be referring to the same dates.

Domestic selling price in Colombia

In Colombia, independent selling prices are fixed by individual steel companies with the approval of the Government. A comparison of the recent selling prices of PDR and SIP for some of the selected steel products is given in Appendix 13-1. It would be noted that the ex-works prices of PDR are lower than those of SIP.

13 - Competitiveness of Colombian Steel (cont'd)

Colombian prices vs other Latin American prices

For comparing the domestic steel prices of Colombia and other Latin American countries, data obtained from a single source has been utilised. Though this may not represent the exact prices obtaining in individual countries at a point of time, it is assumed that relatively for purposes of comparison, the prices given for selected countries would be valid. The prices of typical steel products in selected Latin American countries during February 1975 are given in Table 13-1.

Table 13-1

DOMESTIC STEEL PRICES IN SELECTED LATIN AMERICAN COUNTRIES (FEB 1975) (US $ per ton) a/

	Andean Group				Others		
Items	Colombia	Chile	Peru	Venezuela b/	Argentina	Brazil	Mexico
Reinforcing rods ..	261	320	228	386	747	510	321
Wire rods ..	301	305	402	520	712	-	214
HR sheets ..	351	-	349	360	426	510	256
CR sheets ..	-	427	429	409	682	-	314
Galvanised sheets ..	-	584	-	615	1 035	689	580
Angles ..	319	419	-	341	757	-	354
Plain bars ..	-	428	-	402	803	565	354

a/ Foreign exchange rates adopted: 1 US $ = 29.31 Colombian pesos; 2,260.00 Chilean escudos; 43.80 Peruvian soles; 4.30 Venezuelan bolivares; 9.98 Argentinean pesos; 7.62 Brazilian cruceiros and 12.50 Mexican pesos.

b/ Refers to November 1974.

Source: ILAFA

13 - Competitiveness of Colombian Steel (cont'd)

This comparison shows that the Colombian prices are not only competitive within the Andean Group but also in Latin America as a whole, with the exception perhaps of Mexico. Domestic availability of iron ores and cheap natural gas help in keeping steel costs at low level.

Compared to Venezuela specially, the steel prices in Colombia are considerably lower. This is also brought out from a comparison of the selling prices of PDR and C.V.G. Siderurgica del Orinoco C.A. (SIDOR) as given in Appendix 13-2. It will be noted that in 1974, the PDR prices of bars and wire rods were about 70 per cent of that of SIDOR, while the prices of medium profiles were almost the same. In 1975, even after a revision, the prices of bars and wire rods from PDR are at 80 to 85 per cent of the 1974 prices of SIDOR.

<u>Colombian prices vs Western European domestic prices</u>

The competitiveness of Colombian steel structure is shown in Table 13-2 which compares the current (1975) selling prices of PDR with those prevailing in Western Europe.

13 - Competitiveness of Colombian Steel (cont'd)

Table 13-2

COMPARISON OF PDR AND WESTERN EUROPEAN DOMESTIC STEEL PRICES (US $/ton)

		PDR	Western Europe[a/]
Rebars	..	262	269 - 348
Wire rods	..	303	262 - 335

a/ Metal Bulletin Monthly, March 1975.

This shows that the Colombian prices compare favourably with the Western European domestic prices.

Domestic and imported prices in Colombia

Comparison with import prices is extremely difficult because of the price fluctuations in the world market. Further, the export prices, which reached an all-time high in mid-1974, started showing a downward trend from the 3rd quarter of that year and sharply declined in early 1975. On the other hand, due to the general increase in the national costs, the steel producers in Colombia were obliged to revise the steel prices again in May 1975, the earlier revision having taken place in August 1974.

A comparison of the domestic prices of main domestic steel products of Colombia, namely reinforcing bars and wire rods has been made with the imported prices of these products in Table 13-3.

13 - Competitiveness of Colombian Steel (cont'd)

Table 13-3

COMPARISON OF DOMESTIC AND IMPORTED STEEL PRICES
(US $ per ton)

	Continental export price (f.o.b) a/	Computed landed price b/	Domestic price Belencito c/
Reinforced bars ..	199	337	271
Wire rods ..	207	357	326

a/ Continental steel export prices prevailing in April 1975, Metal Bulletin, April 1975.

b/ Prices at Colombian port, based on ocean freight/insurance at $ 30 per ton, agency charges at 5% of c.i.f. price, port handling charges at $ 8 per ton, customs duty of 20% ad valorem on bars and 24% on wire rods, and financial charges at 18% on c.i.f. price.

c/ As in Appendix 13-2.

A similar comparison of steel prices delivered at Bogota, the major market in Colombia, has been made in the expansion report of PDR (updated 1975) and is given below:

	US $/ton					
	Dec. 1972		Dec. 1973		Dec. 1974	
	PDR	Imported	PDR	Imported	PDR	Imported
Non-flat products						
Wire rod and bars less than 12 mm in dia ..	193	238	193	476	252	459
Rebars and smooth rounds 12 mm and greater in dia	182	233	181	466	268	414
Medium sections 25 mm to 200 mm	228	282	232	440	302	507
Flat products						
Hot rolled:						
Hot strip ..	-	-	275	413	351	445
Light gauge from hand mill ..	222	-	244	-	360	463
Semi-finished products						
Billets ..	150	206	165	356	217	317

The comparisons show that the domestic prices in Colombia have been competitive with imported steel after allowing for a 20 per cent protection.

FUTURE PROSPECTS

The competitiveness of Colombian steel in future would depend on a large number of factors such as cost of raw materials, energy and manpower prevailing in Colombia and in other countries. It is difficult to project the effects of so many variables and therefore, the future prospects have been discussed generally keeping in view the prevailing prices of major raw materials obtaining in Colombia and other countries.

Comparison on unit costs

A comparison of 'basic unit costs' prevailing in selected South American countries is presented in Table 13-4, on the next page. In comparing the effect of unit cost of raw materials on the cost of steel, the process technology and the scale of operation need to be reckoned with. Assuming the adoption of similar technology, while the specific consumptions of major raw materials would depend mainly on their quality, the other items of cost would be significantly dependent on the scale of operation. The scale of operation would differ not only from country to country, but also from

13 - Competitiveness of Colombian Steel (cont'd)

Table 13-4

BASIC UNIT COSTS IN SELECTED LATIN AMERICAN COUNTRIES

	Colombia		Chile	Peru	Venezuela		Brazil
	PDR US $	Barranquilla US $	US $	US $	Matanzas US $	Maracaibo US $	US $
Iron ore per ton							
Local ..	4.7	-	10	-	11	17	4.8
Imported ..	-	25	-	-	-	-	-
Pellet ..	-	40	-	13	-	-	21.3
Coal per ton							
Local ..	14	24	N.A.	-	43	34	48
Imported ..	-	-	N.A.	86-100	76	71	70
Limestone per ton ..	3	3	9	N.A.	7	6	6
Scrap per ton							
Local ..	-	84	N.A.	-	59	42	100
Imported ..	-	147	N.A.	125	147	142	130
Natural gas per thousand cu m	-	35	-	-	27.2	27.2	-
Electric power per thousand kWh	-	0.013	-	-	0.006	0.006	-

13 - Competitiveness of Colombian Steel (cont'd)

plant to plant within the same country. Therefore, the effect of cost of major raw material inputs only has been taken into account in making the comparisons.

The blast furnace route which is being followed at PDR and is proposed for the new integrated steel plant in Colombia, is also being adopted in Peru, Chile and Brazil. In Venezuela, the possibilities of installing a new integrated steel plant adopting the blast furnace route at Maracaibo is under consideration. A comparison of the costs of iron ore and coal required per ton of hot metal for the different countries is given in Table 13-5.

Table 13-5

COMPARISON OF COSTS OF IRON ORE AND COAL PER TON HOT METAL (US $)

	Colombia				Venezuela	
	PDR	Barranquilla	Chile	Peru	Maracaibo	Brazil
Iron ore/pellet ..	9	43	16	19	28	7
Coal[a] ..	16	21	48[b]	65[c]	64[d]	62[d]
	25	64	64	84	92	69

a/ Assumed 1,470 kg coal per ton BF coke. Coke rate excluding fuel injection. Average price of imported coal assumed at US $ 75 at all locations.
b/ 65% imported coal. Local coal assumed at US $ 40/ton.
c/ 100% imported coal.
d/ 80% imported coal.

13 - Competitiveness of Colombian Steel (cont'd)

From Table 13-5, it would be observed that the total cost of iron ore and coal per ton of hot metal is lowest at PDR followed by the new integrated steel plant in Colombia as well as in Chile, and is highest at Maracaibo, Venezuela.

The direct reduction route is being extensively adopted at Venezuela and is also proposed to be adopted to a lesser degree at Colombia and Brazil. The major inputs which will affect the cost of steel from this route are the costs of pellet, natural gas, scrap, electric power and labour and supervision. From the unit costs presented in Table 13-4, it would be observed that Venezuela enjoys a certain advantage over Colombia specially regarding natural gas and electric power. The pellet prices of Venezuela may also be lower. However, it may be mentioned that the average manpower cost in Venezuela (US $ 7,500 per man year) is about three times that of Colombia and this should to a certain extent offset the advantages accruing to Venezuela from the lower unit prices. In addition, the Colombian authorities may review the unit prices of natural gas and electric power. Further, the blast furnace route would continue to be adopted for producing larger proportion of steel in Colombia.

Dependence on imports

With regard to the conventional blast furnace route, which will continue to account for the bulk of the steel production in Colombia, Peru, Chile and Brazil, and also is likely to be adopted in Venezuela at a future date, it would be noted that none of these countries have both iron ore and coking coal locally available. Excepting Colombia, all the other countries have adequate availability of local iron ore of suitable quality but would have to depend on imports of coking coal. The proportions of imported coking coal required by these countries may range between 65 and 100 per cent. On the other hand, in 1985 in Colombia the new integrated steel plant would be utilising imported iron ore, while PDR will be utilising domestic iron ore and about 50 per cent of the total iron made would be based on imported iron ore.

The fluctuations in the international prices of iron ore and coal would, therefore, have to be taken into consideration. Based on US export prices, it is noted that the average f.o.b. price of coal has risen from about US $ 31 per ton in June 1972 to about US $ 67 per ton in April 1975. During the same period, the export prices of pellets from Peru have increased from about US $ 11 per ton to about US $ 22/25 per ton.

The availability of prime quality coking coal in the world market is scarce, while there is adequate availability of good quality iron ore. In addition, a large proportion of the coking coal traded in the international market originates from advanced countries, while the developing countries are the major exporters of high grade iron ore. In view of these considerations, it is likely that the coal prices would be escalating at a faster rate. In this connection, it may also be mentioned that with the rising petroleum prices, the savings in coking coal which have been hitherto brought about through auxiliary fuel injection at the blast furnaces may not continue at the level and this in turn, would tend to increase the coking coal demand in the world.

It would, thus appear that so far as raw material supply is concerned, the Colombian steel industry may be subject to a lesser degree to the fluctuations/ escalations of the international trade, compared to other Latin American countries.

Investments on new facilities

The investments to be made on the new facilities would be reflected in the cost of steel, interms of maintenance expenses, depreciation, and interest charges. While the maintenance cost and the depreciation charges would be directly proportional to the investment, the interest charges would depend on the mode of financing of the project, which is different from country to country.

A comparison of the available information on the proposed investments for expanding the steel capacity in selected Latin American countries is given in Table 13-6. It is emphasized that the data available for different countries are not strictly comparable, since the coverages could be different. For example, some estimates, include interest during construction, start-up, commissioning and preliminary expenses as well as provision for escalation. Similarly, in some cases, the cost of mines development are included.

13 - Competitiveness of Colombian Steel (cont'd)

Table 13-6

COMPARISON OF INVESTMENT ON NEW STEEL CAPACITY IN SELECTED LATIN AMERICAN COUNTRIES

Country	Scheme	Additional ingot capacity mill tons	Estimated investment mill US $	Investment/ annual ton US $
Colombia	NSP-II	2.54	1 716	676
	NSP-III	2.53	1 797	710
Brazil[a/] ..	Expansion of CSN, USIMINAS and COSIPA	4.4	3 183	723
Peru[b/] ..	Expansion of Chimbote	1.65	1 348	817
Venezuela[c/]	SIDOR - Phase-I	3.40	1 900	559
	- Phase-II	2.60	2 893[d/]	1 113

a/ Woods F - Outlook of the Brazilian steel industry, IISI 9, Mexico City, October 1975.

b/ Data furnished by Chimbote, March 1975.

c/ Based on data furnished by CVG, April 1975.

d/ Includes replacement of existing open hearth shop.

The comparison in Table 13-6 indicates that the investment proposed in Colombia is reasonable and within the range obtaining in other countries.

The outlook

From the foregoing review, it would be observed that at present Colombian steel prices are competitive. The estimated investments for the future developments are also comparable with those of other Latin American countries. Therefore, considering the resources endowment, specially of coking coal, it is likely that Colombian steel prices will continue to be competitive with those of other Andean countries. This in turn will be helpful in the development of the domestic metal-mechanic sector. With regard to steel export, however, in view of the overall surplus capacity planned for installation in the Andean Group by 1985, and in view of the fact that the steel prices in other countries could be significantly influenced by their various economic policy decisions such as the pricing of energy and domestic natural resources, deliberate surplus capacity for export has not been incorporated in the National Steel Plan of Colombia.

Competitiveness of PDR steel

The average cost of finished steel produced at PDR after expansion is estimated (Table 6-7) at about US $ 243 per ton. Compared to this, the average cost of finished steel produced at other plants (SIP and new plants) in 1985 is estimated at about US $ 300 per ton. These costs include depreciation and interest charges. As mentioned earlier in this chapter (Appendix 13-1), at present the PDR prices are lower than those of SIP. Therefore, PDR would continue to be competitive in the domestic market after expansion. In addition, the comparison of domestic steel prices in Colombia and other Andean countries (Table 13-1) indicates that Colombian prices are competitive within the enlarged Andean market.

14 - OTHER RECOMMENDATIONS AND SUGGESTIONS

This chapter discusses the recommendations and suggestions regarding the exploratory and survey work on major raw materials, important laboratory and pilot plant tests and follow-up studies. Investigations and infrastructure development to be carried out to enable decision taking as well as organisations/agencies to be set up to execute the programme are also discussed.

EXPLORATION AND SURVEYS ON RAW MATERIALS

Detailed and systematic geological investigations would have to be conducted on all major raw materials, that is, iron ore, coal and limestone. The major steps in the exploration programme would be as follows:

i) All geological reports, prospecting data and other relevant information available with different agencies should be collected and reviewed.

ii) Based on the available data, preliminary exploratory work consisting of geological mapping, pitting, trenching and limited drilling should be carried out to identify the potential deposits.

iii) Detailed exploration of the potential deposits should be taken up to establish reserves and grades which would form the basis of development planning.

14 - Other Recommendations and Suggestions (cont'd)

Iron ore

The prospecting work completed so far on the iron ore deposits, other than those of PDR, is meagre. Therefore, extensive work would have to be completed before planning additional capacity (except PDR) on new iron ore deposits. The geological survey may also cover other promising regions, such as Llanos Orientales, where a possible extension of the Venezuelan type iron ore is not unlikely. All these investigations would be time-consuming.

Coal

A ccordinated exploration programme for the coal deposits would have to be planned and it would be advantageous to set up a proper organisation/agency for planning and coordinating the national coal development. Systematic prospecting work would have to be conducted in different coal bearing areas to establish the reserves as well as to classify the coals according to grade. The national plan can be developed only on the basis of such information. Identification of suitable areas and mines to sustain the coal requirements of the new integrated plant would have to be completed at an early date to enable the development work to be finished on time.

14 - Other Recommendations and Suggestions (cont'd)

Limestone

Although limestone occurrences are scattered widely in Colombia, data on gradewise reserves are scanty. With regard to the new integrated steel plant, it is suggested that the deposits occurring near Barranquilla should be properly explored and the reserves blocked out gradewise. It would be desirable to obtain limestone containing about 51/52 per cent CaO, and about 2 per cent SiO_2 for use in steelmaking.

Dolomite and magnesite

The steelmaking practice of PDR as well as that of the new integrated steel plant is based on the basic oxygen process and the electric arc furnaces would also be operating with basic linings. Therefore, the demand for basic refractory materials will increase considerably. Till date, there are no known occurrences of suitable quality dolomite and magnesite in Colombia and the entire requirements are met through imports.

Proper geological investigations should be carried out in the sedimentary rock formations for locating dolomite deposits of suitable grade and physical characteristics. Similarly, intensive exploration in areas containing ultrabasic rocks in the western part of the country will have to be conducted to locate magnesite of acceptable quality.

14 - Other Recommendations and Suggestions (cont'd)

Ferro-alloy minerals

The known occurrences of manganese ore are small and generally contain less than 40 per cent manganese. It would be advisable to carry out geological investigations to locate suitable manganese ore deposits for planning the development of a domestic ferro-manganese industry.

Quartzite occurs in a number of areas and at present a small ferro-silicon plant is operating. Further exploration on quart/quartzite may be taken up to identify areas where additional ferro-silicon capacity should be installed.

LABORATORY AND PILOT PLANT TESTS

Iron ore beneficiation

Tests on beneficiation conducted so far by different agencies like Minnesota School of Mines and Rheinstahl have not yielded encouraging results. Further investigations would have to be conducted on different ores, including PDR ores, to explore the possibilities of upgrading. A large number of agencies carry out such investigations and some of these are:

Institut de Recherches de la Siderurgie, France
Sala Maskinfabrik AB, Sweden,
Lurgi Geselleschaft fur Chemie und Huttenwesen GmbH, West Germany
KHD Industrieanlagen AG, Germany,
Swindell-Dressler Corporation, U.S.A.,
National Metallurgical Laboratory, India.

Utilisation of ore fines

The sintering characteristics of the local iron ores also need to be properly investigated to establish the optimum technology for the production of good quality sinter. This is specially important for PDR.

The possibility of utilising iron ore fines and blast furnace flue dust has already attracted attention of COLAR. A pilot kiln of about 1 m dia and 9 m long, designed and fabricated locally, is being installed to study the possibility of prereducing the ore fines with coke breeze, using blast furnace gas as fuel. The product is proposed to be charged into the blast furnace. The unit is scheduled to start up in 1975. It is suggested that this investigation may be conducted not only to find a possible use of by-products and wastes, but also to encourage development of local technology.

Coal blending

A number of tests on the feasibility of blending different coals has been made by IIT, Bogota. A systematic series of tests should be carried out to establish the optimum blend that could be utilised at the new integrated steel plant. These tests can be taken up by the local agencies like IIT.

Gas based direct reduction

In connection with the installation of sponge iron plants, necessary test work would have to be carried out. For the gas-based sponge iron plant, which is suggested for early installation, some tests may have to be conducted to select the source of pellets as well as to obtain the necessary process guarantees from the equipment supplier. These tests would necessarily be conducted by the process and equipment suppliers and the details of tests, sample requirements, and the order of magnitude of testing fee payable are indicated in Appendix 14-1.

Coal based direct reduction

Extensive test work would possibly be required for the coal-based direct reduction plant. As a first step, laboratory scale tests should be conducted on a number of coal samples to pre-select a few suitable coals which would be subjected to pilot scale tests. Similar small-scale tests would also be required on the pellets proposed to be used. Pilot plant tests may be conducted at the laboratories of the process/

14 - Other Recommendations and Suggestions (cont'd)

SIP expansion

Plans for expansion of SIP including requirements of balancing facilities would have to be finalised separately for each plant.

Project reports on direct reduction

A project report on gas-based direct reduction plant should be initiated immediately. The study should also include selection of location and finalisation of plant capacity. Based on the expansion proposals of SIP and possible exports in the initial years, the possibility of installing a 350,000 tons unit in NSP-III needs evaluation. A suitable method for transporting sponge iron should also be investigated.

Studies on coal-based direct reduction plants should continue and the plans for test work drawn up.

Feasibility report on new integrated steel complex

A feasibility report for the proposed integrated steel complex will have to be prepared to finalise the selection of plant location and to draw up the preliminary plans, based on which further work on this project would be undertaken.

TRANSPORT

The transport development needed for the steel industry will have to be evaluated in the context of the overall national development.

equipment suppliers and the relevant information with regard to the sample requirements, approximate test fee payable etc are given in Appendix 14-2.

Before taking a final decision on the establishment of a rotary kiln plant, it is suggested that full scale trials may be conducted with the selected raw materials. There is a possibility of conducting such tests at the Piratini Plant in Brazil. The Government of Colombia would have to take up the matter at the appropriate time with SIDERBRAS to decide upon the terms and conditions as well as the raw materials requirements for these tests.

Calcination of limestone

Some laboratory scale tests may have to be conducted for establishing the calcining characteristics of limestone from new deposits. The sample requirements and the types of tests to be conducted are given in Appendix 14-3.

FOLLOW UP STUDIES

Report on PDR expansion

A project report would have to be prepared for the expansion of PDR, in order to finalise the plan of execution, and for obtaining more precise estimates of costs. Preparation of this report should be taken up immediately.

Railways

Barranquilla, the proposed location for new plants, will have to be connected to the existing railway network system, by establishing a new link between Fundacion and Barranquilla. The other new links which may have to be established are Saboya-Carare and Armenia - Ibague. The carrying capacity of the railway system in different sectors will have to be investigated. Sectors of particular importance are Fundacion-Bogota via a new rail link, Puerto Berrio-Cali via Medellin and via Armenia-Ibague, Cali-Buenaventura and Belencito-Bogota.

Measures to cut down disruption of train schedules and improving the turn-round time will have to be initiated. Arrangements will have to be made to augment the rolling stock as well as motive power, specially to suit the traffic for the steel industry.

Road

Completion and strengthening of road network in certain sectors particularly in the sectors between Barranquilla and Bogota, Barranquilla and Medellin and Cali, and in the coal field areas of Cundinamarca and Norte de Santander needs investigation. The feasibility of using higher capacity vehicles also needs to be studied.

River

For the utilisation of river transport system for the steel industry, investigations with regard to the possibilities of creating adequate storage and handling facilities at the river ports of Barranquilla and Barrancabermeja will have to be conducted. Barges suitable for bulk material and steel product handling will have to be obtained.

Selection of port locations

Port facilities for importing iron ore and pellets will be required for the new integrated steel plant and sponge iron plant. The new integrated steel plant as well as the gas-based sponge iron plant are proposed to be located on the Atlantic coast and based on the reconnaissance of the existing ports, Barranquilla appears advantageous. However, investigations will have to be taken up to identify a suitable port location to receive iron ore and coal, if necessary. The development of port facilities on the Pacific coast will also be required for importing pellets for the coal-based direct reduction plant. Necessary investigations will have to be taken up in this case also.

Further studies and investigations are required for finalising the locations of ports for exporting coal.

As discussed in Chapter 12, there is a possibility of expanding/rehabilitating the coal exporting facilities available at Puerto Baru, south of Cartagena. This location is reported to have adequate draft for handling large carriers. It is also understood that a number of alternative locations are under consideration for the development of a suitable port to handle Cerrejon coal. Bahia de Concha has also been considered in the past as a location for exporting coal. The relative advantages and disadvantages of these alternative locations will have to be studied and decision taken on whether one or more ports have to be developed for the export of coal.

NATIONAL ENERGY POLICY

An overall national energy policy will have to be defined, including the tariff patterns, priorities of development and use of different forms of energy. In developing this policy, due consideration will have to be given to the fuel and energy needs of the iron and steel industry.

Electric power

The planning for electric power development was prepared by ISA based on statistical forecasts of demand. It is suggested that a more realistic assessment of the anticipated demand may be made through an actual load survey of prospective consumers, particularly the major consumers. This would obviate possibilities of major shortfalls in power supply.

The Colombian power system is at present about 65 per cent hydel-based, which is likely to rise to about 85 per cent in 1986 and to about 95 per cent by end of the century according to existing plans. Even the present 100 per cent thermal system of CORRELCA will become a predominantly hydel-based system with only about 40 per cent thermal capacity by 1985. The installation of the semi-continuous strip mill at the new integrated steel plant will impose fast rising peak demand in repetitive cycles. For the size of the strip mill envisaged, a peak load of about 40 MW is likely to be imposed on power supply system, with a rate of power rise of about 4 to 6 MW per second. To meet this fast rising peak demand without affecting the voltage and particularly the frequency, the system supplying power to such a plant should have adequate thermal generating capacity.

Studies may therefore be made for substantially increasing the thermal component of the CORRELCA system and in this respect, the establishment of thermal power stations using Cerrejon coal may be given due consideration.

The electricity tariff structure varies widely from region to region. As wide variations exist even in the tariff structrues applicable to heavy industrial consumers including iron and steel plant, it is suggested that La Junta Nacional de Tarifas de Servicios Publicos, the national organization which is responsible for making policy decisions in this respect, may review the existing tariff structures and bring about a suitable revision and rationalisation of the electricity tariff policy. The possibilities of offering some concessional tariffs to electro-metallurgical plants with good power factors, such as ferro-alloy plants, may be examined.

Natural gas

The policy on natural gas should cover priorities and the method of utilisation. The other aspect which would be equally important is the pricing policy of natural gas. With regard to the use of natural gas for direct reduction, it has been indicated that the well-head cost of natural gas would be about US $ 28 per thousand cu m (US $ 0.8 per thousand cft) and as such, the price payable by the consumers may be of the order of US $ 35 per thousand cu m. The available information indicates that the well-head cost of natural gas is about US $ 23 per thousand cu m at Venezuela and the sponge iron plant receives it at about US $ 27 per thousand cu m. A much lower price has been in vogue in Mexico, where it has been of the order of US $ 12 per thousand cu m (US $ 0.34 per thousand cft). This may be kept in view while finalising the natural gas tariff, as the cost of gas will affect the cost of sponge iron.

National coal plan

An appropriate agency in the form of a Coal Board or a National Coal Authority may be set up to plan, coordinate and execute the coal development programme. The national coal plan will have to take into account various aspects of the coal industry such as the exploration programme, classification of reserves according to grades, priorities of domestic utilisation for different industries/uses like electric power generation, iron and steel industry, carbo-chemical industry, also use as an industrial fuel as well as the possibilities of export. From a long-term view point, it may also be desirable to initiate necessary research and development work, for example on coal gassification, blending and washing etc. Therefore, the national coal programme will have to be developed in close coordination with the development programmes of other sectors, mainly the electric power and iron and steel.

14 - Other Recommendations and Suggestions (cont'd)

Some of the important aspects which may be kept in view while preparing the plan are as follows:

i) Collection of all available data on exploration work conducted in the coal fields and mines in different areas.

ii) Collection and regular updating of all information regarding coal mining, production of coke and other uses of coal.

iii) Drawing up of a programme of coal exploration and identifying potential areas, where detailed investigations should be taken up on a priority basis not only to meet the domestic requirements but also for the purpose of export.

iv) Classifying the reserves gradewise.

v) Identifying the necessity of washing the coal and to plan the use of middlings.

vi) Evaluating the development of infrastructure required, indicating priorities, and ensuring a coordinated development of the coal mines and infrasturcture work.

vii) Getting necessary test work done with regard to the utilisation of different coals for production of coke and if necessary, incorporating measure for conserving the coking coal reserves.

viii) Negotiating with other Andean countries and/or other prospective importers of coal for joint exploration and development of coal mines and for supply of coal on long-term basis.

ix) Financial planning for coal development.

x) Assisting the Government in drawing up an overall energy policy.

The present world market situation indicates immense possibilities for Colombia to emerge as an important coal exporter. With regard to the requirements of imported iron ore and pellets to sustain the Colombian steel programme, there exists a possibility of bartering Colombian coal with suitable iron ores from countries like Brazil, Peru, Chile and Venezuela. It is suggested that this should be further examined in order to identify the best possible method of obtaining the iron ore supplies in exchange for coal.

COORDINATION OF STEEL DEVELOPMENT PROGRAMME

The implementation of the steel programme will need close coordination of a wide variety of activities including selection and development of raw material sources, and infrastructure, making long-term arrangements for import of raw materials etc.

It is suggested that an apex body may be established with necessary authority and executive power for coordinating and implementing the National Steel Plan. Some of the more important activities of the apex body would be to take a final decision on the plan to be implemented, to scrutinise and approve the expansion projects of different steel companies, to collect and collate relevant statistical data and to coordinate the various activities within the overall policy framework laid down by the Government. The apex body would, in addition, help in the procurement of capital and operating resources for the steel plants, coordinate the industrial and the commercial policies of the steel industry and stimulate the formation and development of the human resources needed for the steel programme.

At present, there is considerable information gap even with regard to the installation of new plants. For example, in September 1975, the Consultants became aware that a new semi-integrated plant, Aceries de Bogota Ltda, has been set up (the existence of which was not known during the field survey) and is expected to start producing carbon constructional steels some time in the beginning of 1976. This plant envisages to produce higher alloy steels at a future date. Though the present production capacity of this plant is small, and will not materially affect the national plans indicated in this study, but from the long-term view point and in preparing detailed plans for execution, it would be essential that complete information is available on all existing installations. The setting up of the apex body would also be helpful in this connection.

14 - Other Recommendations and Suggestions (cont'd)

It may be mentioned that such executive organizations exist in other developing countries. For example, Siderurgia Brazileria S.A. (SIDERBRAS), a holding company in the public sector, promotes and manages the Government interests in the iron and steel industry in Brazil, and in Venezuela, the Council Siderurgica National is steering the steel development programme.

The apex body should be assisted by specialised working groups in different fields of activity. In addition, for the evaluation of specific techno-economic aspects of the development programme as well as for other specialised activities, it may also secure the services of consultants from time to time.

A P P E N D I C E S

Appendix 11-1

PRELIMINARY ESTIMATES OF CAPITAL COST FOR BAR AND ROD MILL COMPLEX AND NEW LIGHT PROFILE MILL FACILITIES (million US $)

	NSP-II		NSP-III	
	Facilities	Capital cost	Facilities	Capital cost
A. BAR AND ROD MILL COMPLEX				
Steelmaking	Four 65-ton arc furnaces; Two 4-strand billet casters	32	Two 65-ton arc furnaces; One 4-strand billet caster	18
Rolling mills	One 400,000 tons bar and rod mill	65	One 200,000 tons bar and rod mill	55
Sub-total (A)		97		73
B. NEW LIGHT PROFILE MILL COMPLEX				
Steelmaking	One 35-ton arc furnace; One 3-strand continuous casting machine	10	One 35-ton arc furnace; One 3-strand continuous casting machine	10
Rolling mills	One 50,000 tons light profile mill	5	One 50,000 tons light profile mill	5
Sub-total (B)		15		15
Total (A) + (B)		112		88

Appendix 11-2

PHASING OF NEW INVESTMENTS - NSP-II AND NSP-III
(million US $)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
NSP-II											
SIP ..	5	16	16	20	5	-	-	1	2	1	66
PDR[a] ..	-	69	102	78	28	34	26	6	-	-	343
Sponge iron plants ..	10	18	29	9	12	10	18	24	-	-	130
Bar and rod mill complex	-	15	23	35	-	-	10	14	-	-	97
Light profile mill complex	-	-	-	-	-	-	6	9	-	-	15
New integrated plant ..	-	-	-	150	350	250	173	142	-	-	1 065
Total ..	15	118	170	292	395	294	233	196	2	1	1 716
NSP-III											
SIP ..	5	16	16	20	5	-	-	1	2	1	66
PDR[a] ..	-	86	149	134	50	47	34	6	2	-	508
Sponge iron plants ..	9	15	20	-	-	-	5	9	12	-	70
Bar and rod mill complex	-	-	-	-	15	25	33	-	-	-	73
Light profile mill complex	-	-	-	-	-	-	6	9	-	-	15
New integrated plant ..	-	-	-	150	350	250	173	142	-	-	1 065
Total ..	14	117	135	304	420	322	251	167	16	1	1 797

a/ Includes cold rolling facilities under Current Improvement Programme.

Appendix 11-3

MANUFACTURING COSTS OF DOMESTIC STEEL PRODUCTION - NSP-II AND NSP-III[a]
(Unit: Production - '000 tons & Value - million US $)

Year	SIP and light profile mill[a]		PDR		Bar & rod mill		New integrated plant		Total	
	Production	Value	Production[b]	Value	Production	Value	Production	Value	Production	Value
NSP-II										
1976	136	40	219	34	-	-	-	-	355	74
1977	159	47	236	37	-	-	-	-	395	84
1978	202	61	250	38	-	-	-	-	452	99
1979	220	61	344	60	50	11	-	-	614	132
1980	268	75	394	70	150	35	-	-	812	180
1981	304	88	451	63	200	48	-	-	955	199
1982	312	88	499	69	200	47	-	-	1 011	204
1983	312	89	544	78	255	59	-	-	1 111	226
1984	337	95	541	74	355	83	555	97	1 788	349
1985	374	104	541	74	400	93	780	137	2 095	408
Total	2 624	748	4 019	597	1 610	376	1 335	234	9 588	1 955
NSP-III										
1976	136	40	219	34	-	-	-	-	355	74
1977	159	47	236	37	-	-	-	-	395	84
1978	202	61	250	38	-	-	-	-	452	99
1979	220	60	344	59	-	-	-	-	564	119
1980	268	75	394	69	-	-	-	-	662	144
1981	304	83	551	77	-	-	-	-	855	160
1982	312	84	639	89	-	-	-	-	951	173
1983	312	88	724	100	100	24	-	-	1 136	212
1984	337	94	741	102	145	34	555	97	1 778	327
1985	374	104	741	102	200	48	780	137	2 095	391
Total	2 624	736	4 839	707	445	106	1 335	234	9 243	1 783

a/ Includes ordinary and special steels

b/ Production figures indicate only finished rolled steel and exclude semis.

Appendix 11-4

ANNUAL DEPRECIATION AND INTEREST CHARGES - NSP-II AND NSP-III (million US $)

Year	SIP	PDR	Bar and rod mill	Light profiles	D.R. plant	New integrated plant	Total
NSP-II							
1976	2	6	-	-	-	-	8
1977	5	6	-	-	-	-	11
1978	8	6	-	-	-	-	14
1979	8	20	11	-	8	-	47
1980	11	20	11	-	8	-	50
1981	11	49	11	-	12	-	83
1982	11	49	11	-	12	-	83
1983	11	57	15	-	12	-	95
1984	11	57	15	2	20	160	265
1985	12	57	15	2	20	160	266
NSP-III							
1976	2	6	-	-	-	-	8
1977	5	6	-	-	-	-	11
1978	8	6	-	-	-	-	14
1979	8	20	-	-	7	-	35
1980	11	20	-	-	7	-	38
1981	11	73	-	-	7	-	91
1982	11	73	-	-	7	-	91
1983	11	82	11	-	11	-	115
1984	11	82	11	2	11	160	277
1985	12	82	11	2	11	160	278

Appendix 11-5

FOREIGN EXCHANGE COST OF IMPORTED STEEL - NSP-II AND NSP-III[a]

Year	NSP-II		NSP-III	
	Imports '000 tons	Value[a] million US $	Imports '000 tons	Value million US $
1976	438	134	438	134
1977	507	155	507	155
1978	578	176	578	176
1979	570	174	620	189
1980	559	171	709	216
1981	588	179	688	210
1982	733	224	793	242
1983	857	261	832	254
1984	438	134	448	137
1985	413	126	413	126
	5 681	1 734	6 026	1 839

a/ Based on an average f.o.b. price of US $ 275 per ton and ocean freight and insurance at US $ 30 per ton.

Appendix 11-6

TOTAL FOREIGN EXCHANGE REQUIREMENT - NSP-II AND NSP-III
(million US $)

Year	NSP-II				NSP-III			
	Imported slab	Raw material and supplies	Imported finished steel	Total	Imported slab	Raw material and supplies	Imported finished steel	Total
1976 ..	4	16	134	154	4	16	134	154
1977 ..	4	19	155	148	4	19	155	178
1978 ..	3	26	176	205	3	26	176	205
1979 ..	17	25	174	216	17	19	189	225
1980 ..	23	43	171	237	23	24	216	263
1981 ..	-	55	179	234	-	28	210	238
1982 ..	-	51	224	275	-	28	242	270
1983 ..	4	57	261	322	4	39	254	297
1984 ..	-	96	134	230	-	74	137	217
1985 ..	-	112	126	238	-	98	126	224
Total ..	55	500	1 734	2 289	55	371	1 839	2 265

Appendix 11-7

PRESENT VALUES OF OUTFLOW AND INFLOW - NSP-II AND NSP-III
(million US $)

Year		NSP-II Outflow		NSP-II Inflow		NSP-III Outflow		NSP-III Inflow	
		Current value	At 11% discount	Current value	At 11% discount	Current value	At 11% discount	Current value	At 11% discount
1975	..	87	87.0	41	41.0	87	87.0	41	41.0
1976	..	15	13.5	48	43.2	14	12.6	48	43.2
1977	..	118	95.8	54	43.8	117	95.0	54	43.8
1978	..	170	124.3	61	44.6	185	135.2	61	44.6
1979	..	292	192.4	99	65.2	304	200.3	94	61.9
1980	..	395	234.2	118	70.0	420	249.0	105	62.3
1981	..	294	157.3	153	81.9	322	172.3	154	82.4
1982	..	233	113.3	169	81.5	251	121.9	171	82.4
1983	..	196	85.2	187	81.2	167	72.5	194	84.2
1984	..	2	0.8	307	120.0	16	6.3	308	120.4
1985	..	1	0.4	367	129.2	1	0.4	363	127.8
Total	(1975-85)	1 803	1 104.2	1 604	801.6	1 884	1 152.5	1 586	794.0
1986	..	-	-	421	133.0	-	-	417	132.0
1987	..	-	-	442	126.0	-	-	438	125.0
1988	..	-	-	442	114.0	-	-	438	112.0
1989	..	-	-	442	102.0	-	-	438	101.0
1990	..	-	-	442	93.0	-	-	438	92.0
Total	(1975-90)	1 803	1 104.2	3 793	1 370.6	1 884	1 152.5	3 755	1 356.0

Appendix 11-8

ESTIMATES OF FERRO-MANGANESE AND FERRO SILICON REQUIREMENTS IN 1980 AND 1985

A. PRODUCTION PROGRAMME

i) Crude Steel Production (thousand tons)

Process & Types of Steel		NSP-II		NSP-III	
		1980	1985	1980	1985
Oxygen Steel Process[a]					
Flat products	..	138	1 248	138	1 248
Non-flat products	..	202	356	202	584
Electric Steel[b]					
Ordinary steels	..	461	849	284	598
Carbon constructional steels	..	30	35	30	35
Alloy constructional steels	..	20	33	20	33
Free cutting steels	..	6	13	6	13
Spring steels	..	20	24	20	24
Electrodes	..	10	17	10	17

a/ Includes PDR and new integrated plant
b/ Include SIP, PDR arc furnace, new bar and rod mill complex and new profile mill complex

ii) Foundry Production (thousand tons)

Assuming that the demand will be fully met, the production of castings are:

		1980	1985
Iron castings	..	74	127
Steel castings	..	25.4	43

B. NORMS OF CONSUMPTION

Products		Ferro manganese kg/ton of crude steel	Ferro silicon kg/ton of crude steel
Oxygen steel			
Flat products	..	7.6	2.3
Non-flat products	..	12.3	2.7
Electrical steel			
Ordinary steels	..	12.3	2.8
Carbon constructional steels	..	11.2	4.6
Alloy constructional steels	..	11.2	4.6
Free cutting steels	..	15.8	2.8
Spring steels	..	14.0	24.0
Electrodes	..	6.5	-
Foundry			
Iron castings	..	-	10
Steel castings	..	10	7

C. REQUIREMENT OF FERRO-ALLOYS

Process & Type of Steel		NSP-II (tons)				NSP-III (tons)			
		1980		1985		1980		1985	
		FeMn	FeSi	FeMn	FeSi	FeMn	FeSi	FeMn	FeSi
Oxygen Steel									
Flat products	..	1 050	320	9 490	2 870	1 050	320	9 490	2 870
Non-flat products	..	2 480	550	4 380	960	2 480	550	7 180	1 580
Electric Steel									
Ordinary steels	..	5 670	1 290	10 440	2 380	3 500	800	7 360	1 680
Carbon constructional steels	..	335	145	400	170	335	145	400	170
Alloy constructional steels	..	225	95	370	150	225	95	370	150
Free cutting steels	..	100	20	210	40	100	20	210	40
Spring steels	..	280	480	340	580	280	480	340	580
Electrodes	..	65	-	110	-	65	-	110	-
Sub-total (A)	..	10 205	2 900	25 740	7 150	8 035	2 410	25 460	7 070
Foundry									
Iron castings	..	-	740	-	1 270	-	740	-	1 270
Steel castings	..	250	180	430	300	250	180	430	300
Sub-total (B)	..	250	920	430	1 570	250	920	430	1 570
Total (A+B)	..	10 455	3 820	26 170	8 720	8 285	3 330	25 890	8 640

Appendix 12-1

ESTIMATES OF COKING COAL AND COKE REQUIREMENTS OF SELECTED LATIN AMERICAN COUNTRIES
(million tons)

Country	1980 Coke - blast furnace - hot metal prodn	1980 Coal consumption			1985 Coke - blast furnace - hot metal prodn [a]	1985 Coal consumption [b]			Coke import 1980
		Domestic	Imported	Total		Domestic	Imported	Total	
Argentina ..	5.20	0.47	2.64	3.11	9.60	0.87	4.88	5.75	-
Brazil ..	10.72	2.30	6.90	9.20	18.92	4.06	12.18	16.24	-
Chile ..	0.80	0.35	0.52	0.87	2.30	1.01	1.50	2.51	-
Mexico ..	7.14	5.15	2.25	7.40	9.00	6.49	2.84	9.33	0.82
Peru ..	1.12	-	0.84 [a]	0.84	1.88	-	1.41	1.41	-
Venezuela ..	-	-	-	-	8.00	1.41 [c]	5.00	6.41	0.30
Total ..	24.98	8.27	13.15	21.42	49.70	12.43	27.81	41.65	1.12

a/ Coke requirement indicated by ILAFA converted to equivalent coal considering the present plans of coke oven installation.
b/ Coal consumption projected pro-rata from 1980.
c/ Assumed about 20% local coal in blend.

Source: Gomez A - Outlook for Latin American Steel Industry, IISI, 9 October 1975.

Appendix 12-2

MAJOR LIMESTONE DEPOSITS IN COLOMBIA

Department & deposit	Chemical analysis			Reserves, million tons		
	CaO	MgO	SiO_2	Proved	Probable	Possible
ANTIOQUIA						
Majagual	55.5	0.30	0.40	-	0.7	-
Frontino	32.37 to 47.20	0.15 to 2.76	-	-	-	-
Abejorral	50.1	0.03	2.3	-	5.0	-
Alto Cabezas	50.3	0.24	5.4	-	-	8.0
Amalfi	High	-	-	-	-	1.0
Nare	-	-	-	-	-	-
Nus	-	-	-	-	-	-
BOYACA						
Nobsa-Corrales	50.09	0.52	8.32	17.73 a/	21.526	24.700
Las Monjas-La Carrera	-	-	-	-	50.8	12.07
BOLIVAR						
Bolivar	-	-	-	-	-	-
CORDOBA						
La Cantera	53.35 to 54.70	0.03 to 0.35	-	-	-	4.968
La Floresta and El Sena	53.30 to 54.33	0.48 to 1.52	-	-	-	29.393
CUNDINAMARCA						
Pueblo Vieja	48.14 to 49.70	Traces	5.01 to 5.99	-	-	7.0
Puerto Arturo and Alrededo	51.16 to 54.80	0.16 to 0.67	0.65 to 4.04	-	2.0	-
MAGDALENA						
Cienaga	34.63 to 55.30	0.25 to 17.50	0.60 to 3.80	-	10.0	-
Durania	46.70	0.68	14.21 (Insol)	-	200.0	-
VALLE						
Guacas	-	-	-	1.20	3.0	-
Portachuelo	-	-	-	0.48	2.0	-

a/ About 12 million in PDR concessions and the balance in Cementos Boyaca's concession.

Source: Memoria del Minas Gerando Silva Valderrama - 1974.
Questionario Sobre Materias Primas.

Appendix 12-3

PROGRAMMES OF POWER GENERATION AND TRANSMISSION SYSTEM

Programme of power generation

According to the existing plan, ten power stations with a total capacity of about 6,338 MW are expected to be commissioned between 1976 and 1986. Of these, only two, Cartagena and Cerrejon, are thermal, with a total capacity of 257 MW. The rest are all hydro-electric power stations. The planning beyond 1986 is tentative and no definite target dates have yet been fixed for materialisation of the individual projects. According to the present indications, seventeen new projects are expected to be commissioned in the period from 1987 to 2000 AD, in addition to the expansion of three projects which would be initially commissioned by 1986. The total installed additional generating capacity on account of these projects would be about 22,100 MW, of which only 425 MW would be thermal and the rest hydro-electric.

If the future development programme materialises according to schedule, the progressive total installed generating capacities that would be available at different periods of time under the various power supplying authorities and in the country as a whole are given in the next page.

Programme of transmission system

The most important of the future transmission and distribution projects is the 500 kV interconnection between the predominantly thermal system of CORELCA in the north and the hydel systems of the central and southern regions. In the first stage of this project, a 500 kV single-circuit transmission line interconnecting the Sabanalarga substation of CORELCA with the San Carlos substation in the central region is expected to be commissioned by 1978-79. The construction of this line would be a singnificant step towards the development of the national power grid covering the entire country. The other major development schemes in the field of power transmission and distribution are the extensive 220 kV interconnections both in the central and southern regions as well as CORELCA region in the north.

Appendix 12-3 (continued)

Year	Type of station	Progressive total installed generating capacities in MW under different authorities from 1975 to 2000 AD						
		ISA	EEEB	EPM	CVC	ICEL	CORELCA	Total
1975	Hydel	-	552	671	524	301	-	2 048
	Thermal	-	154	-	50	340	442	986
	Small	-	5	10	10	71	49	145
	Total	-	711	681	584	712	491	3 179
1976 to 1978	Hydel	500	552	671	524	301	-	2 548
	Thermal	-	154	-	50	340	574	1 118
	Small	-	5	10	10	71	49	145
	Total	500	711	681	584	712	623	3 811
1979 and 1980	Hydel	1 000	552	951	524	301	-	3 328
	Thermal	-	154	-	50	340	574	1 118
	Small	-	5	10	10	71	49	145
	Total	1 000	711	961	584	712	623	4 591
1981 and 1982	Hydel	1 620	552	951	524	352	-	3 999
	Thermal	-	154	-	50	340	699	1 243
	Small	-	5	10	10	71	49	145
	Total	1 620	711	961	584	763	748	5 387
1983 and 1984	Hydel	1 620	552	951	734	352	700	4 909
	Thermal	-	154	-	50	340	699	1 243
	Small	-	5	10	10	71	49	145
	Total	1 620	711	961	794	763	1 448	6 297
1985	Hydel	1 620	552	951	734	352	1 160	5 369
	Thermal	-	154	-	50	340	699	1 243
	Small	-	5	10	10	71	49	145
	Total	1 620	711	961	794	763	1 908	6 757
1986	Hydel	2 520	1 072	951	734	1 692	1 160	8 129
	Thermal	-	154	-	50	340	699	1 243
	Small	-	5	10	10	71	49	145
	Total	2 520	1 231	961	794	2 103	1 908	9 517
2000	Hydel	19 020	1 572	951	734	6 212	1 330	29 819
	Thermal	-	154	-	50	340	1 124	1 668
	Small	-	5	10	10	71	49	145
	Total	19 020	1 731	961	794	6 623	2 503	31 632

Appendix 12-3 (continued)

Though the long term programme for the future development of the transmission and the distribution systems beyond 1986 is yet to be finalised, it is noted that two important transmission line interconnections have been thought of for possible future implementation. However, the dates of their implementation have not yet finally decided upon. One of these is the 500 kV interconnection of the 2,700 MW hydel power station at Patia with the national grid and the other is the second 500 kV circuit interconnecting San Carlos with Sabanalarga. Both these lines would play vital roles in proper distribution of power over the national grid.

Appendix 12-4

ESTIMATED ADDITIONAL FUTURE POWER DEMAND

	Supply system	1980 NSP-II MW	1980 NSP-III MW	1985 NSP-II MW	1985 NSP-III MW
A. EXISTING PLANTS					
PDR	ICEL-N	90	100	90	100
SIP - Zone I	ICEL-N & EEEB	24	24	24	24
- Zone II	EPM	18	18	18	18
- Zone III	CVC	17	17	25	25
- Zone V	CORELCA	6	6	6	6
B. NEW PLANTS					
Sponge iron - Zone III	CVC	-	-	3	3
- Zone V	CORELCA	8	6	15	6
Bar and rod mill complex - Zone V	CORELCA	47	47	90	47
Light profile mill	-	-	-	18	18
Integrated plant	CORELCA	-	-	120	120
Total ..		210	218	409	367

Appendix 12-5

REVIEW OF ESTIMATED EFFECTIVE POWER POTENTIAL OF COLOMBIA BETWEEN 1980 AND 1986

The estimated effective power potential of Colombia to meet the developing power demand from 1980 to 1986 is reviewed as follows:

	Total generating capacity connected to national grid		Anticipated peak power demand on national grid			Required[c] firm generating capability	Surplus (+) or Deficit (-)
Year	Installed[a] MW	Firm capability[b] MW	Projected[a] MW	Estimated for NSP MW	Total MW	MW	MW
1980	4 591	3 996	4 276	220	4 496	4 996	(-) 1 000
1981	5 387	4 694	4 752	223	4 975	5 528	(-) 834
1982	5 387	4 694	5 214	223	5 437	6 041	(-) 1 347
1983	6 297	5 505	5 698	252	5 950	6 611	(-) 1 106
1984	6 297	5 505	6 227	393	6 620	7 356	(-) 1 851
1985	6 757	5 915	6 787	400	7 187	7 986	(-) 2 071
1986	9 517	8 374	7 415	400	7 815	8 683	(-) 309

a/ The figures of installed capacities and projected peak demands are in accordance with information and documents received by the Consulting Engineers from ISA. The demand projection is based on anticipated growth rate only.

b/ The firm power generating capability is arrived at by reducing the total installed capacity by 10 per cent for maintenance shut-downs and after allowing 10 per cent of thermal capacity and 1 per cent of hydel capacity for station services.

c/ The firm generating capability required to meet the total anticipated peak demand is arrived at after allowing 10 per cent loss in the system transmission and distribution.

Appendix 12-6

TRAFFIC PATTERN OF MAJOR MATERIALS (1985)[a]
(thousand tons)

Commodity	Origin	NSP II - Consumers Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	NSP III - Consumers Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Iron ore	Zone V[b]	-	-	-	-	1 375	-	-	-	-	-	1 375	-
Pellets	Zone V[b]	-	-	-	-	980	-	-	-	-	-	308	-
	Zone III[b]	-	-	190	-	-	-	-	-	190	-	-	-
Coking coal	Zone I	-	-	-	-	945	-	-	-	-	-	945	-
Non-coking coal	Zone III	-	-	127	-	-	-	-	-	127	-	-	-
Sponge iron	Zone V	94	29	-	-	436	-	56	-	-	-	164	-
	Zone III	-	48	67	-	-	-	-	64	51	-	-	-
Rolled steel Non-flats	Zone I	334	4	17	14	-	-	522	4	17	14	-	12
	Zone II	-	79	11	-	-	-	-	79	11	-	-	-
	Zone III	30	5	20	-	10	-	30	5	20	-	10	-
	Zone V	266	40	76	110	60	48	82	38	76	110	60	34
Flats	Zone I	292	39	-	-	-	-	292	39	-	-	-	-
	Zone V	122	258	160	-	100	-	122	258	160	-	100	-
Imports	Zone V[c]	200	80	60	25	30	10	200	80	60	25	30	10

a/ Excludes PDI raw material traffic.
b/ Importing port.
c/ It is assumed that the materials would be mostly imported through Atlantic ports, and only a part may be through Pacific ports (Zone III)

Appendix 13-1

STEEL PRICES OF PDR AND SIP
(US $/ton)

		PDR[a/]	SIP[b/]
Plain bars	..	262-311	273-473
Ribbed bars	..	318-326	337-410
Wire rods	..	303-326	366-433
Light profiles	..	-	380-467
Medium profiles	..	356	-
H.R. sheets/strip	..	321-364	-

a/ Effective April 1975
b/ Effective March/May 1975

Appendix 13-2

COMPARISON OF PDR AND SIDOR PRICES
(US $/ton)

	PDR		SIDOR
	July 1974	April 1975	August 1974
1. Bars - 18 mm	219	271	330
2. Wire rods - 6 mm	263	326	377
3. Medium profiles	299	356	309-314

Appendix 14-1

REQUIREMENT OF TESTS ON GAS-BASED DIRECT REDUCTION PLANTS

The test schedule for two gas-based direct reduction processes, HyL and Midrex are given below:

HyL PROCESS

Testing agency .. Swindell-Dressler Company
441, Smithfield Street
Pittsburgh
Pennsylvania 15222, USA

A. Laboratory Test

1. Quantity of sample - 50-100 kg of lump ore/pellets
2. Duration of tests - 4-6 weeks from receipt of sample
3. Test schedule:
   a) Complete chemical analysis of pellets - Contents of Total Fe, Ferrous Fe, SiO_2, Al_2O_3, CaO, MgO, S, P, Cu etc
   b) Screen analysis of pellets
   c) Apparent bulk density of pellets
   d) Compression strength of pellets
   e) Reduction test - single particle reduction test
   f) Bag test - packed bed reduction test
4. Testing fee including preparation of report - US $ 3,000 per sample.

B. Pilot Plant Test

1. Quantity of sample - 50/100 tons of lump ore/pellets
2. Duration of tests - 5 weeks from receipt of sample
3. Testing fee including preparation of report - US $ 31,000

Test should be carried out by using natural gas equivalent to gas available in Colombia.

MIDREX PROCESS

Testing agency .. Korf Engineering Corpn
D 757 Badan-Badan
Ludwig-Welhelm-Strasse 15
W. Germany

Appendix 14-1 (continued)

A. Laboratory Test

1. Quantity of sample - 50 kg of pellets
2. Duration of tests - 6-8 weeks from receipt of sample
3. Test schedule:
   a) Complete chemical analysis of pellets - Contents of Total Fe, Ferrous Fe, SiO_2, Al_2O_3, CaO, MgO, S, P
   b) Screen analysis
   c) Apparent bulk density
   d) Compression strength
   e) ASTM tumble index
   f) Thermal degration
   g) Reduction tests - Midrex-Linder test
      Laboratory metallisation test (static) - chemical analysis (Fet, Fem, C, P and S), screen analysis - 6 mesh, compression strength of pellets, bulk density, ASTM tumble index - 6 mesh, clustering characteristics.
   h) Basket test - Analysis of product for Fet, Fem and C
4. Testing fee including preparation of report - US $ 2,000 per sample.

B. Pilot Plant Test

1. Quantity of sample - 7,000 tons of pellets
2. Duration of tests - 8-10 weeks after receipt of sample
3. Testing fees - To be negotiated.

Appendix 14-2

REQUIREMENTS OF TESTS ON COAL BASED DIRECT REDUCTION PROCESS (ROTARY KILN)

1. **Testing Agencies:**

Lurgi Gessellschaft fur Chemie
und Huttenwessen mbH
6 Frankfurt Main
Gervinustrasse 17/19
West Germany.

Krupp Industrie und Stahalbau
43 Essen
West Germany

A. Laboratory Tests

a) Quantity of samples:

Iron ore/pellet	..	100 kg each if sized, or 250 kg of + 25 mm
Coal	..	250 kg of each run-of-mine.

b) Duration of tests .. 3 to 4 weeks from receipt of samples.

c) Test Schedule:

i) Complete chemical analysis of iron ore/pellet - Total Fe, Ferrous Fe, SiO_2, Al_2O_3, CaO, MgO, S, P and Cu.

ii) Proximate and ultimate analyses of coal on dry and wet basis - ash (775°C), fixed carbon, volatile matter, moisture, sulphur and hydrogen.

iii) Swelling index of coal.

iv) Caking index.

v) Gross and net calorific values.

vi) Softening, melting and flow points of coal ash in reducing atmosphere.

vii) Reactivity of coal.

Appendix 14-2 (continued)

viii) Screen analysis of ore/pellet and coal.

ix) Compression strength of pellet.

x) Reducibility of ore/pellet.

xi) Sizing characteristics of ore and coal. Determination of minus 6 mm fraction in sizing the ore to 6 to 15/20 mm, and minus 3 mm fraction of coal in sizing to 3 to 10 mm.

xii) Reduction tests with varying combinations of ore and coal at 1050°C and 1100°C with varying retention periods (say 30 minutes and 60 minutes) to be carried out in laboratory type rotary tubes.

xiii) Analysis of sponge iron produced - total iron, metallic iron, carbon content and sulphur content.

xiv) Screen analysis of the sponge iron to determine the minus 1 mm fraction produced.

xv) Short rotary furnace tests to study the reduction at varying temperatures (1050°C to 1100°C) and varying retention times with ore and coal in the ratio of fixed carbon to Fe content at 0.5. Analysis of sponge iron - total Fe, Metallic Fe, Sulphur and carbon for different size fractions, +15, 6 to 15, 1 to 6 and minus 1 mm; screen analysis of the ore, sponge iron, feed coal and non-magnetic portion. Quantity and chemical analysis of non-magnetic portions.

d) Test fee including preparation of report:

US Dollars 7,000 for one sample of ore/pellet and one sample of coal.

B. Pilot Plant Tests

a) Quantity of sample .. To be determined on the basis of the results of the laboratory tests, but generally about 200 tons of each type of ore and about 100 tons of each type of coal.

Appendix 14-2 (continued)

b) Duration of tests .. To be negotiated.

c) Test schedule:

i) Chemical and screen analysis of samples similar to those undertaken for laboratory tests.

ii) Pilot kiln tests utilising varying proportions of ore, coal and desulphurising agent; varying maximum temperatures; varying kiln speeds; varying the amount of coal feed with the ore and through the discharge end; etc to determine the optimum conditions.

iii) For each test series, the ore throughput rate, the iron recovery, carbon ratios at feed end and discharge end, carbon consumption, heat consumption, screen analysis and chemical analysis of sponge iron, quantity and analysis of recoverable char, determination of recyclable char etc.

d) Test fee including preparation of report .. To be negotiated depending on the quantity of ore to be tested.

Appendix 14-3

REQUIREMENTS OF LABORATORY TESTS ON LIMESTONE

1. Quantity of sample required .. 150 kg

2. Duration of tests .. 4 to 6 weeks after receipt of sample

3. Test schedule:

   a) Mineralogical studies .. Mineral constituents and texture

   b) Chemical analysis .. Contents of CaO, MgO, SiO_2, Al_2O_3, Fe_2O_3, P, S, and loss on ignition.

   c) Screen analysis
   d) Apparent bulk density
   e) Compression strength
   f) Shatter index
   g) Calcination characteristics:

      i) Calcination test at isothermal temperatures of 930°C, 1000°C and 1050°C.
      ii) Calcination test at constant rate of heating upto 1050°C and then at 1050°C

   h) Characteristics of burnt lime:

      i) Chemical analysis
      ii) Screen analysis
      iii) Reactivity tests

4. Approximate test fee .. US $ 1,000 per sample.

B - 563

81.08.28